

SICEEP DARLING SQUARE

Pedestrian Assessment

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Incorporating



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LEND LEASE PTY LTD DARLING SQUARE

Pedestrian Assessment

Subtitle

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1 INTRODUCTION

Arcadis has been commissioned to undertake a high level pedestrian activity review and analysis of pedestrian movements to and from the Darling Square precinct. The Darling Square precinct is a new neighbourhood and a community hub that forms part of the Sydney International Convention, Exhibition and Entertainment Precinct SICEEP Project at Darling Harbour.

1.1 Background

The SICEEP Site is located within Darling Harbour. Darling Harbour is a 60-hectare waterfront precinct on the south-western edge of the Sydney Central Business District that provides a mix of functions including recreational, tourist, entertainment and business.

With an area of approximately 20 hectares, the SICEEP Site is generally bound by the Light Rail Line to the west, Harbourside shopping centre and Cockle Bay to the north, Darling Quarter, the Chinese Garden and Harbour Street to the east, and Hay Street to the south (refer to Figure 1).

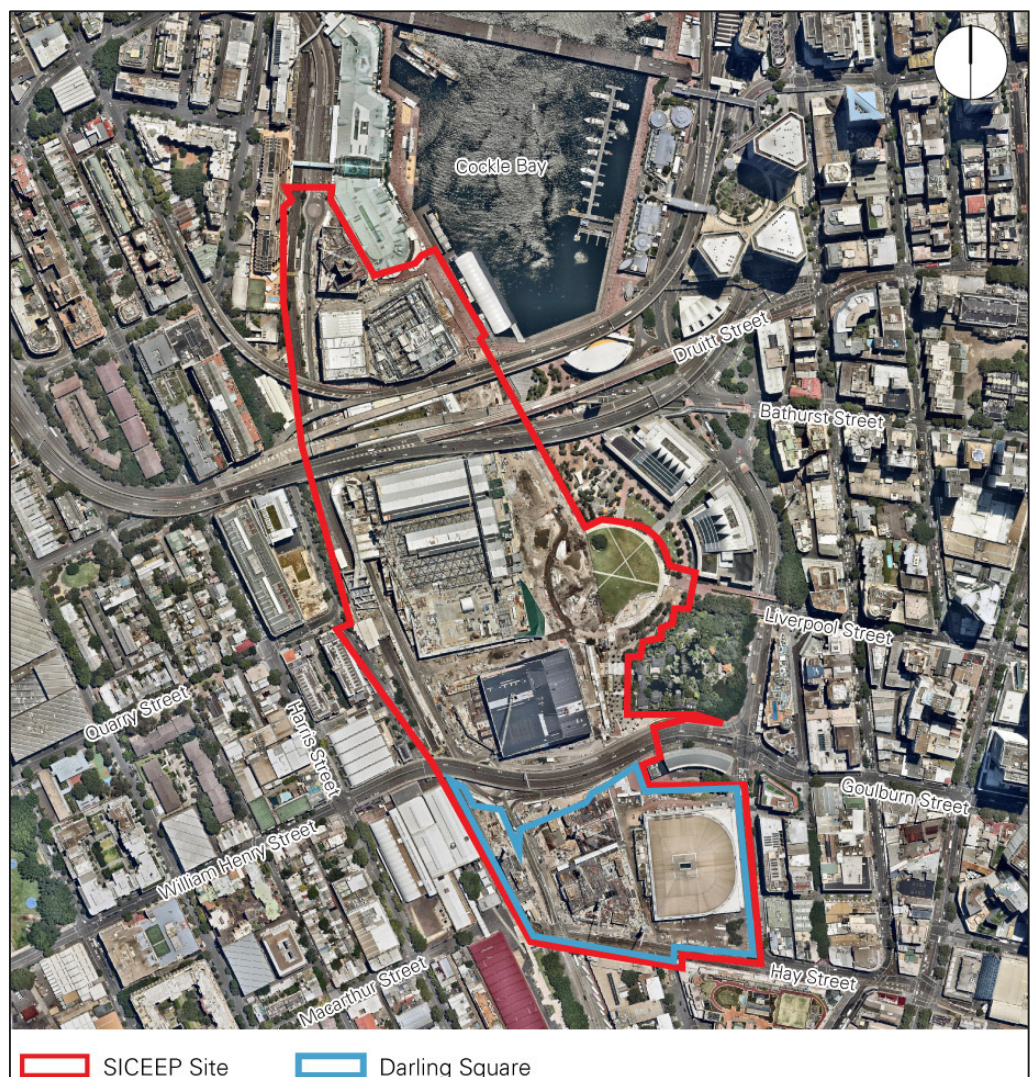


Figure 1 SICEEP

The project will develop Darling Square into one of Sydney's most innovative residential and working districts. Darling Square (refer to Figure 2) is located in the south of the SICEEP Site, within the northern portion of the suburb of Haymarket. It is bounded by the Powerhouse Museum to the west, the Pier Street overpass and Little Pier Street to the north, Harbour Street to the east, and Hay Street to the south. It is irregular in shape and occupies an area of approximately 37,770m².

