

CBD AND SOUTH EAST LIGHT RAIL PROJECT
ENVIRONMENTAL IMPACT STATEMENT

VOLUME 2

Technical papers

TECHNICAL PAPER 1: TRANSPORT OPERATIONS REPORT



booz&co.

AECOM

**FINAL
REPORT**

TRANSPORT OPERATIONS REPORT

**TRANSPORT
FOR NSW**

**6 NOVEMBER
2013**

SYDNEY

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Executive Summary

Purpose of the Report

This report documents the traffic and transport assessments undertaken for the permanent (operational) changes associated with the CBD and South East Light Rail (CSELR) proposal, including:

- The management and operation of:
 - traffic and transport integration;
 - access to key light rail stops and interchanges (considering customer access by bus, private vehicle, foot, bicycle, light rail, heavy rail, and ferry);
 - traffic once the CSELR proposal is in operation; and
 - pedestrian, cyclist and traffic and transport safety¹
- The integration of traffic and light rail within the road environment
- Intersection analysis validating the proposed traffic management changes for intersections directly along the corridor
- Parking and access strategy including an assessment of the impact of light rail on:
 - vehicular access to properties located along the proposal corridor;
 - kerbside access including parking, loading zones, bus zones; and
 - the provision for emergency vehicle access, refuse collection vehicles and other service vehicles
- Special events analysis, to assess the compatibility of light rail with special events (such as street parades, major sporting and cultural events) along the proposal corridor.

It is one of a number of technical documents prepared to support the planning approvals process for Transport for NSW's (TfNSW) State Significant Infrastructure Application for the CSELR proposal under Part 5.1 of the NSW Environmental Planning & Assessment Act 1979 (EP&A Act).

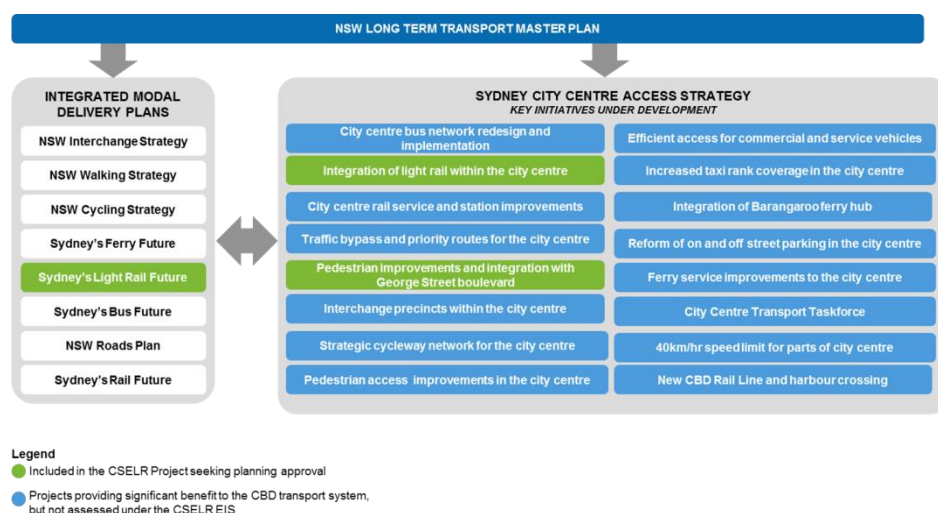
Strategic Context

Since November 2011, the NSW Government has been developing a number of transport strategies to underpin the NSW Long Term Transport Master Plan (LTTMP) – the guiding blueprint for the allocation of infrastructure investment and delivery of transport services in NSW. As illustrated in Figure 0-1 one key supporting document is the Sydney City Centre Access Strategy (CCAS), which outlines a suite of initiatives to dramatically and meaningfully improve the way the CBD transport system operates. Two critical projects which form part of the CCAS are the CSELR project and pedestrianisation of George Street. Planning approval for these two projects is currently being sought as part of the CSELR Environmental Impact Assessment.

Other components of the CCAS are anticipated to be implemented over a number of years, but complementary to and in coordination with the CSELR proposals. One component of the CCAS of particular relevance to the CSELR is the city centre bus network redesign. These bus changes are being prepared in parallel with development of the CSELR proposal and will be consistent with the CSELR proposal. These will not, therefore, form part of the EIS for the CSELR proposal, with the exception of cumulative impact considerations.

