

# Pedestrian Analysis

## Technical Report

City of Melbourne

February 2014





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## TABLE OF CONTENTS

<b>GLOSSARY</b>	<b>1</b>
<b>EXECUTIVE SUMMARY</b>	<b>2</b>
Stage 1	2
Stage 2	4
<b>1 INTRODUCTION</b>	<b>6</b>
<b>2 METHOD</b>	<b>8</b>
2.1 Travel time matrix	8
Travel zones	8
Network	10
Origin and destination connection	12
2.2 Effective job density	15
2.3 Relationship between economic activity and walk effective job density	22
2.4 Scenarios	25
<b>3 NETWORK EXPANSION STUDY</b>	<b>30</b>
3.1 Method	30
Expansion of the pedestrian network	30
Effective job density	45
3.2 Analysis	45
Accessibility to all land	45
Access to parkland	48
Access to employment land	49
Impact of the E-Gate development	55
<b>4 AREAS FOR FURTHER RESEARCH</b>	<b>58</b>
<b>5 REFERENCES</b>	<b>59</b>
<b>APPENDIX</b>	<b>60</b>

## LIST OF FIGURES

FIGURE 1.	IMPACT ON GROSS VALUE ADDED (\$MILLION 2009-10)	4
FIGURE 2.	SHARE OF COM EMPLOYMENT IN CBD (SELECTED INDUSTRIES)	7
FIGURE 3.	TRAVEL ZONES	9
FIGURE 4.	TRAVEL TIME MATRIX CONCEPT	10
FIGURE 5.	NETWORK DESIGN	11
FIGURE 6.	NETWORK CONNECTION	12
FIGURE 7.	PEDESTRIAN TRIP	13
FIGURE 8.	TRAVEL TIME FROM SELECTED PROPERTY	14
FIGURE 9.	EFFECTIVE JOB DENSITY – WALKING	16
FIGURE 10.	EMPLOYMENT, DISTRIBUTION AND DENSITY	18
FIGURE 11.	WALKING CONNECTIVITY, EFFECTIVE JOB DENSITY	18
FIGURE 12.	EFFECTIVE JOB DENSITY	19
FIGURE 13.	SNAMUTS MEASURE	20
FIGURE 14.	COMBINED EJD-SNAMUTS MEASURE	21
FIGURE 15.	CBD GRID BUILDING LABOUR PRODUCTIVITY	23
FIGURE 16.	WALK EFFECTIVE JOB DENSITY AND LABOUR PRODUCTIVITY	24
FIGURE 17.	CITY OF MELBOURNE EMPLOYMENT GROWTH 1996-2011, EJD DECILE	25
FIGURE 18.	KING STREET EJD INDEX COMPARED TO BASE CASE EJD INDEX	26
FIGURE 19.	HIGH CONNECTIVITY SCENARIO	27
FIGURE 20.	BEST CONNECTION EJD INDEX COMPARED TO BASE CASE EJD INDEX	27
FIGURE 21.	NO LANES EJD INDEX COMPARED TO BASE CASE EJD INDEX	28
FIGURE 22.	IMPACT ON GROSS VALUE ADDED (\$MILLION 2009-10)	29
FIGURE 23.	EXPANSION OF PEDESTRIAN NETWORK TO MELBOURNE LGA	31
FIGURE 24.	PEDESTRIAN BEHAVIOUR, HIGH AND LOW TRAFFIC AREAS	32
FIGURE 25.	CLUSTERS USED FOR ANALYSIS	33
FIGURE 26.	NETWORK COVERAGE	35
FIGURE 27.	NETWORK DESIGN – WEST MELBOURNE	36
FIGURE 28.	NETWORK DESIGN – SOUTH WHARF	37
FIGURE 29.	NETWORK DESIGN – CARLTON AND PARKVILLE	38
FIGURE 30.	NETWORK CENTROIDS – CARLTON AND PARKVILLE	39
FIGURE 31.	NETWORK CENTROIDS – KENSINGTON	40
FIGURE 32.	NETWORK CENTROIDS CONNECTIONS– ARDEN MACAULAY	40
FIGURE 33.	NETWORK CENTROIDS CONNECTIONS– SOUTH WHARF	41
FIGURE 34.	PEDESTRIAN TRIP – WRECKYN ST NORTH MELBOURNE TO RUSSELL ST	42
FIGURE 35.	PEDESTRIAN TRIP – COLLINS ST TO SOUTHBANK BOULEVARD	43
FIGURE 36.	TRAVEL TIME FROM SELECTED PROPERTY – CBD EXAMPLE	44
FIGURE 37.	ACCESSIBILITY TO ALL LAND (INCLUDING PARKLAND)	46
FIGURE 38.	ACCESSIBILITY TO ALL LAND (EXCLUDING PARKLAND)	47
FIGURE 39.	ACCESSIBILITY TO PARKLAND	48
FIGURE 40.	ACCESS TO EMPLOYMENT LAND	49
FIGURE 41.	EFFECTIVE JOB DENSITY (2011)	50
FIGURE 42.	EMPLOYMENT DENSITY FORECAST (2016-2031)	51
FIGURE 43.	FUTURE EFFECTIVE JOB DENSITY (2016-2031)	52
FIGURE 44.	EFFECTIVE JOB DENSITY (2031)	53
FIGURE 45.	EFFECTIVE JOB DENSITY CHANGE (2011-2031)	54
FIGURE 46.	E-GATE SITE	55
FIGURE 47.	EFFECTIVE JOB DENSITY RESULTING FROM E-GATE DEVELOPMENT	56
FIGURE 48.	CHANGE IN EJD RESULTING FROM E-GATE	57
FIGURE 49.	EFFECTIVE JOB DENSITY (2016)	60
FIGURE 50.	EFFECTIVE JOB DENSITY (2021)	61
FIGURE 51.	EFFECTIVE JOB DENSITY (2026)	62



FIGURE 52. EFFECTIVE JOB DENSITY (2031)	63
FIGURE 53. EMPLOYMENT DENSITY (2011)	64
FIGURE 54. EMPLOYMENT DENSITY (2016)	65
FIGURE 55. EMPLOYMENT DENSITY (2021)	66
FIGURE 56. EMPLOYMENT DENSITY (2026)	67
FIGURE 57. EMPLOYMENT DENSITY (2031)	68
FIGURE 58. EMPLOYMENT CHANGE (2016-2031)	69

## LIST OF TABLES

TABLE 1. TRAVEL ZONES	9
TABLE 2. NETWORK CATEGORY & WALK SPEED	10
TABLE 3. ESTIMATED GROSS VALUE ADDED PER WORKER	22
TABLE 4. ELASTICITY FROM OTHER STUDIES OF AGGLOMERATION	24
TABLE 5. IMPACT OF REDUCED WALKING CONNECTIVITY IN CBD GRID	25
TABLE 6. NETWORK CATEGORY & WALK SPEED	34

# GLOSSARY

Term	Definition
Agglomeration economies	The benefits which flow to firms from locating in areas which have access to a large number of other firms and a deep labour pool.
Centroid	A defined point within a travel zone from which all trips are assumed to start or end. Centroids are located to reflect the centre of activity in a travel zone, not necessarily the geographic centre. Centroids are connected to the network via centroid connectors, abstract links that represent general access into the formal network.
Connector	Abstract links that connect centroids to network nodes and represent general access from a TAZ to the formal transportation network
Effective job density	The level of employment relative to the time taken to gain access to that employment, adjusted by the current mode split of those workers in their travel to employment.
Employment density	Number of jobs allocated within an area (jobs/area)
Link	A primary element of a transportation network defined by a starting and an ending node and having attributes such as length, travel time and/or speed, and capacity.
Node	A point joining two or more links in a transportation network.
Pedestrian network	An interconnected set of points (nodes) and lines (links) that represent possible routes from one location to another. Commonly used for analysis of moving resources through a set of interconnected features. It includes determination of optimum paths using specified decision rules.
Travel zone	The basic geographical unit of analysis for conventional travel forecasting. All locations in a study area are contained in only one analysis zone, the number and size of which depend on the scale and scope of the modelling effort.

# EXECUTIVE SUMMARY

The people who locate in the CBD of large cities generate new ideas. These ideas are circulated throughout the CBD community through both formal and informal linkages. These ideas quickly solidify into knowledge, and from this knowledge income can be generated. Much of this transferring of ideas and knowledge takes place face-to-face. These face-to-face meetings are very often the result of a walking trip within the CBD. This is why CBDs are so important to the economic prosperity of cities and nations. The large number of people located in close proximity to each other allows ideas to be quickly generated, refined into knowledge and put to work solving complex problems. There is a strong relationship between connectivity and productivity. This relationship is referred to as agglomeration economies.

For those who work in knowledge intensive industries, creativity as a tacit knowledge form is integral to day-to-day business operations. Locations within the CBD grid which offer the chance to walk to a large range of other jobs in all directions are more sought after than locations with more limited options. Quantifying agglomeration economies is challenging. As this is an emerging area, to ensure the available data and methodologies are capable of understanding the value of walking to agglomeration economies, the analysis in this project has focused on the CBD grid of the City of Melbourne.

The term agglomeration economic is used in spatial economics to describe the benefits which flow to firms from locating in areas which have a higher density of economic activity. Macroeconomic theory would describe agglomeration as part of economies of scale and scope

## Stage 1

Using a measure known as Effective Job Density (EJD), the dynamics of agglomeration economies in the CBD grid have been examined. EJD is based on the time it takes to travel (in this case there is a focus on travel time by walking) to all other jobs in all directions from a particular location.

The analysis shows that, in terms of EJD, the densest parts of the CBD grid are located at the eastern end of Collins Street, the area surrounding Melbourne Central and QV, and between Queen Street and Elizabeth Street south of Bourke Street. The first two locations have high levels of walk connectivity – they provide a lattice of connectivity on which employment and economic activity can grow. The high EJD of the third location is related to the large number of jobs physically located there.

SNAMUTS (Spatial Network Analysis for Multimodal Urban Transport Systems) is an index that measures the accessibility of a location based on how effectively the public transport system provides access from that location to jobs and residents within metropolitan Melbourne. In this analysis, SNAMUTS was combined with walk EJD. Using this combined measure, the areas with high connectivity within the CBD grid are extended. The length of Bourke Street, Collins Street and Flinders Street are seen to have higher connectivity, as do Spring Street, Elizabeth Street and Swanston Street. This is no doubt a result of the regular tram services along these routes. Conversely, the north-west corner of the CBD grid is prominent in the analysis due to its poor walk EJD and SNAMUTS score.

Highlighting the importance of walking to the CBD economy, if the walking connectivity within the CBD grid was reduced by 10 per cent, the value of the economy of the CBD grid would be reduced by \$2.1 billion. This represents a 6.6 per cent reduction in the value of the economy. In simple terms, if the time taken for every walking trip in the CBD grid was increased by 10 per cent (via changes to light phasing or walk speeds were reduced due to congestion etc) then firms would be less inclined to interact with each other. This reduced interaction would lead to less business activity which leads to a reduced income for Melbourne.

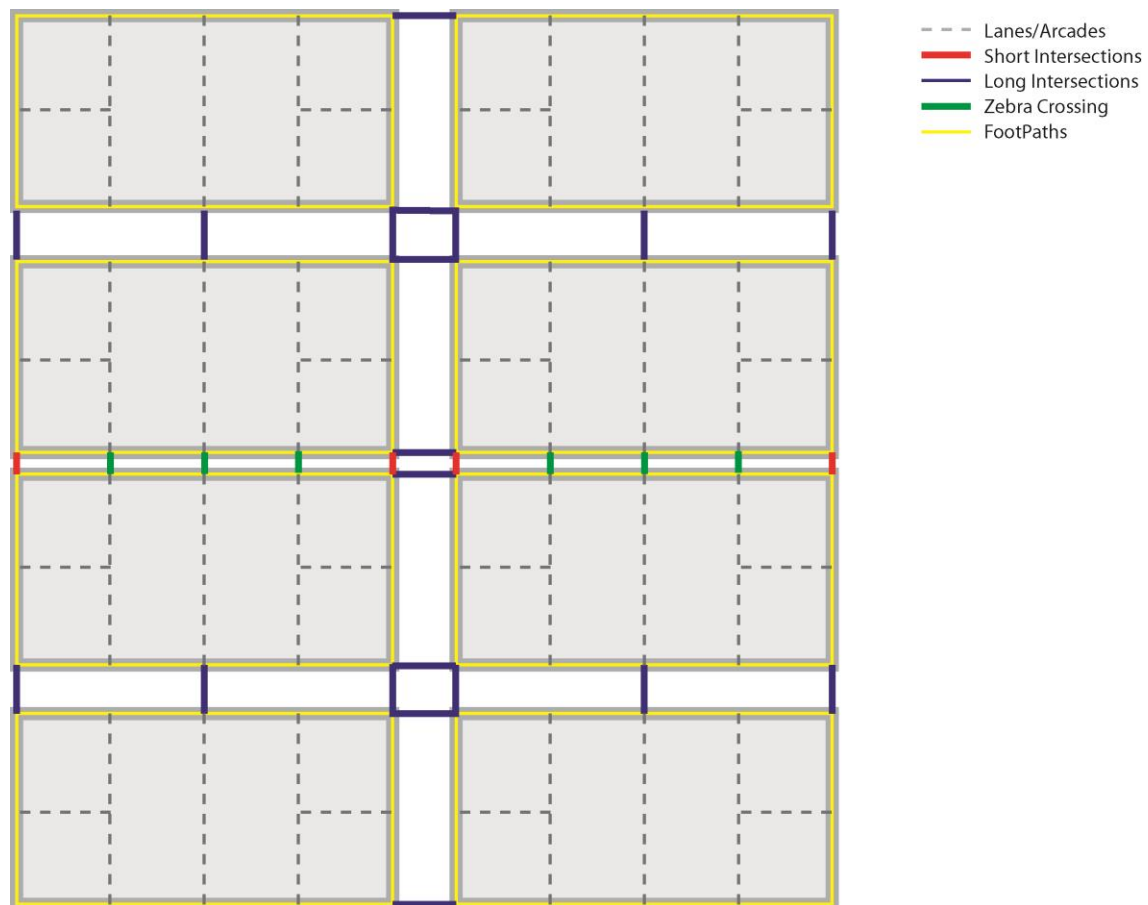
These estimates should be treated as upper estimates, as businesses could maintain their connectivity in the face of reduced walkability by switching to other transport modes (trams, taxis, bus, train, etc.), albeit these alternatives would impose additional costs on businesses. The estimates do provide an indication of the scale of the value of walking to the economy.

Three specific scenarios have been developed to further demonstrate the value of walking to the economy of the City of Melbourne. These can be described as:

- Improving connectivity across **King Street**, reducing delay for pedestrians.
- A **high level of connectivity** for each block (see figure below).
- The value of **existing through block links** within the CBD grid.

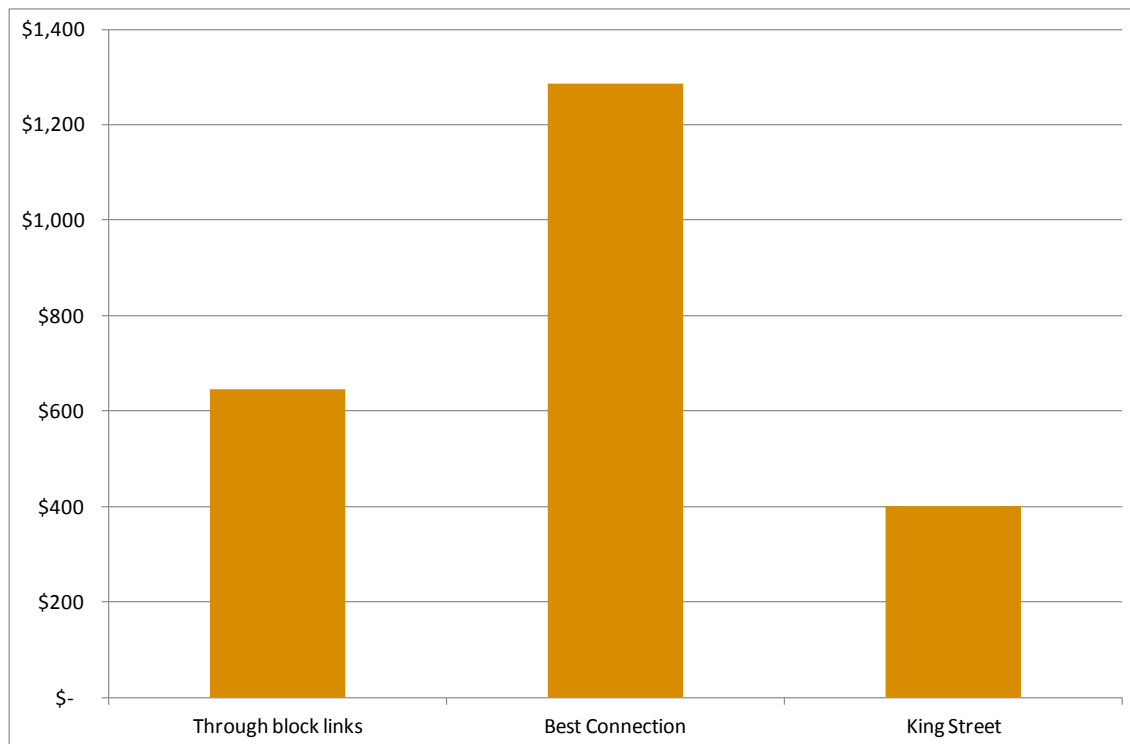
The figure below illustrates the high connectivity scenario, where blocks are connected via long and short intersections as well as cross-road mid-block connections and lanes/ arcades.

#### HIGH CONNECTIVITY SCENARIO



The value to the economy of each of these scenarios is presented below. Improving connectivity across King Street would add \$400 million to the economy. This is an annual benefit which would accrue each year into the future. Through way connections are worth over \$600 million to the economy. The best connection scenarios has been valued at almost \$1.3 billion.

**FIGURE 1. IMPACT ON GROSS VALUE ADDED (\$MILLION 2009-10)**



## Stage 2

As metropolitan areas grow, those with a monocentric economic structure, such as Melbourne which sees key economic activity centred in one location, tend to see CBD activity extend into nearby suburbs and locales, as emerging firms take advantage of lower rents on the CBD fringe. These areas provide some of the benefits of a CBD location with lower cost. Over time, these inner locales can develop into industry clusters as they concentrate around existing businesses and facilities, thus expanding the area where agglomeration economies are achieved in Melbourne.

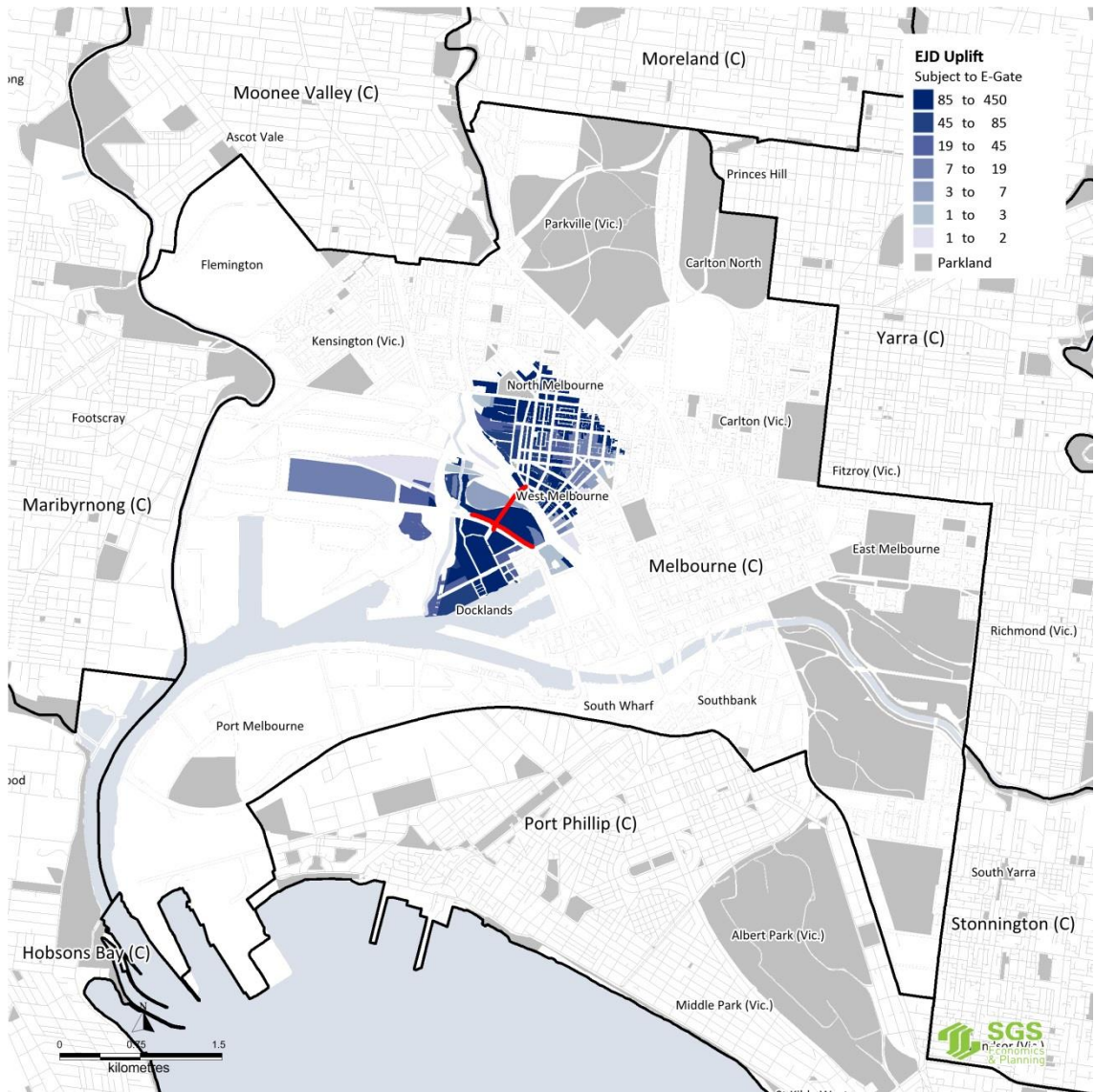
Following the work undertaken in Stage 1 – on the value of pedestrian accessibility to agglomeration economies for Melbourne's CBD grid - Stage 2 extended the analysis to gain an understanding of pedestrian accessibility and productivity in the City of Melbourne local government area. Stage 2 considered accessibility to jobs as well as the impact of development of E-Gate.

Stage 2 adopted the same methodology as Stage 1 for determining walking travel time and EJD, only this was calculated for the whole municipality.

The figure below illustrates the expected uplift in EJD as a result of improved pedestrian connections (including two additional pedestrian connections) as part of the E-Gate development.



CHANGE IN EJD RESULTING FROM E-GATE



# 1 INTRODUCTION

In the global age, the Central Business District (CBD) of cities are vital to the economic prosperity of nations. This is due to knowledge-related activities, including creativity as a tacit knowledge form<sup>1</sup>, becoming central to creating employment and wealth, sustaining economic growth and place-making (Howells, 2002). There is fierce competition for direct investment, skilled labour, tourist dollars and prestige between global cities. The quality of the urban environment is an important part of a city's offer, playing a role in attracting and retaining people and businesses.

The ease of movement on foot within the CBD contributes to the economic prosperity of the City of Melbourne. The ability of pedestrians to comfortably and safely walk from one location to another allows business opportunities to be seized. This may involve customers travelling to cafes, restaurants or retail stores, or to business meetings or to work which, in turn, generate economic value.

With Melbourne's diverse cultural, recreational and green space offer, a walk may simply provide a high degree of amenity for residents and visitors. That is, the appeal of the urban environment may see people walking to their destination, even if it is quicker to travel by tram, train or car.

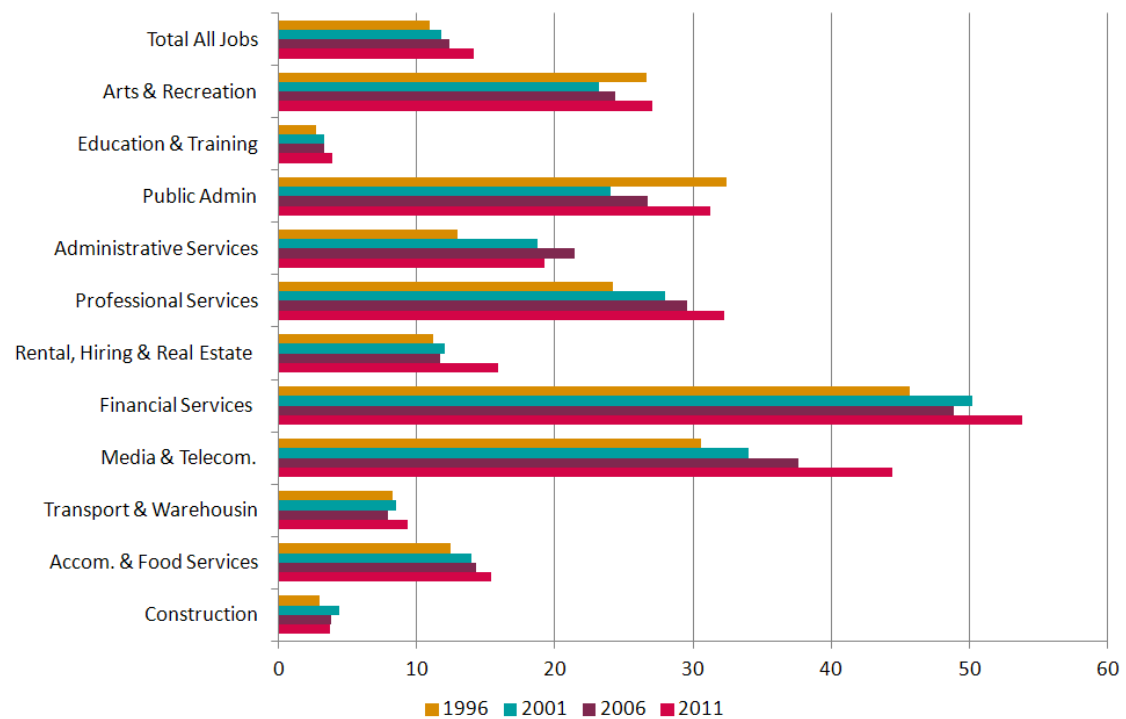
The density of the Melbourne CBD means that walking is of far more importance to the economy than other parts of the metropolis. This is due as much to the economic structure of the city as it is the urban form.

The City of Melbourne is the acknowledged heartland of Victoria's knowledge economy (Rawnsley & Spiller 2010). Knowledge jobs crave high levels of connectivity (as they require complex interactions with suppliers, customers and their labour force) which provides them with higher levels of productivity. Figure 2 shows the high percentage of knowledge intensive industry (Financial, Professional, Media) jobs within the CBD, which have been increasing over time. The relationship between connectivity and productivity, termed 'agglomeration economies', is critical in Melbourne's CBD and in CBDs around the world. It has been observed in cities since the mid-1880s and continues to be a driving force in shaping cities (Marshall, 1920).

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<sup>1</sup> Tacit knowledge, (unlike explicit knowledge), is the kind of knowledge that is difficult to transfer between people by writing it down or verbalizing it.

**FIGURE 2. SHARE OF COM EMPLOYMENT IN CBD<sup>2</sup> (SELECTED INDUSTRIES)**



Source: SGS estimates based on ABS Census Place of Work

This project investigates the feasibility of measuring the economic value of walking to agglomeration economies in the City of Melbourne. As this is an emerging area, to ensure the available data and methodologies are capable of understanding the value of walking to agglomeration economies, the analysis in this project has focused on the CBD grid of the City of Melbourne.

This technical report is one of the outputs of the project. The other key outputs are:

- a walk network for the CBD
- a travel time matrix for the CBD, and
- a series of maps.

<sup>2</sup> As defined by the CBD grid, Southbank and Docklands.

## 2 METHOD

This section briefly outlines the method employed in each step of the analysis. The method is consistent with the method which has been used to assess the economic impact of a range of transport and land use projects. Examples of Melbourne projects include the Melbourne Metro, East West Link, Rowville Rail Link, Arden-Macaulay Metro Station, and a range of tram and train service improvements. The method is detailed in full in the Council of Australian Governments Reform Council report *Productivity and Agglomeration Benefits in Australian Capital Cities*<sup>3</sup>.

### 2.1 Travel time matrix

Firstly, a travel time matrix was produced, involving three key tasks:

- defining the geographies to be used in the model
- designing a network to connect pedestrian trips, and
- connecting the network to the travel zones.

These tasks are described in more detail in the following section.

#### Travel zones

The project covers two areas, those within the study area (CBD grid) and those outside the study area (the surrounding area). The area outside of the CBD grid is used to provide an indication of the proximity of employment on the fringe of the CBD grid. For example, the corner of Swanston Street and Latrobe Street has a high degree of proximity to the jobs located at Melbourne University. To cover the data requirements of this step, three data sources were employed to develop travel zones for this analysis:

- **Property Boundaries** for the study area
- **CLUE Blocks** for areas located outside the study area, but within the City of Melbourne (for example Southbank and Docklands), and
- **Australian Bureau of Statistics (ABS) Statistical Area 1 (SA1)** for areas located within a 30 minute walk of the study area but outside the City of Melbourne (for example Fitzroy and South Melbourne).