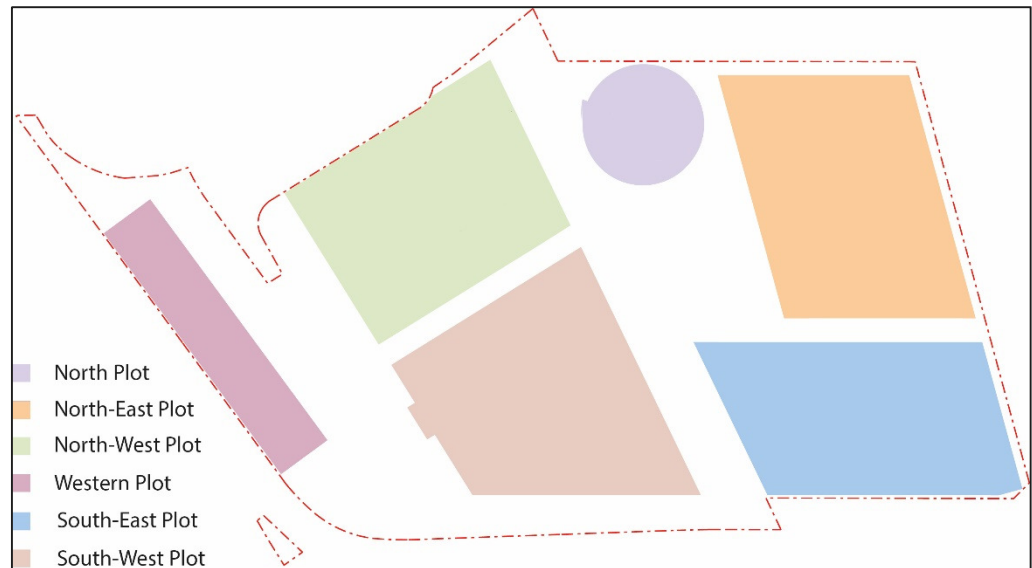


Figure 2 Darling Square Precinct

1.2 Purpose of this report

The purpose of this analysis is to establish the implications on the potential quantum of pedestrian movements and flows of the Darling Square development and vis-à-vis its interface with the Light Rail operations and pedestrian activity attributed to boarding and alighting at the adjacent light rail station at Paddys' Market. The assessment also considers pedestrian levels of service based on existing patronage data provided by TfNSW.

The objective of this report is to provide an indicative assessment of the current pedestrian activity in the vicinity of Darling Square and the future pedestrian activity with the opening of Darling Square. This preliminary report identifies treatment options for consideration in future investigations.

2 EXISTING CONDITIONS

2.1 Existing Pedestrian Network

Pedestrian access to and from Darling Square precinct and adjacent areas of the SICEEP Precinct is provided by a network of footpaths alongside major roads. Pedestrian connectivity across Darling Harbour and adjacent areas in the CBD consists of multiple road crossings or overhead walkways including steps, ramps or lifts.

The major pedestrian links to the Darling Square precinct include connection to Central Station to the southeast, Sydney CBD to the east via Chinatown, Darling Harbour/Tumbalong Park to the north across Pier Street and Ultimo to the southwest via Darling Drive. From Central Station, a direct route exists along Quay Street but is under-utilised as linkages close to Central Station are poor.

The recently opened Goods Line is a shared pedestrian and cycle path connecting Ultimo with Darling Harbour, connecting cultural and educational institutions, and improving pedestrian access from Central Station and Railway Square through to Pyrmont and Darling Harbour. The Goods Line opened in August 2015.

2.2 Pedestrian Activity

Pedestrian volumes within the SICEEP precinct flow along a general north-south axis from Harbour Street to Harbourside with pedestrian inflow from the east via Liverpool Street, Druitt Street, Bathurst Street, Goulbourn Street, Hay Street and Harbour Street.

Footpaths are provided along both sides of streets, though some are narrow (less than 1.5m) or obstructed by poles, signage, bins or landscaping. Pedestrian volumes vary across the week with weekends having the peak pedestrian activity across the year, and the midday period being the peak period for both weekdays and weekends.

The pedestrian activity areas are generated by:

- Hay Street from George Street and Central Station via Chinatown – pedestrian movements between Central Station, Sydney CBD, George Street;
- Quay Street is the most direct link connecting Railway Square to Darling Square;
- Factory Street through to Dixon Street mall - Dixon Street between Goulbourn Street and Hay Street is a major pedestrian pedestrian mall where more than 2,000 pedestrians can pass through in a single hour¹; and
- Paddy's Markets' Light Rail stop located west of Harbour Street.