¹ For detailed guiding principles for light rail customer safety, please refer to the Light Rail Operational Service Plan Report by Interfleet.

Figure 0-1: Transport for NSW Strategic Framework



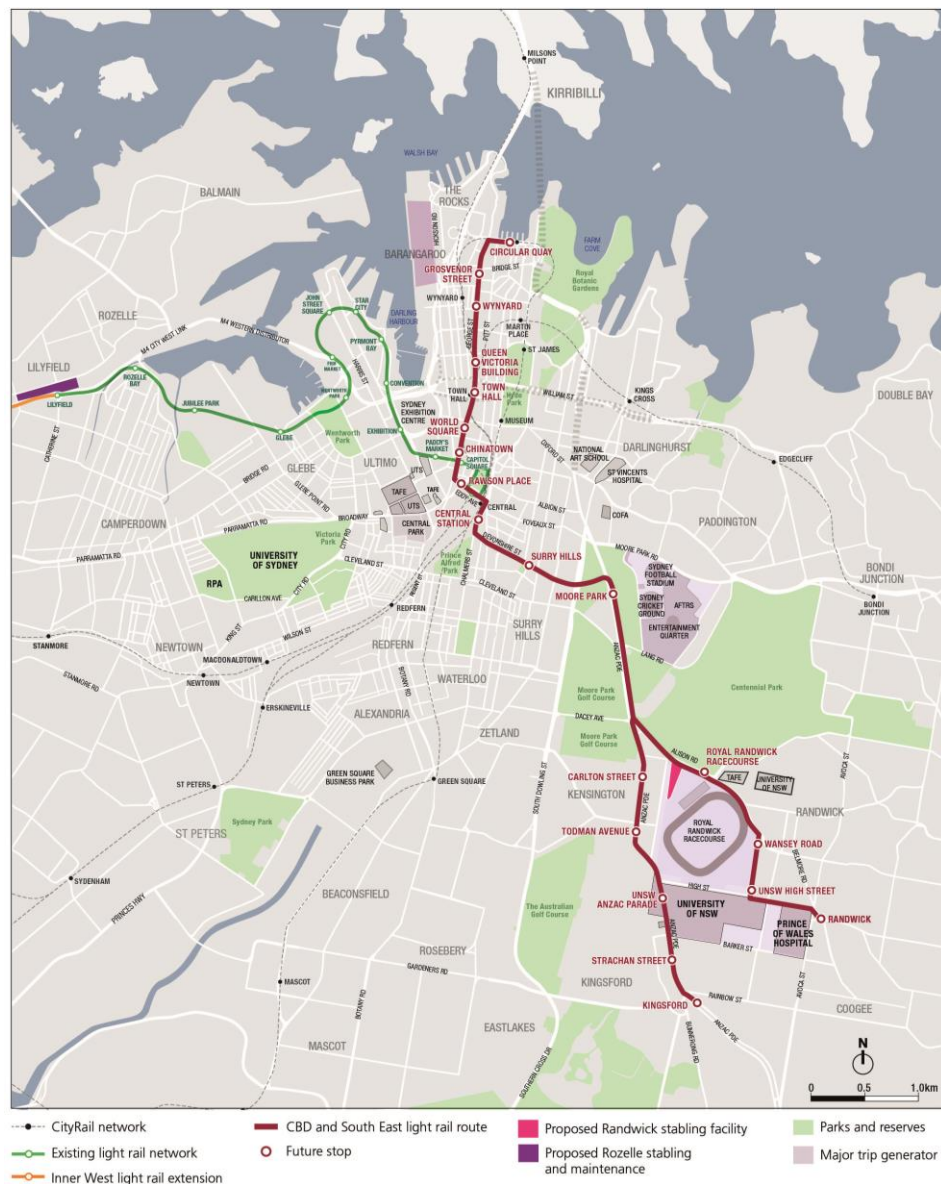
The CCAS will provide an integrated solution aimed at improving amenity, transport capacity and reliability within the CBD and South East.