As shown in Table 1, there are a total of 1,805 travel zones included in the analysis. A graphic representation of the different zones is displayed in Figure 3. The conceptual interaction between the various travel zones is presented in Figure 4.

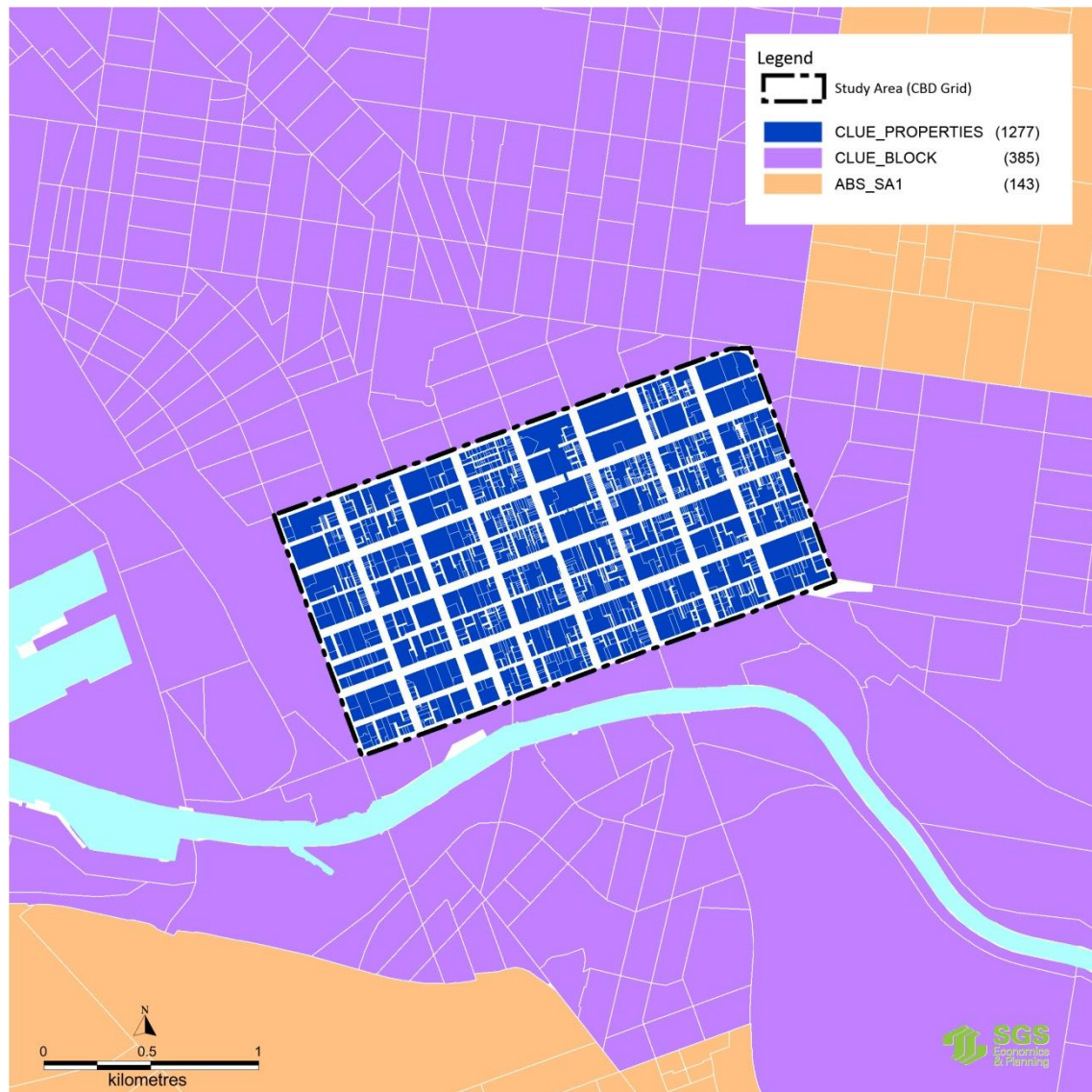
<sup>3</sup> SGS Economics and Planning, 2012, *Productivity and Agglomeration Benefits in Australian Capital Cities*

**TABLE 1. TRAVEL ZONES**

Geography	Zones	
<b>Inside study area</b>	Properties	1,277
	CLUE blocks	385
<b>Outside study area</b>	ABS-SA1	143
<b>Total</b>		<b>1,805</b>

Source: SGS Economics & Planning

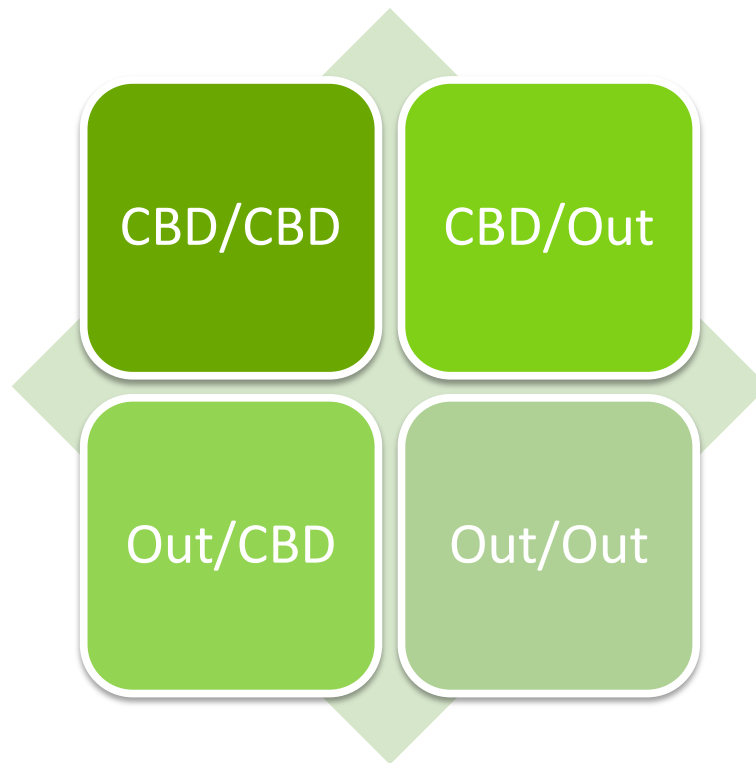
**FIGURE 3. TRAVEL ZONES**



Source: SGS Economics & Planning



**FIGURE 4. TRAVEL TIME MATRIX CONCEPT**



Source: SGS Economics & Planning

## Network

Connectivity between travel zones is based on a pedestrian network created for this project. The network was disaggregated into categories and assigned an average walk speed (Table 2). An example of this network is presented in Figure 5.

**TABLE 2. NETWORK CATEGORY AND WALK SPEED**

Type	Speed (Km/h)
Footpath	4
Lane	4
Arcade	4
Outer Areas Footpath	4
Crossings	
Main road intersections	2
'Little' street intersections	3
Zebra crossings	3
Access to tram stops	3
King Street intersections	1
Swanston Street intersections	3

Source: SGS Economics & Planning

These speeds were used as they best represent real world travel speeds when considering traffic light phasing and other delays in walking around the CBD grid.

FIGURE 5. NETWORK DESIGN



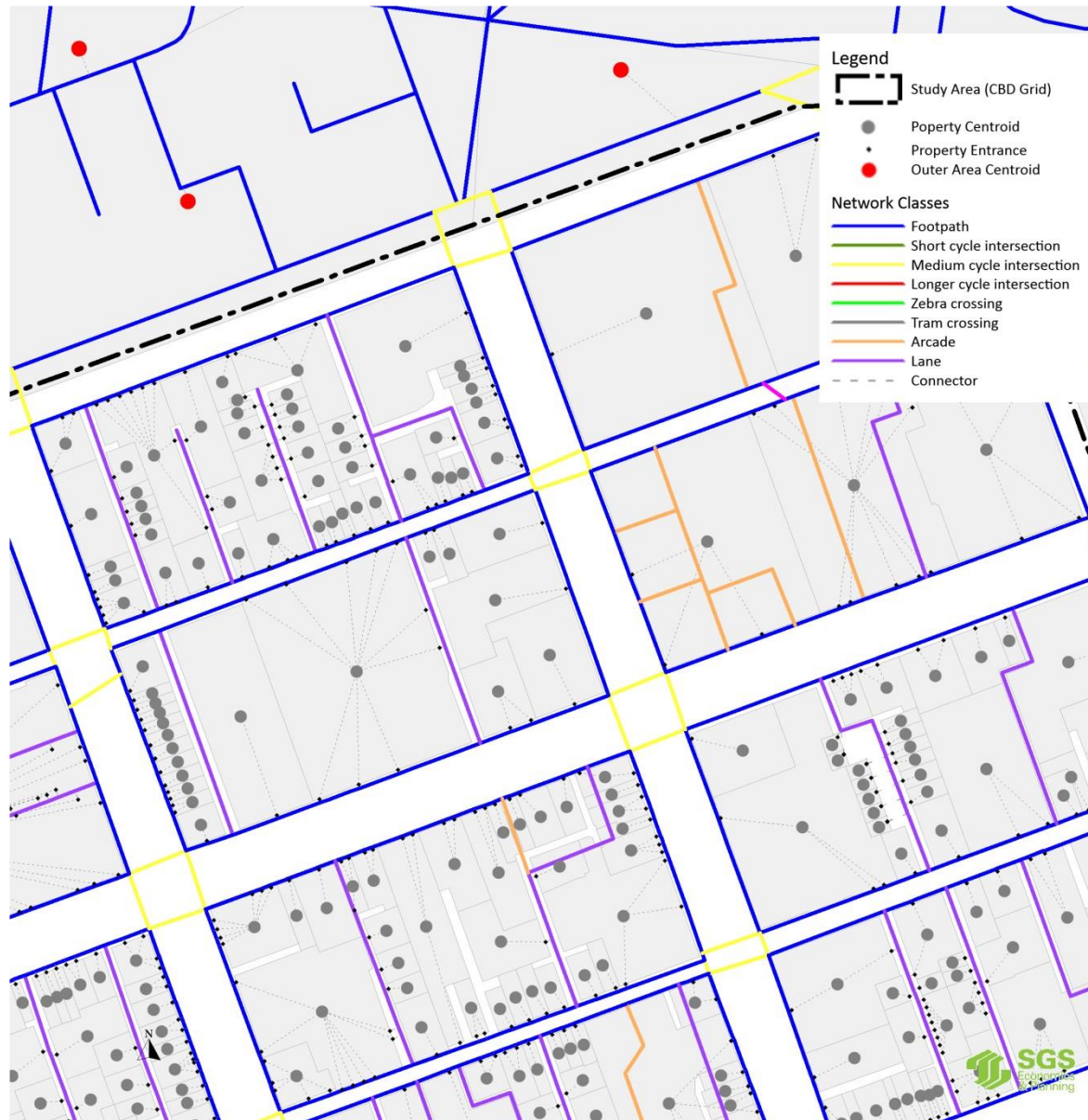
Source: SGS Economics & Planning

## Origin and destination connection

To improve the accuracy of the analysis, additional detail was given to the network through the creation of a unique centroid layer. Within the study area, centroids were connected to property entrances allowing the analysis to best represent the real world movements of pedestrians.

The travel zones outside of the study area were connected to the network at the centroid of the travel zone. That is, it was assumed that walking to the centre of the travel zone would provide access to all the jobs in that travel zone. This provides a rough reflection of the real world movements of pedestrians.

**FIGURE 6. NETWORK CONNECTION**



Source: SGS Economics & Planning



Connecting the network and centroids made it possible for a pedestrian trip from any property within the CBD to any other property within the network to be modelled. This enabled the distance and travel time to be determined (see Figure 7).

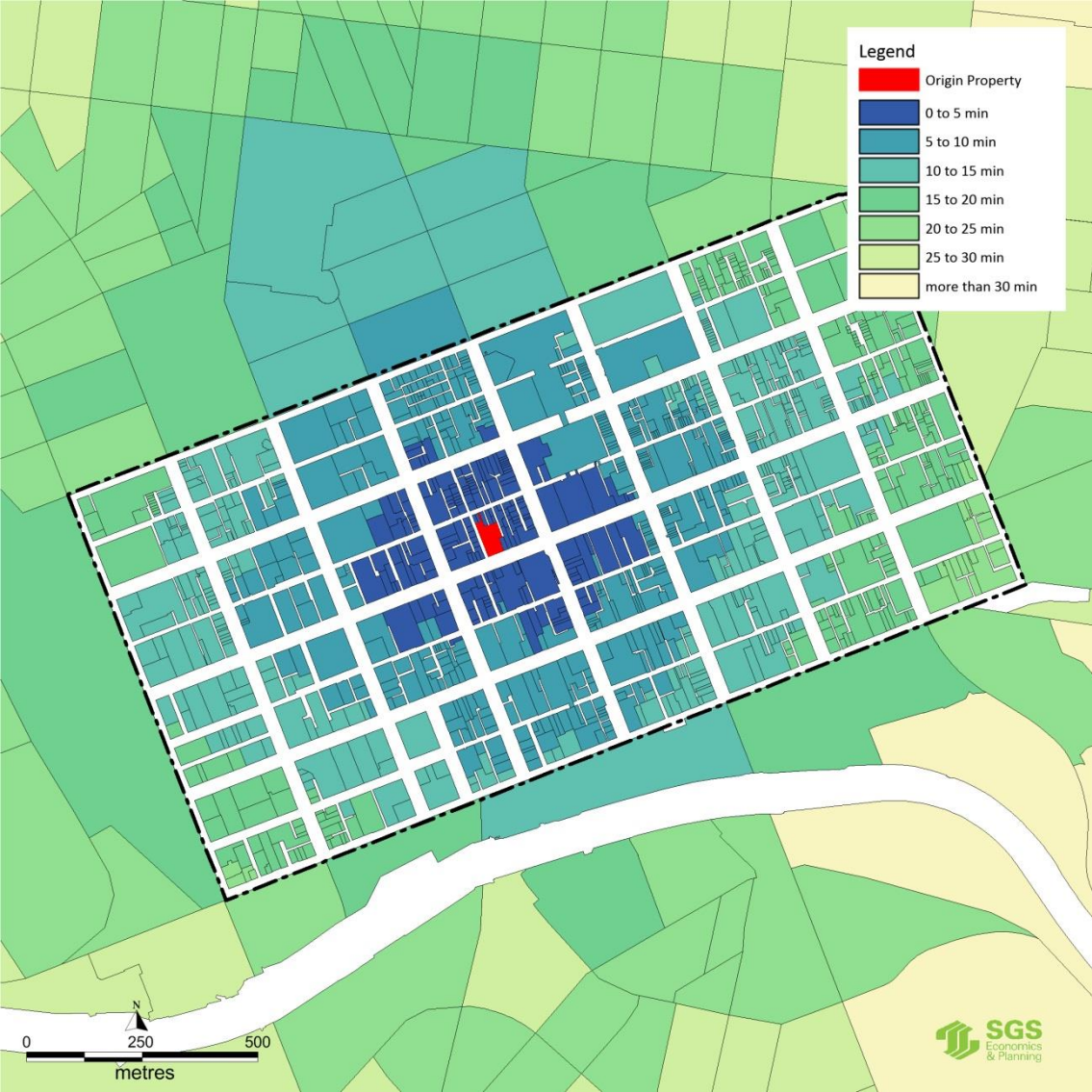
**FIGURE 7. PEDESTRIAN TRIP**



Source: SGS Economics & Planning

This process was used to generate a travel time matrix to relate every property of the CBD grid to all other travel zones identified within the analysis. Figure 8 provides an example of the type of analysis which can be undertaken using the travel time matrix.

**FIGURE 8. TRAVEL TIME FROM SELECTED PROPERTY**



Source: SGS Economics & Planning



## 2.2 Effective job density

EJD is a measure of connectivity of a location and can be used to understand the strength of agglomeration economies in a particular location. The term agglomeration is used in spatial economics to describe the benefits which flow to firms from locating in areas which have a higher density of economic activity.

The travel time matrix above was combined with travel zone industry employment data to estimate a walk EJD value for each travel zone in the CBD grid using the formula below. Travel zones are defined as:

- CLUE Buildings (within the CBD grid)
- CLUE Blocks (for the rest of the City of Melbourne), and
- Australian Bureau of Statistics Statistical Area Level 1 (SA1) for areas outside of the City of Melbourne.

$$EJD_i = \sum_j \left( \frac{Employment_j}{Walk\ Travel\ Time_{ij}} \right)$$

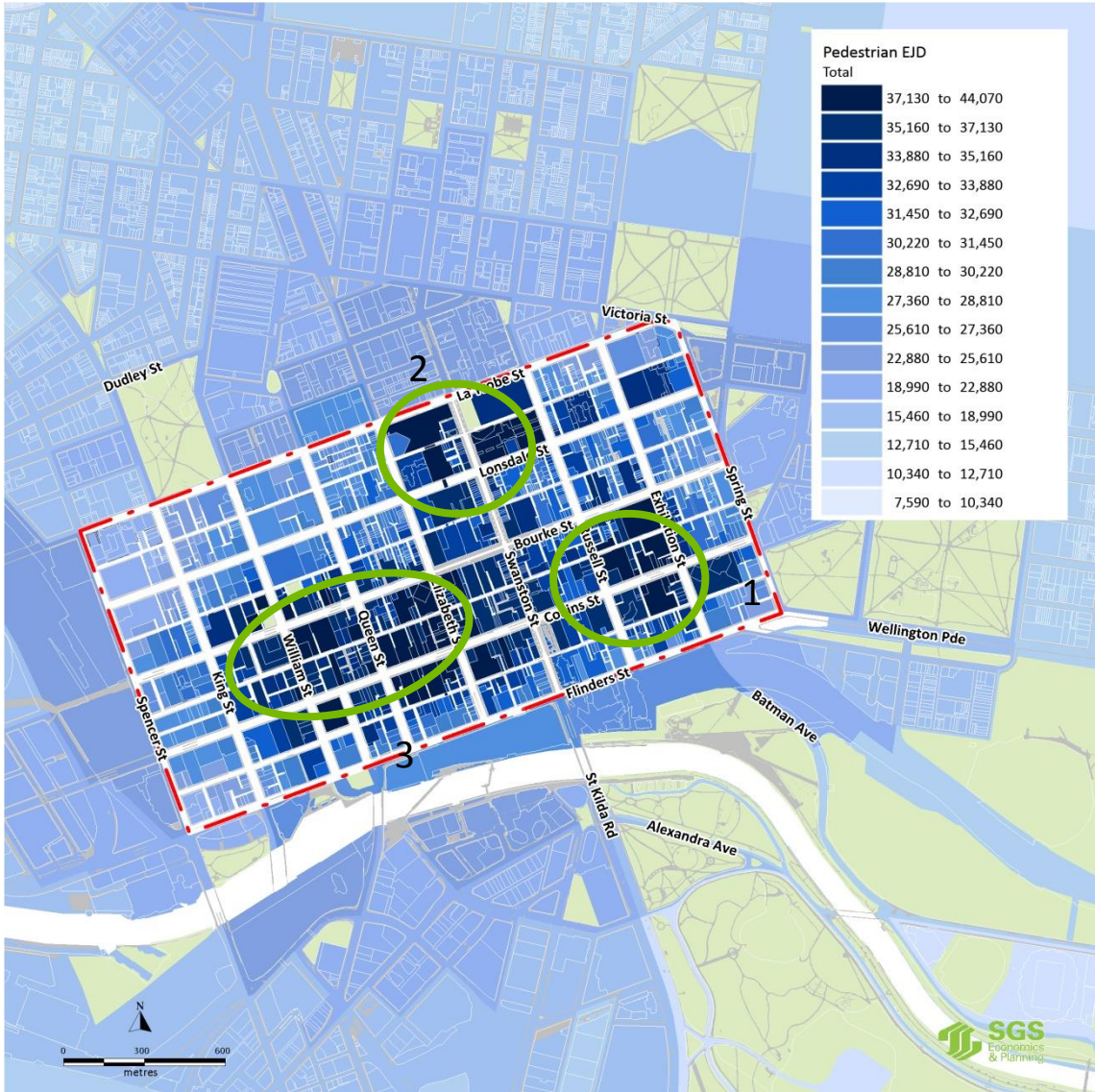
That is, the effective job density ( $EJD_i$ ) for a particular travel zone ( $i$ ) is a cumulative measure of the accessibility to all other jobs, determined by the sum of the number of jobs in each other travel zone scaled by travel time.

The number of jobs in each travel zone (denoted above as  $Employment_i$ ) is the total number of jobs across all industries (including professional services, retail and so on).

Figure 9 presents the EJD for the CBD grid. The most dense areas within the CBD grid are located:

- at the eastern end of Collins Street (1)
- surrounding the Melbourne Central and QV (2), and
- south of Bourke Street between William Street and Elizabeth Street (3).

FIGURE 9. EFFECTIVE JOB DENSITY – WALKING



Source: SGS Economics & Planning

There are two drivers behind walk EJD – the physical clustering of jobs and the ease of walking between jobs (i.e. connectivity). Figure 10 shows the employment density for a location using this formula:

$$\text{Employment Density}_i = \left( \frac{\text{Employment}_i}{\text{Land Area}_i} \right)$$

This represents a more traditional employment density (i.e. jobs per hectare). However, does not consider if there are many/few jobs within close proximity of the particular location. Land area is equal to lot area.

Presented in Figure 11 is the walk connectivity for a location using this formula:

$$\text{Walking Connectivity}_i = \sum_j \left( \frac{\text{Land Area}_j}{\text{Walk Travel Time}_{ij}} \right)$$

This effectively weights all of the land around a particular location by the time taken to walk to it each piece of land. The result is an index of connectivity and the specific value does not have a meaningful interpretation. A higher score represents improved walking connectivity and a lower score represents relatively poorer walking connectivity.

Figure 10 illustrates the distribution of jobs and job density, that is, the number of jobs per hectare. Figure 11 illustrates the EJD, or the floor area that can be reached within a 30 minute walk scaled by the distance to each land parcel. Together, the two maps show that the high employment density exhibited in the south western segment of the grid is a reflection of the large number of jobs that are clustered in that precinct (Figure 10); however, walking between jobs in this area of the CBD is relatively more difficult when compared to the eastern end of the CBD, where high EJD is predominately driven by high walk accessibility (Figure 11).



FIGURE 10.EMPLOYMENT, DISTRIBUTION AND DENSITY

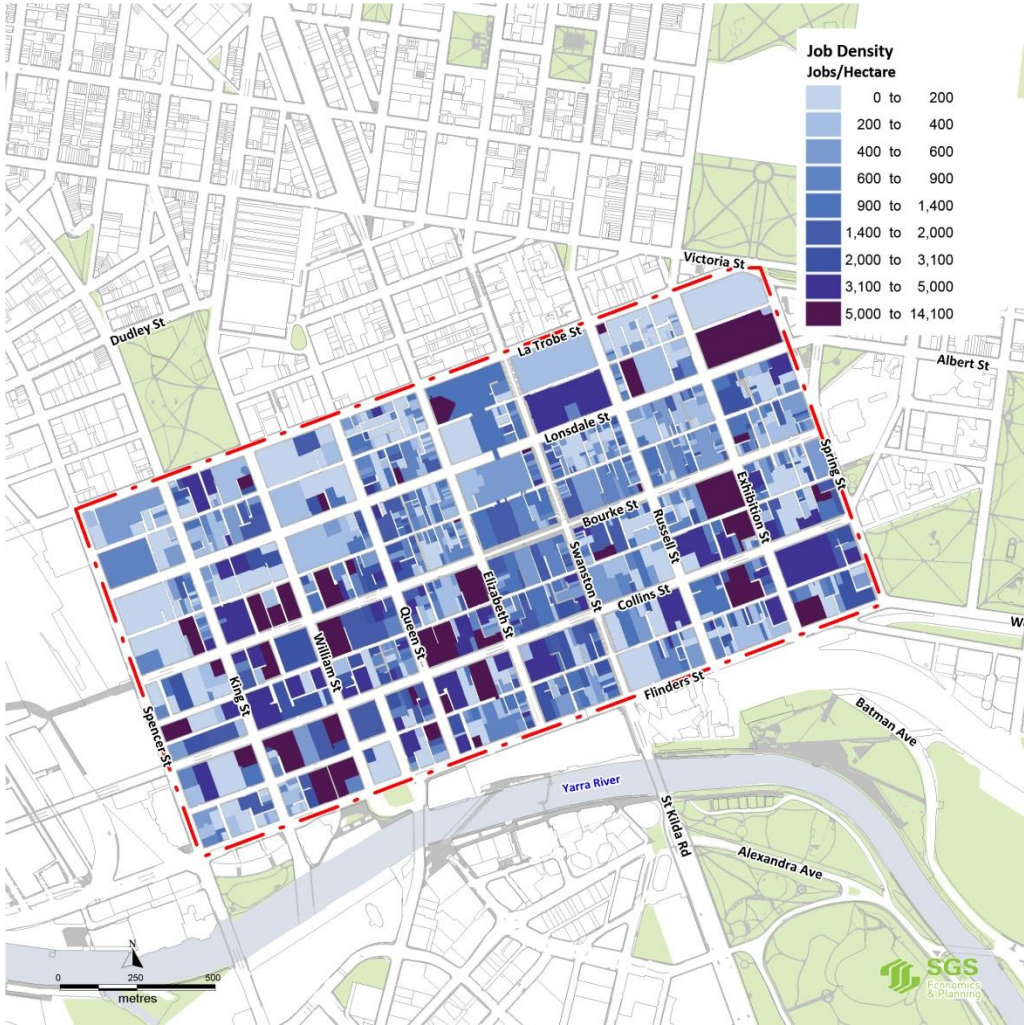


FIGURE 11.WALKING CONNECTIVITY, EFFECTIVE JOB DENSITY

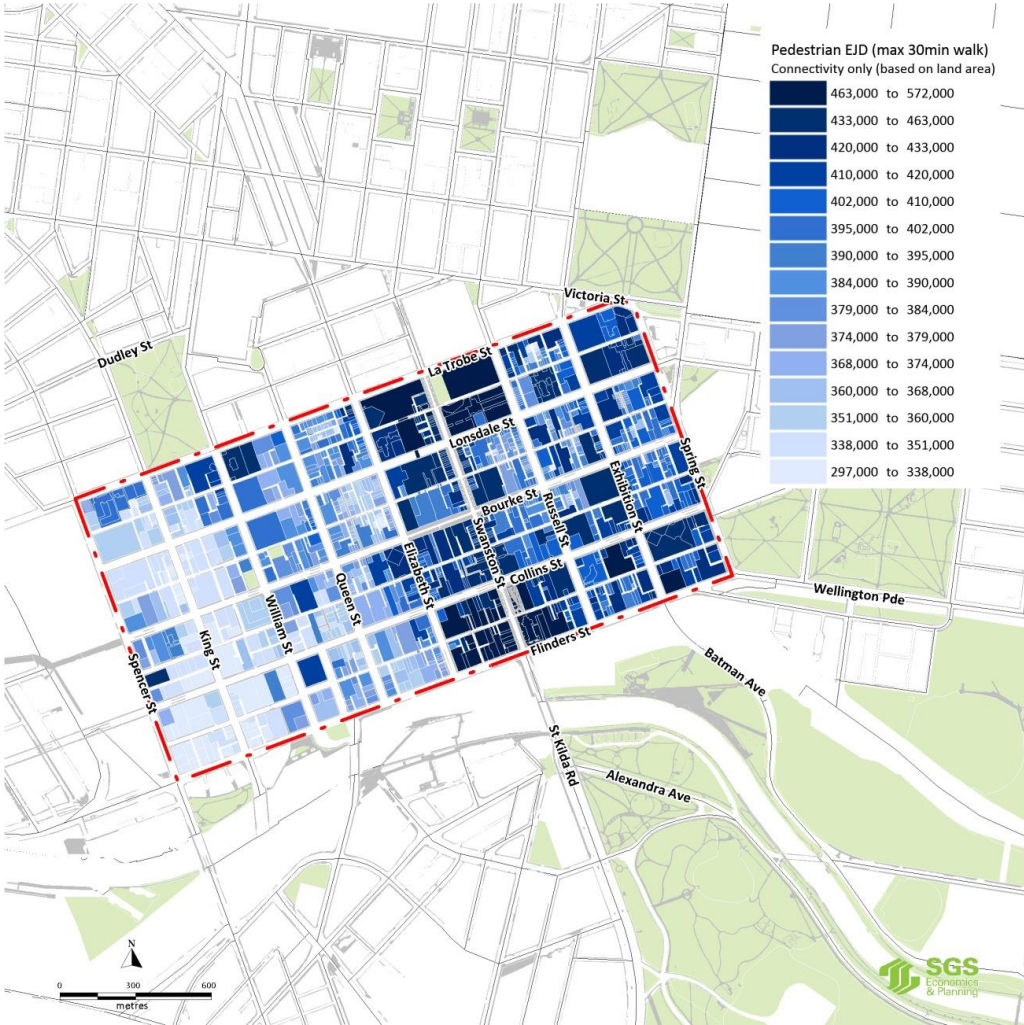
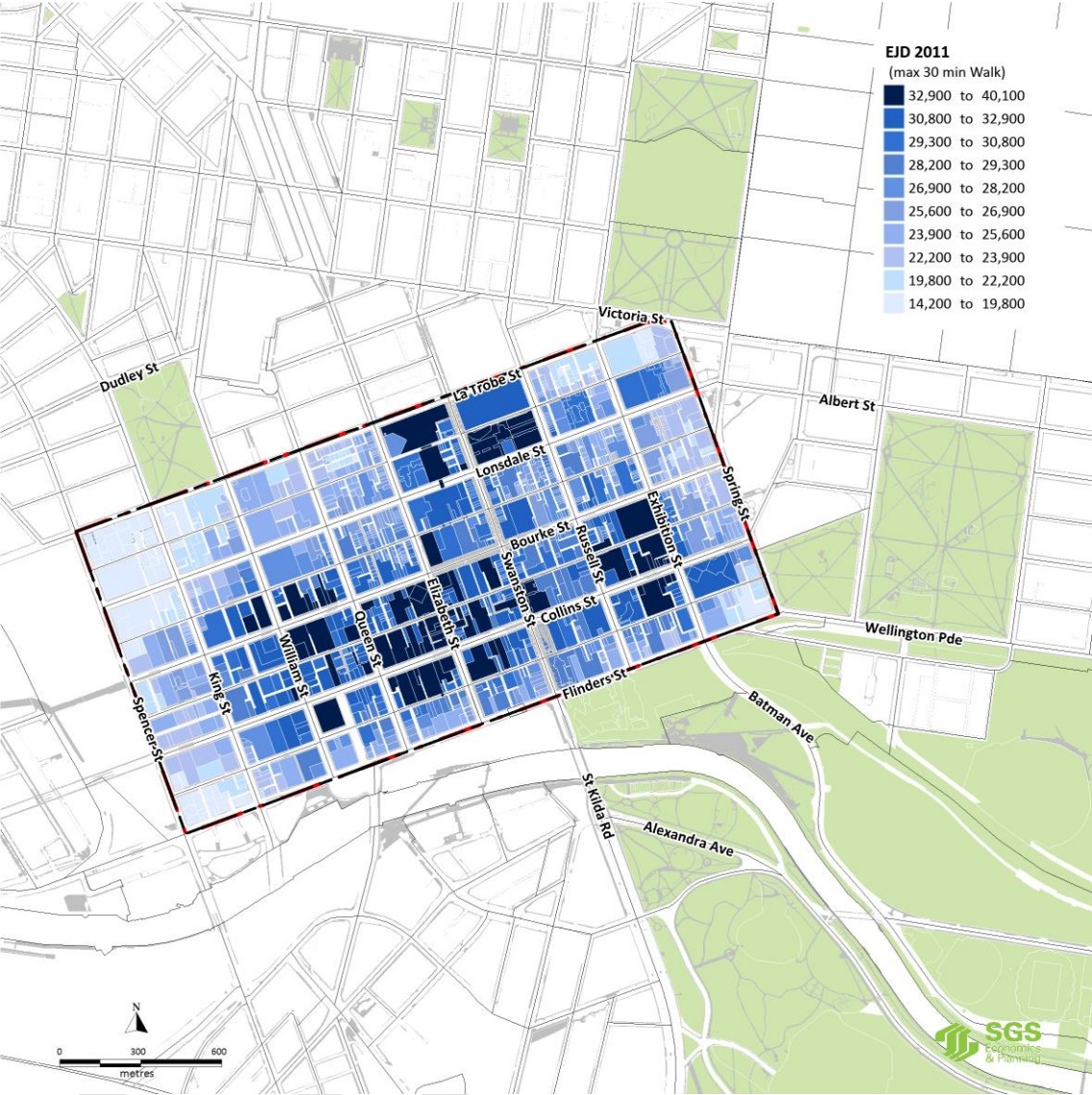


