

MEASURING THE PERFORMANCE OF TRANSIT-ORIENTED DEVELOPMENTS IN WESTERN AUSTRALIA



Planning and Transport Research Centre

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Executive Summary

This report makes recommendations regarding measurement of the performance of transit oriented developments (TODs) using a holistic perspective based on liveability and sustainability. Recent studies in the United States, particularly in New Jersey and California, provide a framework for measuring TOD performance and demonstrate a means for dissemination of performance data through an online TOD searchable database.

The report has been prepared for the TOD Coordinating Committee of the State Government of Western Australia, as a basis for a program to monitor the future performance of transit oriented developments which may be implemented in Perth, Western Australia.

The method reported here recommends longitudinal measurement of performance indicators in six categories, including travel behaviour, the local economy, the natural environment, the built environment, the social environment and the policy context. Data have been collected and reported here in these categories in five potential TOD precincts in Perth metropolitan area. Recommended indicators for each category are presented below:

1. Travel Behaviour

- Vehicles kilometres travelled (VKT)
- Mode split
- Frequency of public transit usage
- Resident commuting time
- Quality of transit service
- Vehicle ownership
- Transport-related perceptions of residents:
 - I feel safe walking around my neighbourhood at night
 - My neighbourhood is well served with public transport
 - Traffic is not a major issue in the area
 - The neighbourhood is easy to walk around
 - Footpaths are in good condition
 - It is easy to cross the street
 - I feel safe from traffic while walking
 - Drivers give way to pedestrians crossing the road
 - I can easily walk to the train station from my house
 - Hills along the route area barrier to walking to the train station
 - One of the main reasons I live here is to be close to the train station.

2. The Local Economy

- Number of jobs by type
- Vacancy rate
- Home ownership vs. rental
- Weekly housing expenses
- Property value

3. The Natural Environment

- Transport energy consumption (computed)
- CO2 emissions (computed)
- Park space
- Percent of land cover as greenspace
- Percent of land cover as trees

4. The Built Environment

- Population and housing density
- Street Quality
- Amount and quality of public space
- Land cover/land use distribution
- Pedestrian accessibility (ped shed)
- Parking inventory

5. The Social Environment

- Education
- Income
- Quality of life (resident perceptions)
 - My neighbourhood is a good place to live
 - My neighbourhood is a better place to live than other parts of Perth
 - My neighbourhood is clean and well maintained
 - My neighbourhood is a low crime area, compared to other parts of Perth
 - The neighbourhood centre is an attractive place that is nice to be in
 - I can do all my weekly/day-to-day shopping in the neighbourhood centre
 - There is a strong community feeling in my neighbourhood
 - The area is quiet and free from traffic and other noise pollution
 - The neighbourhood is well provided with community facilities
 - There are many opportunities for recreation in my neighbourhood

6. The Policy Context

- TOD future potential (TOD Assessment Tool)
- Existing zoning
- Resident support for more retail development
- Resident support for more office space development
- Resident support for more residential development.

The indicators presented here are a top-down approach to measuring TOD performance. Future data collection and analysis should be overseen by the State of Western Australia's TOD Coordinating Committee (TODCC). Data collection should occur on a regular interval, say once every five years. If the TODCC were to collect data on 5 precincts per year, it would be possible to monitor 25 stations in a five-year cycle. It is recommended that stations be assessed at least twice, because longitudinal comparisons yield the most useful information. The TODCC may want to consider conducting other surveys of employees and users of the TOD space. The TODCC should also coordinate its assessments with TravelSmart.

This study also recommends a bottom-up approach to complement the top-down, data-driven approach. This would include creating local stakeholder committees to help establish and monitor short, medium and long-term goals based on local needs.

Introduction

Transit-oriented development (TOD) is gaining wide acceptance in Australia as a tool to achieve sustainable development, particularly in Western Australia (WA). *Hope for the Future: The Western Australian State Sustainability Strategy* (2003) discusses the need to manage growth, revitalise declining centres and suburbs, and integrate land use with balanced transport to reduce automobile dependence. TOD seeks to accomplish these goals, creating compact, mixed-use, pedestrian-friendly precincts around major public transport stations. *Network City: Community Planning Strategy for Perth and Peel* (Government of Western Australia, 2004) calls for 60 per cent of future development to occur as 'infill'. An important way this can occur, without generating significant additional traffic congestion across Perth, is in the form of TOD.

TOD is facilitated in Perth through the State's TOD Coordinating Committee (TODCC), a cross-agency partnership including the State's Department for Planning and Infrastructure (DPI), Public Transport Authority (TransPerth), Department of Housing and Works (DHW), Main Roads WA, LandCorp (the WA Land Commission), the East Perth and Midland Redevelopment Authorities (EPRA and MRA), and the WA Local Government Association. The TODCC recently finalised a 'TOD Assessment Tool' for the purpose of evaluating and prioritising station precincts for potential TOD development.

This report sets forth a framework for establishing a set of baseline-data key performance indicators to measure the success of TODs where they are implemented across Perth. The aim is to assess the post-implementation performance of TODs by comparing their outcomes with the baseline data; typically this longitudinal assessment would be done by means of periodic data collection at regular intervals over say 5 years after formal implementation.

The study also tests the feasibility of collecting data for a number of indicators across multiple dimensions, including travel behaviour, the local economy, the natural, built and social environments, and the policy context. The goals of this study were to recommend to the TOD Committee in Western Australia a number of key performance indicators for TOD developments in Perth and to evaluate the feasibility of collecting relevant data for ongoing TOD monitoring.

Background

Sustainable development seeks to create an urban environment which maximises economic development and social equity, whilst minimising the impact of negative externalities upon the natural environment (see Figure 1). From a land use and transport perspective, the priority in this regard is to reduce automobile dependence through development of mixed land use and compact cities with an array of travel alternatives focused on walking, bicycling, and public transport (Banister, Pucher, & Lee-Gosselin, 2006; Newman & Kenworthy, 1999).

Figure 1: Theoretical Model of Sustainable Development

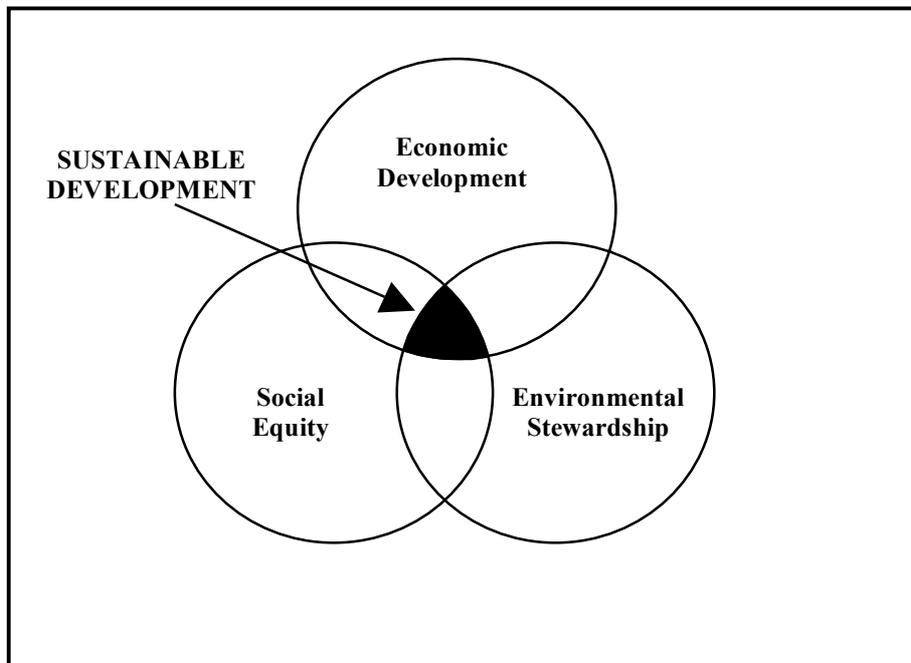


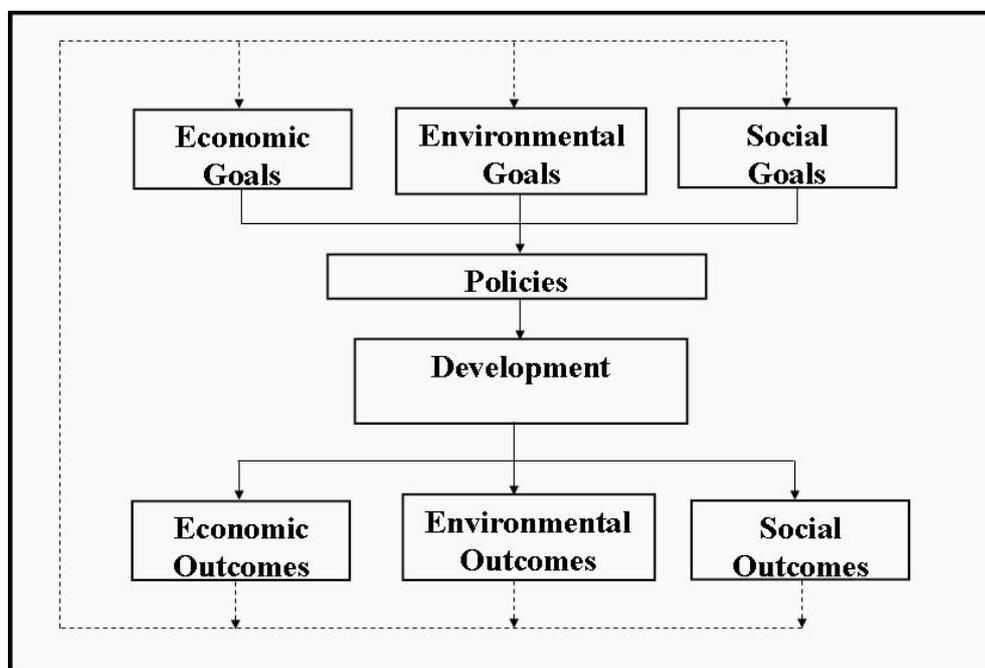
Figure 2 presents a framework which illustrates how sustainability is related to land use and transport policies and thus to development outcomes. Implicit in all land use and transport policies are economic, environmental and social goals. Policies take the form of strategic development plans, land use and zoning regulations, parking requirements, design guidelines, and transportation system investment plans and priorities. The policies help to shape the built environment leading to economic, environmental and social outcomes.

When instituting a system for measuring land use and transport outcomes, it becomes difficult to classify indicators using the three basic categories of sustainable

development (economic, environmental, and social) since many indicators cross boundaries. The method presented here evaluates six aspects of TOD outcomes, including:

1. Travel Behaviour
2. The Local Economy
3. The Natural Environment
4. The Built Environment
5. The Social Environment, and
6. The Policy Context.

Figure 2: Framework for Evaluating Sustainable Development Policies



The Difficulty of Measuring TOD Success

Success is subjective and multi-dimensional, no two TODs are alike in all respects. One TOD might yield a high transit mode share but lacks social diversity. Another might be deficient in shopping and entertainment choices but provide affordable housing on reclaimed brownfields. Moreover, the myriad of goals and aspirations commonly held out for TOD can obscure success. A recent study found that planners in Perth felt TOD was important for its contribution to increasing transit ridership, spurring economic development, increasing housing choice, relieving traffic

congestion, reducing sprawl, creating a diverse community, improving neighbourhood quality, and increasing political support for transit (Renne, 2005a). With so many goals for TOD, measuring success becomes a matter of balance and perspective.

To achieve this balance and perspective, the evaluation of TOD should be both cross-sectional and longitudinal. Indicators of performance can compare a TOD with regional and sub-regional averages, since TODs function as part of a larger whole. This approach is better than a matched-pair analysis, which is sometimes suggested for comparing TODs to similar developments not built near a transit node. The problem with matched-pair analysis is that it is often impossible to find two developments that exhibit similar characteristics for comparison purposes; when a cross-sectional comparison is made it is therefore usually only one or two-dimensional. After creating baseline data, future TOD outcomes should also be compared longitudinally to determine if individual TODs are becoming more sustainable over time.

A Focus on Travel Behaviour, Vehicle Ownership, Property Values, and Markets

Past studies have focused mainly on only a few aspects of success – travel behaviour, vehicle ownership, property values and understanding markets for location in TOD precincts. Several studies have looked at commuting behaviours in TODs. A 2003 study of TODs across California found that residents were up to five times more likely to commute via transit compared to non-TOD areas (Lund, Cervero, & Willson, 2004). In the San Francisco Bay Area, Cervero (1994) found that, “[o]n average, residents living near stations were five times as likely to commute by rail transit as the average worker living in the same city, and in some cases as much as seven times as likely” (Cervero, 1994, p. 177). Another study of 103 TODs across twelve regions in America found that, on average, residents were 2 – 2.5 times more likely to commute on transit compared to the average resident of the region (Renne, 2005b).

Studies which investigate non-commute trips in TODs have been less conclusive on travel behaviour impacts (Boarnet & Crane, 2001), although Chatman (2006) found that residents and employees near rail stations have a higher non-auto share of commuting and non-work travel. He attributed the effects mainly to the level of

convenience (or inconvenience) in using an automobile. His study also found higher shares of non-auto use closer to job centres.

TOD households exhibit lower automobile ownership in comparison to regional averages. One study found that American households near train stations owned 0.9 cars per household compared to 1.6 cars per household across regions (Center for Transit-Oriented Development, 2004). A study of 103 TODs by Renne (Renne, 2005b) found that 37 percent of TOD households owned two or more cars compared to 55 percent of regional households.

