

2013 Travel Survey and Campus Counts

Analysis Summary

Never Stand Still

Introduction

2013 Travel Survey

The annual Travel Survey is a key element of the University's Transport Strategy outlined in the Kensington Campus Development Control Plan. The Survey completed its seventh year in 2013 and has become an essential database for the University's operational activities and forward planning. The Survey is conducted on-line by Facilities Management on a voluntary basis for staff and students that attend the Kensington campus – the main campus of UNSW. The Survey seeks to determine the method of travel to and from the campus, arrival and departure points, where car driver's park, times of arrival and departure, the time taken to travel and the point of travel origin.

The Survey was conducted over a three-week period in April and received the highest ever response from more than 2,100 staff and 8,200 students. The response represented 23% of staff and 19.1% of students attending the campus. The sample percentages were then applied to the average daily campus population to derive the actual numbers and to fully understand the travel impacts of staff and students. The margin of error was assumed at 1%. (www.surveymonkey.com/mp/sample-size).

The key Survey results are analysed each year to assist in implementing measures to reduce car dependence and parking demand at the campus while at the same time improving public transport access and related public domain improvement works at strategic locations. The 2013 Survey proved especially valuable in supporting the University's planning for light rail in conjunction with Transport for NSW and other key stakeholders.

Attached to this Analysis Summary are the 2013 Travel Survey results. For each question the results are tabulated; firstly to show the percentages of total staff and students that responded to the question; and secondly to show the actual numbers and percentages of respondents between staff and students. The percentages of total respondents for each question are represented by a chart to more clearly convey the results.

The results from Questions 5 and 6, related to staff and student daily arrival and departure times have been excluded from this analysis summary. Instead, the arrival and departure times collected from the Campus Counts have been used. The Counts provided a more detailed set of results and for a longer span of time. See details of Campus Counts below.

2013 Campus Counts

In 2013 simultaneously with the Travel Survey, the University conducted a count of movements at the campus perimeter during a typical semester's day.

The aim was to obtain more specific data of where and how many pedestrians, cars, bicycles, motorbikes and commercial vehicles arrived and departed from, the campus. All arrival and departure movements at strategic points on the campus perimeter were counted in 15 minute intervals over two half days – Monday 8 April from 2.30pm to 9pm and Tuesday 9 April from 7am to 2.30pm.

The Campus Counts provided a better data capture than the results of Question 5 and 6 of the Travel Survey and have therefore been used in in this summary to analyse arrival and departure times.

For more information regarding the Survey and Counts, please contact Ms. Kuhu Gupta, Campus Planner at UNSW Facilities Management on 93853362 or kuhu.gupta@unsw.edu.au

Glossary

Total campus population – recorded at 51,476 on Monday, 29th April. (9,199 staff and 42,277 student headcounts)

Data source: UNSW Institutional Analysis and Reporting Office

Average daily population – approximated at 41,200 on the assumption that around 80% of the total campus population attend the campus Monday to Thursday during University semesters i.e. a typical semester day.

Data source: UNSW 2013 Travel Survey

Method of Travel (2013 Travel Survey)

Figures 1 and 2 demonstrate the changing trends in the method of travel to and from the campus since 2007. The percentage of respondents in Figure 1 are then applied in Figure 2 to the average daily population to derive the actual numbers of staff and students that travelled to and from the campus on a typical semester day.

The results confirm a continuing trend to more sustainable methods of travel with public transport being the most obvious. Staff and students however, continue to drive to the campus. There are perhaps three main reasons for this:

- The availability of free and unrestricted parking in streets immediately surrounding the campus;
- Increased travel times to and from the campus for users of public transport;
- The availability of staff parking at comparatively low commercial rates; and
- Minimal or no public transport services to suburban routes after 8 pm.

The opportunity for free parking in streets around the campus encourages the use of private cars and creates less of a need to use public transport. UNSW will be unable to achieve targets in sustainable travel modes while substantial parking remains available in local streets. Further discussions are required with Randwick City Council on this issue.

In 2013, the university teaching hours increased significantly with several postgraduate courses finishing after 8 pm. With several bus services also finishing after 8pm, staff and students must then consider whether to use private vehicles or taxis to travel to home.

Figure 1. Travel Trends 2007-2013 (Percentage of Respondents)

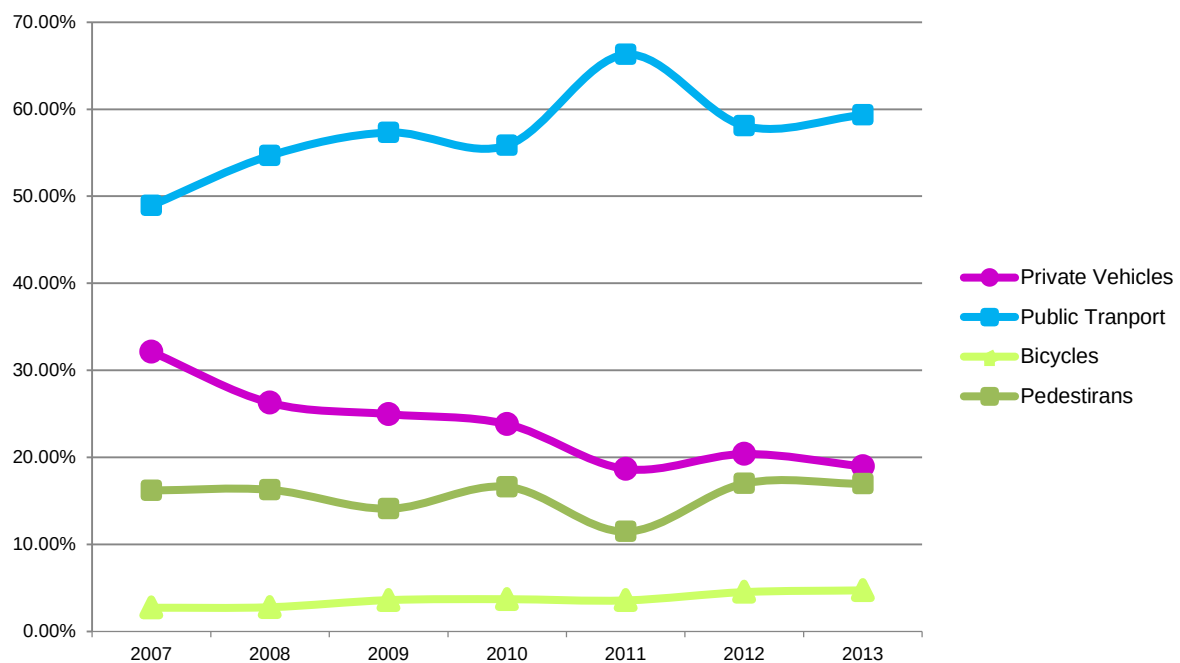
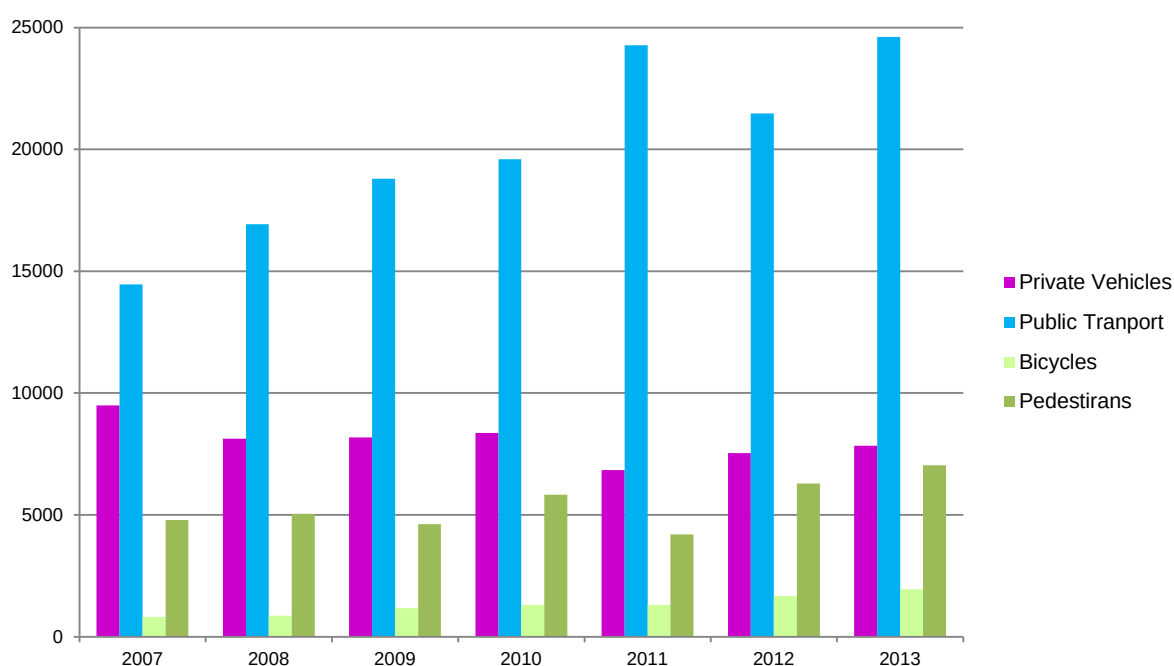


Figure 2. Travel Trends 2007-2013 (Staff and Students on a Typical Semester Day)



Private Motor Vehicles (Car Driver, Car Passenger, Motorbike)

In 2013 19% of respondents travelled in private vehicles, a 13% decrease in the overall travel trend for private vehicle usage since 2007. When the percentages were applied to the average daily population, the results demonstrated a decrease from 9,500 daily private vehicles users in 2007 to 7,850 in 2013. This equated to an average decrease of 235 private vehicle users each year despite an increase in the total campus population of approximately 14,000 since 2007.

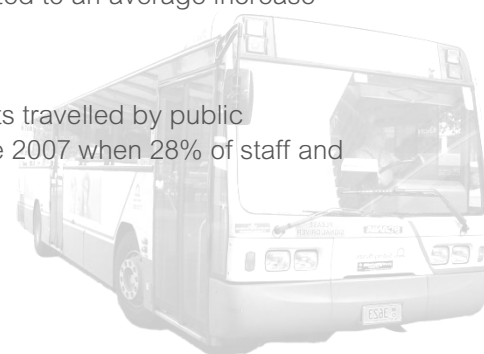
The results also demonstrated that 43.8% of staff and 12.6% of students travelled by private vehicle in 2013, continuing the decrease in private vehicle users since 2007 when 59% of staff and 30% of students used this method of travel.



Public Transport (Bus, Train, Ferry)

In 2013 the majority of respondents (59.4%) travelled by public transport, a 10.4% increase since 2007 when this method of travel was used by only 49% of staff and students. When the percentages were applied to the average daily campus population the results demonstrated an increase from 14,450 daily public transport users in 2007 to 24,616 in 2013. This equated to an average increase of 1,450 public transport users each year.

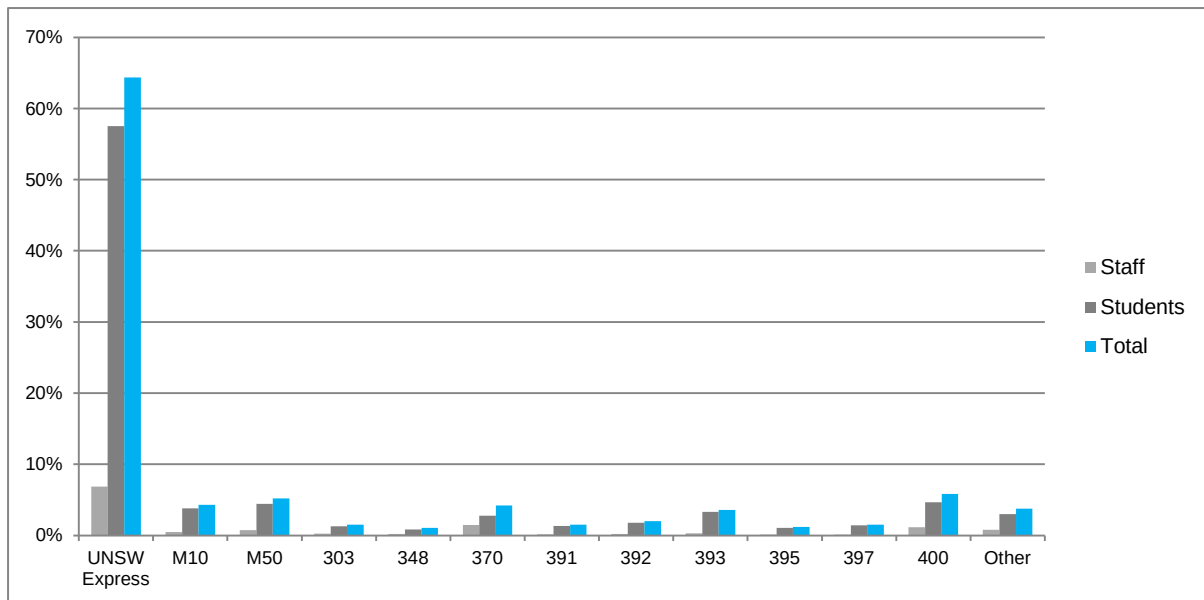
The results also demonstrated that 36.9% of staff and 65.1% of students travelled by public transport in 2013, continuing the increase in public transport users since 2007 when 28% of staff and 50% of students used this method of travel.



Buses only

A new question was introduced to the 2013 Travel Survey that asked those that travelled to and from the campus by public transport, which bus service were they used. A large majority (64.4%) responded that they used the UNSW express buses services (890, 891, 892 and 895). Other bus services that were less used, but still notable (3-6%) included the 400, 370, M50 and M10.

Figure 3. Arrival and Departure by Bus (Percentage of Respondents)



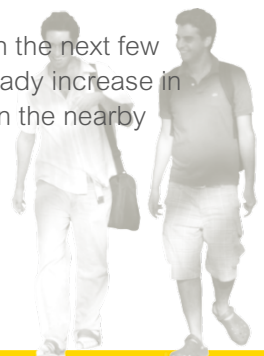
Bicycles

The percentage of respondents cycling to and from the campus increased from 2.7% in 2007 to 4.7% in 2013, demonstrating a continuing upward trend despite coming from a low base.

Pedestrians (Walk to or Live on Campus)

The percentage of respondents walking to and from, or living on the campus has remained steady over the last six years at around 17%. When this percentage was applied to the average daily campus population it demonstrated that there were approximately 7,000 staff and students that either walked to, or lived on, the campus on a typical semester day in 2013. Although this equated to an average increase of 320 staff and students walking to campus each year, the largest increases have taken place over the last five years with the opening on the campus of New College Village in 2009 (315 beds), UNSW Village in 2010 (1,100 beds) and University Terraces in 2013 (412 beds).

The number of students walking to, or living on the campus is expected to increase in the next few years with completion of the Kensington Colleges redevelopment, together with a steady increase in the provision of private sector student housing and other high density dwellings within the nearby suburbs of Randwick, Kensington and Kingsford.



Arrival and Departure Points on Campus (2013 Travel Survey)

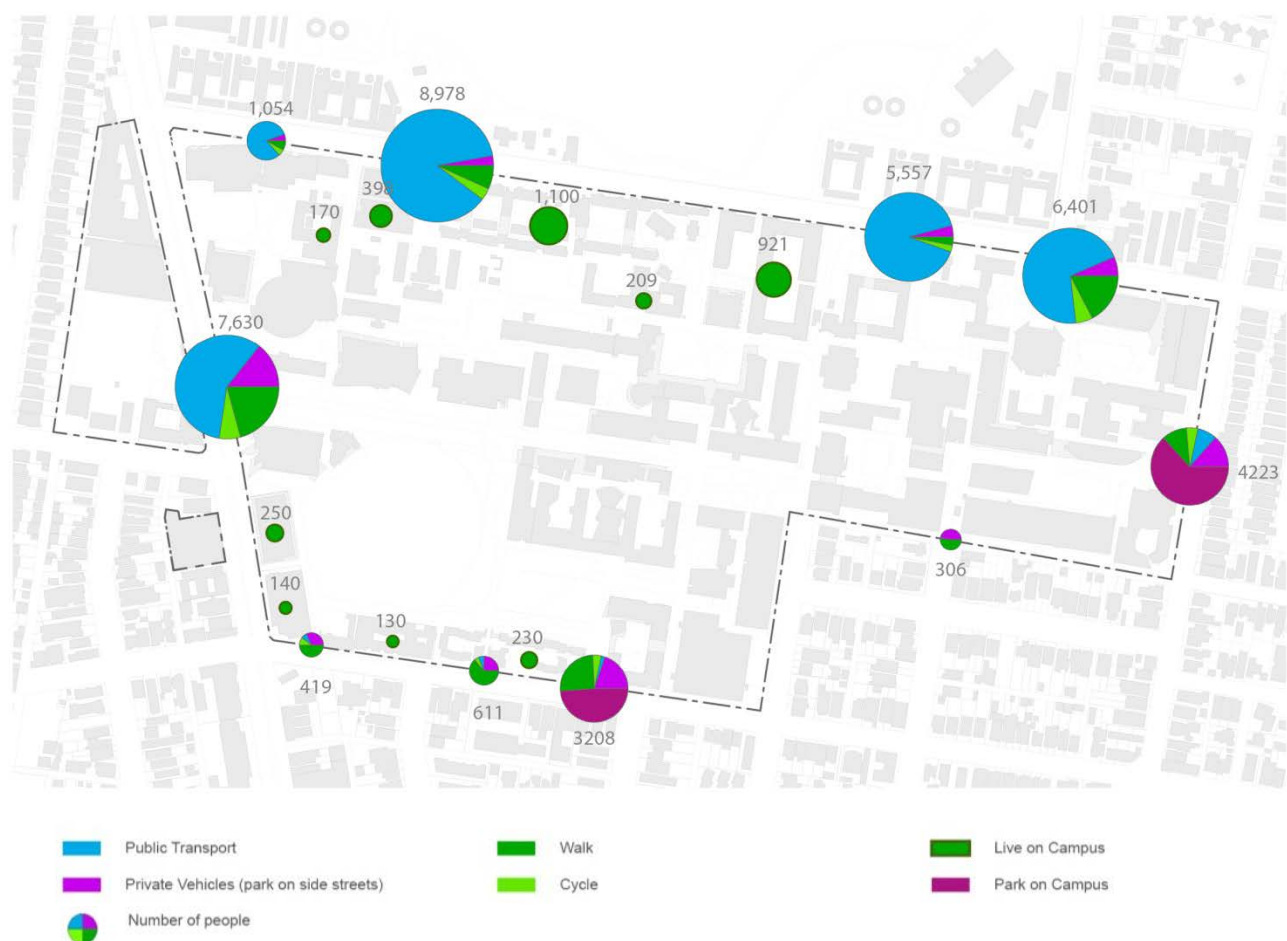
Two new questions were introduced to the 2013 Travel Survey to determine which gate or entrance staff and students arrived to and departed from, the campus. These were to assist in understanding pedestrian movements for the planning of campus light rail stops and for campus planning generally.

Arrival

The University Mall/Anzac Parade, Gates 2, 8, 9, 11 and 14 continue to be the major arrival points in 2013 with 36,000 staff and students arriving at these locations on a typical semester day.

Gate 2, High street is the most popular arrival point with close to 9,000 staff and students arriving at this gate.

Figure 4. Arrival Points



Departure

The University Mall/Anzac Parade, Gates 9, 11 and 14 continue to be the major departure points in 2013 with close to 33,000 staff and students departing at these locations on a typical semester day.

University Mall/Anzac parade is the most popular departure point with over 17,000 staff and students departing from this location on a typical semester day. Gate 9, High Street, is the second most popular departure point with just over 8,000 staff and students departing from this gate on a typical semester day.

Figure 5. Departure Points



Parking (2013 Travel Survey)

In 2013, of the respondents that were car drivers 54.7% parked on the campus while 45.3% parked in local streets. For the actual numbers of staff and students, the results showed that most staff parked on the campus (86.5%) while most students parked in local streets (76.1%) on a typical semester day. These results are comparable with previous years and are a consequence of on-campus parking being restricted to staff or with a parking fee, and the availability of free parking in surrounding streets.

Figure 6. Surrounding streets on which drivers parked



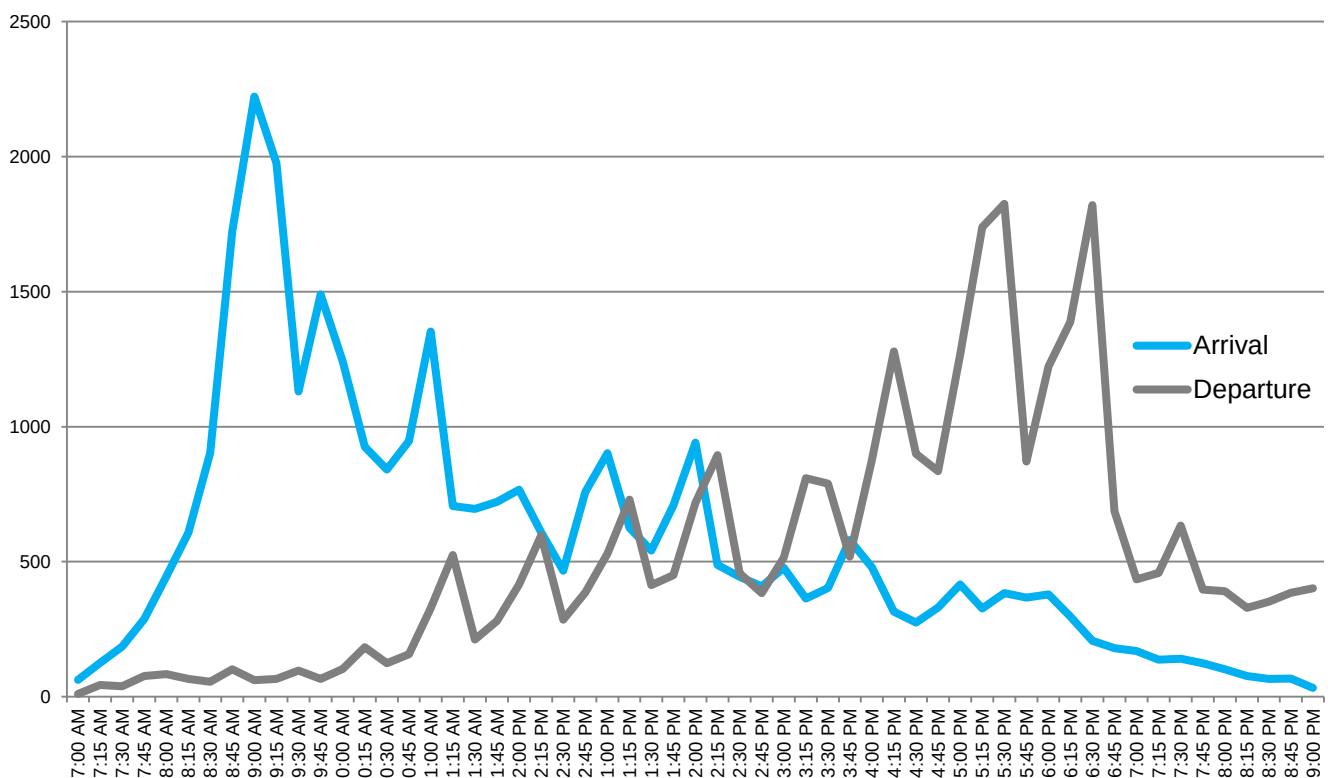
Arrival and Departure Times (2013 Campus Counts)

The peak arrival period in 2013 occurred between 8.45 am and 9.15 am with 15% (6,200) of all staff and students arriving at the campus within these 30 minutes. This is consistent with the Travel Survey results from previous years where the arrival peak occurred between 8 am and 9 am on a typical semester day.

The peak departure is less concentrated and occurs in two periods between 4.45 and 5.30 pm and between 6.00 and 6.30 pm. Approximately 19% (7,900) of all staff and students depart the campus at these times on a typical semester day. These results are again largely comparable with the Travel Survey results of previous years, but with a slight increase in people departing between 6pm and 7 pm in 2013.

The results also demonstrate the significant numbers of staff and students departing the campus after 8 pm. This can be mainly attributed to timetabling changes in 2013 that increased the number of evening classes.

Figure 7. Arrival and Departure Times (Staff and Students on a Typical Semester Day)

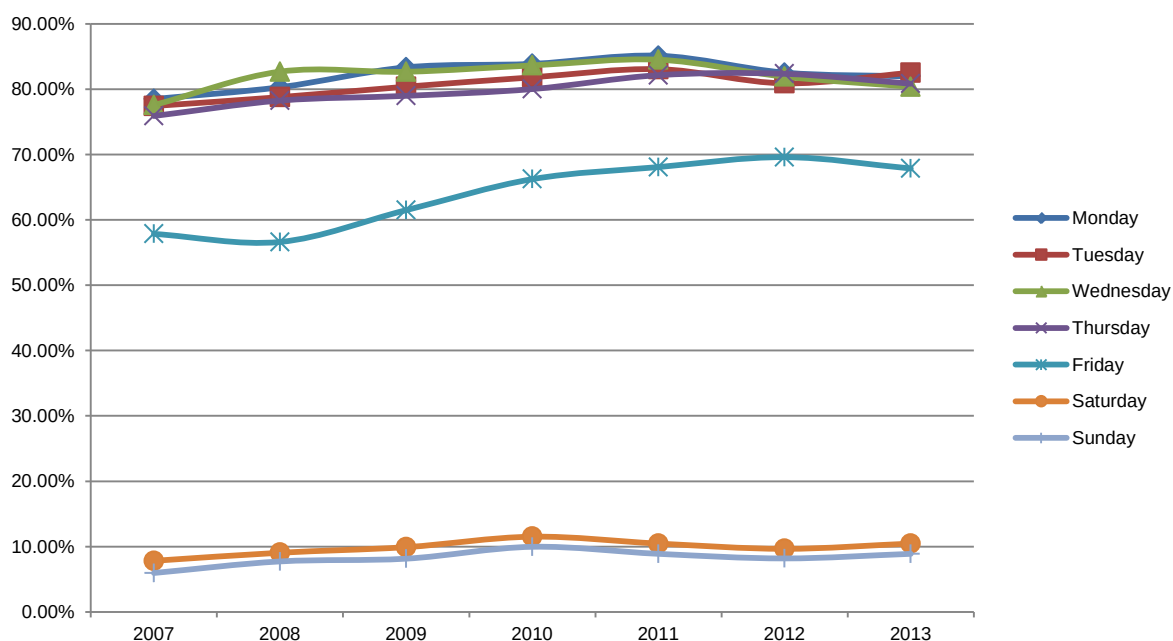


Weekly Campus Attendance (2013 Travel Survey)

81% of respondents attended the campus on a typical semester day. 68% of respondents attended on Fridays, consistent with previous years. The lower attendance on Fridays is mainly due to less classes being timetabled.

Saturdays and Sundays were consistent previous years with only 8-10% of respondents attending the campus on these days.

Figure 8. Weekly Campus Attendance (Percentage of Respondents)



Postcode of Origin (2013 Travel Survey)

The postcodes of where respondents lived identified how far staff and students travelled to and from the campus. The results showed that approximately 49% of staff and students live 10 km or less from the campus.

Significant numbers of staff and students travel from suburbs throughout the Sydney metropolitan area, including 2.5% of respondents from suburbs in the Blue Mountains.

Figure 9. Staff and Students Postcode of Origin in the Sydney Metropolitan Area

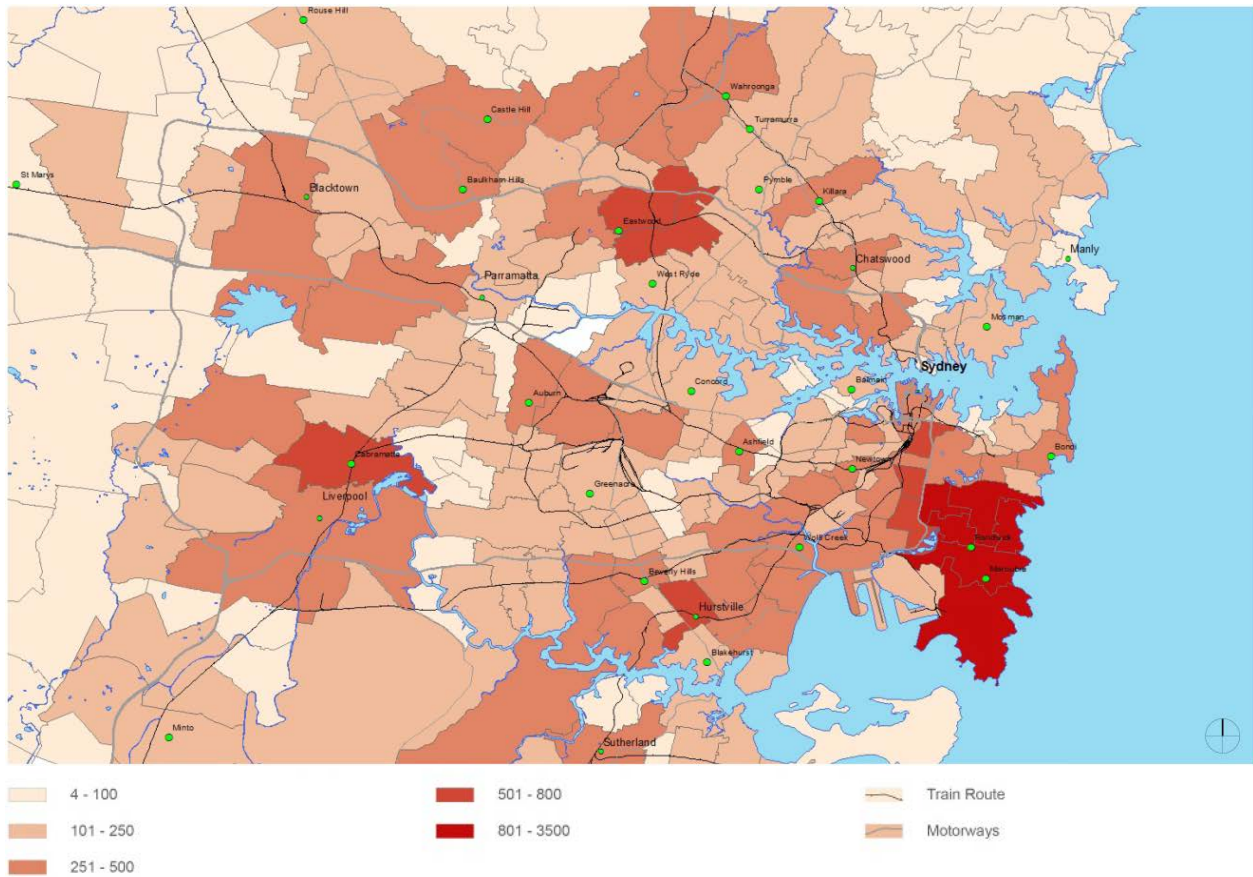


Figure 10. Postcode of Origin of Staff and Students Using Public Transport

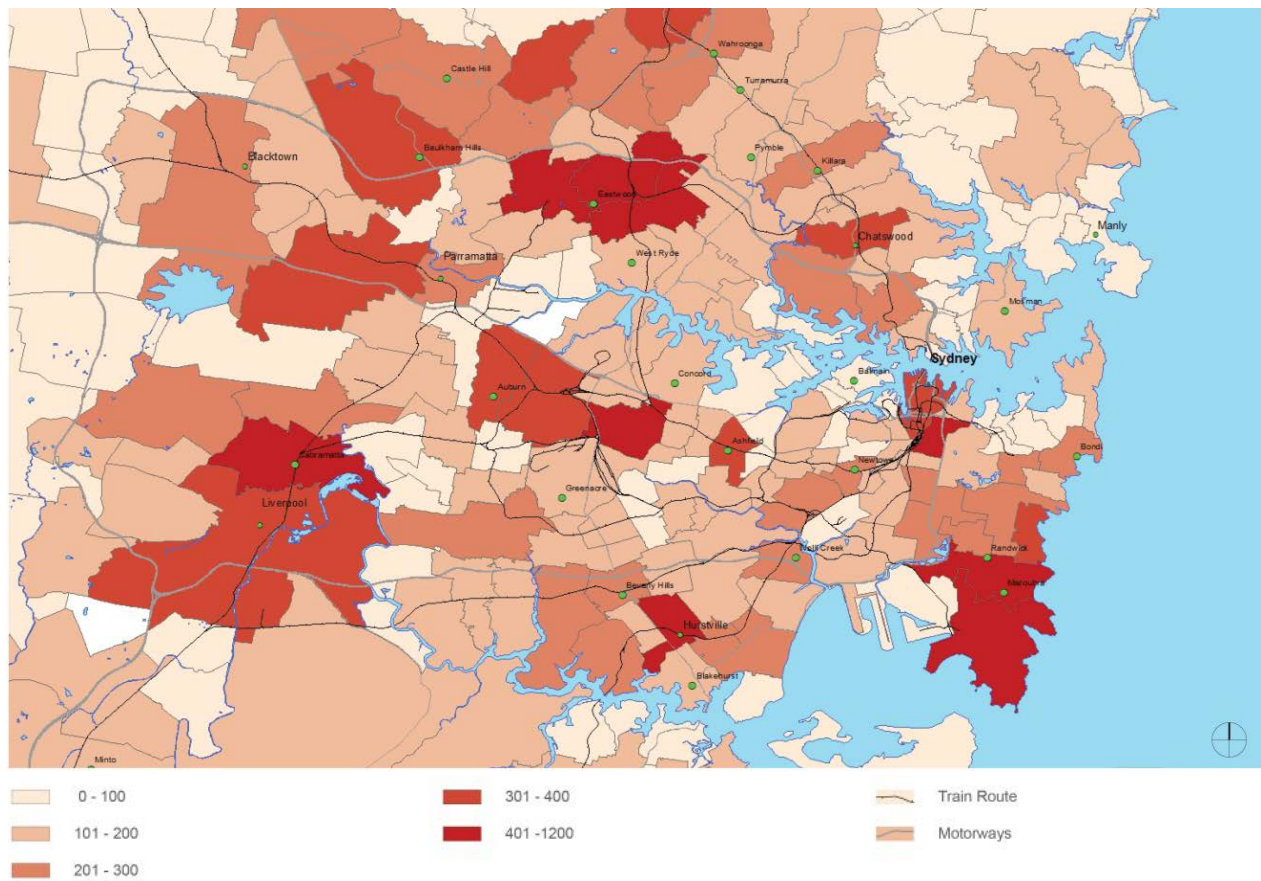
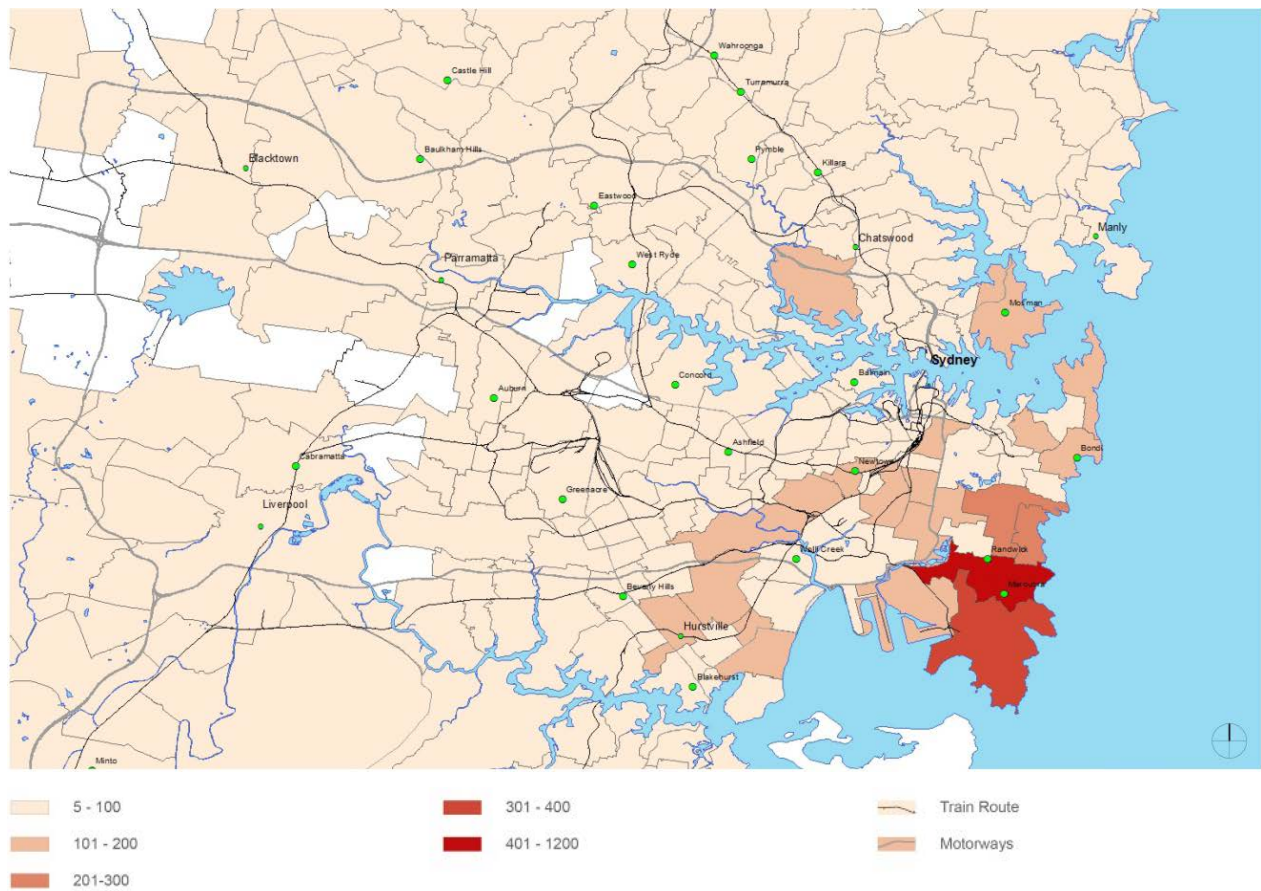


Figure 11. Postcode of Origin of Staff and Students Using Private Vehicles





CBD & SOUTH EAST LIGHT RAIL PROJECT

(RANDWICK CITY COUNCIL & UNSW AREA)

TECHNICAL REVIEW – TRAFFIC ENGINEERING & ROAD SAFETY (DECEMBER 2013)



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NIL

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VERSION HISTORY

Version	Date	Type	Prepared By	Approved By
A	07/11/2013	Draft Report	A. Coyle / N. Green	A. Coyle
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1 INTRODUCTION

Traffix Group Pty Ltd has been engaged by Randwick City Council and University of New South Wales to provide independent technical advice regarding the proposed CBD & South East Light Rail project.

2 ASSIGNMENT SCOPE

The purpose of this assignment is to provide independent technical advice regarding the proposed CBD & South East Light Rail project to ensure that the project best meets the objectives and vision of Randwick City Council and University of New South Wales.

The plans prepared by Transport for New South Wales have been reviewed and the sites inspected with representatives from Randwick City Council and University of New South Wales.

In particular, the review focussed on key issues such as:

- Location - Surrounding Land Uses, Land Acquisition.
- Layout - Platform Size, Storage, Swept Paths.
- Access - Crossing Points, Ramps, Illegal Access, Safety, Footpath / Shared Path, Vehicle.
- Intermodal - Sharing of Tracks, Bus Stops, Bus / LRV Transfer, Bus Priority.
- Signal Operation – Overview, LRV Movements, Bus Movements, Pedestrian Movements, Traffic Impacts.

3 CBD & SOUTH EAST LIGHT RAIL PROJECT

The CBD & South East Light Rail Project (the 'Project') is a new light rail line extending 12 kilometres from Circular Quay along George Street to Central Station, then to Kingsford via Anzac Parade and Randwick via Alison Road.

Key features of the project include:¹

- nine stops between Circular Quay and Central Station.
- seven stops between Kingsford and Central Station, including the University of NSW at Anzac Parade and Moore Park.
- six stops between Central Station and Randwick, serving the Prince of Wales Hospital, University of NSW at Wansey Road, Randwick Racecourse and Moore Park.
- interchanges located at major rail stations – Central Station, Town Hall, Wynyard and Circular Quay and bus interchanges at both Randwick and Kingsford.
- pedestrian zone from Bathurst Street to Hunter Street with light rail operating through the centre.
- segregated traffic and light rail lanes between Central Station and Bathurst Street and between Hunter Street and Circular Quay.

Key benefits include:

- Increased capacity:
 - space for 300 commuters on each 45 metre long light rail service – equivalent to five standard length buses.
 - reduced crowding and congestion.
 - buses freed up to service other destinations.
- Faster, simpler, more reliable services:
 - 'turn up and go' services every two to three minutes in peak times.
 - 97 per cent reliability.
 - services that are on time and fast.
 - real time information at all stops and on vehicles, showing route and stop locations.
 - simple to navigate.
 - effective wayfinding at stops and interchanges, to help you transfer to bus, ferry or heavy rail.
- Urban renewal opportunities:
 - pedestrian friendly streets, open spaces and revitalised public areas
 - reduced congestion at the heart of the CBD
 - a more attractive, accessible environment for visitors, businesses and workers
 - improved connections where people live, work and visit.

- Improved amenity:
 - integrated, electronic ticketing available at outlets or on-board
 - light rail stops maximise accessibility, with multiple doors available to alight at your stop
 - smooth, comfortable and quiet services, with air-conditioned vehicles
 - safe, clean, accessible and comfortable environment.

An overview of the project is shown in Figure 1. The study areas for this investigation are highlighted in red.



Source: <http://www.transport.nsw.gov.au/light-rail-program/cbd-and-south-east-light-rail>

Figure 1: Project Overview and Study Areas

¹ Source: <http://www.transport.nsw.gov.au/light-rail-program/cbd-and-south-east-light-rail>

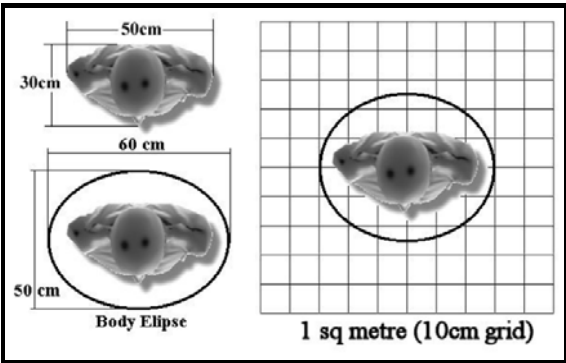
4 REFERENCE DOCUMENTS

The following documents were reviewed during the preparation of this report:

- Transport Operations Report, Final Report, Transport for NSW, 8 October 2013, Sydney.
- CBD and South East Light Rail Engineering, Light Rail Systems and Urban Design Definition Design - Volume 3 - Part 1 - South East Corridor, Final, CSELR-00WP-GN-R-0019, prepared for Transport for NSW, 16 August 2013.
- CBD & South East Light Rail Engineering, Light Rail Systems and Urban Design Definition Design Report - Volume 4 - Urban Design, CSELR-00WP-GN-R-0020, Final, prepared for Transport for NSW, 16 August 2013.