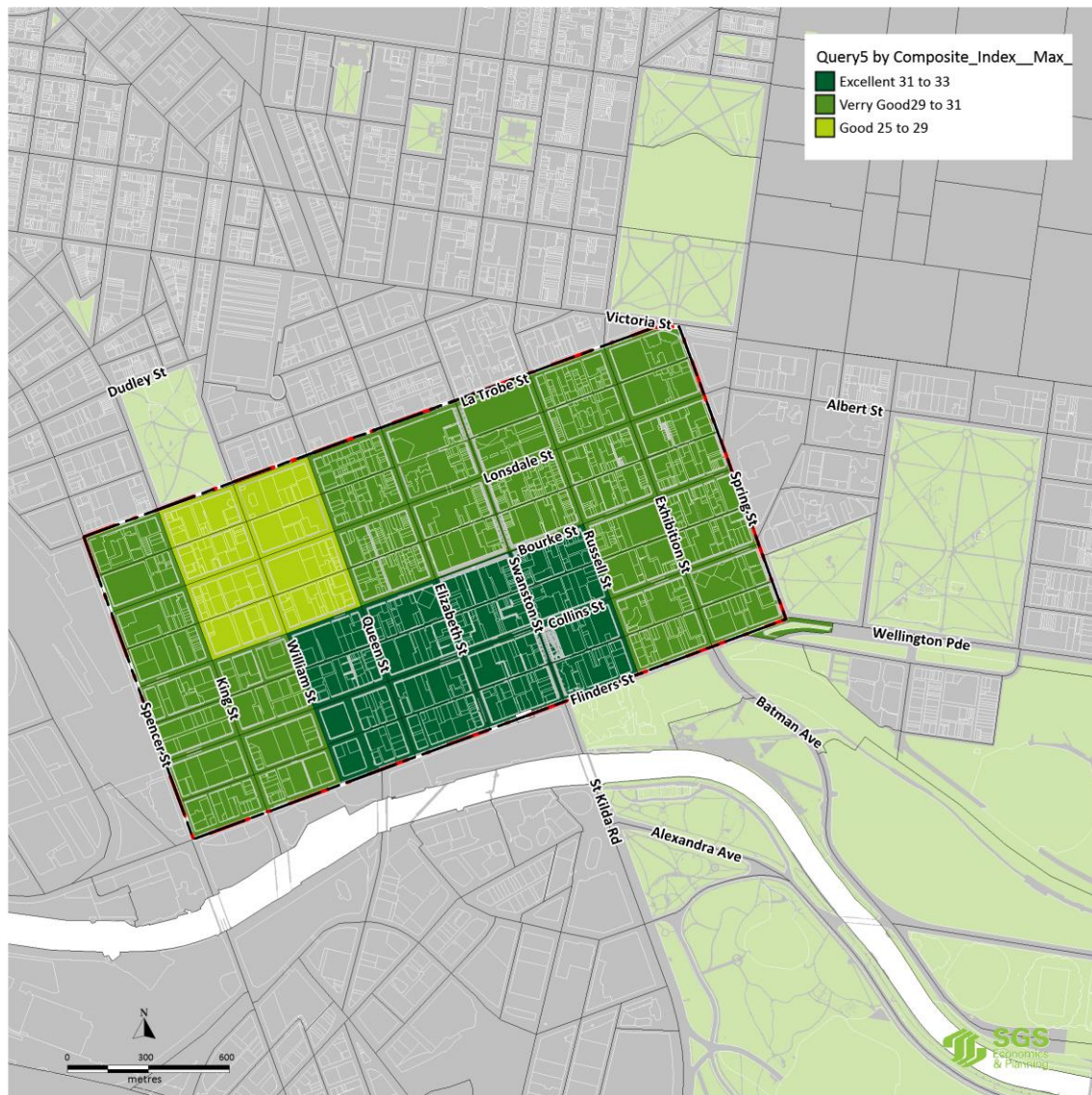


FIGURE 12.EFFECTIVE JOB DENSITY





**FIGURE 13. SNAMUTS MEASURE**



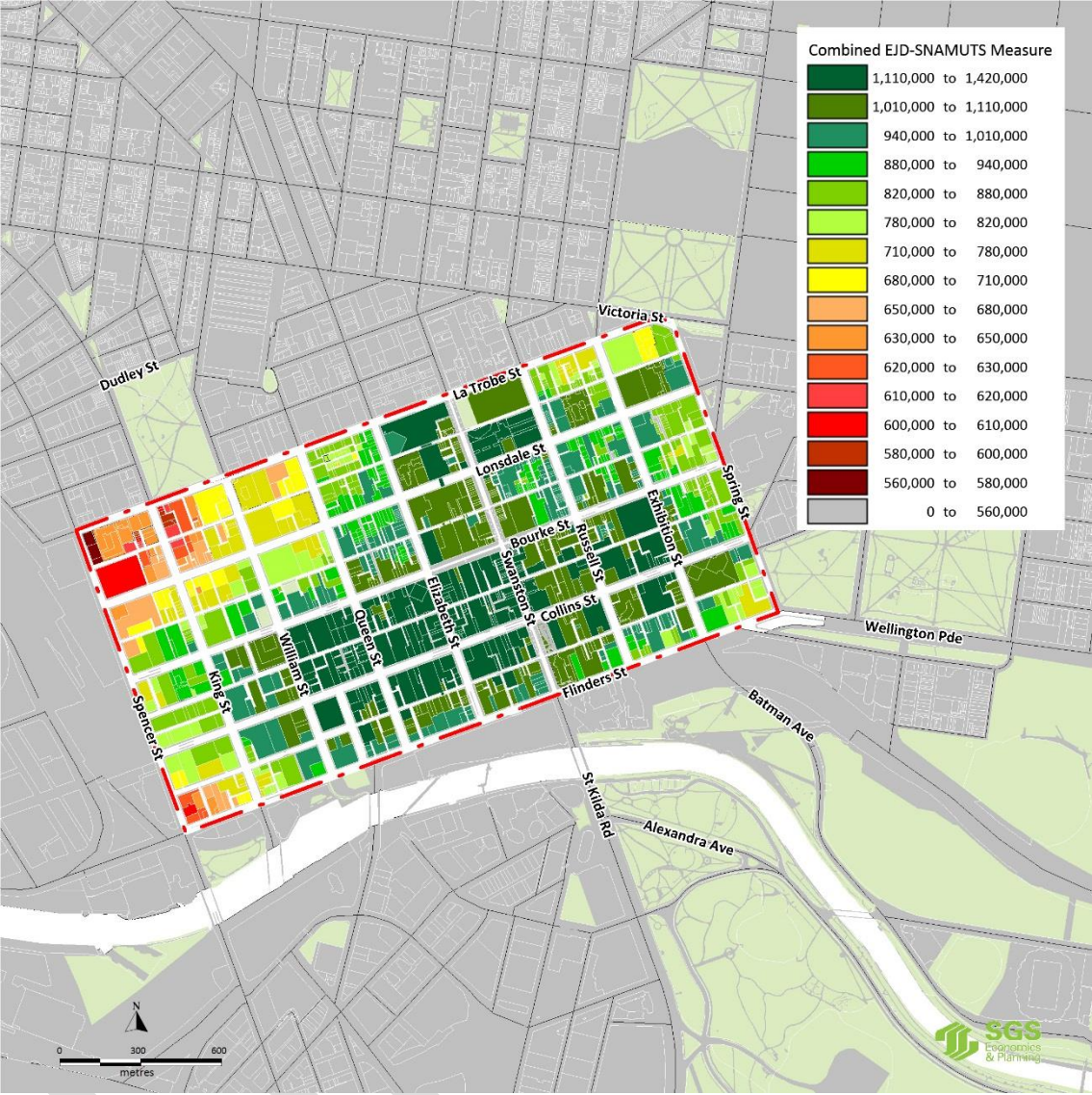
Source: SGS Economics & Planning

To further understand the connectivity within the CBD grid, the walk EJD was combined with the SNAMUTS (Spatial Network Analysis for Multimodal Urban Transport Systems).

Figure 14 shows a combined EJD-SNAMUTS measure obtained by multiplying EJD and SNAMUTS values for each property. This highlights areas which have both high connectivity via walking and high connectivity via public transport.

When the SNAMUTS is incorporated with walk EJD, the areas with high connectivity within the CBD grid are extended. The length of Bourke Street, Collins Street and Flinders Street are seen to have higher connectivity, as do Spring Street, Elizabeth Street and Swanston Street. This is no doubt a result of the regular tram services along these routes. Conversely, the north-west corner of the CBD grid has poor connectivity, having low walk EJD and SNAMUTS scores.

FIGURE 14.COMBINED EJD-SNAMUTS MEASURE





## 2.3 Relationship between economic activity and walk effective job density

A 'rough' measure of labour productivity was produced to provide an indication of the economic contribution which walking provides to the CBD grid. This was based on SGS estimates of average Gross Value Added (GVA) (the sum of wages and profits) per worker for each ANZSIC industry (see Table 3). For industrial based industries, an assumed average GVA per worker, across all industries, was assigned. This was done to reflect that they are a head office rather than the site of actual industrial production. Agriculture and Mining employment in the City of Melbourne was deemed to consist of purely office based employment. Figure 15 presents the average labour productivity per worker for buildings in the CBD grid.

**TABLE 3. ESTIMATED GROSS VALUE ADDED PER WORKER**

Industry	Average GVA per worker
Agriculture and Mining	\$141,623
Manufacturing	\$ 91,908
Electricity, Gas, Water and Waste Services	\$ 91,908
Construction	\$ 91,908
Wholesale Trade	\$ 91,908
Retail Trade	\$ 46,278
Food and Beverage Services	\$ 21,329
Accommodation	\$ 257,740
Transport, Postal and Storage	\$ 91,908
Information Media and Telecommunications	\$ 159,288
Rental and Hiring Services	\$ 368,225
Real Estate Services	\$ 368,225
Business Services	\$ 141,623
Admin and Support Services	\$ 91,908
Public Administration and Safety	\$ 97,816
Education and Training	\$ 29,120
Health Care and Social Assistance	\$ 76,661
Arts and Recreation Services	\$ 42,388
Other Services	\$ 35,927

Source: SGS Economics & Planning

*Labour productivity is the value of production (GDP) per hour worked. Labour productivity reflects not only the contribution of labour, but is also influenced by the contribution of capital and other factors of production (land, labour, capital and enterprise).*

The measure is 'rough' as labour productivity requires hours worked as a measure of the labour input. This rough measure wouldn't capture an instance where a worker (in the same industry) in one location worked 40 hours a week while a worker in another location worked 45 hours a week. However, there is a lack of data on hours worked at such a fine geographical level; furthermore, there is limited data explaining how industry GVA may vary across the CBD grid.

FIGURE 15. CBD GRID BUILDING LABOUR PRODUCTIVITY



Source: SGS Economics & Planning

Figure 16 illustrates the relationship between EJD and labour productivity for each block in the CBD. Blocks with higher EJD tend to have higher levels of labour productivity. The variation in walk EJD explains almost 40<sup>4</sup> per cent of the variation in labour productivity. This is a reasonably strong relationship considering all the other factors that influence labour productivity. The elasticity is 6.6 per cent. This observed relationship fits with the empirical findings from the agglomeration literature (see Table 4). For more information on this topic please refer to the COAG Reform Council Paper<sup>5</sup>.

**TABLE 4. ELASTICITY FROM OTHER STUDIES OF AGGLOMERATION**

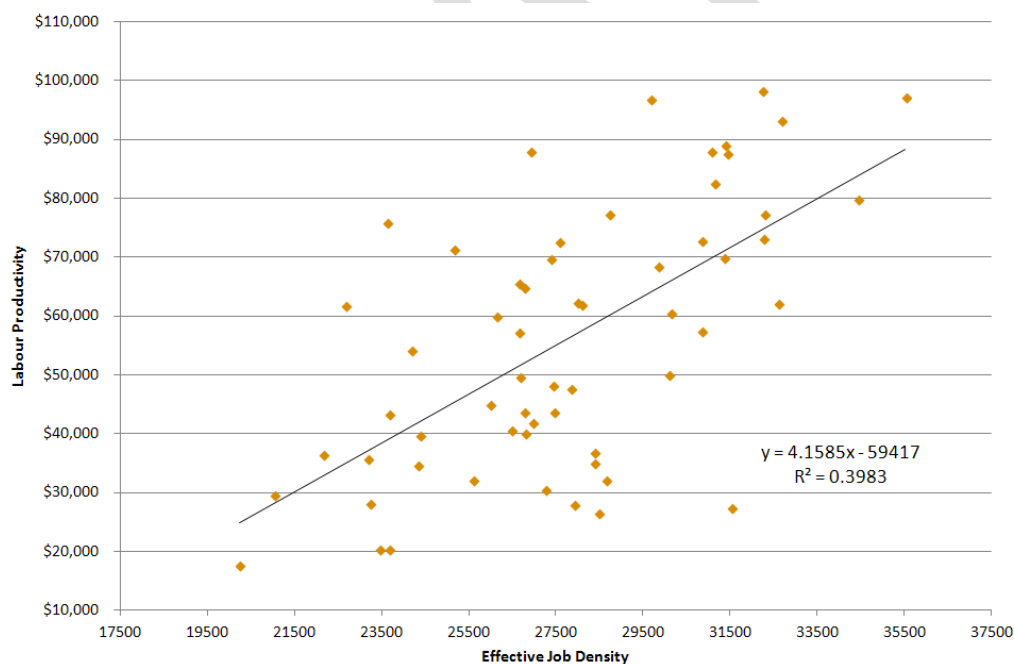
Author	Elasticity	Location of Analysis
Graham (2006)	0.13	United Kingdom
Rawnsley & Szfraniec (2010)	0.08	Melbourne
Mare and Graham (2009)	0.07	New Zealand
Trubka (2009)	0.07	Australia
Ciccone (2000)	0.06	United States of America
Ciccone & Hall (1996)	0.05	European Union

Source: Various

This relationship provides an opportunity to place an economic value on walking within the CBD grid.

Research indicates that locations with high levels of connectivity attract more productive firms. It should be noted that if walkability levels were to be reduced, a business could maintain its connectivity by relying on other transport modes (trams, taxis, bus, train, etc.); however, these alternatives would impose additional costs on the business.

**FIGURE 16. WALK EFFECTIVE JOB DENSITY AND LABOUR PRODUCTIVITY**



Source: SGS Economics & Planning

SGS has estimated that, in 2009-10, the value of the economy of the CBD grid was worth \$32.8 billion<sup>6</sup> (internal SGS analysis). If the walking EJD for each travel zone within the CBD grid was reduced by 10 per

<sup>4</sup> As measured by the R-Squared statistic.

<sup>5</sup> [http://www.coagreformcouncil.gov.au/agenda/docs/cities/productivity\\_and\\_agglomeration\\_benefits.pdf](http://www.coagreformcouncil.gov.au/agenda/docs/cities/productivity_and_agglomeration_benefits.pdf)

<sup>6</sup> In 2010-11 dollars.

cent, say through a commensurate reduction in accessibility, the value of the economy of the CBD grid would be reduced by \$2.1 billion (a 6.6 per cent reduction in the value of the economy).

In simple terms, if the time taken for every walking trip in the CBD grid was increased by 10 per cent (via changes to light phasing or a reduction of walk speed due to congestion etc) then firms would be less inclined to interact with each other. This reduced interaction would lead to a decline in business activity, which would in turn lead to reduced income (GVA).

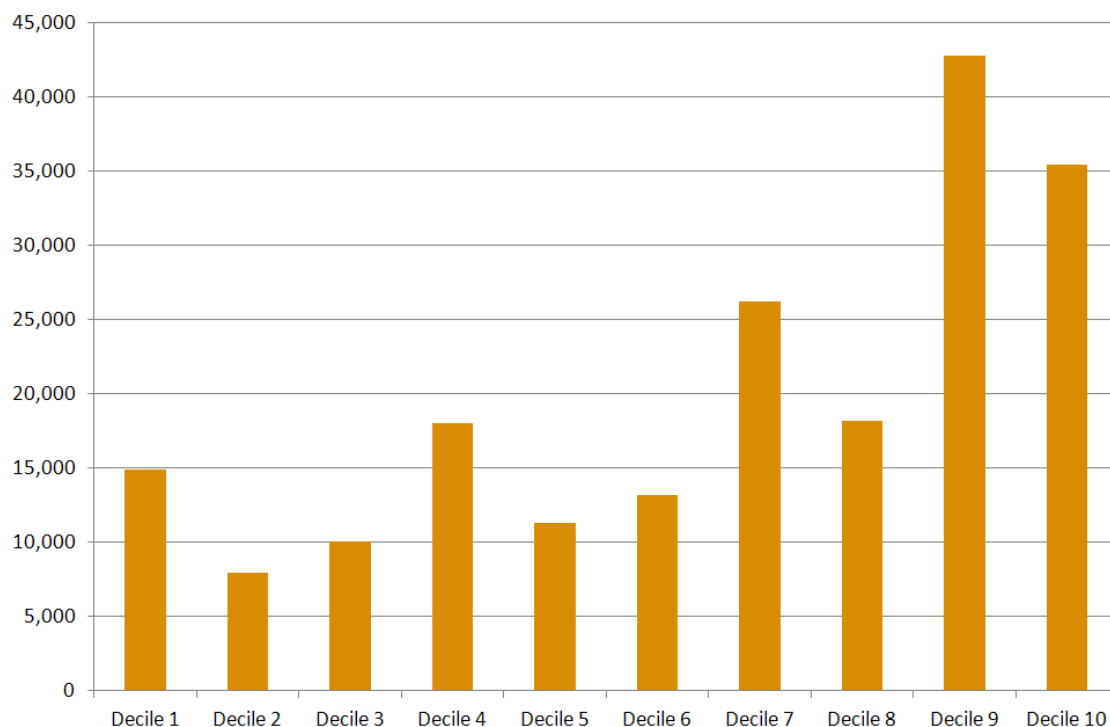
**TABLE 5. IMPACT OF REDUCED WALKING CONNECTIVITY IN CBD GRID**

Scenario	Impact \$ million	% impact on economy of City of Melbourne
10 per cent reduction	2,179	6.6%
20 per cent reduction	4,563	13.9%
30 per cent reduction	6,947	21.1%

Source: SGS Economics & Planning

Figure 17 is based on EJD analysis using private car and public transport at a metropolitan scale. It presents employment growth in each EJD decile across the whole of Melbourne between 1996 and 2011. This indicates that with high connectivity are the locations that encourage the growth of employment and economic activity. It is likely that a similar relationship exists between walk EJD and employment growth and other positive economic outcomes.

**FIGURE 17. CITY OF MELBOURNE EMPLOYMENT GROWTH 1996-2011, EJD DECILE**



Source: SGS Economics & Planning

## 2.4 Scenarios

Three specific scenarios were developed to further demonstrate the value of walking to the City of Melbourne's economy:

- Improving connectivity across **King Street**, reducing delays for pedestrians (Figure 18).
- A **high level of connectivity** for each block (see Figure 20).
- The value of **existing through block links** within the CBD grid (see Figure 21).

For each scenario, a new EJD Index was created and compared to the base case EJD Index. The impact of the three scenarios is presented below.

**FIGURE 18. KING STREET EJD INDEX COMPARED TO BASE CASE EJD INDEX**

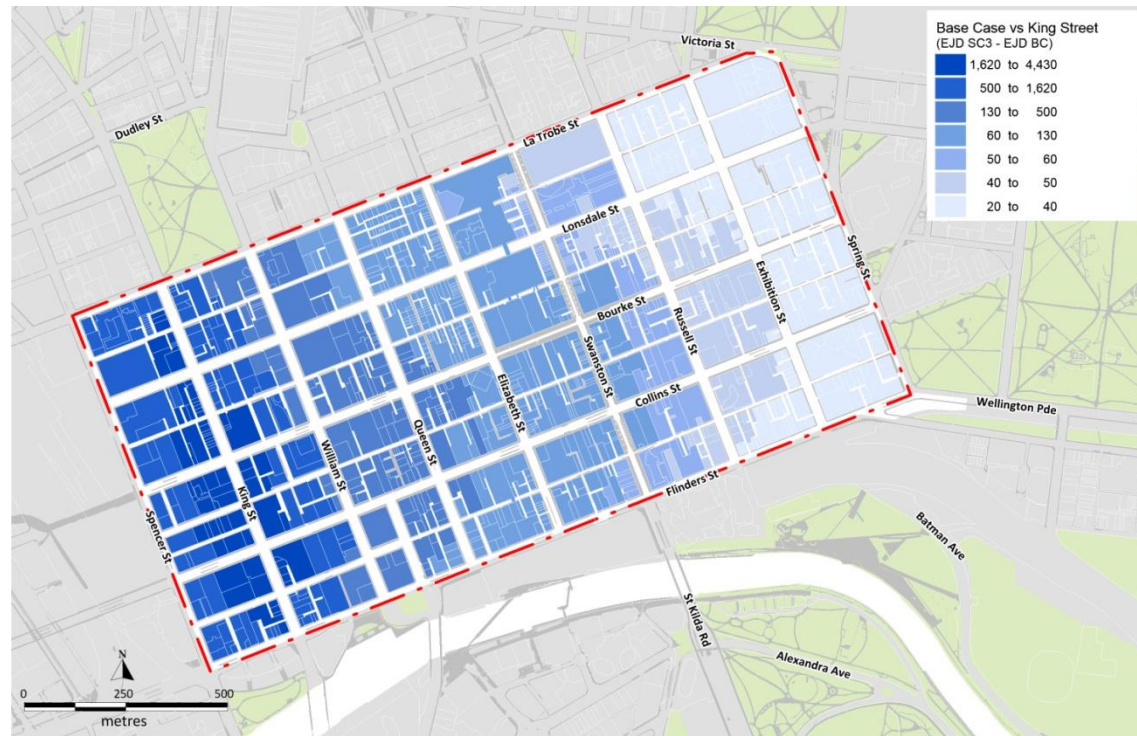


Figure 19 below illustrates the high connectivity scenario, with connections at intersections as well as at mid-block points, lanes and arcades. Figure 20 shows the EJD of this scenario compared to the base case EJD.