In looking at property value, a number of hedonic price studies found a premium on land value closer to rail stations (California Department of Transportation, 2002b; Cervero et al., 2004). A report published by the City of Cleveland summarizes a number of these studies (see Figure 3). A study in the Santa Clara Valley of California found that commercial parcels located within a quarter mile of a light rail station was worth 24 percent more (an additional US\$4.10 per square foot) due to the station. Residential parcels experienced a 28 percent premium due to the station (an additional US\$9.20 per square foot) (Robert Cervero & Michael Duncan, 2002; R. Cervero & Michael Duncan, 2002)

Figure 3: Summary of Studies on Land Value Near Train Stations

Location	Increase in Property Value	Decrease in Property Value	No Effect in Property Value
Commuter/Rapid Rail			
Commercial Property	4	0	1
Residential Property	6	0	1
Light Rail			
Commercial Property	2	0	0
Residential Property	6	1	1
Total	18	1	3

Source: (City of Cleveland, 2001)

Finally, some studies have looked at the market for TOD and necessary elements of local markets for a TOD to thrive. Huang (1996) studied the land-use impacts of rail systems on real estate development and concludes that “zoning incentives, attractive station sites with available land, and strong local economies are necessary for development to occur around transit stations” (p. 28). Bertolini contends that several factors have led to an increased number of station-area urban developments. This

includes the expansion of high-speed rail systems across Europe and Asia and light rail systems across the United States, an increased process of privatisation of railway companies, a decreased presence of manufacturing in cities, and attempts to make urban areas compete more effectively in attracting new residents (Bertolini, 2007).

The building of a new railway line does not automatically create TODs around stations. Loukaitou-Sideris and Banerjee (2000) examined why TOD failed to materialize along the Blue Line in Los Angeles, despite impressive growth in transit ridership. They propose eleven missing antecedents for economic development, including:

1. The corridor's industrial 'back-door' location of Los Angeles
2. Missing density gradients near stations
3. Inaccessible stations
4. Pedestrian-unfriendly station locations
5. Lack of an urban design framework for station locations
6. Landscape depravation and the 'broken window syndrome'
7. Relatively high land costs
8. Antiquated zoning and regulatory barriers
9. Lack of institutional commitment
10. Absence of critical mass, and
11. Lack of community involvement and participation.

Changing demographics are supporting TODs when a number of factors coexist, including a healthy local real estate market, community and institutional support, and transit and road network accessibility. Several studies indicate the supply of transit-accessible mixed-use neighbourhoods is much lower than the demand to live in such locations (Center for Transit-Oriented Development, 2004; Levine & Inam, 2004; Planning and Transport Research Centre (2007); Urban Land Institute & PriceWaterhouseCoopers, 2005). Levine (2006) argues that zoning policies are artificially restricting TODs and other smart growth developments.

Transit Oriented Development in America: Experiences, Challenges, and Prospects (Cervero et al., 2004) was the seminal report on TOD in the United States, sponsored by the Federal Transit Administration. This study, which reviewed the literature, surveyed and interviewed a number of stakeholder groups, and conducted case studies across ten regions concluded that "[t]he literature is replete with

platitudes that have been heaped on the TOD concept; however, relatively few serious studies have been carried out that assign benefits to TOD in any quantitative or monetary sense. For the most part, anecdotes and story lines are relied on instead” (p. 119). The study went on to note that transit ridership impacts and land value gains were the areas with the most amount of quantitative research.

Studies in Holistic Measurement of TOD Success

Some studies have attempted to study TOD success from a holistic viewpoint. The *Statewide Transit-Oriented Development Study: Factors for Success in California* (California Department of Transportation, 2002a; 2002b) reported on ten areas of potentially major benefit, including:

1. Increased mobility choices
2. Increased public safety
3. Increased transit ridership
4. Reduced rates of vehicle-km travelled (VKT)
5. Increased households’ disposable income
6. Reduced air pollution and energy consumption rates
7. Preservation of farmland and open space
8. Enhanced economic development
9. Reduced infrastructure costs, and
10. A contribution to more affordable housing (pp. executive summary 4-6).

In addition to providing data within the final reports which address each of these areas, the State of California also launched an online TOD searchable database (<http://transitorienteddevelopment.dot.ca.gov/>). This database provides data for 21 TODs across California about land uses, mapping, implementation processes, financing, facilities, zoning, design features, pedestrian access, transit services, photos, travel benefits, local contacts, and other variables.

Wells and Renne (2003) proposed a set of indicators to evaluate the success of the New Jersey Transit Village Initiative, a state program that facilitates TODs, sometimes referred to as Transit Villages. This study recommended an evaluation framework based on economic activity, environmental and transport activity, institutional changes, and community perceptions. Data availability was most readily

available for economic activity, travel behaviour, and public perception. Figure 4 illustrates the indicators suggested for each of the categories. In attempting to collect the data, it was found that significant data were missing and difficult to obtain. Subsequent efforts to work with local and state governments in New Jersey met with some difficulty in collecting data, as many of the variables were unavailable or available only in paper format from municipal libraries. Due to the time consuming effort required to collect the data, designated Transit Villages were encouraged to collect and report data to the State for analysis by researchers at Rutgers University. This led to a series of reports as part of the Transit Village Monitoring Research program (available at: http://www.policy.rutgers.edu/vtc/tod/tod_projects.html).

The findings in New Jersey prompted a national study, to determine what benefits and measures of TOD were reported by local, county, state departments of transportation and transit agencies across the United States (*Transit-Oriented Development: Developing a Strategy to Measure Success*, (2005). This study revealed 56 indicators, categorized as: travel behaviour, economic performance, environmental performance, the built environment and social benefits. The findings from this study revealed that half of the agencies surveyed had access to five or fewer indicators to measure these criteria. While the study sought to determine which indicators were most useful and easiest indicators to collect (see Figures 5 and 6) it did not include actual data collection for any of the indicators.

The project recommended the following nine indicators of performance as the most important for inclusion in a TOD evaluation framework:

1. Transit ridership
2. Population and housing density
3. Quality of streetscape design
4. Quantity of mixed-use structures
5. Pedestrian activity and pedestrian safety
6. Increase in property value/tax revenue
7. Public perceptions — measured by resident and merchant surveys
8. The quality of intermodal connections at transit stations, and
9. Parking configuration—for commuters and residents, and shared parking (Renne & Wells, 2005)

Figure 4: Recommended Indicators to Evaluate TOD as Part of the Evaluation of the New Jersey Transit Village Initiative

<i>Economic Activity</i>	<i>Environmental and Transportation Activity</i>	<i>Institutional Changes</i>	<i>Community Perception</i>
<p>Public Investment</p> <ul style="list-style-type: none"> • Municipal funds • State funds <ul style="list-style-type: none"> ○ Grants ○ Loans • Federal funds <ul style="list-style-type: none"> ○ Grants ○ Loans • Tax abatements • Total public investment (calculated from indicators above) <p>Private Investment, Commercial</p> <ul style="list-style-type: none"> • New or substantially rehabilitated retail/office space¹ • Estimated private investment² • Estimated new property taxes generated³ <p>Private Investment, Residential</p> <ul style="list-style-type: none"> • New or substantially rehabilitated housing units¹ • Estimated private investment² • Estimated new property taxes generated³ • Number of new studios / one bedroom • Number of new two bedrooms • Number of new three or more bedrooms • Number of new units for sale • Number of new units for rent • Number of new subsidized units for rent and for sale (with income limits) 	<p>Pedestrian</p> <ul style="list-style-type: none"> • Length of improved streetscape • Number of improved intersections/street crossings for pedestrian safety • Length of façade improvement • Pedestrian activity counts <p>Parking</p> <ul style="list-style-type: none"> • Number of new spaces for shoppers only • Number of new spaces for commuters only • Number of spaces that are shared • Number of new bicycle racks or lockers provided <p>Traffic Flow</p> <ul style="list-style-type: none"> • Number of new shuttle or jitney services provided to and from the transit station • Number of traffic control or flow improvements <p>Land Use</p> <ul style="list-style-type: none"> • Amount of brownfield properties remediated under a [Department of Environmental Protection] approved plan • Number/size of vacant buildings rehabilitated or replaced • Number/amount of underutilized/vacant lots reclaimed for construction or green/recreation space • Number of new or improved park areas 	<ul style="list-style-type: none"> • New TOD ordinances • New TOD or smart growth designations 	<p>Residential Survey</p> <ul style="list-style-type: none"> • How would you rate your town/neighborhood as a place to live? • Do you feel the downtown (or transit station area) is more or less attractive now compared to (number) years ago? • Is it more or less pleasant to walk around the downtown (or transit station area) now compared to (number) years ago? • Does the downtown (or transit station area) seem more or less safe now compared to (number) years ago? • Does the downtown (or transit station area) offer better or worse shopping now compared to (number) years ago? • Does the downtown (or transit station area) offer more or less restaurant options now compared to (number) years ago? • Does the downtown (or transit station area) offer more or less entertainment options now compared to (number) years ago?

Source: (Wells & Renne, 2003)

Figure 5: Indicators Rated Very Useful for TOD by at Least 50% of the Respondents (national study conducted across the United States)

<i>Indicator</i>	<i>Percentage as 'Very Useful'</i>	<i>Category</i>
Qualitative rating of streetscape (i.e., pedestrian orientation/human scale)	77	Built environment
Pedestrian activity counts	77	Travel behavior
Number of transit boardings	70	Travel behavior
Population / housing density	67	Built environment
Estimated increase in property value	63	Economic
Public perception (administered survey)	63	Social diversity / quality
Number of bus, ferry, shuttle, or jitney services connecting to transit station	63	Travel behavior
Number / square feet of mixed-use structures	60	Built environment
Number of improved intersections / street crossings for pedestrian safety	60	Built environment
Estimated amount of private investment	57	Economic
Number of parking spaces for residents	53	Travel behavior
Number of shared parking spaces	53	Travel behavior
Number of convenience/service retail establishments (i.e., dry cleaners, video rental)	53	Economic
Employment density (i.e., number of jobs per acre / square mile)	53	Economic / built environment
Estimated amount of private investment by type of land use	52	Economic

Note: Bold indicators were also reported as easy to collect (see Table 3)

Source: Renne and Wells, 2005, p. 19

Figure 6: Indicators of TOD Rated Very Easy to Collect by at Least 50% of the Respondents (national study conducted across the United States)

<i>Indicator</i>	<i>Percentage as 'Very Easy to Collect'</i>	<i>Category</i>
Number of bus, ferry, shuttle or jitney services connecting to transit station	79	Travel behavior
Number of bicycle racks or lockers	72	Travel behavior
New or improved cultural/artistic institutions or establishments	71	Social diversity/quality
Mileage of bicycle lanes	71	Travel behavior
Amount of improved public park area / public space	68	Built environment
Number of subsidized housing units	64	Economic
Number of neighborhood institutions (i.e., local clubs or organizations)	64	Social diversity/quality
Number/amount of underutilized lots reclaimed for construction or green/recreation space	63	Built environment
Number of parking spaces for commuters	62	Travel behavior
Number of traffic flow improvements (i.e., traffic-calming devices)	61	Travel behavior
Number/acreage of brownfield properties remediated	61	Built environment
Number of affordable housings units	61	Social diversity/quality
Number of transit boardings	61	Travel behavior
Number of improved intersections / street crossings for pedestrian safety	59	Built environment
Number/size of vacant buildings rehabilitated or replaced	57	Built environment
Estimated amount of new property taxes generated	57	Economic
Amount of crime	57	Social diversity/quality
Number of convenience/service retail establishments (i.e., dry cleaning, video rental)	57	Economic
Length of facade improvement	57	Built environment
Number / square feet of mixed-use structures	54	Built environment
Length of improved streetscape	54	Built environment
Number of substantially rehabilitated housing units	50	Economic

Note: Bold indicators were also reported as most important to collect (see Table 2)

Source: Renne and Wells, 2005, p. 20

Methodology

This study was commissioned jointly by two agencies in the State of Western Australia (WA), the Department for Planning and Infrastructure (DPI) and the Public Transport Authority (PTA), both members of a state TOD Coordinating Committee (TODCC). Other members of the TODCC include Main Roads WA, the East Perth and Midland Redevelopment Authorities, the Department of Housing and Works, and the WA Local Government Association. The TODCC coordinates and prioritizes TOD initiatives in the metropolitan area of Perth (the State's capital city) for encouragement by the State government. The Committee recently developed a 'TOD Assessment Tool', to assist in prioritizing stations to receive capital investments, and works closely with local government in the Perth metropolitan area. It has ranked all stations on Perth's commuter rail system with respect to public and or private partnership potential, strategic significance of location in the urban centres hierarchy, and potential for maximising transit ridership, development opportunities and socio-economic benefits.

As the TODCC recommends state resources be directed to encouraging creation of TODs, they would like a way to track subsequent outcomes from implementation. This tool was commissioned to be flexible so progress could be measured across a variety of benefit types. The goal of the study was to develop a method for measuring the performance of TODs in Perth against selected economic, environmental, social, and other performance criteria, and to establish the structure for a database required to undertake on-going periodic performance measurement. Therefore, while collecting data was an important part of the study, an equally important part of the project was to test which data were available for collection. This study has established a baseline against which future analyses can be measured.