¹ Chinatown Public Domain Study - Existing Traffic, Transport and Parking Conditions Report, Arup 2010.

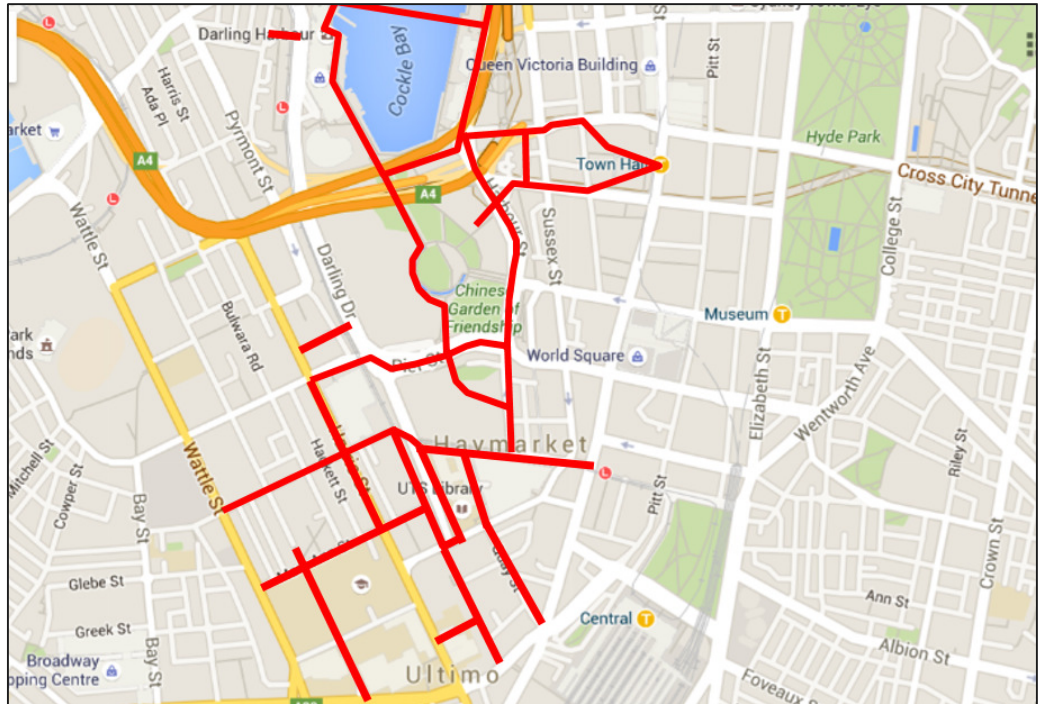


Figure 3 Existing Pedestrian Connections

2.3 Pedestrian Volumes

2.3.1 Previous Pedestrian Surveys

Pedestrian surveys were undertaken in 2013 as part of the assessment for the SICEEP proposal. The surveys were carried out during a Friday and a Saturday over a two-hour period each for both AM and PM peak periods. The counts were recorded by directional flow in 15-min intervals. In general, the pedestrian counts revealed:

- Friday AM peak was observed to occur at 8:15-9:15 AM;
- Friday PM peak was observed to occur at 5:00-6:00 PM;
- Saturday AM peak was observed to occur at 12:00-13:00;
- Saturday PM peak was observed to occur at 6:00-7:00 PM
- Saturday survey hours manifested higher pedestrian movements per hour when compared to Friday with Saturday PM showing the highest volume.

Particularly relevant to this assessment were the pedestrian volumes observed between the former Sydney Entertainment precinct area (now Darling Square) to and from Tumbalong Park / Darling Harbour. A total of 1,100 pedestrians (two-way flow) were observed to be the peak flow volume of pedestrians. These pedestrian volumes may represent pedestrian movements through Darling Square via Harbour Street and to/from the areas adjoining Darling Square to the south and east.

2.3.2 Paddy's Market Light Rail Stop Patronage

The Sydney Light Rail Inner West Line provides a direct connection from Central Station/CBD on the eastern side with the Inner West suburbs passing through Hay Street, south of Darling Square. The Sydney light rail transport system traverses east west from Central Station along Hay Street via Capitol Square, Paddy's Market, then travels north parallel to Darling Drive with stops at ICC Exhibition Centre, Convention

Centre, up to Pyrmont Bay, then Star Casino then onwards to Lilyfield then then Dulwich Hill. The light rail operates from 6am to 11pm daily between Central Station and Lilyfield with a service frequency of 10-15 minutes and 24 hours daily between Central Station and Star Casino with night service at 30 minute intervals. Extended hours up to midnight are also observed on the route on Fridays.