FIGURE 19.HIGH CONNECTIVITY SCENARIO

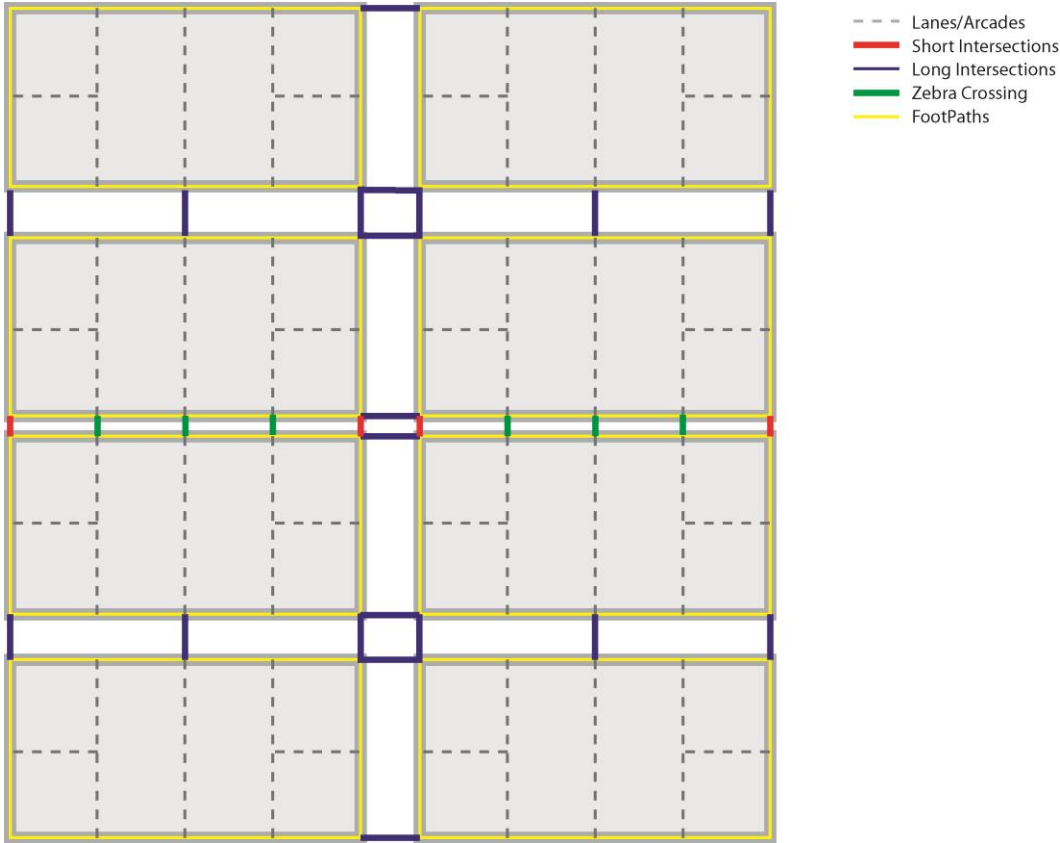
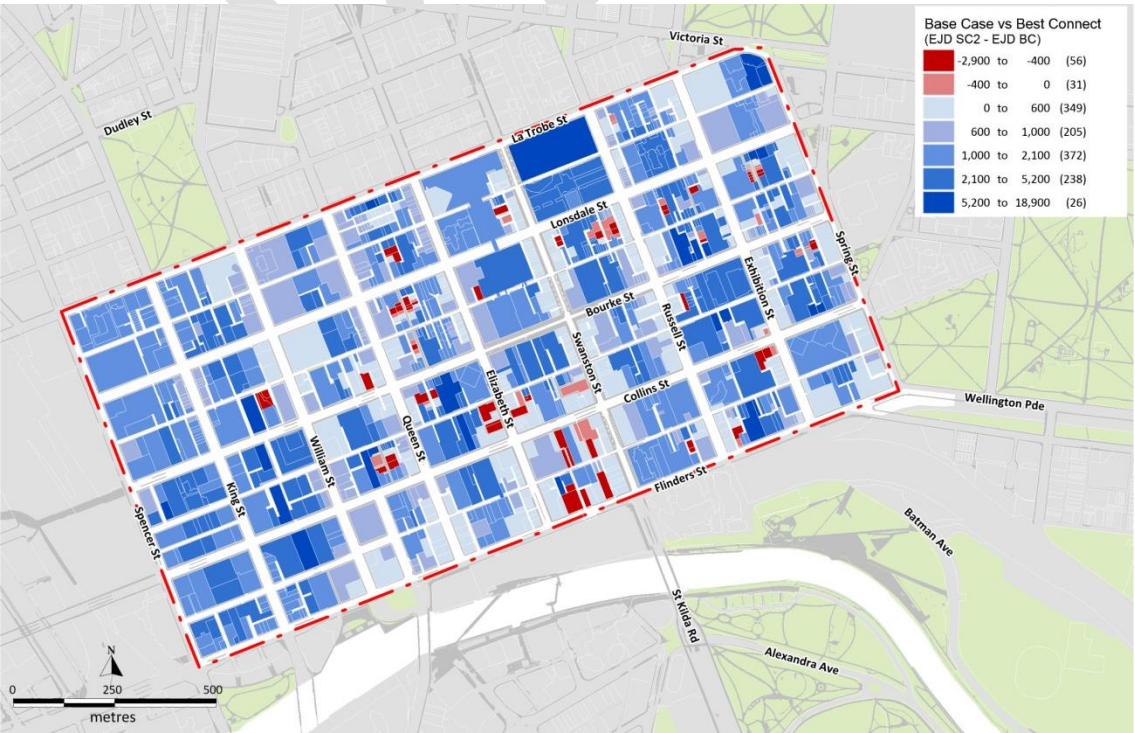
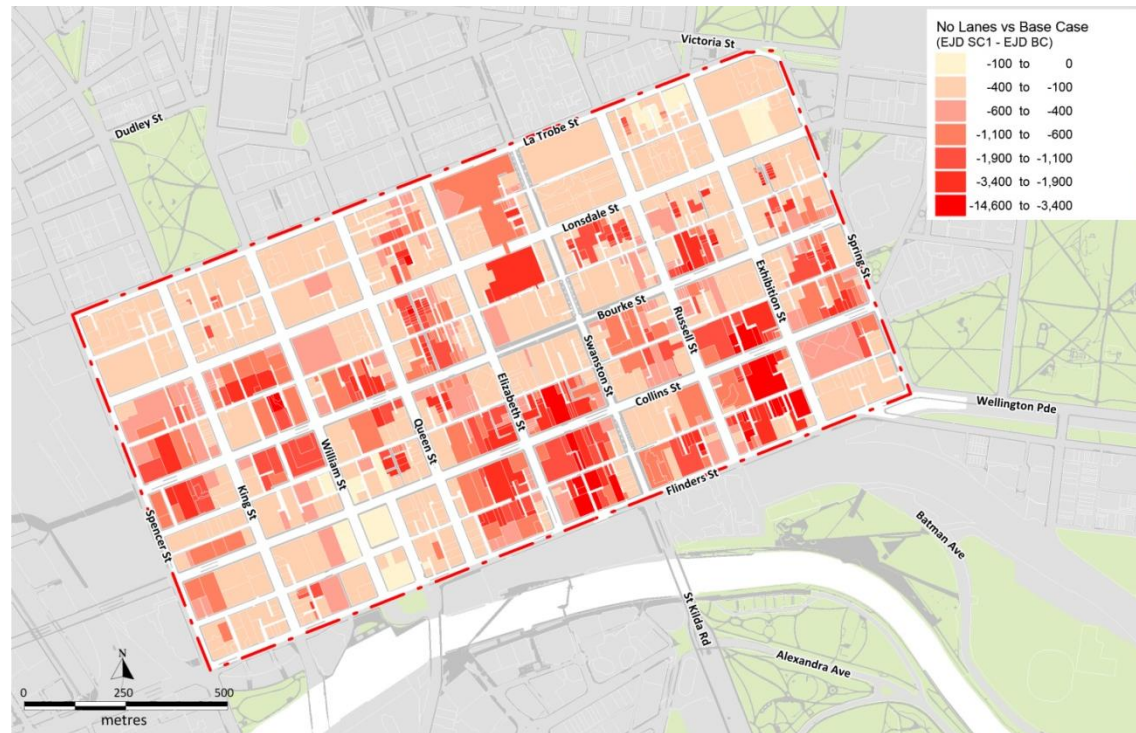


FIGURE 20.BEST CONNECTION EJD INDEX COMPARED TO BASE CASE EJD INDEX



The through block link (ie. no lanes) scenario tests the impact of removing the through block links provided by laneways in the CBD grid. This has the impact of reducing EJD (see Figure 21).

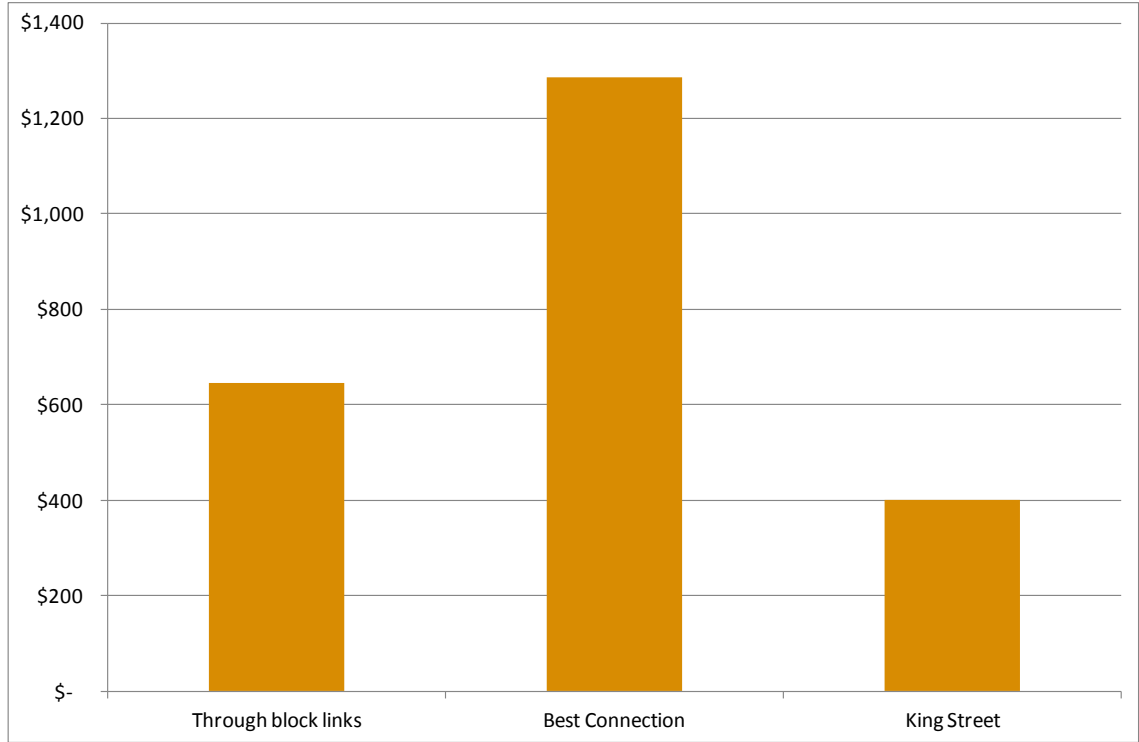
**FIGURE 21. NO LANES EJD INDEX COMPARED TO BASE CASE EJD INDEX**



Source: SGS Economics & Planning

The economic value of each scenario is presented below (see Figure 22). Improving connectivity across King Street would add \$400 million to the economy, through block links are worth over \$600 million to the economy, while the best connection scenario is valued at almost \$1.3 billion.

**FIGURE 22.** IMPACT ON GROSS VALUE ADDED (\$MILLION 2009-10)



Source: SGS Economics & Planning

# 3 NETWORK EXPANSION STUDY

Following the work explored in previous chapters – on the value of pedestrian accessibility to agglomeration economies for Melbourne’s CBD grid - this chapter extends the analysis to gain an understanding of pedestrian accessibility and productivity in Melbourne’s inner suburbs. Accessibility to parkland and jobs are considered, as is the impact of the E-Gate development, and future accessibility scenarios are mapped.

As discussed above, the relationship between connectivity and productivity is critical to the Melbourne CBD (and to CBDs around the world). The concentration of business activity and linkages within the Melbourne CBD generates economic activity and productivity advantages. This concentration of activity is aided by a high level of pedestrian accessibility, which encourages the face-to-face transfer of knowledge and ideas. This is particularly the case for knowledge intensive industries.

As metropolitan areas grow, those with a monocentric economic structure, such as Melbourne which sees economic activity centred in one location, tend to see CBD activity extend into nearby suburbs and locales, as emerging firms take advantage of lower rents on the CBD fringe. These areas provide some of the benefits of a CBD location with lower cost. Over time, these inner locales can develop into industry clusters as they concentrate around existing businesses and facilities, thus expanding the area where agglomeration economies are achieved in Melbourne.

## 3.1 Method

This section presents the approach applied to develop the pedestrian network across the City of Melbourne.

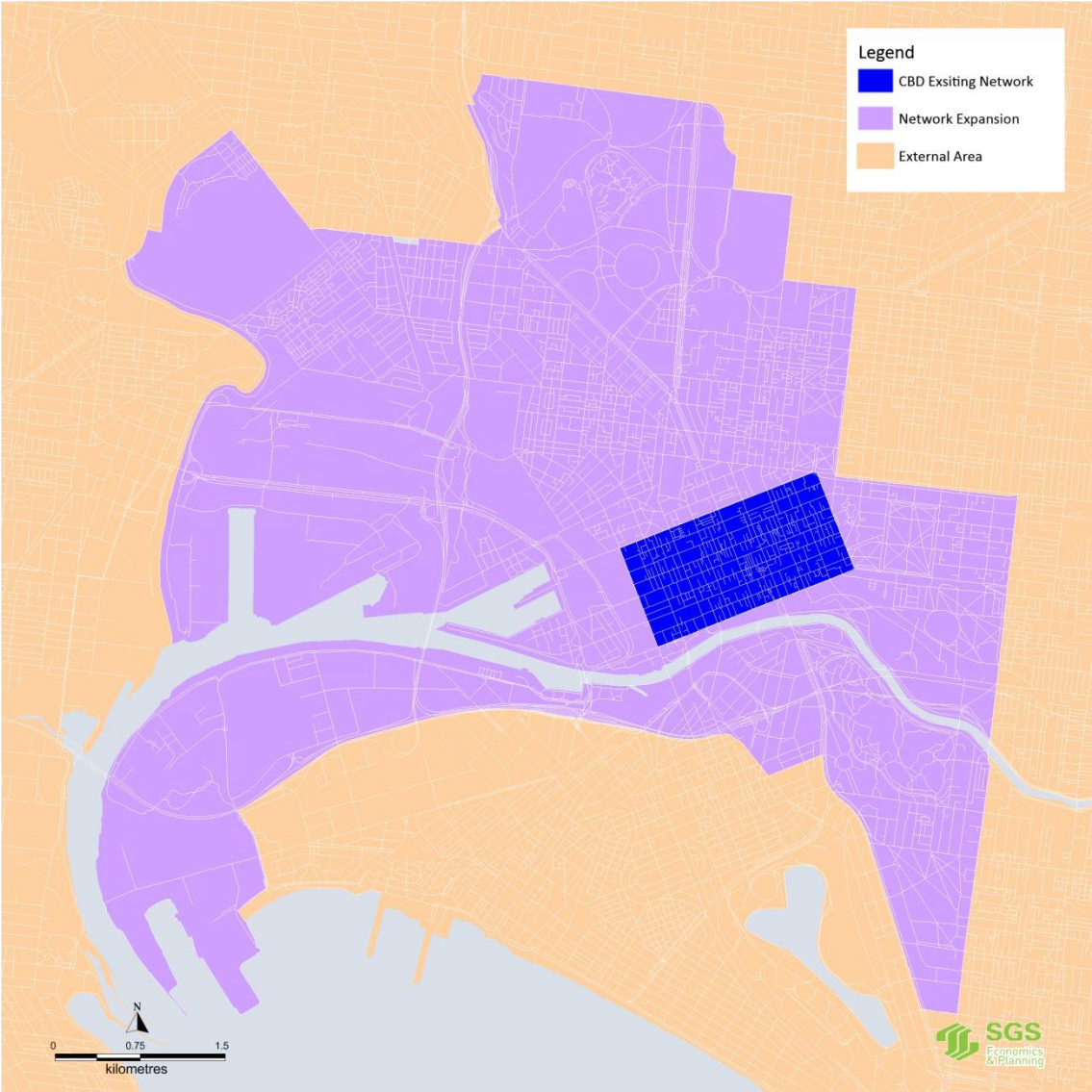
### Expansion of the pedestrian network

#### Study area

The first step of the analysis expanded the pedestrian network from the CBD grid network, defined in Stage 1 of this project, to the entire City of Melbourne (see Figure 23).



**FIGURE 23.** EXPANSION OF PEDESTRIAN NETWORK TO MELBOURNE LGA



Source: SGS Economics & Planning



## Road based clusters

Figure 24, below, illustrates pedestrian behaviour for busy and low traffic locations. Each rectangle represents a property, while the grey lines represent likely pedestrian routes. The figure shows that, in high traffic areas, pedestrians are most likely to take a longer route to get from Point A to Point B in order to use a pedestrian crossing to safely cross the road. In areas of low traffic, pedestrians are likely to avoid more congested intersections and cross the street 'mid-block' at the most convenient time.

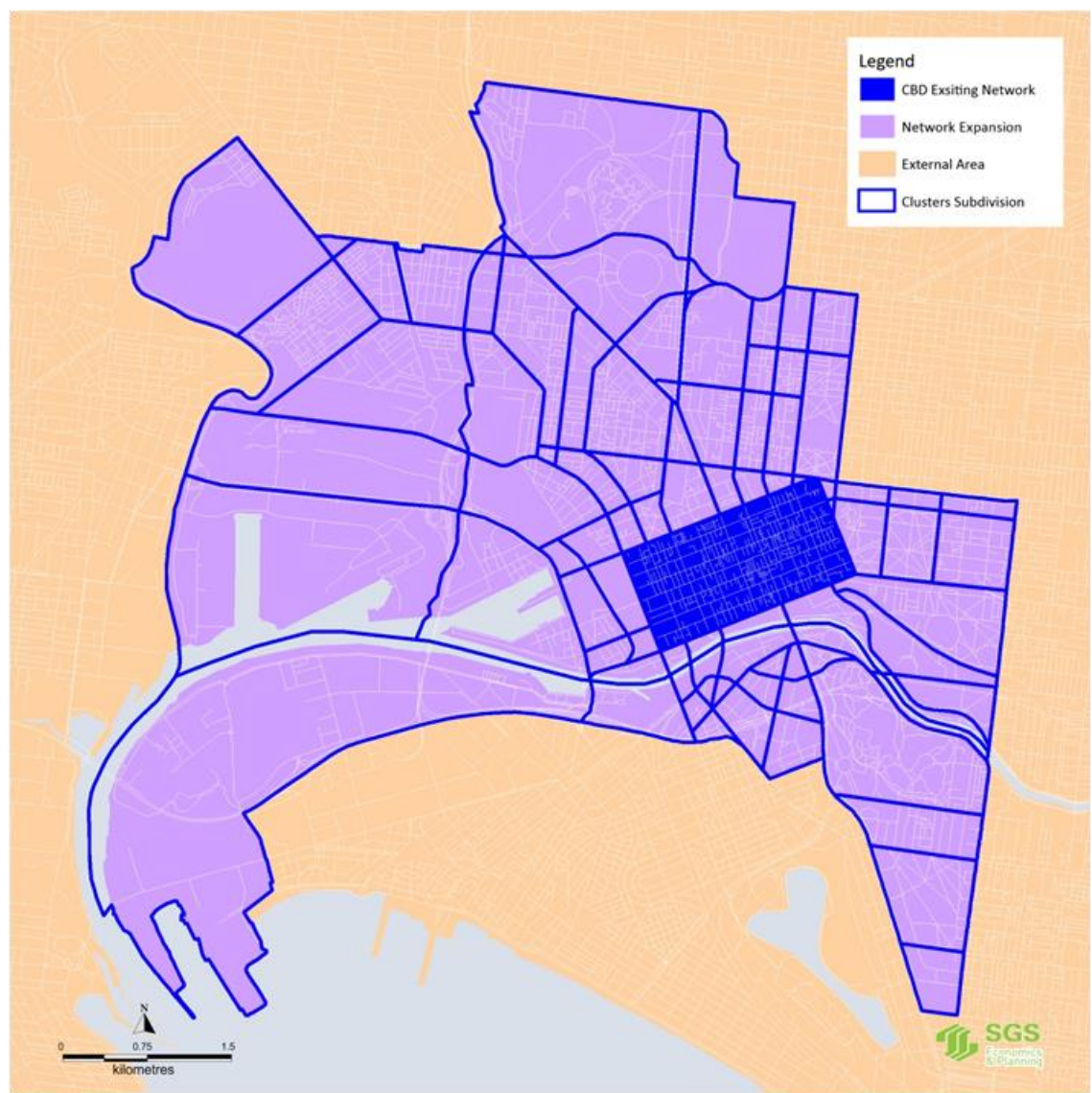
**FIGURE 24. PEDESTRIAN BEHAVIOUR, HIGH AND LOW TRAFFIC AREAS**



Source: SGS Economics & Planning

To best reflect natural pedestrian behaviours, the City of Melbourne was disaggregated into categories or clusters, according to high traffic roads (see Figure 25).

**FIGURE 25.**CLUSTERS USED FOR ANALYSIS



Source: SGS Economics & Planning

Network categories (outlined in the below table) were then developed, including footpaths and crossings. As in Stage 1, an estimated average walk speed was assigned for each category. The speeds selected best represent real world travel speeds, having consideration for traffic light phasing and other delays experienced when walking around the CBD grid. For example, travel speed is expected to be slower as a result of using main road intersections, which are subject to long wait times at traffic lights/ crossings. Owing to similar walkability characteristics in the two locations, the same speeds were adopted for Melbourne's inner suburbs and the City of Melbourne.

Table 6 presents the various network categories and assigned walk speeds, which range from one to four kilometres per hour.

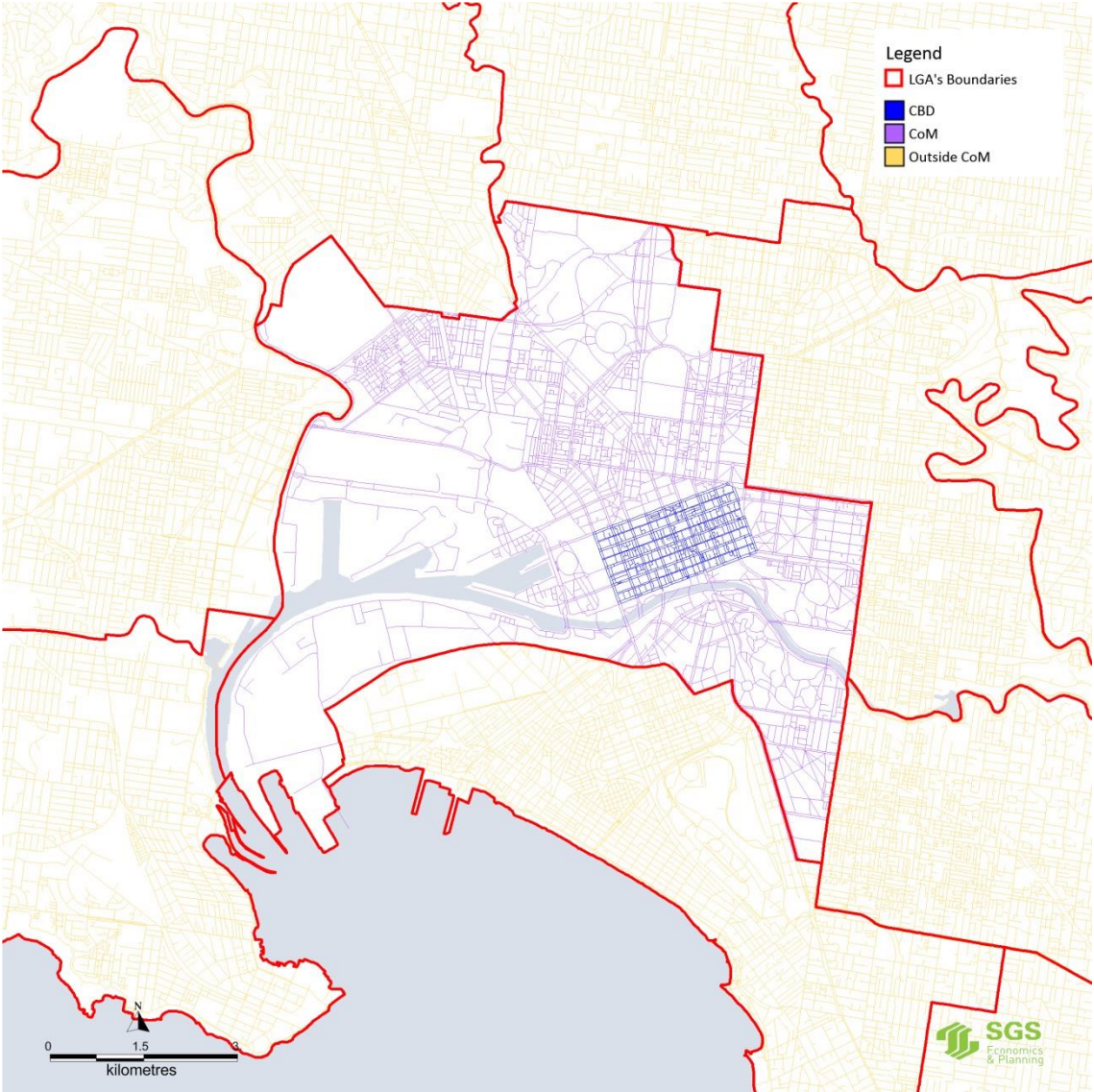
**TABLE 6. NETWORK CATEGORY AND WALK SPEED**

Category	Speed (km/h)
Footpath	4
Lane	4
Arcade	4
Footpath outside CBD	4
Crossings	
Main road intersections	2
'Little' street intersections	3
Zebra crossings	4
Access to tram stops	3
King Street intersections (at signalised crossings)	1
Swanston Street intersections (at signalised crossings)	3

Source: SGS Economics & Planning

To ensure that the impact of neighbouring areas (outside of the City of Melbourne) was captured, the network was extended to up to three kilometres from municipal borders (reflecting a 45 minute walk at four kilometres per hour) (see Figure 26).

**FIGURE 26. NETWORK COVERAGE**

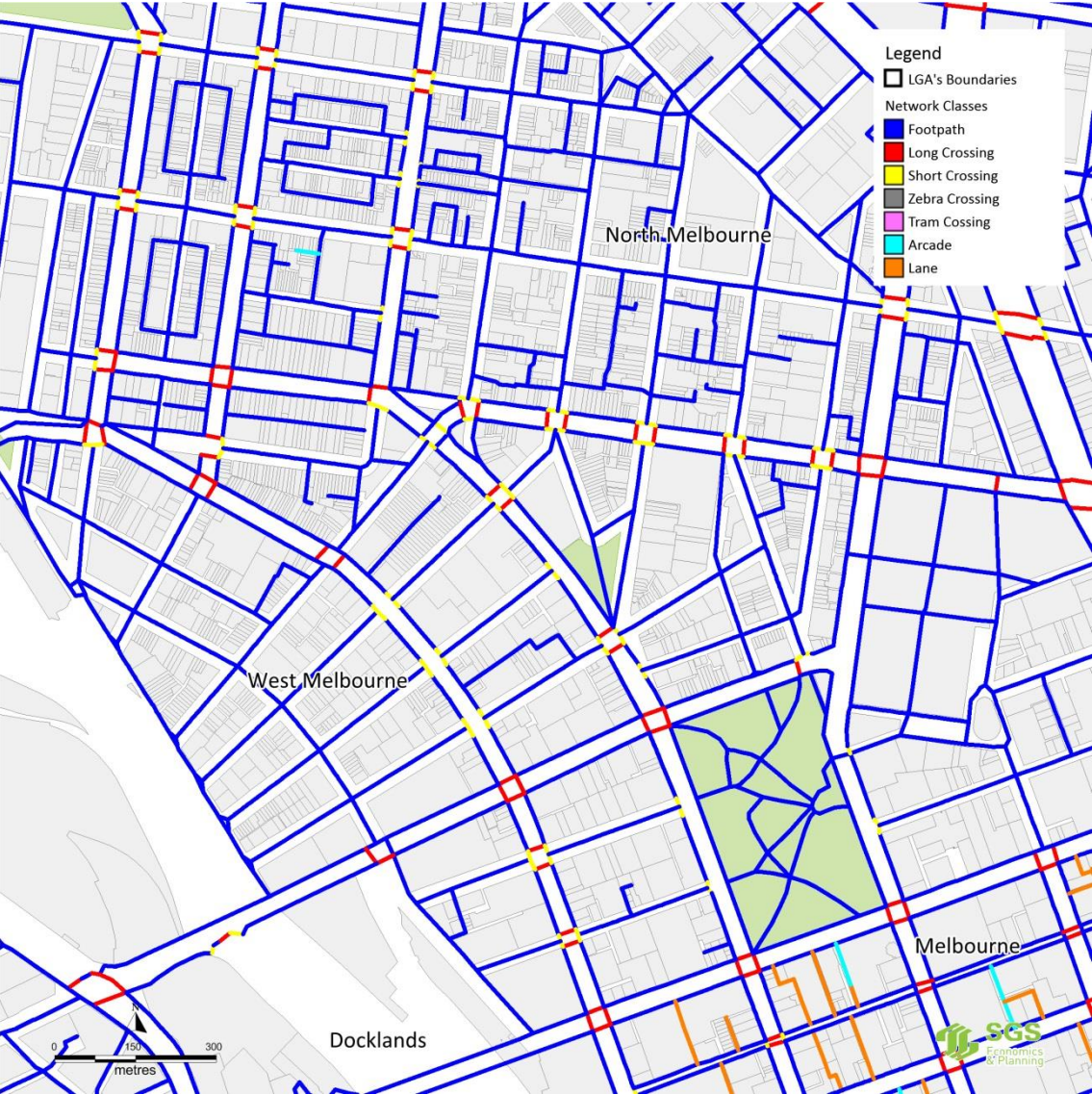


Source: SGS Economics & Planning



The following series of maps depict the network using the categories shown in Table 6 for three example areas – West Melbourne, South Wharf and Carlton/ Parkville. As described in Figure 24, roads illustrated with two lines reflect main, higher traffic roads – where pedestrians are most likely to travel to an intersection to cross the road – while single lines reflect low traffic roads – where pedestrians are likely to cross mid-block, resulting in a more direct route.