The project began by selecting five transit precincts for analysis. This selection was done by the study researchers and planners from DPI and PTA, who sought to identify five stations which were representative of the different types of stations across Perth's transit system. The five stations selected were:

1. Mosman Park, a relatively compact, mixed-use and mixed-income established suburb

2. Subiaco, an awarding-winning textbook TOD build in the early 2000s, which has been so successful that property values have priced out most lower-income residents
3. Maylands, a lower/middle-income suburb close to central Perth with an underutilized mainstreet and commercial centre
4. Joondalup, an awarding-winning New Urbanist outer-fringe new 'town' built in the early 1990s, which some argue has not taken full advantage of the train station within the urban fabric, and
5. Glendalough, a station surrounded by car-oriented land uses that is hostile towards pedestrians.

The next step was to identify appropriate data categories, performance indicators and data sources. The project team then embarked on collecting the data, working with local and state governments to collect as much secondary data as possible before primary data collection. Our primary data collection sought to identify performance within approximately 800-metre station precincts, but some of the secondary data sources did not allow for an analysis at such a fine geographic scale.

Primary data collection took the form of site visits and a Household Survey administered in all of the five selected study areas. The purpose of the primary data collection, particularly the household survey, was to collect important data to gauge perceived and actual measures of liveability and sustainability. The entire data collection (primary and secondary data) effort served two purposes:

1. To test which data were available to collect through primary and secondary sources
2. To establish a baseline set of data to measure future performance

The site visits sought to collect indicators from field observation, whereas the Household Survey aimed to collect data from households living within the study areas. 2,503 households were randomly selected across the five study area. Because the Joondalup study area had only 364 households within the station precinct, all of these households were selected. In each of the remaining four study areas, 535 households were randomly selected and sent surveys (534 households in Glendalough). A letter was sent by the study team to each selected household stating that it had been selected to participate in a study and that they would soon be

receiving a questionnaire that was important for the future of planning in Perth (see Appendix A for the cover letter and questionnaire). The first round of questionnaires were mailed within a week after this initial letter. To generate the highest possible response rate, each packet contained an introductory letter, an eight page questionnaire, and a postcard to return separately (to ensure complete anonymity for subsequent responses). After two weeks, households that did not return postcards were sent a second round of questionnaires.

In total, 332 surveys were returned as bad addresses resulting in 2,171 surveys sent to valid households. A total of 848 completed questionnaires were returned, giving a response rate of 39.1 percent of households with valid addresses. This response rate is in line with another household TOD mail survey using a similar methodology (a household mail questionnaire of three TODs in New Jersey recently resulted in a response rate of 40 percent (Renne & Wells, 2003)).

It is important to note the limitations of the methodology used for this study. Many of the indicators draw from secondary data sources, so the data may contain biases inherent in the methodologies used for the original collection of data. As for the primary data collection, which sought to elicit a range of attitudinal data, the TOD Household Survey may be biased as a consequence of respondents' self selection: those who have the strongest opinions are perhaps more likely to complete and return the questionnaire. Moreover, since we surveyed only households that live within 800 metres of a train station, the habits of the population might be skewed compared to the general population due to locational self-selection. Despite these limitations, the collection of these data represent one of the first attempts to amass such a broad set of indicators to assist in measuring the success of TOD based on a sustainability framework.

Travel Behavior

Figure 7 lists the potential measures, indicators, and possible data sources for measuring travel behaviour of residents living in TODs, while Figure 8 reports information collected from secondary data sources. Three cells pertaining to vehicle kilometres travelled (see reverse coloured cells) are identified because the data seem unreliable, probably due to the small sample sizes in the limited areas chosen for this study. This data comes from the Perth and Regional Travel Survey (PARTS) which surveyed 14,651 households across the Perth metropolitan region. The percent of the sample living within the station area precincts ranged from a high of 0.54 percent (79 households) in Mosman Park to a low of 0.055 percent (8 households) in Joondalup. The Household Survey conducted for this study used a much larger samples in each of the five station area precincts.

The questionnaire asked residents how they use public transport (see Figure 9), the time taken to walk to the nearest train station (see Figure 10), and how they travel for shopping and commute trips (Figure 11). These data reveal that cars are used for approximately 70 percent of all shopping and commute trips. Of the remaining 30 percent, residents in these five station areas are more likely to use public transport for commuting and more likely to walk or ride a bike for shopping. The survey also collected the number of vehicles, bicycles, and licensed drivers within each household (results not reported here).

The survey also asked a number of opinion questions related to transportation, as reported in Figure 12.

Figure 7: Potential Travel Behaviour Measures, Indicators and Possible Data Sources

Measure	Indicator	Possible Data Sources
Vehicle Use/Modal Split	Vehicle kilometres travelled (VKT) per household	Travelsmart, PARTS, Survey
	Number of trips per day, by mode, per household	Travelsmart, PARTS, Survey
	Method of journey to work (residents)	ABS, Survey
	Method of journey to work (employees)	ABS, Survey
	Method of other journey (visitors)	Survey
Trip Lengths	Average daily commuting time and distance (residents)	Travelsmart, PARTS, Survey
	Average daily commuting time and distance (employees)	Travelsmart, PARTS, Survey
Transit Quality	Number of high frequency, line haul and local public transport services available	PTA
	Integration of services both spatially and timetable	PTA, DPI
Vehicle Ownership	Number of vehicles per household	ABS
Pedestrian Accessibility	Ped Shed	DPI

Note: TravelSmart – a State Government Program in Western Australia that works to reduce automobile dependence; PARTS – Perth and Regional Travel Survey; Survey – The household TOD survey conducted for this project; ABS – Australian Bureau of Statistics census data; PTA – Public Transport Authority; DPI – Department for Planning and Infrastructure

Figure 8: Secondary Travel Behaviour Data

TOD Performance Indicators	Mosman Park Station	Town of Mosman Park	Subiaco Station	City of Subiaco	Maylands Station	City of Bayswater	Glendalough Station	City of Stirling	Joondalup Station	City of Joondalup	Perth Metro Area
Average VKT per household (per day)	11.87	17.57	66.62	31.10	13.47	18.41	48.48	21.40	164.32	23.45	26.38
Mode Share of Daily Household Trips (all trips)											
% trips by private vehicle (driver or pass) inc truck, mbike, taxi	68.91	80.52	79.39	75.34	74.49	86.21	91.02	86.18	92.68	85.80	83.88
% trips by public transport (all modes)	5.88	4.68	5.64	5.18	7.65	0.95	3.91	2.90	3.05	2.39	3.87
% trips walking, cycling, other	25.21	14.81	16.16	19.49	17.86	10.12	4.69	10.85	3.96	11.75	12.17
Method of Journey to Work (residents)											
% trips by private vehicle (driver or pass) inc truck, mbike, taxi	63.16	32.00	78.87	74.30	78.26	87.50	95.24	88.95	90.00	89.30	86.51
% trips by public transport (all modes)	10.53	40.00	18.31	15.08	17.39	7.29	3.17	8.51	6.67	7.79	9.26
% trips walking, cycling, other	10.53	28.00	2.82	10.61	4.35	5.21	1.59	2.54	3.33	2.91	4.23
Method of Journey to Work (employees)											
% trips by private vehicle (driver or pass) inc truck, mbike, taxi	64.29	80.00	82.93	78.11	66.67	87.50	91.89	89.19	91.18	89.86	86.51
% trips by public transport (all modes)	21.43	4.00	12.20	12.94	27.78	7.55	5.41	7.88	5.88	6.69	9.26
% trips walking, cycling, other	14.29	16.00	4.88	8.96	5.56	4.69	2.70	2.75	2.94	3.23	4.21
Method of other journey (visitors)											
% trips by private vehicle (driver or pass) inc truck, mbike, taxi	70.09	81.52	78.32	74.65	77.53	86.04	89.73	85.74	93.52	85.17	83.53
% trips by public transport (all modes)	4.02	4.08	4.07	4.54	3.93	3.08	3.78	2.29	2.73	1.87	3.10
% trips walking, cycling, other	25.89	14.40	17.62	20.81	18.54	10.89	5.95	11.93	3.55	12.88	13.33
Trip lengths (residents)	9.723	2.810	11.341	10.257	9.601	11.240	13.254	11.952	8.273	15.443	14.404
Trip lengths (employees)	9.274	6.680	12.318	11.276	8.654	11.381	13.297	11.842	9.487	15.210	14.404
Number of services available (train and bus) <i>total services</i>	256		632		286		502		700		
Timetable coordination											
##trips, bus services co-ordinated with trains	0		0		0		200		524		
##trips, bus services not co-ordinated with trains	76		132		0		0		0		
##trips, bus services not serving station	36		332		122		78		0		
Number of vehicles per household	1.139	1.275	1.286	1.223	1.353	1.562	1.429	1.573	0.875	1.880	1.694
Passengers boarding (Average Weekday Boardings (AWB))	677		2504		1418		1791		2444		68416
Percent AWB of Total	1.0%		3.7%		2.1%		2.6%		3.6%		100%

Note: Data from multiple secondary sources including the Perth and Regional Travel Survey (PARTS), the Australian Bureau of Statistics, and the the Public Transport Authority of Western Australia (PTA). Reverse coloured cells represent questionable data possibly due to small sample sizes.

Figure 9: Frequency of Public Transport Usage

How often do you use public transport such as bus or a train?	Percent
5 days per week or more	32.1
1 to 4 day(s) per week	25.1
1-3 day(s) per month	24.3
Less Often	18.3
Never	0.3

N = 742

Figure 10: Walking Distance to the Nearest Train Station

Approximately how long does it take you to walk to nearest train station?	Percent
Less than 5 minutes	19.7
5-10 minutes	61.0
10-20 minutes	17.0
More than 20 minutes	1.9
Don't know	0.4

N = 839

Figure 11: Mode Choice for Shopping and Commute Trips

Mode	Shopping Trips	Commute Trips - Survey Respondent	Commute Trips - Survey's Partner (if available)
	Percent		
Automobile	69.5	63.5	69.6
Public Transport	3.6	22.5	11.6
Walk and Bicycle	24.7	5.7	6.5
Motorcycle and Taxi	2.1	4.2	5.7
	N = 827	N = 614	N = 352

Figure 12: Transportation Attitudinal Questions

Transportation Perception Question	Strongly Disagree	Slightly Disagree	Neutral	Slightly Agree	Strongly Agree
	Percent				
I feel safe walking around my neighbourhood at night	7.8	17.2	18.5	34.2	22.1
My neighbourhood is well served with public transport	1.0	2.4	3.5	22.6	70.5
Traffic is not a major issue in the area	14.8	21.6	17.6	28.2	17.8
The neighbourhood is easy to walk around	1.8	4.1	7.2	33.5	53.3
Footpaths are in good condition	4.3	9.9	13.8	34.4	37.7
It is easy to cross the street	7.7	11.8	14.7	34.4	31.4
I feel safe from traffic while walking	4.3	11.4	13.0	37.1	34.2
Drivers give way to pedestrians crossing the road	16.6	21.9	26.2	26.8	8.5
I can easily walk to the train station from my house	1.8	3.8	3.7	17.3	73.4
Hills along the route area barrier to walking to the train station	57.2	16.7	14.5	6.0	5.5
One of the main reasons I live here is to be close to the train station	17.4	11.4	27.8	22.2	21.2

Local Economy

The potential measures, indicators, and possible data sources for economic variables are reported in Figure 13. The economic indicators focus on the range and success of local business, the amount, affordability, and tenure of housing, property values, taxes, and percent of income spent on housing and transportation.

Figure 13: Potential Local Economy Measures, Indicators, and Possible Data Sources

Measure	Indicator	Possible Data Sources
Range of Businesses	Number of retail, commercial and industrial businesses (possibly on GIS)	DPI, Local Government
	Suitability of local retail for residents (Index of Retail Variation)	DPI, Site Visit
Business Success	Rate/ Number of vacant buildings/units (retail, commercial, industrial)	REIWA, Site Visit, DPI
	Number of jobs in area (by, categories, FT/PT)	DPI, ABS
	Number of people in home-based employment	Survey
Range of Housing	Number of residential units (houses/flats/apartments)	ABS, Local Government, DPI
	Number of rental and owner-occupied residences	ABS, Local Government, DPI
	Number of affordable housing units (to be defined) Range of 1, 2 and 3+ bedroom	ABS, Local Government, DHW, Real Estate Agents
Financial Base	Property value (over time)	Valuer General, REIWA, DPI
	Percentage of income spent on housing and transport	ABS, PARTS, Survey
	Taxes collected by local government (\$)	Local Government

Note: Survey – The household TOD survey conducted for this project; ABS – Australian Bureau of Statistics census data; PTA – Public Transport Authority; DPI – Department for Planning and Infrastructure, DHW – Department of Housing and Works; REIWA – Real Estate Institute of Western Australia