5 PEDESTRIAN LEVEL OF SERVICE

The Victorian Rail Industry Operators Group Standards VRIOGS 002.1 Railway Station Design Standard and Guidelines (Revision A, 29/03/2011) includes details of the Fruin Levels of Service. It is a concept used in the design of places of public assembly and uses typical body ellipse (see below) to represent the space occupied by a person without touching an adjacent person i.e. it is slightly more than the space occupied by the physical person.



Source: Victorian Rail Industry Operators Group Standards VRIOGS 002.1

Figure 2: Body Ellipse

Fruin	Area Per Person		Edge		
Level of Service	Square Feet	Sq Metres	Feet	Metres	Density
LoS F	5	0.46	2.24	0.68	2.17
LoS E	10	0.93	3.16	0.96	1.08
LoS D	15	1.39	3.87	1.18	0.72
LoS D	20	1.86	4.47	1.36	0.54
LoS C	25	2.32	5.00	1.52	0.43
LoS B	30	2.79	5.48	1.67	0.36
LoS B	35	3.24	5.92	1.80	0.31
LoS A	40	3.72	6.32	1.93	0.27

Source: Victorian Rail Industry Operators Group Standards VRIOGS 002.1

Figure 3: Fruin Level of Service

The widths of key station elements – ramps and stairs – can be tested using a level of service approach whereby the recommended width is calculated by:

Width required = pedestrians/unit time/service level flow rate.

The service level flow rates normally adopted are shown in Figure 4

Service Level	Flow Rate (pedestrians/m/min)	
	Walkway or Ramp	Stair
A	23	16
B	28	20
C	41	26
D	58	38
E	74	49

Source: Victorian Rail Industry Operators Group Standards VRIOGS 002.1

Figure 4: Ramp Flow Rates & Service Levels

This information can be used to assess the key LRV stop elements.

6 PASSENGER BOARDING & ALIGHTING VOLUMES

The 'Transport Operations Report, Final Report, Transport for NSW, 8 October 2013, Sydney' provides information regarding predicted passenger boarding and alighting numbers as well as bus transfers and walk ups. Daily pedestrian movement data (by location and mode at each of the main access points) was provided by UNSW and are presented in Figure 4 and Figure 12. A summary of this data is provided in Table 1.

Table 1: Passenger Boarding & Alighting Volumes

Location	Transport Operations Report Predicted Volumes (AM Peak Hour*)	UNSW Data Existing Volumes (Daily)
Wansey Road / High Street Stop (UNSW)	Precinct Access Plan (Table 7-21) states: 749 boardings & 2,188 alightings forecast for 2021 (total – 2,937 per hour). 842 boardings & 2,803 alightings forecast for 2036 (total – 3,645 per hour).	High number of daily arrivals (11,957) from the gates in High Street near Wansey Road, with approximately 80% (9,525) by public transport. There is also a high number of daily departures (9,607) to the existing gates in High Street, with approximately 74% (7,087) by public transport. Entries (alightings for public transport passengers): Max. - 632 per 15 minutes. 95th Percentile - 352 per 15 minutes. Exits (boardings by public transport): Max. - 387 per 15 minutes. 95th Percentile - 279 per 15 minutes.
Anzac Parade UNSW Stop (UNSW)	Precinct Access Plan (Table 7-16) states: 626 boardings & 1291 alightings forecast for 2021 (total – 1,917 per hour). 708 boardings & 1673 alightings forecast for 2036 (total – 2,381 per hour).	High number of daily arrivals (17,662) from the gates in Anzac Parade near University Mall, with approximately 74% (13,110) by public transport. There is also a high number of daily departures (20,050) to the existing gates in Anzac Parade near University Mall, with approximately 76% (15,323) by public transport. Entries (alightings for public transport passengers): Max. - 898 per 15 minutes. 95th Percentile - 579 per 15 minutes. Exits (boardings by public transport): Max. – 1,143 per 15 minutes. 95th Percentile - 594 per 15 minutes.
Strachan Street Stop (Council)	Precinct Access Plan (Table 7-17) states: 802 boardings & 84 alightings forecast for 2021 (total – 886). 1024 boardings & 99 alightings forecast for 2036 (total – 1,123).	-
Kingsford Tram Stop & Terminus (Council)	Precinct Access Plan (Table 7-18) states: 1454 boardings & 515 alightings forecast for 2021 (total – 1,969). 1851 boardings & 615 alightings forecast for 2036 (total – 2,466).	-

* It is noted that it has been assumed that the patronage stated in the tables are from Tables 7-16, 7-17, 7-18 and 7-21 are AM Peak Hourly Volumes although it is not stated in the table.

The above volumes were used to calculate the likely passenger loadings at each of the stops, and using the information in Section 5, determine the expected level of service of the stop platforms.

7 WANSEY ROAD / HIGH STREET STOP (UNSW)

The proposed Wansey Road / High Street stop will service the upper campus of UNSW.

7.1 EXISTING CONDITIONS

The existing conditions are shown in Figure 5 and Figure 6 and are summarised as follows:

- Unsignalised T-intersection (priority along High Street). Left turn slip lane on west leg. University vehicle access immediately east of intersection.
- Pedestrian 'zebra crossing' on east leg. Pedestrian refuges on west leg. Existing shared path along west side of Wansey Road.
- Bus routes along High Street. Bus stops located to the east and west of the intersection.
- Pedestrian access to UNSW's upper campus.
- Large numbers of public transport (bus) passenger accessing bus stops on High Street.



Source: <http://maps.six.nsw.gov.au/>

Figure 5: Wansey Road / High Street – Existing Conditions



Figure 6: Wansey Road / High Street – Photographs

Daily pedestrian movement data (by location and mode at each of the main access points) was provided by UNSW and are presented in Figure 7. This shows the high number of arrivals (11,958) from the existing bus stops in High Street near Wansey Road, with approximately 80% (9,500) by public transport. There is also a high number of departures (9,607) to the existing bus stops in High Street, with approximately 74% (7,100) by public transport.

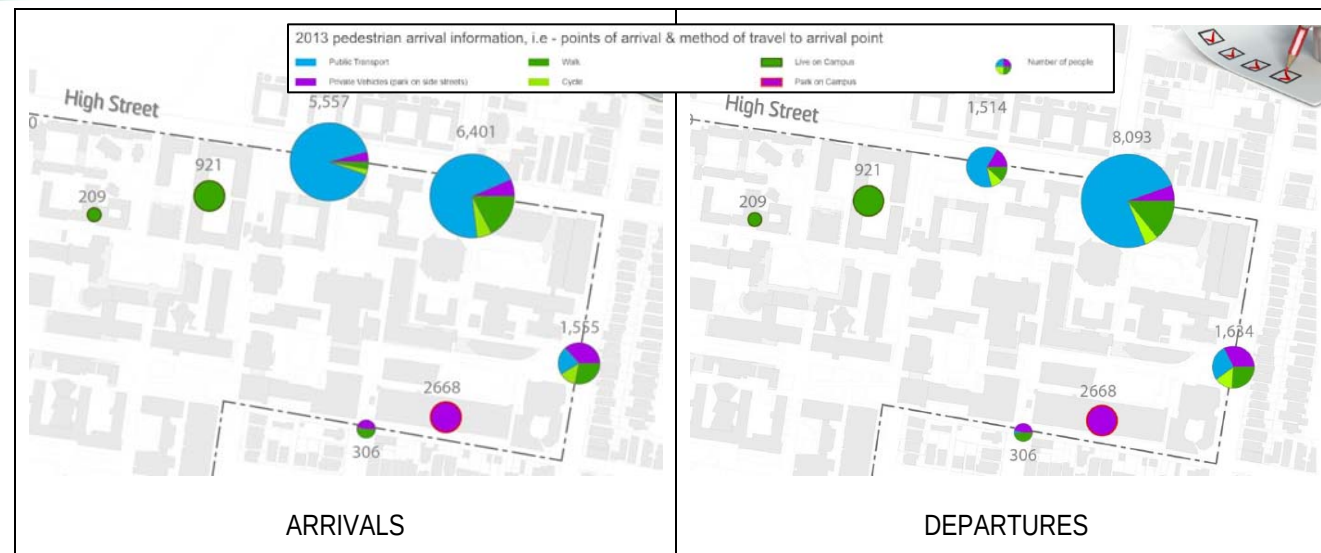


Figure 7: UNSW Daily Pedestrian Movements - by location by mode

Figure 8 presents the breakdown of pedestrian movements in 15 minute intervals.

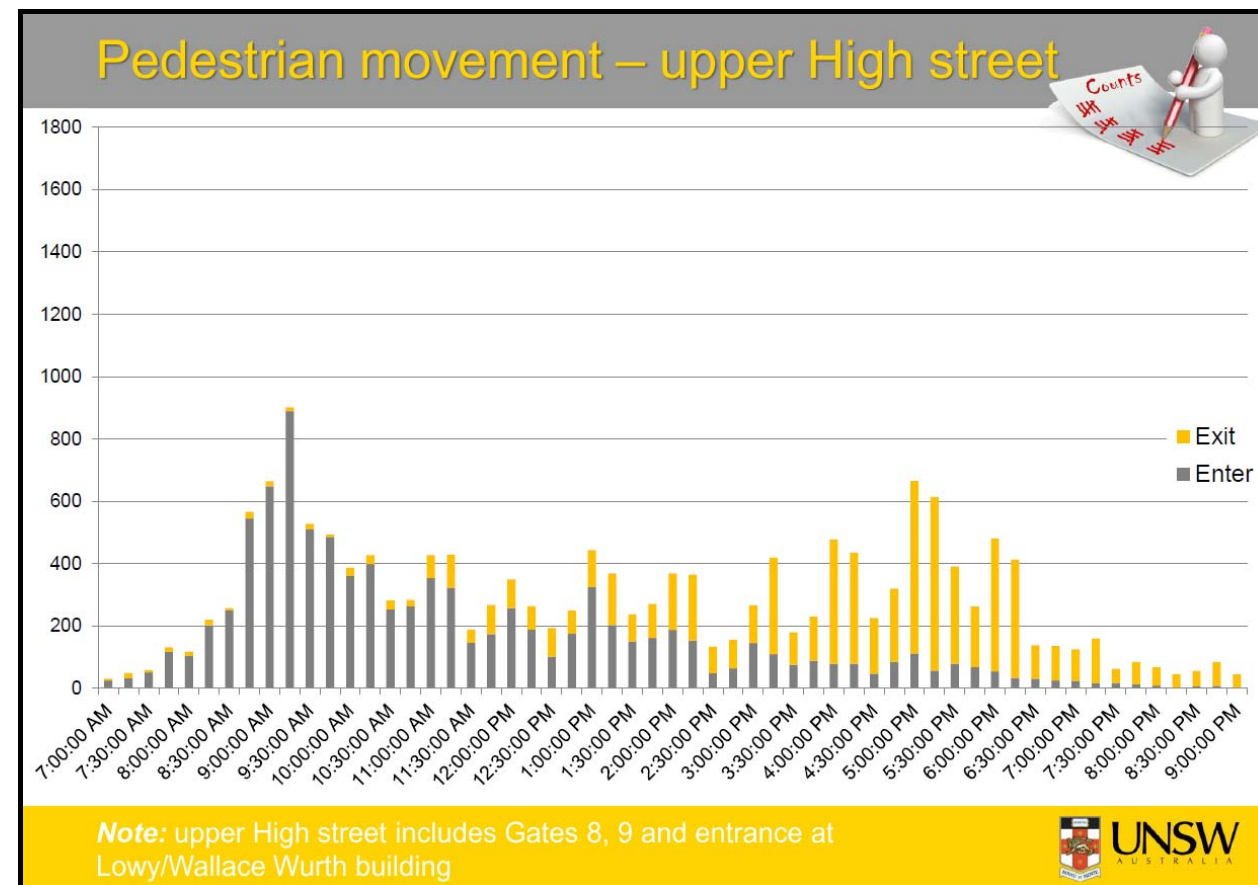


Figure 8: UNSW Pedestrian Movements – 15 minute intervals

7.2 PROPOSED CONDITIONS

It is proposed to construct (as shown in Figure 9):

- new light rail tracks on the north and east legs of the intersection.
- tram platform stops on the north leg.
- traffic signals.

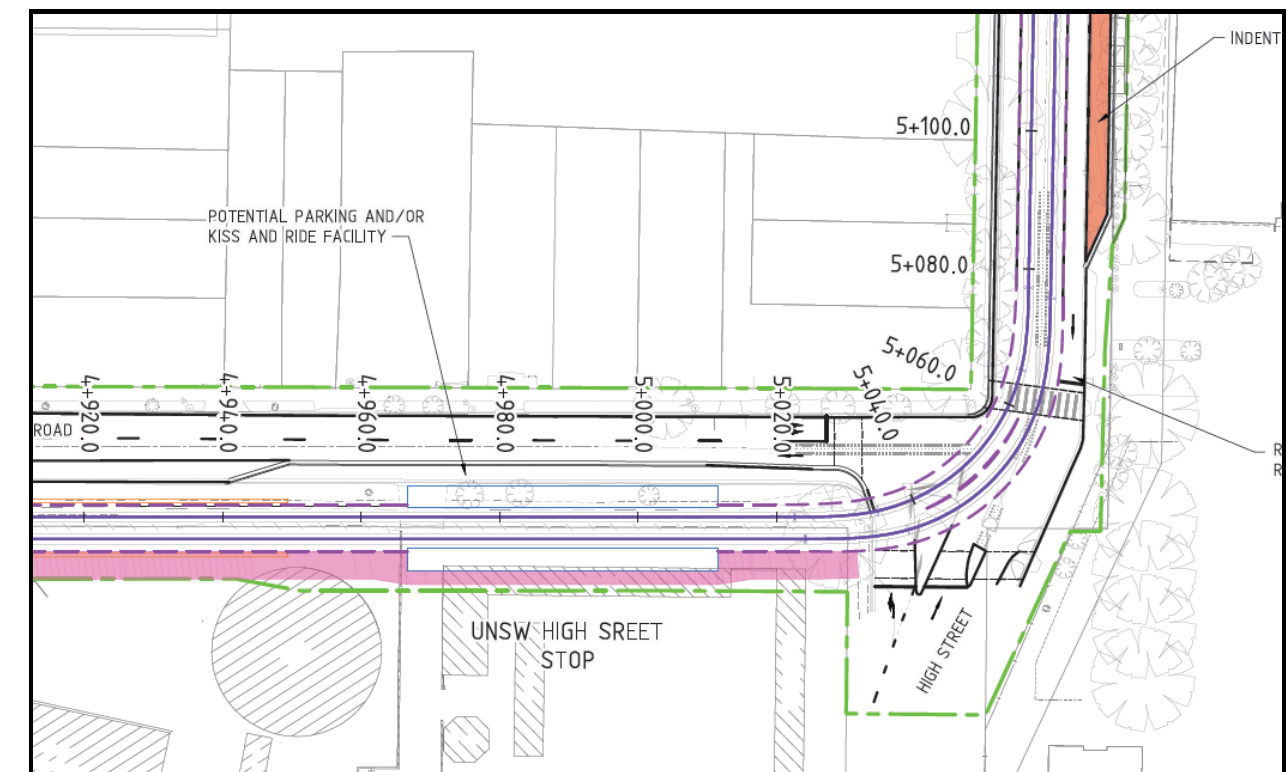


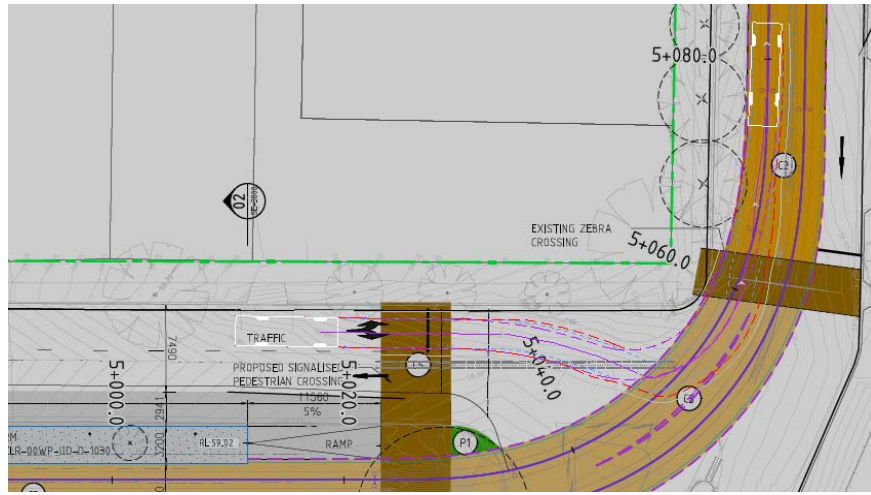
Figure 9: Proposed Conditions - Wansey Road / High Street

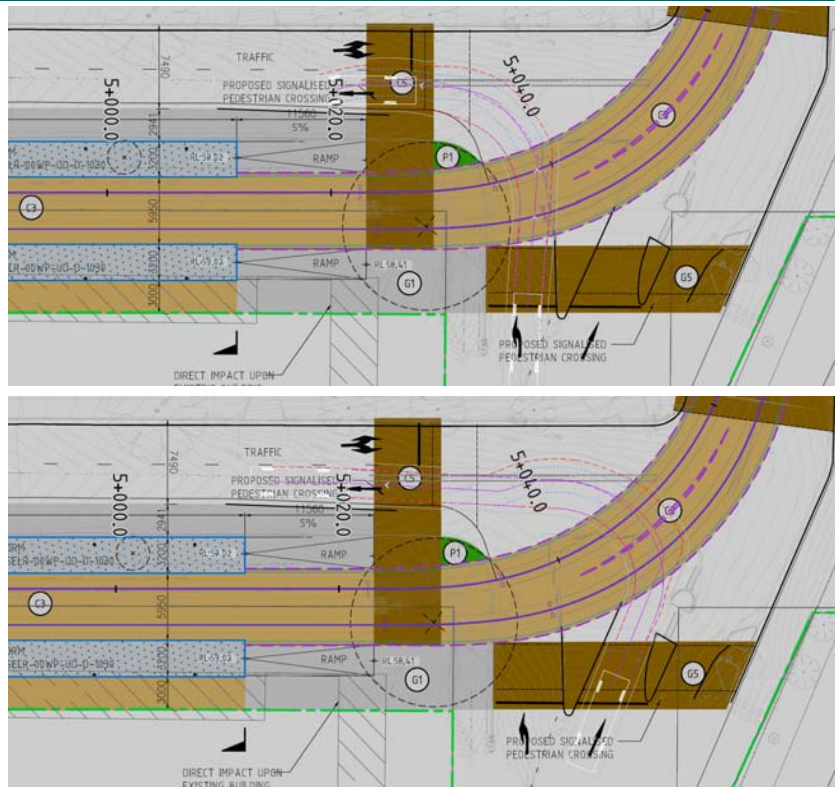
Source: Transport for NSW -

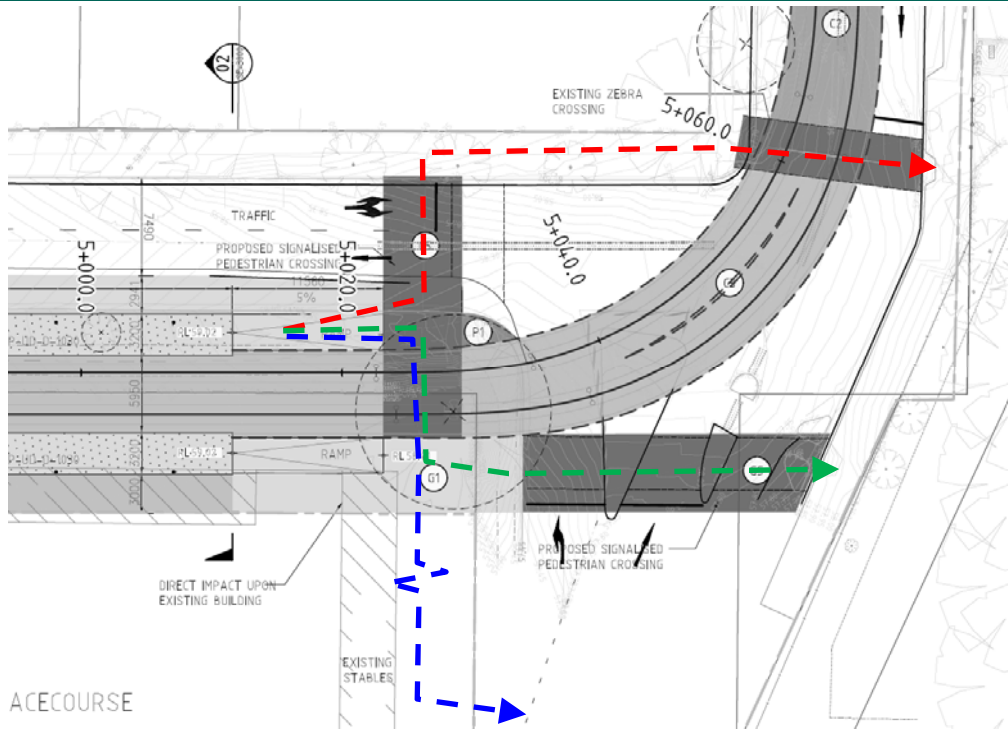
7.3 TECHNICAL REVIEW

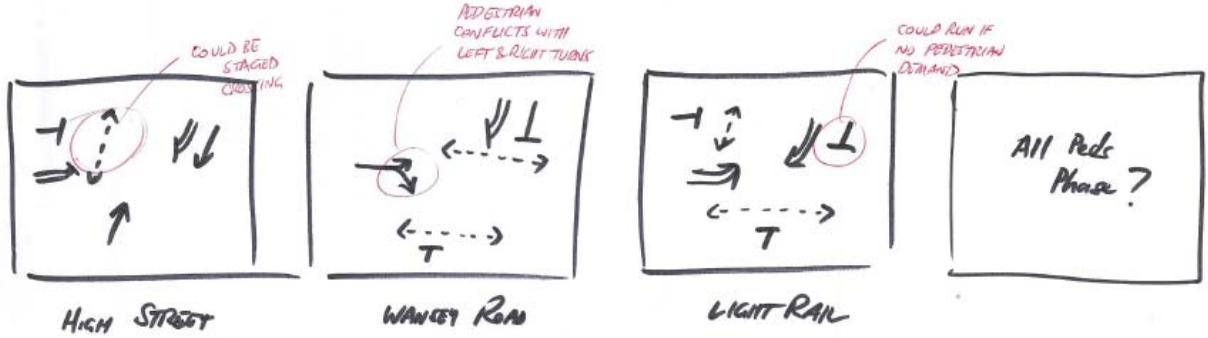
The findings from the review of this location are included in Table 2.

Table 2: Wansey Road / High Street

Category	Sub-Category	Proposed Conditions	Issue / Comment	Potential Alternative / Mitigating Measure
Consistency	-	-	The 'Road Engineering' plans and the 'Stop Plans' show different configurations for the pedestrian crossings. It has been assumed that the Stop Plans are the basis for comment.	Update plans to be consistent.
Location	Surrounding Land Uses	Located at north east corner of UNSW campus, on north side of High Street.	Proposed stop is located adjacent to UNSW campus, a major passenger generator.	Nil – not enough room in High Street to locate tracks, stops and traffic lanes.
	Land Acquisition	Required from Randwick Racecourse on west side of Wansey Road.	Nil.	Nil.
Layout	Track Location	Tracks located on west side of Wansey Rd and centre of High Street.	Track curves require tracks to be located on west side of Wansey Road. Additional land acquisition would be required from residential properties on north east corner of intersection to realign track curves.	Nil.
	Platform Size	Both platforms 45.0m x 3.2m = 144.0 sqm.	Assumption: LRV at 2-3 minute frequencies at CBD end will result in LRV at 4-6 minute frequencies at this location. Assume approximately 3 LRV each 15 minute period. Alighting: Assuming a capacity of 300 pax per LRV, should be no more than 300 pax alighting at any one time. Capacity of platforms to cater for peak alighting numbers (approx. 632 pax in 15 minute period). Using the Fruin Level of Service criteria, the ramp (average flow rate of 42 pax per minute) is expected to operate with a Level of Service of A. However, if 211 pax alighted from one LRV, the Level of Service would drop to E. Boarding: Capacity of platforms to cater for peak boarding numbers (approx. 480 pax in 15 minute period). Using the Fruin Level of Service criteria, this platform is expected to operate with a Level of Service of D (129 pax waiting for LRV). The ramp (average flow rate of 26 pax per minute) is expected to operate with a Level of Service of A. However, the signalised crossings will meter the flows of pedestrians.	Alighting: Proposed outbound platform ramp will restrict flow off the stop and will 'meter' pedestrians reaching the crossing points. However, predicted flow rates are expected to be within capacity. Boarding: Proposed citybound platform will be very congested (Level of Service F) with some pax being required to wait on ramp and approaches.
	Storage	Ramps provided at both north and south ends to provide access.	Ramps and approaches will provide additional storage if stops are congested. Road safety risk is if pax cannot clear light rail tracks or roads. As the citybound stop will have the highest boarding numbers, the ramp and large storage area is expected to accommodate all required pax without queuing across the light rail tracks and roads.	Nil.
	Swept Paths	The proposed tracks and stops will reduce the width of Wansey Road and High Street.	North to east left turns (from Wansey in to High) – very tight radius, turning vehicles may encroach on to citybound light rail tracks. 	Ensure design vehicles able to undertake turn. If cannot undertake turn, stop line on east leg of intersection may need to be set back.
			West to north left turns (from High in to Wansey) – very tight radius, turning vehicles may encroach on to southbound traffic lane or mount footpath, potential conflict with pedestrians if right turners allowed turn at same time as pedestrians.	Ensure design vehicles able to undertake turn. If cannot undertake turn, consider removal of the left turn slip lane and allow left turns from the eastbound 'through' lane. The left

Category	Sub-Category	Proposed Conditions	Issue / Comment	Potential Alternative / Mitigating Measure
				turn slip lane could then be used as a larger pedestrian area and reduce the width of the crossing across the west leg of the intersection. The Wansey Road stop line could then also be moved further south.
			North to east right turns (from Wansey in to High) – very tight radius, turning vehicles may encroach on to waiting areas, may impact on parking along High Street, potential conflict with pedestrians if right turners allowed turn at same time as pedestrians.	Ensure design vehicles able to undertake turn. Review conflict with pedestrians – consider early start for pedestrians on crossing.
			LRV clearances increase around tight radii. Turning LRV may encroach in to pedestrian crosswalks and waiting areas.	Ensure adequate clearances to turning LRV around curves and modify crosswalks and waiting areas to suit.
			Westbound through movements have poor delineation through intersection.	Build out southern side of High Street out to existing kerb outstand.
Access	Crossing Points	The 'Road Engineering' plans and the 'Stop Plans' show different configurations for the pedestrian crossings. Signalised Pedestrian Crossings are proposed at Wansey Rd/High St intersection, across Light rail tracks (at north and south ends) and also across Wansey Rd at north end of stops.	A key design consideration must be the movement of pedestrians to and from the stops. In the AM Peak, there will be a very high movement of pedestrians from the southbound platform, down the ramp, and then across the roads at the signalised access points. Even though these movements are to be controlled by signals, it is expected that pedestrians will cross the tracks and roads against the signals. Therefore, although signalised crossings are required for the road crossings, the crossings of the tracks should be 'LRV priority crossings' which will allow pedestrians to cross as required except for when LRV are present. As the stops are located on the north side of High Street, pedestrians to UNSW will be required to either: - cross Wansey Road and High Street, - cross tracks then High Street, or - cross tracks, walk westbound along High Street then cross at zebra crossing.	Agree that road crossings should be signalised. Recommend that crossings of the tracks should be unsignalised with priority given to LRV. Electronic signs could be used to provide increased warning of an approaching LRV e.g. 'GIVE WAY TO LIGHT RAIL VEHICLE' The removal of the left turn slip lane could increase the storage areas for pedestrians and reduce the crossing width. The southbound shared path ends just north of High Street. Shared path users will need to share this space with large numbers of pedestrians. Provide a surface treatment that clearly delineates the end of the shared path and warns of pedestrians. Consider an alternative access down northern side of High Street to a new pedestrian overpass to provide direct connection in to UNSW campus.

Category	Sub-Category	Proposed Conditions	Issue / Comment	Potential Alternative / Mitigating Measure
			 It is noted that the existing zebra crossing on High Street to the west of the Wansey Road intersection (as shown in Figure 6) is used by a large number of pedestrians (mostly bus passengers) and UNSW has safety concerns regarding its operation. Adjacent to this zebra crossing is a raised walkway into UNSW's grounds. A potential future option is to create a pedestrian overpass (to replace the zebra crossing) that connects directly to the raised walkway within UNSW. This option would mean that a significant number of LRV pax would only have to cross the tracks and no roads.	
	Ramps	DDA compliant ramps provided at both north and south ends to provide access.	The ramps end at the crossing points which may create congestion as pedestrians wait to cross the tracks or Wansey Rd.	Shorten ramps if possible to create larger waiting areas prior to cross points.
	Illegal Access	No fencing has been shown.	The crossing at northern end important to provide access to from residential area and park and ride. Illegal or undesirable crossings are expected to occur between the shared path, track and park and ride footpath (especially during the AM Peak).	Install fence between shared path and tracks (to protect shared path users from opposing LRV), and between park and ride footpath and tracks (to prevent pedestrians crossing tracks away from formal crossing points).
	Safety	-	Illegal access is the main safety issue as discussed above.	Nil.
	Footpath / Shared Path	4.0m shared path on Wansey Road narrows to 3.0m past platform.	Shared path ends at southern end of platform. Shared path users, especially cyclists, will enter an area with significant numbers of pedestrians.	Nil – 3.0m is desirable width for shared path. Ensure path material and signage indicate end of shared path. Consider installation of bicycle lanterns for crossing of High Street to allow cyclists to cross without dismounting.
	Vehicle	-	University access restricted to left in/left out.	Nil.
Intermodal	Sharing of Tracks	-	n/a	n/a
	Bus Stops	Westbound bus stops (indented bays) proposed on south side of High Street east of intersection.	Proposed stop will replace a number of existing bus stops in High Street.	Nil.
		Eastbound bus stops retained on north side of High Street west of intersection.	Nil.	Nil.
	Bus / LRV Transfer	-	It is noted that some bus stops will be retained, and passengers may transfer to LRV. These passengers likely to cross High Street then Wansey Road.	Nil.

Category	Sub-Category	Proposed Conditions	Issue / Comment	Potential Alternative / Mitigating Measure
	Bus Priority	No bus priority shown on plans.	LRV and pedestrian priority likely to be highest priorities, so unlikely to be able to also provide bus priority. In addition, buses will not be located in separate lanes so additional priority unlikely to be effective.	Nil.
Signal Operation	Overview	No details provided.	Separate phases likely to be required for High Street throughs, Wansey Road left/right, and tram movements. Some other movements (vehicle and pedestrian) could run with LRV phases. Some traffic movements conflict with pedestrian movements. 	Review phasing to determine optimal operation for LRV and pedestrians.
	LRV Movements		Signalised left and right turn movements. LRV movements could run separately. May not want green for pedestrians across Wansey Road at same time as LRV movements as pedestrians may observe green walk signal and think it applies to the crossing of the tracks. Need to determine southbound trams 'trigger' signals. The time at stops is variable and only want to provide time to LRV phases when needed. Providing advance detection of east leg will be possible. Advance detection on north leg not possible due to proximity of stop. So when LRV detected, need to be able to 'close' down other phases as quickly as possible. The restriction on closing down phases will be pedestrian crossing clearance times. If pedestrian crossing can be as short as possible, this reduces the time required to 'stop' the pedestrian phase and switch to the LRV phase.	If crossing of Wansey Road is signalised and crossing of tracks is not, stagger the crossings so that pedestrians are required to change direction. Modify intersection to increase distance between light rail stop and crossing point to allow detection of southbound LRV. Modify intersection to reduce length of the pedestrian crossings. Signal operation should be set up to allow LRV phase to run between other phases to reduce delays.
	Bus Movements	Bus movements eastbound and westbound through intersection.	No additional priority.	Nil.
	Pedestrian Movements	Pedestrian Operated Signals and LRV Priority Crossings.	Some traffic and tram movements conflict, need to consider how they will be undertaken safely. One option may be to run an all pedestrian phase which allows pedestrians to cross in all directions at one time.	Consider an all pedestrian phase which allows pedestrians to cross in all directions at one time.
	Traffic Impacts	Right turn movement from east to north removed.	Northbound (left turn) and eastbound (through) traffic will share High Street with LRV. Although light rail tracks are separated midblock, right turning vehicles share the tracks.	Consider some form of traffic metering, especially in High Street east of intersection, to hold traffic in Wansey and/or High to reduce congestion for eastbound LRV. Note this may impact on High Street bus services.

8 ANZAC PARADE UNSW STOP (UNSW)

The proposed Anzac Parade stop will service the lower campus of UNSW.

8.1 EXISTING CONDITIONS

The existing conditions are shown in Figure 10 and Figure 11 are summarised as follows:

- Three traffic lanes in each direction, central median with pedestrian fence. Kerbside lane is a bus lane in peak periods in peak direction and parking lane at other times.
- Pedestrian facilities – Pedestrian Operated Signals.
- Bus routes along High Street. Bus stops located to the north (northbound) and south (southbound) of the POS.
- Pedestrian access to UNSW's lower campus and NIDA campus.



Source: <http://maps.six.nsw.gov.au/>

Figure 10: Anzac Parade (UNSW) – Existing Conditions



Figure 11: Anzac Parade (UNSW) – Photographs

Daily pedestrian movements (by location and mode at each of the main access points) was provided by UNSW and are presented in Figure 12: UNSW Daily Pedestrian Movements - by location by mode. This shows the high number of arrivals (17,662) from the existing bus stops in Anzac Parade and High Street, with approximately 74% (13,100) by public transport. There is also a high number of departures (20,049) to the existing bus stops in Anzac Parade and High Street, with approximately 76% (15,300) by public transport.

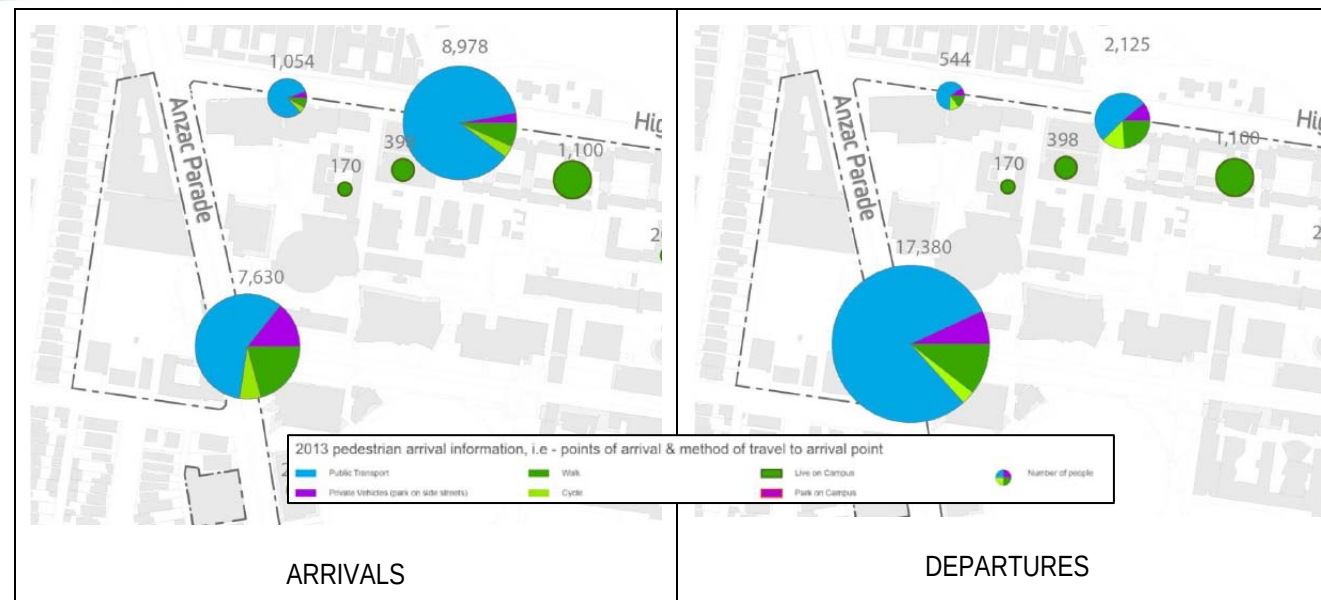


Figure 12: UNSW Daily Pedestrian Movements - by location by mode

Figure 13 presents the breakdown of pedestrian movements in 15 minute intervals.

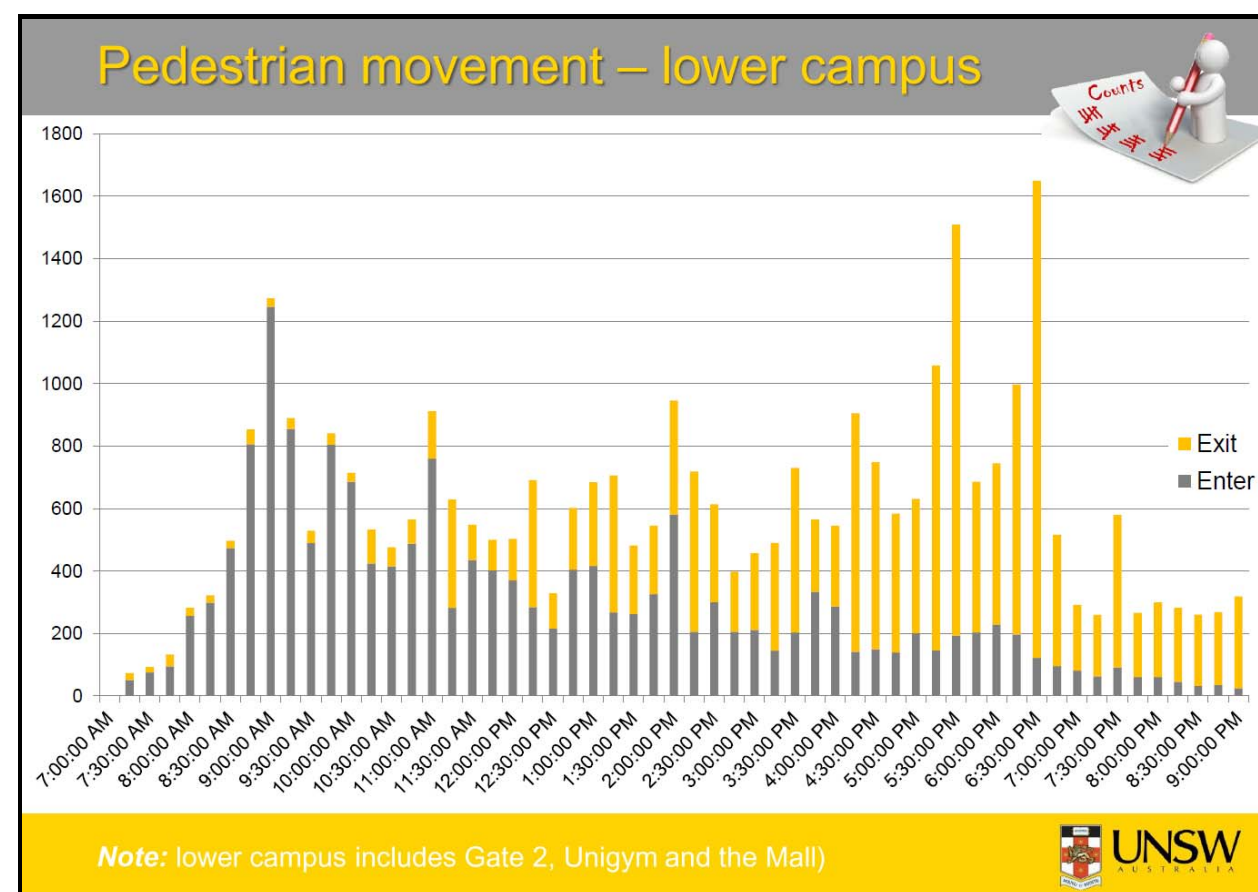


Figure 13: UNSW Pedestrian Movements – 15 minute intervals

8.2 PROPOSED CONDITIONS

It is proposed to construct (as shown in Figure 14):

- new light rail tracks on the east side of Anzac Parade.
- island platform (northbound LRV) and side platform (southbound LRV).
- retention of existing northbound bus stop on west side of Anzac Parade.
- Pedestrian Operated Signals modified to control movements of LRV, buses and traffic moving across lanes.