The introduction of light rail will fundamentally change the way transport services are delivered and used within Inner Sydney. Aligned with the NSW 2021 transport goals, the construction of a new high-capacity, frequent and reliable mode of transport presents a rare opportunity to integrate the surrounding road and public transport system to unlock additional capacity and provide a better experience to customers who rely on the system every day through providing safe journeys and reduced travel times. Historically, Sydney has relied on a radial public transport system where each 'spoke' entered the City Centre independently. With light rail as a 'trunk' line, it can be integrated with a reorganised surrounding surface public transport system to provide significant customer benefits, including enhanced accessibility and mode share connectivity, and improve the efficiency of the network as a whole.

The CSELR Project

In December 2012, the NSW Government announced that it would extend light rail from Circular Quay to Kingsford and Randwick, through the heart of the Sydney CBD via George Street as illustrated in Figure 0-2. The Project comprises 20 stops, and will integrate with both the bus network and heavy rail stations at Circular Quay, Wynyard, Town Hall and Central. Services will be provided by 45 metre low-floor light rail vehicles, providing capacity for up to 300 customers (the equivalent of five standard length buses). The line will operate in a dedicated light rail lane, minimising competition with other modes of transport such as cars and buses. In addition, light rail will be given signal priority at intersections where possible to deliver a 97% level of service reliability – substantially better than existing bus services.

Figure 0-2: Route of the CBD South East Light Rail Project



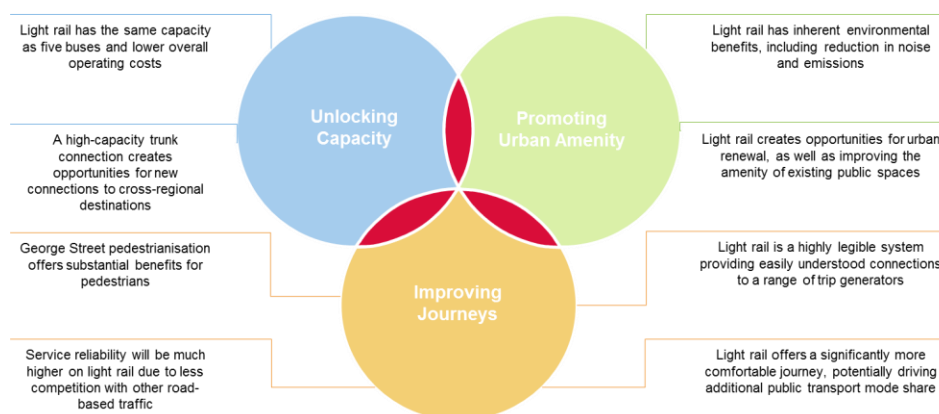
Case for Change

Delivery of the CSELR project addresses a number of deficiencies of the existing transport system in Inner Sydney, which highlight the cost of doing nothing. The key deficiencies include:

- Current levels of congestion are restraining economic development, with the avoidable cost of congestion in Sydney equalling more than \$3.5 billion per year and predicted to rise to \$7.8 billion by 2020;
- The capacity of buses to continue providing the lion's share of service is limited due to the significant number of services currently operating in the City Centre (around 1,600 in the 2 hour morning peak) causing service quality to substantially degrade on a regular basis;
- The CBD and South East (CSE) corridor does not have the capacity to support the growth of the existing bus-based transport system due to limited road space, constrained access to the CBD and the impracticality of constructing additional surface road capacity;
- The performance of the existing public transport system in the CSE corridor is not meeting community expectations. Analysis suggests the proportion of bus services arriving at the CBD within 2 minutes of their scheduled time is between 19 and 34 per cent; and
- Significant growth in Inner Sydney – including an additional 99,000 residents and 140,000 workers in the City of Sydney as well as 24,000 new residents and 13,000 new workers in the Randwick Local Government Area (LGA) – will place increasing pressure on Sydney's ageing public transport infrastructure.

The CSELR project offers a number of benefits that can address these challenges, summarised in Figure 0-3.

Figure 0-3: Potential Benefits from the Introduction of the CSELR²



These benefits are substantial, and flow from a co-ordinated and well-planned shift to a higher order transport system. This is because:

- Light rail provides substantial additional capacity compared to the existing bus solution. A single light rail vehicle can carry the equivalent of five standard rigid buses while using the same road length as just three buses;
- It also provides significantly improved reliability – by operating in a segregated environment without competition for road space, light rail can achieve service reliability of 97 per cent;
- Light rail can facilitate the reorganisation of the public transport network to provide additional cross-regional connections and improved access to key destinations;

² Booz & Company analysis

- Light rail is also more legible than the current transport system, attributable to comprehensible signage and clarity in the fixed design of the routes and stops, making it much easier for customers unfamiliar with the system to travel with ease.