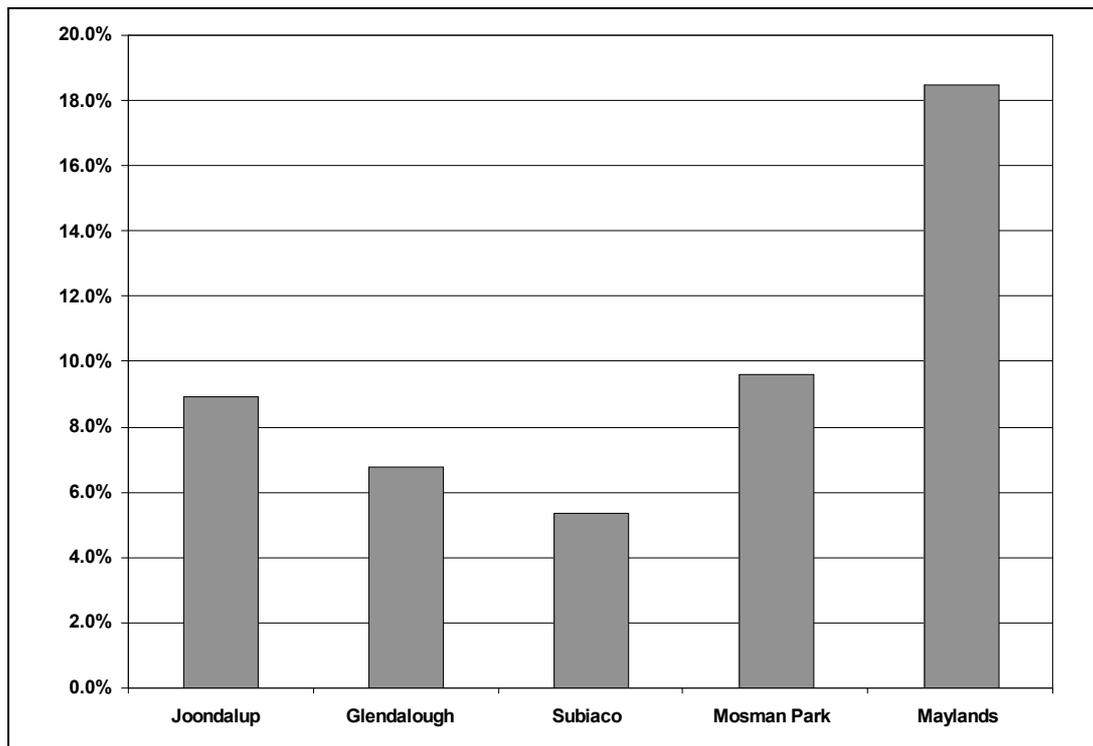
Figure 14: Number of Businesses and Jobs, by Type, for Each Station Precinct

Business/Job Type	Station Area Precinct									
	Mosman Park		Subiaco		Maylands		Glendalough		Joondalup	
	# of Businesses	# of Jobs	# of Businesses	# of Jobs	# of Businesses	# of Jobs	# of Businesses	# of Jobs	# of Businesses	# of Jobs
Primary/Rural	0	0	0	0	0	0	0	0	0	0
Manufacturing/ Processing/ Fabrication	1	2	30	93	2	5	2	3	1	4
Storage/Distribution	0	0	48	64	1	0	6	18	3	0
Service Industry	8	17	49	98	8	20	7	21	6	23
Shop/Retail	43	248	89	1951	71	442	9	96	147	1549
Other Retail	8	22	15	76	3	9	5	21	10	38
Office/Business	30	93	427	1763	20	78	18	70	125	1286
Health/Welfare/ Community Services	6	25	29	127	7	9	2	22	14	195
Entertainment/ Recreation/Culture	4	8	21	179	5	22	0	0	14	156
Utilities/ Communications	1	4	52	83	6	4	0	0	16	8
Total	101	419	761	4434	123	589	49	251	336	3259

Source: Department for Planning and Infrastructure

The number of jobs, by type, for each station area are presented in Figure 14. The bulk of the jobs across the areas are in retail, office, services, health care, and entertainment. These are exactly the type of jobs that are compatible with TOD, as opposed to heavy industry jobs. Vacancy rates, reported by DPI are shown in Figure 15. DPI also reports the number of vacant buildings, but the data reported here are based on floorspace to capture buildings that are totally or partially vacant.

Figure 15: Vacancy Rate (Vacant Floorspace/Total Floorspace)



Source: Department for Planning and Infrastructure

Figure 16 reports housing tenure for each station precinct and Figure 17 presents the weekly payment towards rent or mortgage. The average amount spend on petrol, based on the TOD Household Survey, was \$46.94 AUD per week, where as the average spent on parking and public transport was \$14.44 AUD and \$14.39 AUD, respectively.

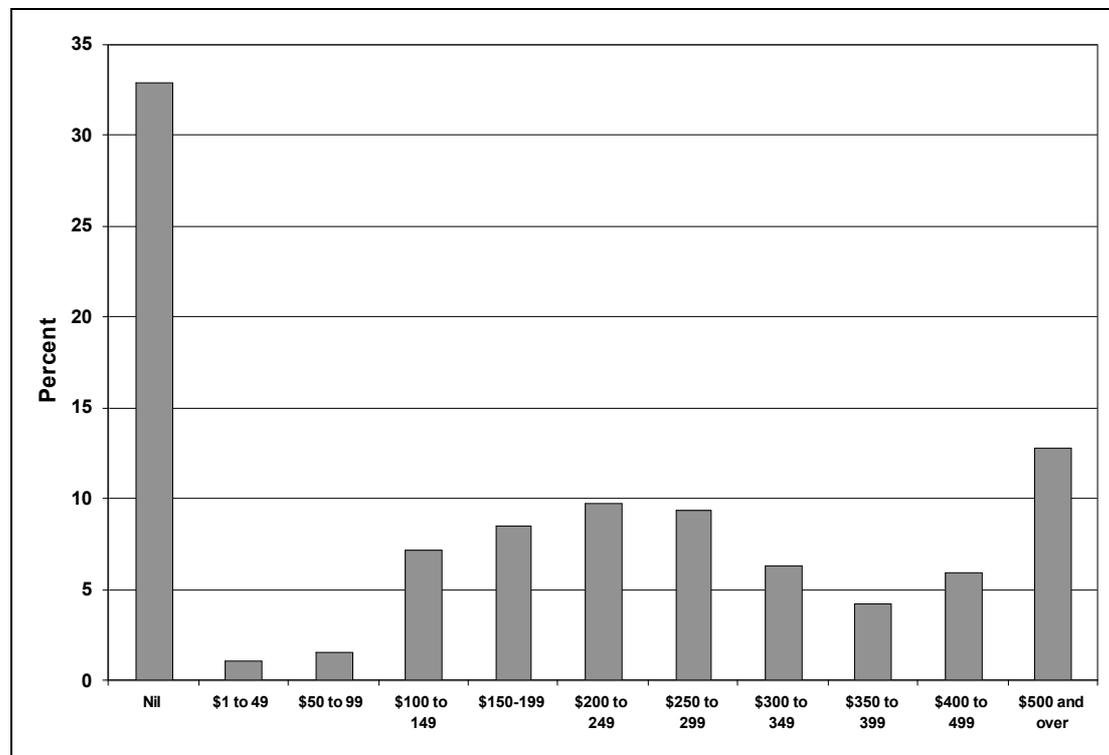
While property values were not collected in this analysis, we did determine that the information is readily available from both private sources as well as the Valuer General.

Figure 16: Housing Tenure for Each Station Precinct

Housing Tenure	Station Area Precinct				
	Mosman Park	Subiaco	Maylands	Glendalough	Joondalup
Fully Owned	32%	26%	21%	23%	24%
Being Purchased	15%	22%	21%	23%	8%
Rented	45%	42%	48%	45%	64%
Other	8%	10%	10%	9%	4%

Source: Australian Bureau of Statistics

Figure 17: Weekly Payments for Rent or Mortgage from TOD Household Survey



Natural and Built Environment

An ideal TOD includes compact development and mixed land uses while still provided green and natural space. The potential measures, indicators and possible data source are listed in Figures 18 and 19.

Figure 18: Potential Natural Environment Measures, Indicators, and Possible Data Sources

Measure	Indicator	Possible Data Sources
Air Quality and Pollution	Estimate emissions based on VKT	Survey, PARTS, Travelsmart
Energy use (people)	Estimate car fuel use based on VKT	Survey, PARTS, Travelsmart
Noise	Average and Peak noise levels	Local Government
Stormwater Retention	Volume of water	Local Government

Note: Travelsmart – a State Government Program in Western Australia that works to reduce automobile dependence; PARTS – Perth and Regional Travel Survey; Survey – The household TOD survey conducted for this project

Figure 20 reports housing density and the amount of public space, which is a vital component for creating a successful built environment. Figure 21 reports employment and residential density. Newman and Kenworthy (2006) argue for a minimum urban intensity in TODs of 35 jobs plus residents per hectare. Subiaco is the only precinct that exceeds this threshold. Figure 22 reports the number of official parking spaces at each train station and the quality of the streetscape as measured by the percentage of footpaths along street fronts.

An analysis of land use by remote sensing depicts the amount and variety for different types of land uses (see Figures 23 – 27). This also includes the pedestrian accessibility rating (ped shed) Figure 28 shows a comparison across the five station precincts. The measure of asphalt did not appear to be a good proxy for surface parking. It is recommended for future analyses to determine how many total surface parking spaces exist within each precinct. This could be achieved through a parking inventory study.

The TOD Household Survey also asked a number of detailed questions about the quality of the natural and built environment. Some of the data, including the quality of

the footpaths, perceptions of safety, and other indicators related to transportation as it relates to the environments were reported in Figure 12. Other data obtained in response to questions about the respondent's ideal neighbourhood and the types of land uses that were important to them were asked on the questionnaire but not reported here for the sake of brevity.

Figure 19: Potential Built Environment Measures, Indicators, and Possible Data Sources

Measure	Indicator	Possible Data Sources
Vibrancy	Resident population (density)	DPI, ABS
	Pedestrian counts	Site visit
	Area/number of vacant land parcels	Site visit, Local Government, DPI
Attractiveness	Subjective measure of façade quality	Site visit, Survey
	Subjective measure of streetscape quality (inc. pedestrian amenity)	Site visit, Survey
	Number of heritage buildings preserved	Local Govt, State Heritage Register
	Public Art	Site visit, Local Govt
Safe and inviting area	Quality of lighting	Site visit
	Security at railway station	PTA
	Facilities (incl. retail) at railway station	DPI, PTA, Site visit
	CPTED (Crime Prevention Through Environmental Design)	
	Building Frontages - SAFE assessment (measures to be determined)	
Mixture of uses	Number of mixed use buildings	DPI, Local Govt., Site Visit
	Housing/Population density	DPI, Local Govt., Site Visit, ABS
Space for people rather than cars	Area of plazas and parks	Local Govt., Site Visit, DPI
	Area/number of auto-oriented land uses	Local Govt., Site Visit
	Area/number of pedestrian-oriented land uses	Local Govt., Site Visit
	Bicycle parking spaces	Site Visit, DPI
	Bicycle traffic volume	Site Visit
	Presence of Principal Shared Paths (PSP) and on-street bicycle lanes	DPI
	Number of traffic calming features	Local Govt., Site Visit
	Auto traffic speed and volume	Main Roads, Local govt.
	Number of parking spaces (surface, on-street, and parking structures)	Local Govt., PTA, Site Visit

Note: Survey – The household TOD survey conducted for this project; ABS – Australian Bureau of Statistics census data; PTA – Public Transport Authority; DPI – Department for Planning and Infrastructure