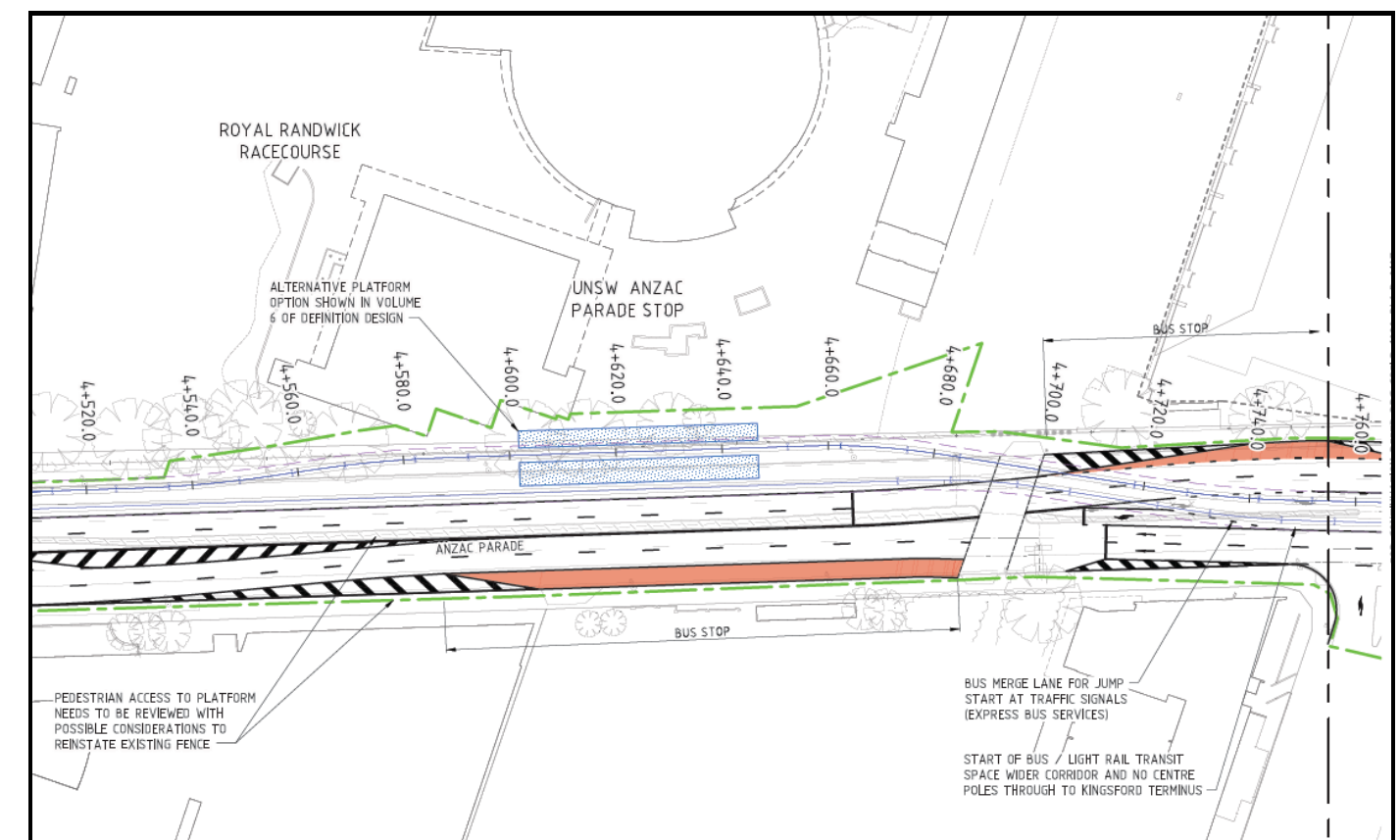


Figure 14: Anzac Parade (UNSW) – Proposed Conditions

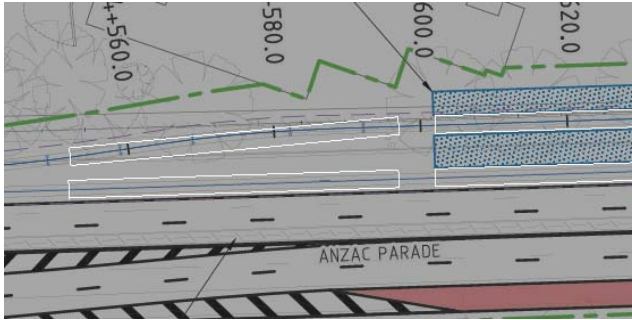
Source: Transport for NSW

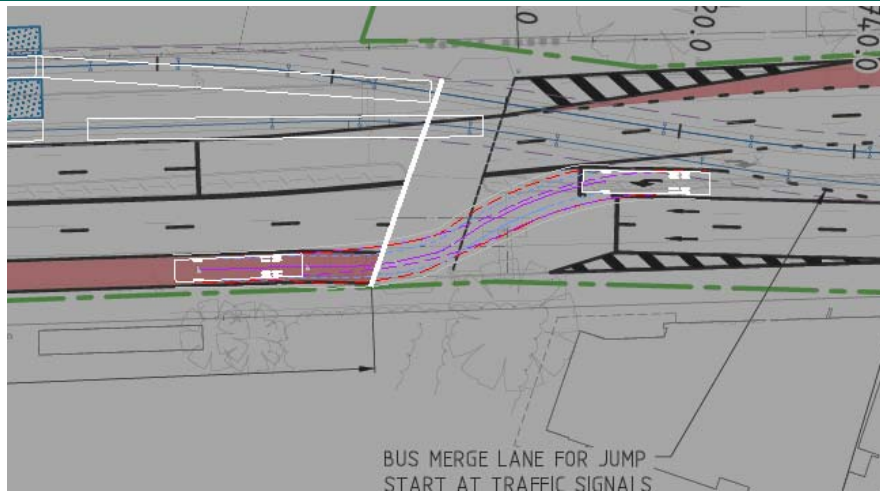
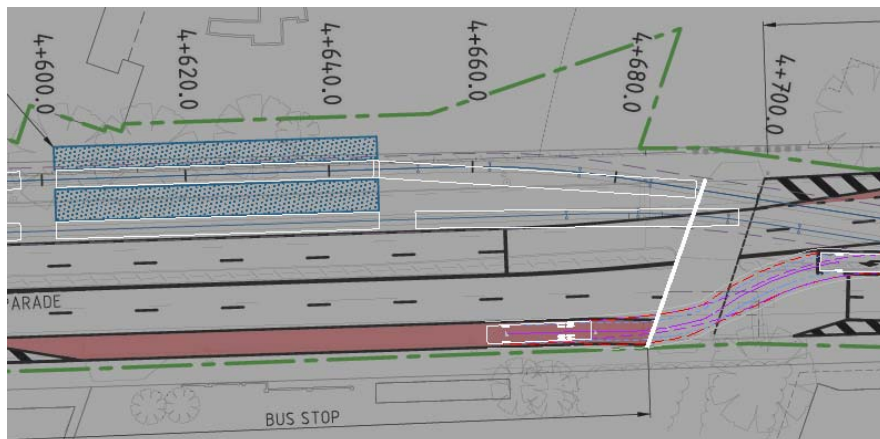
8.3 ISSUES / OPPORTUNITIES

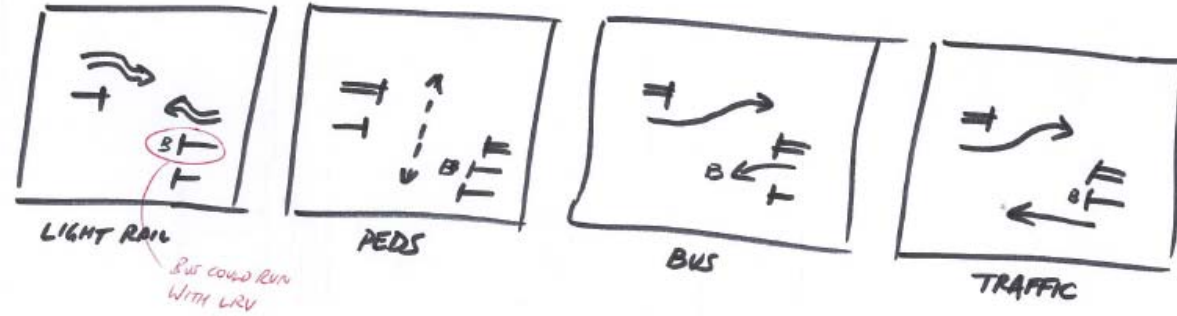
The findings from the review of this location are included in Table 3.

Table 3: Anzac Parade (UNSW)

Category	Sub-Category	Proposed Conditions	Issue / Comment	Potential Alternative / Mitigating Measure
Consistency	-	-	The 'Road Engineering' plans and the 'Stop Plans' show different configurations for the pedestrian crossings. It has been assumed that the Stop Plans are the basis for comment.	Update plans to be consistent.
Location	Surrounding Land Uses	Proposed stop located adjacent to UNSW campus and close to University Mall.	Location adjacent to University Mall is a good location close to a major attractor. However, need to consider what is more important to be located at the western end of University Mall. LRV stops likely to be used by significantly more pedestrians than the POS.	Nil.
	Land Acquisition	Land acquisition required from UNSW, impacts on Square House Building to be confirmed.	Moving stops further south could reduce that impact.	Nil.
Layout	Track Location	Tracks change from centre of road to east side at High Street signalised intersection and change back to centre of road at University Mall Pedestrian Operated Signals.	Light rail tracks changing from centre of Anzac Parade to east side and back will create additional delays to LRV. For example, along Harbour Esplanade in Melbourne, two years ago trams were changed from crossing to and from the centre of the road to travelling down the middle of the road over a 500m length. This was done to reduce delays to trams, and to provide a clearer separation between trams, pedestrians and cyclists. Previously, trams, pedestrians and cyclists used to share a wide, undefined plaza. The light rail tracks changing from centre of Anzac Parade to east side and back will create additional delays to light rail vehicles, buses and other traffic along Anzac Parade. In addition, the changing of the tracks creates a very complex intersection at the Pedestrian Operated Signals at University Mall, with LRV movements, bus movements, traffic movements and pedestrian movements. Southbound traffic must undertake a lateral shift across diagonal light rail tracks with no physical separation from northbound LRV and buses. This arrangement may create confusion for drivers and wet light rail tracks are slippery. The stop line will be set back approximately 20m from the Pedestrian Operated Signals and the plans show no delineation (lane lines) through this area to direct southbound traffic. It is understood that 'the UNSW Anzac Parade stop is proposed in an offline location which will minimise interaction between cars and pedestrians on the eastern side of Anzac Parade. This enables customers alighting at the stop to directly access the University Mall without having to cross Anzac Parade.'	Retain light rail tracks in centre of road and construct a wide centre island platform, with access from the University Mall Pedestrian Operated Signals. This will reduce delays to LRV, traffic and buses, locate the stop adjacent to University Mall, and simplify the intersection at the Pedestrian Operated Signals. Land acquisition could still be used to facilitate the wider platform stop. The main trade-off for this arrangement is that the majority of passengers would need to cross one LRV track and two southbound traffic lanes. This has a higher safety risk than the proposed arrangement of that requires a crossing of one LRV track only. Also need to consider pedestrians using the Pedestrian Operated Signals. When northbound traffic stops, pedestrians may think they can walk, but it may be for LRV or buses. <i>NB: The following sections review the proposed light rail tracks on the eastern side of Anzac Parade. The above alternative is provided for consideration and discussion.</i> Traffic islands could be created within the centre of the two directions of traffic (subject to the swept path of the northbound bus) to direct southbound traffic across the tracks away from northbound LRV and buses. An island between the northbound traffic lanes and the northbound bus lane would be beneficial to physically separate these lanes.
	Platform Size	Side platform 45.0m x 3.2m = 144.0 sqm. Island platform 45.0m x 4.4m = 198.0 sqm. The report indicates the need to make provision for future lengthening of stops, but there is not sufficient room at the northern end.	Assumption: LRV at 2-3 minute frequencies at CBD end will result in LRV at 4-6 minute frequencies at this location. Assume approximately 3 LRV each 15 minute period. Alighting: Assuming a capacity of 300 pax per LRV, should be no more than 300 pax alighting at any one time. Capacity of platforms to cater for peak alighting numbers (approx. 898 pax in 15 minute period). Using the Fruin Level of Service criteria, the ramp (average flow rate of 60 pax per minute) is expected to operate with a Level of Service of A. However, if 299 pax alighted from one LRV, the Level of Service would drop to E. Boarding: Capacity of platforms to cater for peak boarding numbers (approx. 1,143 pax in 15 minute period). Using the Fruin Level of Service criteria, this platform is expected to operate with a Level of Service of E (381 pax	Alighting: Proposed southbound platform ramp will lead directly to footpath and will not restrict flow off the stop (subject to proposed fencing arrangements to separate stop from shared path). Congestion may encourage some passengers to use northern pedestrian access. Boarding: Proposed citybound platform will be very congested (Level of Service E/F) with some pax being required to wait on ramp and approaches. The short ramp and limited storage area on the crossing may prevent all passengers being able to access the platform stop at peak times. This will prevent

Category	Sub-Category	Proposed Conditions	Issue / Comment	Potential Alternative / Mitigating Measure
			waiting for LRV). The ramp (average flow rate of 76 pax per minute) is expected to operate with a Level of Service of E. One example of a large centre island platform stop in Melbourne is the Melbourne University stop. This is approximately 6.5m wide and 60m long with ramps and signalised pedestrian crossings at both ends. 	safe passenger circulation along the stop. Design track layouts to provide for future lengthening of citybound stop. 
	Storage	Ramps provided at both north and south ends to provide access.	The short ramp and limited storage area on the crossing to the citybound stop may prevent all passengers being able to access the platform stop at peak times. This will prevent safe passenger circulation along the stop.	Review size of platform stop and length of ramp to cater for peak passenger loads.
	Swept Paths	Nil.	LRV and buses will create wider swept paths as they undertaken turns to and from the centre of the road.	Review swept paths of turning LRV and buses.

Category	Sub-Category	Proposed Conditions	Issue / Comment	Potential Alternative / Mitigating Measure
				
	LRV	LRV Priority crossings at both ends of stops. University Mall Pedestrian Operated Signals located approximately 30m south of southern stop crossing. NB: Stop line for Pedestrian Operated Signals should be located 6m back from crosswalk.	Southbound LRV will need to 'trigger' LRV phase to cross back to centre of road. There is not enough length between stop and Pedestrian Operated Signals for LRV to store without blocking southern crossing. A second northbound LRV could follow another LRV through the Pedestrian Operated Signals as there is just enough room for it to store clear of the Pedestrian Operated Signals. However, the second northbound LRV would reduce visibility to pedestrians using the Pedestrian Operated Signals. 	Review how southbound LRV will 'trigger' tram phase. Review storage of southbound LRV between stop and POS. Review storage of northbound LRV between stop and POS.
	Signal Pedestals	There is no room between either the two directions of traffic or between the southbound traffic lanes and the northbound light rail tracks.	There is no room available for signal pedestals to be located next to the southbound traffic. Large mast arms will be required. The height and location of the large mast arms will need to consider the overhead light rail wires. The complex movements required at the intersection of the Pedestrian Operated Signals would also benefit from adjacent signal pedestals. However, large mast arms are likely to be required.	Review layout to create space for signal pedestals
	Crossing Points	LRV priority crossings are shown at the north and south ends of the stops.	As shown on the Stop Plan, the crossings do not need to extend on to the northern Light rail tracks. Access at the northern end is important if land use within UNSW changes and provides an alternative access/egress to the stop during peak times. LRV Priority Pedestrian Crossings are proposed. In Melbourne, the signs used in these instances are 'Give Way to Trams'. With the high number of pedestrians and complex movements for the LRV, static signs may not be enough. Could consider supplementary LRV-activated LED signs to warn of approaching LRV. Important to used different materials to indicate LRV areas and pedestrian waiting areas.	Remove crossings across northbound tracks. Install a fence along the east side of the northbound tracks.
	Ramps	DDA compliant ramps provided at both north and south ends to provide access.	The ramp ends at the crossing points which may create congestion as pedestrians wait to cross the southbound track.	Shorten ramps if possible to create larger waiting areas.
Access	Illegal Access	No pedestrian fencing shown.	Existing pedestrian fence is located in the centre median adjacent to the Pedestrian Operated Signals. Illegal pedestrian movements to and from the platform stops is likely.	Consider the installation of pedestrian fencing adjacent to the citybound LRV track.
	Safety	-	Illegal access is the main safety issue as discussed above.	Nil.
	Footpath / Shared Path	Wide footpath to be provided along east side of tracks.	Footpath along east side of Anzac Parade used as a bicycle route.	Consider barrier along outside of side platform to prevent people from just walking out on to shared path and creating

Category	Sub-Category	Proposed Conditions	Issue / Comment	Potential Alternative / Mitigating Measure
				pedestrian/cyclist conflict.
	Vehicle	-	n/a	n/a
	Sharing of Tracks	Buses to share LRV track south of this location.	Bus movements out of LRV corridor provided through a jump start lane. There is no separation between the bus lane and the adjacent traffic lanes. It is desirable to create an island between the bus lane and the adjacent traffic lanes to ensure drivers do not move off when the bus moves off (as the bus needs to cut in front of the traffic). A bus storing in this lane may be unable to store clear of the light rail tracks and may block the tracks. It is unclear how southbound buses get on to light rail tracks.	Review layout of bus jump start lane to create separation between bus lane and adjacent traffic lanes. Review how southbound buses get on to light rail tracks.
	Bus Stops	Existing northbound bus stops (80m) retained. Provision for one southbound bus stop (15m).	Nil.	Nil.
Intermodal	Bus / LRV Transfer	-	Adjacent bus stops are expected to be for local bus routes. Unlikely to be high number of transfers.	Nil.
	Bus Priority	-	As above.	Nil.
Signal Operation	Overview	Complex intersection at Pedestrian Operated Signals to cater for all movements.	Multiple phases will be required – LRV phase, pedestrian phase, northbound bus phase (which could run with tram phase or SB traffic) and a traffic phase. A road safety risk is that when pedestrians see traffic come to a stop (particularly those pedestrians on the west side of Anzac Parade), they may assume that the pedestrian phase may run next. However, the bus or LRV phases may run and create a conflict with pedestrians. 	Review the potential phasing arrangement to minimise conflicts.
	LRV Movements	LRV to cross to and from centre of Anzac Parade, through Pedestrian Operated Signals.	As outlined above, LRV will be delayed moving to and from the centre of the road and the storage of LRV whilst waiting to move through intersection may block crossings.	Nil.
	Bus Movements	Buses to share LRV track south of this location.	Citybound buses waiting to merge across could delay LRV, run bus clearance phase at same time as LRV phase. Ideally would be some separation between citybound bus and northbound vehicles.	Review layout to create separation between northbound buses and northbound traffic.
	Pedestrian Movements	Pedestrian Operated Signals crossing approximately 23m wide across Anzac Parade.	If a LRV or bus is detected, the pedestrian phase will take the longest to 'close down' (to ensure adequate clearance time for pedestrians to complete their crossing).	Consider PUFFIN at Pedestrian Operated Signals.
	Traffic Impacts	Complex intersections at High Street and University Mall will increase delays to other traffic.	No right turn proposed in to Day Avenue. It is understood that this is a key local route through this area and more suitable than Barker Street. Keeping tracks on east side of Anzac Parade may permit right turn into Day Avenue to be retained.	Review layout of University Mall Pedestrian Operated Signals and Day Avenue traffic movements.

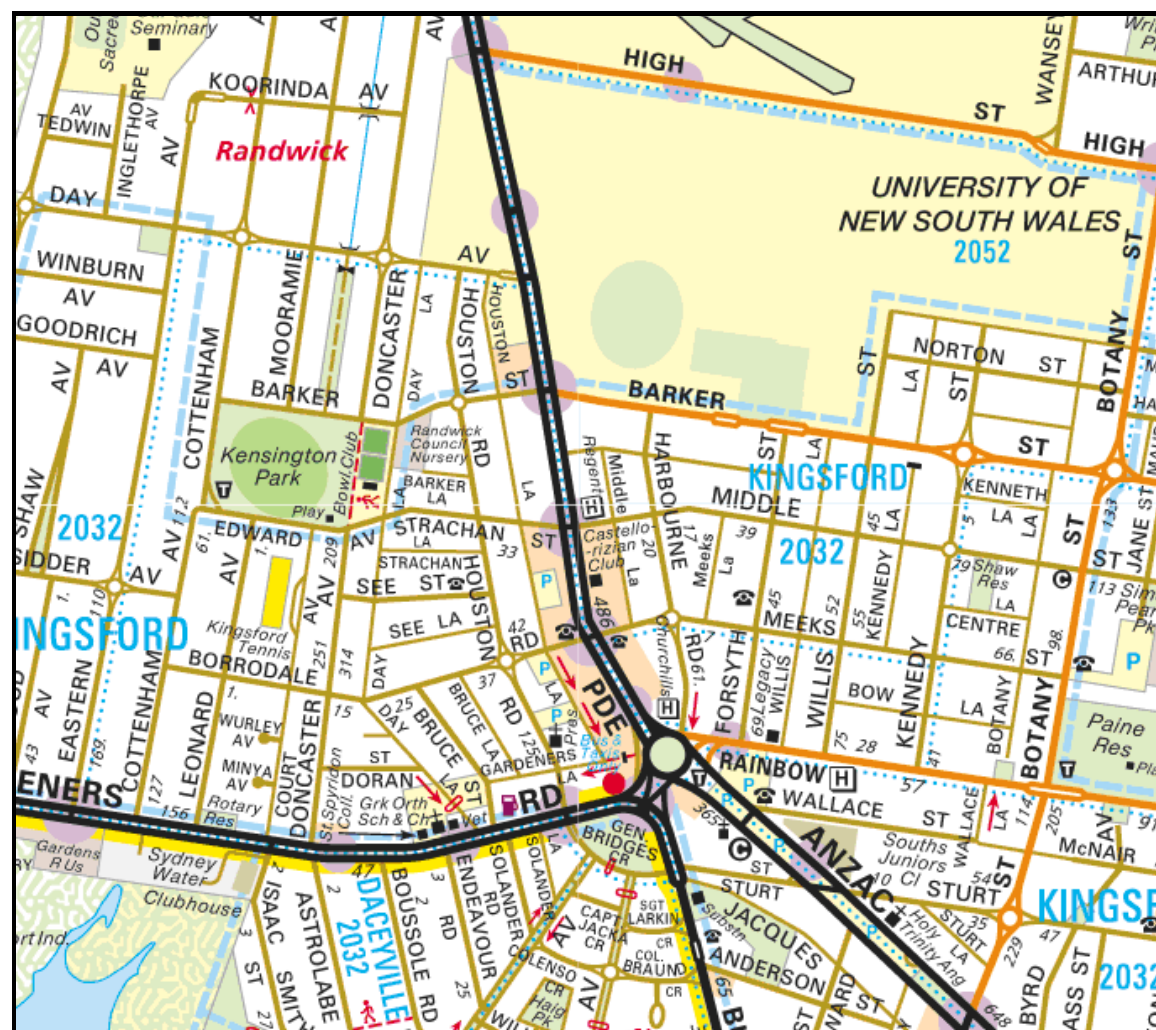
9 ANZAC PARADE – UNSW TO NINEWAYS (COUNCIL)

The proposed works on Anzac Parade between the UNSW stop and Nineways intersection service the commercial and residential area along Anzac Parade.

9.1 EXISTING CONDITIONS

The existing conditions are shown in Figure 15 and Figure 16 are summarised as follows:

- Two traffic lanes in each direction, central median with pedestrian fence. Kerbside lane is a bus lane in peak periods in peak direction and parking lane at other times.
- Signalised cross intersections at Barker Street, Strachan Street / Middle Street, Borrodale Road / Meeks Street.
- Unsignalised intersections at Day Avenue (T-intersection) and Nineways (roundabout).
- Pedestrian Operated Signals located between Borrodale Road / Meeks Street and Nineways roundabout.
- Bus routes along Anzac Parade.
- Commercial and high density residential along route.



Source: Melways Publishing

Figure 15: Anzac Parade (UNSW to Nineways) – Existing Conditions

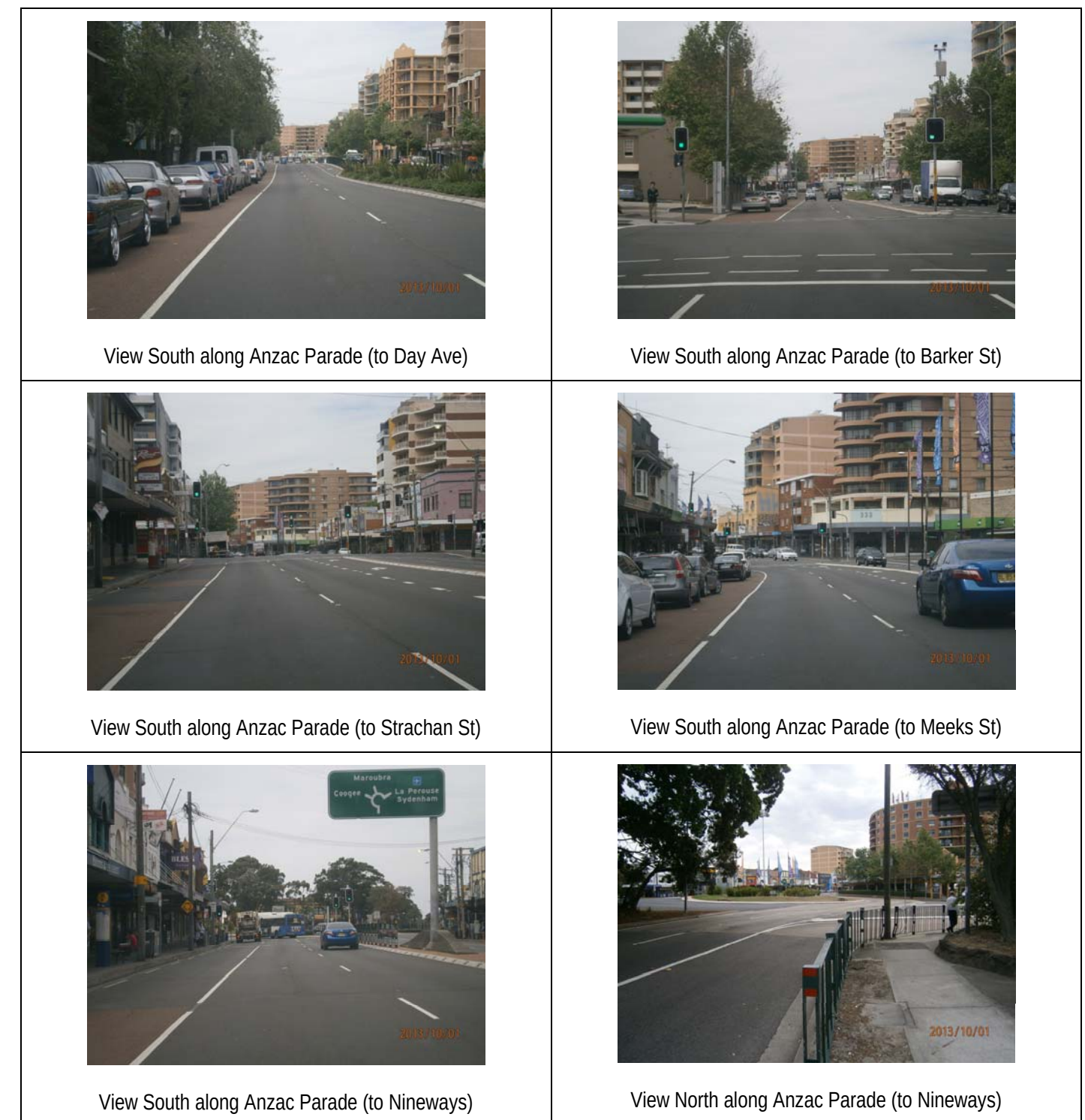


Figure 16: Anzac Parade (UNSW to Nineways) – Photographs

9.2 PROPOSED CONDITIONS

It is proposed to construct (as shown in Figure 17 and Figure 18):

- Light rail tracks in centre median (with express buses to use tracks).
- Island platform at Strachan Street / Middle Street.
- Retention of two traffic lanes in each direction and removal of bus lane and parking lane (in most locations).

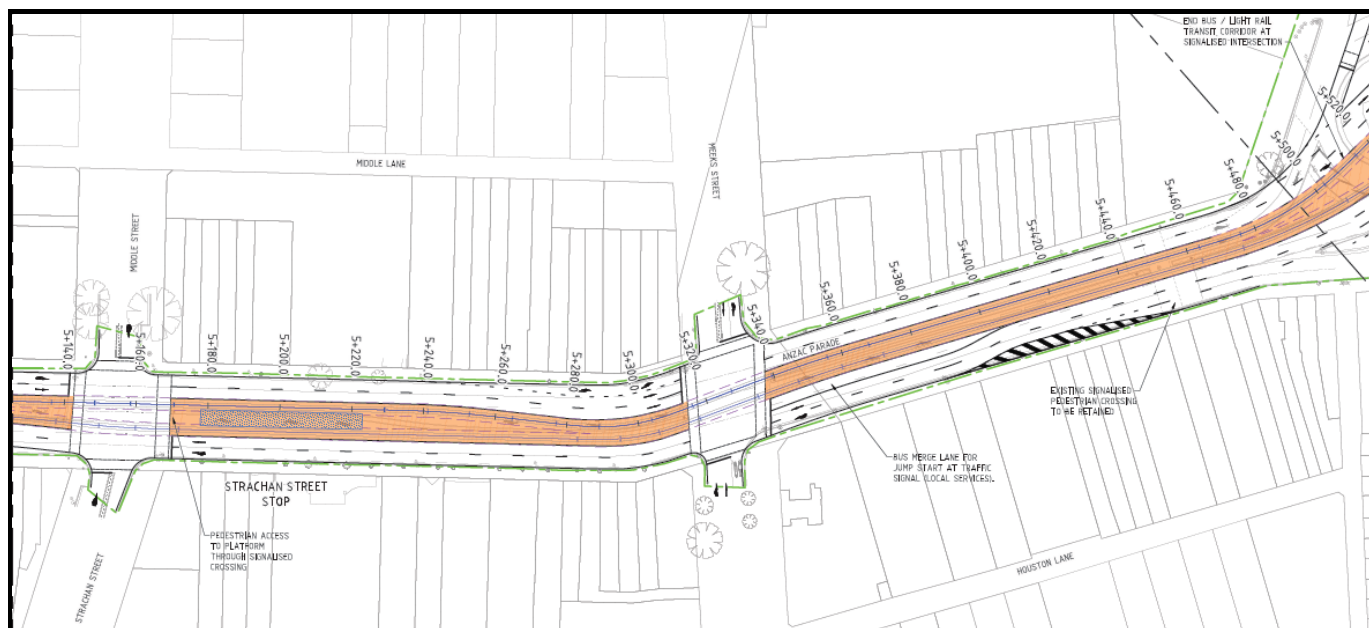
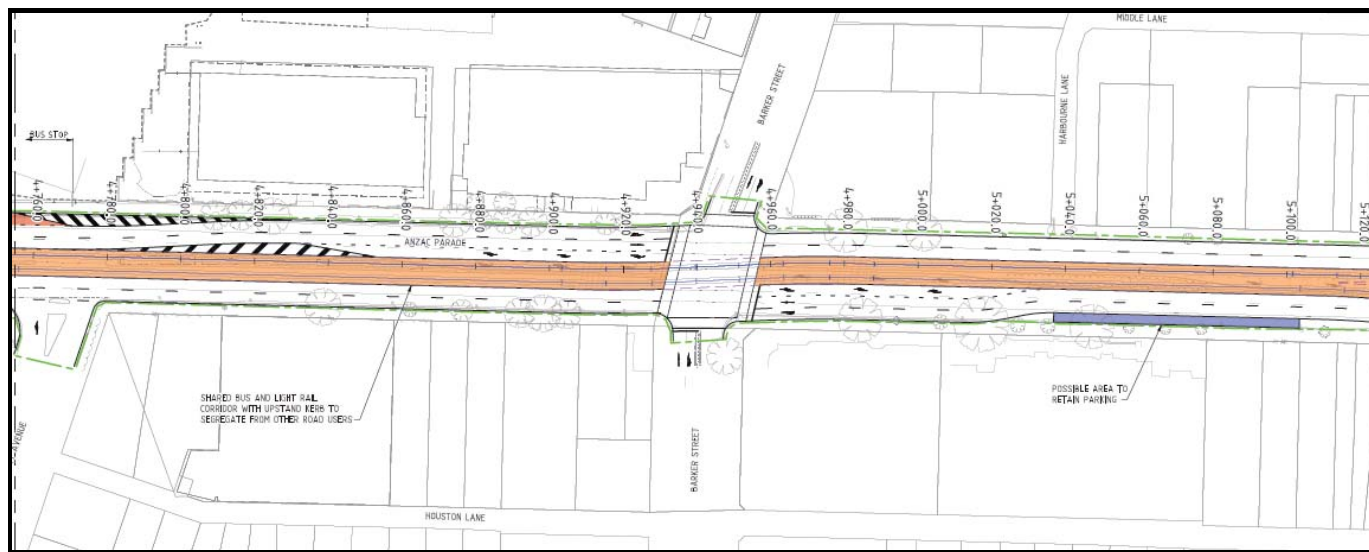


Figure 17: Anzac Parade (UNSW to Nineways) – Proposed Conditions

Source: Transport of NSW

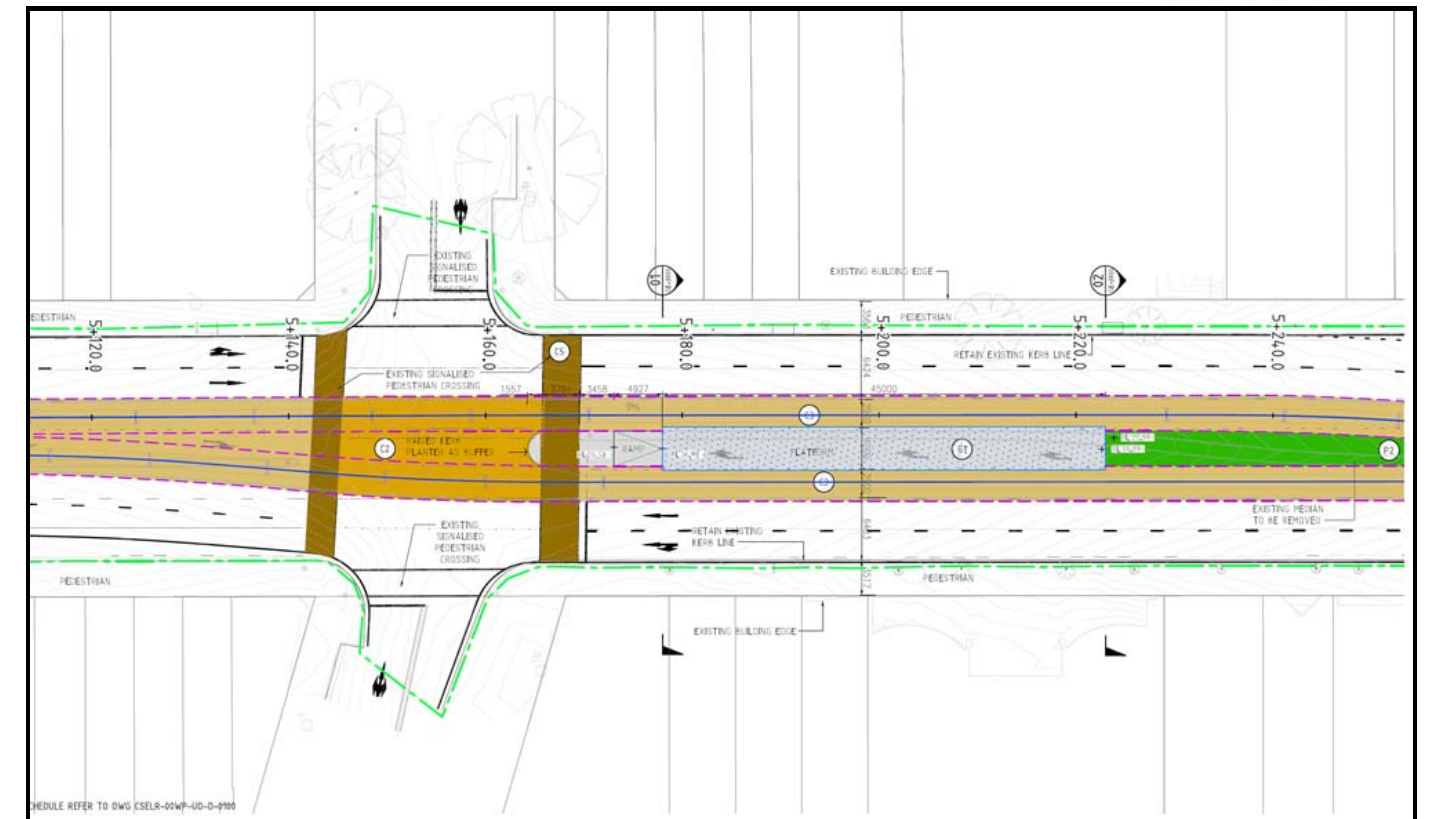


Figure 18: Anzac Parade / Strachan Street – Proposed Conditions

Source: Transport of NSW

9.3 ISSUES / OPPORTUNITIES

The findings from the review of this location are included in Table 5.

Table 4: Anzac Parade (UNSW to Nineways)

Category	Sub-Category	Proposed Conditions	Issue / Comment	Potential Alternative / Mitigating Measure
Consistency	-	-	The 'Road Engineering' plans and the 'Stop Plans' show different configurations for the pedestrian crossings. It has been assumed that the Stop Plans are the basis for comment.	Update plans to be consistent.
Location	Surrounding Land Uses	Strachan Street stop located in centre of Kingsford commercial area. Located approximately 500m from other stops.	Large spacing between stops may increase illegal crossings to and from the southern end of the Strachan Street stop.	Nil.
	Land Acquisition	-	n/a	Nil.
Layout	Track Location	Tracks located in centre of road, traffic island to separate tracks from traffic lanes.	Nil.	Nil.
	Platform Size	Island platform 45.0m x 4.2m = 189 sqm.	Precinct Access Plan (Table 7-17) states: 802 boardings & 84 alightings forecast for 2021 (total – 886). 1024 boardings & 99 alightings forecast for 2036 (total – 1,123). Platform stops easily able to accommodate pax numbers.	Nil.
	Storage	Storage area provided adjacent to signalised crosswalk.	Storage at signalised crosswalk is critical. Pedestrians will need to go both directions. Need space for a signal pedestal to locate push button/s.	Provide push button at northern end of stop.
	Swept Paths	Tracks slew across Barker Street intersection to create right turn lanes.	Slewing of tracks across Barker Street reduces width of traffic lanes. Traffic lane stop lines may need to be set back to accommodate the swept paths of LRV.	Review impacts of LRV swept paths on traffic lanes.
	LRV	-	LRV at Strachan Street likely to get majority of green time at intersection. Side road phase unlikely to be able to be cut short due to time required for pedestrian crossings. Staging of pedestrian crossings not desirable as it reduces level of service for pedestrians, there are not suitable storage areas and increases illegal pedestrian movements. Need to determine how northbound LRV at Strachan stop can trigger LRV priority phases.	Review advance detection for northbound LRV.
	Signal Pedestals	There is no room at the Barker Street intersection to install traffic signal pedestals between the traffic lanes and the light rail tracks.	There is no room available for signal pedestals to be located between the traffic lanes and the light rail tracks. Large mast arms will be required. The height and location of the large mast arms will need to consider the overhead light rail wires.	Review how signal control will be provided.
	Traffic Lanes	Two lanes in each direction. Right turn lanes at Barker Street (both directions). Left turn lane at Meeks Street (southbound only).	General: Right turns at Barker Street (both directions) will need to be fully controlled (red arrows) to give priority to LRV and buses. Currently, left turn movements occur in the bus / parking lane. These movements will now occur in the shared left / through traffic lane and will reduce the traffic capacity along Anzac Parade. There is an increased road safety risk of rear end crashes than existing conditions. Southbound: Need to ensure right turn lanes have sufficient capacity to store vehicles. NB: No information provided to review. At Meeks Street, consider removal of left turn lane to allow provision of an island to install traffic signal pedestals and/or increase the radius of the light rail tracks across the curve to the north of the intersection, and reduce the slewing of the tracks across the intersection. Northbound: The taper at the end of the parking lane immediately south of Barker Street is too short. A taper of increased length with either shorten the right turn lane or reduce the length of the parking lane. It is proposed to reduce the number of lanes from 3 to 2 immediately north of the existing Pedestrian Operated Signals just north of Nineways. The proposed taper is very short, and it is not appropriate to end the third lane	Review layout of traffic lanes.

Category	Sub-Category	Proposed Conditions	Issue / Comment	Potential Alternative / Mitigating Measure
			immediately after the Pedestrian Operated Signals.	
	Parking Lanes	Northbound parking lane between Strachan Street and Barker Street.	As outlined above, a taper of increased length with either shorten the right turn lane or reduce the length of the parking lane.	Review layout of parking lane.
Access	Crossing Points	Strachan Street stop has a signalised crosswalk at the northern end. All other intersections maintain existing crosswalks.	Nil.	Nil.
	Ramps	Ramp provided at northern end of Strachan Street stop.	Nil.	Nil.
	Illegal Access	No access provided to southern end of Strachan Street stop.	Although no access is provided at southern end of Strachan Street stop, it is very difficult to prevent illegal access from this end of the stop. The only way to prevent access would be the installation of fencing along both sides of the light rail tracks.	Consider installation of landscaping to discourage use of the southern end of the stop, but it is better that illegal movements occur from the landscaped area rather than walking along the tracks and stepping up on to the stop platforms.
	Safety	-	Illegal access is the main safety issue as discussed above.	Nil.
	Footpath / Shared Path	-	Nil.	Nil.
	Vehicle	Right turns banned at several locations (Day Av, Strachan St, Meeks St).	Turn bans will change traffic patterns through streets adjacent to Anzac Parade.	Nil.
Intermodal	Sharing of Tracks	Buses and trams to share tracks in narrow corridor. Some cross section plans show narrow traffic island, other plans show tracks are raised. No separation island is shown between tracks.	Buses may encroach on to opposite track / bus lane. Any traffic islands should be designed to minimise risk of being a trip hazard for pedestrians if midblock crossings across tracks are expected. Any traffic islands should be able to be mounted by emergency service vehicles. Emergency services vehicles use the light rail tracks in Melbourne in particular within the CBD. In Melbourne, cars usually position themselves with their right tyre to the right of the right track or between the two tracks. Driving with both tyres on the tracks creates discomfort and reduces skid resistance in wet conditions. Need to consider where bus tyres will be positioned on the tracks. It is unclear if southbound buses can access the light rail tracks at locations other than the UNSW stop.	Provide narrow 'guide kerb' to ensure buses do not encroach in to opposing direction LRV or buses, especially around tight corners. Consider the lateral position of buses on the light rail tracks when determining width of shared LRV/bus lanes.
	Bus Stops	It is understood some of the existing local bus stops in Anzac Parade will be retained.	Local buses still stopping along Anzac Parade will now stop in traffic lane (rather than parking lane or bus lane as before). This will reduce traffic capacity as one lane will be blocked at times. Bus stops on the departure sides of intersection will cause queuing through the intersection. Bus stops on the approach sides of intersections should be set back to allow left turning vehicles to move around the stopped bus, and enable sufficient warning to left turning vehicles as the bus moves off from the stop.	Review the location of retained bus stops, and if required, relocate from the departure site of the intersection.
	Bus / LRV Transfer	-	There may be some transfers to/from local buses near Strachan Street.	Consider the location of bus stops near Strachan Street
	Bus Priority	Northbound bus jump lane provided at Meeks Street for local buses to get off the light rail tracks.	Bus movements out of LRV corridor provided through a jump start lane. There is no separation between the bus lane and the adjacent traffic lanes. It is desirable to create an island between the bus lane and the adjacent traffic lanes to ensure drivers do not move off when the bus moves off (as the bus needs to cut in front of the traffic). As discussed above, removal of the southbound left turn lane may create space for a narrow traffic island.	Review layout of bus jump start lane to create separation between bus lane and adjacent traffic lanes.