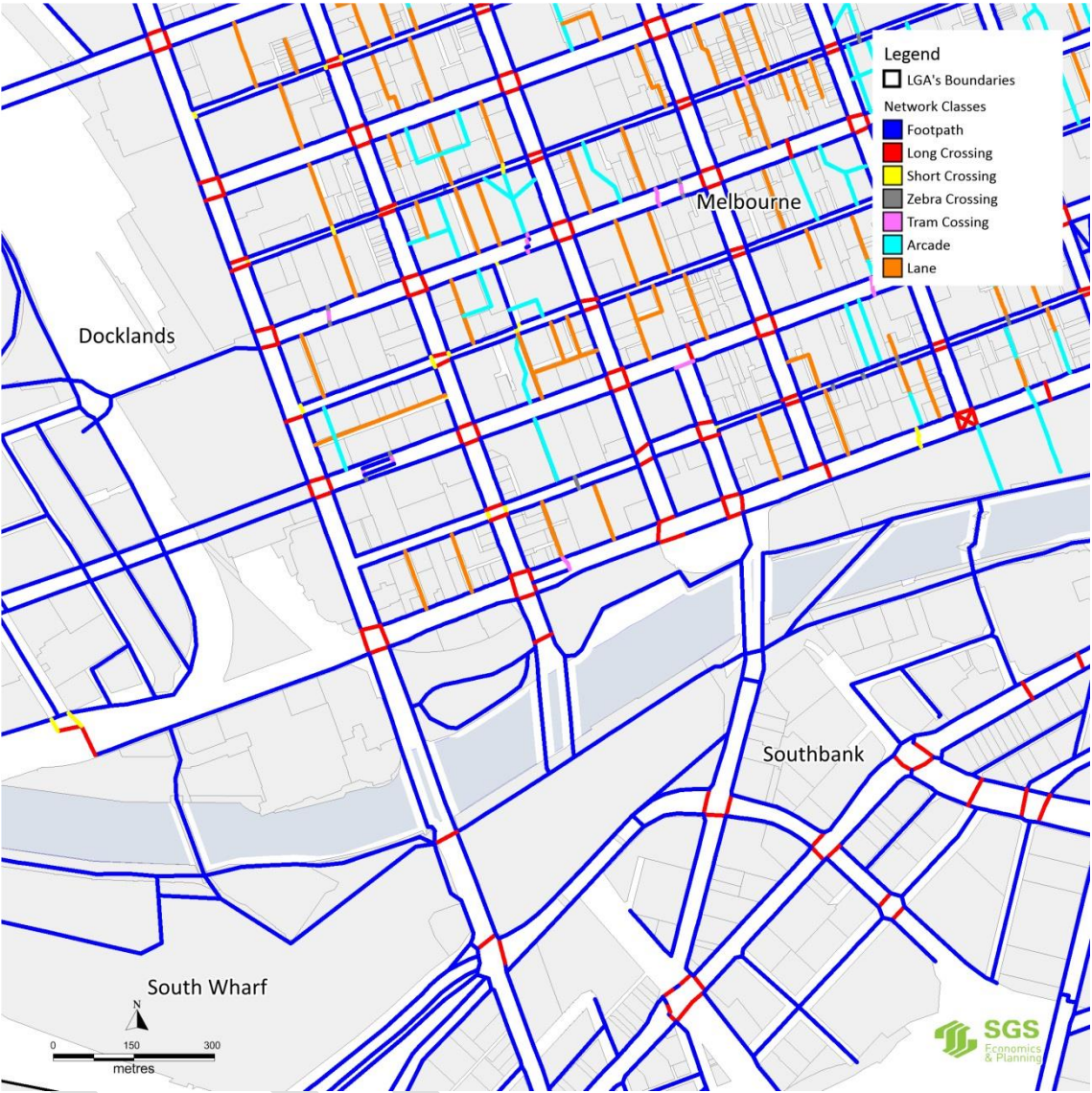
**FIGURE 27. NETWORK DESIGN – WEST MELBOURNE**



Source: SGS Economics & Planning

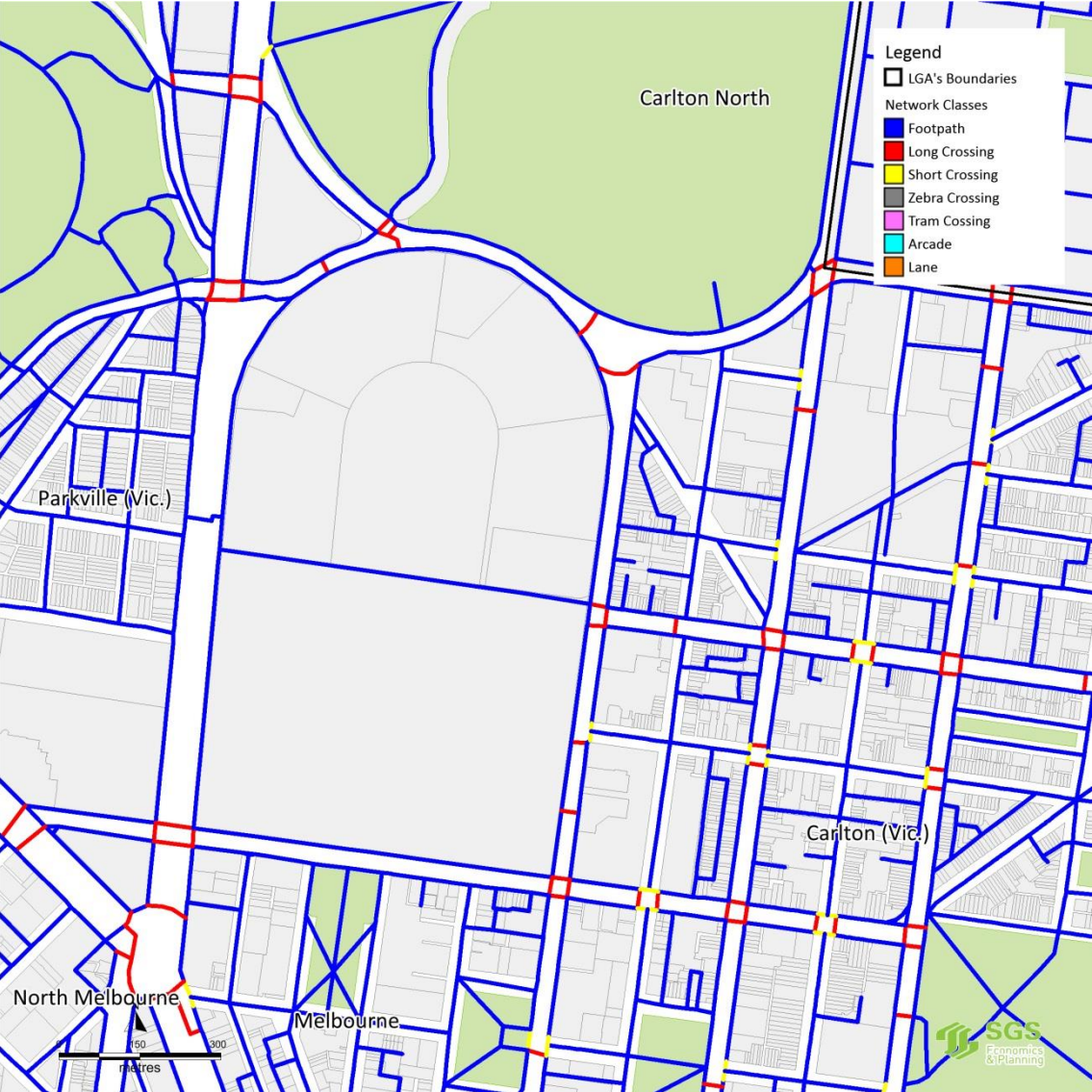


**FIGURE 28. NETWORK DESIGN – SOUTH WHARF**



Source: SGS Economics & Planning

FIGURE 29. NETWORK DESIGN – CARLTON AND PARKVILLE



Source: SGS Economics & Planning



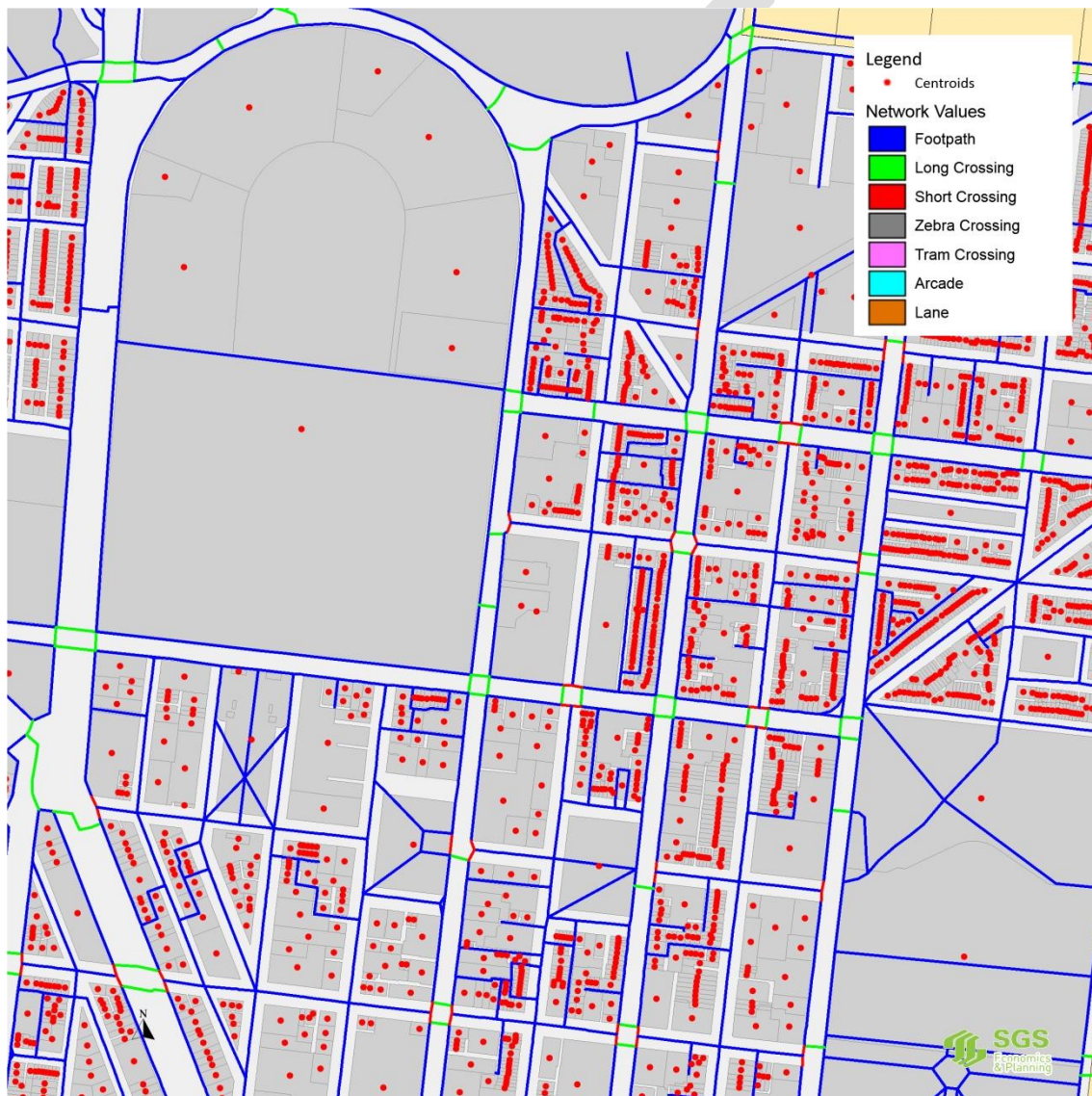
## Origin and destination connection

A centroid layer was created to enable trips to be mapped and analysed. Centroids were connected to property entrances, allowing the analysis to best represent the real world movements of pedestrians.

The travel zones outside the study area were connected to the network at the centroid of the travel zone. That is, it was assumed that walking to the centre of the travel zone would provide access to all the jobs in that travel zone. This provided a rough reflection of the real world movements of pedestrians.

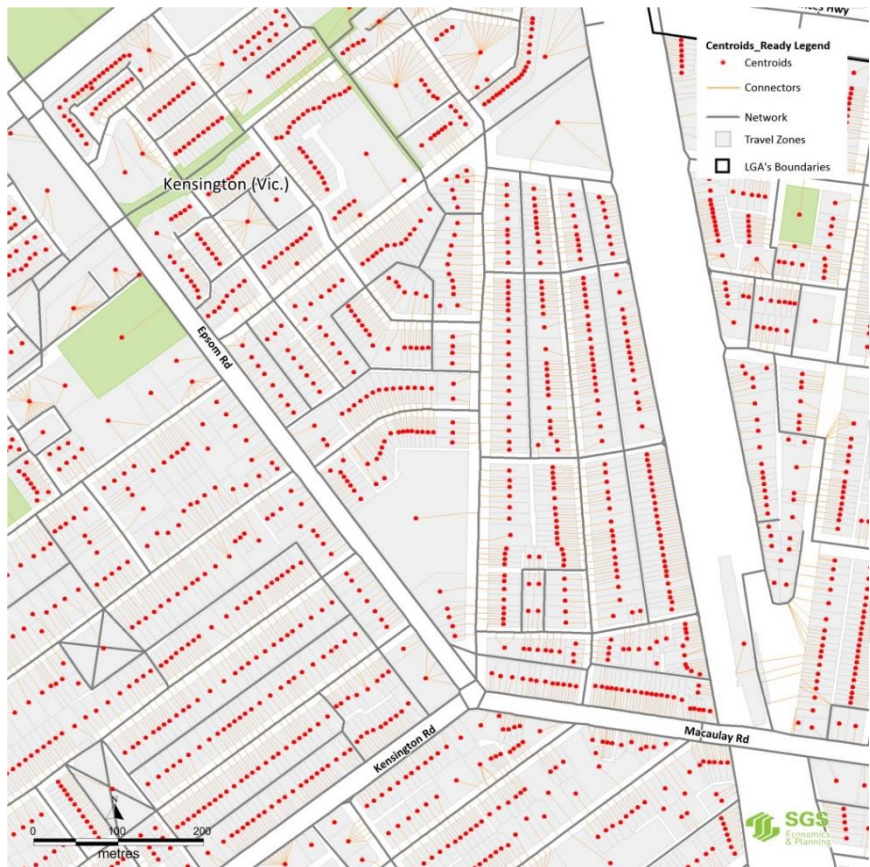
The following map (Figure 30) provides an example of the centroid layer. Figure 31 through Figure 33 then provide examples of connections from the footpath to the centroid.

**FIGURE 30. NETWORK CENTROIDS – CARLTON AND PARKVILLE**



Source: SGS Economics & Planning

**FIGURE 31.NETWORK CENTROIDS – KENSINGTON**



Source: SGS Economics & Planning

**FIGURE 32.NETWORK CENTROIDS CONNECTIONS– ARDEN MACAULAY**



Source: SGS Economics & Planning



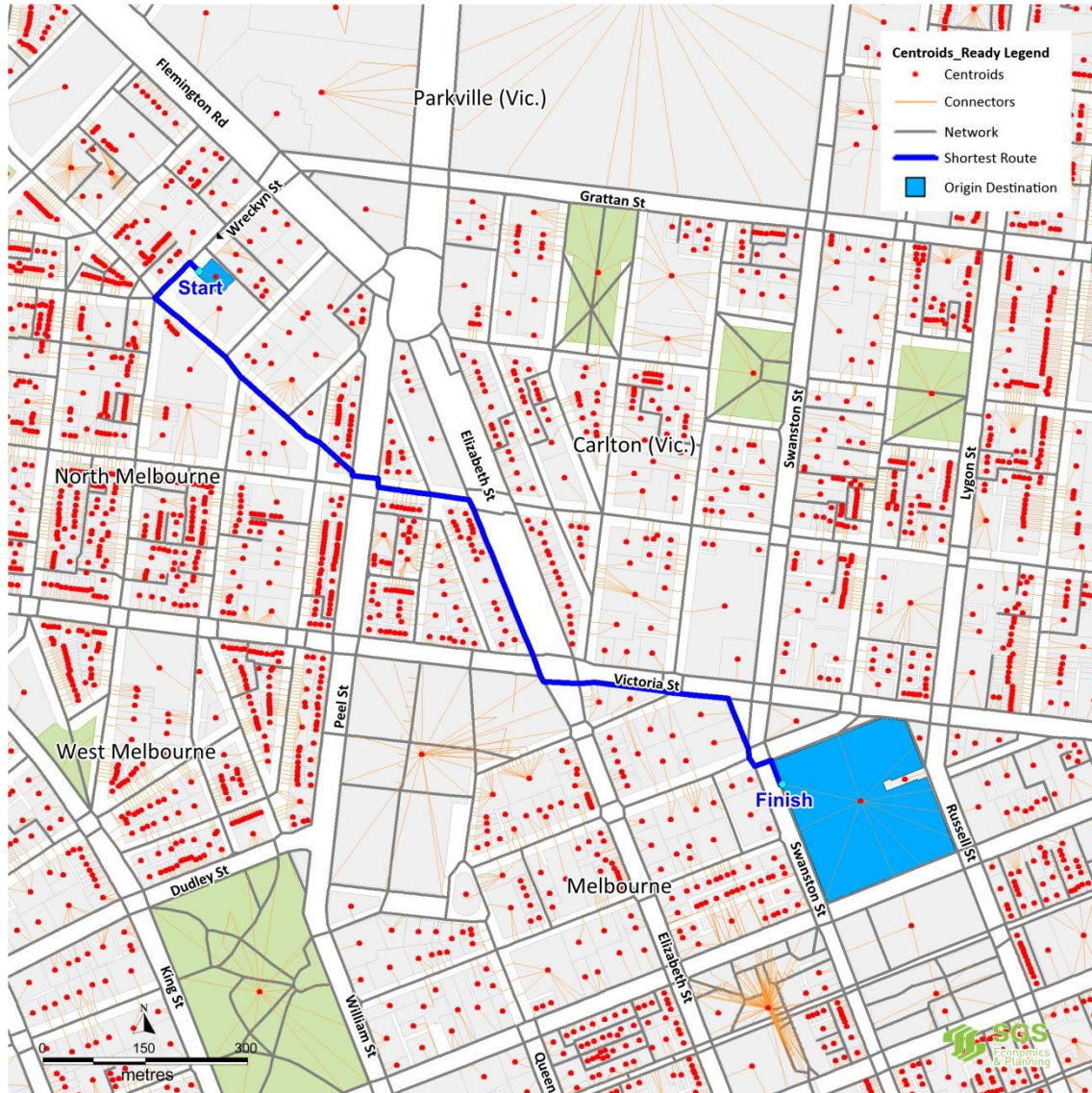
**FIGURE 33.NETWORK CENTROIDS CONNECTIONS– SOUTH WHARF**



Source: SGS Economics & Planning

After connecting the network to the centroids, a pedestrian trip between any points in the City of Melbourne could be modelled, allowing the distance and the time taken to travel door-to-door to be determined (see Figure 34 and Figure 35).

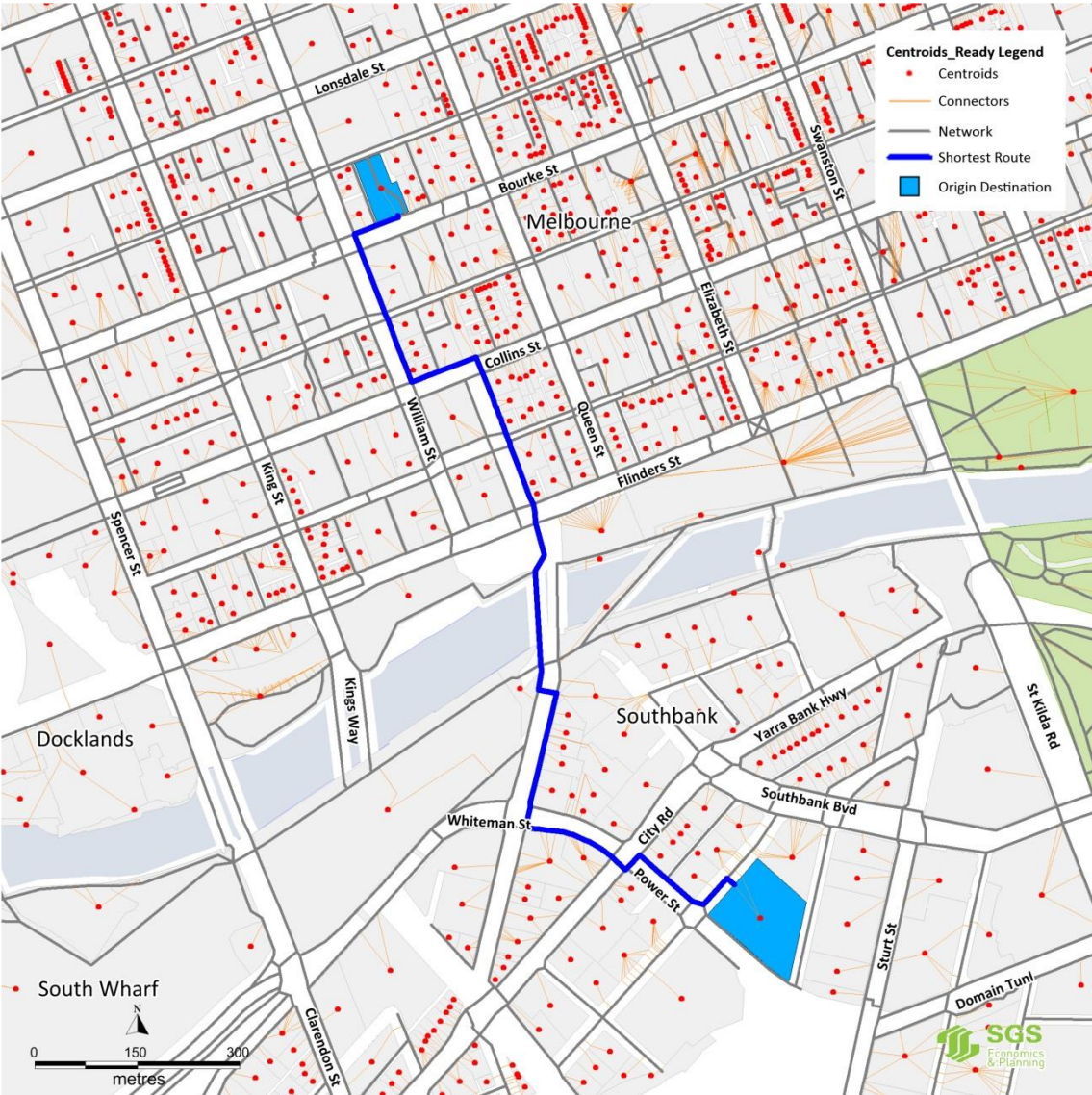
**FIGURE 34. PEDESTRIAN TRIP – WRECKYN ST NORTH MELBOURNE TO RUSSELL ST**



Source: SGS Economics & Planning



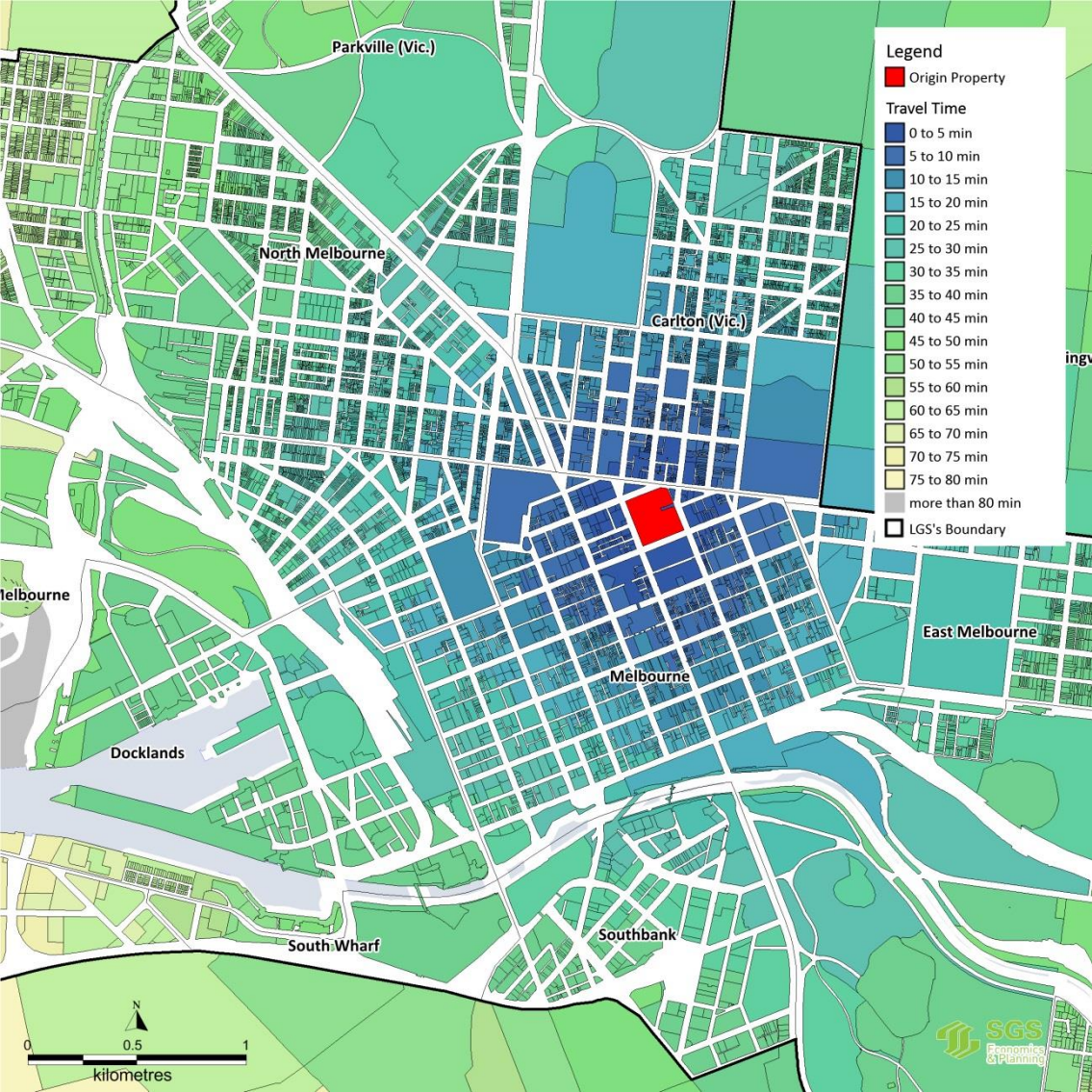
FIGURE 35. PEDESTRIAN TRIP – COLLINS ST TO SOUTHBANK BOULEVARD



Source: SGS Economics & Planning

Following this, a travel time matrix was generated to measure the travel time between every property in the City of Melbourne to each property in the municipality. Figure 36 provides an illustration of this analysis.

**FIGURE 36.** TRAVEL TIME FROM SELECTED PROPERTY – CBD EXAMPLE



Source: SGS Economics & Planning



## Effective job density

As in Stage 1, Stage 2 used EJD to measure agglomeration. See Section 2.2 (p 15) of this report for further information on EJD.

## 3.2 Analysis

The pedestrian network developed allows a range of different walking accessibility analyses to be undertaken. Travel time has been limited to a 30 minute walk and a range of scenarios have been tested. These include:

- including parkland in the pedestrian network
- excluding parkland in the pedestrian network
- access to parkland
- access to non-residential land (proxy for employment areas)
- access to employment through Effective Job Density (EJD)
- future employment density and EJD using employment scenarios, and
- the impact of the E-Gate development on access and EJD.

### Accessibility to all land

Figure 37 shows the accessibility to all land, including parkland, within a 30 minute walk. As shown, areas near parks have high levels of accessibility, reflecting their permeability and the likelihood of pedestrians taking routes through parks to shorten their journeys. Areas in Parkville and near the Botanic Gardens show the highest levels of accessibility.