Figure 20: Housing Density and Area of Plazas and Parks

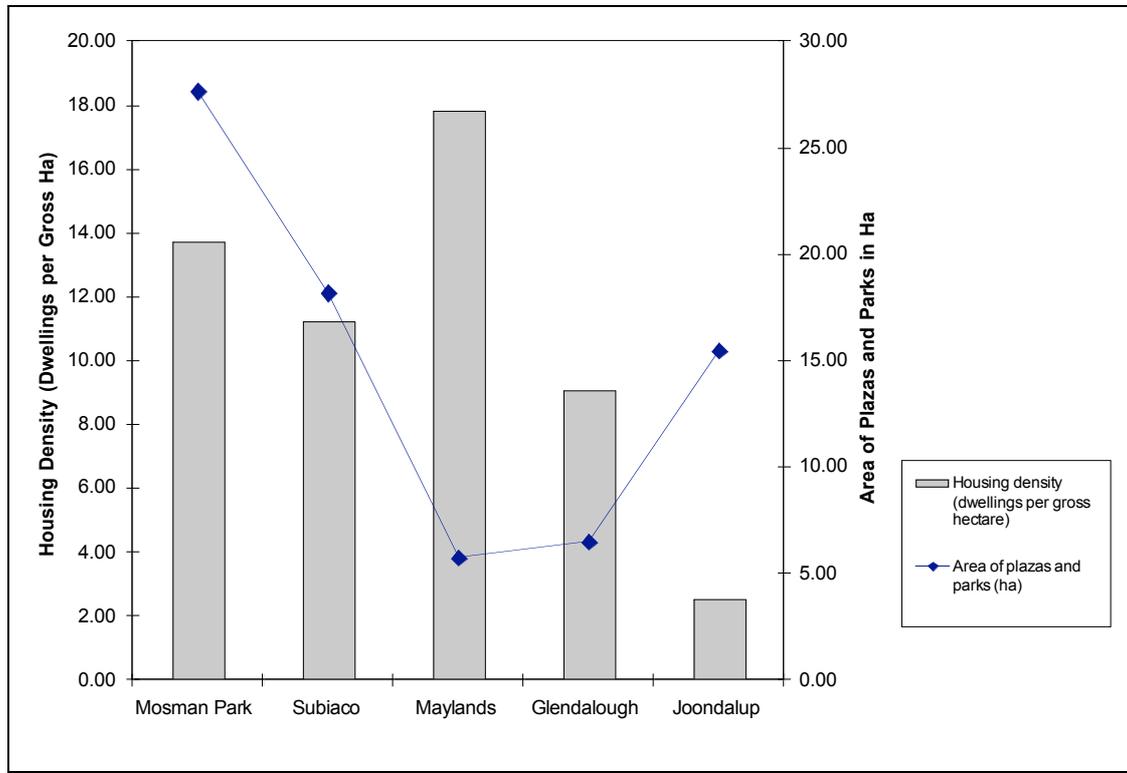
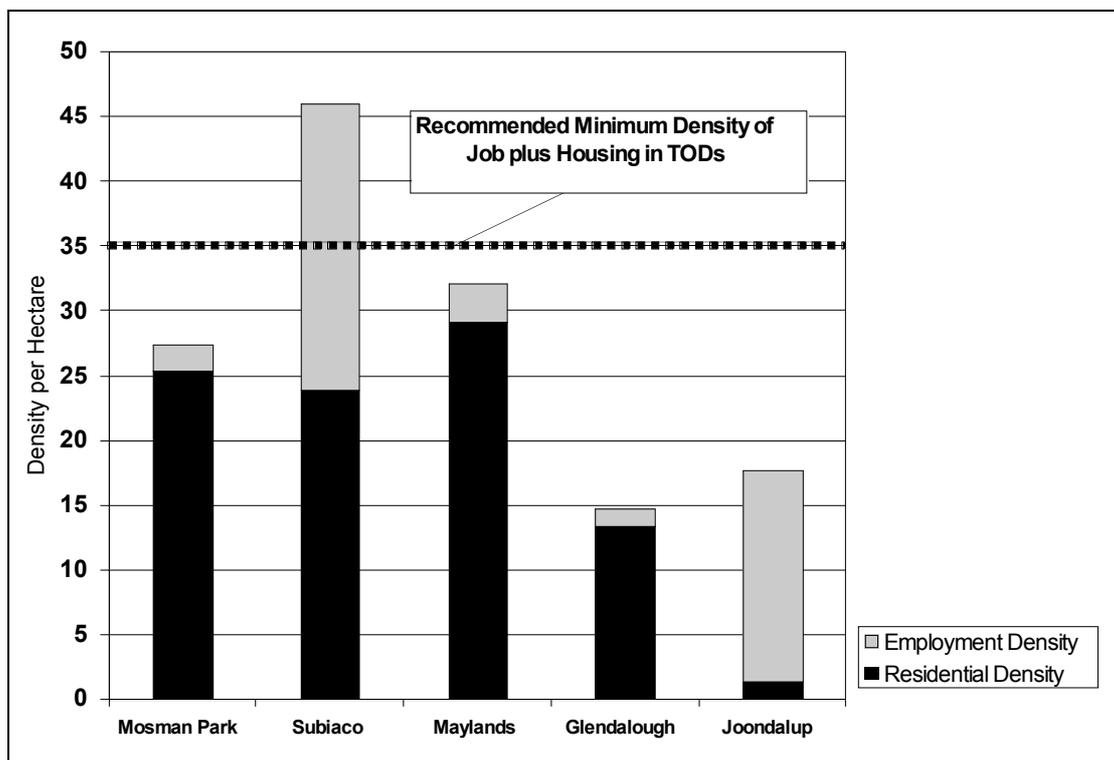


Figure 21: Employment plus Population Density

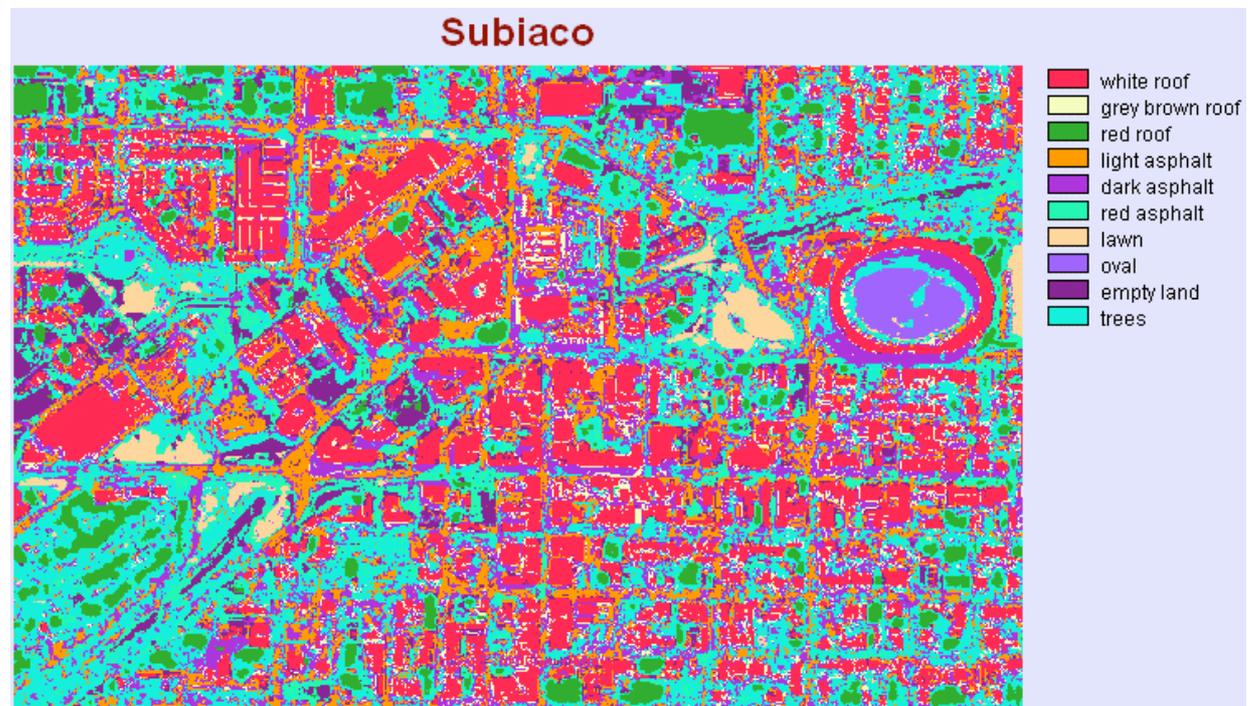


Source: Department for Planning and Infrastructure

Figure 22: Parking and Street Quality

TOD Performance Indicators	Mosman Park	Subiaco	Maylands	Glendalough	Joondalup
Official Number of Parking Spaces at Train Station	40	0	64	227	185
Percent of Street Fronts with Footpaths	78%	89%	79%	62%	69%

Figure 23: Land Cover within the Subiaco Rail Precinct



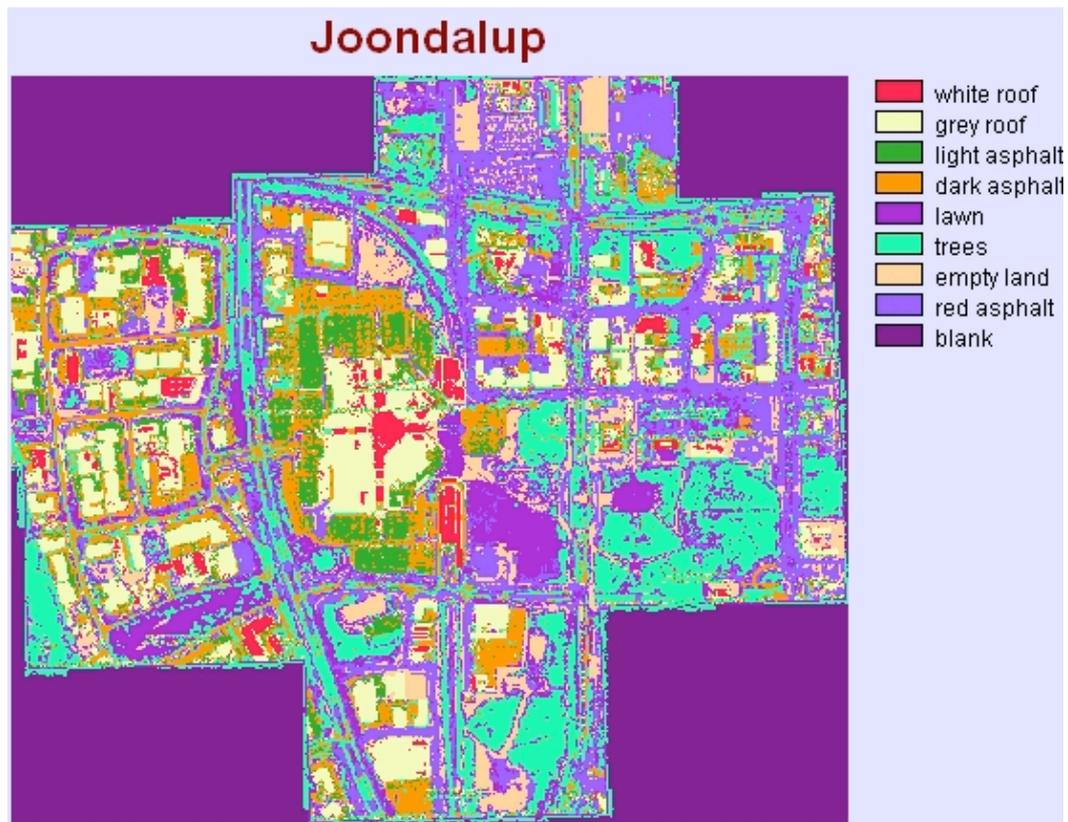
Source: Map Created by Les Chandra

<i>Land Cover Type</i>	
Buildings	28%
Asphalt	41%
Greenspace	3%
Trees	21%
Empty land	7%

Source: Department for Planning and Infrastructure

Pedestrian Accessibility (Ped Shed) – 68%

Figure 24: Land Cover within the Joondalup Rail Precinct



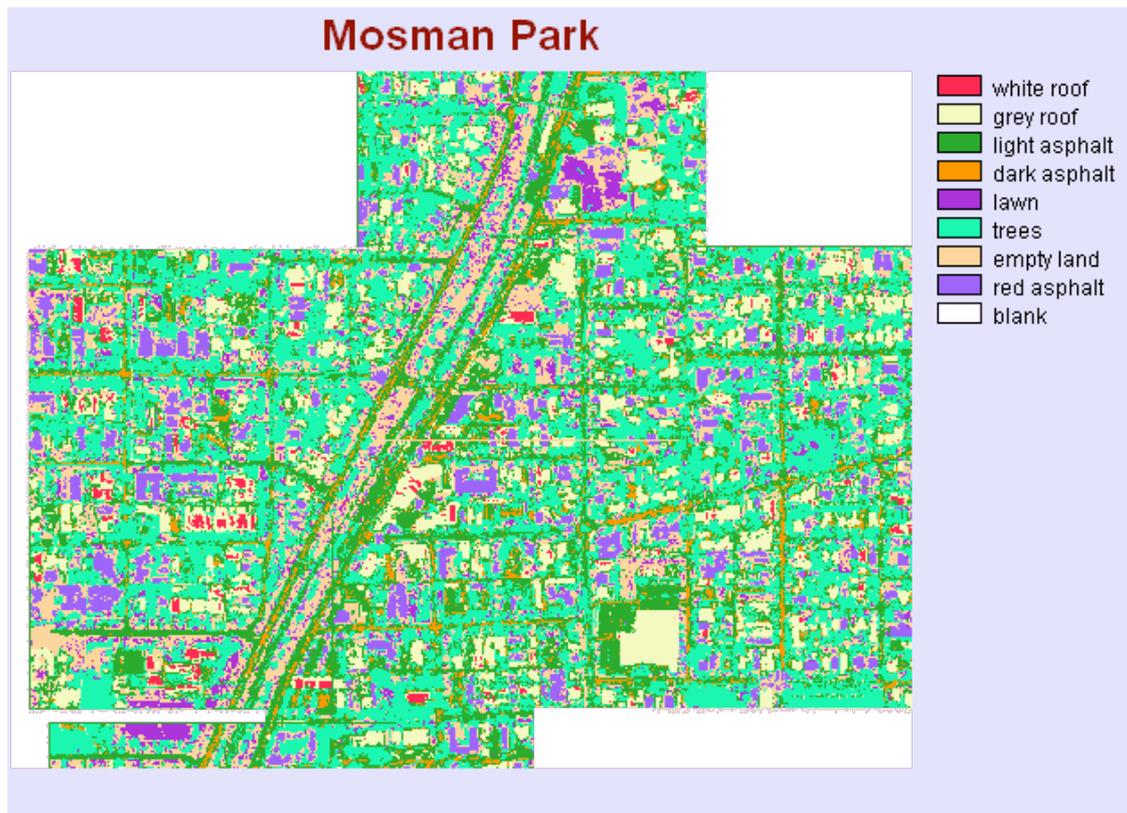
Source: Map Created by Les Chandra

<i>Land Cover Type</i>	
Buildings	16%
Asphalt	33%
Greenspace	18%
Trees	25%
Unused land	8%