Light rail as a catalyst for change

Introduction of the CSELR project provides a once-in-a-generation opportunity to transform the structure, operation and performance of the CBD and South East transport system to improve efficiency and deliver substantially improved customer outcomes. With light rail providing significant line haul capacity and reliability compared to buses on the trunk routes of Alison Road and Anzac Parade, an opportunity exists to redesign the surface transport system to provide simple, fast connections to CBD destinations and more direct cross-regional connections without the need to pass through the CBD.

Of course, as with introduction of any project of this scale into a congested urban environment there are a number of impacts on existing surface transport system users. These constraints are summarised in Table 0-1.

Table 0-1: CSELR Traffic & Transport Constraints³

Category	Traffic & Transport Constraints
<i>Network Operations</i>	■ General traffic lanes occupied by light rail ■ Potential for increased competition for road space between private vehicles and public transport in some locations ■ Capacity of alternate streets to absorb displaced traffic ■ Continued operation of bus priority with changes to bus lanes ■ East-west traffic flow might be impacted where traffic has to intersect with light rail
<i>Access</i>	■ Road operations changed which may limit access to some destinations ■ Potential for bus diversions that limit convenient and direct access to CBD rail stations for interchanging customers ■ Ability of local residents to access bus stops and local facilities ■ Footpath width and layout may constrain access to light rail stops
<i>Amenity</i>	■ Noise generated by light rail operations and passengers accessing light rail ■ Noise generated through diversion of traffic onto secondary streets
<i>Customer Experience</i>	■ Slower journey times for some customers ■ General traffic lanes occupied by light rail ■ Some customers might experience have to interchange due to changes in bus services ■ Pedestrians required to adopt changes in behaviour to ensure personal safety
<i>Kerbside Uses</i>	■ Loss of parking in some areas ■ Limitations on kerbside uses (taxi ranks, service deliveries etc.)
<i>Supporting Infrastructure</i>	■ Footpath capacity in some locations ■ Ability to provide cycling infrastructure

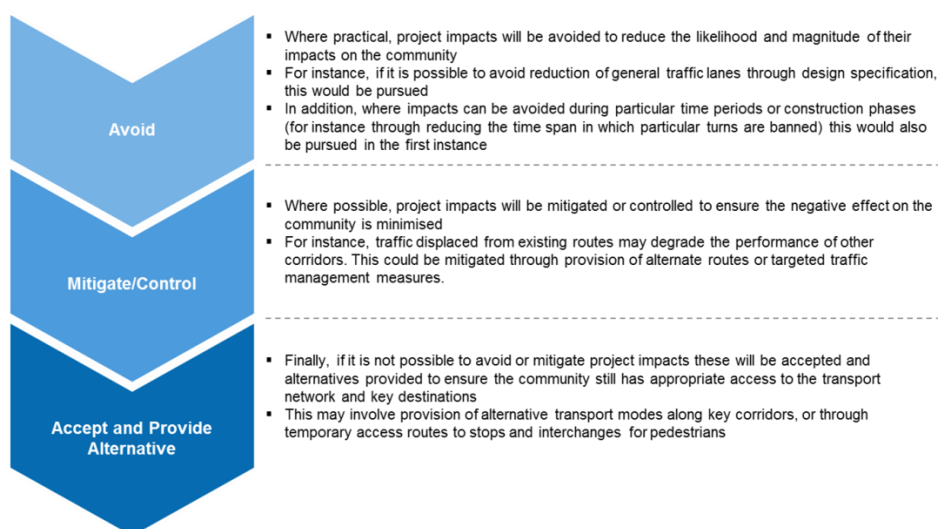
³ Booz & Company analysis

This report documents the significant investigations that were undertaken to determine the best way to integrate light rail into the surface public transport system, while managing those constraints. In particular, integration and network design issues were examined for:

- A. Road network design including benefits, impacts and mitigations in the CBD, Surry Hills, Moore Park, Randwick and Kingsford;
- B. Road network performance including indicative assessments of the impact of CSELR on road network carrying capacity;
- C. Improvements to bus network design including cross-regional connections;
- D. Delivery of integrated and convenient multi-modal access at each light rail stop; and
- E. Assessment of the impacts experienced by a range of kerbside uses and proposed mitigation strategies to manage those impacts.