Category	Sub-Category	Proposed Conditions	Issue / Comment	Potential Alternative / Mitigating Measure
			 The removal of the third northbound traffic lane at the existing Pedestrian Operated Signals (as discussed above) could be used to extend the bus jump lane if required.	
Signal Operation	Overview	-	Majority of time already given to Anzac Parade, so delays to LRV and buses should be minimal. Side road phase unlikely to be able to be cut short due to time required for crossings. Fully controlled right turns will reduce delays to LRV and buses. Staging of pedestrian crossings not desirable as it reduces level of service for pedestrians, there are not suitable storage areas and increases illegal pedestrian movements.	Nil.
	LRV Movements	Need to determine method to detect LRV and buses on tracks.	Priority at Strachan Street for northbound LRV/buses will be difficult due to proximity of stop to intersection, and variable time for boarding / alighting. Advance detection should be able to be provided to extend green time along Anzac Parade at most locations with the exception of northbound approaching Strachan Street (due to the stop). Advance detection is when the LRV is detected passing a particular point upstream of the signals and the signals can be adjusted to provide priority for that vehicle. It works well when there is 'certainty' of travel time.	Review advance detection for north LRV/buses.
	Bus Movements	Northbound bus jump lane provided at Meeks Street for local buses to get off the light rail tracks.	Northbound bus jump start at Meeks Street will require separate phase. This will occur either before or after the northbound through traffic phase, and could occur with the tram phase. If this occurs at the end of the through traffic phase, pedestrians crossing Anzac Parade (in particular from the west), may assume that the pedestrian walk phase is about to commence. This may create a risk of conflict between the buses and pedestrians. Need to develop method of detection if more than one bus is waiting.	Review signal phasing at Meeks Street.
	Pedestrian Movements	All pedestrian crosswalks maintained at signalised intersections.	PUFFIN signals could be used to reduce delays to LRV / buses at existing Pedestrian Operated Signals. Left turn movements will now be undertaken from the shared left turn / through traffic lane rather than the bus / parking lane. Left turning vehicles will feel 'pressured' to clear the through traffic lane, in particular at peak times. This may increase the road safety risk to pedestrians. Consider the use of pedestrian 'early starts' to allow pedestrians to commence their crossing of the side street prior to Anzac Parade traffic receiving a green signal.	Consider PUFFIN at Pedestrian Operated Signals to reduce delays to LRV / buses. Consider the use of pedestrian 'early starts'.
	Traffic Impacts	-	No additional signal issues from a traffic perspective.	Nil.

10 KINGSFORD TRAM STOP & TERMINUS (COUNCIL)

The proposed Kingsford stop and terminus will cater for the high number of bus / LRV transfers. The Nineways roundabout will also be modified significantly and changed to a signalised cross intersection.

10.1 EXISTING CONDITIONS

The existing conditions are shown in Figure 19 and Figure 20 are summarised as follows:

- Three traffic lanes southbound and two traffic lanes northbound, with parking on both sides of each carriageway and wide central median with parking.
- Unsignalised intersections at Nineways (roundabout), Wallace Street (T-intersection) and Sturt Street (cross intersection).
- Pedestrian Operated Signals located between Wallace Street and Sturt Street on southbound carriageway (South Juniors).
- Commercial and residential, with South Juniors located adjacent to proposed terminus.



Figure 19: Kingsford Terminus – Existing Conditions

Source: <http://maps.six.nsw.gov.au/>

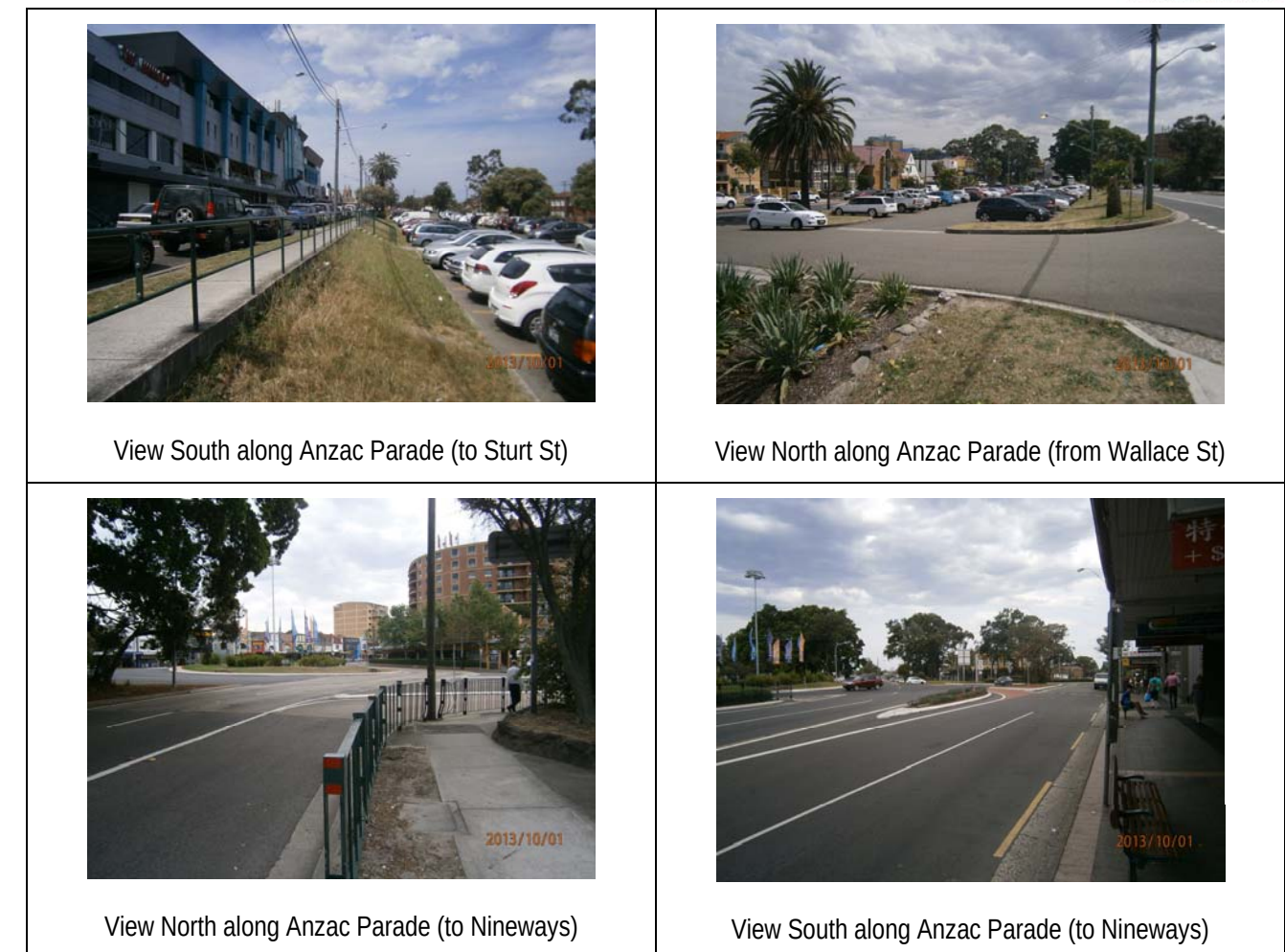
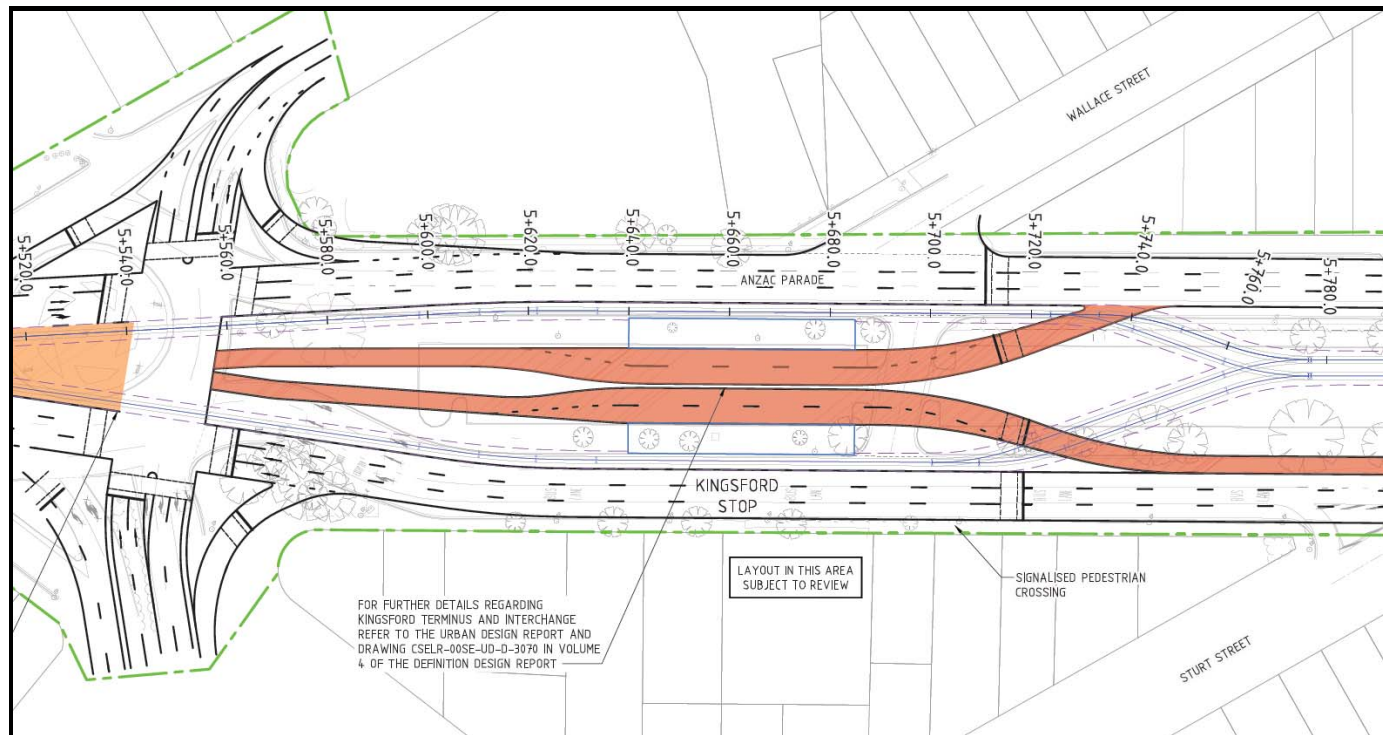


Figure 20: Kingsford Terminus – Photographs

10.2 PROPOSED CONDITIONS

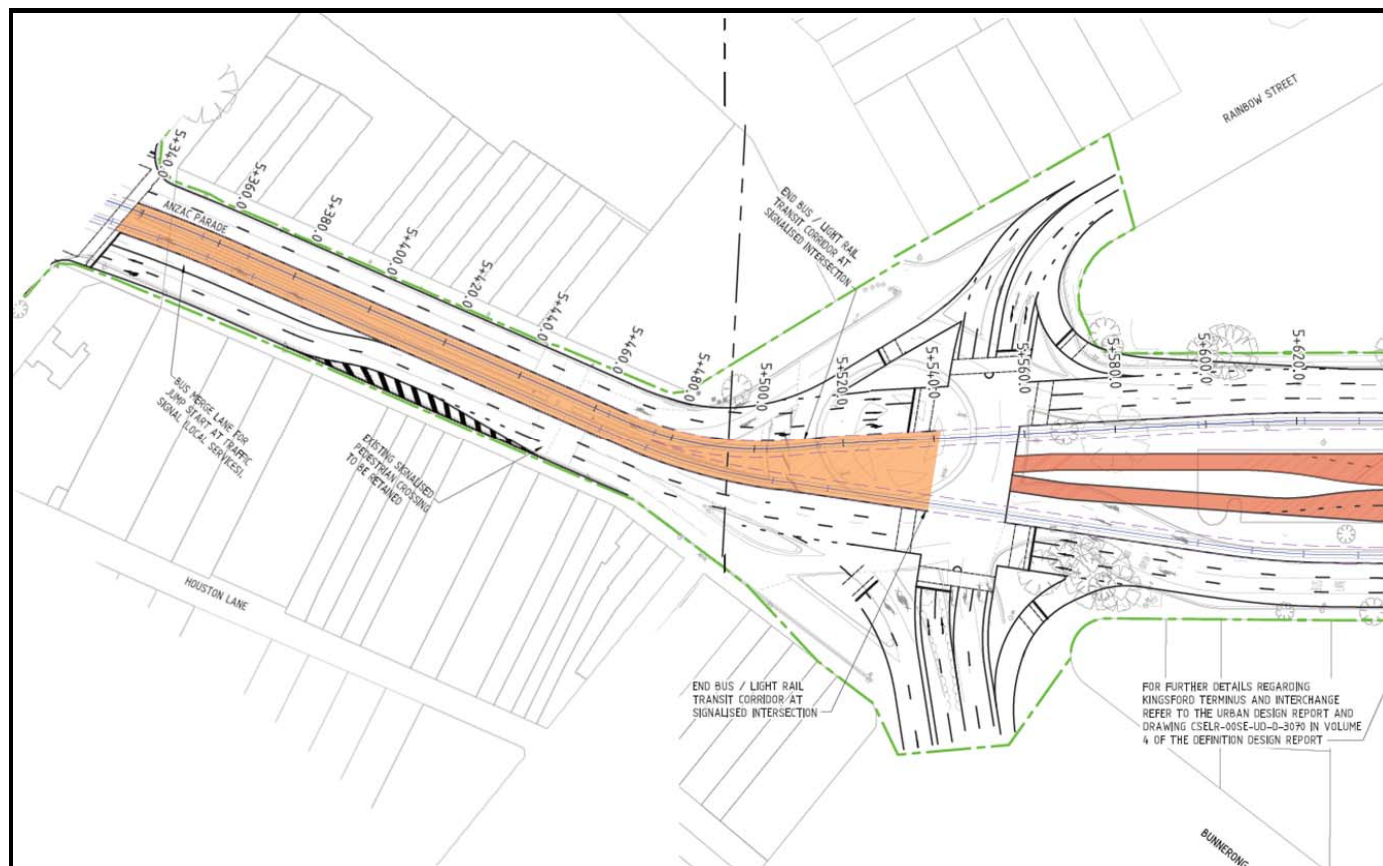
It is proposed to construct (as shown in Figure 21 and Figure 22):

- Stops in centre median to allow transfers between LRV and buses.
- New light rail tracks and bus lanes in centre median.
- Retention of three traffic lanes in each direction.
- Terminus located south of stops.
- Conversion of Nineways roundabout to signalised cross intersection.



Source: Transport of NSW

Figure 21: Kingsford Terminus – Proposed Conditions



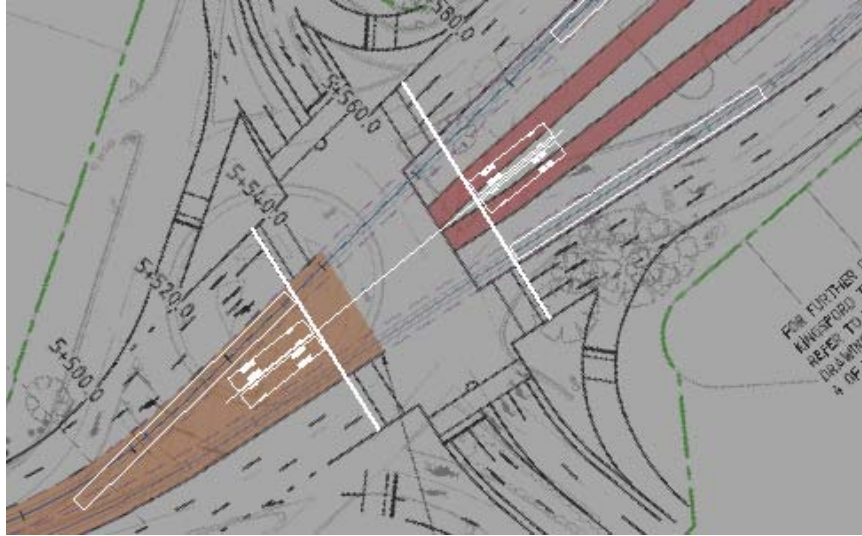
Source: Transport of NSW

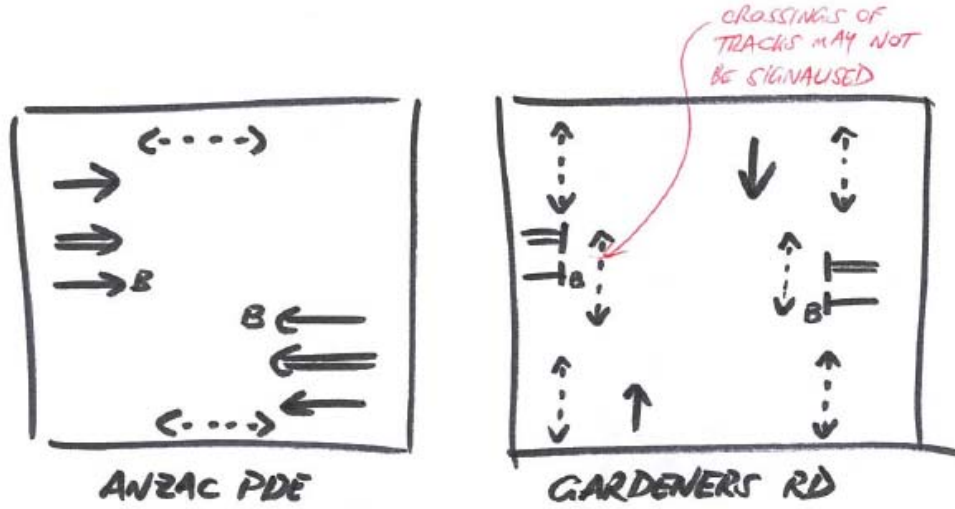
Figure 22: Nineways – Proposed Conditions

10.3 ISSUES / OPPORTUNITIES

The findings from the review of this location are included in Table 5.

Table 5: Nineways Intersection

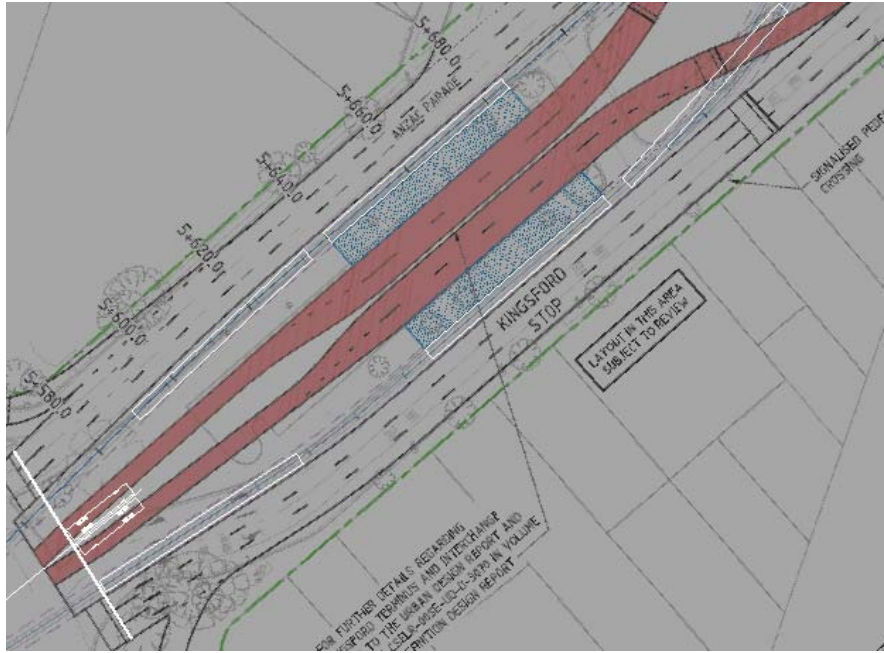
Category	Sub-Category	Proposed Conditions	Issue / Comment	Potential Alternative / Mitigating Measure
Consistency	-	-	The 'Road Engineering' plans and the 'Stop Plans' show different configurations for the pedestrian crossings. It has been assumed that the Stop Plans are the basis for comment.	Update plans to be consistent.
Location	Surrounding Land Uses	Intersection located at southern end of Kingsford commercial area. Signalised cross intersection at Nineways.	Safe pedestrian access around the commercial area and to / from the stops will be improved with the replacement of the roundabout with a signalised cross intersection at Nineways.	Nil.
	Land Acquisition	-	Nil.	Nil.
Layout	Platform Size	-	Nil.	Nil.
	Storage	No pedestrian storage provided between traffic lanes and light rail tracks. No designated area for buses on north side of intersection.	No room between road and tracks for pedestrians to store. This means that it will be more difficult to provide additional priority phases for LRV / buses as pedestrians will need to cross traffic lanes and tracks in one movement. Pedestrian push buttons would need to be provided on the inside of the tracks and there would be no room for signal pedestals between the tracks and the traffic lanes (which are a good way of 'separating' the traffic and LRV / bus movements). At most other locations, these types of crossings will be LRV priority crossings. All pedestrians on the north side of the intersection will be crossing the full width of Anzac Parade. The provision of separate lanes for buses to travel through the Nineways intersection (as provided on the south side only) could improve the priority for buses and LRV. Northbound vehicles could travel through the intersection together and then merge on the north side. Alternatively, northbound vehicles could be given separate phases to travel through the intersection. 	Review layout of Nineways intersection to create pedestrian storage areas between the traffic lanes and the light rail tracks. Review layout of Nineways intersection to create bus lanes on the north side of the intersection.
	Swept Paths	-	n/a	n/a
	LRV	-	Southbound 45m long LRV will block access to potential bus lane on the inside of the light rail tracks. There is sufficient length for second southbound LRV to cross intersection and wait before entering stop.	Nil.
	Signal Pedestals	-	There is no room available for signal pedestals to be located between the traffic lanes and the light rail tracks. Large mast arms will be required. The height and location of the large mast arms will need to consider the overhead light rail wires. Signal phasing for the LRV and bus priority will be complex, with requirements for separate lanterns for each of the movements. Creation of a pedestrian storage area between the light rail tracks and the traffic lanes would create space for traffic signal pedestals for pedestrians, traffic, LRV and buses.	Review layout of Nineways intersection to create pedestrian storage areas between the traffic lanes and the light rail tracks.
	Traffic Lanes	Southbound – 2 through & 1 right turn. Northbound – 3 through.	The layout at the intersection is significantly different in each direction. Southbound:	Update plans to reflect proposed lane configuration.

Category	Sub-Category	Proposed Conditions	Issue / Comment	Potential Alternative / Mitigating Measure
			There is a left turn slip lane, two through lanes (one 30m short lane) and a right turn lane on the approach. There are three through lanes on the departure. It is assumed that the right turn arrows are incorrect and no right turn is proposed. Northbound: There is a left turn slip lane and three through lanes on the approach. There are three through lanes on the departure.	
Access	Crossing Points	Signalised cross intersection, crosswalks across all legs and left turn slip lanes.	Layout provides safe access around intersection except for crossings of the light rail tracks and bus lanes. It is unclear how these will operate with respect to pedestrian movements.	Review layout of Nineways intersection to provide safe pedestrian access across bus lanes and light rail tracks.
	Ramps	-	Nil.	Nil.
	Illegal Access	-	Signalised crossings are provided for all movements so there should be minimal illegal crossings. However, illegal crossings will occur if the crossings of the light rail tracks and bus lanes are signalised.	Nil.
	Safety	-	Illegal access is the main safety issue as discussed above.	Nil.
	Footpath / Shared Path	-	Due to the ramp configuration between the stops, it is expected that the majority of pedestrians coming from the Nineways intersection will access their stop from the Nineways intersection (rather than use the internal ramps).	Nil.
	Vehicle	-	No right turns permitted from Anzac Parade (it is assumed southbound right turn incorrectly shown on plans).	Nil.
Intermodal	Sharing of Tracks	Buses to shared light rail tracks to north of intersection.	As discussed above, review layout for LRV and buses through intersection.	Nil.
	Bus Stops	-	Nil.	Nil.
	Bus / LRV Transfer	-	Nil.	Nil.
	Bus Priority	Buses to shared light rail tracks to north of intersection.	As discussed above, review layout for LRV and buses through intersection.	Nil.
Signal Operation	Overview	-	Only east/west through traffic movements (and potentially east/west pedestrians) will conflict with north/south LRV and bus movements. Should be able to introduce relatively easy phasing with advance detection from the Pedestrian Operated Signals to the north and the stop from the south. If pedestrian crossings are set up as LRV priority, then the priority for LRV and bus should work effectively. The main restriction to priority for north/south LRV and buses will be the crossing time required for pedestrians crossing Anzac Parade i.e. even if a LRV is detected on approach, the signals need to wait until the appropriate walk time and clearance time has finished. 	Review pedestrian crossings of central median – signalised or LRV priority.
	LRV Movements	-	Nil.	Nil.

Category	Sub-Category	Proposed Conditions	Issue / Comment	Potential Alternative / Mitigating Measure
	Bus Movements	-	Nil.	Nil.
	Pedestrian Movements	-	Nil.	Nil.
	Traffic Impacts	-	Nil.	Nil.

The findings from the review of this location are included in Table 6.

Table 6: Kingsford Stop & Terminus

Category	Sub-Category	Proposed Conditions	Issue / Comment	Potential Alternative / Mitigating Measure
Consistency	-	-	The 'Road Engineering' plans and the 'Stop Plans' show different configurations for the pedestrian crossings. It has been assumed that the Stop Plans are the basis for comment.	Update plans to be consistent.
Location	Surrounding Land Uses	Intermodal transfer stop.	Stop will be a major intermodal transfer stop with a predicted low number of 'walk up' passengers. Terminus could be located further south to reduce the loss of car parks within the central median.	Nil.
	Land Acquisition	Car park to east of Anzac Parade.	If used as a Park and Ride location, need to consider how passengers access the stop.	Review passenger access from Park and Ride area to stop.
Layout	Platform Size	Both island platforms 45.0m x 6.0m = 270 sqm.	Precinct Access Plan (Table 7-18) states: 1,454 boardings & 515 alightings forecast for 2021 (total – 1,969). 1,851 boardings & 615 alightings forecast for 2036 (total – 2,466). Platform stops easily able to accommodate pax numbers.	Nil.
	Storage	Stops have been designed to facilitate predicted high number of transfers.	Nil.	Nil.
	Swept Paths	-	The swept paths for LRV and buses will increase on the track curves to and from the terminus.	Need to ensure all roadside furniture, stop lines and pedestrian storage areas are setback to cater for the increased clearance requirements.
	LRV	-	There is sufficient length for second southbound LRV to cross intersection and wait before entering stop. Room for one northbound LRV to store within the terminus and another one waiting at the Nineways intersection. However, no room for additional LRV to store outside of the terminus waiting to enter (northbound) as it will block the bus entry and potentially the pedestrian access. 	Review layout to reduce risk of additional LRV blocking the bus and pedestrian access.

Category	Sub-Category	Proposed Conditions	Issue / Comment	Potential Alternative / Mitigating Measure
	Signal Pedestals	-	Signal pedestals may be required if bus / LRV interaction is to be controlled.	Review how signal control will be provided.
	Traffic Lanes	3 lanes in both directions.	Nil.	Nil.
	Parking Lane	-	It is assumed that some on road parking will continue to be provided.	Nil.
Access	Crossing Points	Access to stop from Nineways intersection and Pedestrian Operated Signals.	The Wallace Street Pedestrian Operated Signals are located too close to the Wallace Street intersection e.g. left turners from Wallace Street may not see signals. Also, stop line for Pedestrian Operated Signals should be 6m back from crosswalk. It is unclear if the South Juniors Pedestrian Operated Signals remain. Some pedestrians may use this location to access the central median to walk to the stop. Also, if centre median parking is retained, there may be a number of pedestrians who walk along the centre median to reach the stop. No footpaths are shown in the central median. There is no storage between the traffic lanes and the light rail tracks for pedestrians. In addition, they also have to get across the bus lanes. Different crossing locations are proposed on different plans. On the Stop Plans, the pedestrian crossing point is located very close to the southbound bus stop, which may reduce visibility to pedestrians using the crossing.	Review layout of Wallace Street Pedestrian Operated Signals, including signalisation of the Wallace Street left turn (amber / red when crossing activated, Give Way at other times). Review layout of central median and accommodate pedestrian movements if required. Review layout of pedestrian crossings across the traffic lanes, and within the stop area.
	Ramps	Back to back ramps at each end to provide transfers.	Back to back ramps required due to level differences. The number of transfers between stops is expected to be low. At the northern end, it is expected that most pedestrians will choose which stop to access from the Nineways intersection. The location of bicycle storage cages will also influence the use of the ramps.	Nil.
	Illegal Access	-	There is the potential for illegal access along Anzac Parade between Nineways and the Pedestrian Operated Signals, how this expected to be relatively low.	Consider the provision of fencing between the traffic lanes and the light rail tracks.
	Safety	-	Illegal access is the main safety issue as discussed above.	Nil.
	Footpath / Shared Path		Nil.	
	Vehicle	Central median break opposite Wallace Street to be closed.	The Wallace Street intersection could be reconfigured as only left in and left out movements will be permitted. A traffic island could be installed or the intersection realigned to reduce vehicle entry speeds from Anzac Parade. Pedestrian movements across this intersection may increase from the car park to the west of Anzac Parade to the stop access immediately south of Wallace Street. One of the reports indicates that a Kiss and Ride area should be created – this is supported as otherwise kiss and ride activities will occur throughout the area. This is not shown on the plans. The location of the Kiss and Ride area should be close to the stops and close to a signalised crossing point if located on the left hand side of the road.	Review layout of Wallace Street intersection. Review provision of Kiss and Ride area.
Intermodal	Sharing of Tracks	LRV and buses will share tracks north of the Nineways intersection.	As discussed above, unclear how LRV and bus movements will be controlled across Nineways intersection.	Review control of LRV and bus interaction.
	Bus Stops	-	It is unclear if bus stops on Anzac Parade will be retained. If so, they will only be for local services. Access from the bus stops to the LRV stops needs to be considered.	Review access between local bus stops and LRV stops.
	Bus / LRV Transfer	-	Stop will be a major intermodal transfer stop with a predicted low number of 'walk up' passengers.	Nil.
	Bus Priority	-	As discussed above, unclear how LRV and bus movements will be controlled within terminus area.	Review control of LRV and bus interaction.
Signal Operation	Overview	-	There will be some interaction between buses and other traffic when southbound buses exit the stop back on to Anzac Parade.	Nil.
	LRV Movements	-	n/a	n/a
	Bus Movements	-	There is no provision for bus entry and exit for local buses between stop and Nineways to remove buses from Nineways intersection. Future provision for these movements should be provided so that any route changes, or the removal of the buses from the light rail tracks further north, could be accommodated. Bus movements exiting the stop will require southbound traffic on Anzac Parade to be stopped. The Pedestrian Operated Signals near Wallace Street could be used	Review layout to make provision for bus entry and exit movements to the north of the stop but south of the Nineways intersection. Review control of southbound bus movements exiting the stop.
	Pedestrian	Inconsistency between Road Engineering and	The plans appear to show signalised crossings of bus and light rail tracks. However, it is unlikely that pedestrians will obey the signals. LRV or bus priority crossings are expected to be more suitable to this	Review control of pedestrian crossings.



Category	Sub-Category	Proposed Conditions	Issue / Comment	Potential Alternative / Mitigating Measure
	Movements	Stop Plans.	environment, subject to the control of LRV and bus conflicts.	
	Traffic Impacts	-	Expected to be minimal traffic impacts. Wallace Street Pedestrian Operated Signals could be linked to Nineways intersection located approximately 150m to the north.	Review linking of Pedestrian Operated Signals.

PLATFORM STOPS - PASSENGER AREA ASSESSMENT

Based on pedestrian movement data (by gate) and mode.

Fruin Level of Service based on Victorian Rail Industry Operators' Group Standards (VRIOGS).

WANSEY ROAD - 2020

Alighting

100% of pedestrians via Gate 9 (southern end of stop)

Alighting (Average per LRV)	Platform Length (m)	Platform Width (m)	Space (m ² /ped)	Platform Storage (Fruin LOS)	Ramp Access - if arrive by signals (Fruin LOS)
448	45	6.0	0.55	E	E
448	45	7.0	0.65	E	D
448	45	8.0	0.75	E	D
448	45	9.0	0.85	E	D
300	45	6.0	0.83	E	D
300	45	7.0	0.98	D	C
300	45	8.0	1.13	D	C
300	45	9.0	1.28	D	C

Boarding

100% of pedestrians via Gate 9 (southern end of stop)

Boarding (Average per LRV)	Platform Length (m)	Platform Width (m)	Space (m ² /ped)	Platform Storage (Fruin LOS)	Ramp Access - if arrive by signals (Fruin LOS)
248	45	6.0	1.00	D	C
248	45	7.0	1.18	D	B
248	45	8.0	1.36	D	B
248	45	9.0	1.54	C	A

Alighting volumes are higher than boarding volumes at Wansey Road.

Therefore, cover requirements for passengers waiting at the platform are not as high.

If each passenger takes up 1 sqm, this is approximately 250 sqm. A stop of 45m x 8.4m has an area of 378sqm. Coverage would be 65%.

ANZAC PARADE - 2020

Alighting

100% of pedestrians via Uni Mall

Boarding (Average per LRV)	Platform Length (m)	Platform Width (m)	Space (m ² /ped)	Platform Storage (Fruin LOS)	Ramp Access - if arrive by signals (Fruin LOS)
452	45	7.0	0.65	E	D
452	45	8.0	0.75	E	D
300	45	7.0	0.98	D	C
300	45	8.0	1.13	D	C

Boarding

100% of pedestrians via Uni Mall

Boarding (Average per LRV)	Platform Length (m)	Platform Width (m)	Space (m ² /ped)	Platform Storage (Fruin LOS)	Ramp Access - if arrive by signals (Fruin LOS)
617	45	4.4	0.28	F	F
617	45	5.0	0.33	F	E
617	45	6.0	0.40	F	D
617	45	7.0	0.47	E	D

70% via Uni Mall (for boarding ramp calculations only)

Boarding (Average per LRV)	Platform Length (m)	Platform Width (m)	Space (m ² /ped)	Platform Storage (Fruin LOS)	Ramp Access - if arrive by signals (Fruin LOS)
432	45	4.4	0.00	0	D
432	45	5.0	0.00	0	D
432	45	6.0	0.00	0	C
432	45	7.0	0.00	0	C

30% via Uni Walk (for boarding ramp calculations only)

Boarding (Average per LRV)	Platform Length (m)	Platform Width (m)	Space (m ² /ped)	Platform Storage (Fruin LOS)	Ramp Access - if arrive by signals (Fruin LOS)
185	45	4.4	0.00	0	B
185	45	5.0	0.00	0	A
185	45	6.0	0.00	0	A
185	45	7.0	0.00	0	A

Boarding volumes are higher than alighting volumes at Wansey Road.

Therefore, cover requirements for passengers waiting at the platform are very high.

Maximum boarding passenger numbers will take up a significant area. A platform of 45m x 7.3m has an area of 330sqm.

Even at 0.5sqm per passenger, they will take up the whole platform. Therefore, coverage should be for the full platform.

Fruin	Space (m ² /ped)	Density (ped/m ²)	Flow Rate (ped/min/m)
Level of Service			
LoS A	≥ 3.24	≤ 0.27	≤ 23
LoS B	2.32 to 3.24	0.43 to 0.31	23 to 33
LoS C	1.39 to 2.32	0.72 to 0.43	33 to 49
LoS D	0.93 to 1.39	1.08 to 0.72	49 to 66
LoS E	0.46 to 0.93	2.17 to 1.08	66 to 82
LoS F	≤ 0.46	≥ 2.17	variable

University of New South Wales

Proposed Light Rail Platform Stops on Anzac Parade

Feasibility Design Stage Road Safety Audit



Project Ref: TS-13-RSA-0619C
Prepared for: University of New South Wales
Date: 26th November 2013

2013

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Document control

Project Ref	Date	Revision	Author	Reviewer
TS-13-RSA-0619C.docx	26 November 2013	C	Darren Vella	Simon Penca

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1. Introduction

Transafe has been engaged by the University of New South Wales to undertake a feasibility design stage road safety audit of the proposed alternate light rail platform stops on Anzac Parade, at the University of New South Wales in Kensington.

This audit was conducted by:

Darren Vella [BEng Civil (Hons), Director]

RMS Accredited (Level 3) Senior Road Safety Auditor (Auditor ID: RSA-03-0530)

and;

Simon Penca [BEng Civil (Hons), Director]

RMS Accredited (Level 3) Senior Road Safety Auditor (Auditor ID: RSA-03-0531)

The auditors have had no involvement in the design or development of the subject site being audited.

2. Road safety audit process

A road safety audit is a formal examination of an existing or future road or traffic project in which an independent, qualified team reports on the projects crash potential and safety performance (Austroads 2009). This road safety audit has been carried out in accordance with the Austroads Guide to Road Safety Part 6: Road Safety Audit (2009) with reference to relevant standards and guides, and draws on industry practice and experience to identify potential road safety audit findings. However, no guarantee is made that every deficiency has been identified.

3. Responding to this audit

As set out in the road safety audit guidelines, responsibility for the road safety audit always rests with the project team and not the auditor. The project team is under no obligation to accept or agree with all of the audit findings. Also, it is not the role of the auditor to agree to or approve the project teams response to the audit. This audit report should be responded to in writing including reasons for rejection of an audit finding. Acceptance of all findings of this report would not guarantee that every potential road safety issue has been addressed, rather adoption of the audit findings should improve the level of safety of the subject site.

4. Site details

Anzac Parade is a primary state arterial road generally aligned north-south with three lanes in each direction and a narrow central median with pedestrian fencing. Buses operate along Anzac Parade to cater for the large patronage to the adjacent university and NIDA facilities. The kerbside lane along Anzac Parade is a bus lane in peak periods in the peak direction and reverts to a parking lane at other times. A wide pedestrian operated signalised crossing exists on Anzac Parade to facilitate east-west pedestrian movements (across Anzac Parade). Bus stops are located to the north (for northbound) and south (for southbound) of the pedestrian operated signals. Anzac Parade is subject to a posted speed limit of 60km/h.

Figure F1: Location plan



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Photo P1 – Anzac Parade view north from pedestrian operated signals



Photo P2 – Anzac Parade view south to pedestrian operated signals



Photo P3 – Anzac Parade view south to pedestrian operated signals



Photo P4 – University Mall view west across pedestrian operated signals

5. Proposed works and scope of the audit

As part of new Sydney Light Rail network, light rail tram platforms are proposed for northbound and southbound movements on Anzac Parade, adjacent to the University of New South Wales. At the completion of the project and allowing for a steady growth in population and shift to public transport, on a typical semesters day the Anzac Parade light rail platforms are expected to cater for approximately 13,000 arrivals and 16,000 departures, with an arrival peak in the order of 1,100-1,200 (15mins) and departure peak in the order of 1,500-1,600 (15mins). To cater for such demand, four proposed light rail platform options are being considered as follows:

- Transport for NSW option: Involves the central light rail tracks deviating to the eastern side of Anzac Parade (commencing to the south of the pedestrian operated signals and through the High Street intersection). A central island platform is proposed adjacent to Square House, with uncontrolled pedestrian crossings at each end of the platform. Pedestrian crossing movements of Anzac Parade will be facilitated via the existing pedestrian operated signals. Refer to Appendix A1.
- Option 6 – Modified Transport for NSW proposal with wider platform, shifted west: This option is similar to the previous option, with the exception that the platforms will be provided to the left side of each arriving light rail vehicle. Pedestrian crossing movements of Anzac Parade will be facilitated via the existing pedestrian operated signals. Refer to Appendix A2.
- Option 7 – Centre Platform: This option involves maintaining the central light rail track alignment within the median of the opposing traffic lanes, with a central island platform. Pedestrian crossing movements of Anzac Parade will be facilitated via the existing pedestrian operated signals and via new pedestrian operated signals (to the north of the platforms). Refer to Appendix A3.
- Option 8 – Side Platforms: This option involves the central light rail tracks deviating to the kerbside lanes along Anzac Parade by crossing northbound and southbound traffic lanes (commencing to the south of the pedestrian operated signals and just north of the NIDA building). Platforms will simply be constructed behind the Anzac Parade kerb line. Pedestrian crossing movements of Anzac Parade would be facilitated via the existing pedestrian operated signals (to the south of the platforms) and via new pedestrian operated signals (to the north of the platforms). Refer to Appendix A4.

The scope of this road safety audit is to review the proposed options and identify potential safety deficiencies relating to the infrastructure changes with respect to all road users including vehicles, buses, light rail, pedestrians and cyclists, with a recommendation on the preferred option from a safety perspective to be provided.

This audit does not include an assessment of the existing conditions at the subject site. Although this audit may cover lighting pole locations, this is not a formal lighting luminance assessment. Similarly, this audit may cover pedestrian accessibility, however this is not a formal DDA assessment.

6. Crash statistics

Limited details of known crashes are available at the subject site. Nonetheless, the crash history at the subject site is not expected to influence the findings of this audit at this early feasibility design stage assessment.

7. Documents used to facilitate audit

The following information / drawings were used to facilitate the audit:

- UNSW Anzac Parade Stop Proposed by TfNSW, Drawing No: PV-01 Sheet 1 of 13 and PV-02 Sheet 2 of 13, Created: N. Bettini;
- UNSW Anzac Parade Stop Option 6, Drawing No: PV-03 Sheet 3 of 13 Version 5.1 and PV-04 Sheet 4 of 13 Version 5.1, both Modified 20/11/2013, Created: N. Bettini;
- UNSW Anzac Parade Stop Option 7a, Drawing No: PV-05 Sheet 5 of 13 Version 5.1 and PV-06 Sheet 6 of 13 Version 5.1, both Modified 20/11/2013, Created: N. Bettini;
- UNSW Anzac Parade Stop Option 8, Drawing No: PV-11 Sheet 11 of 13 Version 5.1 and PV-12 Sheet 12 of 13 Version 5.1, both Modified 20/11/2013, Created: N. Bettini;
- Site photos (taken 1/10/13) and background information including nature of the road environment, abutting development, pedestrian behaviour, and available transport links: Provided by Anthony Coyle – Senior Associate at TraffixGroup;
- UNSW Future Circulation Structure, Drawing No: -- Sheet 1 of 3, Created: N. Bettini;
- UNSW Significant Trees, Drawing No: -- Sheet 2 of 3, Created: N. Bettini;
- UNSW Potential Future Development, Drawing No: -- Sheet 3 of 3, Created: N. Bettini;
- UNSW Daily Student and Staff Movements: Departures 2013 (Monday-Thursday);
- UNSW Daily Student and Staff Movements: Arrivals 2013 (Monday-Thursday); and,
- Fig 1a, Ridership Projections 2020, Revision 2, 14 November 2013.

8. Audit findings

The findings of the road safety audit are detailed on the following pages. A response from the project team should be inserted into the relevant columns. Responses to audit findings are generally not required by the auditors; rather a record should be kept for reasons of adoption or rejection of the findings for future reference by the project team.