Source: Department for Planning and Infrastructure

Pedestrian Accessibility (Ped Shed) – 68%

Figure 25: Land Cover within the Mosman Park Rail Precinct



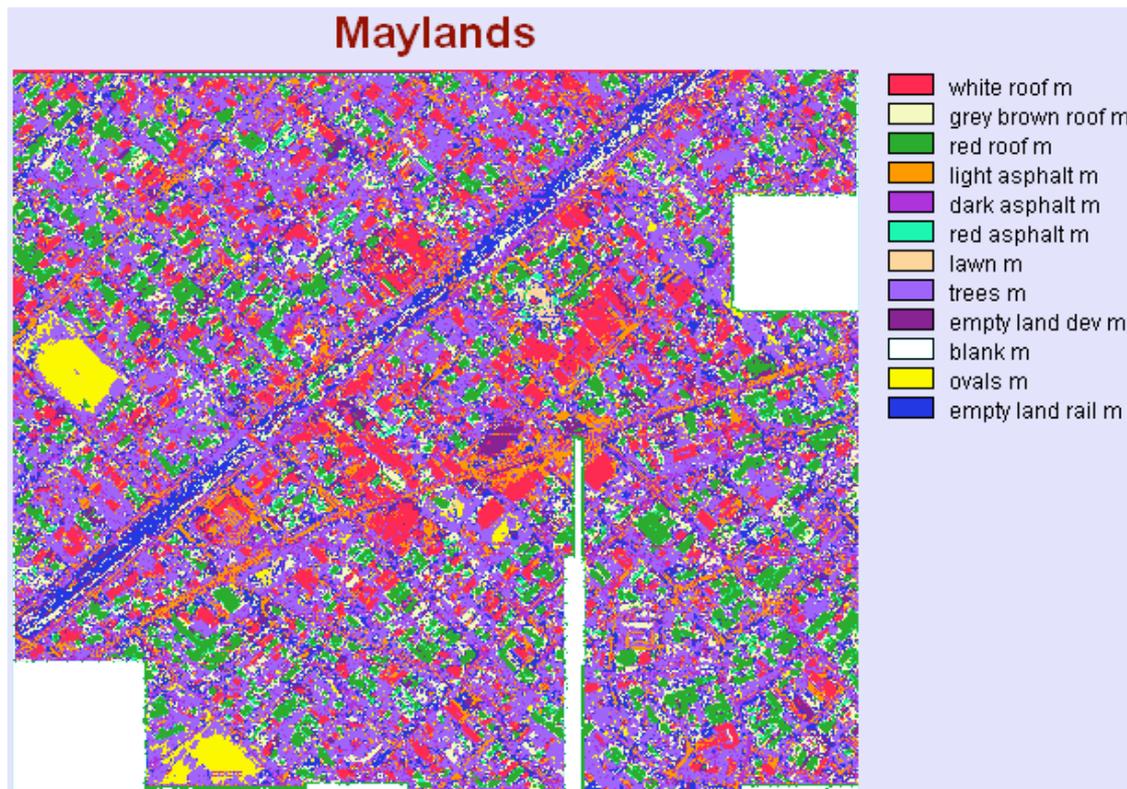
Source: Map Created by Les Chandra

<i>Land Cover Type</i>	
Buildings	13%
Asphalt	32%
Greenspace	4%
Trees	35%
Unused land	16%

Source: Department for Planning and Infrastructure

Pedestrian Accessibility (Ped Shed) – 77%

Figure 26: Land Cover within the Maylands Rail Precinct



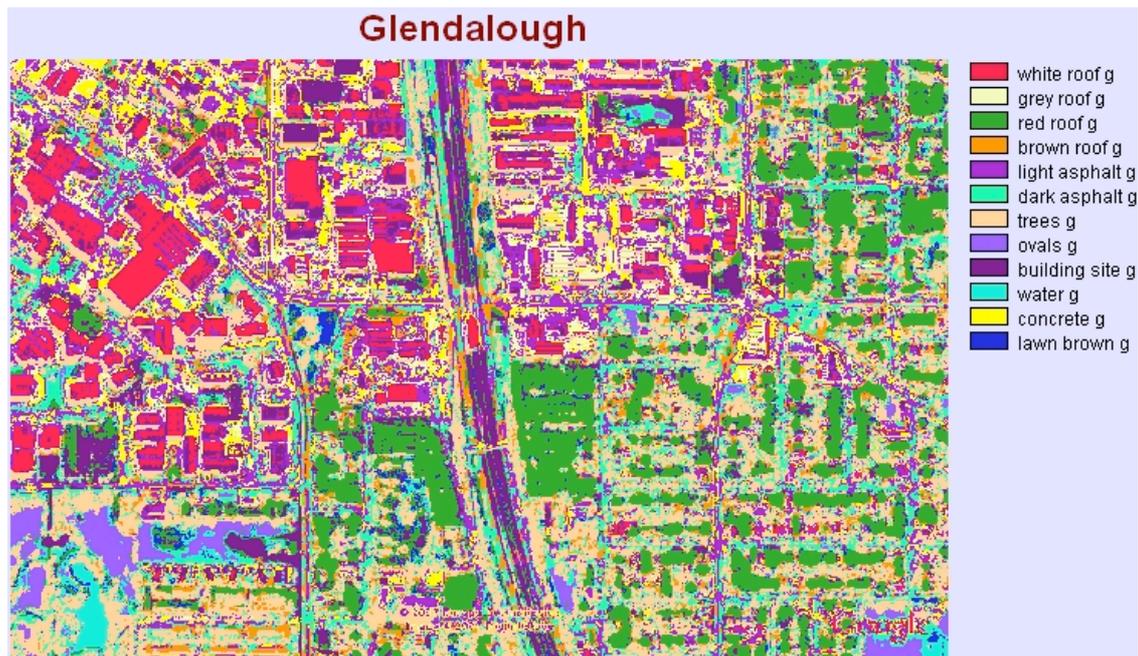
Source: Map Created by Les Chandra

<i>Land Cover Type</i>	
Buildings	32%
Asphalt	21%
Greenspace	4%
Trees	26%
Unused land	16%

Source: Department for Planning and Infrastructure

Pedestrian Accessibility (Ped Shed) – 68%

Figure 27: Land Cover within the Glendalough Rail Precinct



Source: Map Created by Les Chandra

<i>Land Cover Type</i>	
Buildings	30%
Asphalt	35%
Greenspace	5%
Trees	20%
Unused land	10%

Source: Department for Planning and Infrastructure

Pedestrian Accessibility (Ped Shed) – 68%

Figure 28: Land Cover and Ped Shed Comparison across Rail Station Precincts

	Glendalough	Joondalup	Maylands	Mosman Park	Subiaco
	Percent				
Buildings	30	16	32	13	28
Asphalt	35	33	21	32	41
Greenspace	5	18	4	4	3
Trees	20	25	26	35	21
Unused land	10	8	16	16	7
Ped Shed	68	68	68	77	68

Source: Department for Planning and Infrastructure

Social Environment

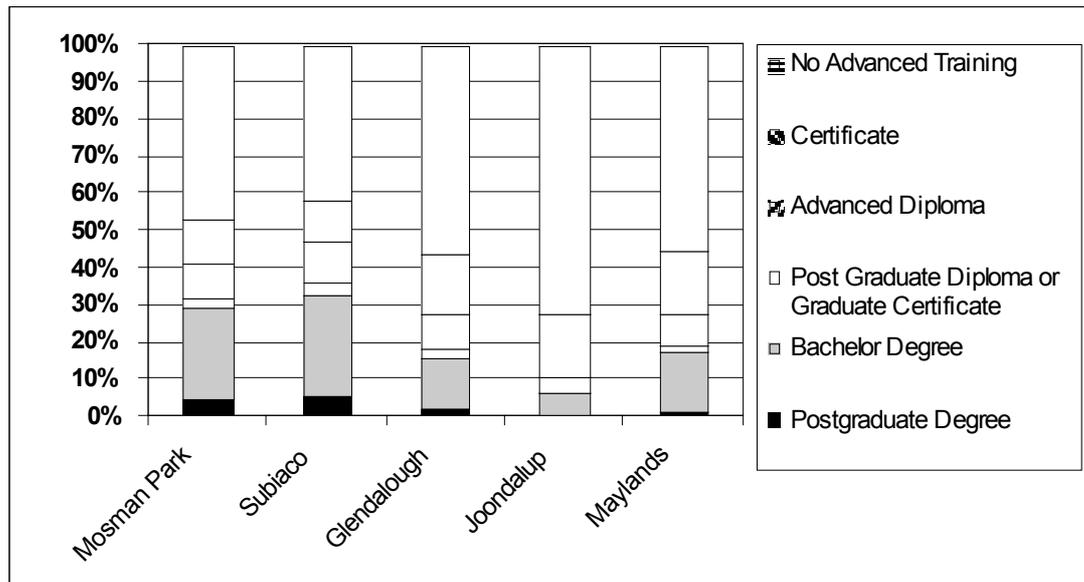
Potential measures, indicators and possible data sources of the social environment are reported in Figure 29. Figures 30 and 31 report educational attainment and income distribution of the population. Some of the data on safety and security were reported in Figure 12. While we did attempt to collect data of safety and security at train stations, we were not able to obtain useful data. Moreover, since the perception of crime is most important, the data presented here is based on the household survey which gauges public perception of safety within the social environment. We also collected data on age and gender, as well as the perception of neighbourhood quality. Figure 32 reports quality of life indicators collected through the TOD Household Survey.

Figure 29: Potential Social Environment Measures, Indicators, and Possible Data Sources

Measure	Indicator	Possible Data Sources
Safety and Security	Public perception of: neighbourhood, crime, pedestrian and bicycle safety	Survey
	Recorded incidents of crime, pedestrian and cycle accidents	Police, Local Govt.
Ownership	Public perception of community	Survey
	Perceived quality of retail environment	Survey
	Community support for further (re)development	Survey
Residential diversity	Breakdown of population by age, education, ethnicity and income level and household formation (size)	ABS
Opportunities for advancement	Number of libraries, theatres, galleries etc	Site Visit, Local Govt
	Number of other community facilities	Site Visit, Local Govt
	Perceived quality of community facilities	Survey
	Number of festivals and events	Local gov't
	Perceived quality of events	Survey
	Educational Opportunities	Site visit

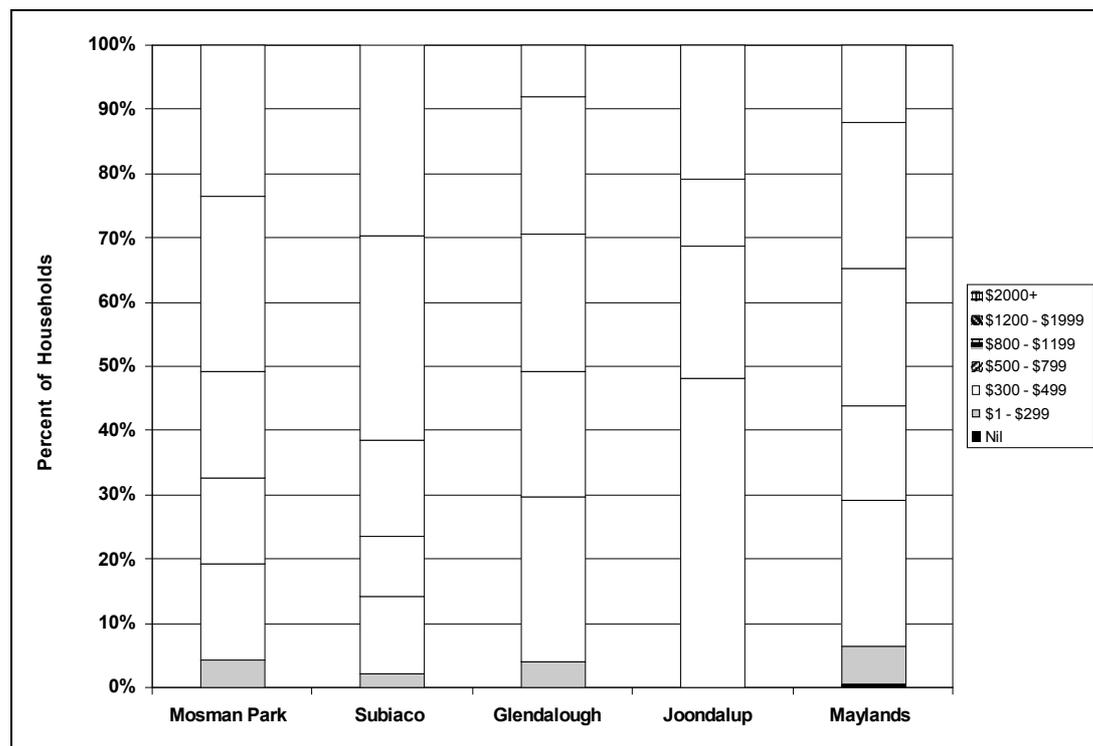
Note: Survey – The household TOD survey conducted for this project; ABS – Australian Bureau of Statistics census data

Figure 30: Educational Attainment of Residents Living within the Rail Precincts



Source: Australian Bureau of Statistics

Figure 31: Weekly Income of Households Living within the Rail Precincts



Source: Australian Bureau of Statistics

Figure 32: Quality of Life Indicators from the TOD Household Survey

Quality of Life Perception Question	Strongly Disagree	Slightly Disagree	Neutral	Slightly Agree	Strongly Agree
	(Percent)				
My neighbourhood is a good place to live	0.9	2.1	6.2	24.0	66.9
My neighbourhood is a better place to live than other parts of Perth.	1.7	2.6	15.3	28.1	52.3
My neighbourhood is clean and well maintained	2.9	7.3	12.3	37.8	39.7
My neighbourhood is a low crime area, compared to other parts of Perth	3.3	12.5	28.1	34.4	21.6
The neighbourhood centre is an attractive place that is nice to be in	4.6	10.0	21.6	30.1	33.6
I can do all my weekly shopping in the neighbourhood centre	5.0	8.4	6.8	26.5	53.3
I can do my day-to-day shopping in the neighbourhood centre	2.2	4.1	5.6	25.3	62.7
There is a strong community feeling in my neighbourhood	6.0	13.7	35.8	29.8	14.7
The area is quiet and free from traffic and other noise pollution	19.3	24.4	17.5	26.4	12.5
The neighbourhood is well provided with community facilities	5.1	8.9	20.0	35.4	30.6
There are many opportunities for recreation in my neighbourhood	4.5	9.0	18.0	33.9	34.6

Policy Context

The locations selected in this study vary to a certain degree with respect to TOD potential. Glendalough is the most automobile dependent and is fairly built-out. The potential for changing Glendalough into a TOD is therefore low. Subiaco is a mostly completed TOD. It also has little room for change. Other station precincts, such as Maylands, Mosman Park, and Joondalup may be more malleable. As mentioned above, DPI and The TOD Committee of Western Australia have been gauging TOD potential as part of the TOD Assessment Tool. The possible measures and indicators and potential data sources for the policy context are depicted in Figure 33.