These five areas are discussed in more detail below to determine appropriate mitigations to the impacts of the Project. Potential mitigations were examined in three categories to determine the best approach to manage project effects on the community. These are summarised in Figure 0-4. This framework was used when examining and determining the best response to project impacts in each of the categories described above.

Figure 0-4: Traffic & Transport Impact Management Framework⁴



⁴ Booz & Company analysis

(A) Integrating with the road network

A light rail system, by its nature as a road based public transport mode, needs to be designed into the road network and requires detailed consideration of all modes and associated management issues in all precincts along the corridor. Ultimately, the objective of this project is to maximise the level of passenger carrying capacity along the corridor and ensure a superior customer experience that encourages a mode shift from private vehicles. To achieve this, a number of key network changes are proposed including:

- A notable increase in public transport carrying capacity along the corridor;
- Pedestrianisation of sections of George Street and Alfred Street in the CBD;
- Development of significant transport interchanges at Circular Quay, Rawson Place, Chalmers Street, Randwick and Kingsford; and
- Re-prioritisation of the road hierarchy and kerbside uses in the CBD, Surry Hills, Randwick, Kensington and Kingsford.

CBD Precinct

The most significant change in the CBD is the transformation of George Street from a vehicle-based north-south corridor in the CBD to a part-pedestrianised public transport spine for the City, dedicated to the efficient delivery of light rail services to the heart of the City.

The pedestrianised zone delivered in conjunction with light rail yields substantial sustainability and amenity benefits through the provision of high-quality, safe and comfortable pedestrian connections through the heart of the CBD. However, the impacts on displaced traffic need to be acknowledged, and this report examines appropriate mitigation strategies to manage those consequences. Within the pedestrianised zone, no through traffic lanes are provided on George Street with vehicle restrictions ensuring only local access, service and emergency vehicles are permitted. Those vehicles that do access this section of George Street will travel adjacent to the light rail alignment in a shared zone environment. Cross-city connections in the East-West direction will be maintained through the pedestrianised zone.

Outside of the pedestrianised zone, the standard George Street cross section will consist of a single kerbside traffic lane in each direction with centre running light rail. This will reduce the importance of George Street as a route for through running traffic.

Chalmers Street has been designed as a major interchange between light rail and heavy rail at Central Station. The stop will be located on the western side of Chalmers Street, which will reduce the number of lanes available to buses and general traffic. Current planning allows from buses to be retained in Chalmers Street (using the third – special events only – light rail lane). These services will be permitted to proceed into Elizabeth Street. To compensate for the removal of general traffic lanes in this location, Randle Street will be reversed from one-way southbound to one-way northbound to enable a connection to the northbound lanes introduced on Elizabeth Street.

In addition to the significant changes on George Street, other changes in the CBD will affect the flow of vehicle based traffic through the City. These include:

- Conversion of Pitt Street to two-way operation between Bridge and Alfred Streets;
- Addition of a turning circle at the northern terminus of Pitt Street;
- Conversion of Hunter Street between Pitt and George Street to two-way operation providing enhanced connectivity to the east and west;
- Construction of a significant bus-light rail interchange in Rawson Place facilitating cross-platform interchange between bus and light rail for a significant number of customers travelling south-west of Railway Square along Broadway;

- Construction of the light rail line on the southern side of Eddy Avenue, requiring the relocation of existing coach facilities to a dedicated 4.5 metre wide island coach platform accessed (by coaches) from the existing Eddy Avenue traffic lanes.

Surry Hills Precinct

In the Surry Hills precinct, (on Devonshire Street) significant changes are required to facilitate provision of light rail in the southern lanes. The primary changes include:

- Delivery of a single eastbound traffic lane;
- Existing right turn movements for vehicles travelling eastbound along Devonshire Street wishing to head south are consolidated to Elizabeth Street and Crown Street only;
- A number of connecting streets will be closed at the Devonshire Street intersection; and
- No provision for parking would be accommodated along Devonshire Street.