Audit findings table

University of New South Wales – Proposed Light Rail Platform Stops on Anzac Parade Feasibility Design Stage Road Safety Audit		
Item	Findings	Project team response
General		
8.1	Specific design parameters such as lane widths, horizontal geometry, signs and line marking, etc are unknown at this early design stage and therefore have not been audited as part of this assessment. It is assumed that such design parameters will be accommodated in accordance with Austroads and RMS standards.	
8.2	Ideally poles and other objects should be set back from the road. Each of the proposed options require realignment of adjacent traffic lanes along Anzac Parade, resulting in traffic being deviated and ultimately located closer to existing fixed hazards such as power poles and trees. It is acknowledged that there is an existing risk associated with collisions into parked vehicles in the kerbside lane, and the severity of a crash into the new hazards rather than the existing parked cars is difficult to quantify, however, the change in alignment and narrowing of lanes is expected to increase the likelihood of crashes overall. Ideally no pole (or any other roadside hazard) should be placed within the clear zone. In practice, this is difficult to achieve, particularly in urban areas. A clear zone of 3.0m is applicable for a posted speed limit of 60km/h at the subject site.	
8.3	Further to the previous point, the inherent nature of the raised tram platforms presents possible roadside hazards. Ideally, the approach end of raised tram platforms should be shielded using a crash cushion (depending on its location with respect to adjacent traffic, clear zone, etc). The longitudinal side of a tram platform should also be considered for shielding using safety barrier (depending on the stop use, patronage, type, location, etc).	
8.4	Catenary utility poles will be required to provide power to trams. Where possible, the location of these poles should be provided in between the opposing tram tracks to reduce the number of poles required (i.e. try and avoid the use of a line of poles on each side of the road, effectively doubling the required number of poles), and maximise the offset of these poles to adjacent traffic (i.e. the tram reserve effectively provides a 'buffer'). Ideally, all new catenary poles should be positioned outside the clear zone as they are considered significant roadside hazards.	

University of New South Wales – Proposed Light Rail Platform Stops on Anzac Parade Feasibility Design Stage Road Safety Audit		
Item	Findings	Project team response
8.5	Fencing is proposed at most of the new stops for each proposed option to encourage particular pedestrian routes, which is supported in principle. Fencing should be considered to also act as a physical obstruction should a tram driver open the incorrect side tram doors (and physically restrain tram patrons and prevent them stepping out into traffic). Any fencing located within the clear zone should be crashworthy (i.e. no horizontal members). Typical roadside fencing such as weldmesh is considered appropriate.	
8.6	Given the nature of the abutting development and very high volumes of pedestrians expected to be in the vicinity of Anzac Parade traffic, consideration should be given to implementing a fulltime 40km/h speed limit along the subject length of Anzac Parade to lessen the severity of possible conflict between vehicles/trams and pedestrians and cyclists.	
8.7	The longitudinal step-up/down from the platforms to the tram tracks is a potential pedestrian hazard. Pedestrians can reasonably be expected to take shortcuts directly from the platforms to their desired destination and between platforms. This hazard cannot be effectively addressed given the need to maintain access between the platforms and trams, however its presence can be highlighted using adequate delineation. Appropriate devices such as signage, line marking and pavement marking, raised reflective pavement markers and flexible paddles/bollards should be considered to highlight the ramps and step-down (in addition to tactile ground surface indicators for DDA compliance).	
8.8	Special attention is required when developing either option to ensure the widths of the pedestrian crossings and signalised crossing times are adequate to accommodate the peak pedestrian platoons (e.g. morning and afternoon weekdays). Narrow crossings (with fencing that creates a bottleneck) can result in 'bunching', and short crossing phases can result in pedestrians being stranded on the roadway and /or tram reserve during high pedestrian demand times. Of particular concern is the likely increased crossing distance to accommodate the light rail tracks; this needs to be carefully considered, along with crossing technology such as PUFFIN.	
8.9	Specific cyclist provisions along Anzac Parade are unclear at this early design stage. Ideally, cyclists should be catered for in the form of exclusive bicycle lanes, segregated from other road users. Where this cannot be achieved, other facilities such as shared use paths, on road bicycle lanes, wide kerbside lanes etc should be considered, along with subtle additions such as head-start storage boxes at signals.	

University of New South Wales – Proposed Light Rail Platform Stops on Anzac Parade Feasibility Design Stage Road Safety Audit		
Item	Findings	Project team response
8.10	Further to the previous point, where bicycle lanes/traffic lanes cross tram tracks, consideration should be given to the crossing angle to limit the likelihood of bicyclists and motorcyclists wheels being caught or redirected by the tracks. The tracks are also particularly slippery for two-wheeled vehicles and therefore avoiding crossing of traffic lanes and tracks so far as possible should be achieved.	
8.11	It is unclear if and how access and egress movements to and from abutting side roads such as Day Avenue can / will be facilitated (if at all – this is unclear from the information provided). Where right-turn movements in / out of these roads will be prohibited, ensure appropriate alternative areas for U-turns are provided. Right-turn movements across the tram tracks can be facilitated where appropriate sight lines, gaps in traffic and storage space can be accommodated, however it is preferred it be avoided to prevent unnecessary conflict points and delaying light rail.	
8.12	It is understood that southbound buses (in some options) will drive along the light rail track south of the university to access the terminus further south. It is unclear how southbound buses will safely access the light rail tracks from the adjacent traffic lanes. This requires further investigation.	
8.13	Options 6, 7 and 8 include the provision of 3 sets of traffic signals within a relatively short distance of approximately 240m. This could result in a see-through effect, and is likely to affect overall level of service for both trams and vehicles. Nonetheless, such close arrangements of signals are common at busy transport hubs such as this and the overall risk posed is considered low. Nevertheless the signals will need to be in coordinated to avoid see-through effect road safety issues.	
8.14	Apart from option 7 (centre platform), each of the options will not be able to accommodate kerbside parking during off-peak periods (if only one through lane of traffic is considered acceptable during such off-peak periods).	

University of New South Wales – Proposed Light Rail Platform Stops on Anzac Parade Feasibility Design Stage Road Safety Audit		
Item	Findings	Project team response
Option proposed by Transport for New South Wales		
8.15	The longitudinal edge and face of the island platform will be located approximately 3.5m from adjacent southbound traffic, which is just outside the 3.0m clear zone for 60km/h. The immediate preceding southbound traffic lanes are aligned straight and therefore the likelihood of errant vehicle encroachment into the platform is considered low.	
8.16	While northbound tram patrons will alight from the right side of the tram at the platform stop, the appropriate side for southbound trams is unclear. Patrons wishing to board a southbound tram may be confused whether to wait in the central island or the kerbside. Similarly, a tram driver may inadvertently open the doors on the incorrect side especially if abutting tram stops are central island type stops. Alternatively, if the intention is for both platforms to be used at once, both sides of the tram could be opened.	
8.17	Light Rail Vehicle (LRV) priority pedestrian crossings are proposed at each end of the proposed platform, which increases the likelihood of pedestrian/tram conflict and is less preferred than a signalised fully controlled crossing. Given the short length of the proposed crossings in this particular case, uncontrolled crossings would be warranted (it is acknowledged that it is difficult to control pedestrian movements even where signalised crossings are provided). It is important to ensure uncontrolled crossing movements are made as safe as possible. The main way to make uncontrolled crossings as safe as possible is to ensure appropriate sight lines are provided at crossing points, and to provide direct access to the adjacent roadside. Signs and pavement markings (for pedestrians) to ensure they 'look and give-way' to trams should also be considered.	
8.18	Northbound bus drivers propped in the bus bays (north of the pedestrian operated signals) will have difficulty seeing and picking gaps in traffic given the offset of the preceding traffic lanes closer to the kerb and behind propped buses. To a lesser extent, southbound bus drivers will have some difficulty sighting approaching vehicles due to the curved preceding road alignment.	
8.19	It is understood that northbound buses will utilise the central tram tracks south of the pedestrian operated signals before moving across to the kerbside lane and bus stops north of the crossing. While the general principle of this operation (including using the signals as a head-start) is supported in principle, the alignment of the tram tracks/bus lane south of the crossing is in direct line with the southbound fast lane. The directly opposing lane arrangement is undesirable and may 'spook' southbound drivers. This is expected to be exacerbated at night when vehicle headlights are on, adding glare.	

University of New South Wales – Proposed Light Rail Platform Stops on Anzac Parade Feasibility Design Stage Road Safety Audit		
Item	Findings	Project team response
8.20	Further to the previous point, the delineation of the skewed southbound traffic lanes and deviation through the crossing and across the light rail tracks is reliant on line marking only, without the benefit of separation and a median. The reliance of such delineation without separation and a physical barrier such as a raised median is undesirable and likely to increase the risk of conflict such as head-on (southbound vehicles and northbound buses) and sideswipe (vehicles in same direction).	
8.21	Maintaining the existing signalised pedestrian operated signals is supported, however the following potential safety issues associated with the crossing should be considered for this proposed light rail platform option: • Pedestrians crossing from the eastern side of Anzac Parade are likely to wait within the tram reserves before crossing the traffic lanes given the seemingly wide free open tram reserve available when trams are not immediately present. This increases the risk of conflict between pedestrians and trams. • Pedestrians crossing from the western side of Anzac Parade and wishing to access the tram platform are simply likely to complete crossing the southbound traffic lanes and take a shortcut along the tram reserve to access the platforms. Such movements cannot be prevented due to the need to maintain access. This increases the risk of conflict between pedestrians and trams especially as pedestrians walking north will have their back to northbound trams. Similar issues are likely for pedestrians leaving the platform (to the south) and walking directly to the pedestrian crossing to travel west across Anzac Parade. • No central median is proposed in this option, which removes the possible opportunity for a safe refuge. Crossing against a red man can reasonably be expected (and this is consistent with advice provided to Transafe during the audit inception meeting) and the provision of two staged crossing movement and a median refuge lessens the risk. • The vehicle hold lines need to be positioned well in advance of the pedestrian crossing due to the nature of the light rail track alignment and bus jump lane. This offset may encourage pedestrians to cross against the red man as they seemingly will have more 'time' to do so, however this increases the likely speed at the conflict point and consequences of impact (especially at the end of a pedestrian walk phase). • Pedestrians crossing against the red man may use the red vehicle signal aspects as a guide to see if it is 'safe' to cross, unaware that an early start phase may be given to northbound buses from the light rail tracks. This increases the risk of conflict between buses and pedestrians.	

University of New South Wales – Proposed Light Rail Platform Stops on Anzac Parade Feasibility Design Stage Road Safety Audit		
Item	Findings	Project team response
8.22	Further to item 8.4, catenary power poles are likely to be located close to adjacent traffic where the tram tracks cross the traffic lanes (i.e. they are likely to be located close to traffic to support the wires that span across the traffic lanes). Suitable protection of these poles is likely to be difficult, which could result in significant unshielded roadside hazards.	
8.23	The deviation of the light rail tracks from the centre of Anzac Parade to the eastern side of the road is proposed through the signalised intersection at High Street. This arrangement is expected to complicate an otherwise typical intersection, affecting the typical operation of the signal phases, position of vehicle hold lines and pedestrian crossing arrangements. Some of the following issues are likely: • The southbound vehicle hold line is required well in advance of the intersection. This will result in increased left-turn speeds into High Street due to the additional acceleration length (this only applies at the end of the red southbound vehicle phase. Also, the risk doesn't change during the green phase for this intersection for any of the options). The opportunity for eye contact between left-turning motorists and crossing pedestrians is also lost, which puts crossing pedestrians at increased risk of conflict. • Pedestrians crossing from the eastern side of Anzac Parade are likely to wait within the tram reserve before crossing the traffic lanes given the seemingly wide free open tram reserve available when trams are not immediately present. This increases the risk of conflict between pedestrians and trams. • Pedestrians crossing Anzac Parade in either the eastbound or westbound direction may do so against the red man, or when there appears to be a through traffic red light (when southbound traffic is propped at the hold line), but be in conflict with trams during the signal phase where trams are permitted through the intersection. • The southbound traffic lanes will be deviated to the west through the intersection. This required deviation would be difficult to delineate across the tram tracks, with the tram tracks and likely surrounding concrete apron providing a misleading visual cue for southbound motorists. Some vehicles may inadvertently drive along the tram reserve, while others may inadvertently follow a tram that has departed the intersection immediately before the southbound green vehicle phase is given. • The presence of tram tracks within the intersection can result in loss of skid resistance, particularly when the pavement is wet. This will be exacerbated by the increased need for braking that is increased at an intersection.	

University of New South Wales – Proposed Light Rail Platform Stops on Anzac Parade Feasibility Design Stage Road Safety Audit		
Item	Findings	Project team response
8.24	This option limits the possibility of extending the length of the central island platform (for future growth demands) due to the nature of the curved light rail tracks on each approach side of the proposed platform. As patronage increases, waiting numbers of passengers may not be able to be appropriately and safely accommodated.	
8.25	Much of the opposing traffic lanes within the subject length of road will only be separated by a centre dividing line instead of a physical median (i.e. the existing situation). The narrowing of traffic lanes and removal of physical separation is expected to increase the risk of conflict such as head-on and sideswipe.	
8.26	This option involves the unusual arrangement of northbound trams travelling towards and to the left of southbound traffic without a buffer between the approaching trams and southbound traffic lanes. This arrangement is expected to be disconcerting for some motorists and is likely to lead to 'spooking' creating a shy-line effect and encroachment of the right southbound lane (from the left southbound lane).	

University of New South Wales – Proposed Light Rail Platform Stops on Anzac Parade Feasibility Design Stage Road Safety Audit		
Item	Findings	Project team response
Option 6 – Modified Transport for New South Wales proposal with wider platform shifted west		
8.27	The longitudinal edge and face of the island platform will be located immediately adjacent to southbound traffic, and therefore within the 3.0m clear zone for 60km/h. The immediate preceding southbound traffic lanes are skewed on approach to the platform and therefore increase the likelihood of errant vehicle encroachment into the platform. This arrangement would require a longitudinal safety barrier and approach crash cushion to adequately shield traffic from the platform hazard and also protect pedestrians from errant vehicles.	
8.28	Southbound slow lane vehicles are likely to have obstructed sight distance around the curved alignment adjacent to the platform due to the close proximity of pedestrian fencing (and possible safety barrier). Sight distance to the actual signals is expected to be met, however the concern is the likely obstructed sight distance between drivers and pedestrians (and vice versa) that chose to cross against the red man.	
8.29	A tram driver may inadvertently open the doors on the incorrect side especially if abutting tram stops are central island type stops.	
8.30	The final stopping point along these platforms is important. Ideally each stopping tram should stop as close to the relevant pedestrian crossing as possible to encourage crossing pedestrians to utilise the crossing. In reality, during busy times, trams may need to stop at the end of the platform due to the presence of trams ahead. This is expected to increase the likelihood of pedestrians crossing 'mid-block' between the available pedestrian crossings. A fence between the two opposing trams lines could discourage this.	
8.31	Northbound and southbound bus drivers propped in the bus bays (north and south of the pedestrian operated signals respectively) will have difficulty seeing and picking gaps in traffic due to the curved preceding road alignment. This could be mitigated somewhat by the use of the signals, but would only apply when the signals are called-on by pedestrians.	
8.32	It is understood that northbound buses will utilise the central tram tracks south of the pedestrian operated signals before moving across to the kerbside lane and bus stops north of the crossing. While the general principle of this operation (including using the signals as a head-start) is supported in principle, the alignment of the tram tracks/bus lane south of the crossing is in direct line with the southbound fast lane. The directly opposing lane arrangement is undesirable and may 'spook' southbound drivers. This is expected to be exacerbated at night when headlights are on, adding glare. A physical median (denoted in green hatching with planting) may help reduce the spooking and glare effect somewhat.	

University of New South Wales – Proposed Light Rail Platform Stops on Anzac Parade Feasibility Design Stage Road Safety Audit		
Item	Findings	Project team response
8.33	Maintaining the existing signalised pedestrian operated signals is supported, however the following potential safety issues associated with the crossing should be considered for this proposed light rail platform option: • Pedestrians crossing from the eastern side of Anzac Parade are likely to ignore the red man (if a controlled crossing of the tram tracks is applicable in this case) across the tram reserve given the seemingly wide free open tram reserve available when trams are not immediately present. This increases the risk of conflict between pedestrians and trams. • A narrow central median is proposed in this option, which provides some opportunity for a safe refuge. While crossing against a red man can reasonably be expected, the provision of two staged crossing movements and a median refuge lessens the risk. Overall, this proposed arrangement is considered to be of similar risk to the existing narrow 'refuge' available. • The northbound vehicle hold line needs to be positioned well in advance of the pedestrian crossing due to the nature of the bus jump lane. This offset may encourage pedestrians to cross against the red man as they seemingly will have more 'time' to do so, however this increases the likely speed at the conflict point and consequences of impact. • Pedestrians crossing against the red man may use the red vehicle signal aspects as a guide to see if it is 'safe' to cross, unaware that an early start phase may be given to northbound buses from the light rail tracks. This increases the risk of conflict between buses and pedestrians. • The restricted sight lines likely within the southbound slow lane as a result of the adjacent fence and possible safety barrier increases the risk of conflict between vehicles and pedestrians crossing against the red man (the fence will also reduce available sight distance between pedestrians and vehicles).	
8.34	Further to item 8.4, catenary power poles are likely to be located close to adjacent traffic where the tram tracks cross the traffic lanes (i.e. they are likely to be located close to traffic to support the wires that span across the traffic lanes). Suitable protection of these poles is likely to be difficult, which will result in significant unshielded roadside hazards.	
8.35	A section of approximately 100m of the opposing traffic lanes within the subject length of road will only be separated by a centre dividing line instead of a physical median (i.e. the existing situation). The narrowing of traffic lanes and removal of physical separation is expected to increase the risk of conflict such as head-on and sideswipe, particularly near the university walk crossing where the southbound traffic lanes deviate.	

University of New South Wales – Proposed Light Rail Platform Stops on Anzac Parade		
Feasibility Design Stage Road Safety Audit		
Item	Findings	Project team response
8.36	Allowance for pedestrian/tram patron 'lean-back' will need to be allowed for with this option given the close proximity of the western side of the platform to the southbound traffic lane. A buffer and physical separation (e.g. offset fencing) should be provided to ensure pedestrians/tram patrons leaning back on platform railing cannot be struck by passing vehicles, including trucks/buses with protruding side mirrors.	
8.37	The lateral shift of the southbound traffic lanes is abrupt and it is unlikely that vehicles can negotiate the proposed lateral shift at the 60km/h speed. This may be exacerbated for high vehicles and may result in some vehicles leaving their lane and sideswipe conflict.	
8.38	The low radius curves in the tram tracks will require trams to negotiate them at lower speed, increasing travel time and reducing overall level of service.	

University of New South Wales – Proposed Light Rail Platform Stops on Anzac Parade Feasibility Design Stage Road Safety Audit		
Item	Findings	Project team response
Option 7 – Centre platform		
8.39	The longitudinal edge and face of the central island platform will be located approximately 3.5m from adjacent traffic, which is just outside 3.0m clear zone for 60km/h. The immediate preceding traffic lanes are aligned straight and therefore the likelihood of errant vehicle encroachment into the platform is considered low.	
8.40	Maintaining the existing signalised pedestrian operated signals is supported, however the following potential safety issues associated with the crossing should be considered for this proposed light rail platform option: • Pedestrians crossing from the central island of Anzac Parade are likely to wait within the tram reserve before crossing the traffic lanes given the seemingly wide free open tram reserve available when trams are not immediately present. This increases the risk of conflict between pedestrians and trams. • Pedestrians crossing against the red man may use the red vehicle aspects as a guide to see if it is 'safe' to cross, unaware that an early start phase may be given to northbound buses from the light rail tracks. This increases the risk of conflict between buses and pedestrians. • Sight lines between southbound vehicles and pedestrians crossing from the central island to the eastern side of the road are likely to be obstructed by the adjacent fence and therefore increases the risk of conflict between vehicles and pedestrians crossing against the red man. • Southbound tram patrons crossing from the centre platform wishing to access the university will need to cross the southbound traffic lane compared to the other options. Although the crossing is signalised, the additional crossing movement will marginally increase the risk of conflict between vehicles and pedestrians.	
8.41	It understood that the area north of the centre platform between the two light rail tracks may be used as a storage area for pedestrians during high demand. This measure is supported, based on the assumption that this area will be cordoned off using fencing to channel pedestrians between the northern crossing and the proposed tram platform (and the tracks fenced-off), and appropriate ramps provided to the platform. This option has the benefit of extending the platform as demand grows.	

University of New South Wales – Proposed Light Rail Platform Stops on Anzac Parade Feasibility Design Stage Road Safety Audit		
Item	Findings	Project team response
Option 8 – Side platforms		
8.42	The longitudinal edge and face of the kerbside platforms will be located approximately 3.5m from adjacent traffic, which is just outside the 3.0m clear zone for 60km/h. The immediate preceding traffic lanes are aligned straight and therefore the likelihood of errant vehicle encroachment into the platform is considered low.	
8.43	A tram driver may inadvertently open the doors on the incorrect side especially if abutting tram stops are central island type stops.	
8.44	Sight lines to the south of the driveway/road access located on the western side of Anzac Parade (immediately south of the NIDA building) will be obstructed by trams and/or the adjacent tram platform. While it is appreciated that this driveway/road may only be used infrequently for deliveries, it may need to be closed and a suitable alternative provided.	
8.45	The northbound bus stop cannot be accommodated close to the main university mall access due to the proposed tram platform arrangement. Connectivity and level of service will be reduced as a result.	
8.46	Northbound and southbound bus drivers propped in the bus bays (north and south of the pedestrian operated signals respectively) will have difficulty picking gaps in traffic due to the curved preceding road alignment.	
8.47	It is understood that northbound buses will utilise the central tram tracks south of the pedestrian operated signals before moving across to the kerbside lane and bus stops north of the crossing. While the general principle of this operation (including using the signals as a head-start) is supported in principle, the alignment of the tram tracks/bus lane south of the crossing is in direct line with the southbound fast lane. The directly opposing lane arrangement is undesirable and may 'spook' southbound drivers. This is expected to be exacerbated at night when headlights are on, adding glare. A physical median (denoted in green hatching with planting) may help reduce the spooking and glare effect somewhat.	

University of New South Wales – Proposed Light Rail Platform Stops on Anzac Parade Feasibility Design Stage Road Safety Audit		
Item	Findings	Project team response
8.48	Maintaining the existing signalised pedestrian operated signals is supported, however the following potential safety issues associated with the crossing should be considered for this proposed light rail platform option: • Pedestrians crossing from the either side of Anzac Parade are likely to wait within the tram reserve before crossing the traffic lanes given the seemingly wide free open tram reserve available when trams are not immediately present. This increases the risk of conflict between pedestrians and trams. • The northbound vehicle hold line needs to be positioned well in advance of the pedestrian crossing due to the nature of the light rail track alignment and bus jump lane. This offset may encourage pedestrians to cross against the red man as they seemingly will have more 'time' to do so, however this increases the likely speed at the conflict point and consequences of impact. • The northbound tram tracks cross the northbound traffic lanes in advance of and through the signalised pedestrian crossing. This is expected to result in reduced pavement skid resistance and possible overshooting of the pedestrian crossing (by northbound vehicles), increasing the likelihood of conflict between northbound vehicles and crossing pedestrians. • A narrow central median is proposed in this option, which provides some opportunity for a safe refuge. While crossing against a red man can reasonably be expected, the provision of two staged crossing movements and a median refuge lessens the risk. Overall, this proposed arrangement is considered to be of similar risk to the existing narrow 'refuge' available. • Pedestrians crossing against the red man may use the red vehicle aspects as a guide to see if it is 'safe' to cross, unaware that an early start phase may be given to northbound buses from the light rail tracks. This increases the risk of conflict between buses and pedestrians.	
8.49	Further to item 8.4, catenary power poles are likely to be located close to adjacent traffic where the tram tracks cross the traffic lanes (i.e. they are likely to be located close to traffic to support the wires that span across the traffic lanes). Also, additional kerbside poles (a row for each direction) will be required where the tracks are located adjacent to the platforms. These poles are likely to be just within the clear zone. Suitable protection of these poles is likely to be difficult, which will result in significant unshielded roadside hazards.	
8.50	The low radius curves in the tram tracks will require trams to negotiate them at lower speed, increasing travel time and reducing overall level of service.	

University of New South Wales – Proposed Light Rail Platform Stops on Anzac Parade Feasibility Design Stage Road Safety Audit		
Item	Findings	Project team response
Preferred option from a road safety perspective		
8.51	The key considerations in providing safe light rail platforms at the subject site includes avoiding/limiting potential conflict for all road users, and where this cannot be avoided, ensuring that consequences of potential conflict are minimised. Other important considerations include providing a road environment that: • Is simple, obvious, expected and predictable; • Is free of physical obstructions and is forgiving; • Provides logical connectivity; • Provides direct pedestrian access; and, • Caters for all expected user groups including cyclists and vulnerable/disabled pedestrians. Option 7 - Centre Platform is the preferred platform arrangement out of the four options considered, mainly due to the lowest likely conflict points. The proposed arrangement of option 7 is by the far the safest option from a road safety perspective and each of the other three options are considered very much the same in terms of likely conflict. The design of option 7 is simple and consistent with the likely arrangement of much of the abutting tram network (running within the median). It also: • Is logical and simple. It does not require multiple deviations of the tram tracks and therefore limits potential interaction and therefore conflict between trams and other road users. • It is separate from the roadway and provides the most offset between opposing directions of traffic. • Avoids the need for low radius horizontal curves along the traffic lanes and tram reserve (i.e. is a mostly straight alignment and the need to deviate around curves does not complicate the driving task). • Avoids the need for road users, in particular two-wheeled vehicles to cross the tram tracks. • Due to no crossing of the tram and traffic lanes, there will be fewer delays to both trams and road users. • It enables complete segregation between the tram reserve and likely pedestrian areas. The use of fencing along the tram reserve will physically corral pedestrians to designated crossing points, which are fully controlled (and avoid ambiguous right-of-way confusion between trams and pedestrians often associated with uncontrolled crossings). • It enables staged crossing movements to be performed by pedestrians that choose to	

	cross against a red man (which can reasonably be expected to occur at any signalised crossing), a safer alternative to the other options that either have no central median, or a narrow median. • It enables the installation of a single row of catenary power poles between the two tram tracks, outside the clear zone of adjacent traffic, and therefore limits the risk associated with this necessary tram infrastructure. • Has the option of expanding the platform waiting area within the central median as demand grows. • Enables close connectivity of adjacent bus stops. • Allows a straight alignment and therefore good visibility for egressing bus drivers is expected. • Provides the possibility of facilitating kerbside parking (with a single through lane of adjacent traffic) during off-peak periods. • Centre island platforms are particularly suited to locations where patronage tends to peak in one direction (such as at the university). • Can be implemented in conjunction with a reduced speed limit of 40km/h to further reduce risk and consequences of conflict. A centre platform arrangement has been in operation for several years at one of Melbourne's busiest transport hubs, Flinders Street at Swanston Street. At this location, a centre platform caters for very high volumes of tram patrons; linking to the busy Flinders Street train station and central tram route along Swanston Street (which provides the main tram access to the northern and southern suburbs of Melbourne). This central island platform arrangement has been a success largely due to the separation provided between trams and adjacent traffic and the provision of fencing between the tram reserve and adjacent traffic lanes which forces pedestrians to access the tram platform from the fully controlled signalised crossing at each end of the platform.	
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View east along Flinders Street – Eastbound carriageway (double traffic lane)



View west along Flinders Street – Westbound carriageway (single traffic lane)

The Flinders Street arrangement is much preferred over other arrangements that involve complex deviations of the tram tracks (e.g. from the centre of the road to the kerbside and vice versa) and multiple potential conflict points. A perfect example is that along Harbour Esplanade at the Docklands precinct (Melbourne). The tram reserve was previously located on the western side of

	Harbour Esplanade adjacent to a shared use path and pedestrian footpath. Delineation and segregation of the tram reserve at this location was difficult and resulted in a mixture of pedestrians and bicyclists utilising the tram reserve. It also resulted in a reduced level of service for both tram patrons and other road users along this roadway because of the required tram reserve crossovers (with the traffic lanes). The potential for conflict and reduced level of service was duly recognised and the kerbside arrangement was recently changed to a central tram reserve arrangement, albeit with side platforms (within the central median).	
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Project team response undertaken by:

Name.....Signed.....Date.....

9. Audit conclusion

This road safety audit has attempted to balance the safety needs of all road users within the site/design constraints. It is the intention that all audit recommendations are realistic and feasible and commensurate with the actual risk posed.

A handwritten signature in black ink, appearing to read 'D Vella'.

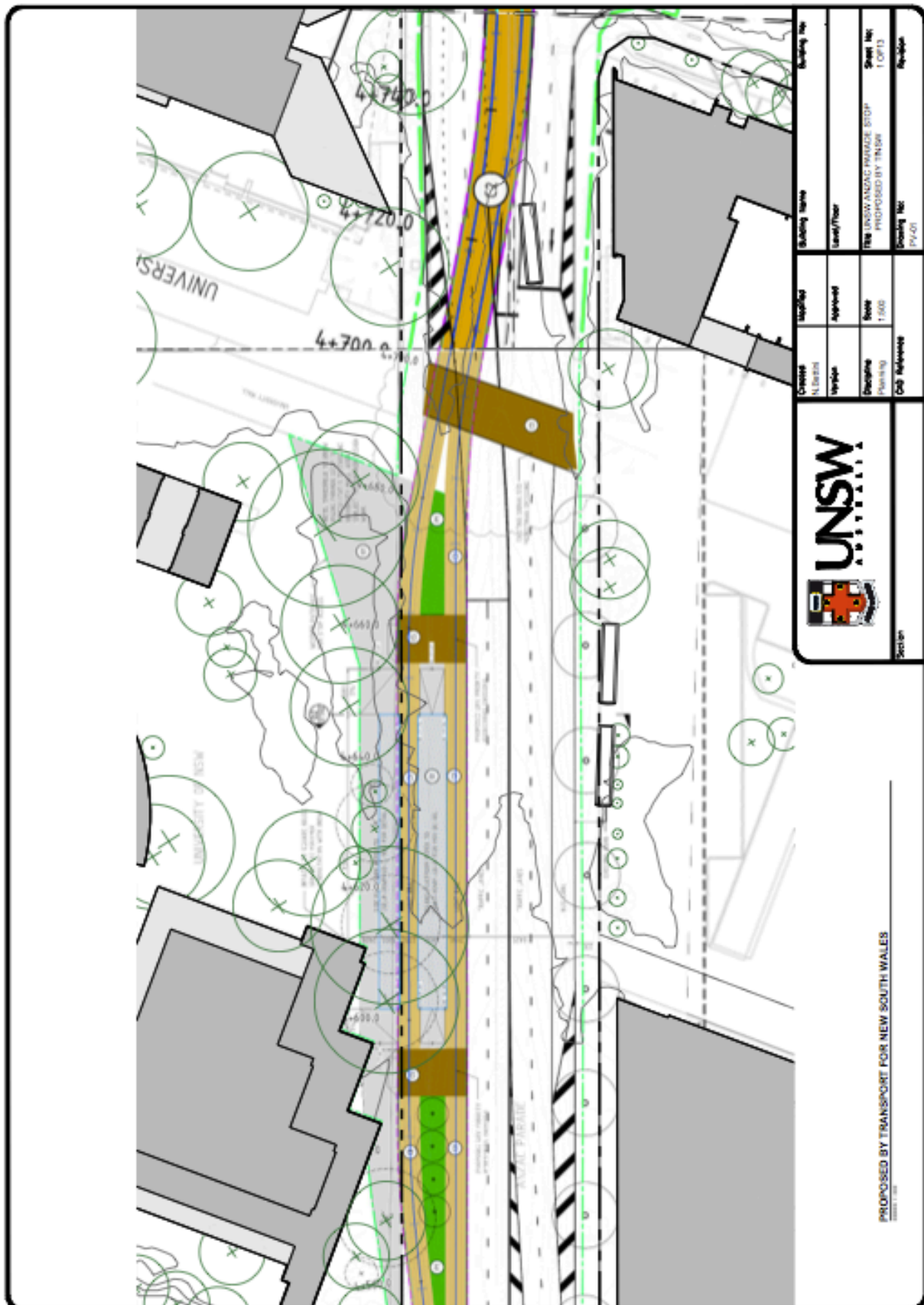
Darren Vella [BEng Civil (Hons), Director]
Accredited Senior Road Safety Auditor

and;

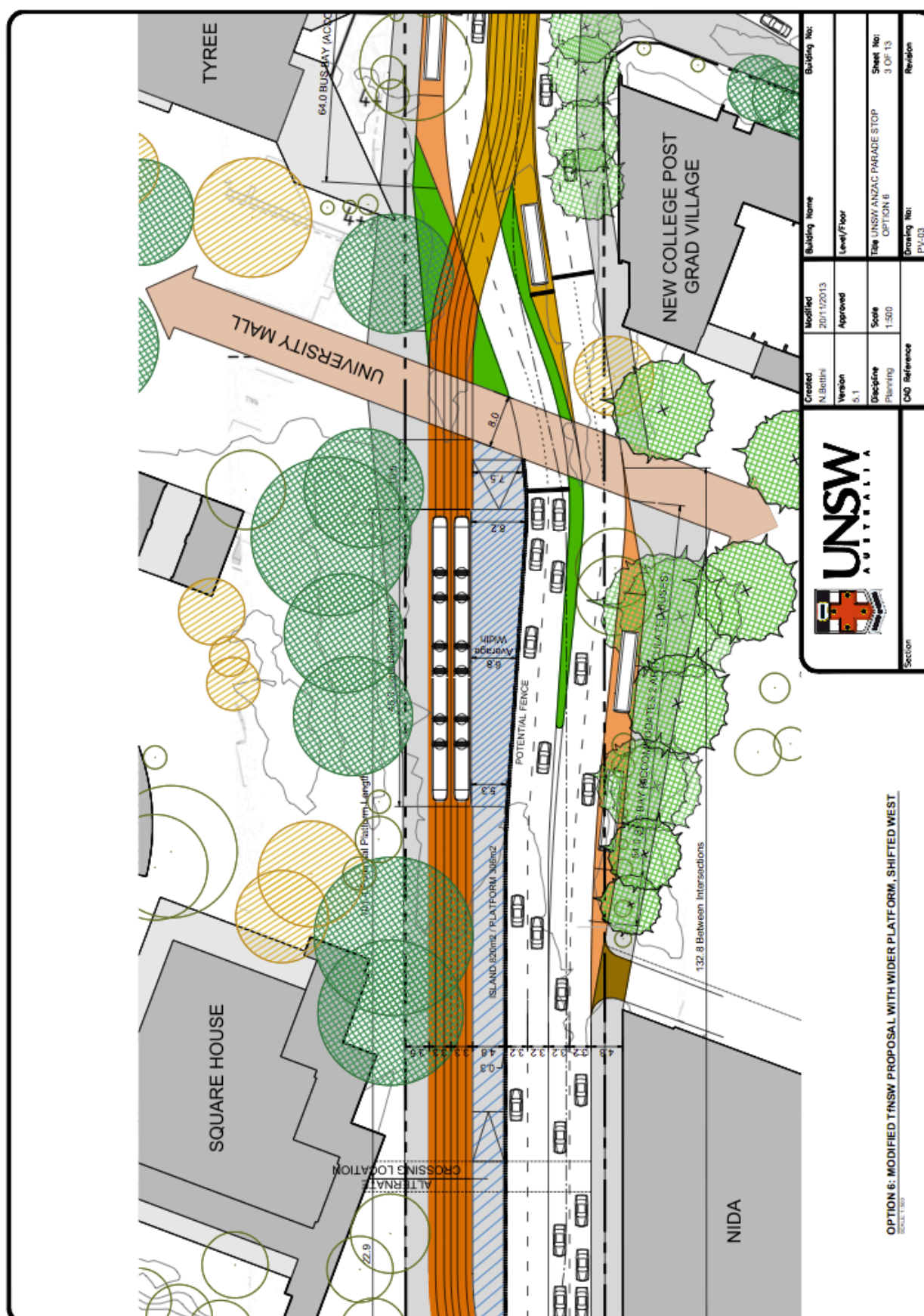
A handwritten signature in black ink, appearing to read 'Simon Penca'.

Simon Penca [BEng Civil (Hons), Director]
Accredited Senior Road Safety Auditor

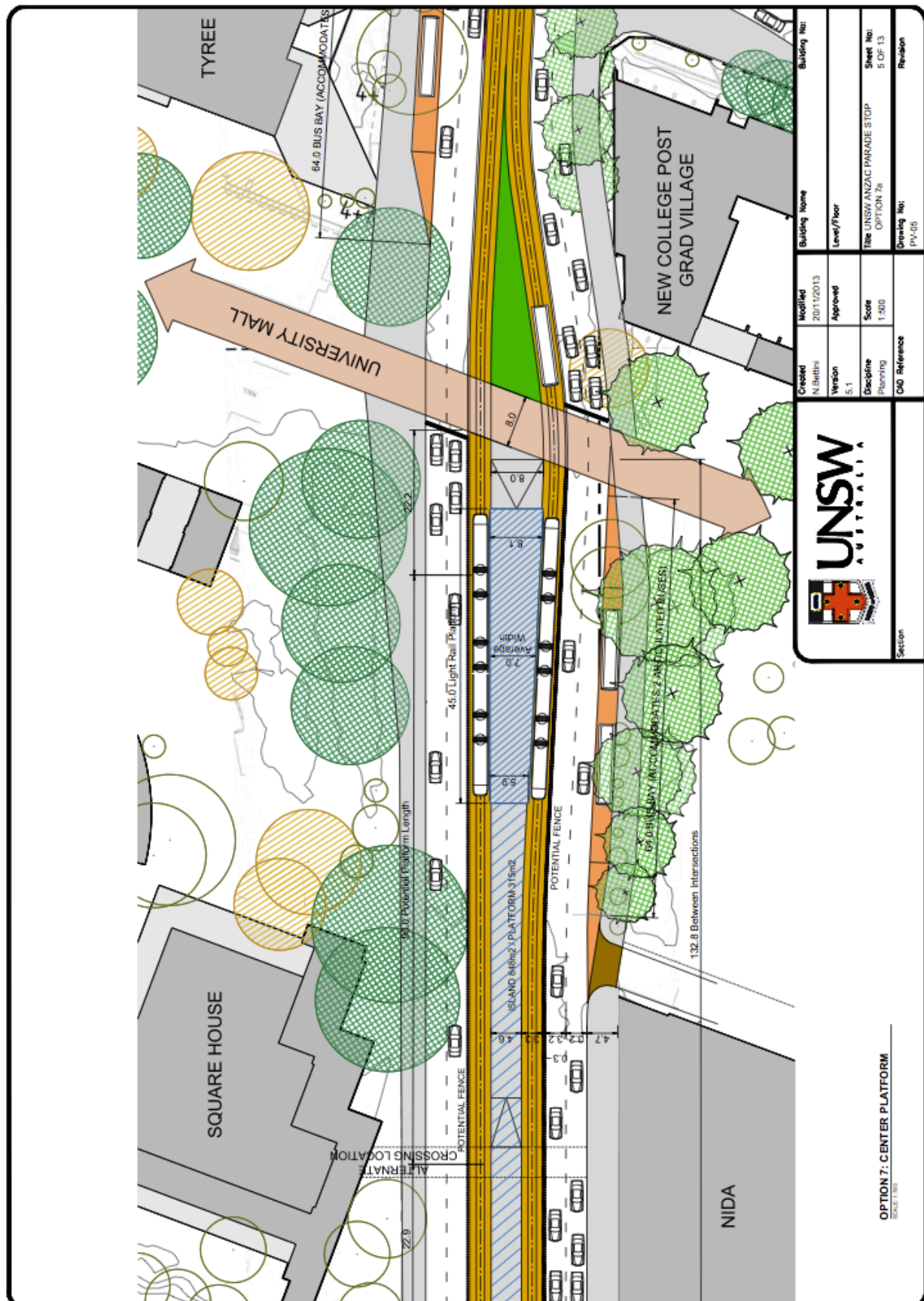
10. Appendix A1: Transport for NSW option



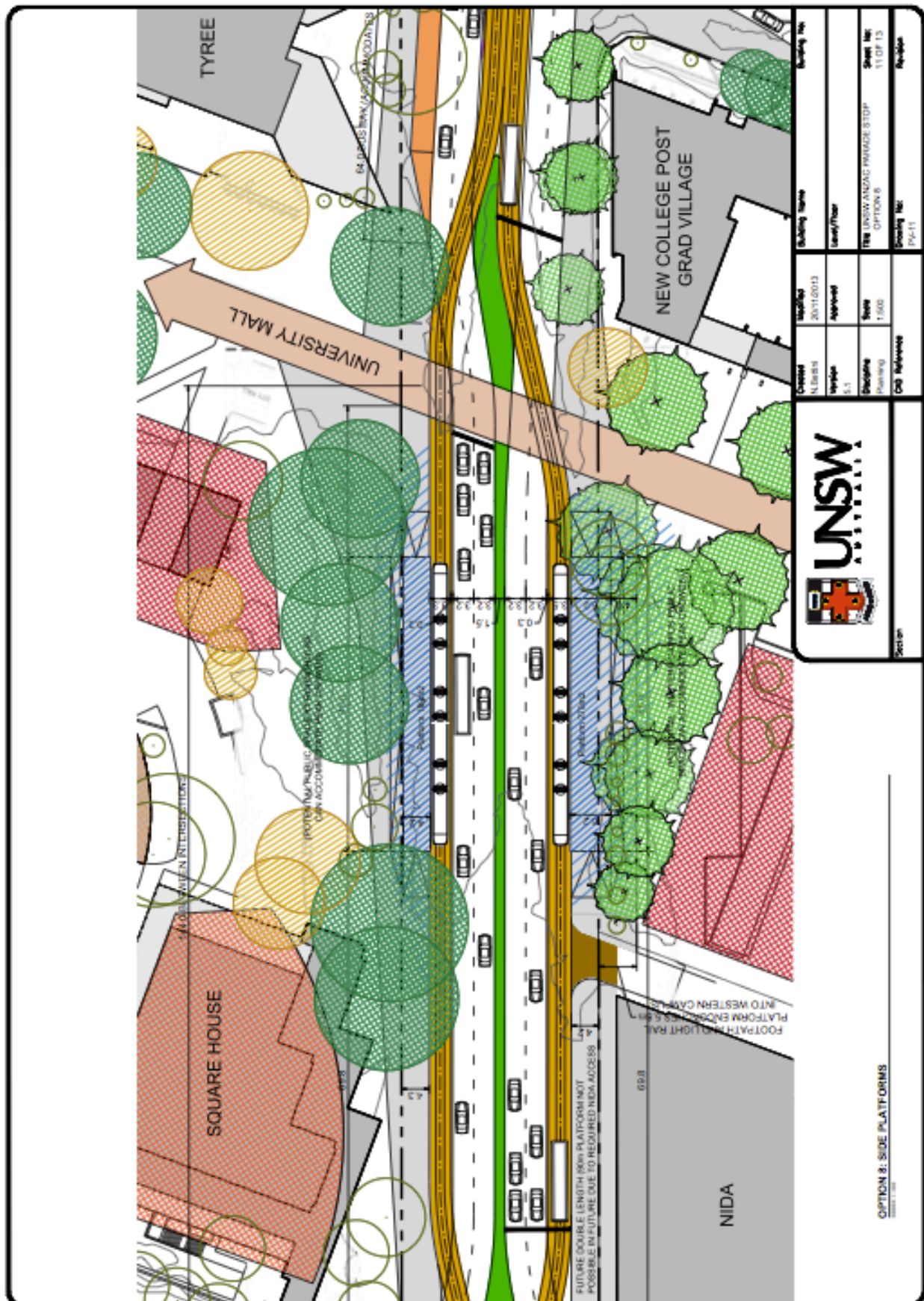
11. Appendix A2: Option 6 – Modified Transport for NSW proposal



12. Appendix A3: Option 7 – Centre platform



13. Appendix A4: Option 8 – Side platforms



University of New South Wales

Proposed Light Rail Platform Stops on Wansey Road

Feasibility Design Stage Road Safety Audit



Project Ref: TS-13-RSA-0625B
Prepared for: University of New South Wales
Date: 5th December 2013

2013

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Document control

Project Ref	Date	Revision	Author	Reviewer
TS-13-RSA-0625B.docx	5 December 2013	B	Darren Vella	Simon Penca

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1. Introduction

Transafe has been engaged by the University of New South Wales to undertake a feasibility design stage road safety audit of the proposed light rail platform stops on Wansey Road, at the University of New South Wales in Kensington.