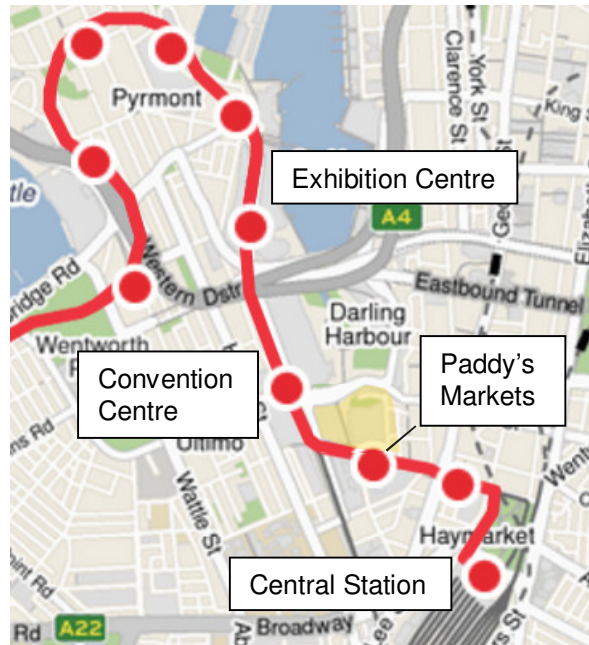


Figure 4 Sydney Light Rail Inner West Line

Paddy's Markets light rail stop is located along Hay Street just south of Darling Square and east of Quay street. Access to the stop on the southern side of Hay Street is provided for by the 2.8m (approx.) pedestrian footpath fronting the Markets and access to stop on the northern side is provided for by at-grade access along Hay Street.

Opal data for boarding and alighting at Paddy's Markets Light Rail Stop was provided by TransDev for a period of seven days from March 21 to 27, 2016. For the month of March 2016, a total of 72,872 boarding and 78,787 alighting (for a total of 151,659) passengers were recorded. The data indicated that Monday had the peak ridership at that station with approximately 8,200 passengers on a single day. A review of overall light rail patronage data for all stations also indicated that on the overall, Monday presented the peak daily volumes, which also appears to be almost double that of the average mid-week daily volume.

The key desire line for light rail passengers was between Paddy's Markets, Darling Harbour/Tumbalong Park, Hay Street /Harbour Street, and Chinatown, towards the local catchment or retail, commercial, educational and leisure activity centres.

The current patronage of the Paddy's Markets light rail station provides indication of two-way pedestrian volumes along Hay Street to/from the stop. Further to this, on-site observations indicate that more pedestrians to/from the light rail stop have origins and destinations in the vicinity of Paddy's Markets and the Darling Harbour precinct.

Figure 5 shows the daily variation of passenger boarding and alighting at the Paddy's Markets light rail station.

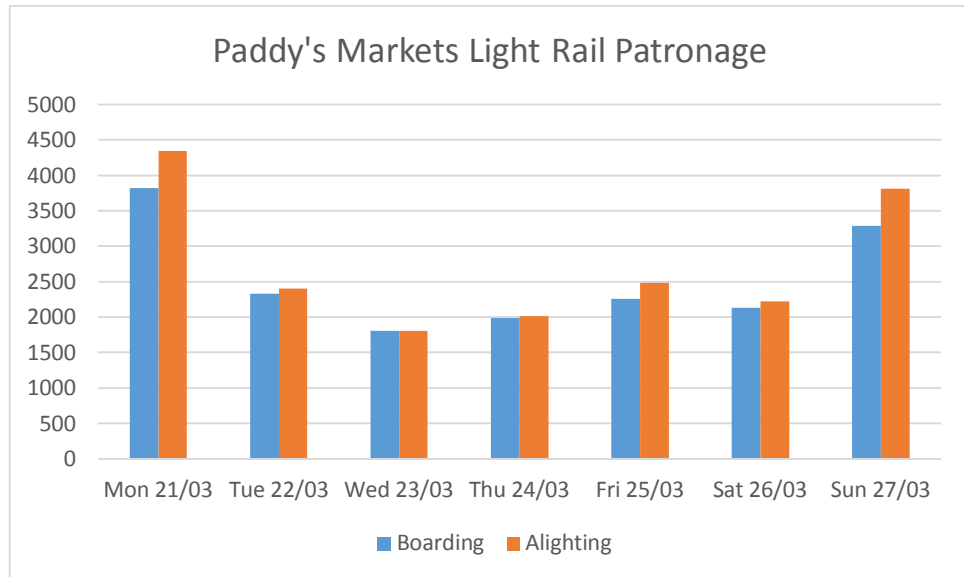


Figure 5 Paddy's Markets Station Light Rail Patronage
Source: TransDev, 2016

No data was provided on the hourly breakdown of the light rail passengers at the Paddy's Markets stop. For the purpose of this exercise, a 'guesstimate' of 15% is made on the likely 'high' peak volume per hour. It is estimated that a total of 1,200 passengers board and alight during the peak hour and peak day. This translates to 600 passengers (300 boarding; 300 alighting) on either direction of the stop.