To mitigate these local access impacts, a number of network changes are proposed to improve accessibility whilst maintaining the benefits to light rail operations including:

- Signalising of the intersection of Devonshire Street and Marlborough Street;
- Signalising of the intersection of Devonshire Street and Bourke Street;
- Reinstatement of the Cooper Street connection to Riley Road; and
- Introduction of a westbound service lane connection between Bourke Street and Crown Street.

Moore Park Precinct

Light rail is anticipated to exit Surry Hills through the site currently occupied by Olivia Gardens, a residential apartment block, crossing South Dowling Street at grade before entering a cut and cover tunnel across Moore Park. The alignment will then be tunnelled under Anzac Parade to minimise traffic impacts to Anzac Parade during construction. To manage traffic in this area, southbound and northbound traffic on South Dowling Street will be controlled by signals. The light rail will then travel within Moore Park until it reaches the Alison Road / Anzac Parade intersection, where it splits into two branches.

Randwick Precinct

On Alison Road, light rail is proposed to operate within the existing busway alignment on the north/east side of the road as far as Doncaster Avenue, facilitating the retention of existing traffic movements and lane configurations in the northern section of Alison Road. At Doncaster Avenue the alignment crosses Alison Road to run adjacent to the racecourse, and continues on the southern side of Alison Road before turning into Wansey Road. Corridor width restrictions have restricted city bound traffic to two through lanes adjacent to the Darley Road/Alison Road intersection. On-street parking has also been restricted in this section of the corridor.

The design alignment for Wansey Road is located on the western edge of Wansey Road. Two-way traffic is retained, but on-street parking is removed. The cycleway and footpath will be retained on the western side.

Light Rail operates in the eastern section of High Street between Wansey Road and the Randwick terminus adopting a 'centre-running' arrangement with a single kerbside traffic lane in each direction. High Street is an important cross-regional bus route, and is used by a significant number of students, staff and visitors seeking to access the University of New South Wales (UNSW) and Prince of Wales Hospital. Other key design issues include:

- Introduction of traffic signals at the intersection of High Street and Hospital Road, as well as the intersection of High Street and Clara Street;

- Consolidation of the vehicular entrance at the Adult hospital to a four way intersection at Clara Street;
- Restriction of access to Eurimbla Avenue to Left in Left out;
- Additional parking restrictions and removal of parking spaces on High Street and Wansey Road;
- Provision for indented bus bays for westbound buses on High Street adjacent to the Adult hospital and between Botany Street and Wansey Road;
- Provision of bus stops in Clara Street;
- Removal of the eastbound bus stop in High Street, between Wansey Road and Botany Street is required. Eastbound buses will use the existing bus stop in High Street, west of Wansey Road and the new stop in Clara Street; and
- Relocation of the westbound bus stop adjacent to the Children's Hospital emergency entrance to Clara Street, with access to the hospital via a signalised intersection.

Kingsford Precinct

On Anzac Parade, light rail is proposed to operate in the median for virtually the full length of the alignment except for the section next to Moore Park, where light rail will run adjacent to the existing bus roadway (which will be retained). The significant available width of this corridor has permitted the retention of at least two general traffic lanes in each direction, with a third lane provided for peak hour bus priority and off-peak local parking where possible.

Due to the operation of light rail in the median, a reduction in permitted right turn locations has been required south of Alison Road. Right turns off Anzac Parade would be restricted to:

- A southbound right turn into Dacey Avenue;
- A southbound and northbound right turn into Todman Avenue;
- A northbound right turn into High Street; and
- A southbound and northbound right turn into Barker Street.

Existing right turn movements from signalised side roads into Anzac Parade will be retained.

Other design considerations in this area included:

- A fully integrated station design at the Kingsford terminus, permitting cross-platform interchange for the significant volume of customers expected to access the CSELR by bus;
- A shared running arrangement between the Kingsford terminus and Meeks Street, providing an opportunity to deliver operational priority for buses while also improving the functioning of the Gardeners Road/Anzac Parade intersection.

(B) Road Network Performance

Introduction of the CSELR and associated bus network changes in the CBD and South East will result in a considerable change to current traffic operating patterns. Providing a segregated route for the light rail to maximise public transport network carrying capacity will necessarily displace some road-based traffic. Traffic is expected to adopt one of three alternative behaviours:

- **Change mode** – current road users may change mode from private vehicles to public transport, taking advantage of reduced journey times and improved reliability provided by the light rail system;
- **Change time of travel** – increasingly flexible working arrangements provide some commuters with the ability to adjust their time of travel to avoid the most congested periods of the day; and
- **Reroute to other corridors** – displaced traffic will seek alternative routes that provide a lower level of delay, though the levels of congestion in the region provide limited alternative options.