This audit was conducted by:

Darren Vella [BEng Civil (Hons), Director]

RMS Accredited (Level 3) Senior Road Safety Auditor (Auditor ID: RSA-03-0530)

and;

Simon Penca [BEng Civil (Hons), Director]

RMS Accredited (Level 3) Senior Road Safety Auditor (Auditor ID: RSA-03-0531)

The auditors have had no involvement in the design or development of the subject site being audited.

2. Road safety audit process

A road safety audit is a formal examination of an existing or future road or traffic project in which an independent, qualified team reports on the projects crash potential and safety performance (Austroads 2009). This road safety audit has been carried out in accordance with the Austroads Guide to Road Safety Part 6: Road Safety Audit (2009) with reference to relevant standards and guides, and draws on industry practice and experience to identify potential road safety audit findings. However, no guarantee is made that every deficiency has been identified.

3. Responding to this audit

As set out in the road safety audit guidelines, responsibility for the road safety audit always rests with the project team and not the auditor. The project team is under no obligation to accept or agree with all of the audit findings. Also, it is not the role of the auditor to agree to or approve the project teams response to the audit. This audit report should be responded to in writing including reasons for rejection of an audit finding. Acceptance of all findings of this report would not guarantee that every potential road safety issue has been addressed, rather adoption of the audit findings should improve the level of safety of the subject site.



Photo P1 – High Street/Wansey Road intersection, view north from east side of intersection



Photo P2 – High Street/Wansey Road intersection, view north from west side of intersection



Photo P3 – High Street/Wansey Road intersection, view east from south side of intersection



Photo P4 – High Street/Wansey Road intersection, view west from south side of intersection

5. Proposed works and scope of the audit

As part of new Sydney Light Rail network, light rail tram platforms are proposed on Wansey Road, immediately north of the intersection with High Street, adjacent to the University of New South Wales. At the completion of the project and allowing for a steady growth in population and shift to public transport, on a typical semesters day the Wansey Road light rail platforms are expected to cater for approximately 10,000 arrivals and 7,000 departures, with arrival peaks in the order of 1,100-1200 (15mins) and departure peaks in the order of 600-700 (15mins). To cater for such demand, three proposed light rail platform options are being considered as follows:

- Transport for NSW option: Involves the central light rail tracks along High Street deviating to the western side of Wansey Road through the intersection of Wansey Road / High Street. Side platforms are proposed to west of Wansey Road - a two-way, two-lane roadway, with proposed signals at the intersection of Wansey Road / High Street), and a zebra crossing across Wansey Road. Refer to Appendix A1.
- Option 3 – Modified Transport for NSW proposal: This option is similar to the previous option, with the exception that on-street parking will be provided on the eastern side of Wansey Road (indented), platforms will be wider, and a dedicated bicycle path provided on the far western side of Wansey Road (west of the light rail platforms and pedestrian area). There is also provision in this option for Gate 9 to be relocated to the intersection of Wansey Road / High Street to form a fourth leg. Refer to Appendix A2.
- Option 7 – Centre Platform: This option is essentially the same as option 3 (in terms of the overall positioning of the tracks and arrangement of the traffic and parking lanes on Wansey Road), with the exception that a central light rail platform stop is proposed for both directions of travel. There is also provision in this option for a scramble pedestrian crossing to be incorporated into the intersection signals (at the Wansey Road / High Street intersection). Refer to Appendix A3.

The scope of this road safety audit is to review the proposed options and identify potential safety deficiencies relating to the infrastructure changes with respect to all road users including vehicles, buses, light rail, pedestrians and cyclists, with a recommendation on the preferred option from a safety perspective to be provided.

This audit does not include an assessment of the existing conditions at the subject site. It also does not include an assessment of the proposed light rail arrangement along High Street, outside of the intersection with Wansey Road, nor does it include an assessment of the intersection with Arthur Street and Botany Street. Although this audit may cover lighting pole locations, this is not a formal lighting luminance assessment. Similarly, this audit may cover pedestrian accessibility, however this is not a formal DDA assessment.

6. Crash statistics

Limited details of known crashes are available at the subject site. Nonetheless, the crash history at the subject site is not expected to influence the findings of this audit at this early feasibility design stage assessment.

7. Documents used to facilitate audit

The following information / drawings were used to facilitate the audit:

- UNSW High Street Stop Proposed by TfNSW, Drawing No: PV-01 Sheet 1 of 13 Version 6.2 and PV-07 Sheet 7 of 13 Version 6.3, Created: N. Bettini;
- UNSW High Street Stop Option 3, Drawing No: PV-02 Sheet 2 of 13 Version 6.3 and PV-08 Sheet 8 of 13 Version 6.3, Created: N. Bettini;
- UNSW High Street Stop Option 7, Drawing No: PV-05 Sheet 5 of 13 Version 6.3 and PV-11 Sheet 11 of 13 Version 6.3, Created: N. Bettini;
- Site photos (taken 1/10/13) and background information including nature of the road environment, abutting development, pedestrian behaviour, and available transport links: Provided by Anthony Coyle – Senior Associate at TraffixGroup;
- UNSW Future Circulation Structure, Drawing No: -- Sheet 1 of 3, Created: N. Bettini;
- UNSW Significant Trees, Drawing No: -- Sheet 2 of 3, Created: N. Bettini;
- UNSW Potential Future Development, Drawing No: -- Sheet 3 of 3, Created: N. Bettini;
- UNSW Daily Student and Staff Movements: Departures 2013 (Monday-Thursday);
- UNSW Daily Student and Staff Movements: Arrivals 2013 (Monday-Thursday); and,
- Fig 1a, Ridership Projections 2020, Revision 2, 14 November 2013.

8. Audit findings

The findings of the road safety audit are detailed on the following pages. A response from the project team should be inserted into the relevant columns. Responses to audit findings are generally not required by the auditors; rather a record should be kept for reasons of adoption or rejection of the findings for future reference by the project team.

Audit findings table

University of New South Wales – Proposed Light Rail Platform Stops on Wansey Road Feasibility Design Stage Road Safety Audit		
Item	Findings	Project team response
General		
8.1	Specific design parameters such as horizontal geometry, signs and line marking, etc are unknown at this early design stage and therefore have not been audited as part of this assessment. It is assumed that such design parameters will be accommodated in accordance with Austroads and RMS standards.	
8.2	Ideally, poles and other objects should be set back from the road. Each of the proposed options require realignment of adjacent traffic lanes along High Street and Wansey Road, which could result in traffic being deviated and ultimately located closer to existing fixed hazards such as power poles and trees. It is acknowledged that there is an existing risk associated with collisions into parked vehicles in the kerbside lane, and the severity of a crash into the new hazards rather than the existing parked cars is difficult to quantify, however, while the change in alignment and narrowing of lanes would typically be expected to increase the likelihood of crashes overall, the proposed change in the immediate road environment (overall) is expected to result in lower operating speeds and a lower likelihood of crashes. Ideally no pole (or any other roadside hazard) should be placed within the clear zone. In practice, this is difficult to achieve, particularly in urban areas. A clear zone of 3.0m is applicable for a posted speed limit of 60km/h, less for speeds less than 60km/h (i.e. 2m clear zone would be applicable at 40km/h).	
8.3	The inherent nature of the raised tram platforms presents possible roadside hazards. Ideally, the approach end of raised tram platforms should be shielded and the longitudinal side of a tram platform should also be considered for shielding (depending on the stop use, patronage, type, location, clear zone offset etc). High profile barrier kerbs/omni stop bollards can be considered for this purpose in low speed environments (i.e. less than 60km/h), instead of crash cushions and safety barriers.	

University of New South Wales – Proposed Light Rail Platform Stops on Wansey Road Feasibility Design Stage Road Safety Audit		
Item	Findings	Project team response
8.4	Catenary poles will be required to provide power to trams. Where possible, the location of these poles should be provided in between the opposing tram tracks to reduce the number of poles required (i.e. try and avoid the use of a line of poles on each side of the road, effectively doubling the required number of poles), and maximise the offset of these poles to adjacent traffic (i.e. the tram reserve effectively provides a 'buffer'). Ideally, all new catenary poles should be positioned outside the clear zone as they are considered significant roadside hazards.	
8.5	Further to item 8.4, catenary poles are likely to be located close to adjacent traffic at the intersection of Wansey Road and High Street in order to support overhead wires that span the relatively large area of the intersection. Areas of particular concern at this intersection include the northeast and southwest corners of the intersection where eastbound and westbound vehicles will be required to deviate through the intersection. Poles at these corners would be undesirable as they will be located within the expected errant vehicle departure paths should a motorists fail to negotiate the deviation. Suitable protection of these poles is likely to be difficult, which could result in significant unshielded roadside hazards.	
8.6	The use of fencing at each of the proposed new stops options to encourage particular pedestrian routes is supported in principle. Fencing should also be considered to act as a physical obstruction should a tram driver open the incorrect side tram doors (and physically restrain tram patrons and prevent them stepping out into traffic or the other tram track). Any fencing located within the clear zone should be crashworthy (i.e. no horizontal members). Typical roadside fencing such as weldmesh is considered appropriate.	
8.7	Given the nature of the abutting development and very high volumes of pedestrians expected to be in the vicinity of Wansey Road and High Street traffic, consideration should be given to implementing a fulltime 40km/h speed limit along the subject lengths of Wansey Road and High Street to lessen the severity of possible conflict between vehicles/trams and pedestrians and cyclists. 40km/h is considered a minimum for the works proposed given the resulting road environment. Much lower speeds (e.g. 10km/h) would be adopted in a shared zone.	

University of New South Wales – Proposed Light Rail Platform Stops on Wansey Road Feasibility Design Stage Road Safety Audit		
Item	Findings	Project team response
8.8	The longitudinal step-up/down from the platforms to the tram tracks is a potential pedestrian hazard. Pedestrians can reasonably be expected to take shortcuts directly from the platforms to their desired destination and between platforms. This hazard cannot be effectively addressed given the need to maintain access between the platforms and trams, however its presence can be highlighted using adequate delineation. Appropriate devices such as signage, line marking, pavement marking, and fencing should be considered to highlight the ramps and step-down (in addition to tactile ground surface indicators for DDA compliance).	
8.9	Specific details of proposed bus infrastructure along High Street in close proximity to Wansey Road is unclear. It is understood that some buses will continue to operate along High Street (with trams expected to replace the majority of buses). Where bus patrons are expected to use the proposed trams as a connecting form of transport, ensure proposed bus stops are appropriately positioned (i.e. in close proximity to facilities, connecting tram platforms, pathways for passengers between connecting facilities and trams, etc). It is also important that bus stops are appropriately positioned to provide bus drivers appropriate sight lines when entering back into the traffic stream.	
8.10	It is understood that the right-turn vehicle movement from High Street into Wansey Road will be prohibited for each of the proposed options. This measure is supported, as it will help simplify the intersection, reduce the number of likely tram/vehicle/pedestrian conflicts and reduce likely delays at the intersection.	
8.11	It is understood that the signals at the intersection of Wansey Road and High Street for option 7 are likely to include a scramble type crossing where each leg of the intersection is required to yield to all crossing pedestrians. Crossing pedestrians are permitted to cross perpendicular or diagonal. The provision of a scramble type crossing is strongly supported and should ideally be incorporated into either option at this location given the expected number of pedestrians and nature of the intersection. A standard signalised crossing arrangement at this location is likely to operate as a defacto scramble crossing with the risk of conflict to those pedestrians not specifically permitted to cross during a particular phase. Furthermore, any proposed scramble type crossing would need to give due consideration to disabled and vision impaired users. Vision impaired and physically impaired pedestrians would cross perpendicular to the crossing as directed by tactile ground surface indicators. TGSIs would need to be designed and positioned to direct such pedestrians across the crossings via the shortest distance (across the roadway), but not necessarily the shortest overall route. Able-body pedestrians would be free to cross anywhere within the scramble crossing (i.e. the shortest route, but not necessarily the shortest distance across the roadway).	

University of New South Wales – Proposed Light Rail Platform Stops on Wansey Road Feasibility Design Stage Road Safety Audit		
Item	Findings	Project team response
8.12	Planting areas are proposed for each option. Ensure only low, non-hazardous vegetation is provided. Vegetation should not obstruct motorist and pedestrian sight lines around the corners at the intersection.	
8.13	It appears likely that larger eastbound vehicles that turn left into Wansey Road will encroach upon the opposing traffic lane. Expected vehicle turning movements should be checked to ensure this does not occur. It is also important that the left rear of the turning vehicle cannot mount the pedestrian crossing located on the north western corner of the intersection (at the southern end of the tram platforms), where pedestrians may be waiting to cross.	
8.14	Special attention is required when developing either option to ensure the widths of the pedestrian crossings and signalised crossing times are adequate to accommodate the peak pedestrian platoons (e.g. morning and afternoon weekdays). Narrow crossings (with fencing that creates a bottleneck) can result in 'bunching', and short crossing phases can result in pedestrians being stranded on the roadway and /or tram reserve during high pedestrian demand times. Option 7 provides shorter pedestrian crossings at the Wansey Road / High Street intersection, and a greater island storage area between the tram tracks (north side of the intersection). Such features are important to reduce the likelihood of pedestrian conflict.	
8.15	It is understood that Wansey Road may ultimately become a shared zone for pedestrians, trams and vehicles. Careful consideration needs to be given to how the interim arrangement could be adapted to a shared zone in the future. Specific considerations such as providing a sense of equality for all users by removing kerb and other level differences is one important consideration for effective shared zones, however this may be difficult to achieve with the provision of trams and need to provide at-grade access to the trams.	
8.16	Several vehicle movements through the intersection of Wansey Road and High Street require vehicles to cross the tram tracks. Also, east-west movements require a deviation through the intersection (an existing condition). This required deviation would be difficult to delineate across the tram tracks, with the tram tracks and likely surrounding concrete apron providing a misleading visual cue for eastbound motorists. Some vehicles may inadvertently drive along the tram reserve. Also, the presence of tram tracks within the intersection can result in loss of skid resistance, particularly when the pavement is wet. This will be exacerbated by the need for braking, which is increased at an intersection. Appropriate delineation devices such as signage, line marking and pavement marking, raised reflective pavement markers and flexible paddles/bollards should be considered to highlight the necessary traffic paths.	

University of New South Wales – Proposed Light Rail Platform Stops on Wansey Road Feasibility Design Stage Road Safety Audit		
Item	Findings	Project team response
8.17	Further to the previous item, bicyclists and motorcyclists are particularly vulnerable when crossing tram tracks as their wheels can be caught or redirected by the tracks. This should be avoided as much as possible and crossing points should desirably be closer to perpendicular.	
8.18	It is understood that a bicycle lane may be provided on the west side of Wansey Road for each option to cater for north-south bicycle movements. While this is supported in principle, it is also understood that as part of the overall long-term arrangement, cyclists will be encouraged to use Botany Street as the north-south route. This provision of a suitable alternative away from the tram platforms and potential conflict with trams and pedestrians is supported and preferred.	
8.19	It is understood that a 'G' turn is proposed to accommodate eastbound motorists that wish to turn right from High Street into Botany Street. This is planned by requiring such motorists to turn left into Wansey Road, then right into Arthur Street and then right into Botany Street to travel south. A number of potential issues associated with this proposal require further consideration: • This may exacerbate the issue raised in item 8.13. • This movement will be very difficult to sign / advise eastbound motorists wishing to travel south at Botany Street. Its likely that such motorists will not realise that the right turn is not permitted until they reach the Botany Street / High Street intersection. • The overall 'G' turn movement will direct additional traffic along Wansey Road, which is undesirable and increases overall potential for conflict with pedestrians and tram patrons at the adjacent tram platforms. • Further to the previous item, the 'G' turn would require two additional right-turns (compared to the one at Botany Street). This increases overall risk of motorist conflict (motorist versus motorist) and pedestrian conflict (motorist versus pedestrians).	

University of New South Wales – Proposed Light Rail Platform Stops on Wansey Road Feasibility Design Stage Road Safety Audit		
Item	Findings	Project team response
Option proposed by Transport for New South Wales & Option 3 – Modified Transport for New South Wales proposal		
8.20	<i>The option proposed by Transport for New South Wales and Option 3 (modified Transport for New South Wales proposal) are essentially the same. Option 3 provides more detail and has an improved crossing arrangement (i.e. use of kerb outstands), provision for a bicycle path, and wider platforms for pedestrian manoeuvrability / storage. The following comments made for this proposed arrangement apply to both the original option and option 3.</i>	
8.21	The longitudinal edge and face of the island platform will be located immediately adjacent to southbound traffic, and therefore within the clear zone. The immediate preceding northbound traffic lanes are essentially aligned straight and operating speeds at this location are expected to be very low. Nonetheless, there is still a risk of an errant vehicle encroaching the platform due to no offset / buffer being provided. This arrangement would require a longitudinal and approach protection of the tram platform to adequately shield traffic from the platform hazard and also protect pedestrians from errant vehicles. The use of high-profile barrier kerb and omni-stop bollards could be explored instead of crash cushions and safety barrier given the low operating speeds expected at this location.	
8.22	Potential pedestrian/tram patron 'lean-back' will need to be allowed for with this option given the close proximity of the eastern side of the platform to the northbound traffic lane. A buffer and physical separation (e.g. offset fencing) should be provided to ensure pedestrians/tram patrons leaning back on platform railing cannot be struck by passing vehicles, including larger vehicles with protruding side mirrors.	
8.23	A tram driver may inadvertently open the doors on the incorrect side especially if abutting tram stops are central island type stops.	
8.24	The east-west crossing of Wansey Road at the northern end of the platforms is to consist of a zebra crossing across the traffic lanes and a signalised crossing over the tram tracks, while the southern end will consist of a fully controlled signalised crossing. The following potential safety issues associated with these crossings should be considered: The zebra crossing is proposed further north of the signalised crossing over the tram tracks. This will result in a 'reverse-maze' arrangement where pedestrians crossing from east to west between the zebra crossing and tram tracks will be diverted south and have their back to trams approaching from the north (the most immediate potential conflict). A similar issue results for pedestrians travelling north to the tram crossing at the northern end of the platform. All such maze type crossings should be aligned so that crossing pedestrians face the immediate adjacent potential conflict / approaching trams / traffic. It appears possible in this case to shift the zebra crossing further south of the signalised crossing of the tram tracks.	

University of New South Wales – Proposed Light Rail Platform Stops on Wansey Road Feasibility Design Stage Road Safety Audit		
Item	Findings	Project team response
	- The inconsistent crossing types in close proximity are undesirable. Pedestrians crossing the tram tracks on a green man may unwittingly assume they have complete right-of-way across the zebra crossing, however zebra crossings require pedestrians to be alert and not assume all vehicles will see them / give-way. - While fully controlled signalised crossings of tram tracks are supported in principle, ideally they should always display the green crossing man phase and only change to the red man when a tram is approaching (applicable to the northern end crossing only). Having the crossing operate like a typical pedestrian crossing (i.e. red man displayed until activated by a pedestrian) is likely to result in non-compliance. - Northbound trams approaching the signalised crossing should be given the green tram phase when departing the tram stop and not be required to stop at the crossing and partially at the tram platform (similar principle should be applied to southbound trams approaching the Wansey Road / High Street intersection signals). - The central island located at the southern end of the southbound tram platform is relatively narrow and may be used as a refuge for pedestrians crossing from the east to the west (and vice versa) against a red man. This increases the potential for pedestrian and tram conflict, as well as pedestrians potentially being stranded on the roadway during a green vehicle phase. When the signals at the southern end of platforms (at the intersection) display a red man for the east-west crossing phase, some pedestrians may choose to continue north along Wansey Road and cross Wansey Road mid-block between parked vehicles. This increases the risk of conflict between crossing pedestrians and vehicles on Wansey Road	
8.25	A dedicated off-road north-south bicycle path is proposed on the western side of Wansey Road / the proposed tram platforms. The provision of such an asset is supported in principle however the following potential issues associated with this proposed arrangement should be considered: - It may be difficult to segregate pedestrians and bicyclists along the bike path and immediately adjacent to it. Pavement marking and signage are often ineffective. This could result in pedestrians encroaching the bicycle path and result in conflict between pedestrians and cyclists. - Providing a suitable intersection at the southern end of the bicycle path and the perpendicular pedestrian footpath will be difficult. Potential conflict is likely at this intersection (of the bicycle path and pedestrian path). Either the pedestrians or the cyclists will be required to give-way and this will be difficult to make obvious, mark, and sign. Furthermore, compliance to such give-way requirements is likely to be poor.	

University of New South Wales – Proposed Light Rail Platform Stops on Wansey Road Feasibility Design Stage Road Safety Audit		
Item	Findings	Project team response
	- There is no continuity of the bicycle path at the southern end and details of a suitable north south crossing to cater for cyclists have not been provided. Ideally a separate pedestrian / cyclist crossing should be provided, however as previously mentioned, it would be difficult to restrict the crossing to cyclists and not pedestrians. - Sight lines between southbound cyclists and pedestrians using the east-east footpath immediately at the southern end of the bicycle path are likely to be restricted by the adjacent Randwick Racecourse property (even with the small splay provided as shown).	
8.26	Gate 9 is proposed to be relocated to the signalised intersection of Wansey Road and High Street to create a fourth leg, and permit all movements into and out of Gate 9. While it is appreciated that this access road is expected to only cater for low volumes (i.e. deliveries etc), it is preferred that this access remain in its current location away from the signals. Allowing a fourth leg and all turn movements (from the fourth leg) will increase potential for conflict at the intersection where pedestrians will be crossing. Furthermore, it is preferred that the intersection be kept as simple as possible (i.e. by avoiding another leg if possible). The left-in, left-out arrangement further east for Gate 9 as per option 7 is preferred.	

University of New South Wales – Proposed Light Rail Platform Stops on Wansey Road Feasibility Design Stage Road Safety Audit		
Item	Findings	Project team response
Option 7 – Centre platform		
8.27	This option involves the unusual arrangement of southbound trams travelling towards and to the left of northbound traffic without a buffer between the approaching trams and northbound traffic. This arrangement is expected to be disconcerting for some motorists and is likely to lead to ‘spooking’ creating a shy-line effect and possible encroachment of the opposing lane. This effect could be minimised by providing a fence between northbound traffic and southbound trams.	
8.28	The longitudinal edge and face of the central island platform will be located approximately 3.5m from adjacent traffic, and therefore will be outside the clear zone and the risk of vehicle encroachment upon the platform is considered very low (also due to the likely low operating speeds at this location).	
8.29	The east-west crossing of Wansey Road at the northern end of the platform is to consist of a zebra crossing across both the traffic lanes and the tram tracks, while the southern end will consist of a fully controlled signalised crossing. The following potential safety issues associated with these crossings should be considered: - The adjoining zebra crossings across the southbound tram tracks and Wansey Road is of particular concern as follows: - Pedestrians crossing from the east may have right-of-way over vehicles on Wansey Road and lower their level of awareness when continuing over the tram tracks. With no separation between the tracks and roadway, there is little margin for error. This would be exacerbated by the inability for trams to stop all of a sudden. - Further to the previous point, southbound tram drivers approaching the zebra crossing may have difficulty seeing pedestrians crossing from the east due to sight line obstructions created by queued southbound vehicles waiting at the zebra crossing. - Northbound motorists may have a momentary sight line obstruction to pedestrians crossing from the central platform to the east soon after a southbound tram has passed. Pedestrians may choose to cross immediately after a tram has passed, seemingly ‘appearing’ at the zebra crossing. - Similar to the previous point, southbound cyclists may have a momentary sight line obstruction to pedestrians crossing from the central platform to the west soon after a northbound tram has passed. Pedestrians may choose to cross immediately after a tram has passed, seemingly ‘appearing’ at the zebra crossing.	

University of New South Wales – Proposed Light Rail Platform Stops on Wansey Road Feasibility Design Stage Road Safety Audit		
Item	Findings	Project team response
	- Both directions of approaching trams will not have right-of-way at the northern zebra crossing. The free-flowing and sometimes unpredictable nature of a zebra crossing is likely to lead to tram and pedestrian conflict at this location, exacerbated by the close proximity of the crossing to the tram stop (i.e. trams may depart the stop but have to give-way to crossing pedestrians soon after), and the inability for trams to stop all of a sudden. - Notwithstanding the previous point, northbound trams required to give-way to pedestrians at the northern zebra crossing will be required to stop while still partially at the platform, which is undesirable. - Southbound trams approaching the signalised crossing at the intersection of Wansey Road / High Street should be given the green tram phase when departing the tram stop and not be required to stop at the crossing and partially at the tram platform.	
8.30	It appears that a dedicated off-road north-south bicycle path is also proposed as part of this option, on the western side of Wansey Road / the proposed tram platforms. The provision of such an asset is supported in principle however the following potential issues associated with this proposed arrangement should be considered: - It will be difficult to segregate pedestrians and bicyclists along the bike path and immediately adjacent to it. Pavement marking and signage are often ineffective. This could result in pedestrians encroaching into the bicycle path and result in conflict between pedestrians and cyclists. - Providing a suitable intersection at the southern end of the bicycle path and the perpendicular pedestrian footpath will be difficult. Either the pedestrians or the bicyclists will be required to give-way and this will be difficult to make obvious, mark, and sign. Furthermore, compliance to such give-way requirements is likely to be poor. Potential conflict is likely at this intersection (of the bicycle path and pedestrian path). As per the previous item, this is also likely to be an issue at the northern end zebra crossing. - Ensure that the drop-off between the bicycle path and the tram tracks is protected. It is likely that a fence would be required to prevent cyclists falling onto the tram tracks if they lose balance, or need to avoid a hazard.	
8.31	Many of the potential issues associated with the previous two items 8.28 and 8.29 could possibly be avoided or minimised by simply omitting the pedestrian crossing of Wansey Road and the tram tracks at the northern end of the platform for this option. Pedestrians wishing to travel north from the central island platform can do so by walking between the two tram tracks to the Arthur Street intersection where crossing movements can be facilitated via the intersection signals.	

University of New South Wales – Proposed Light Rail Platform Stops on Wansey Road Feasibility Design Stage Road Safety Audit		
Item	Findings	Project team response
	Pedestrians coming from the north wishing to access the tram platform can do so from the Arthur Street signals, and pedestrians coming from the north to access the university can do so by either walking along the platform / area between the tram tracks, or using the eastern side Wansey Road footpath. Furthermore, the requirement for the far western side pedestrian footpath (west of the bicycle path) is all but redundant in this option given the other available north-south routes. This would eliminate the potential conflict at the zebra crossing and bicycle lane intersection and enable the provision of an exclusive bicycle path free of pedestrians (provided pedestrians comply with signs and markings at each end of the bicycle path advising that pedestrian access is prohibited).	
8.32	Gate 9 is to remain in its current location and allow only left-in and left-out movements. This arrangement is supported.	

University of New South Wales – Proposed Light Rail Platform Stops on Wansey Road Feasibility Design Stage Road Safety Audit		
Item	Findings	Project team response
Preferred option from a road safety perspective		
8.33	The key considerations in providing safe light rail platforms at the subject site includes avoiding/limiting potential conflict for all road users, and where this cannot be avoided, ensuring that consequences of potential conflict are minimised. Other important considerations include providing a road environment that: • Is simple, obvious, expected and predictable; • Is free of physical obstructions and is forgiving; • Provides logical connectivity; • Provides direct pedestrian access; and, • Caters for all expected user groups including cyclists and vulnerable/disabled pedestrians. There is not a great difference between the proposed options. Although option 7 - Centre Platform is expected to have less potential conflict points compared with option 3 (<i>assuming the northern crossing in option 7 is either removed as detailed in item 8.30, which is preferred, or alternatively is fully controlled with signals. The removal of the subject crossing would have the added benefit of reducing delays to tram services and improving overall level of service</i>). The design of option 7 is simple and consistent with the likely arrangement of much of the abutting tram network (running within the median). It also: • Provides an offset buffer (i.e. the width of the southbound tram reserve) between the tram platform and adjacent traffic, providing improved level of safety for both motorists and pedestrians / tram patrons. • The separation of the two opposing tram tracks requires less space for the provision of the 90degree curve through the intersection. Compared to option 3, this enables a larger central refuge island at the southern end of the platform, and reduces the required north-south crossing distance. • It enables complete segregation between the tram reserve and Wansey Road. The use of fencing along the tram reserve will physically corral pedestrians to designated crossing points (not mid-block between parked cars or between platforms), of which the southern end is fully controlled (and will avoid ambiguous right-of-way confusion between trams and pedestrians often associated with uncontrolled crossings and sometimes zebra crossings – this is particularly worth noting if the northern end crossings are removed as per item 8.30). • It allows for the provision of a scramble crossing at the intersection of Wansey Road and High Street. While such a crossing can be adopted in option 3, the shorter crossing distances in option 7 makes it better suited to a scramble crossing (i.e. less crossing time required and therefore reduced overall delay at the intersection). • Centre island platforms are particularly suited to locations where patronage tends to peak in one direction (such as at this stop / the university).	

Project team response undertaken by:

Name.....Signed.....Date.....

9. Audit conclusion

This road safety audit has attempted to balance the safety needs of all road users within the site/design constraints. It is the intention that all audit recommendations are realistic and feasible and commensurate with the actual risk posed.

A handwritten signature in black ink, appearing to read 'D Vella'.

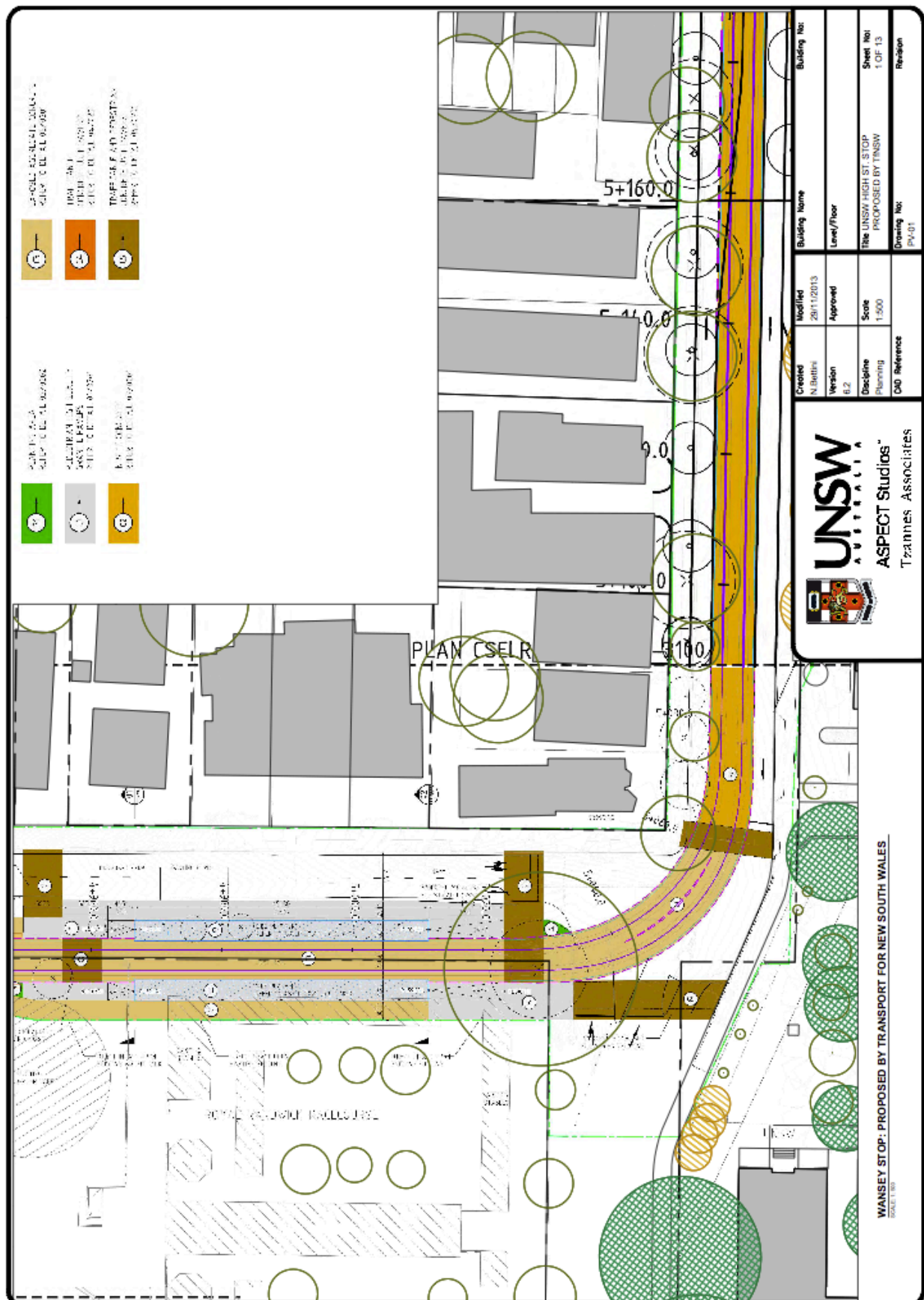
Darren Vella [BEng Civil (Hons), Director]
Accredited Senior Road Safety Auditor

and;

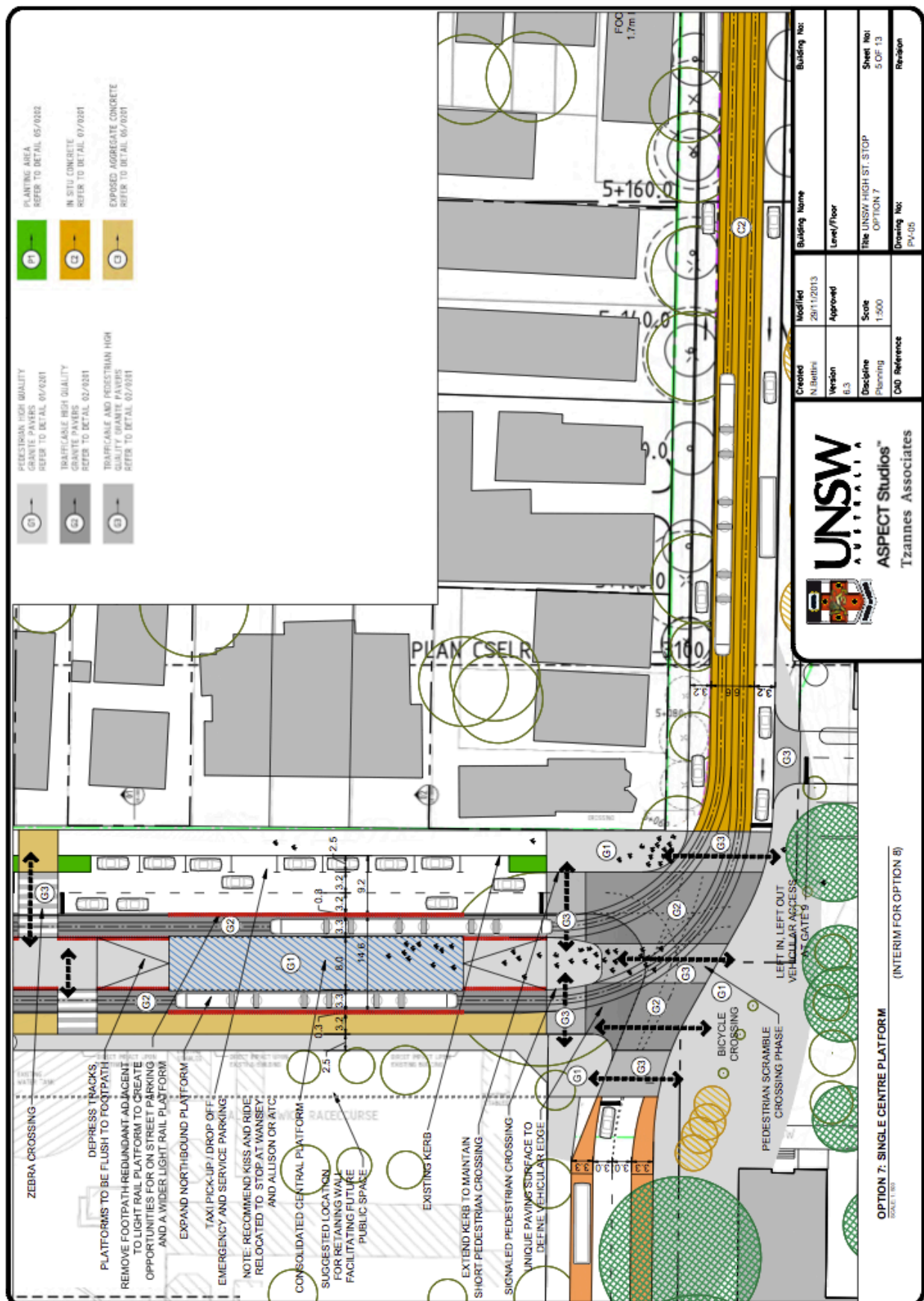
A handwritten signature in black ink, appearing to read 'Simon Penca'.

Simon Penca [BEng Civil (Hons), Director]
Accredited Senior Road Safety Auditor

10. Appendix A1: Transport for NSW option



12. Appendix A3: Option 7 – Centre platform



ANZAC PARADE - 40KM/H SPEED LIMIT

1.1 OBJECTIVE

The purpose of this report to provide an overview of the potential speed limits to be implemented as part of construction of the new light rail stop on Anzac Parade at University Mall.

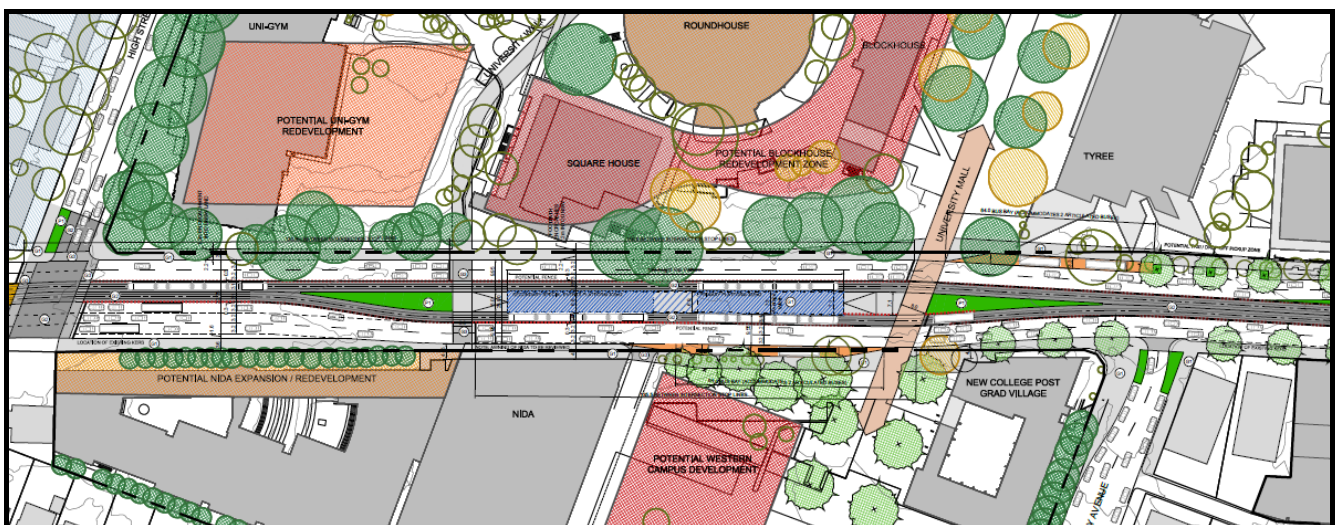
1.2 EXISTING CONDITIONS

Anzac Parade is a 6 lane divided road (with fence in central median) and a posted speed limit of 60km/h. A bus lane in the kerbside lane operates in the peak period in the peak direction. At all other times, parking is permitted in the kerbside lane.



1.3 PROPOSED CONDITIONS

It is proposed to construct a centre island platform stop in Anzac Parade between the existing University Mall pedestrian operated signals (POS) and a new set of POS that links with College Walk. The spacing of the traffic signals will be as follows: High Street – ~130m – College Walk – ~140m – University Mall – ~240m – Barker Street. Indented bus bays will be located near the University Mall POS. Lane widths will be reduced to 3.2m and each lane will be adjacent to either a kerb or traffic island.



The figure below presents existing pedestrian movements (arrivals and departures) along Anzac Parade per day. There are predicted to be approximately 15,500 arrival movements and 19,000 departure movements per day by 2020.



It is considered that Anzac Parade is High Pedestrian Activity Area. Following the construction of the new light rail stop and bus stops, and realignment of the traffic lanes, this level of pedestrian activity is expected to increase.

1.4 GUIDELINES

There are a number of relevant guidelines in relation to speed limits in New South Wales as follows:

Table 1: Speed Limit Guidelines

Title	Year	Key Issues
40km/h High Pedestrian Activity Area (HPAA) Fact Sheet  	2012	<i>Areas of high pedestrian activity, near shopping strips, railway stations, bus interchanges, beach-sides and services such as medical centres.'</i> <i>The maximum speed limit is 40km/h at all times. The different road environment helps to alert drivers to the lower speed limit and makes them aware of the presence of pedestrians moving about or near the road.</i> <i>This creates a safer road environment for all road users, particularly for pedestrians, cyclists and children.</i> <i>Why 40 km/h?</i> <i>Managing speed, in accordance with safe system principles, is a key component in managing pedestrian safety. Research and scientific analysis show that a pedestrian hit by a car travelling at 40 km/h has twice the chance of surviving the collision than if the car was travelling 50 km/h.</i> <i>Travelling speeds higher than 40 km/h greatly increases the risk of injury and death to pedestrians.</i>
NSW speed zoning guidelines 	2011	<i>The speed zoning guidelines are important in determining speed limits that assist drivers to recognise the speed limit for the road environment being encountered. The setting of speed limits is now based on this approach so that avoiding death and serious injuries becomes a priority.</i> <i>(b) 40 km/h speed limits</i> <i>40 km/h speed limits are used in areas where vulnerable road users are</i>

Title	Year	Key Issues
		<i>present, such as:</i> - <i>School zones (at prescribed times).</i> - <i>High pedestrian activity areas.</i> - <i>Local traffic areas.</i> - <i>Toll plazas in pedestrian access areas.</i> - <i>School bus blackspot zones.</i> <i>(c) School zones speed limits</i> <i>School zones are implemented outside schools to reduce vehicle speeds where there is an increased potential for conflict between vehicles and schoolchildren. School zones operate on government gazetted school days.</i> <i>School zones are installed and signposted in accordance with the RTA Technical Direction, 40 km/h School Zones.</i> <i>(d) High pedestrian activity areas</i> <i>Vehicle speed is a key factor in pedestrian injuries and fatalities. 40 km/h high pedestrian activity speed limits are installed where there are relatively large numbers of pedestrians and/or other vulnerable road users.</i> <i>These areas should be established in conjunction with a suitable local area traffic management scheme. The area will need to contain physical devices or treatments to create a self-enforcing 40 km/h speed environment.</i> <i>For further details on how to identify and install 40 km/h high pedestrian speed limits in high volume pedestrian areas refer to the RTA's 40 km/h speed limits in high volume pedestrian areas (refer to Section 1.6 for reference details).</i>

1.5 DISCUSSION

Based on a review of the above guidelines, it is considered that Anzac Parade between High Street and Barker Street is able to be considered as a High Pedestrian Activity Area.