3 FUTURE PEDESTRIAN ACTIVITY WITH SICEEP DEVELOPMENT

3.1 Future Pedestrian Network with SICEEP

The future pedestrian network provides interfacing with the improved pedestrian network around South Darling Harbour. Aside from maintaining existing routes, the design will extend the Goods Line to Darling Drive to improve access and strengthen linkages between Central Station, the education precinct (UPS/TAFE), Haymarket, Chinatown from the south towards the Powerhouse Museum and Darling Harbour to the north. The reconfiguration of Darling Drive and the new pedestrian connections will enhance accessibility to Quarry Street to the west and create new east-west connections through Tumbalong Place.

The development design of the SICEEP project will enhance at-grade pathways through Darling Square towards Tumbalong Park creating a direct north-south promenade extending from Quay Street to the Harbourside and linking major public gathering spaces (Darling Square, Tumbalong Park and Harbourside) within the Precinct. The main boulevard (referred to as the “Boulevard”) will be up to 20m wide and will have sufficient capacity to cater to peak pedestrian demand anticipated during events at the Convention Centre and Exhibition Centre. It also provides the main linkage between Darling Square, Darling Central and Bayside.

The SICEEP Traffic Transport and Access Plan for the whole precinct illustrates the proposed pedestrian connections and linkages.

In addition, there are ongoing initiatives are being implemented by the Sydney Harbour Foreshore Authority and the City of Sydney aimed at improving pedestrian and cyclist access from the CBD into Darling Harbour. Works are underway to improve the overall landscape, amenity and character of the adjoining area to complement the development of the SICEEP.

3.2 Pedestrian network Adjoining Darling Square

The development design layout for Darling Square provides new east-west and north-south pedestrian linkages to connect with the existing pedestrian pathways to the Sydney CBD to the east and Ultimo to the west. These linkages provide enhanced access to George St for improved access to bus services, rail stations and to the future CBD and South East Light Rail (CSELR).

Pedestrian connectivity with Darling Square is provided from at least seven major linkages with the external network.

- From Darling Drive, there are two pedestrian crossing locations – one at the signalised intersection of Darling Drive/Hay Street and another at the mid-block pedestrian crossing from the Western plot towards the North West plot. Within Darling Square, Dickens Lane provides the east-west connection from Darling Drive to the Boulevard.
- From the north, the key pedestrian linkage to Darling Square is along the Boulevard;
- From the east, there are two signalised pedestrian crossing points – one at the intersection of Harbour Street/Goulburn and another at the mid block crossing between Little Hay Street/Hay Street. However, on-site observations revealed that many pedestrians coming from/going to Hay Street cross at the

corner of Hay Street and Harbour Street or across the light rail corridor on Hay Street from Paddy's market to the Entertainment Centre square/

- From the south, pedestrians currently cross the light rail corridor at random locations along Hay Street. However, once the Boulevard is open, it is anticipated that the key pedestrian linkage from the south is Quay Street and across Hay Street to/from the Boulevard.

Figure 6 shows the pedestrian linkages to/from Darling Square precinct.