FIGURE 37.ACCESSIBILITY TO ALL LAND (INCLUDING PARKLAND)

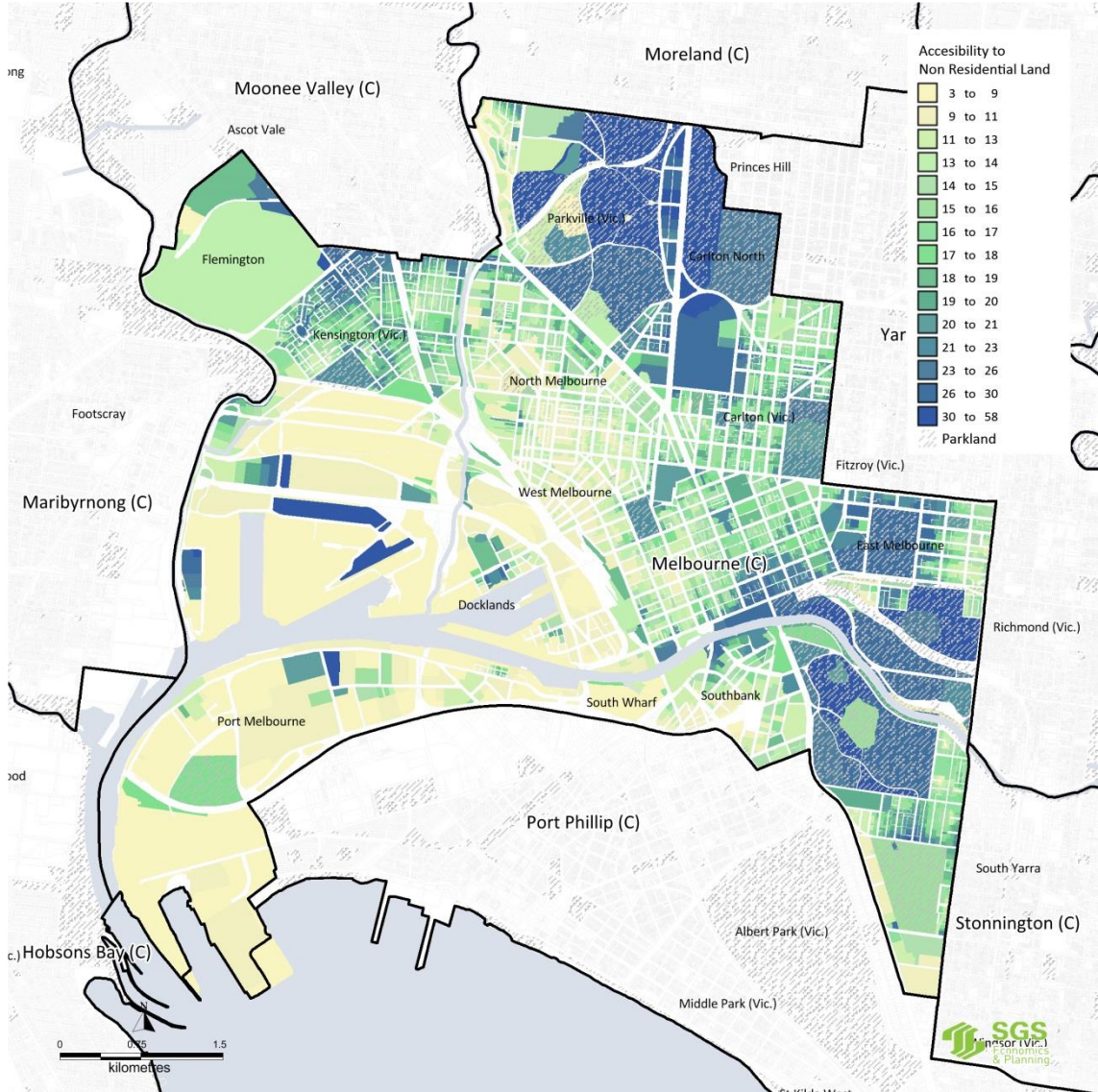
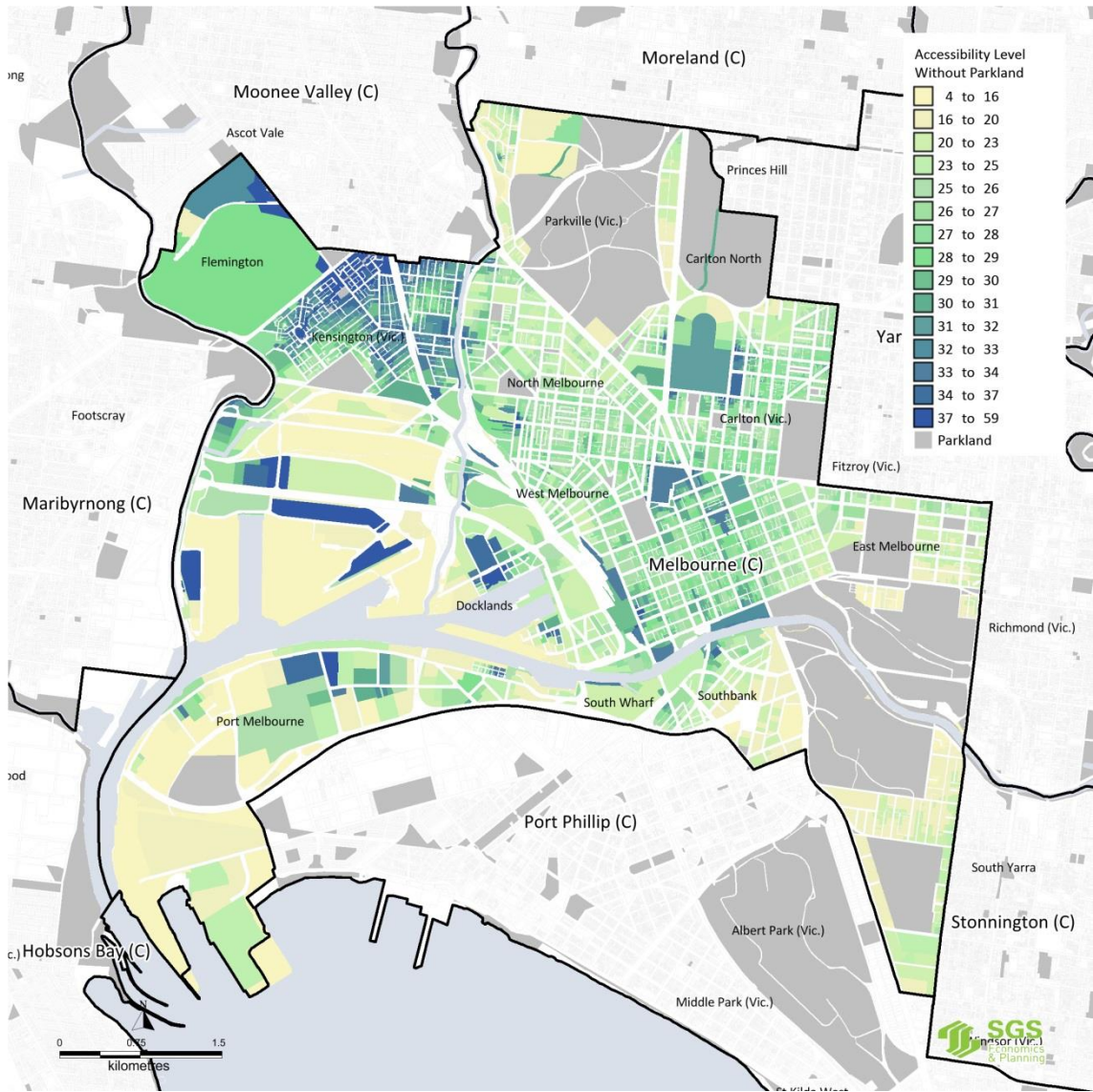


Figure 38 illustrates the pedestrian network’s accessibility to all land, excluding parkland, which was removed from the analysis as it is not residential or employment land. Compared to Figure 37 - which includes parkland – accessibility in this scenario is markedly reduced in areas near parkland, such as in the south east of the LGA and in Parkville. Accessibility within the CBD remains relatively the same, reflecting the permeability offered by smaller streets and laneways.

**FIGURE 38.ACCESSIBILITY TO ALL LAND (EXCLUDING PARKLAND)**



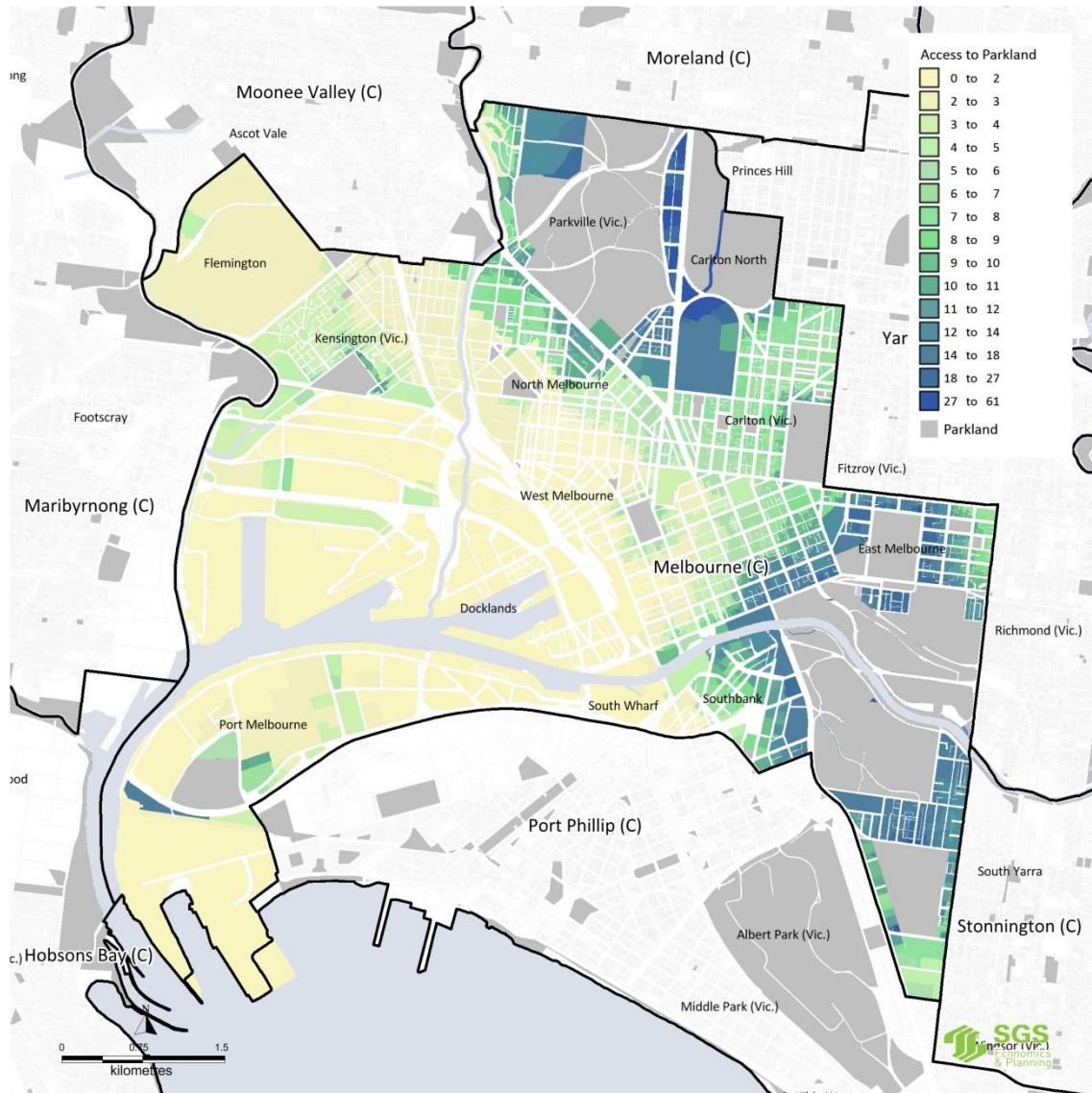
Source: SGS Economics and Planning



## Access to parkland

Figure 39 illustrates access to parkland within a 30 minute walk. Areas which border Royal Park, the Botanic Gardens, Fawkner Park, the MCG and Treasury Gardens show the highest levels of accessibility. Notably, access to parkland in the west of the municipality is quite low, and is most pronounced in Docklands, South Wharf and West Melbourne.

**FIGURE 39. ACCESSIBILITY TO PARKLAND**



Source: SGS Economics and Planning

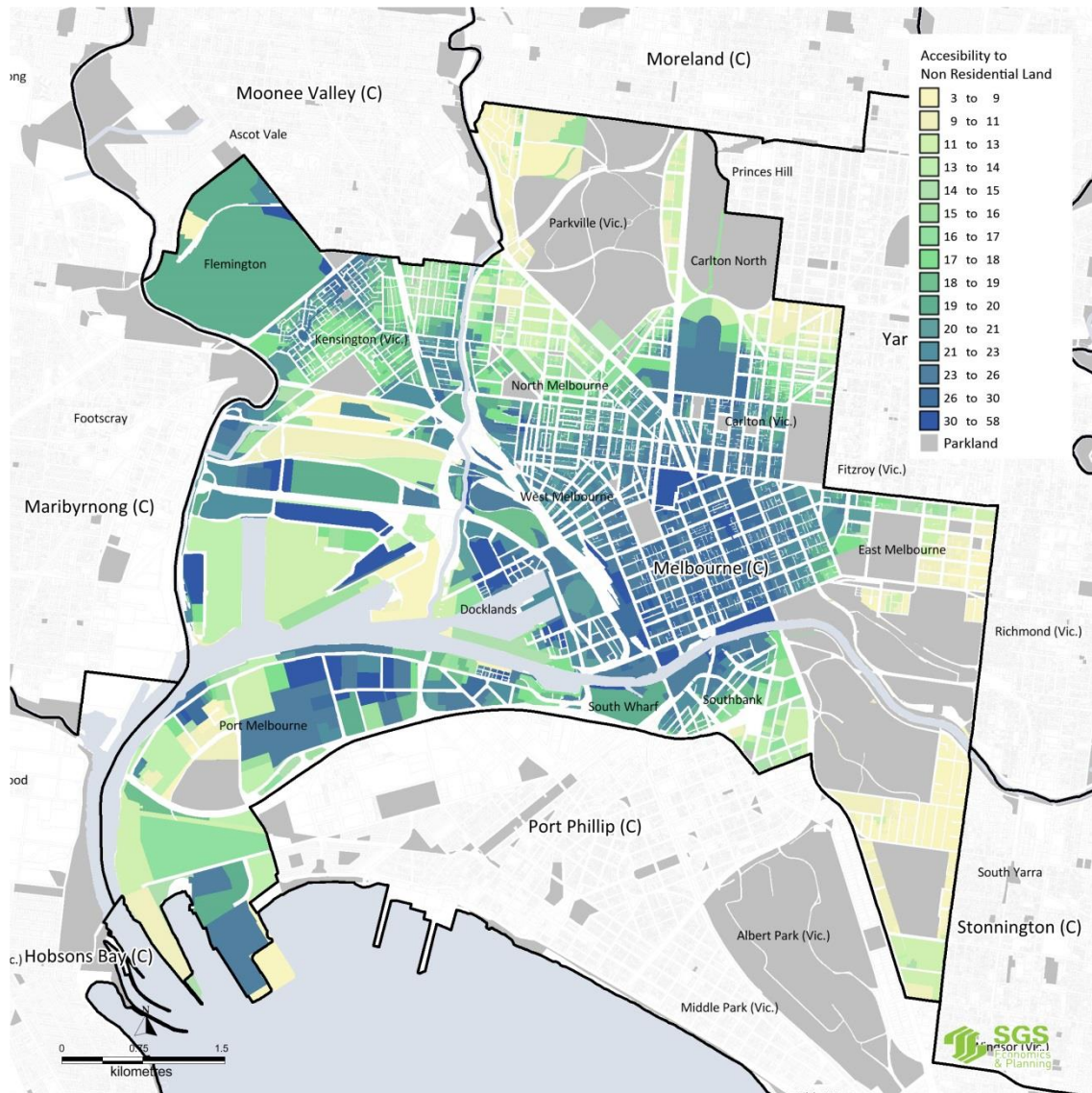


## Access to employment land

### Current employment

Figure 40 illustrates the level of access to employment land within a 30 minute walk, as determined by land use zoning. The CBD, Docklands, Port Melbourne and southern parts of Carlton and North Melbourne have the highest accessibility. Lower accessibility is evident in the northern parts of Parkville, eastern parts of East Melbourne, North Carlton and South Yarra (those locations which fall within the City of Melbourne).

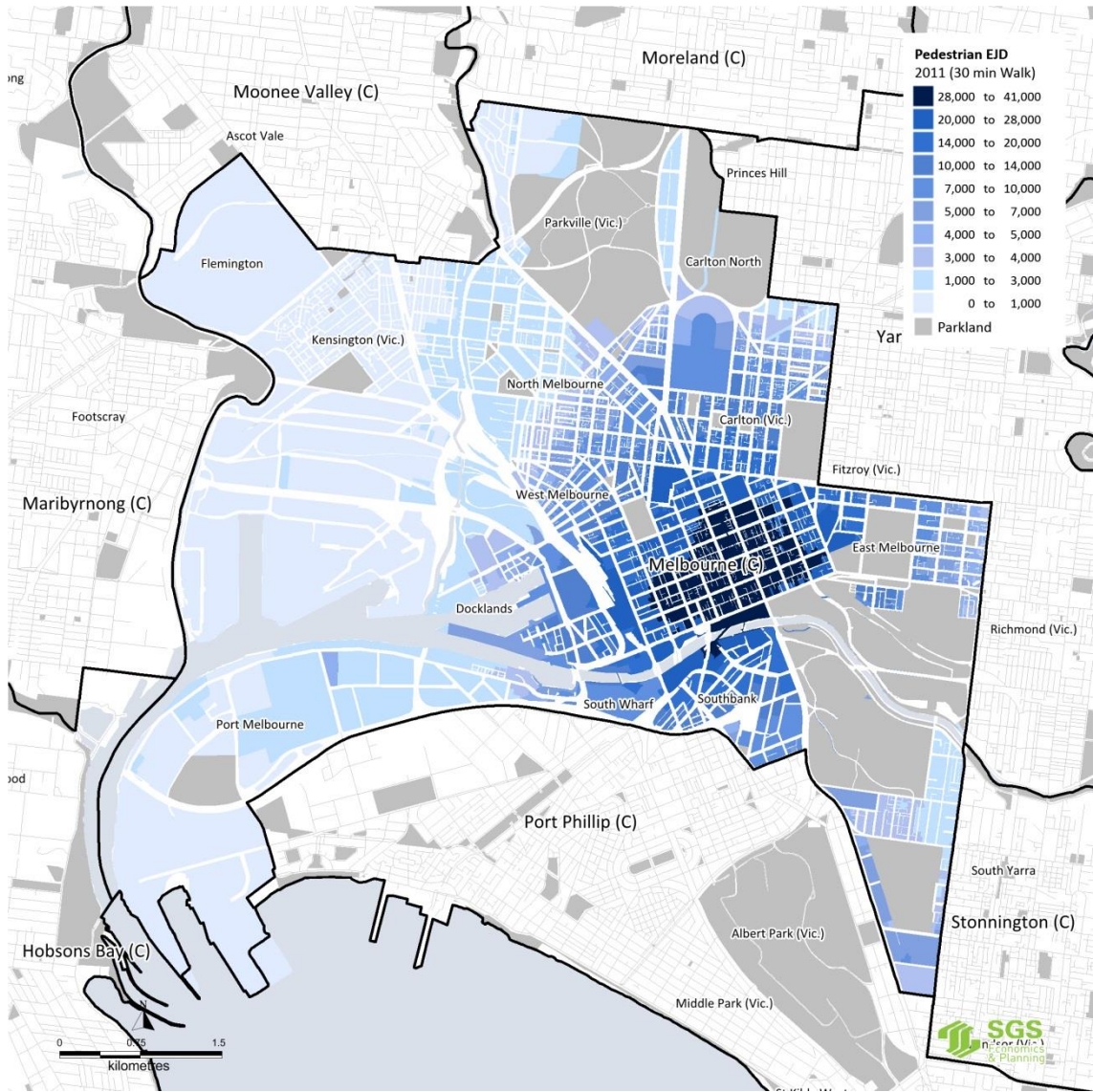
**FIGURE 40. ACCESS TO EMPLOYMENT LAND**



Source: SGS Economics and Planning

Figure 41 further illustrates accessibility to employment, using EJD as a measure. The CBD has the highest density of jobs available within a 30 minute walk. Density gradually decreases towards suburbs surrounding the CBD, and is quite low in residential areas of Kensington and parts of North Melbourne and Parkville. Due to the land-intensive nature of employment in Port Melbourne, EJD is quite low.

**FIGURE 41.EFFECTIVE JOB DENSITY (2011)**

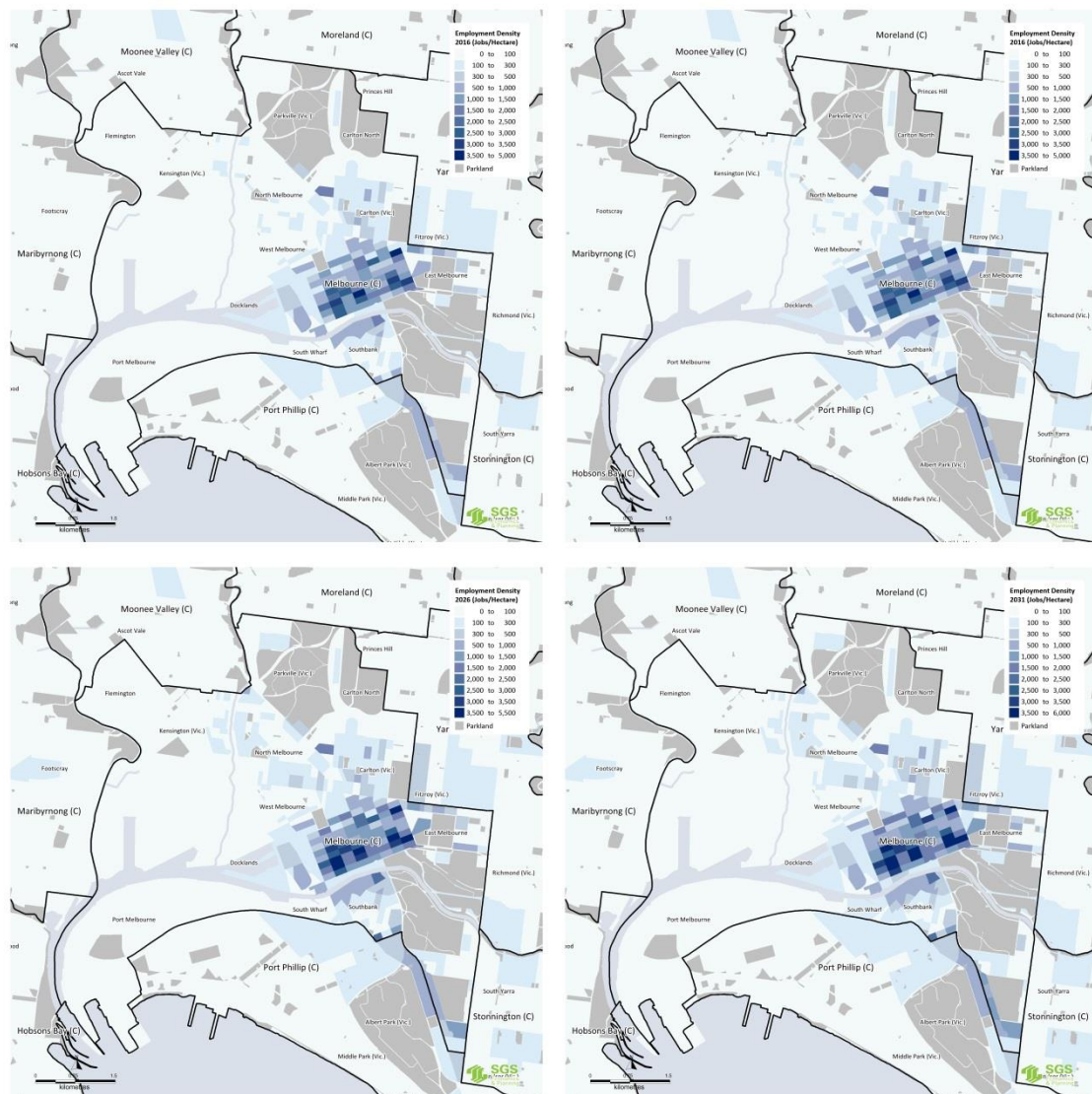




## Future employment

Using the current pedestrian network and employment projections for the City of Melbourne, employment density forecasts were developed for 2016, 2021, 2026 and 2031. Figure 42 displays projected employment density (jobs per hectare) for the City of Melbourne for each year. The most significant change is higher employment density in North Melbourne (reflecting Arden Macaulay). The Appendix contains maps with a finer level of detail for each year.

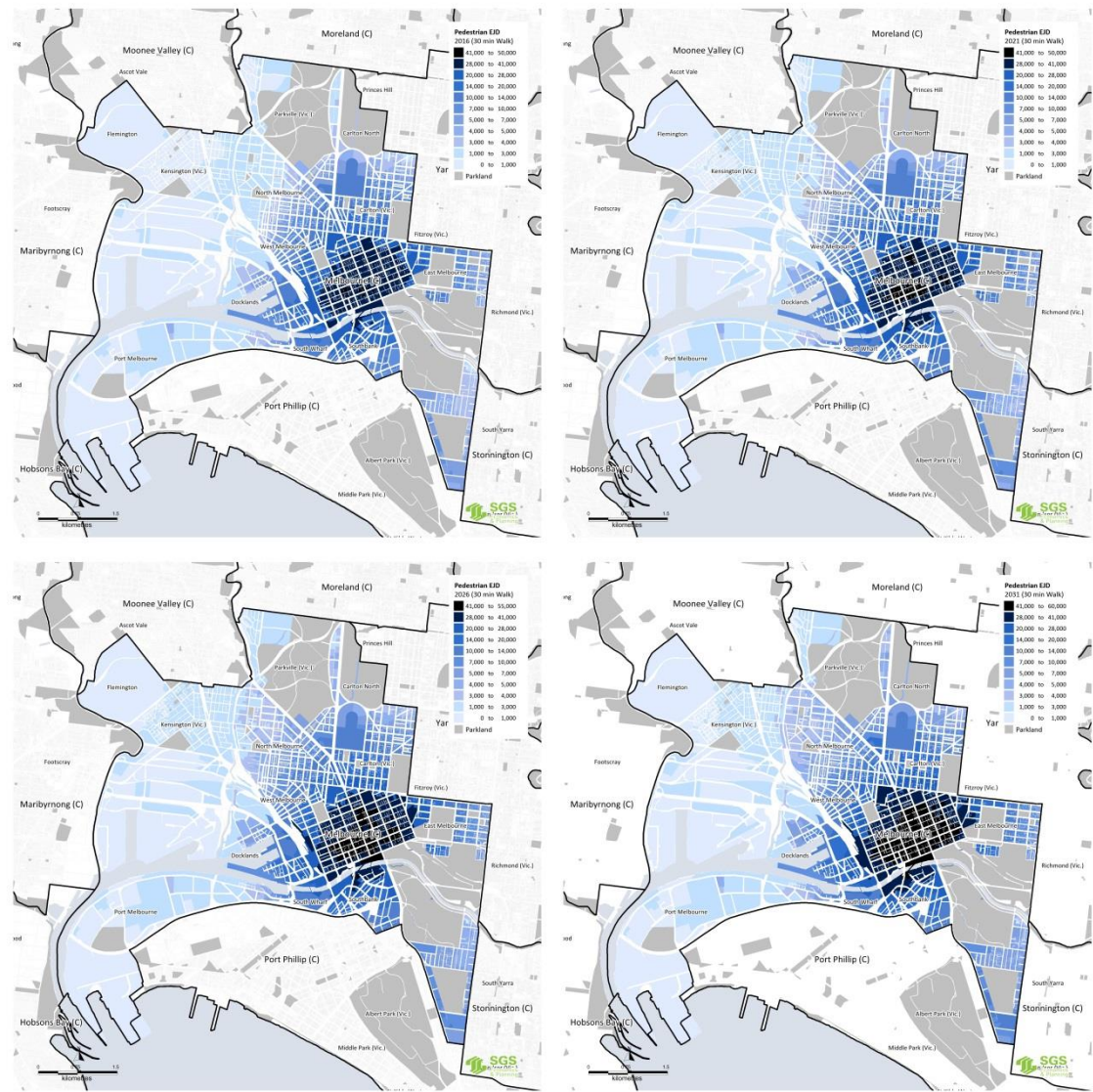
**FIGURE 42. EMPLOYMENT DENSITY FORECAST (2016-2031)**



Source: SGS Economics and Planning

Using the revised employment density with the travel time matrix for pedestrians, EJD forecasts were prepared. The following figure displays the change in EJD for 2016, 2021, 2026 and 2031. Again, the most significant projected change is an increase in EJD for North Melbourne. The Appendix contains maps with a finer level of detail for each year.

**FIGURE 43. FUTURE EFFECTIVE JOB DENSITY (2016-2031)**

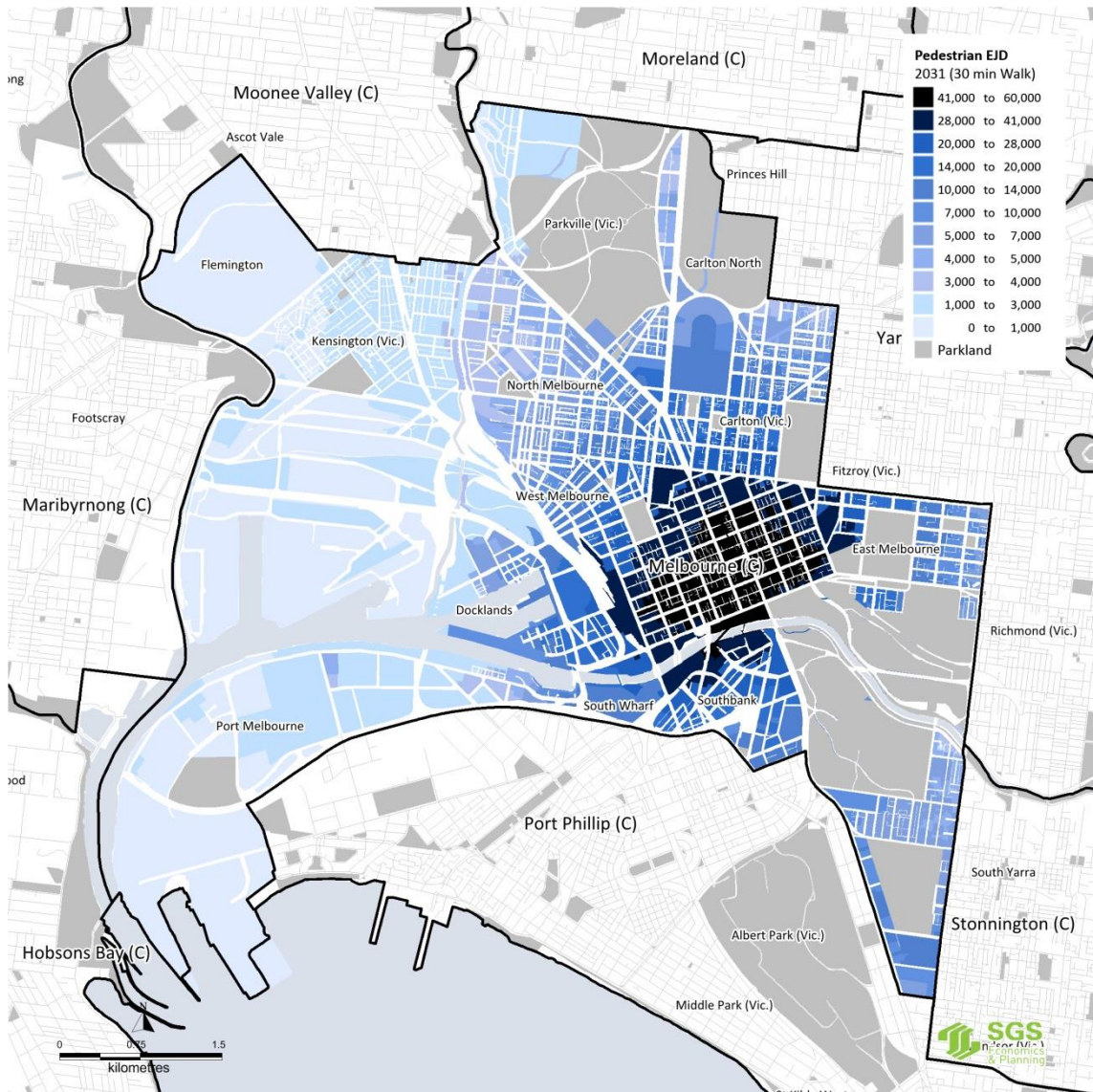


Source: SGS Economics and Planning



The following map provides a more detailed look at EJD in 2031, when EJD in North Melbourne is projected to improve to mirror the accessibility enjoyed by Carlton, West Melbourne and East Melbourne.