In New South Wales, 40km/h school speed zones 'are implemented outside schools to reduce vehicle speeds where there is an increased potential for conflict between vehicles and schoolchildren. School zones operate on government gazetted school days.' It is considered that students attending UNSW, in particular overseas students and school students that attend special programs, would have the same level of risk as school students. Therefore, a speed zone similar to a school speed zone could be implemented along Anzac Parade.

The road environment along this section of Anzac Parade will support the installation of a 40km/h speed limit due to the following:

- traffic lanes (3.2m) adjacent to kerbs or traffic islands.
- lateral shifts of the traffic lanes.
- a large central light rail platform stop.
- significant pedestrian activity along and across Anzac Parade.
- Closely spaced traffic signals at High Street, College Walk, University Mall and Barker Street.

1.6 RECOMMENDATION

It is recommended that a 40km/h High Pedestrian Activity Area speed limit be implemented along Anzac Parade between High Street and Barker Street as part of construction of the new light rail stop on Anzac Parade at University Mall.

WANSEY ROAD / HIGH STREET - 40KM/H SPEED LIMIT

1.1 OBJECTIVE

The purpose of this report to provide an overview of the potential speed limits to be implemented as part of construction of the new light rail stop on Wansey Road at High Street.

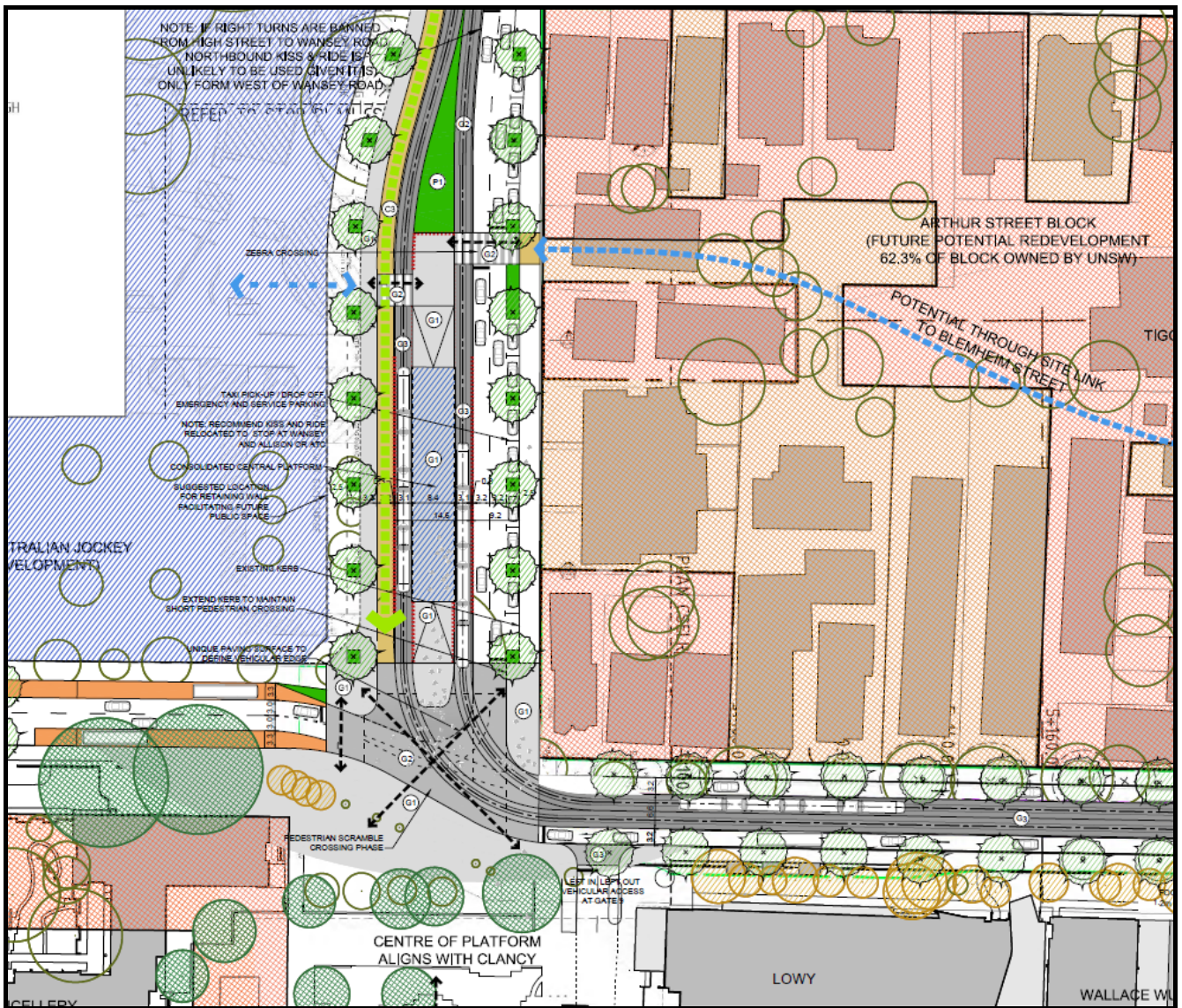
1.2 EXISTING CONDITIONS

Wansey Road is an existing two lane, two way Local Road (Local Council) with parking on both sides. High Street is an existing two lane, two way Major Road (Local Council) with parking on both sides. Both roads are within a 50km/h speed limit area (although Wansey Road may previously have had a 40km/h speed limit).

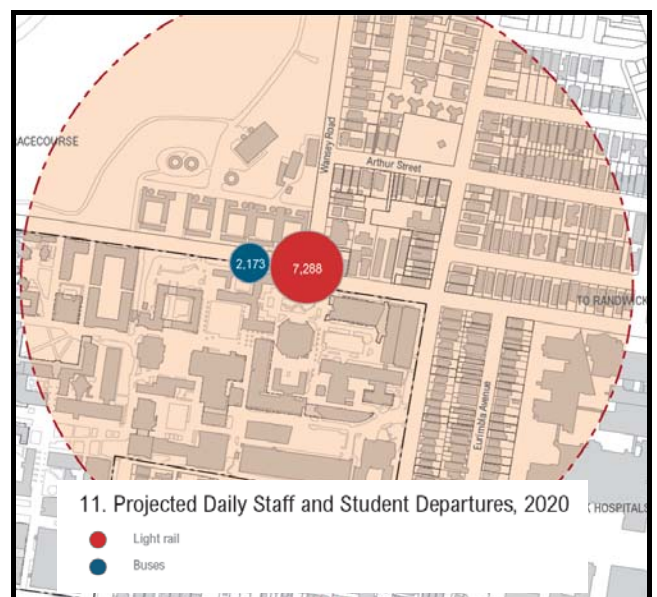
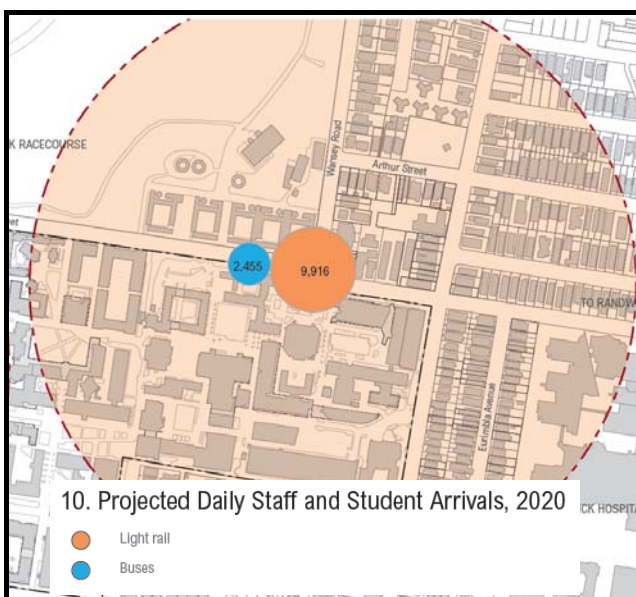


1.3 PROPOSED CONDITIONS

It is proposed to construct a centre island platform stop in Wansey Road between High Street and Arthur Street. Traffic signals will be installed at the Wansey Road / High Street intersection to facilitate crossings of both roads. A pedestrian scramble crossing is proposed at the intersection to cater for the large volumes of pedestrians and various travel paths. Traffic signals may be installed in the future at the Wansey Road / Arthur Street intersection. Parking will be removed from both High Street (east of Wansey Road) and Wansey Road. Bus stops will be located on High Street west of Wansey Road. Future development of land to the east and west of Wansey Road will further change the road environment with the potential for a pedestrian plaza arrangement adjacent to the light rail stop.



The figure below presents existing pedestrian movements (arrivals and departures) near the Wansey Road / High Street intersections. There are predicted to be approximately 12,000 arrival movements and 9,500 departure movements per day by 2020.

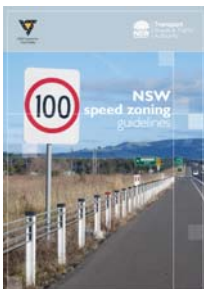


It is considered that these sections of Wansey Road and High Street are a High Pedestrian Activity Area. Following the construction of the new light rail stop and bus stops, and realignment of the traffic lanes, this level of pedestrian activity is expected to increase.

1.4 GUIDELINES

There are a number of relevant guidelines in relation to speed limits in New South Wales as follows:

Table 1: Speed Limit Guidelines

Title	Year	Key Issues
40km/h High Pedestrian Activity Area (HPAA) Fact Sheet  	2012	<i>Areas of high pedestrian activity, near shopping strips, railway stations, bus interchanges, beach-sides and services such as medical centres.'</i> <i>The maximum speed limit is 40km/h at all times. The different road environment helps to alert drivers to the lower speed limit and makes them aware of the presence of pedestrians moving about or near the road.</i> <i>This creates a safer road environment for all road users, particularly for pedestrians, cyclists and children.</i> <i>Why 40 km/h?</i> <i>Managing speed, in accordance with safe system principles, is a key component in managing pedestrian safety. Research and scientific analysis show that a pedestrian hit by a car travelling at 40 km/h has twice the chance of surviving the collision than if the car was travelling 50 km/h.</i> <i>Travelling speeds higher than 40 km/h greatly increases the risk of injury and death to pedestrians.</i>
NSW speed zoning guidelines 	2011	<i>The speed zoning guidelines are important in determining speed limits that assist drivers to recognise the speed limit for the road environment being encountered. The setting of speed limits is now based on this approach so that avoiding death and serious injuries becomes a priority.</i> <i>(b) 40 km/h speed limits</i> <i>40 km/h speed limits are used in areas where vulnerable road users are present, such as:</i> <i>- School zones (at prescribed times).</i> <i>- High pedestrian activity areas.</i> <i>- Local traffic areas.</i> <i>- Toll plazas in pedestrian access areas.</i> <i>- School bus blackspot zones.</i> <i>(c) School zones speed limits</i> <i>School zones are implemented outside schools to reduce vehicle speeds where there is an increased potential for conflict between vehicles and schoolchildren. School zones operate on government gazetted school days.</i> <i>School zones are installed and signposted in accordance with the RTA Technical Direction, 40 km/h School Zones.</i> <i>(d) High pedestrian activity areas</i> <i>Vehicle speed is a key factor in pedestrian injuries and fatalities. 40 km/h high pedestrian activity speed limits are installed where there are relatively large numbers of pedestrians and/or other vulnerable road users.</i> <i>These areas should be established in conjunction with a suitable local area traffic management scheme. The area will need to contain physical devices or treatments to create a self-enforcing 40 km/h speed environment.</i>

Title	Year	Key Issues
		<i>For further details on how to identify and install 40 km/h high pedestrian speed limits in high volume pedestrian areas refer to the RTA's 40 km/h speed limits in high volume pedestrian areas (refer to Section 1.6 for reference details).</i>

1.5 DISCUSSION

Based on a review of the above guidelines, it is considered that the sections of Wansey Road and High Street in the vicinity of the intersection are able to be considered as High Pedestrian Activity Areas.

In New South Wales, 40km/h school speed zones 'are implemented outside schools to reduce vehicle speeds where there is an increased potential for conflict between vehicles and schoolchildren. School zones operate on government gazetted school days.' It is considered that students attending UNSW, in particular overseas students and school students that attend special programs, would have the same level of risk as school students. Therefore, a speed zone similar to a school speed zone could be implemented along Wansey Road and High Street.

The road environment along this section of Wansey Road will support the installation of a 40km/h speed limit due to the following:

- traffic lanes (3.2m) adjacent to kerb outstands or traffic islands.
- signalised T-intersection.
- a large central light rail platform stop.
- significant pedestrian activity along and across Wansey Road.
- future high density development along both sides of Wansey Road.

The road environment along this section of High Street will support the installation of a 40km/h speed limit due to the following:

- single traffic lanes (3.2m) adjacent to kerb and light rail tracks.
- signalised T-intersection.
- light rail curves into Wansey Road.
- bus stops on High Street west of Wansey Road.
- significant pedestrian activity along and across High Street.
- future high density development along north side of High Street.

1.6 RECOMMENDATION

It is recommended that a 40km/h High Pedestrian Activity Area speed limit be implemented along Wansey Road and High Street in the vicinity of the intersection as part of construction of the new light rail stop on Wansey Road at High Street.

CBD and South East Light Rail Project UNSW Campus and Adjacent Trees

Client: University of New South Wales

Document: 13076 - UNSW Campus and Adjacent Trees / DRAFT

Date: 13 December 2013

Chapter 1

Tree Statement

The interfaces to both the Anzac Parade and High Street stops as proposed in TfNSW's EIS is strongly characterised by its significant tree cover.

Mature Fig plantings, particularly to Anzac Parade, High Street and Wansey Road create a distinct gateway character to the Health and Education Precinct of UNSW and the Randwick Hospitals Campus. The UNSW Significant Tree Plan identifies that the majority of the significant trees that interface with the proposed light rail stops along the boundaries of High Street and Anzac Parade have long life expectancies.

These character defining mature trees are also recognised in the Randwick City Council (RCC) Significant Tree Register.

The RCC Street Tree Master Plan (RCC STMP) locates the UNSW Kensington Campus within the Plateau, Northern Leeward Slopes and Northern Swamp Valley Floor Precincts. The Randwick Hospital Campus is located on the Plateau. The RCC STMP proposes diverse tree plantings to express each of these Precincts.

The proposed TfNSW light rail stops at UNSW High Street and UNSW Anzac Parade require the removal of several historic and significant trees. The landscape impact assessment (Hassell and ARUP) has deemed that the construction and operation of the CSELR will have high adverse landscape impacts on Wansey Road at the proposed High Street Stop. Anzac Parade and the UNSW Kensington Campus is deemed to be of regional sensitivity, due to its visual prominence in the locality of Randwick. Due to the required vegetation offset (as per the Vegetation Offset Guide by TfNSW in the EIS), a number of street trees will be removed and thus the character of UNSW's Anzac Parade frontage will change drastically. The construction and operation of the CSELR will have a high and moderate adverse landscape impact on both the Anzac Parade street trees and the UNSW Pool Lawn and University Mall. We request that the proposal be reviewed to minimise the adverse effect that the CSELR may have on its immediate surrounds.

TfNSW has committed to replacing every tree lost with eight replacement trees in the local area. We support this commitment; however, consideration must be made in regards to the replacement tree species, pot sizes and location. Where the landscape and public domain character has been disturbed as a result of the CSELR and tree removal, mature trees should be installed in the immediate vicinity and species selected which are reflective of the surrounding character and uplift the public domain. We support the landscape strategy's recommendation of planting replacement trees as close as possible to their original locations to mitigate adverse effects.

The landscape strategy in the EIS proposes several key principles for the extent of the CSELR to minimise adverse impacts on its surrounds by minimising and mitigating the loss of existing trees, promoting the use of native trees in accordance with local plans, providing improved streetscapes and enhanced public open space, and using the landscape elements as way finding elements.

The landscape strategy as compiled by Hassell lacks detail in regards to the stop character at UNSW High Street and UNSW Anzac Parade, however provides recommendations in regards to tree replacement strategies. No trees have been proposed for the UNSW High Street stop, as the Park typology planting palette consists only of grasses/tufted plants, sedges and groundcovers.

The proposed UNSW High Street stop requires the removal of historic Fig tree plantings within the Racecourse to enable the circulation of pedestrians, cyclists and vehicular traffic with the proposed CSELR. The Fig trees along this boundary provide the majority of shade to the western footpath of Wansey Road, and their removal will drastically change the streetscape as well as the quality of pedestrian and cyclist journey. The strategy references the Randwick City Council Street Tree Master Plan, which has developed planting palettes based on a series of precincts, defined by landscape topography. We support the proposed use of species such as *Angophora costata* and *Eucalyptus haemastoma* or *Lophostemon confertus* as street tree planting on Wansey Road. Whilst the use of *Agathis robusta* would certainly create a distinct avenue for

the CSELR, its form and habit would not provide the amenity offered by the other species proposed.

We also support the recommendations to protect the existing Figs at the Australian Turf Club (Randwick Racecourse) and that whilst the Fig species are not referenced in any Randwick City Council STMP, that any trees requiring removal should be replaced with trees of the same species.

The Boulevard typology proposes only *Livistona australis* (Cabbage Tree Palms), with a palette of grasses/tufted plants, sedges and groundcovers which is an identical palette to that of the Park typology. The proposed species will create a clear link between the stops and throughout the CSELR corridor, however the proposal should be reconsidered to better reflect the diverse character of the landscape in which the Boulevard typology traverses. Prominent tree plantings of Figs extend from The Parklands through to the Racecourse and UNSW. We request that TfNSW consider that the use of a Palm is not an accurate reflection of the landscape, nor does it provide any amenity for pedestrians or cyclists. We support the potential use of Figs and Brush Box on the street verges, as these species would be reflective of the existing landscape character and provide amenity for both pedestrians and cyclists.

ASPECT Studios, 13th December 2013

Subject UNSW Bicycle Masterplan: External Bicycle Network

Date 11 December 2013

Job No/Ref 233486

1 Background

The following document provides an overview of the existing bicycle network in the areas surrounding UNSW, and proposes augmentation of this network to support the provision of a high quality regional transport network.

The University of New South Wales (UNSW) is a major destination point within the Randwick LGA. Major land uses nearby include Randwick Racecourse, Prince of Wales Hospital and the Randwick, Kensington and Kingsford town centres. These areas generate a significant number of trips on a daily basis, and therefore should be served by a high quality transport network that considers all modes of travel.

It is noted that in the order of 5% of all journeys to UNSW every day are made via bicycle – equivalent to approximately 2,000 daily trips. Additionally, trends from the annual travel survey undertaken by the University indicates that cycling as a mode of transport is growing in popularity, with a 13% increase on average recorded each year since 2007.

2 Principles of Bicycle Planning

2.1 Key Design Principles

The needs of bicycle users and their requirements for an efficient and useable bicycle network can be summarised by the five design principles below:

1. **Safety:** A good quality route enhances the safety of all users, including cyclists, pedestrians and motorists. Streets and intersections along key bicycle routes should be designed to a standard which incorporates cyclist movements.
2. **Coherence:** The bicycle network should link popular destinations with local residential streets via a mix of both local and regional routes. The network should be continuous and easily identifiable to both novice and experienced cyclists.
3. **Directness:** Bicycle routes should be as direct as possible, having consideration for major barriers such as road intersections and steep topography. The rider should ideally be able to maintain a safe and comfortable consistent riding speed throughout their journey.
4. **Attractiveness:** The bicycle network must be designed so that complements and enhances its environment in such a way that cycling is attractive. Clear and strategically placed wayfinding information should indicate distances and times to major destinations.
5. **Comfort:** Bicycle routes must be comfortable and easy to use for all cyclists. Depending on the road environment and topography, some level of separation (e.g. clearly marked bicycle lanes, painted green) may be required.

2.2 Network Hierarchy

It is important to consider the road network hierarchy when planning a system of good quality bicycle routes. This hierarchy entails both local and regional routes to facilitate safe, connected and efficient bicycle movements.

Regional bicycle routes provide the most direct means of travelling between key centres, with riders generally travelling at higher speeds and less likely to deviate off the nominated route. Regional routes generally carry the majority of through cycling movements, and should therefore avoid interactions with other modes of transport such as cars, bus and light rail.

Local bicycle routes provide connections from regional routes to key destination points, with riders travelling at lower speeds in a more mixed traffic environment (e.g. shared space with either pedestrians or vehicles).

2.3 Appropriate Bicycle Facilities

When determining the most appropriate cycling treatment on a bicycle route, consideration must be given to the traffic speed and traffic volume. The NSW Bicycle Guidelines provide direction relating to the most suitable cycling treatment for different roads, as reproduced in Figure 1.

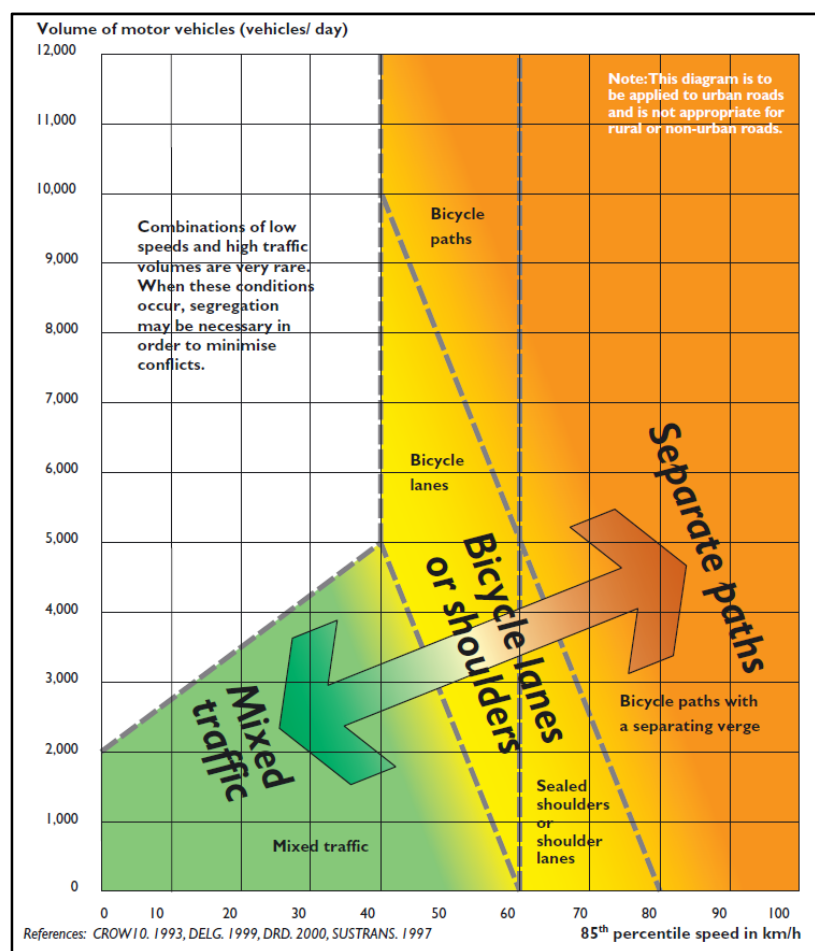


Figure 1 Separation of Bicycles and Motor Vehicles According to Traffic Speed and Volume

Source: NSW Bicycle Guidelines, Figure 3.2

3 Existing Bicycle Network

The existing bicycle network in the area surrounding UNSW and environs is generally fragmented and incomplete, with a number of missing links present. Doncaster Avenue provides a north-south route which connects links Kingsford and Kensington to the Anzac Parade cycleway at Centennial Park, continuing on to the Sydney CBD. A shared path exists on Alison Road and Wansey Road which provides a connection between the UNSW, Randwick Racecourse and Centennial Park.

Existing deficiencies and missing links in the bicycle network include:

- the conclusion of the Wansey Road shared path at the Wansey Road / High Street intersection, with no linkages towards Coogee, Randwick or lower campus available;
- absence of a dedicated east-west bicycle facility linking Randwick town centre and Anzac Parade, requiring many less confident cyclists to travel through UNSW;
- no connection from the bicycle facility on Doncaster Avenue / Houston Road across Anzac Parade into UNSW;
- no formal bicycle connection into Prince of Wales Hospital along High Street;
- incomplete bicycle route on Todman Avenue, between Kensington Road and Doncaster Avenue; and
- no connection along Cottenham Avenue between the bicycle routes on Day Avenue and Tresidder Avenue

The growth in cycling activity recorded at UNSW in recent years is significant given the absence of a high quality bicycle network surrounding the campus.

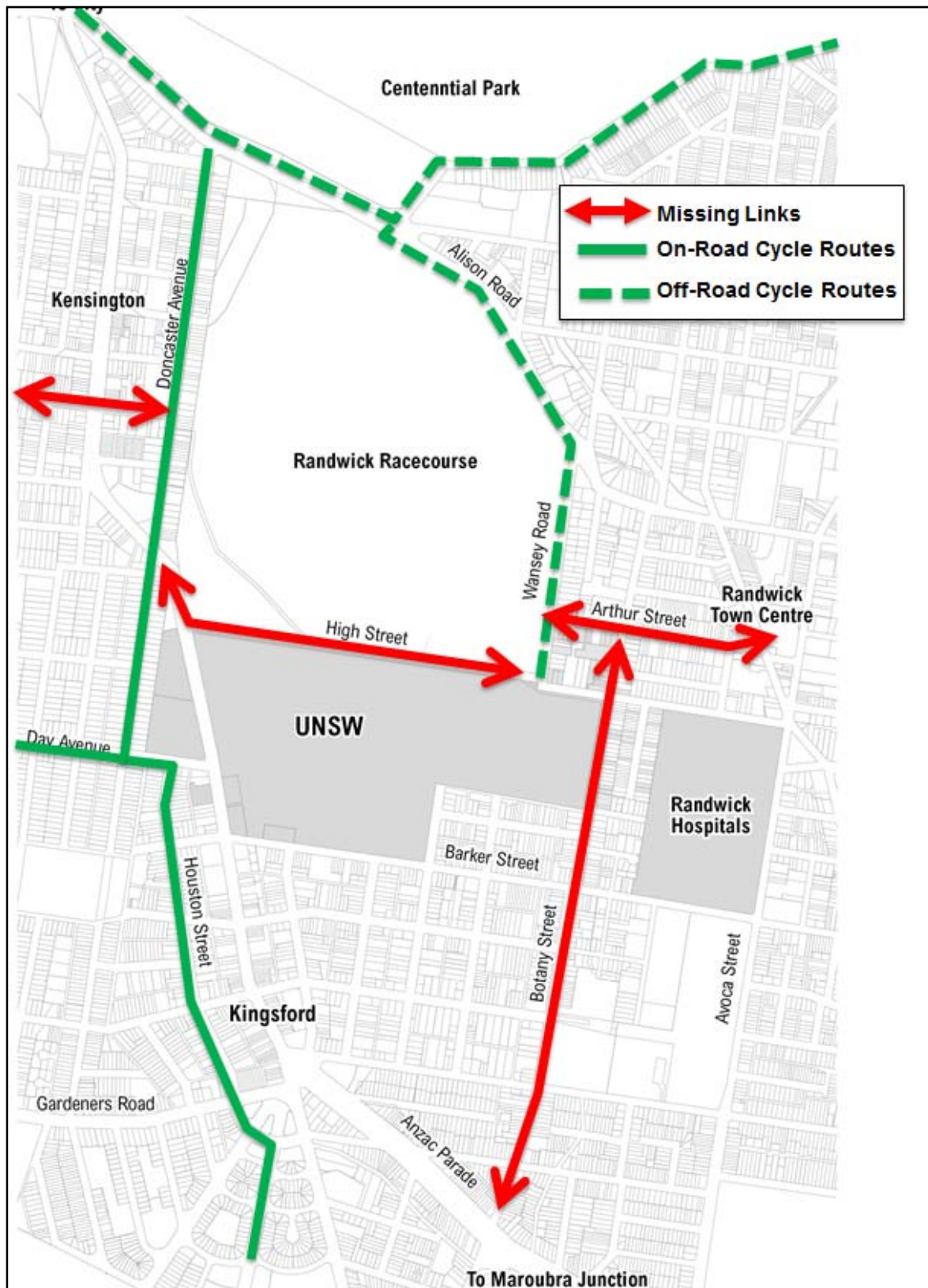


Figure 2 Existing Cycle Network

4 Proposed Bicycle Network

The proposed regional bicycle network aims to deliver a good quality series of routes by considering the five key principles of bicycle planning. The regional routes have been selected to avoid major arterial or collector roads carrying large amounts of vehicular traffic. They build on the existing regional bicycle network by addressing existing missing links and providing local connections to major destinations in the precinct. The network provides integration with future development associated with the Randwick UAP and the CBD and South East Light Rail project. This supports bicycle access to key destinations in the precinct including UNSW, Prince of Wales Hospital and other major developments.

Key features of the proposed network are described below:

4.1 Doncaster Avenue / Houston Street

Doncaster Avenue / Houston Street to the west of UNSW is a key component the regional bicycle network serving major centres including the Sydney CBD, Surry Hills and Kingsford. It is proposed to retain this route as the principal north-south bicycle facility. Local connections from this bicycle route will be provided to key destinations including UNSW and Kingsford shops.

The existing facility consists of white line-markings indicating on-road cycle lane. Many cyclists unfamiliar with the area travel down the busy Anzac Parade as they are unaware of the extent of this route, particularly at the Doncaster Avenue / Anzac Parade intersection.

To emphasise the importance of this regional bike route, it is recommended green paint be installed along the length of the route. This will provide a visual indication for cyclists that they may continue along their path of travel, enhanced continuity and improved level of safety as it would signify to motorists that this is a cyclist only area.



Figure 3 Existing Doncaster Avenue On-Road Bicycle Lane



Figure 4 Example of On-Road Cycleway with Green Paint

Source: Google Street View (2013)

4.2 **Barker Street**

Barker Street is proposed to provide local access for cyclists travelling from the Doncaster Avenue / Houston Street route into UNSW. Traffic signals at the Anzac Parade / Barker Street intersection will provide controlled access for cyclists riding between the campus and Houston Street.

4.3 **Botany Street**

Botany Street currently acts as a missing north-south link in the existing cycle network surrounding the campus. It is listed as a priority 2 route in Randwick City Council's current bike plan. Providing a formal bicycle facility at this location (on-road cycleway with green pavement) would deliver a connection between Centennial Park / Randwick Racecourse (via the Wansey Road cycleway) and Maroubra Junction (via the future Anzac Parade shared path).

4.4 **Arthur Street**

Arthur Street is proposed to provide a connection from the Wansey Road regional bicycle route into the Randwick Town Centre, providing local connections to Prince of Wales Hospital and UNSW. Arthur Street is a quiet, residential street suitable to accommodate bicycle movements, and would provide linkages to adjacent routes including the Wansey Road shared path and the proposed cycleway along Botany Street.

This route avoids interaction with the light rail and bus stops on High Street, and minimises potential conflicts with other modes of transport. Given the low traffic speeds and volumes on Arthur Street, a mixed traffic environment would be appropriate where bicycle logos would be painted near the centre of the road to indicate the space is to be shared between motorists and cyclists. This is a similar arrangement to many streets across Sydney (see Figure 5).



Figure 5 Examples of Mixed Traffic Streets (North Sydney LGA)

4.5 **Anzac Parade**

Randwick City Council is currently investigating the introduction of an off-road bicycle path along Anzac Parade (south of 9-ways roundabout). This facility would be located within the existing median. It will be important for Council to ensure that safe and convenient connections are provided from the end of the shared path to adjacent cycle routes – particularly along Houston Street.

Due to the high pedestrian volumes on Anzac Parade following the introduction of light rail, it is not recommended the Anzac Parade shared pathway be extended to run between 9-ways roundabout and High Street. Houston Road / Doncaster Avenue should be retained as the primary north-south regional bicycle route serving cyclists travelling longer distances at higher speeds.

4.6 **Wansey Road**

Wansey Road acts as an important regional bicycle route in the precinct, providing a connection between Centennial Park, Randwick Racecourse and UNSW.

The Environmental Impact Statement (EIS) of the light rail project indicates the shared bike path on the western side of Wansey Road is to be retained following the completion of the light rail. A significant number of pedestrians are forecast to utilise the light rail stop on Wansey Road during the morning and afternoon peak periods. Retention of the shared path, particularly given the topography of the area, increases the potential for conflicts between pedestrians and cyclists.

It is recommended that as the design of the light rail on Wansey Road progresses, consideration be given to a good quality separated, on-road bicycle facility. The ability to provide this facility will be dependent on the available road reserve, given the constrained width to allow for the light rail tracks.

4.7 High Street

A major deficiency in the existing bicycle network is the lack of a good quality east-west bicycle route connecting the local town centres of Kensington, Kingsford and Randwick.. The topography of the area makes cycling between these areas challenging for many riders, and therefore it is important a good quality facility be provided. A series of local connections across High Street can strengthen local connections to both UNSW and the future development at the southern end of Randwick Racecourse.

It is proposed that this be achieved by utilising the existing road reserve to provide an on-road bicycle lane for cyclists travelling east (uphill), with cyclists travelling west (downhill) to ride in the middle of the road.

The proposed solution could be implemented in the short term prior to the development of the Racecourse site. This option considers the slow operating speeds of cyclists travelling uphill and relatively high speeds when descending. When riding at higher speeds comparable to motor vehicles (due to steep topography), cyclists feel safer and more comfortable towards the middle of the road, reducing the risk of being hit by someone opening their car door. A parking separation line, 2.2m from the kerb, can be installed to maximise the usable road space. An example of this treatment is shown in Figure 6.

Travelling uphill cyclists require a greater degree of separation from vehicles and therefore a dedicated bicycle lane is appropriate. This arrangement is similar to that installed in Mount Street, Coogee (Figure 7), where a bicycle lane is provided in uphill sections only. A potential road cross-section for High Street is illustrated in Figure 8.

There may be future opportunities to improve this bicycle route in association with outcomes that may arise as part of the Randwick UAP.



Figure 6 Parking Separation Line, Darlinghurst



Figure 7 Mount Street, Coogee

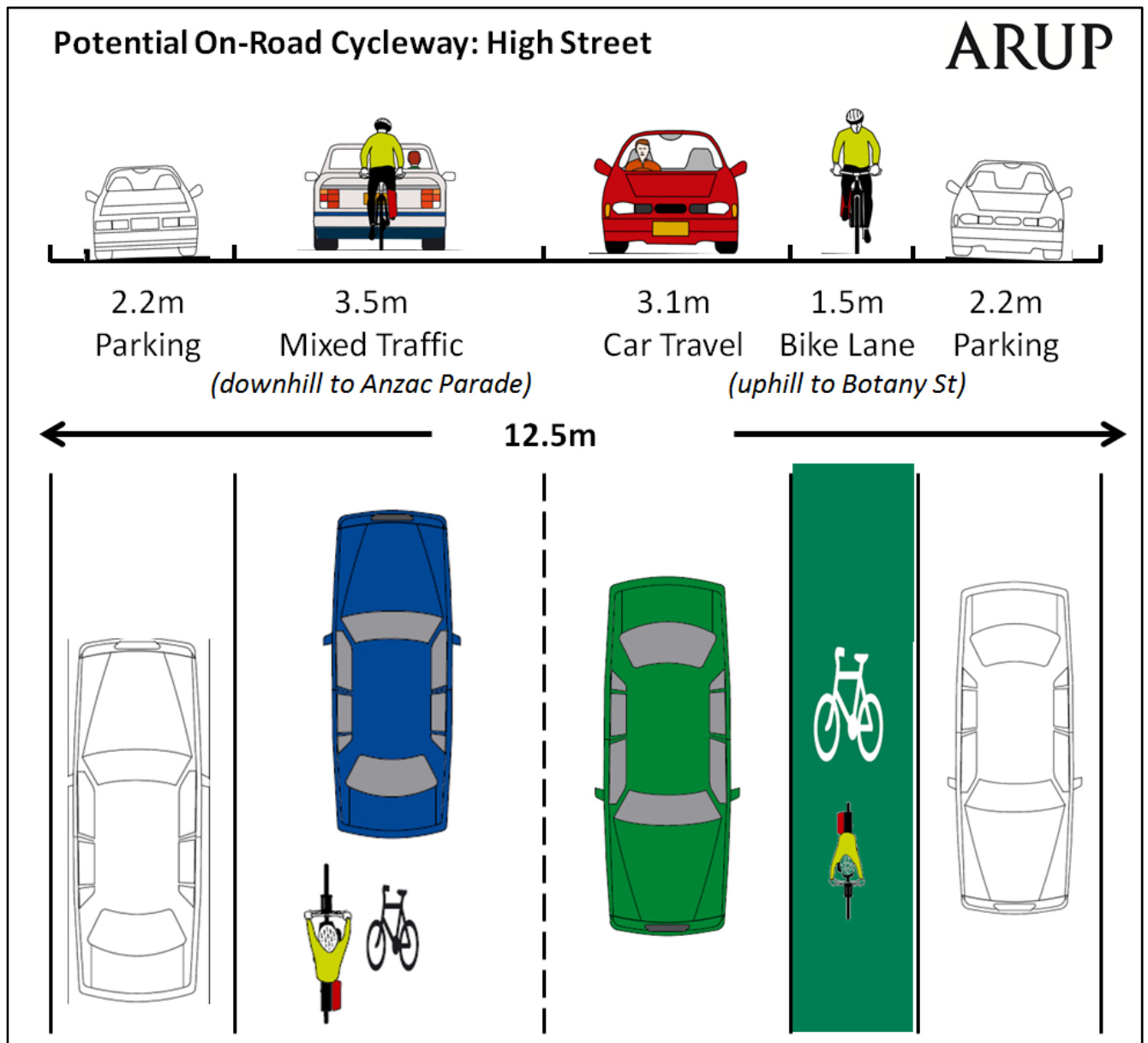


Figure 8 Potential High Street Cross Section

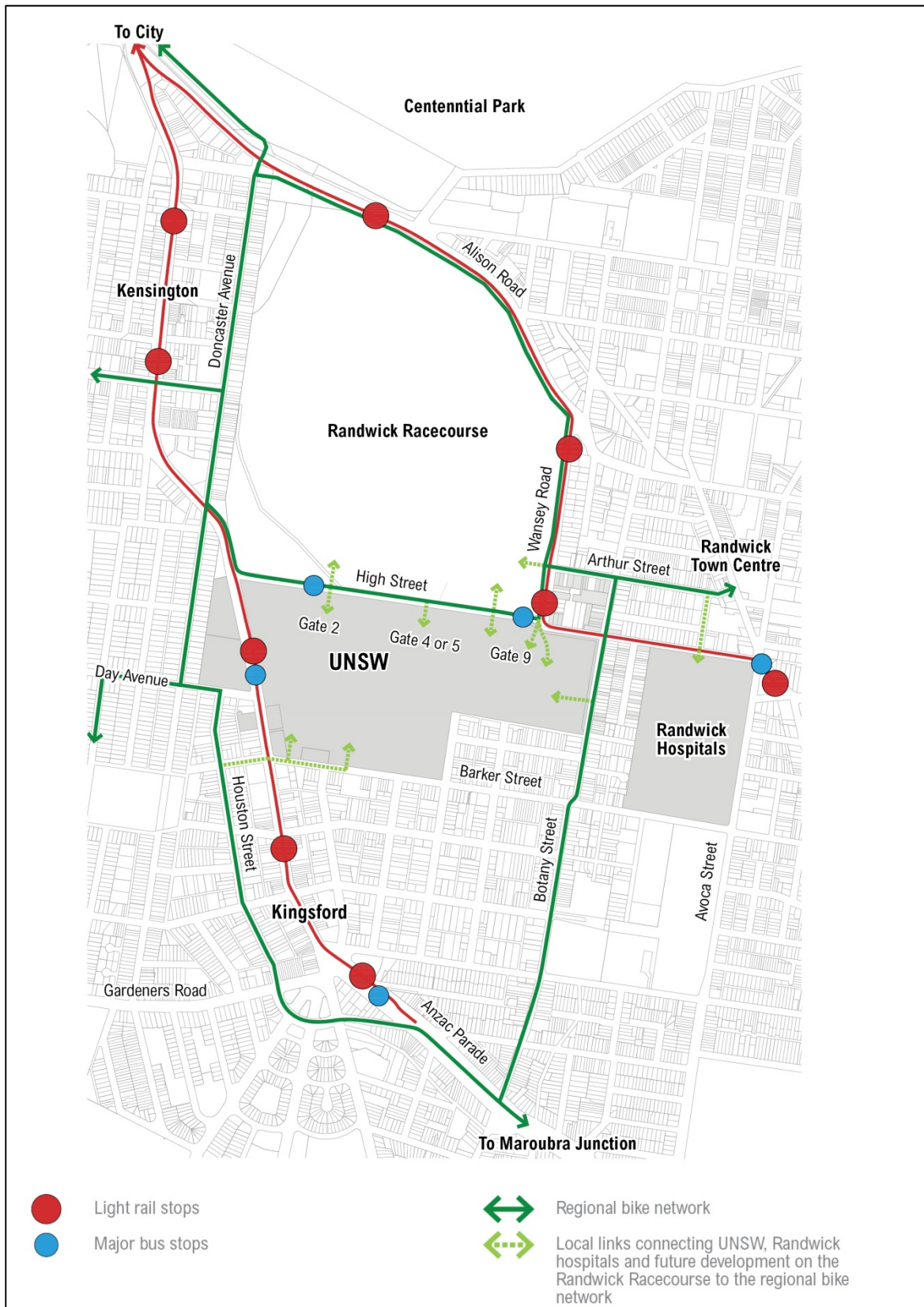


Figure 9 Proposed Bicycle Network

5 Wayfinding & Signage

Directional signage provides critical information to cyclists who are unfamiliar with the local bicycle network. Strategically positioned directional signage reinforces the connectivity and coherence of the bicycle network and directs cyclists to travel on the recommended bicycle routes.