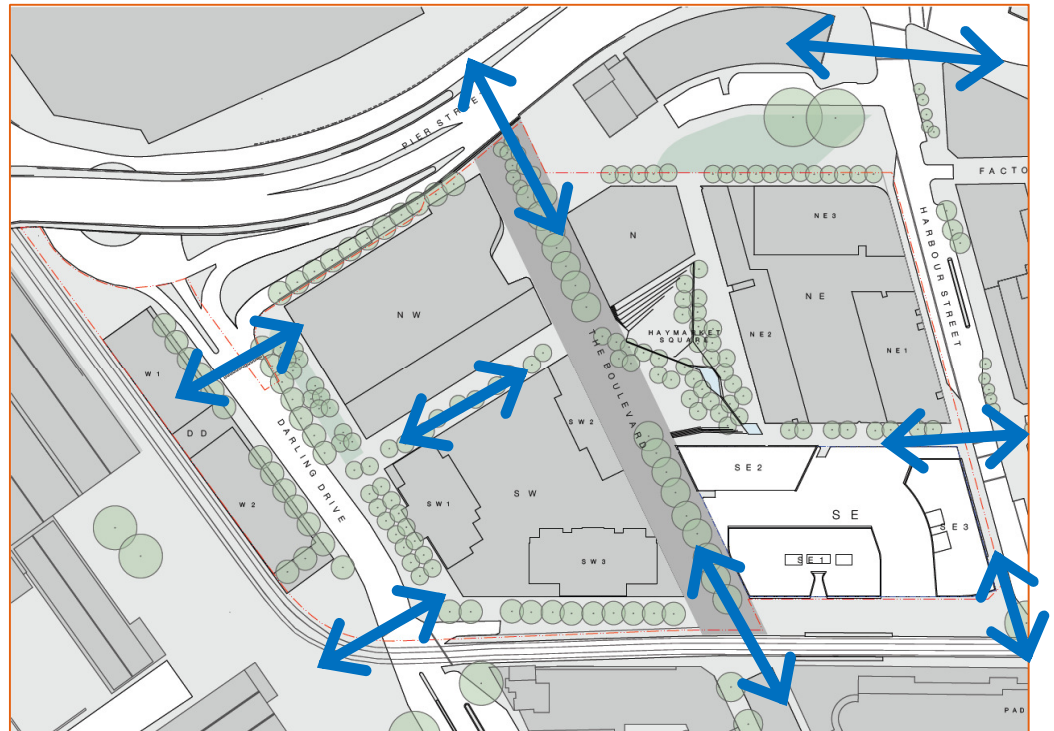


Figure 6 Pedestrian Linkages with Darling Square

3.3 Implications on pedestrian volumes due to Darling Square Development

The Darling Square precinct when approved will cater to approximately 1,600 high density residential units within the SW, NW and NE plots, 1,300 beds for student accommodation at the western plot and a total of approximately 28,000 m² of retail.

The development is expected to impact on pedestrian desire lines, focusing on the light rail stops, contribute an increase number of pedestrians crossing the light rail corridor along Hay Street, and walking between Darling Square to Chinatown, George Street, Central Station, among others.

A review of Journey-to-Work (JTW) data of residents from travel zones immediately adjacent to Darling Square (south and east) indicate a high proportion of residents use train as the main mode of travel (around 40%) with up to 10% of walk trips and 4% of tram (assumed to be referring to light rail) trips. The statistics suggest that there is a high propensity for residents living in the area to walk to the train station (the nearest being Central Station) for their commute to work.

Future pedestrian movements attributed to the residential development are estimated on the basis of potential person trip generation from the development. The RMS Guide to Traffic Generating Developments, TDT 2013/04a provides generation rates for high density residential for AM and PM peak. The rates were derived from surveys

conducted in 2012 on sites close to public transport, on buildings greater than 6 storeys high and almost exclusively residential in nature. One site that was surveyed was located in Harris Street, Pyrmont and the survey data presented the following:

- AM peak person trips per unit – 0.69 trips/unit
- PM peak person trips per unit – 0.49 trips/unit
- Saturday peak hour person trips per unit – 0.79 trips/unit

Applying the above rates to the residential component of Darling Square suggests a peak person trip on a weekday to be 1,073 person trips. Assuming a high case scenario of 60% of these person trips will be using the pedestrian network surrounding Darling Square during the AM peak hour, this translates to roughly 650 pedestrians in one hour and which is in addition to existing pedestrian volumes.

The quantum of pedestrian movements can only be clearly assessed with more detailed analysis of future directional flows. This preliminary assessment merely intends to establish an indicative overview of likely pedestrian volumes.

4 PEDESTRIAN CAPACITY ASSESSMENT

4.1 Capacity Assessment

To understand whether there is adequate capacity on footpaths to accommodate peak pedestrian demands while ensuring the safety and convenience for pedestrians, Fruin Theory, as reproduced in the 'Transit Capacity and Quality of Service Manual – 3rd Edition – Part 10 has been used, which involves evaluating the pedestrian capacity and level of service (LOS) of an area.

Congestion and capacity is qualified and quantified in terms of Fruin's Level of Service (LoS). The LoS concept was first introduced in 1971 and has been used as the standard for assessing pedestrian movement since then. Pedestrian levels of service (LOS) are measures of pedestrian density and congestion used for evaluating the capacity of infrastructure for pedestrian crowds. John Fruin developed levels of service for walkways and stairways as part of his seminal work on pedestrian planning in the 1960's and 1970's. Since then, other researchers have demonstrated that Fruin's LoS measures do not always apply (for example, in particularly disciplined crowds or in panic conditions). However, they tend to be used today as the industry standard for pedestrian congestion analyses.

Fruin's LoS analyses pedestrian conditions at spaces with many different activities or multi-directional flows, such as rail station platforms, common waiting areas, vertical circulation vestibules, fare collection zones, transit stop areas, footpath corners and pedestrian crossings. Conceptually, the time-space method considers pedestrian facilities as time-space zones with moving and standing pedestrians requiring different amounts of space and occupying the zones for different periods of time. Time-space is the product of an area (or space) and a time period. The time-space concept considers the type of activities occurring in a space within a given time period and the number of people who are involved in each. The amounts of time-space required for each activity are summed and compared to the time-space available or proposed within the facility. The walk-time space requirement is a function of the walking distance, walk speed and the number of people in that space. Walk speed is affected by the amount of space available per person, which is a function of the total amount of space available, and the number of people using that space. The total space required for waiting / processing within a facility is a function of the space required per person, the amount of time spent waiting, and the number of people waiting.