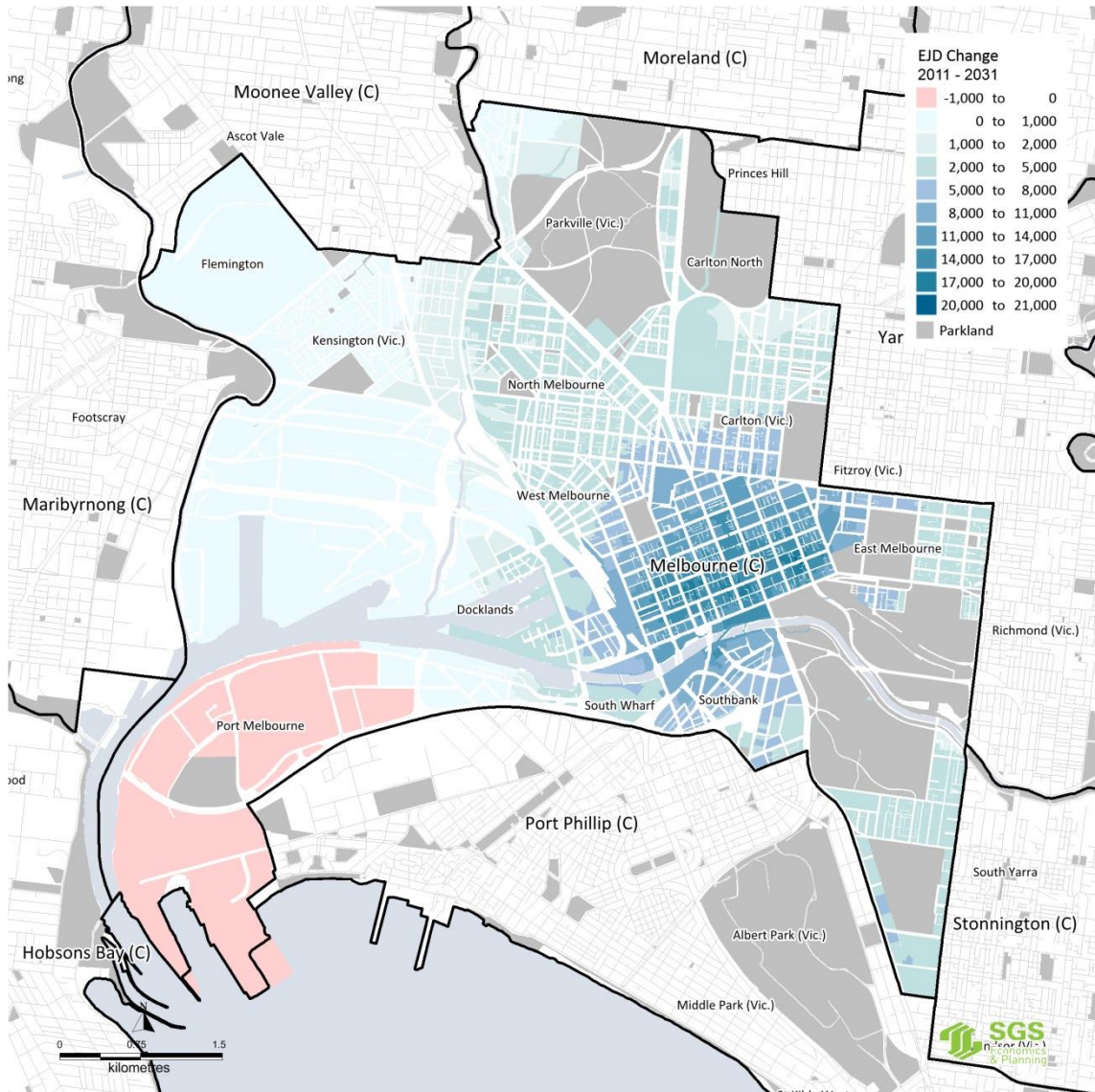
**FIGURE 44.EFFECTIVE JOB DENSITY (2031)**



Source: SGS Economics and Planning

To further understand the change in EJD, Figure 45 illustrates the uplift in EJD that is anticipated from 2011 to 2031. The map shows EJD increasing most markedly in the CBD – due to the existing high levels of employment, this change is not as clearly depicted in maps showing overall EJD. This uplift is the result of a projected increase in the number of jobs and is not related to the pedestrian network. A reduction in employment over the 20 year forecast period shows a decrease in EJD in Port Melbourne.

**FIGURE 45.EFFECTIVE JOB DENSITY CHANGE (2011-2031)**

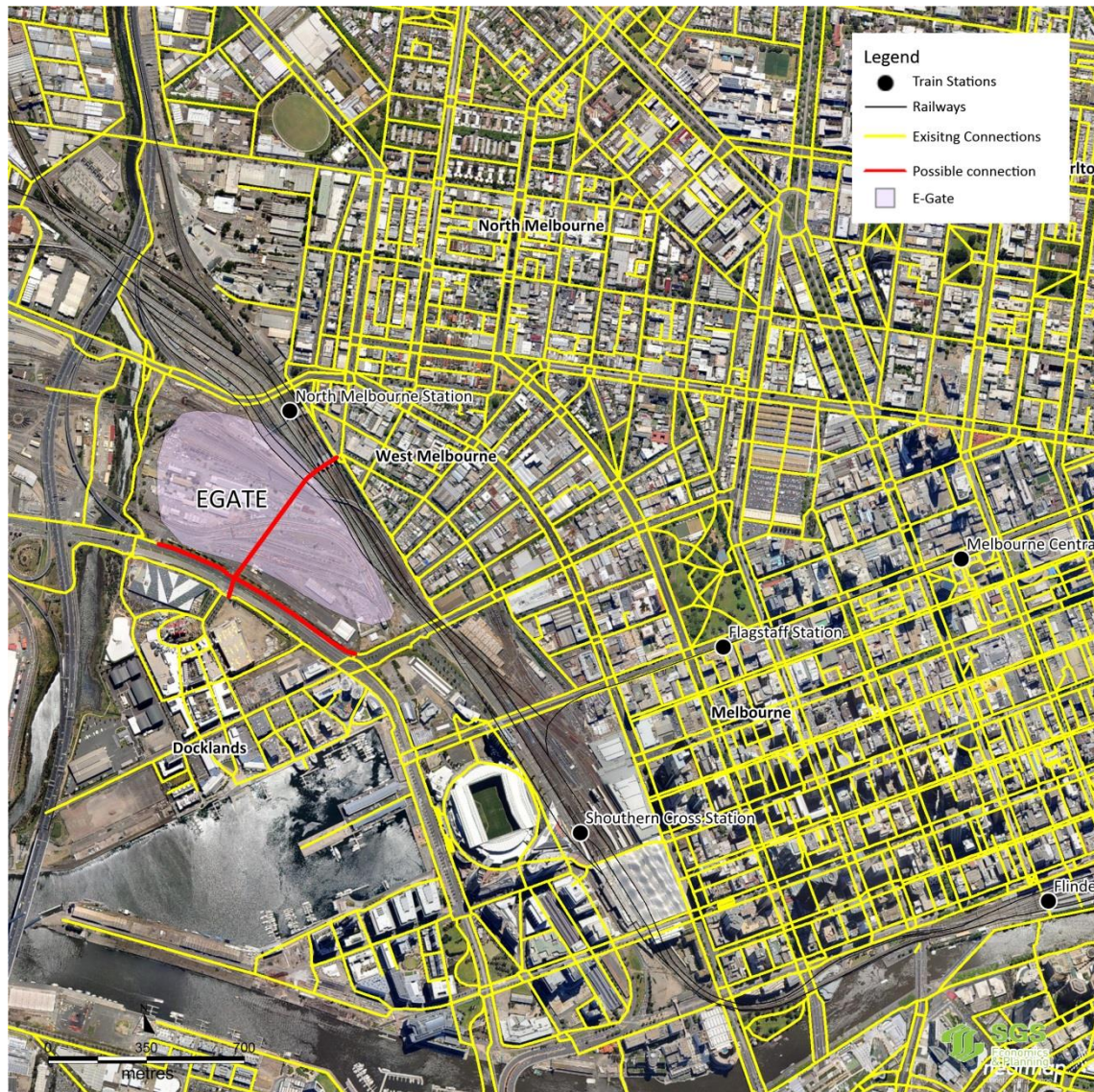




## Impact of the E-Gate development

E-Gate - railway land which is mooted for redevelopment in the future - is strategically located between Docklands and West Melbourne (see Figure 46). Development of E-Gate is likely to change accessibility and EJD within the City of Melbourne.

**FIGURE 46. E-GATE SITE**

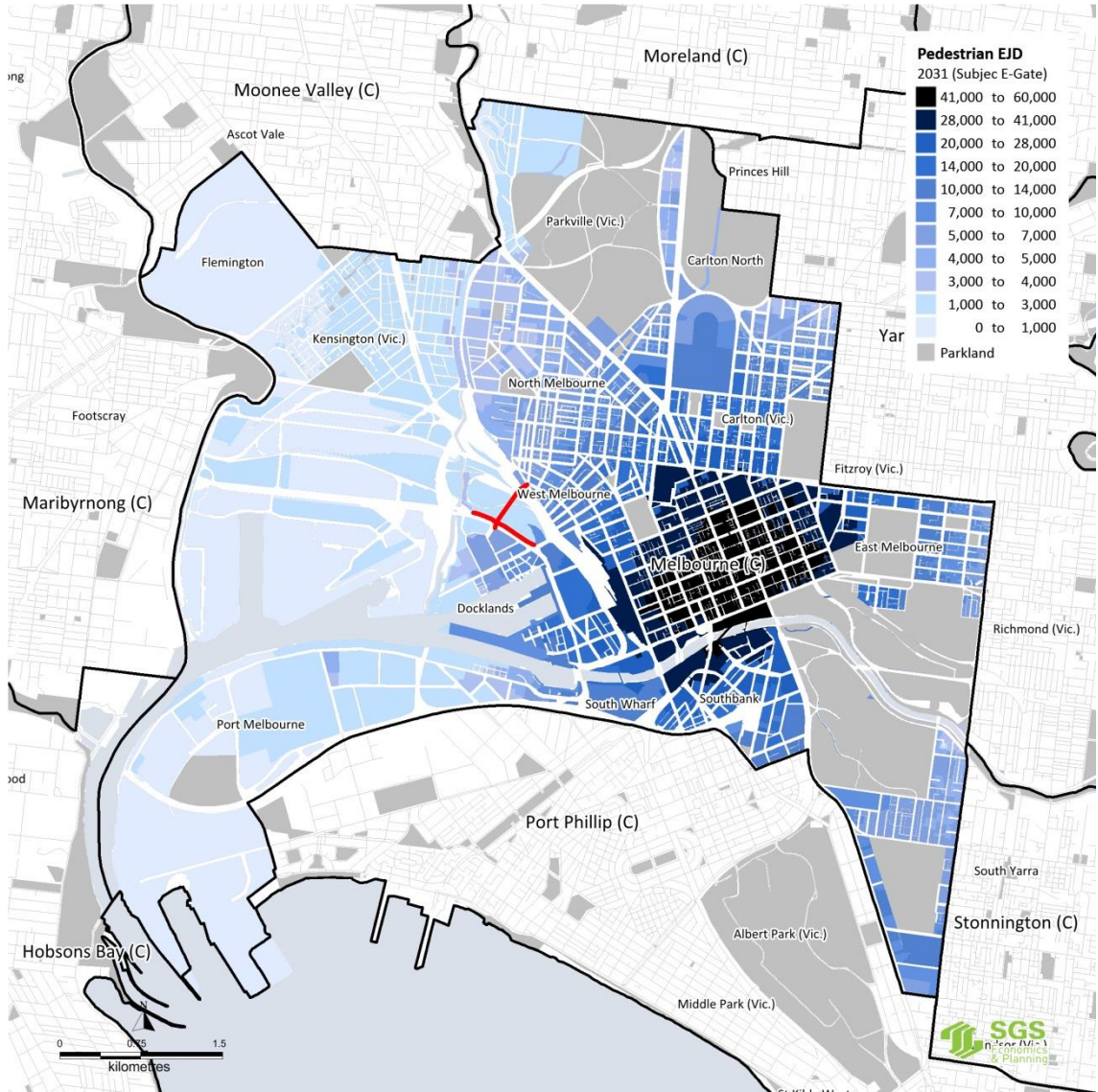


Source: SGS Economics and Planning



To understand the impact of the E-Gate development on accessibility, a revised pedestrian network and EJD was developed, including the addition of two pedestrian connections. Figure 47 shows these connections in red as well as the resultant EJD in surrounding parcels of land.

**FIGURE 47.EFFECTIVE JOB DENSITY RESULTING FROM E-GATE DEVELOPMENT**

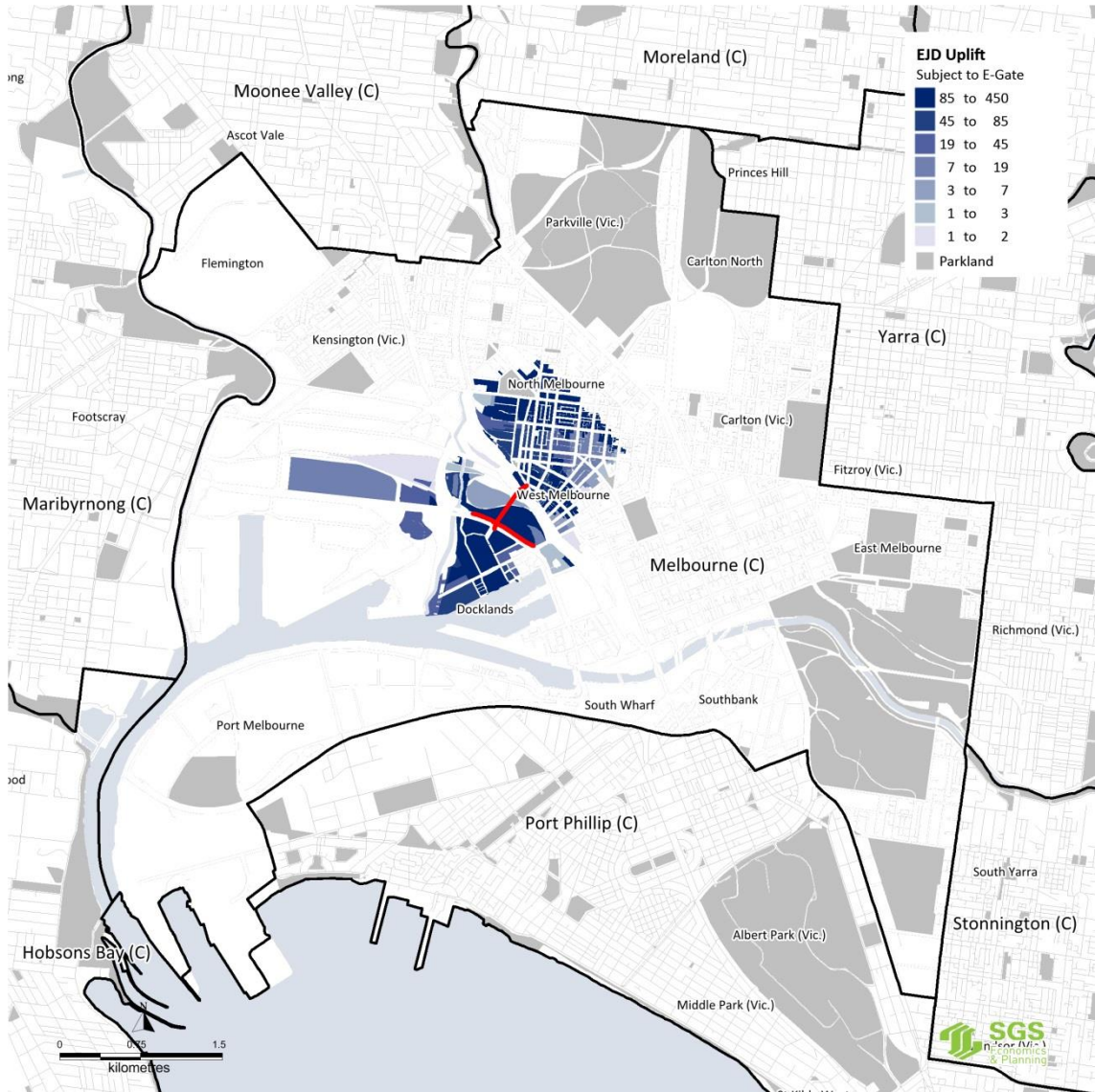


Source: SGS Economics and Planning



Figure 48 isolates the impact of the development of E-Gate (and inclusion of two additional pedestrian connections) on EJD. As shown, the benefit is expected to extend to Docklands, West Melbourne and North Melbourne. Changes in EJD relating to the E-Gate development are a result of improvements to travel time.

**FIGURE 48.CHANGE IN EJD RESULTING FROM E-GATE**



Source: SGS Economics and Planning

## 4 AREAS FOR FURTHER RESEARCH

In applying a method to create a walk EJD, this project has provided an insight into the economic function of the CBD grid. A range of areas for further research have been identified, and include:

- Extending the EJD analysis to the whole of the City of Melbourne.
- Improving the labour productivity statistics for the City of Melbourne.
- Sensitivity analysis around the walk speeds along various links within the network.
- Increase understanding of the capacity of various links within the network.
- Conducting the analysis over time (2002, 2004, 2006, 2008 and 2010) to understand the impact of EJD on employment growth, including examining the impact of any changes made to the network over that time.
- Produce scenarios of proposed changes to the network to test their impact.
- Catchment analysis for various pieces of infrastructures (train stations, tram stops, urban services).
- Better understanding the flow of pedestrians within the City of Melbourne.

## 5 REFERENCES

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< <http://usj.sagepub.com/content/39/5-6/871.short> >

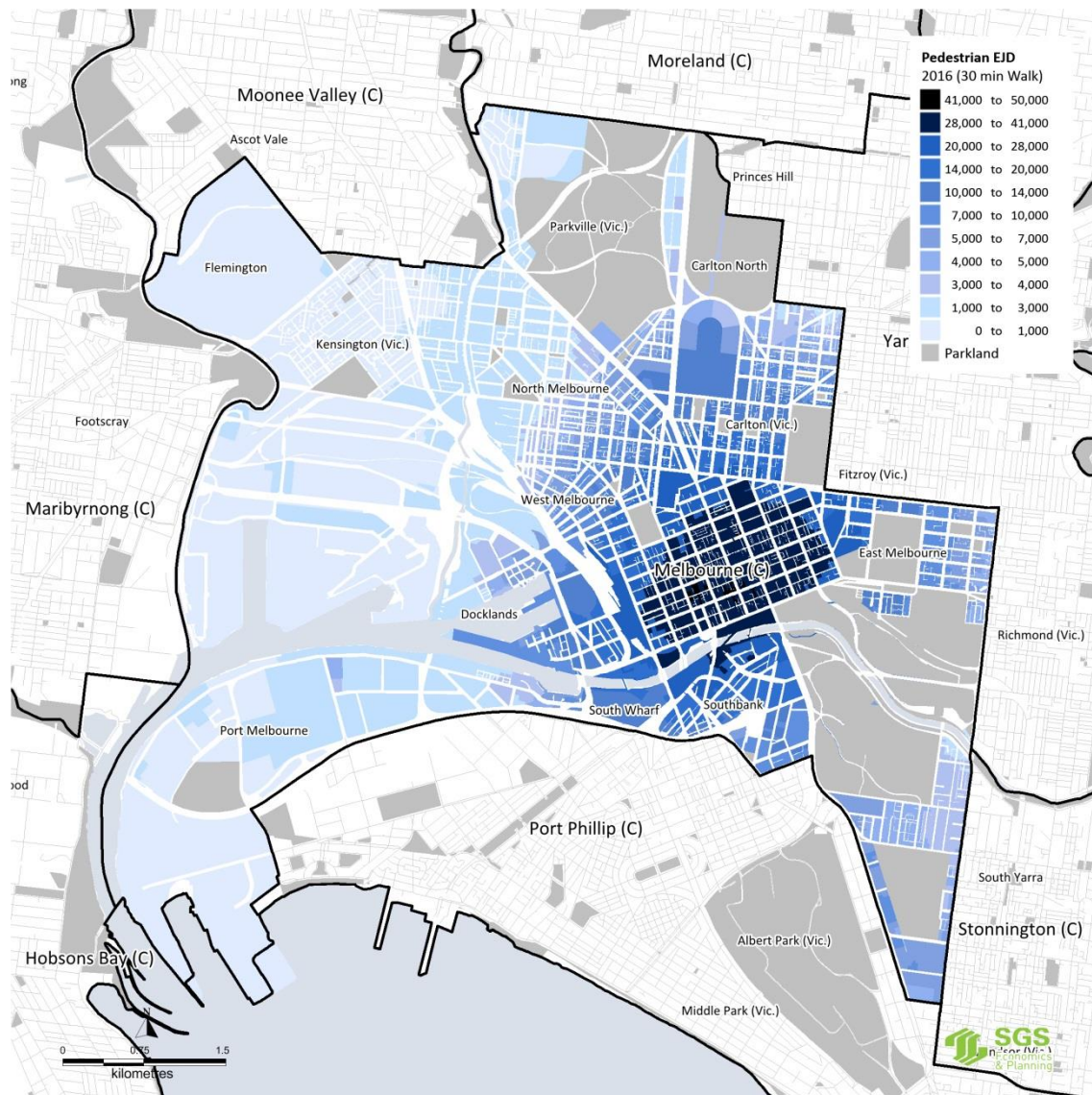
Marshall, A. (1920) 'Principles of Economics', Macmillan and Co Ltd

Rawnsley, T., Spiller, M. (2011) 'Melbourne's Transformation: Rust Belt to Renaissance',  
<[http://www.sgsep.com.au/system/files/Melbourne's\\_Transformation\\_Rust\\_Belt\\_to\\_Renaissance.pdf](http://www.sgsep.com.au/system/files/Melbourne's_Transformation_Rust_Belt_to_Renaissance.pdf)>



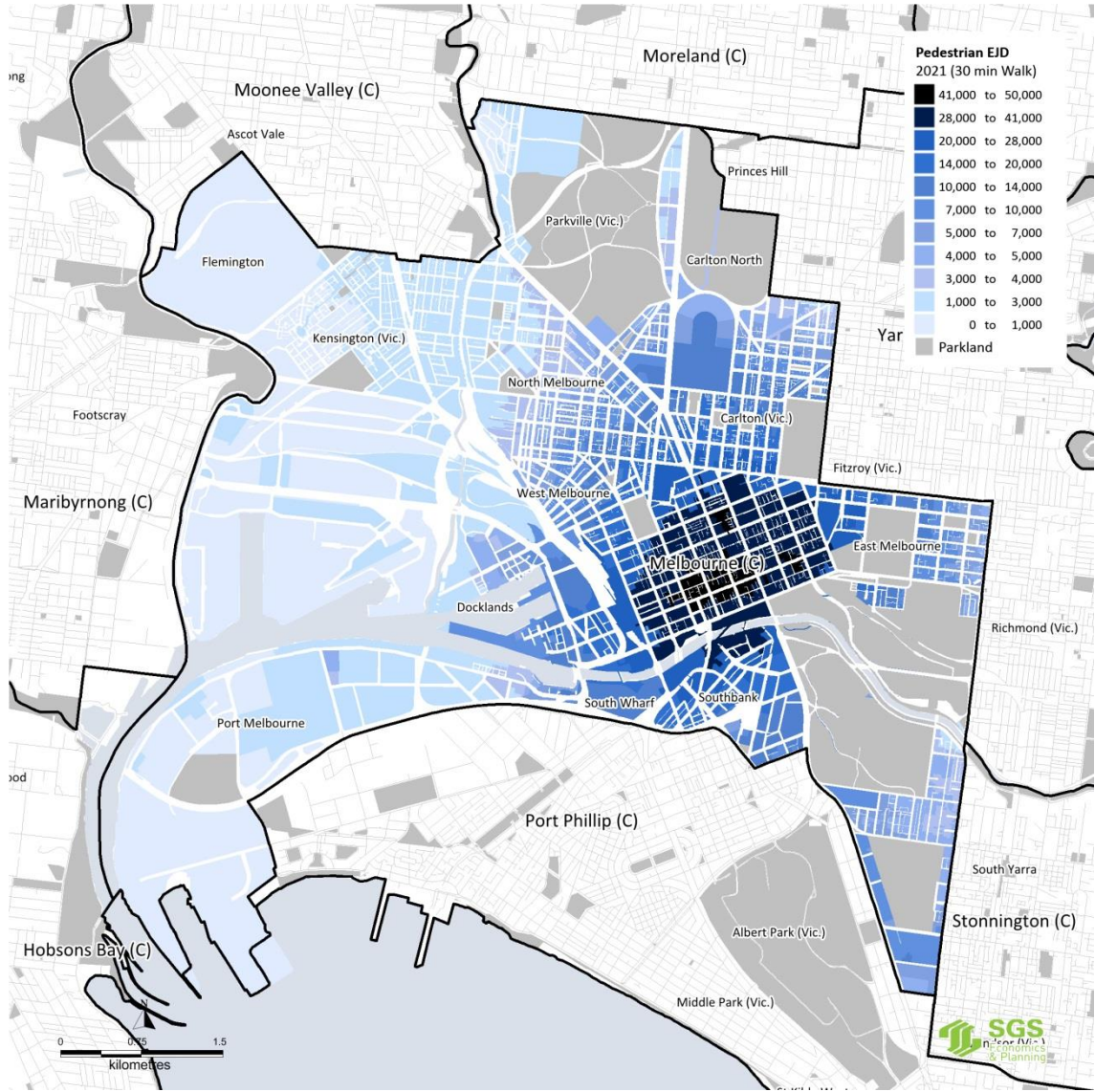
# APPENDIX

**FIGURE 49. EFFECTIVE JOB DENSITY (2016)**



Source: SGS Economics & Planning

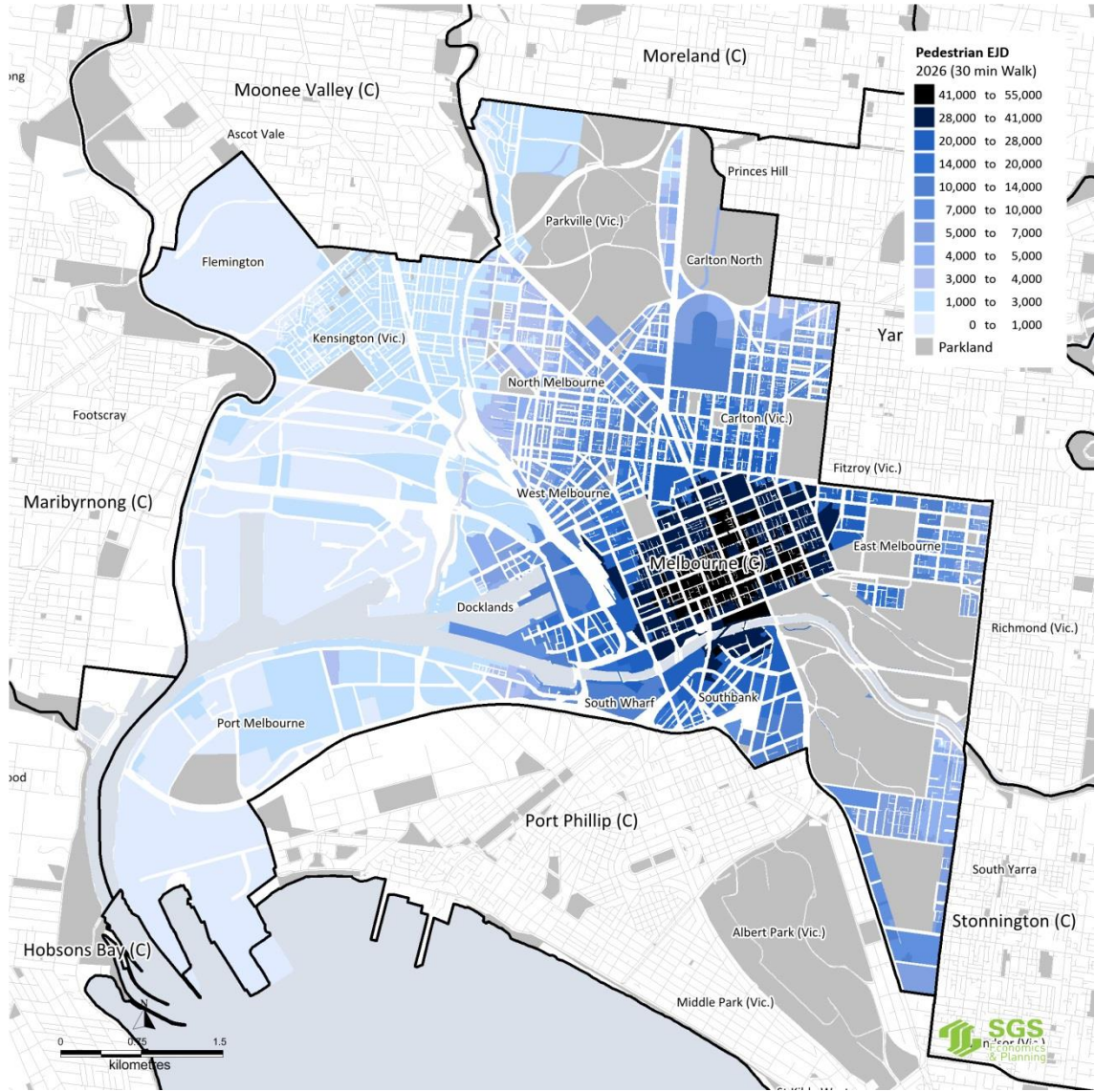
FIGURE 50.EFFECTIVE JOB DENSITY (2021)