The reallocation of road space from traffic lanes to light rail operation will result in a change to existing traffic patterns on and around the corridor. These traffic volume impacts have been assessed and determined through the mesoscopic modelling traffic assessment independently undertaken. This model provides an indication of key flow changes across the wider road network, specifically identifying those corridors that experience a significant change in traffic volumes to existing levels.

By the year 2021 traffic volumes in the study area are forecast to grow by 7% without the implementation of light rail. As a result of this growth on the network average vehicle speeds would likely reduce by approximately 10% from current levels.

Implementation of light rail is forecast to reduce this level of traffic growth by 1% as a result of the positive effect it has on public transport mode share. Whilst the reallocation of road space from general traffic to light rail reduces traffic capacity on the corridor modelling indicates it does not significantly impact functionality of the wider network.

Broadly speaking the traffic analysis demonstrates that the CSELR project can be introduced into the road network without significant detrimental impact to general traffic and buses. A number of key intersections have been identified where further design and optimisation work is underway, to provide increased capacity.

To address the effects of the identified future traffic patterns, TfNSW and RMS are working together to develop an appropriate Network Management Plan (NMP). This includes intersection modifications, traffic signal changes and traffic management measures that integrate to deliver the overall strategy for network operations with CSELR in place. This work is ongoing and the modelling assessment undertaken to date represents the first stage in the development of this wider NMP. As this plan is refined further improvement to the operation of the network is likely to be achieved.

(C) An improved and connected bus network

Light rail presents a significant opportunity to redesign bus routes in the corridor around the principles of a 'connected' network – providing high frequency and reliable connections to a light rail system that acts as a higher capacity, reliable and fast trunk line to the CBD. This will free up existing buses to service other destinations and unlock greater capacity in the transport network, as well as delivering sustainability benefits of reduced buses within the congested Sydney CBD. These changes are being developed as a separate project, however a summary of the future bus network is provided in this report to illustrate light rail's position within an integrated transport system.

The South East bus network has been developed based on a number of principles developed in consultation with Transport for NSW to ensure that in specifying the future bus network, the overall objective of maximising public transport network performance and usage, and successfully integrating bus and light rail services, was upheld.

Overview of the proposed network

The broad features of the proposed bus network for the CSELR in the South East area are summarised as follows:

- The majority of existing All-Stop CBD bus services which operate along Alison Road and Anzac Parade in duplication of the CSELR will no longer operate to the CBD but become feeder routes for the Light Rail;
- The only exceptions to the above are Routes 372 and Route 339 which are retained to provide bus service coverage in Cleveland Street and Albion/Foveaux Streets respectively;
- Cross-regional bus service connections are improved to provide greater access to the CSELR and to provide new cross regional connections which reduce the need for customers to travel through the CBD to access major centres such as Bondi Junction, Green Square and the Airport;
- University Express Bus Services provided between Central Station and the UNSW would be replaced by the CSELR;
- School Special Bus Services provided between Central Station and Sydney Boys High School and Sydney Girls High School would be replaced by the CSELR; and
- Special Event bus services provided between Central Station and the Moore Park Precinct and Randwick Racecourse during events would be replaced by the CSELR and may be reallocated to provide new connections to the special events precincts and together with light rail grow public transport mode share to major events.

Sydney City Centre Bus Network Redesign

In conjunction with the development of the south east corridor bus network the Sydney city centre bus network redesign was undertaken to develop the bus network within the Sydney CBD. The redesign seeks to provide improved legibility and access for existing and future customers to use buses, while the buses are operated more efficiently on city streets and into the City Centre via the gateways. The objectives are summarised below (with additional detail available in the City Centre Access Strategy):

- Create a simpler, all-day City Centre bus network;
- Accommodate high volumes of buses through the City Centre more efficiently with fewer turns and more bus priority; and
- Minimise the need for terminating services in the City Centre and provide sufficient capacity at conveniently located layover facilities.