To assess pedestrian LOS, the criteria of 'Pedestrian Flow Rate' has been adopted. Pedestrian flow rate, measured in pedestrians per metre per minute, is the number of pedestrians that pass a point during a specific period of time. Pedestrian capacity analysis is typically based on peak 15-minute flow. A peak 5-minute sensitivity test is sometimes undertaken to assess the ability of a design to cope with a surge in pedestrian activity. This represents a "worst case" scenario.

Generally people accept or tolerate crowded conditions for situations of short duration, however the longer the wait, the greater the space per person required. Only usable space was represented and areas immediately along walls and those areas occupied or blocked by furniture and equipment were not included in the analysis.

Table 1 shows the Level of Service Criteria for walking and waiting / queuing adopted from Fruin.

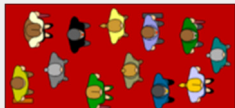
Table 1 Level of Service Criteria for Walk and Wait (Persons/metre/minute)

Level of Service	Walkways		Waiting/Queuing Areas	
	Pedestrian Area Occupancy (m ²)	Average Flow Volume (PMM)	Pedestrian Area Occupancy (m ²)	Average Flow Volume (PMM)
A	>3.3	<23	>1.9	<16
B	2.3-3.3	23-33	1.4-1.9	16-23
C	1.4-2.3	33-49	0.9- 1.4	23-33
D	0.9-1.4	49-66	0.7-0.9	33-43
E	0.5-0.9	66-82	0.4-0.7	43-56
F	<0.5	>82	<0.4	>56

Source: Adopted from Pedestrian Planning and Design (Fruin,1987)

The width used in this assessment is the 'Effective Walkway Width'. The Transit Capacity and QSM, illustrates that the width of a walkway includes an unused buffer depending on walls and other obstruction and in general, 500mm is deducted from the overall width next to a wall or walkway edge and 300mm next to other obstructions, including walls up to about 1 metre high.

Table 2 Fruin Level of Service

	Level of Service	Flow Rate (ped/m/min)	Density (sq.m./ped)	Description
	A	<23.0	>3.25	Free circulation
	B	23.0 – 32.9	3.25 – 2.30	Free circulation for one direction of flow; minor conflict for reverse and crossing flows.
	C	32.8 – 49.2	2.30 – 1.39	Some restriction in the selection of walking speed and the ability to pass others; high probability of conflict.
	D	49.2 – 65.6	1.39 – 0.93	Restricted and reduced walking speed for most pedestrians; difficulties in passing; multiple conflict with momentary stoppages of flow.
	E	65.6 – 82.0	0.93 – 0.46	Restricted and reduced walking speed for all pedestrians; shuffling progress at higher densities; extreme difficulties in reverse and cross flows.
	F	>82.0	0.46	Circulation reduced to shuffling; reverse and cross flows almost impossible; frequent contact; sporadic forward flow.

4.2 Existing Footpath Capacity

An indicative assessment of the existing pedestrian footpaths and facilities surrounding the site from a pedestrian capacity perspective has been completed as part of this exercise to understand any such minor impacts associated with increased pedestrian activity associated with the development of Darling Square.

Table 3 Estimated Peak Pedestrian Volumes

	Peak One Hour two-way volume	Peak 15 minute ¹	Effective walkway width (m) ²	LOS ⁶
Hay Street North (between Harbour and Darling Drive)	300 ³	90	3.8 – 4.8	D / C
Hay Street South (between Harbour and Darling Drive)	300 ³	90	3.8 – 6.0 ⁵	C / B
Harbour Street East (between Hay St and Goulburn St)	330 ⁴	100	2.8 – 3.2	E
Harbour Street West (between Hay St and Goulburn St)	330 ⁴	100	3.2 – 3.5	E / D

¹ In the absence of conversion factors, a 30% proportion is assumed for the 15- minute peak.

² Effective walkway width is estimated footpath width and may vary at some areas.

³ Assumes boarding/alighting passengers in one hour peaks

⁴ Assumes 60% of observed pedestrians flow observed between Entertainment Centre and Tumbalong Park (Refer Section 2.3.1 above) walk in the direction to/from Hay Street. The 40% are assumed to walk to/from Goulburn Street and Dixon Street.

⁵ The wider width applies to the temporary existing open space area.

⁶ Assumes a walking speed of 1.2 m/sec.

4.3 Future Footway Capacity with Darling Square

With the construction of Darling Square, the pedestrian walkways area to the north of Hay Street and the west of Harbour Street will have pedestrian footpaths integrated in the design of the buildings. It is anticipated that the provision of the Boulevard would redistribute pedestrian flow and channel pedestrians inwards instead of along the footpaths bordering the site.

It is expected that the anticipated increase of pedestrian volumes will be catered for by the improved pedestrian linkages and pathways incorporated within the design of the precinct. However, directional control of the pedestrian flows will require not only infrastructure but supporting management measures including wayfinding and signage.