Source: SGS Economics & Planning



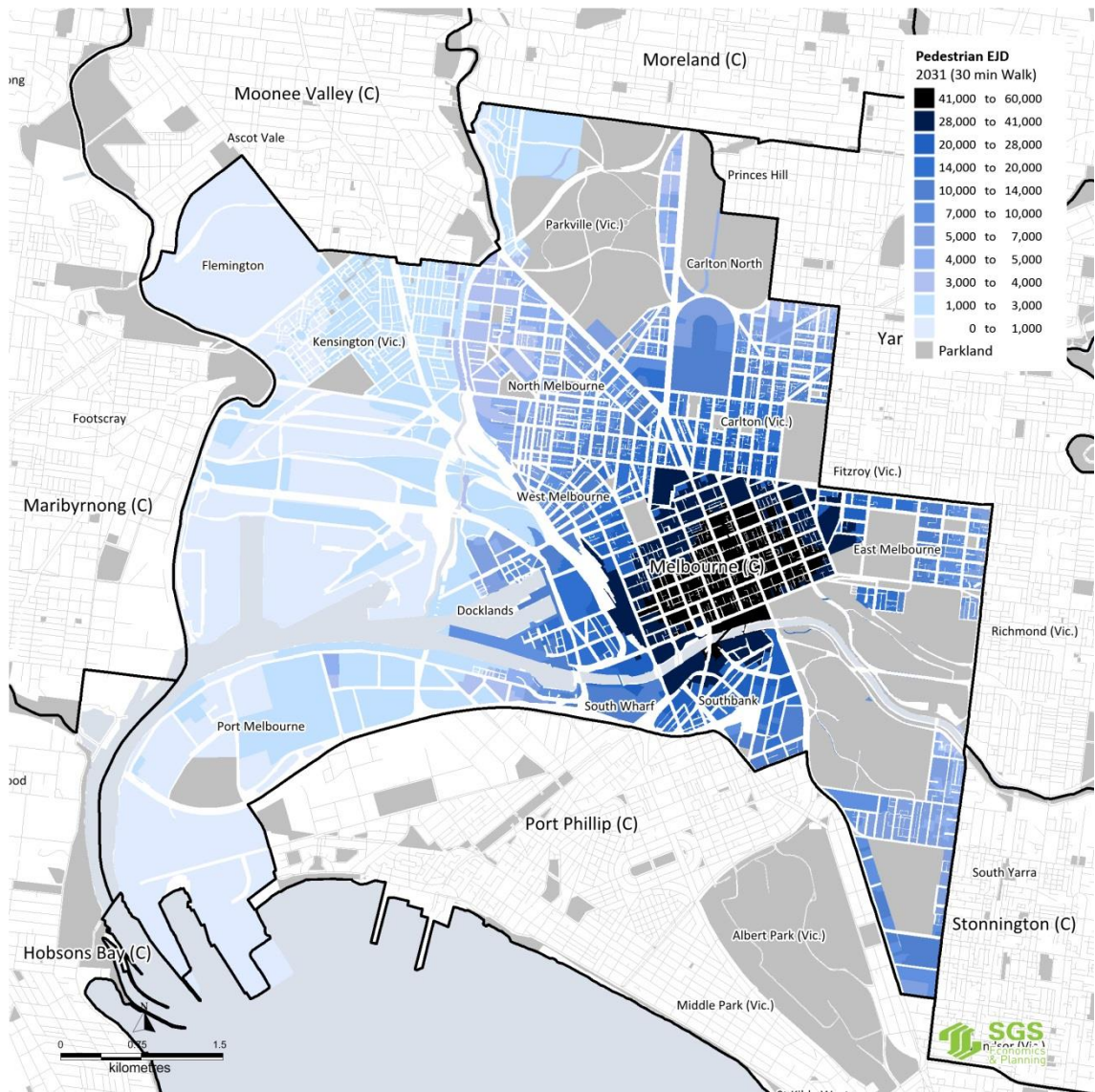
FIGURE 51.EFFECTIVE JOB DENSITY (2026)



Source: SGS Economics & Planning



FIGURE 52.EFFECTIVE JOB DENSITY (2031)



Source: SGS Economics & Planning

FIGURE 53.EMPLOYMENT DENSITY (2011)

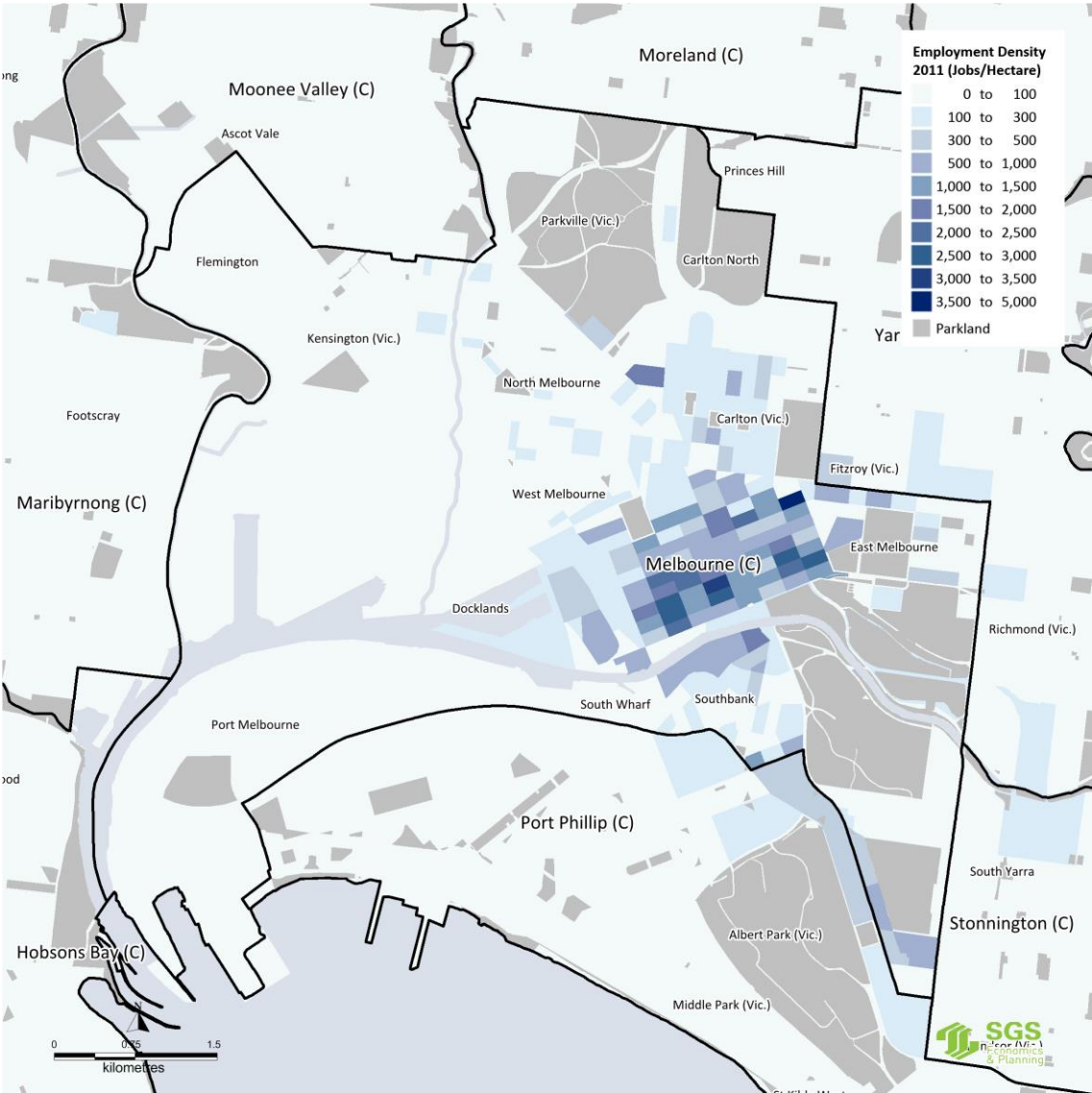


FIGURE 54.EMPLOYMENT DENSITY (2016)

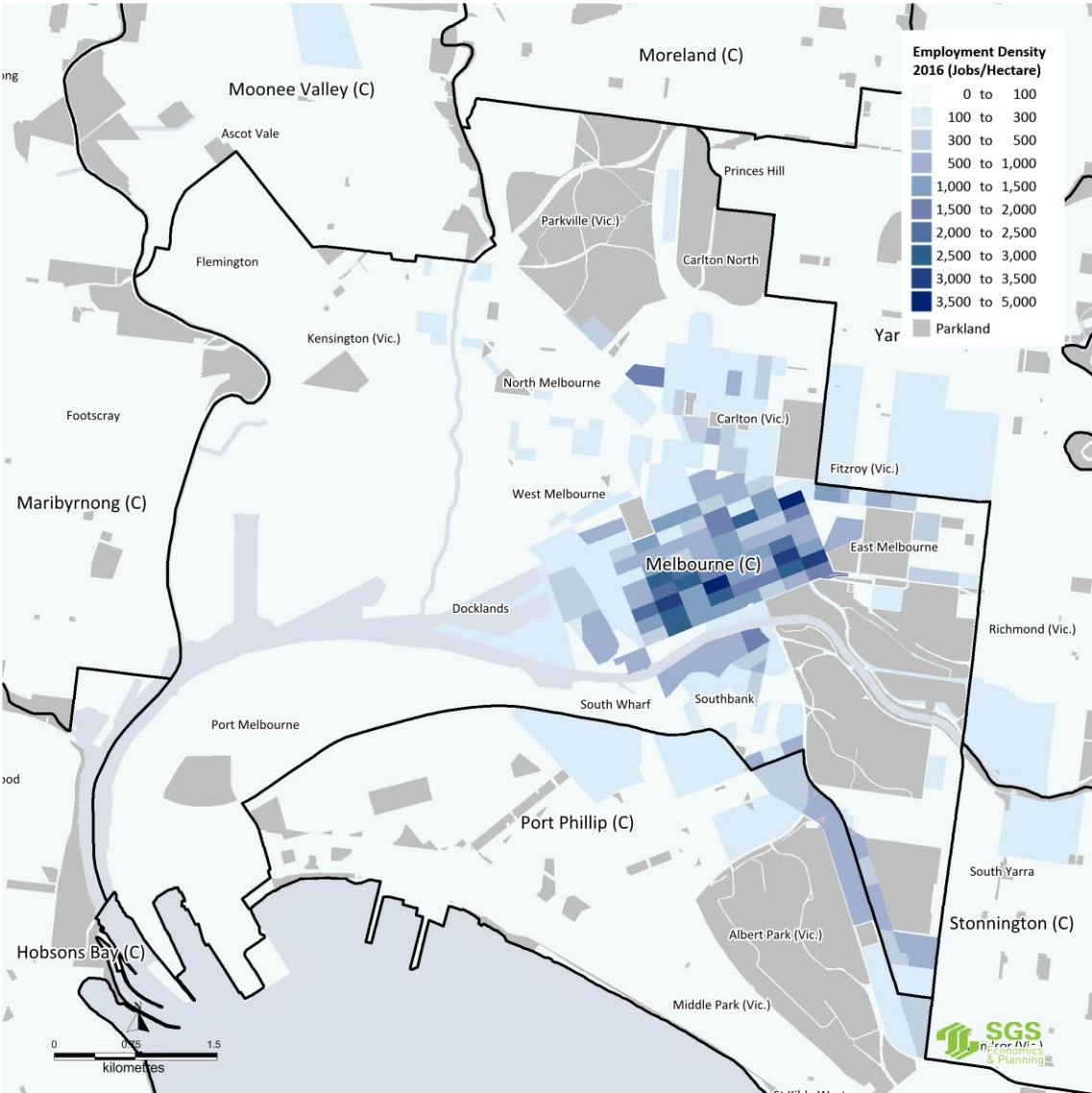




FIGURE 55.EMPLOYMENT DENSITY (2021)

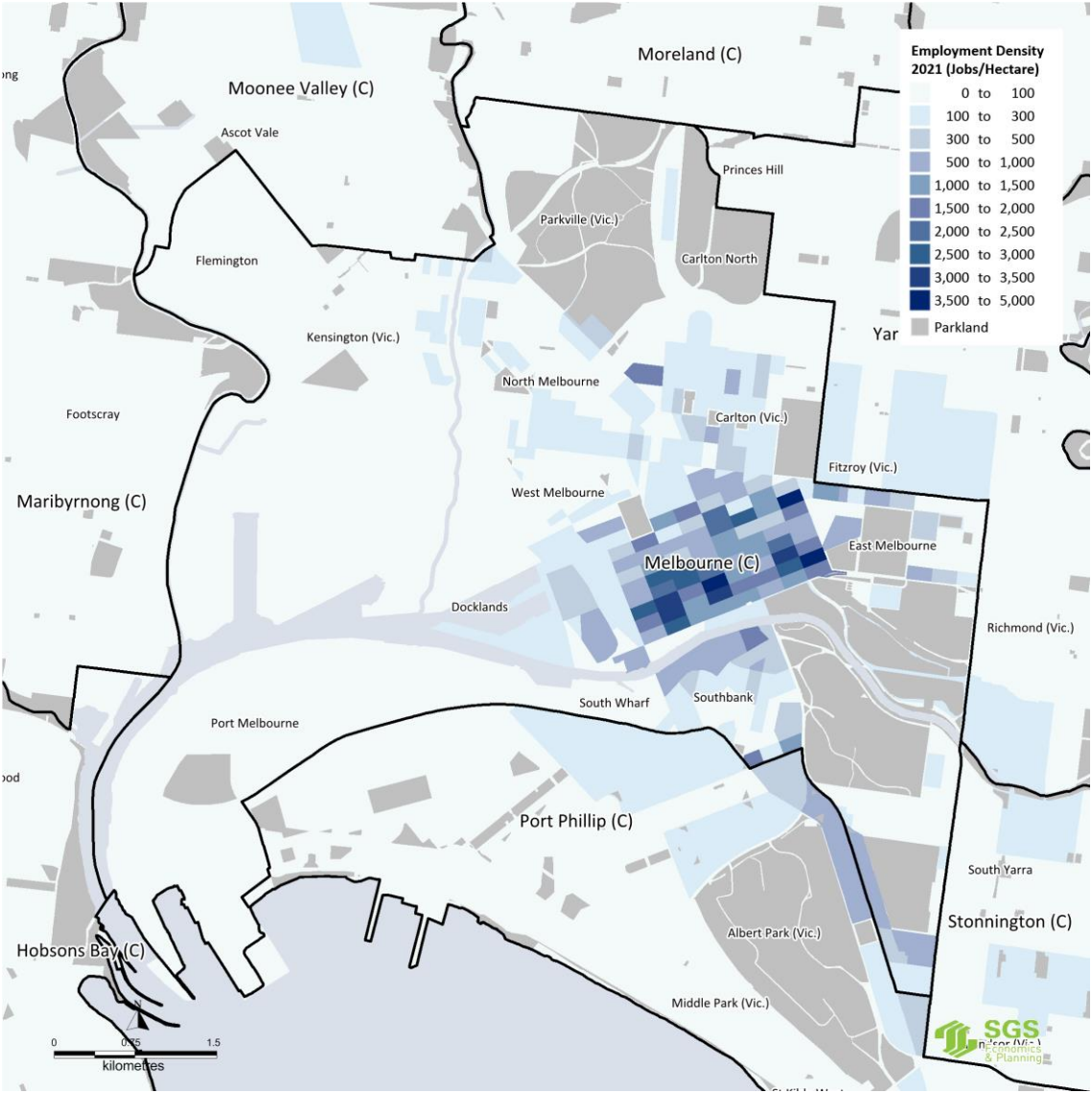


FIGURE 56.EMPLOYMENT DENSITY (2026)

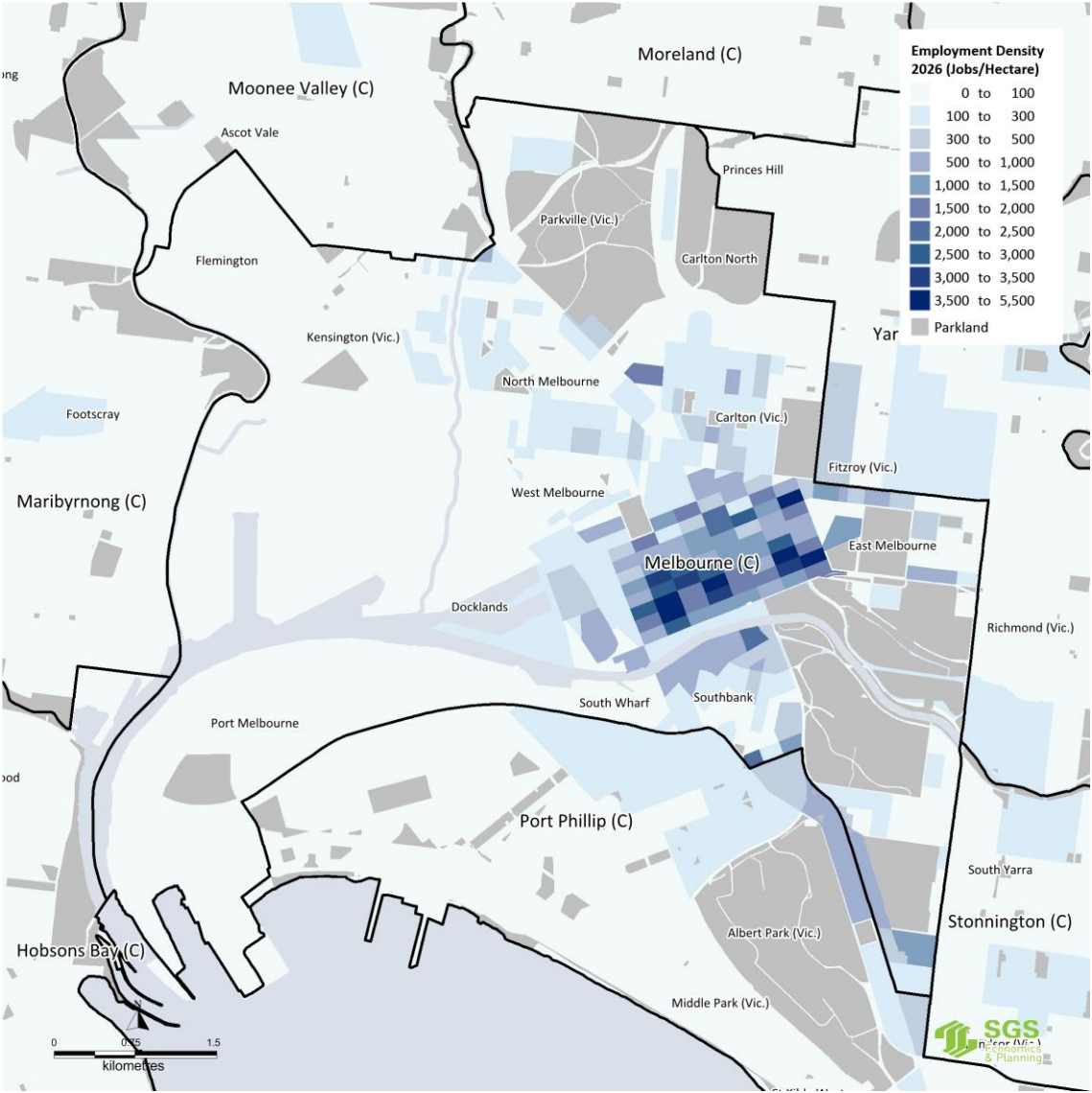
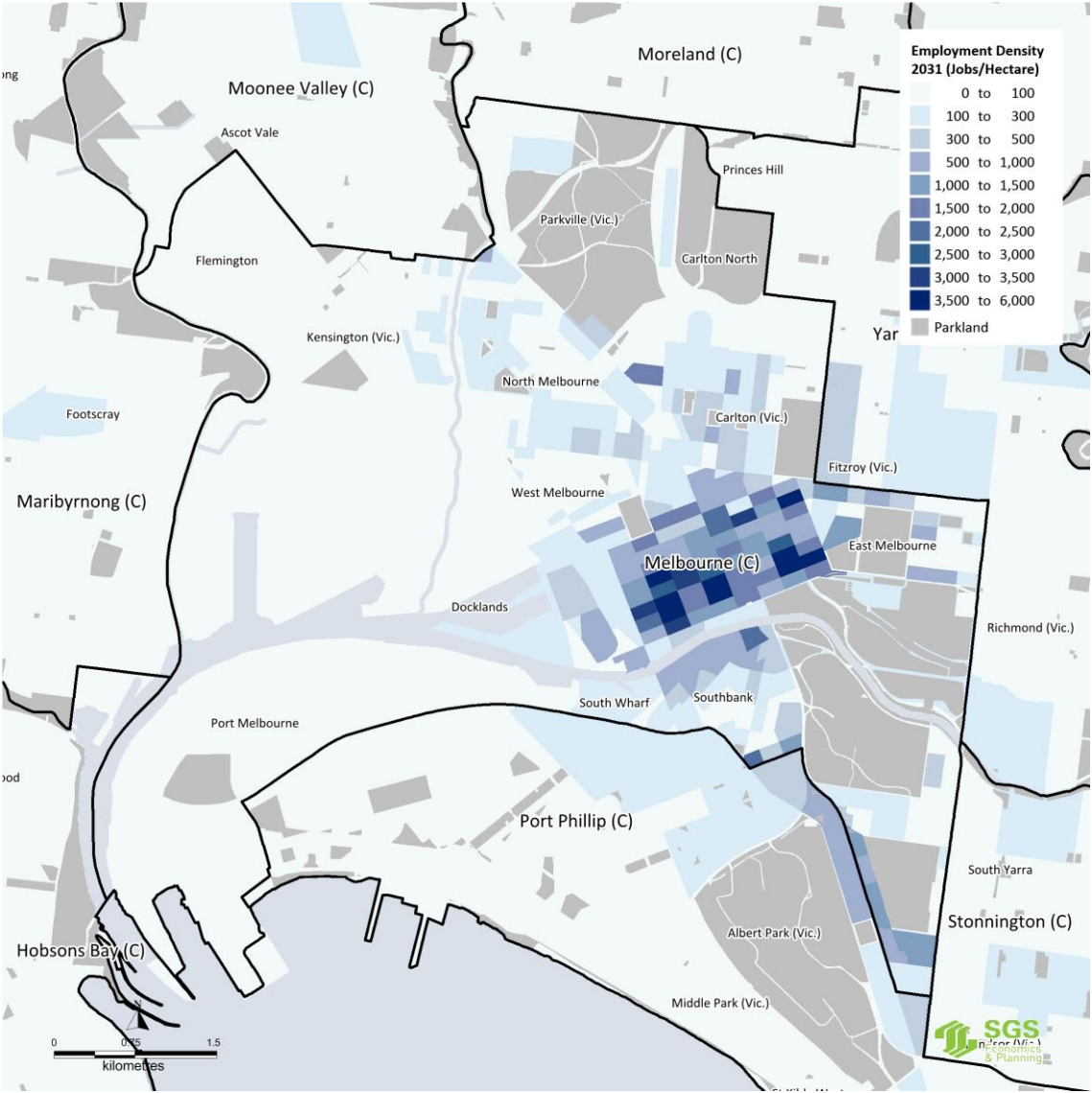
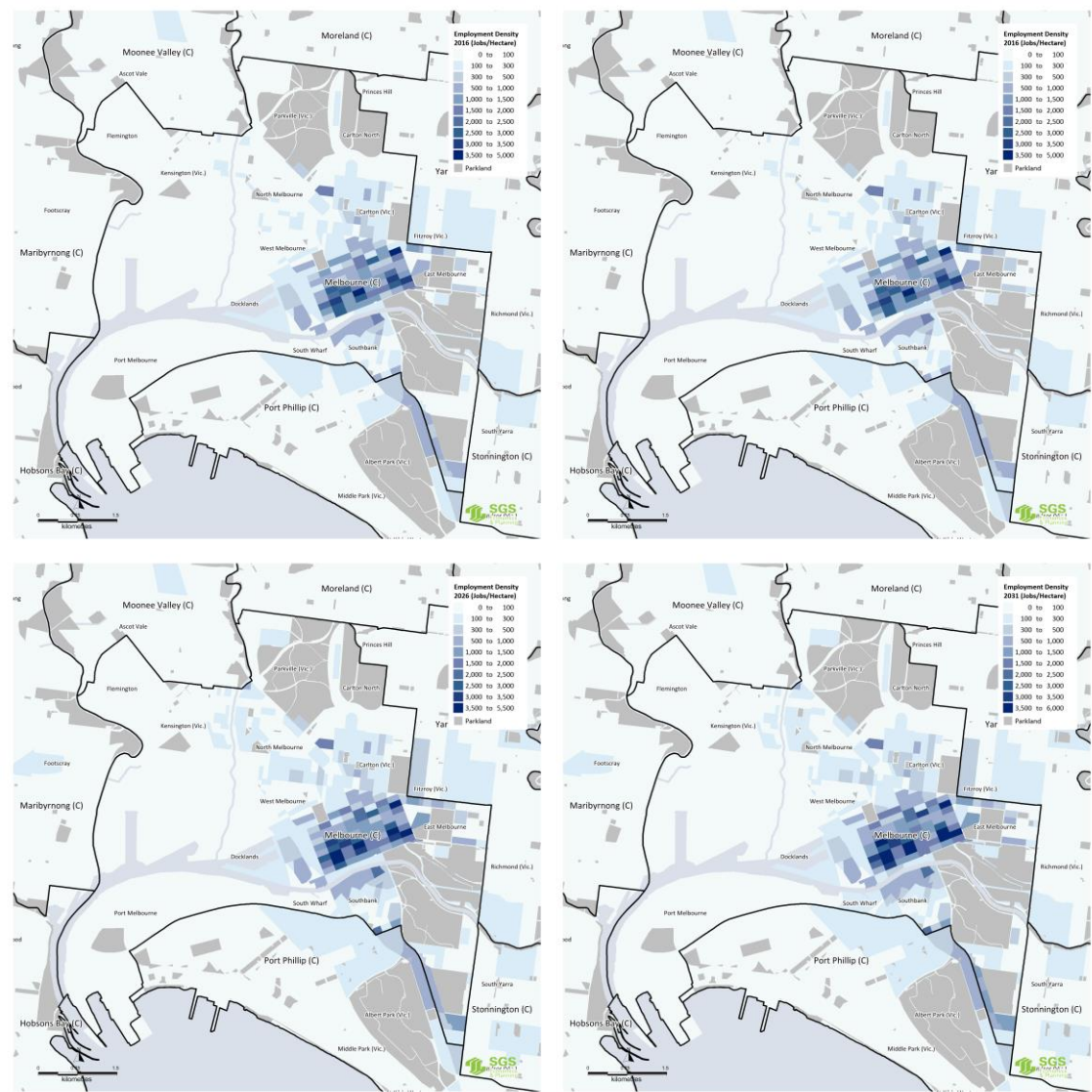


FIGURE 57.EMPLOYMENT DENSITY (2031)





**FIGURE 58. EMPLOYMENT CHANGE (2016-2031)**



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