Many cyclists often select an unsafe or undesirable route when a good quality bicycle facility exists nearby, potentially discouraging them from cycling in the future. For example many cyclists are currently unaware of the on-road bicycle route that exists on Doncaster Avenue parallel to Anzac Parade, and instead choose to cycle in the bus lane along Anzac Parade.

The directional signage would contain key information such as the name of the bicycle route, and directions (including distance and/or time) to major destinations in the area, e.g. UNSW, Prince of Wales Hospital, Randwick Town Centre, Randwick Racecourse.



Figure 10 Directional Signage Examples – City of Sydney

UNSW RESPONSE TO THE CBD AND SOUTH EAST LIGHT RAIL (CSELR) ENVIRONMENTAL IMPACT STATEMENT			
Refer also to the JBA 'Submission on CBD & south-East Light Rail Project' submitted on behalf of the Univeristy of NSW			
EIS Document	Page # in EIS Document	Section #/Table #/Figure #	Comment
Executive Summary	E7	Table: Key regional impacts and benefits of the CSELR - Regional traffic, transport & access	It is essential that the UNSW campus remains accessible during construction of the light rail for retail and other delivery vehicles, construction vehicles for sites on the campus, staff and student parking, cyclists and pedestrians.
	E9	Table: Key regional impacts and benefits of the CSELR - Local traffic, transport & access	
	E10	Table: Key regional impacts and benefits of the CSELR - Impacts on planted trees	It is noted that a large number of trees will be removed along Anzac Parade, Wansey Road and probably High Street. UNSW is concerned at the loss of these trees and the consequential adverse impact on landscape amenity and historical significance of the district in general and the UNSW campus in particular.
	E12	Table: Key regional impacts and benefits of the CSELR - Surface water, hydrology/drainage	The existing local stormwater flooding along Anzac Pde from High Street to Day Street adjacent to UNSW is not addressed. The UNSW overland stormwater flood path drains onto Anzac Parade across the proposed construction compound and the UNSW Anzac Parade stop.
Part B : The proposal & its development. Chapter 4 Definition design development	4-5	Table 4.1 Alignment strategies	It is unclear how the Park typology will apply at the UNSW High Street stop and the Boulevard typology at the UNSW Anzac Parade stop, given that grass tracks will not be implemented and the track treatment for each will be Park/Concrete and Boulevard/Concrete. The statement within the column "Response to requirements" to allow for interchange facilities at the UNSW Anzac Parade stop is incorrect. The interchange is at the Kingsford stop.
	4-9	Figure 4.3 Key design options considered	It is noted and supported that the use of the King Street tram shed for maintenance and the use of Racecourse land near the intersection of Wansey Road and High Street for stabling, were not considered further as options.
	4-17 & 4-18	4.3.3 Alignment on Wansey Road & Figure 4.8 Wansey Road alignment options	Option 1 is supported as the preferred alignment option along Wansey Road.
Part B : The proposal & its development. Chapter 4 Definition design development	4-23	Table 4.4 Short-listed alternative stop locations considered for the CSELR project	The statement for the proposed side running track option that "pedestrian movements between the light rail platforms and the lower campus of UNSW would not require crossing of Anzac Parade", is incorrect. Pedestrians on the western side of Anzac Parade will have to cross the road to access the platforms. Similarly, those alighting from the light rail carriages who wish to access the western side of Anzac Parade will have to cross the road. The side running track on UNSW land is not supported and it should be changed to a centre running track with an island platform so as to avoid loss of UNSW land, relocation of underground services, removal of significant trees and landscaping along the campus frontage. The preservation and maintenance of all significant fig trees along Anzac Parade in the vicinity of the UNSW campus is considered essential to preserve the amenity and character of the campus. No tree replacement strategy is provided. It is unclear how the Boulevard typology will apply at the UNSW Anzac Parade stop, given that grass tracks will not be implemented and the track treatment will be Boulevard/Concrete. Further discussion with UNSW is required as to how pedestrians, cyclists and buses will be managed at this stop.
	4-29	4.5.1 Stabling and maintenance facility options	It is noted and supported that the use of the King Street tram shed for maintenance and the use of Racecourse land near the intersection of Wansey Road and High Street for stabling, were not considered further as options.
Part B: The proposal & its development. Chapter 5 Proposed infrastructure & operations	5-16	5.2.2 The CSELR stops - bicycle parking facilities	The statement that "Convenient bicycle parking facilities would be provided near platforms." requires clarification. For the two UNSW stops, bicycle parking facilities are already provided on the campus.
	5-44 & 5.45	Figure 5.31 Indicative section - UNSW High Street stop & Figure 5.32 Indicative plan - UNSW High Street stop	Further discussion with UNSW is required as to how pedestrians, bicycles, buses and other vehicular traffic will be managed at this stop and at the intersection of Wansey Road and High Street. Clarity is required on integration of the existing share bike path along Wansey Road. It is unclear how the Park typology will apply at the UNSW High Street stop, given that grass tracks will not be implemented. The loss of the mature fig tree on the corner of Wansey Road and High Street is not shown. No tree replacement strategy is provided. Both figures show a 2-way traffic flow in Wansey Road that conflicts with the statement on page 5.44 that the narrowing of Wansey Road around the stop "would require the reduction of existing traffic along Wansey Road into a one-way configuration."

UNSW RESPONSE TO THE CBD AND SOUTH EAST LIGHT RAIL (CSELR) ENVIRONMENTAL IMPACT STATEMENT

Refer also to the JBA 'Submission on CBD & south-East Light Rail Project' submitted on behalf of the Univeristy of NSW

EIS Document	Page # in EIS Document	Section #/Table #/Figure #	Comment
Part B: The proposal & its development. Chapter 5 Proposed infrastructure & operations	5-52 & 5-53	Figure 5.39 Indicative section - UNSW Anzac Parade stop & Figure 5.40 Indicative plan - UNSW Anzac Parade stop	The side running track on UNSW land is not supported and it should be changed to a centre running track with an island platform so as to avoid loss of UNSW land, relocation of underground services, removal of significant trees and landscaping along the campus frontage. The preservation and maintenance of all significant fig trees along Anzac Parade in the vicinity of the UNSW campus is considered essential to preserve the amenity and character of the campus. No tree replacement strategy is provided. Further discussion with UNSW is required as to how pedestrians, cyclists and buses will be managed at this stop. UNSW trade waste, water supply bores and associated reticulation and stormwater will be affected. More specifically, existing underground services include: * Location of two of the three large water production bores and associated services for the city of Kensington Campus which draws some 200kL / day of groundwater for 'commercial' uses, * UNSW main stormwater pipeline runs within part of this strip of land, * Bore water reticulation drain point lies immediately beneath the platform. * Irrigation pipelines run the length of the proposed land acquisition. * Trade waste grease arrester and associated sewer drainage. * Bore water mains exist across Anzac Parade to provide supply to Western Campus and to L5 site. Substantial relocation of stormwater services will be required to remove them from the acquired land.
	5-65	5.2.6 Associated light rail infrastructure and services - security and services	The security systems at the UNSW Anzac Parade stop and the UNSW High Street stop will need to integrate with 24/7 on UNSW on-campus security systems. UNSW will require access to CCTV footage at these stops and at the Chalmers Street stop.
	5-67 & 5-68	5.2.7 Road configuration changes	The provision of an indented bus bay within UNSW for westbound buses on High Street is not supported. No discussion with UNSW on this matter has taken place. Adverse impact on UNSW underground services and loss of large mature trees will result. Clarity is required as to whether this land is to be acquired from UNSW as it is not shown in Table 5.2 on page 5-74. The temporary westbound bus stop west of Wansey Road during construction should become the permanent westbound bus stop in High Street. Consultation with UNSW is required on any restrictions to right hand turns from Anzac Parade into Barker Street and from Anzac Parade into High Street. These streets are used to access the campus vehicle entrances.
	5-69	5.2.9 Street trees	This section does does not address the existing significant trees on Anzac Pde between High Street and Barker Street along the campus frontage.
	5-74	Table 5.2 Permanent land acquisitions	Permanent land acquisition of UNSW land at the UNSW Anzac Parade stop is not supported because the side running track on UNSW land is not supported (see comments above re pages 4-23 and 5-52).
	5-75	Table 5.3 Temporary leases for construction	The temporary lease of UNSW land off Anzac Parade is not supported because the need for a construction compound in on the UNSW campus is not supported. The location of a compound on the lower campus will require the relocation of UNSW underground services, removal of trees, landscaping and lawn and adversely affect pedestrian routes and teaching. The underground services will be inaccessible for repairs and maintenance and may also be damaged during construction due to ground settlement and compaction. The UNSW overland stormwater flood path drains onto Anzac Parade across the proposed construction compound.
	5-82	5.4.7 Ticketing system and passenger information	Ticketing machines and PIDS need to be installed at the Chalmers Street stop and the UNSW Anzac Parade and UNSW High Street stops.
	5-84	5.4.10 Communications system	The proposed communications system should not interrupt UNSW campus activities in terms of public address announcements or electro-magnetic radiatin interference to sensitive research equipment. The EIS does not address the issue of possible electro-magnetic radiation interference.
Part B: The proposal & its development. Chapter 6 Proposed construction	6-22	Figure 6.2h Construction compounds and footprint for the CSELR proposal	The provision of a construction compound in on the UNSW campus is not supported. The location of a compound on the lower campus will require the relocation of UNSW underground services, removal of trees, landscaping and lawn and adversely affect pedestrian routes and teaching. The underground services will be inaccessible for repairs and maintenance and may also be damaged during construction due to ground settlement and compaction. The UNSW overland stormwater flood path drains onto Anzac Parade across the proposed construction compound and the UNSW Anzac Parade stop. Furthermore, noise and light interference will adversely affect nearby student accommodation on the campus, particularly during exam study periods.
	6-25	Table 6.4 Proposed primary construction compounds - UNSW	
	6-27	Table 6.5 Proposed environmental management measures for primary construction compounds - UNSW	
	6-32 to 6-36	Figures 6.3 to 6.7 Proposed construction haulage routes	The indication of a construction compound at UNSW in these Figures is not supported for the reasons given in the comment above.
	6-43	6.10.5 Road changes	The changes to Anzac Parade, High Street and Wansey Road are noted. It is essential that the UNSW campus remains accessible during construction of the light rail for retail and other delivery vehicles, construction vehicles for sites on the campus, staff and student parking, cyclists and pedestrians.

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	6-44	6.10.6 Bus operations	It is essential that Eddy Avenue, Anzac Parade and High Street (and Alison Road during exam periods) remain operable for UNSW express bus services set downs and pick ups during light rail construction.
Part B: The proposal & its development. Chapter 6 Proposed construction	6-46	6.10.13 Property and utility access	It is essential that the UNSW campus remains accessible during construction of the light rail for retail and other delivery vehicles, construction vehicles for sites on the campus, staff and student parking, cyclists and pedestrians.
Part B: The proposal & its development. Chapter 7 Proposed sustainability	7-23	Table 7.6 Medium and high climate change risks identified for the operational phase of the CSELR proposal - flooding of CSELR infrastructure	The existing local stormwater flooding along Anzac Pde from High Street to Day Street adjacent to UNSW is not addressed. The UNSW overland stormwater flood path drains onto Anzac Parade across the proposed construction compound and the UNSW Anzac Parade stop.
Part C: Regional environmental impact assessment. Chapter 9 Regional planning, transport & socio-economic impacts	9-18	Table 9.6 Key road network changes proposed as part of the CSELR - Wansey Road, High Street	No statement is made with regard to the introduction of traffic signals at the intersection of High Street and Wansey Road at the UNSW High Street stop. Further discussion with UNSW is required as to how pedestrians, bicycles, buses and other vehicular traffic will be managed at this stop and at the intersection of Wansey Road and High Street. The provision of an indented bus bay within UNSW for westbound buses on High Street between Botany Street and Wansey Road is not supported. No discussion with UNSW on this matter has taken place. Adverse impact on UNSW underground services and loss of large mature trees will result. The temporary westbound bus stop west of Wansey Road during construction should become the permanent westbound bus stop in High Street.
	9-29	9.2.2 Impacts during operation - Traffic flow changes - performance of intersections within the CSELR corridor - South East corridors - Anzac Parade/ High Street	It is noted that the Anzac Parade/High Street intersection will suffer a loss of service as a result of the proposed switch in the track alignment from centre running to enter UNSW land on the eastern side of Anzac Parade. Under the Randwick Urban Activation Precinct proposals substantial redevelopment for mixed use and residential will occur at this intersection and along High Street on Racecourse land. Therefore any loss of service at the intersection will have adverse effects on traffic flow and access to the UNSW campus via Gate 2 High Street. The side running track on UNSW land is not supported and it should be changed to a centre running track with an island platform for reasons previously explained in the comments above, and to return the Anzac Parade/High Street intersection to its current level of service as a minimum.
	9-36	Figure 9.7 2021 morning peak CSELR boarding and mode of access by light rail stop	The bar graph for Central Station appears incorrect as no transfers from the rail network are shown and the number of passengers appears unrealistically low. The numbers do not corrolate with UNSW arrivals and departure data at the two UNSW stops.
	9-45	9.2.3 Impacts during construction - impacts on bus services	It is essential that Eddy Avenue, Anzac Parade and High Street (and Alison Road during exam periods) remain operable for UNSW express bus services set downs and pick ups during light rail construction.
	9-67 & 9-68	9.4.4 Impacts during construction	It is essential that the UNSW campus remains accessible during construction of the light rail for retail and other delivery vehicles, construction vehicles for sites on the campus, staff and student parking, cyclists and pedestrians. The statement is noted that "A noticable level of noise is likely to be generated during the construction phase of the CSELR proposal, with particular concentrations likely to be experienced around construction compounds". The current proposed location for a compound on the UNSW campus is not supported for the reasons already given in the comments above.
Part C: Regional environmental impact assessment. Chapter 10 Other regional impacts	10-26	Table 10.9 Depth of groundwater in the Sydney Central Basin and Botany Sands aquifers	UNSW's use of a significant daily volume of borewater for its commercial building services has not been mentioned. It is not evident from the Table that any effect on borewater quality, static levels or availablilty will bring significant cost penalty to UNSW. UNSW should be added as a Precinct/Area with Purpose of Bore being "commercial water harvesting for building services" UNSW usage of borewater or ownership of several bores has not been considered anywhere in the EIS.
	10-29	10.4.2 Impacts during operation	The proposed UNSW Anzac Parade stop will result in the destruction of water supply production bore water and another bore alienated from service vehicles. The UNSW overland stormwater flood path will be disrupted because it drains onto Anzac Parade across the proposed construction compound and the UNSW Anzac Parade stop.This results in the requirement for: at least one new production bore to be constructed along with all associated controls and connecting pipelines, power and controls; new borewater connecting water mains; new drain valve and pipeline connection to the stormwater pipework system; and new stormwater pipeline and pits with connection to the stormwater pipework system. Substantial design work will be required to investigate suitable sites for new production bore water and to design the bore construction, including pumping and controls, etc. Costs for bore relocation and all associated services infrastructure are very significant. Pumps need to be chosen to suit the hydraulic properties of the new bores. All such work must be done to meet strict UNSW requirements for production bore water.
	10-30 to 10-32	10.4.3 Impacts during construction	
	10-32 to 10-33	10.4.4 Management and mitigation	
	10-52	10.8.1 Existing utilities	To those utilities already listed, add "borewater" and "UNSW borewater system and underground utilities".

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Part C: Regional environmental impact assessment. Chapter 10 Other regional impacts	10-56	Figure 10.8 Typical treatment zones for utilities under the propose CSELR alignment	The impact zones along the UNSW campus boundary adjacent to Anzac Pde between High Street and Barker Street contains underground potable water pipework and valves serving UNSW buildings. UNSW has a significant amount of large stormwater pipework, drains and pits serving the immediate buildings as well as the wider campus. UNSW also has several hydrant booster points including both underground services and surface installations for fire fighting, plus trade waste infrastructure serving the Square House consisting of pipework, pits and control and monitoring equipment. This infrastructure is critical to UNSW's ongoing operations and maintaining service. Relocating the infrastructure outside the impact zones is critical.
	10-56	10.8 Consultation with utility owners and service providers	The list of utility owners consulted to date does not include AARnet. As AARnet is a major service provider to UNSW it is recommended that they are included on all lists of affected utility providers and consulted throughout the project.
	10-64 to 10.66	10.10.2 Hazards and risks during construction	There is no mention of the risk of services interruptions to UNSW's infrastructure during construction or the impact on UNSW operations if this occurs. It is essential that teaching and research projects on the campus are able to continue uninterrupted during the construction phase.
Part D: Local environmental impact assessment. Chapter 15 Local impacts - Randwick precinct	15-14	15.3.2 Impacts during operation	It is noted that the High Street/Wansey Road intersection will be signalised to accommodate pedestrians and light rail turning movements between Wansey Road and High Street. Also that pedestrian crossings will be provided at this intersection. Further discussion with UNSW is required as to how pedestrians, bicycles, buses and other vehicular traffic will be managed at the UNSW High Street stop and at the intersection of Wansey Road and High Street. Clarity is required on integration of the existing share bike path along Wansey Road. The provision of an indented bus bay within UNSW for westbound buses on High Street between Botany Street and Wansey Road is not supported. No discussion with UNSW on this matter has taken place. Adverse impact on UNSW underground services and loss of large mature trees will result. The temporary westbound stop west of Wansey Road during construction should become the permanent westbound stop in High Street.
	15-17	Table 15.8 Impacts on property access during operation of the CSELR proposal	Access arrangements for UNSW Gate 9 in High Street are unclear given the statement that most property access arrangements in High Street will be restricted to left-in-left-out operation with the exception of right turn access into the hospital. Further discussion with UNSW is required as to how pedestrians, bicycles, buses and other vehicular traffic will be managed at the UNSW High Street stop and at the intersection of Wansey Road and High Street.
	15-18	Table 15.9 Impacts on cyclists during operation of the CSELR proposal	Integration of the existing share bike path along Wansey Road is unclear. Further discussion with UNSW is required as to how pedestrians, bicycles, buses and other vehicular traffic will be managed at the UNSW High Street stop and at the intersection of Wansey Road and High Street. The statement that that Arthur Street will be designated as an alternative route for cyclists requires further discussion with TfNSW, UNSW and Randwick City Council.
	15-19	Table 15.10 Impacts on pedestrians during operation of the CSELR proposal	Further discussion with UNSW is required as to how pedestrians, bicycles, buses and other vehicular traffic will be managed at the UNSW High Street stop and at the intersection of Wansey Road and High Street. The impact on the kerb both sides of High Street will reduce the width of the verges and may also have an impact on existing trees and services within the verge. The section of High Street between Wansey Road and Botany Street is highly pedestrianised on both sides. Any loss of verge width should not reduce the exiting footpath widths.
	15-19	Table 15.11 Impacts on bus operations during operation of the CSELR proposal	The provision of an indented bus bay within UNSW for westbound buses on High Street between Botany Street and Wansey Road is not supported. No discussion with UNSW on this matter has taken place. Adverse impact on UNSW underground services and loss of large mature trees will result. The temporary westbound stop west of Wansey Road during construction should become the permanent westbound stop in High Street.
	15-20	Operational impacts on buses - High Street bus stops	
	15-23 & 15-24	15.3.3 Impacts during construction and Table 15.13 Proposed traffic management for key roads directly impacted by construction of the CSELR proposal	It is essential that the UNSW campus remains accessible during construction of the light rail for retail and other delivery vehicles, construction vehicles for sites on the campus, staff and student parking, cyclists and pedestrians.
	15-25 & 15.26	15.3.3 Impacts during construction. Construction impacts on existing bus services. University express bus services 890,891 and 892	It is essential that Eddy Avenue, Anzac Parade and High Street (and Alison Road during exam periods) remain operable for UNSW express bus services set downs and pick ups during light rail construction.
	15-26 & 15-27	University bus service 890, 891 and 892 and Figure 15.9 UNSW High Street bus relocation.	The existing westbound bus stop between Botany Street and Wansey Road will be relocated west of Wansey Road near Gate 8 during construction. This should be the premanent location following construction. This will alleviate the need for an indented bus bay on UNSW land between Botany Street and Wansey Road as is currently proposed and which is not supported by UNSW.

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	15-31	15.3.4 Management and mitigation - operation	Further discussion with UNSW is required as to how pedestrians, bicycles, buses and other vehicular traffic will be managed at the UNSW High Street stop and at the intersection of Wansey Road and High Street. Clarity is sought on what access arrangements are proposed for UNSW Gate 9 in High Street given that most property access arrangements in High Street will be restricted to left-in-left-out operation with the exception of right turn access into the hospital. The temporary westbound stop west of Wansey Road during construction should become the permanent westbound stop in High Street.
	15-32	15.3.4 Management and mitigation - construction	It is essential that the UNSW campus remains accessible during construction of the light rail for retail and other delivery vehicles, construction vehicles for sites on the campus, staff and student parking, cyclists and pedestrians. Eddy Avenue, Anzac Parade and High Street (and Alison Road during exam periods) must remain operable for UNSW express bus services set downs and pick ups during light rail construction.
Part D: Local environmental impact assessment. Chapter 15 Local impacts - Randwick precinct	15-45	15.4.4 Management and mitigation	Consultation with UNSW is essential during study and exam periods, for both the UNSW campus and for exam venues on the Randwick Racecourse.
	15-45	15.5 Noise and vibration.	It is unclear how existing noise and vibration adjacent to the UNSW campus at High Street has been measured and what the differences will be with the operation of the UNSW High Street stop. There is no reference to electro-magnetic impacts emanating from operation of the light rail tracks or from communications equipment at the UNSW High Street stop or on the light rail carriages. There are UNSW buildings on High Street containing equipment highly sensitive to vibration and electro-magnetic interference. Further discussion is required with UNSW on mitigation measures for noise, vibration and electro-magnetic impacts during both construction and operation.
	15-65	15.6.2 Direct impact to planted trees	The provision of an indented bus bay within UNSW for westbound buses on High Street is not supported. No discussion with UNSW on this matter has taken place. Adverse impact on UNSW underground services and loss of large mature trees will result. The temporary westbound stop west of Wansey Road during construction should become the permanent westbound stop in High Street, leaving the trees unaffected. The section of High Street between Wansey Road and Botany Street is highly pedestrianised and concern is expressed at the potential loss of street trees in this location given that this part of High Street provides an important frontage to the upper campus. There is no statement regarding the loss of the mature fig tree on the corner of Wansey Road and High Street. No tree replacement strategy is provided for this location.
	15-68	15.7.2 Visual sensitivity	The statement that "High Street from UNSW to the Prince of Wales Hospital is part of the institutional setting of Randwick and is considered to be of regional sensitivity" is noted. It is therefore unclear how the Park typology will apply at the UNSW High Street stop, given that grass tracks will not be implemented, the track treatment will be Park/Concrete and there will be loss of street trees in High Street between Botany Street and Wansey Road.
	15-77	15.7.7	No mitigation strategies are proposed with regards to the loss of trees referred to in the comment above relative to page 15-65. Given the regional sensitivity referred to on page 15-68, UNSW requests that tree planting strategies be put in place for High Street.
Part D: Local environmental impact assessment. Chapter 16 Kensington/Kingsford precinct	16-18 & 16-20	16.3.2 Impacts during operation - UNSW Anzac Parade stop. Figure 16.9b Functional changes to the road network	The side running track on UNSW land is not supported and it should be changed to a centre running track with an island platform so as to avoid loss of UNSW land, removal of significant trees and landscaping along the campus frontage. The preservation and maintenance of all significant fig trees along Anzac Parade in the vicinity of the UNSW campus is considered essential to preserve the amenity and character of the campus. No tree replacement strategy is provided. It is unclear how the Boulevard typology will apply at the UNSW Anzac Parade stop, given that grass tracks will not be implemented and the track treatment will be Boulevard/Concrete. Further discussion with UNSW is required as to how pedestrians, cyclists and buses will be managed at this stop.
	16-26 & 16-27	16.3.3 Impacts during construction - construction impacts on property access. Table 16.9 Proposed traffic management for key roads impacted by the construction of the CSELR proposal.	For the Anzac Parade/High Street intersection, concern is expressed at the statement in the Table that "vehicles exceeding 12.5 metres long would be prohibited from turning at this intersection". Barker Street as an alternative access route to the UNSW campus via Gate 14 is not possible for liquid gas deliveries that can only access the northern half of the campus via High Street and Gate 2. It is unclear if vehicles greater than 12.5 metres long are prohibited from this intersection only during weekend construction works, or during operation of the light rail as well. Eddy Avenue, Anzac Parade and High Street (and Alison Road during exam periods) must remain operable for UNSW express bus services set downs and pick ups during light rail construction.
	16-30	16.3.4 Management and mitigation	Clarity is required around the statement that "The staging of the intersection of Anzac Parade and High Street would maintain all existing movements at this intersection". This does not relate to the statement in Table 16.9 that vehicles exceeding 12.5 metres long would be prohibited from this intersection - see comment above.
	16-34	Figure 16.10b Kensington/Kingsford Precinct - land use and property	The temporary and permanent acquisition of land on the UNSW campus for a construction compound and side running track at the UNSW Anzac Parade stop is not supported for the reasons previously given above.
	16-42	16.4.3 Impacts during construction	The use of land on the UNSW campus for a construction compound and a side running track at the UNSW Anzac Parade stop is not supported for the reasons previously given above.

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	16-43 to 16-57	16.5 Noise and vibration	It is unclear how existing noise and vibration adjacent to the UNSW campus at Anzac Parade has been measured and what the differences will be with the operation of the UNSW Anzac Parade stop. There is no reference to electro-magnetic impacts emanating from operation of the light rail tracks or from communications equipment at the UNSW Anzac Parade stop or on the light rail carriages. There are UNSW buildings on Anzac Parade containing equipment highly sensitive to vibration and electro-magnetic interference. There are also a number of residential colleges on the campus fronting Anzac Parade. Further discussion is required with UNSW on mitigation measures for noise, vibration and electro-magnetic impacts during both construction and operation.
	16-58	Table 16.18	The statement that the trees on UNSW land "currently make a substantial contribution to the landscape amenity of the campus and the adjacent section of Anzac Parade", is supported. The preservation and maintenance of all significant fig trees along Anzac Parade in the vicinity of the UNSW campus is considered essential to preserve the amenity and character of the campus. It is unclear how the Boulevard typology will apply at the UNSW Anzac Parade stop, given that grass tracks will not be implemented and the track treatment will be Boulevard/Concrete.
Part D: Local environmental impact assessment. Chapter 16 Kensington/Kingsford precinct	16-60 & 16-61	Figure 16.19b Impacts to planted trees. 16.6.2 Direct impact to planted trees	The removal of planted trees on the UNSW campus is not supported because the construction compound, the side running track and UNSW Anzac Parade stop on UNSW land are not supported - for the reasons previously given above.
	16-61 & 16-62	16.6.3 Mitigation measures	The proposed mitigation measures are not supported because the construction compound, the side running track and UNSW Anzac Parade stop on UNSW land that requires the removal of the fig trees is not supported - for the reasons previously given above.
	16-63	16.7.2 Visual sensitivity	UNSW supports the statement that the "UNSW campus is a clearly defined precinct characterised by mature trees and green lawns, pedestrian plazas and modern institutional buildings. The landscape and visual character of this area is considered to be of regional sensitivity as this precinct is a feature of the locality". Therefore the removal of planted trees on the UNSW campus is not supported because the construction compound, the side running track and UNSW Anzac Parade stop on UNSW land are not supported - for the reasons previously given above.
	16-67	Table 16.20 Kensington/Kingsford precinct - assessment of representative viewpoints	For Anzac Parade at the UNSW campus the table is not supported because the construction compound, the side running track and UNSW Anzac Parade stop on UNSW land are not supported - for the reasons previously given above.
	16-79	16.8.2 Impacts on heritage items and Table 16.27 Summary of impacts on heritage listed items	It is noted that the trees along the western Anzac Parade boundary of UNSW near the main entrance are listed on the Randwick City Council Register of Significant Trees. The proposed CSELR construction and the UNSW Anzac Parade stop will necessitate the removal of a number of these trees. The trees are identified as a significant group of plantings as well as being individual mature plantings with historic significance. The statement that removal of these trees and extensive pruning would have a major adverse impact on the group and result in the loss of individual elements that demonstrate the pre-UNSW racecourse phase of the site is supported. The construction compound, side running track and UNSW Anzac Parade stop on UNSW land is not supported for the reasons previously given above.
	16-81 & 16-82	16.8.4 Management and mitigation	The statement that "Where UNSW significant trees must be removed, suitable replacements would be made where possible" is not supported because the construction compound, side running track and UNSW Anzac Parade stop on UNSW land is not supported - for the reasons previously given above.

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Part E: Environmental management & conclusions. Chapter 18 Environmental management & mitigation	18-6 to 18.40	Tabel 18.4 Environmental risk analysis for the CSELR proposal	The risk assessment fails to identify that UNSW is the service utility provider, owner and maintainer for the UNSW Kensington Campus and as a result has not been consulted on these issues. The risk matrix details that several of the risks identified in the Utilities and Services category have a medium/low residual risk rating. UNSW does not agree with this assessment. The risks include: • Significant number of services and utilities requiring relocation or protection as part of the CSELR proposal, increasing the area of disturbance, • Disruption to asset owner access to services and utilities. • Damage to services and utilities during construction of the proposal (including associated safety risks, such as earth potential rise). • Additional draw of electrical power (and thus additional power supply required in the local area) to run the light rail vehicles and electrical equipment at each of the stops, maintenance facility and stabling yard. • Buried cables and stray leakage currents from the running rails into surrounding earth causing cause electrolysis corrosion of nearby buried metalwork. The risk matrix details that several of the risks identified in the Hydrology, drainage and surface water quality category have a igh/medium/low residual risk rating. UNSW does not agree with this assessment. The risks include; • Potential stormwater ponding along the alignment affecting operation of the LRVs. • Potential for the proposal to result in exacerbation of existing localised stormwater flooding events during operation. The risk matrix details that several of the risks identified in the Groundwater category have a medium/low residual risk rating. UNSW does not agree with this assessment. The risks include: • Localised drawdown of the water table, resulting in a change in groundwater flow direction due to groundwater intersection and dewatering • Ground settlement risks to existing buildings and infrastructure due to groundwater drawdown during construction. • Impacts to bores • Contamination of groundwater aquifers due to accidental chemical spills or leakage from construction and maintenance plant, vehicles, equipment and storage areas.
Appendix I. Proposed mitigation measures	I-5	Table I.1 Detailed design and preconstruction phase environmental management measures - hydrology, drainage and surface water	The current design finished levels along Anzac Pde will potentially dam the north west corner of the UNSW campus, causing medium level flooding to at least three buildings. The design needs to be revisited to reduce the rail levels to suit. A new land detailed level survey is required to ascertain an appropriate design level to provide the same protection as can be provided with the ground levels existing at present.
Appendix I. Proposed mitigation measures	I-5	Table I.1 Detailed design and preconstruction phase environmental management measures - groundwater	A field survey would be undertaken to confirm the existence, usage and condition of any bore located within the construction footprint of the CSELR proposal, or potentially affected by the CSELR proposal (e.g. those located in the vicinity of proposed excavations). This would cover an area appropriate to identify potential dewatering impacts. There is no evidence that the three production bores on UNSW land were included in this field survey.
	I-5	Table I.1 Detailed design and preconstruction phase environmental management measures - groundwater	UNSW Production Bores No3 and 4 are to be relocated to available sites within UNSW campus, to sites which will provide a long term pumping rate for each bore of 18L/sec. This will require the bores to be located in the NW corner of the site to a depth to rock of about 30m (identical to the existing bores). Full hydraulic / mechanical design is required for the bore, casing, pump, controls, power supply, new 150mm bore water connecting mains and a new system drain to stormwater, relocation of associated buried pipeline and valves away from the site to be acquired. All designs are to be as approved by UNSW. Lead time for this work is at least six months with design and construction costs estimated at some \$1m.
Technical Paper 1. Traffic Operations	20 & 21	1.5.2 Project Definition	Special event platforms are to be installed at Chalmers, Randwick Racecourse and Moore Park to accommodate 45m and 90m (double length) light rail vehicles. UNSW Anzac Parade and UNSW High Street stops are listed as only having 45m platforms. The numbers of passengers listed for the other locations are below the numbers listed for UNSW an a daily basis.
	41	2.4 Special Events 2.4.1 Overview	Special events as listed have over 15,000 in attendance. UNSW has a daily attendance of more than 15,000 however an extended platform is not proposed for the two UNSW stops.
	93	Figure 2.30 Existing bicycle network within the Kingsford precinct	The figure shows both existing and planned bicycle paths, not just existing. The on road bike path shown through the Kensington campus is incorrect - it does not exist. The planned off road bike path along Anzac Parade in the vicinity of the campus is not supported - there will be insufficienct footpath widths as a consequence of the light rail construction.
	111	3.1.2.3 UNSW campus development	The numbers listed as arriving by public transport (25,000 to 30,000) supports the installation of special event platforms at UNSW/ Chalmers.
	117	Table 3.11: 2021 AM peak CSELR boardings and mode of access by light rail stop	The bar graph for Central Station appears incorrect as no transfers from the rail network are shown and the number of passengers appears unrealistically low. The numbers do not corrolate with UNSW arrivals and departure data for the two UNSW stops.

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	174 & 175	5.4.5.2 Wansey Road	Integration of the existing share bike path along Wansey Road is unclear. Further discussion with UNSW is required as to how pedestrians, bicycles, buses and other vehicular traffic will be managed at the UNSW High Street stop and at the intersection of Wansey Road and High Street.
	176 & 177	5.4.5.3 High Street	The provision of an indented bus bay within UNSW for westbound buses on High Street is not supported. No discussion with UNSW on this matter has taken place. Adverse impact on UNSW underground services and loss of large mature trees will result. The temporary westbound stop west of Wansey Road during construction should become the permanent westbound stop in High Street, leaving the trees unaffected.
	314	Table 7.11 Central Station Precinct Access Plan	Boarding and alightings numbers in the table are below UNSW arrivals and departures data for the UNSW Anzac Parade and UNSW High Street stops. The numbers do not corrolate with UNSW arrivals and departure data for the two UNSW stops.
	327	7.3.15 UNSW Anzac Parade precinct access plan	The Precinct Plan as currently proposed is not supported because the side running track and UNSW Anzac Parade stop on UNSW is not supported - for the reasons previously given above. Boarding and alightings numbers in the table are below UNSW arrivals and departures data for this stop.
	328	Table 7.16 UNSW Anzac Parade precinct access plan	
	329	Figure 7-15 UNSW Anzac Parade precinct access plan	
	340	7.3.20 UNSW High Street precinct access plan	Further discussion with UNSW is required as to how pedestrians, bicycles, buses and other vehicular traffic will be managed at the UNSW High Street stop and at the intersection of Wansey Road and High Street. Clarity is required on integration of the existing share bike path along Wansey Road. The provision of an indented bus bay within UNSW for westbound buses on High Street between Botany Street and Wansey Road is not supported for the reasons given previously above. The temporary westbound stop west of Wansey Road during construction should become the permanent westbound stop in High Street. Boarding and alightings numbers in the table are below UNSW arrivals and departures data for this stop.
	340	Table 7.21 UNSW High Street precinct access plan	
	341	Figure 7-20 UNSW High Street precinct access plan	
Technical Paper 2. Construction Traffic & Transport Management Strategy	xvi	Executive Summary: Kingford Precinct - construction impacts and mitigation	UNSW notes and supports Kingsford mitigation options of tidal flow operation on Anzac Parade and staged construction activities in the Anzac Parade and Alison Road corridors. It is essential that Anzac Parade and Alison Road (during exam periods) remain operable for UNSW express bus services set downs and pick ups during light rail construction.
	xvi & xvii	Executive Summary: Randwick Precinct - construction impacts and mitigation	UNSW notes there are no mitigation options identified. It is essential that High Street and Alison Road (during exam periods) remain operable for UNSW express bus services set downs and pick ups during light rail construction.
	7	1.4 CSELR Project Overview	Special event sidings 90M long are proposed at Chalmers St and Moore Park but does not include UNSW. UNSW arrivals and departures equate to a special event every day during semester. Further discussion is required on platform lengths at the two UNSW stops.
Technical Paper 2. Construction Traffic & Transport Management Strategy	19 & 20	2.5 Intersection Works	It is essential that the UNSW campus remains accessible during construction of the light rail for retail and other delivery vehicles, construction vehicles for sites on the campus, staff and student parking, cyclists and pedestrians. It is also essential that intersection works cease during exam study periods.
	26	2.10.5 Special Events	UNSW notes that TfNSW will seek agreement to ensure that Class 1 and 2 events do not occur concurrently and that known special events will be incorporated into the construction program with approval managed through the NCLG. UNSW express bus services should be identified as a special event.
	27	3.2.1 Bus Management	UNSW notes that a south east bus plan will be developed.
	30	3.2.1 Bus Management - Eddy Avenue	It is essential that Eddy Avenue remains operable for UNSW express bus services set downs and pick ups during light rail construction.
	44	4.4.1 Network Management Plan	UNSW notes that the Network Management Plan will have "... the high level objective of maintaining network journey times and congestion levels at acceptable levels." Acceptable levels are not defined in the document.
	53	3.9.2 Network Performance and Figure 3.10 Network performance statistics AM peak	Traffic outcomes for the south east corridors are worse than for the CBD cordon e.g. 11% increase in travel time in the CBD cordon versus 15% for the full model area.
	57	3.9.3.2 Intersection delays	UNSW notes that intersection delay diagrams are only shown for the CBD not for the south east.
	129	4.5.2.3 High Street	It is essential that the UNSW campus remains accessible during construction of the light rail for retail and other delivery vehicles, construction vehicles for sites on the campus, staff and student parking, cyclists and pedestrians. It is also essential that intersection works cease during exam study periods.
	132	Table 4.5 Summary of proposed conditions for Anzac Parade intersection closures	UNSW notes only vehicles up to 12.5 metres long will be able to access High Street from Anzac Parade. It is essential that Eddy Avenue, Anzac Parade and High Street (and Alison Road during exam periods) remain operable for UNSW express bus services set downs and pick ups during light rail construction.
	152	4.6.6.5 University express bus services 890, 891 and 892	It is essential that Eddy Avenue, Anzac Parade and High Street (and Alison Road during exam periods) remain operable for UNSW express bus services set downs and pick ups during light rail construction.

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	176 & 177	Appendix B.2 Pitt Street / Eddy Avenue indicative staging	It appears from the diagrams there will be limited access to Eddy Ave from Pitt St. UNSW express buses use Pitt St as a staging area to provide the number of services required. It is essential that Eddy Avenue remains operable for UNSW express bus services set downs and pick ups during light rail construction.
	195 & 196	Appendix B.8 High Street indicative staging plan	It is essential that the UNSW campus remains accessible during construction of the light rail for retail and other delivery vehicles, construction vehicles for sites on the campus, staff and student parking, cyclists and pedestrians. It is also essential that intersection works cease during exam study periods.
Technical Paper 5. Heritage Impact Assessment	(ii)	Executive Summary	The statement that the proposed CSELR route would have an major adverse impact on significant trees on the western Anzac Parade boundary of UNSW is supported.
	(iii)	Executive Summary	It is noted that no mitigation measures with regard to these trees is mentioned in the Executive Summary, but are stated on page 363 of the report.
	176	4.1.1 - Historical Archaeology - Methodology	It is noted that for the works on UNSW land there is a low-moderate potential for historical archaeological remains to be present and that some open area excavation and archival recording during site works and post-excavation analysis may be required.
	322	5.6.3 - Kensington / Kingsford Precinct - Detailed Heritage Impact Assessment	It is noted that the trees along the western Anzac Parade boundary of UNSW near the main entrance are listed on the Randwick City Council Register of Significant Trees. The proposed CSELR construction and the UNSW Anzac Parade stop will necessitate the removal of a number of these trees. The trees are identified as a significant group of plantings as well as being individual mature plantings with historic significance. The statement that removal of these trees and extensive pruning would have a major adverse impact on the group and result in the loss of individual elements that demonstrate the pre-UNSW racecourse phase of the site is supported. The side running track on UNSW land is not supported and it should be moved to a centre running track with an island platform for the reasons previously given above.
	363	6.0 Mitigation Measures - 6.2.3 Built and Landcape Heritage	It is noted that the table identifies the impact on the significant trees on UNSW land as 'Major Adverse'. The proposed mitigation measures for detailed design of the CSELR and the UNSW stop to retain, if possible the two significant Moreton Bay fig trees and eight significant Port Jackson Figs along the Anzac Parade boundary of UNSW is supported and that where these significant trees must be removed then suitable replacements would be made. However, the side running track on UNSW land is not supported and it should be moved to a centre running track with an island platform for the reasons previously given above.
Technical Paper 6. Heritage Interpretation Strategy	45	4.2 Interpretive Concepts	The use of the UNSW Anzac Parade stop as a location for interpretive signage or evocative historical imagery is supported.
Technical Paper 8. Greenhouse Gas Assessment	3	2.2 Australian Policy	This section is now out of date and requires revision
Technical Paper 9. Preliminary Tree Assessment	C1	Appendix C	19 trees were assessed along the Anzac Parade fenceline on UNSW property. All trees were given a SULE rating of 2a. UNSW agrees with this except for trees numbered 744 and 745 on the assessment sheet. Both trees are Ficus macrophylla of significant size and are listed among a group of 10 trees under EIS Volume 5 - Technical Paper 5 - Heritage Impact Assessment , page 327, UNSW Significant Trees. Tees 744 and 745 should have a SULE rating of 1a.
Technical Paper 11. Noise and Vibration Assessment	All	All	It is unclear how existing noise and vibration adjacent to the UNSW campus at High Street has been measured and what the differences will be with the operation of the UNSW High Street stop. There is no reference to electro-magnetic impacts emanating from operation of the light rail tracks or from communications equipment at the UNSW High Street stop or on the light rail carriages. There are UNSW buildings on High Street containing equipment highly sensitive to vibration and electro-magnetic interference. Further discussion is required with UNSW on mitigation measures for noise, vibration and electro-magnetic impacts during both construction and operation.
	53 & 54	6.2.3 Vibration sensitive equipment criteria	UNSW notes that two precincts have been identified as critically sensitive to vibration, since they contain precision research and/or imaging facilities. These are the the Lowy, Wallace Wurth and the Prince of Wales Hospital buildings at High Street; and the Tyree Energy Technology Building at Anzac Parade. UNSW confirms that both of these precincts will continue to be the focus of precision laboratories into the future so that their protection from excess vibratoin should be maintained. UNSW notes that the High Street precinct is identified in the Report as requiring the highest level of vibration protection, Treatment type S3. UNSW requests that the Anzac Parade section from NIDA past the Tyree building, which currently shows no vibratoin treatment, also be identified as requiring Treatment type S3.