Of the five rail precincts, Joondalup and Subiaco were developed under heavy public institutional and financial support. The difference between Joondalup and Subiaco is that Joondalup was not planned with a focus on the train station.

Figure 34 reports the public's support for future growth and development in the train station precinct.

Figure 33: Potential Policy Context Measures, Indicators, and Possible Data Sources

Measure	Indicator	Data Source
Institutional Support	Is the TOD state recognized?	DPI
	Is the precinct zoned for TOD supportive land uses by local government	Local govt
	Is there a specific TOD precinct plan?	Local govt, DPI
	Is there an implementation body?	Local govt, DPI
	Are there public subsidies?	Local govt, DPI
	Is there active public-private partnership to encourage TOD?	Local govt, DPI
Public Support	There should be more shopping/retail development in the train station precinct	Survey
	There should be more commercial/office development in the train station precinct.	Survey
	There should be more flats/apartments/townhouses built in the train station precinct	Survey

Figure 34: Public Support for Future Growth and Development from the TOD Household Survey

Opinions on Future Development	Strongly Oppose	Slightly Oppose	Neutral	Slightly Support	Strongly Support
	(Percent)				
There should be more shopping/retail development in the train station precinct	11.8	12.1	26.7	23.2	26.2
There should be more commercial/office development in the train station precinct	16.5	17.7	34.5	19.2	12.0
There should be more flats/apartments/townhouses built in the train station precinct	23.8	20.1	28.2	16.3	11.6

Framework for Measuring TOD Performance

Measuring TOD performance across multiple dimensions is necessary to evaluate TODs within a liveability and sustainability paradigm. Most previous studies of TOD success narrowly focused upon specific attributes, such as travel behaviour or local economy impacts (measured by land value premiums). A study referenced above recommended nine indicators of performance for inclusion in a holistic TOD evaluation framework. Again, these are:

1. Transit ridership
2. Population and housing density
3. Quality of streetscape design
4. Quantity of mixed-use structures
5. Pedestrian activity and pedestrian safety
6. Increase in property value/tax revenue
7. Public perception — measured by resident and merchant surveys
8. The quality of intermodal connections at transit stations, and
9. Parking configuration—for commuters, for residents, and shared parking

A tension in establishing a framework for measuring TOD performance is the desire to compare TODs across the region with measuring performance based upon local goals and objectives for a neighbourhood over a period of time. This tension is at the core of sustainability – a top-down versus bottom-up approach. The next sections present a framework for measuring TOD performance based on both a top-down and a bottom-up approach. Both methods are important and necessary for monitoring TODs, thus the final section recommends a methodology for monitoring TODs in Western Australia.

A Top-Down TOD Monitoring Approach

The TOD Coordinating Committee (TODCC) facilitates TOD implementation mainly through a top-down approach. This includes regular meetings of state agencies to decide how to allocate resources. This is based upon a rational process of ranking and ordering priorities. When looking at TODs from this perspective, questions about performance often compare:

1. TODs versus other TODs

2. TODs versus non-TOD neighbourhoods
3. TODs versus regional averages

It is recommended that the TODCC collect data on TODs once every 5 years. This study found that while some of the data are available from secondary data sources, there are two problems with relying on such data. First, some data sources (ie. PARTS) do not provide adequate coverage of the precincts. Second, there is no control by the TODCC when secondary data are collected. Even the Census, which occurs every five years is subject to change. For example, the US Census recently changed data collection frequency, which no longer occurs every ten years as it had been for over a century. Despite this, secondary data are useful because they are usually easy to access and analyse.

The household survey conducted as part of this study was necessary for measuring TOD performance. The methodology for this questionnaire was based on a similar project in New Jersey in 2003, which achieved a similar response rate (39 percent in Western Australia compared to 40 percent in New Jersey). The questions on the Perth survey were modified slightly to take account of specific local and regional characteristics.

It is recommended that the TODCC monitor as many rail precincts in Perth as it considers necessary, but at a minimum it should include any area of strategic importance and stations with recent or active precinct-area development. For example, if the TODCC collects data on 6 precincts per year, based on a 5-year cycle, the TODCC could monitor 30 TODs. This number could be expanded or reduced on a needs basis, but **the TODCC should commit to collecting data from the same station for at least two points in time for longitudinal analysis.**

Template for Top-Down TOD Monitoring

1. Based on this study, we found that the most useful data came from the household survey, although other data obtained from secondary sources were also valuable. Figure 35 reports the indicators that can be collected through primary research (a TOD household questionnaire), secondary sources (such as DPI, Census, or other sources) or both. For each indicator, this figure depicts the data source, the relative ease or difficulty of collecting the data, and the accuracy of each indicator.

Figure 35: TOD Indicators Available for Collection in Western Australia

Travel Behaviour Indicators:	Recommended Data Sources	Relative Ease/Difficulty of Collecting Data	Accuracy of Data
Vehicles kilometres travelled (VKT)	Household Survey	Easy for work trip but substantially more difficult for other types of trips unless travel diary included as a supplement to the household survey	High level of accuracy for work trip. Less accurate for other types of trips unless travel diary conducted
Mode split	Household Survey	Easy for work trip but substantially more difficult for other types of trips unless travel diary included as a supplement to the household survey	High level of accuracy for work trip. Less accurate for other types of trips unless travel diary conducted
Frequency of public transit usage	Household Survey	Easy to collect	High level of accuracy
Resident commuting time	Household Survey	Easy to collect	High level of accuracy
Quality of transit service (frequency of headways)	PTA	Easy to collect	High level of accuracy
Vehicle ownership	Household Survey	Easy to collect	High level of accuracy
Transportation perceptions			
I feel safe walking around my neighbourhood at night	Household Survey	Easy to collect	Subjective measure – moderately accurate
My neighbourhood is well served with public transport	Household Survey	Easy to collect	Subjective measure – moderately accurate
Traffic is not a major issue in the area	Household Survey	Easy to collect	Subjective measure – moderately accurate
The neighbourhood is easy to walk around	Household Survey	Easy to collect	Subjective measure – moderately accurate
Footpaths are in good condition	Household Survey	Easy to collect	Subjective measure – moderately accurate
It is easy to cross the street	Household Survey	Easy to collect	Subjective measure – moderately accurate
I feel safe from traffic while walking	Household Survey	Easy to collect	Subjective measure – moderately accurate
Drivers give way to pedestrians crossing the road	Household Survey	Easy to collect	Subjective measure – moderately accurate
I can easily walk to the train station from my house	Household Survey	Easy to collect	Subjective measure – moderately accurate
Hills along the route area barrier to walking to the train station	Household Survey	Easy to collect	Subjective measure – moderately accurate
One of the main reasons I live here is to be close to the train station	Household Survey	Easy to collect	Subjective measure – moderately accurate
Local Economy Indicators:			
Number of jobs by type	DPI	Easy to collect	High level of accuracy
Vacancy rate	DPI	Easy to collect	High level of accuracy
Home ownership vs. rental	Household Survey	Easy to collect	High level of accuracy
Weekly housing expenses	Household Survey	Easy to collect	Moderate level of accuracy
Property Value	Valuer General	Moderate/difficult to collect	High level of accuracy
Natural Environment Indicators:			
Transport energy consumption (computed)	Calculated using VKT	Calculation relatively easy	Moderate level of accuracy
CO2 emissions (computed)	Calculated using VKT	Calculation relatively easy	Moderate level of accuracy
Park space	DPI	Easy to collect	High level of accuracy
Percent of land cover as greenspace	DPI	Easy to collect	High level of accuracy
Percent of land cover as trees	DPI	Easy to collect	High level of accuracy

Figure 35 (continued):

Built Environment Indicators:			
Population and housing density	DPI	Easy to collect	High level of accuracy
Street Quality	Household Survey	Easy to collect	Subjective measure – moderately accurate
Amount of public space	DPI	Easy to collect	High level of accuracy
Quality of public space	Household Survey	Easy to collect	Subjective measure – moderately accurate
Land cover/land use distribution	DPI	Easy to collect	Moderate level of accuracy
Parking inventory	DPI	Moderately difficult to collect	High level of accuracy
Pedestrian accessibility (Ped Shed)	DPI	Easy to collect	High level of accuracy

2. The TOD household questionnaire used in this study was found to be reliable and it is recommended that it be used in the future to produce comparable results. One issue encountered in the survey was that while we know where each respondent worked and shopped, the survey did not collect the home address (or nearest intersection). It was considered that asking this question risked reducing the response rate. Therefore, each household returned a separate postcard identifying their suburb so we could keep track of the response rates while still keeping the survey obviously anonymous. A way to overcome this problem in the future while still keeping the survey anonymous would be for respondents to identify on the questionnaire the closest train station or street intersection to their home. An alternative approach would be to colour code survey forms. Therefore, as they are returned the analysis team can sort based on colour. In other respects, it is very important that future questionnaires use the same wording for questions, in order to ensure direct comparison of responses with those obtained for the research reported here; even a slight change in the wording of questions could result in non-comparable data.

3. The TODCC should consider conducting other surveys that complement the household survey. This would include questionnaires targeted to retail workers, office and professional workers, shoppers, and users of public space, to better understand reasons people choose to work, shop, and recreate in TODs. The TODCC should also coordinate with the TravelSmart program.

4. The TODCC should consider establishing a website similar to the California Transit-Oriented Development Searchable Database¹. An online database provides transparency and value to local residents, town planners, community organisations, and prospective developers. Data collected to monitor TODs in Western Australia may prove valuable for more than just the needs of the TODCC. Private sector developers could use the data to better evaluate where to invest. An online database serves as a marketing and outreach tool to educate the public about TOD.

A Bottom-Up TOD Measurement Approach

In coordination with the top-down TOD measurement approach, the TODCC should consider setting up community-stakeholder meetings with local residents, shop owners, community advocates, government officials and others. These meetings should establish short-, medium- and long-term goals for each TOD. Long-term success should be assessed on the combination of these goals and top-down goals established by the TODCC.

The bottom-up approach provides an opportunity for the TODCC to provide education about the benefits of TOD for liveability and sustainability. It should also make the TODCC more receptive to the needs of local communities than would be achieved by a 'one-size fits all' approach to TOD.

Recommendations for Monitoring TODs in Western Australia

An important goal of this study was to determine a methodology for monitoring TODs. As discussed above, data to monitor TODs in this study came from both primary and secondary sources. In order to collect the necessary data for monitoring TODs in Western Australia it is necessary to establish a systematic data collection effort. This section recommends three steps to establish a TOD monitoring program in Western Australia.

Step 1: Ranking of Indicator Importance

The author recommends that each member of the TODCC rank the importance of each indicator using the worksheet in Figure 36 and then list the ten most important indicators using the worksheet in Figure 37. After each member completes these worksheets, DPI should tally the responses of all members to establish a ranking of all

¹ <http://transitorienteddevelopment.dot.ca.gov/>

indicators from most to least important. DPI should then present this list to the group to discuss the possibility of narrowing the data collection effort if resources to collect data pose a major challenge. The author does not recommend narrowing the data collection effort because it is necessary to conduct a household survey to collect most of the indicators. The cost of a household survey is mainly fixed; therefore, reducing the number of collected indicators would not save much money.

Step 2: Establish a Monitoring Cycle

The TODCC should decide how many TODs to monitor and begin collecting data for each TOD on a regular basis. It might be cost effective to monitor one or more TODs each year within a five-year cycle. For example, if the TODCC wants to monitor 30 TODs, data should be collected on six TODs each year for five years. The cycle would repeat itself starting in year 6. The reason the five-year cycle is important is that the Australian Bureau of Statistics conducts a Census every five years. It is not essential that the Census data and the household survey be conducted in the same year, but creating a similar cycle of data collection is encouraged.

Step 3: Analyze Data and Public Outreach

The TODCC should provide resources to conduct a quantitative and qualitative analysis of the data. After the indicators are collected and analyzed a report summarizing the results of each TOD should be written and distributed to local stakeholders. The TODCC and/or DPI should conduct a local workshop to discuss the results and request local input. This input should be incorporated into a final report, which outlines plans and policies to be incorporated into ongoing planning efforts.