5 SUMMARY

The pedestrian capacity assessment revealed that the existing pedestrian pathways along Hay Street and Harbour Street have restricted capacities during the peak flow. Any future increase in pedestrian movements and light rail passenger patronage may have implications on pedestrian capacity thresholds.

It should be noted that busy pedestrian activity areas may require site-specific pedestrian access solutions to manage crossings and safety, noting the variability and characteristics of pedestrian and traffic demand. In addition to infrastructure facilities, pedestrian access objectives may also be met with transport management measures such as crossing marshals during busy periods such as major events at Darling Harbour.

Key facilities that could be provided within the area surrounding the light rail stop at Paddy's Markets to facilitate pedestrian access include:

- Wayfinding signage
- Access routes to adjacent Quay Street, Boulevard, and Darling Drive, including pedestrian facility links to trip origins/ destinations.

Critical to the operations of the light rail is the random crossing of pedestrians along the corridor. Various treatment options exist to address this concern

Guidance regarding potential treatment options for pedestrian crossings of the light rail corridor can be referenced from the document *Safety Criteria for Light Rail Pedestrian Crossings*² (Irwin, 2003). This document provides appropriate treatment options for pedestrian crossings that are applicable for the Hay Street light rail corridor conditions.

Generally, the principle should be a thorough site analysis and contextual design response. Consideration of passive treatments may be appropriate. Examples of these treatment options are provided in Table 4

Table 4 Passive Treatment Options

Treatment Option	Purpose	Typical Application
"Stop Here" or "Wait Here" Pavement Markings	To identify for pedestrians and cyclists a safe stopping location that is outside the LRV dynamic envelope.	"Stop Here" or "Wait Here" Pavement Markings
Tactile Ground Surface Indicators	To identify for pedestrians a safe stopping location and safe refuge area that is outside the LRV dynamic envelope.	In conjunction with "Stop Here" markings, or where detectable warning is required at light rail station platforms and adjacent trackway crossings.
Channelling	Consists of railings that may be used to channel pedestrians or bicyclists. The purpose is to create a physical barrier that prevents or discourages persons from taking shortcuts or from crossing the trackway in a risky or unauthorized manner	Depends upon the particular conditions associated with the trackway crossing. It requires custom design for the particular location. In all cases, a channelling method that does not impair sight lines to an approaching train shall be selected.

² Presented in Transportation Research Circular E-C058: 9th National Light Rail Transit Conference, and accessed via http://onlinepubs.trb.org/onlinepubs/circulars/ec058/08_02_Irwin.pdf.

Treatment Option	Purpose	Typical Application
		Channelling should be considered where: • A high likelihood exists that persons may cross the trackway in an unauthorized manner, particularly if in a hurry, and • Other elements at the location will be effective in deterring unauthorized crossings.
"Look Both Ways" signage	Serves as a reminder to pedestrians and bicyclists as they approach the trackway to look for approaching trains in both directions.	Reminds pedestrians and cyclists as they approach the trackway to look for approaching trains in both directions. Generally, Look Both Ways signage is not required in city environments because of the slower LRV operating speeds. The signage should be installed at: • Non-CBD trackway crossing locations where LRV design speeds exceed 25 km/h • Light rail platforms in ballasted trackway • Mid-block pedestrian crossings.
Swing Gates	To slow persons who hurriedly approach the trackway. Gate operation is not electrically interconnected into approaching train or vehicular traffic signal systems.	Depends upon the particular conditions associated with the trackway crossing or light rail stop. General preference is barrier free access to light rail stops, following the Principles for the Strategy. Swing gates may be appropriate where: • pedestrian to train sight lines are restricted • a high likelihood exists that persons will hurriedly cross the trackway • channelling or other barriers reasonably prevent persons from bypassing the swing gates • acceptable provisions for opening the gates by disabled persons can be provided.

Treatment Option	Purpose	Typical Application
Pedestrian Barriers	Similar to swing gates, these barriers are intended to slow persons who are hurriedly approaching the trackway. A major advantage of barriers is that there are no operating parts or systems to maintain.	Pedestrian barriers may be appropriate where: • pedestrian to train sight lines are restricted • a high likelihood exists that persons will hurriedly cross the trackway • channelling or other barriers reasonably prevent persons from bypassing the barriers • adequate space is available to accommodate their installation

Source: Adapted from *Safety Criteria for Light Rail Pedestrian Crossings* (Irwin, 2003). Presented at the 9th National Light Rail Transit Conference, 16-18 November 2003, Portland, Oregon.

Source: Adapted from *Safety Criteria for Light Rail Pedestrian Crossings* (Irwin, 2003). Presented at the 9th National Light Rail Transit Conference, 16-18 November 2003, Portland, Oregon.