Figure 36: TOD Indicator Importance Worksheet

Travel Behaviour Indicators:	Rate Importance (circle one for each): (1 – Not Important, 2 – Somewhat Important, 3 – Very Important)		
Vehicles kilometres travelled (VKT)	1	2	3
Mode split	1	2	3
Frequency of public transit usage	1	2	3
Resident commuting time	1	2	3
Quality of transit service (frequency of headways)	1	2	3
Vehicle ownership	1	2	3
Transportation perceptions			
I feel safe walking around my neighbourhood at night	1	2	3
My neighbourhood is well served with public transport	1	2	3
Traffic is not a major issue in the area	1	2	3
The neighbourhood is easy to walk around	1	2	3
Footpaths are in good condition	1	2	3
It is easy to cross the street	1	2	3
I feel safe from traffic while walking	1	2	3
Drivers give way to pedestrians crossing the road	1	2	3
I can easily walk to the train station from my house	1	2	3
Hills along the route area barrier to walking to the train station	1	2	3
One of the main reasons I live here is to be close to the train station	1	2	3
Local Economy Indicators:			
Number of jobs by type	1	2	3
Vacancy rate	1	2	3
Home ownership vs. rental	1	2	3
Weekly housing expenses	1	2	3
Property Value	1	2	3
Natural Environment Indicators:			
Transport energy consumption (computed)	1	2	3
CO2 emissions (computed)	1	2	3
Park space	1	2	3
Percent of land cover as greenspace	1	2	3
Percent of land cover as trees	1	2	3
Built Environment Indicators:			
Population and housing density	1	2	3
Street Quality	1	2	3
Amount of public space	1	2	3
Quality of public space	1	2	3
Land cover/land use distribution	1	2	3
Parking inventory	1	2	3
Pedestrian accessibility (Ped Shed)	1	2	3

Figure 37: Ten Most Important Indicators Worksheet

Rank indicators from 1 to 10 starting with the most important indicator first:
1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

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Appendix A

TOD Household Cover Letter and Questionnaire



Perth “Transit-Oriented Development” Study

About this survey:

As a resident of a train-served suburb of Perth you have been selected to participate in a Murdoch University survey about your local area. Your household has been chosen completely at random based only on the suburb where you live. The information that you provide will help guide planning for the future development of Perth.

So that we can get a full range of community opinions it is important that you are able to complete this questionnaire. There are no right or wrong answers to the survey. We just want to know what you think about life in your suburb and some issues related to transportation. It will only take a few minutes to complete this short questionnaire.

If you have any questions or require any assistance while you are completing the questionnaire please see the enclosed letter for further information and contact details.

Confidentiality:

To make sure all of your responses are anonymous, this questionnaire does not have any way of identifying you. A separate card, which is mailed back to Murdoch University at the same time as your questionnaire, will help us keep track of who participated, but this cannot be linked to your answers on this form.

Instructions:

1. WHO SHOULD FILL OUT THE QUESTIONNAIRE? Either the male or female head of the household should complete the survey.
2. HOW DO I FILL IT OUT? For most questions, just circle the number or tick the box that best fits your opinion. Unless otherwise noted, please choose only one response. For a few questions you will be asked to write in your own answer.
3. WHAT DO I DO WHEN I FINISH FILLING IT OUT? We ask you to please mail this questionnaire back to us in the large reply-paid envelope provided. Please also complete the blue confirmation slip and return it in the small envelope.

PLEASE TAKE A FEW MINUTES RIGHT NOW TO FILL IN YOUR RESPONSES AND MAIL BACK THE QUESTIONNAIRE

PLEASE RETURN THE QUESTIONNAIRE WITHIN 7 DAYS!

Institute for Sustainability and Technology Policy
Murdoch University
MURDOCH WA 6150

1. You and your neighbourhood

We would like to ask you some questions on how you feel about the neighbourhood you live in and about your neighbourhood centre as it currently is.

For each of the following statements please rate your response, from 1 if you totally disagree with the statement to 5 if you totally agree. Just circle the appropriate response

The Community

		Strongly Disagree	Slightly Disagree	Neutral	Slightly Agree	Strongly Agree
1.	My neighbourhood is a good place to live	1	2	3	4	5
2.	My neighbourhood is a better place to live than other parts of Perth.	1	2	3	4	5
3.	My neighbourhood is clean and well maintained	1	2	3	4	5
4.	My neighbourhood is a low crime area, compared to other parts of Perth	1	2	3	4	5
5.	I feel safe walking through my neighbourhood at night	1	2	3	4	5
6.	The neighbourhood centre is an attractive place that is nice to be in	1	2	3	4	5
7.	I can do all my weekly shopping in the neighbourhood centre	1	2	3	4	5
8.	I can do my day-to-day shopping in the neighbourhood centre	1	2	3	4	5
9.	There is a strong community feeling in my neighbourhood	1	2	3	4	5
10.	The area is quiet and free from traffic and other noise pollution	1	2	3	4	5
11.	The neighbourhood is well provided with community facilities	1	2	3	4	5
12.	There are many opportunities for recreation in my neighbourhood	1	2	3	4	5

Walking, driving and public transport

		Strongly Disagree	Slightly Disagree	Neutral	Slightly Agree	Strongly Agree
1.	My neighbourhood is well served with public transport	1	2	3	4	5
2.	Traffic is not a major issue in the area	1	2	3	4	5
3.	The neighbourhood is easy to walk around	1	2	3	4	5
4.	Footpaths are in good condition	1	2	3	4	5
5.	It is easy to cross the street	1	2	3	4	5
6.	I feel safe from traffic while walking	1	2	3	4	5
7.	Drivers give way to pedestrians crossing the road	1	2	3	4	5
8.	I can easily walk to the train station from my house	1	2	3	4	5
9.	Hills along the route are a barrier to walking to the train station	1	2	3	4	5
10.	One of the main reasons I live here is to be close to the train	1	2	3	4	5

2. Looking ahead

We'd now like to ask you some questions on how you think your area should develop into the future, and how you think the ideal neighbourhood centre should be.

Future development

This time, we will be asking you about different types of development that might occur, and whether or not you support them. Please be aware that these options are to help us understand what your preferences are and may not represent any particular current government proposal.

Please circle your response from 1 to 5, where 1 means that you are totally opposed to that proposal, and 5 means strongly support.

		Strongly Oppose	Slightly Oppose	Neutral	Slightly support	Strongly Support
1.	There should be more shopping/retail development in the train station precinct	1	2	3	4	5
2.	There should be more commercial/office development in the train station precinct.	1	2	3	4	5
3.	There should be more flats/apartments/townhouses built in the train station precinct	1	2	3	4	5

Your ideal neighbourhood

This question relates to your 'ideal' neighbourhood centre. Below is listed a range of different services, businesses and facilities that could be located at a neighbourhood centre. For each of these please **circle one number** to indicate to what degree you believe they are appropriate (regardless of whether or not they are currently provided in your centre).

		Very Undesirable	Somewhat undesirable	Neutral	Desirable	Essential
1.	Train station	1	2	3	4	5
2.	Bus service to the city	1	2	3	4	5
3.	Bus service to a regional shopping centre	1	2	3	4	5
4.	Library/ other council services	1	2	3	4	5
5.	Child care centre/kindergarten	1	2	3	4	5
6.	Supermarket/grocery store	1	2	3	4	5
7.	Milk bar/deli	1	2	3	4	5
8.	Butcher/ greengrocer/other fresh food outlet	1	2	3	4	5
9.	Doctor/Dentist/other health services	1	2	3	4	5
10.	Chemist	1	2	3	4	5
11.	Hairdresser/barber/beautician	1	2	3	4	5
12.	Newsagent	1	2	3	4	5
13.	Other speciality stores	1	2	3	4	5
14.	Post office/post office agency	1	2	3	4	5
15.	Bank/Credit Union	1	2	3	4	5
16.	Garage/service station	1	2	3	4	5
17.	Café/restaurant/fast food outlets	1	2	3	4	5
18.	Second hand goods/pawnbroker	1	2	3	4	5
19.	Hotel/tavern	1	2	3	4	5
20.	Park/Plaza/Town Square	1	2	3	4	5
21.	Offices, other professional services	1	2	3	4	5

22.	Townhouses, apartments and other residential units	1	2	3	4	5
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3. Travel Choices

We are researching your area because there are a range of transport options available. We would like to see if these options are actually being used. We'd therefore like to ask you a few questions about your regular travel choices. Please tick the appropriate box, or fill in the details as requested.

Generally Speaking

1. How often do you use public transport, such as a bus or train?

<input type="checkbox"/>	5 days per week or more
<input type="checkbox"/>	1 – 4 day(s) per week
<input type="checkbox"/>	1 – 3 day(s) per month
<input type="checkbox"/>	Less often
<input type="checkbox"/>	Never

2. Approximately how long does it take you to walk to your nearest train station?

<input type="checkbox"/>	Less than 5 minutes
<input type="checkbox"/>	5-10 minutes
<input type="checkbox"/>	10-20 minutes
<input type="checkbox"/>	More than 20 minutes
<input type="checkbox"/>	Don't know

Shopping Trips

3. Where do you do your regular shopping trips? Please give a suburb and name of shopping centre or nearest street corner.

Suburb
e.g. Floreat

Intersection
e.g. Floreat Forum

4. How do you usually travel to these shops? (tick the *one* box that most commonly applies)

<input type="checkbox"/>	Car (as driver)	<input type="checkbox"/>	Bus and Train
<input type="checkbox"/>	Car (as a passenger)	<input type="checkbox"/>	Walk
<input type="checkbox"/>	Train (walk/cycle to station)	<input type="checkbox"/>	Bicycle
<input type="checkbox"/>	Train (park at station)	<input type="checkbox"/>	Motorcycle
<input type="checkbox"/>	Train (dropped off at station)	<input type="checkbox"/>	Taxi
<input type="checkbox"/>	Bus	<input type="checkbox"/>	Other

Work Trips

- You** **Partner**
5. Do you and your partner (if applicable) work full time? Yes No Yes No
6. Do you and your partner work from home? Yes No Yes No
7. Where do you and your partner work? Please give us a suburb and nearest street corner

	You	Partner
Suburb e.g. Subiaco		
Intersection e.g. Cnr Hay Street & Rokeby Road		

8. How did you and your partner usually travel to work last week? (choose *one* only)

You		Partner	
<input type="checkbox"/>	Car (as driver)	<input type="checkbox"/>	Bus and Train
<input type="checkbox"/>	Car (as a passenger)	<input type="checkbox"/>	Walk
<input type="checkbox"/>	Train (walk/cycle to station)	<input type="checkbox"/>	Bicycle
<input type="checkbox"/>	Train (park at station)	<input type="checkbox"/>	Motorcycle
<input type="checkbox"/>	Train (dropped off at station)	<input type="checkbox"/>	Taxi
<input type="checkbox"/>	Bus	<input type="checkbox"/>	Other

Travel Costs

9. In a typical week, approximately how much would your household spend in travel costs? Include in this petrol, parking costs, public transport fares and the like.

Petrol	\$ _____
Parking	\$ _____
Public transport fares	\$ _____
Other	\$ _____

4. About your household

Finally, we would like to ask a few questions about your household. This will enable us to categorise our data appropriately. Please tick the appropriate box or fill in the details as requested

1.	How many adults are there in your household?	<input type="checkbox"/>	4 or more				
2.	How many children?	<input type="checkbox"/>	4 or more				
3.	How many working cars are garaged overnight at your house?	<input type="checkbox"/>	4 or more				
4.	How many bicycles?	<input type="checkbox"/>	4 or more				
5.	How many people have a driver's license?	<input type="checkbox"/>	4 or more				

6. Which best describes the building where your home is located?

<input type="checkbox"/>	A one-family house detached from any other house
<input type="checkbox"/>	A one-family house attached to one or more houses
<input type="checkbox"/>	A building with 2 apartments
<input type="checkbox"/>	A building with 3 or 4 apartments
<input type="checkbox"/>	A building with 5 or more apartments
<input type="checkbox"/>	Other, please describe: _____

7. Is this house or apartment --

<input type="checkbox"/>	Owned and fully paid off by you or someone in this household
<input type="checkbox"/>	Owned and paying mortgage by you or someone in this household
<input type="checkbox"/>	Rented by you or someone in this household
<input type="checkbox"/>	Other, please describe: _____

8. How many years have you lived in your current home? _____ years

9. How much a week does your household pay in rent or make in mortgage repayments?

<input type="checkbox"/>	\$1-49
<input type="checkbox"/>	\$50-99
<input type="checkbox"/>	\$100-149
<input type="checkbox"/>	\$150-199
<input type="checkbox"/>	\$200-249
<input type="checkbox"/>	\$250-299
<input type="checkbox"/>	\$300-349
<input type="checkbox"/>	\$350-399
<input type="checkbox"/>	\$400-499
<input type="checkbox"/>	\$500 and over
<input type="checkbox"/>	Nil

10. What is the approximate weekly (before tax) income of your household?

<input type="checkbox"/>	\$1-199
<input type="checkbox"/>	\$200-299
<input type="checkbox"/>	\$300-399
<input type="checkbox"/>	\$400-499
<input type="checkbox"/>	\$500-599
<input type="checkbox"/>	\$600-699
<input type="checkbox"/>	\$700-799
<input type="checkbox"/>	\$800-999
<input type="checkbox"/>	\$1000-1199
<input type="checkbox"/>	\$1200-1499
<input type="checkbox"/>	\$1500-1999
<input type="checkbox"/>	\$2000 and over
<input type="checkbox"/>	nil

11. What is your age?

<input type="checkbox"/>	Less than 18 years	<input type="checkbox"/>	18-30 years
<input type="checkbox"/>	31-50 years	<input type="checkbox"/>	51-70 years
<input type="checkbox"/>	70+ years		

12. What is your gender?

<input type="checkbox"/>	Male	<input type="checkbox"/>	Female
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Thank you for taking the time to fill in this survey.

Please now return this questionnaire to us in the return post envelope provided.