(D) Delivering integrated and convenient multi-modal access

Ensuring delivery of a successful and well-utilised light rail system requires consideration of the full suite of access modes for the entire system. Demand modelling undertaken for the Project provides an indication of the preferred mode of access to each light rail stop in the future and was used to guide the development of multi-modal access strategies for each stop. These would ensure that pedestrian, cycling, bus transfer, kiss-and-ride, local parking, taxis, heavy and light rail, ferries and car share access were all considered during the Project design phase.

Development of these multi-modal access strategies identified a number of issues for further investigation, and these were addressed directly and resolved satisfactorily with the design team. Some of the key issues included:

- Chalmers Street stop design to ensure its suitability for the large volume of rail transfer passengers, particularly university students, accessing the stop during the weekday as well as significant crowds anticipated during major events;
- Rail replacement bussing arrangements at Central Station;
- Accommodating coach facilities at Central Station;
- Kingsford interchange design to cater for the more than 2,000 bus transfer passengers expected to use the interchange in the 2021 AM peak hour⁵;
- Randwick interchange design to similarly cater for the more than 1,600 bus transfer passengers anticipated to use the interchange in the 2021 AM peak hour⁶;
- Rawson Place interchange design to ensure its capacity to handle the substantial volume of bus transfer passengers travelling to destinations south-west of Railway Square;
- Bus priority and shared running options between Kingsford terminus and UNSW;
- Future operations of the Anzac Parade bus roadway;
- Devonshire Street traffic and local access issues;
- Anzac Parade – Alison Road intersection operation;

(E) Providing a practical mix of kerbside uses

Finally, a project parking and kerbside use strategy was developed to devise measures that balance project design requirements with corridor movement function and access requirements of land uses and stakeholders along the corridor. Fundamentally, this requires the re-allocation of road space to maximise the efficiency of these corridors for the benefit of all users. Throughout the corridors this will impact on, and necessitate changes to, parking and kerbside access. The key policy measures developed to ensure efficient use of road space and balancing the needs of network users with adequate opportunity for access include:

- Retaining existing parking and loading provision where feasible on the alignment.
- Considering replacement of impacted parking and loading on the alignment or in adjacent streets, within the same precinct where appropriate.
- Consolidation of parking and loading to ensure efficiency of road space allocation where appropriate.
- Defining a hierarchy of kerbside access for parking and loading provision including disabled, servicing & loading, short stay (commercial) and long stay (residential/commuter) parking - ordered from highest priority to lowest)

⁵ Transport for NSW, *Sydney Light Rail Round 5.2 Demand Report*, 2013

⁶ *Ibid*

In total, the CSELR alignment will impact on most existing spaces directly on the corridor. Detailed investigations into the usage of these spaces and other kerbside spaces in the surrounding precinct have concluded that the impact of this loss can be addressed through effective demand management measures. Existing parking and loading supply alternatives have been identified in the surrounding precincts to manage this loss, notwithstanding the ability of existing supply to meet the demand. Occupancy surveys conducted in each precinct has identified sufficient latent (i.e. unused) capacity to continue to meet the demand for kerbside uses following construction of the CSELR. Specific local impacts and treatments are also explored in Section 6.

Conclusion

The CSELR project presents an opportunity to shift Sydney's inner-urban public transport system to a higher order network design. With high-capacity, high-frequency, sustainable and reliable trunk services, as well as a redesigned suburban bus network and substantial pedestrian improvements in the CBD, Sydney will experience a step-change in transport service provision. Evolving to this next level of transport service provision in the congested heart of Sydney offers a number of benefits to improve journeys, create new capacity and deliver a sustainable and liveable city.

Of course, any change as significant as the introduction of light rail into a constrained urban environment will undoubtedly have impacts. The significant reprioritisation of the road hierarchy in the CBD, adjustments to the suburban bus system requiring some customers to interchange modes and the realignment of kerbside uses and parking availability will all impact on residents, retailers and commuters in different ways. However, the impacts of these changes have been examined and appropriate mitigation strategies developed to maximise the benefits available without unacceptable burdens falling on any single group of surface transport system users.

To ensure the road hierarchy in the CBD is appropriately reprioritised, George Street has been proposed to primarily cater for pedestrian and light rail use. To ensure optimal traffic operations in the CBD are achieved, priority traffic routes have been identified and will be upgraded as part of the CCAS.

Impacts on existing customers of suburban bus services have been mitigated through the provision of additional cross-regional routes to satisfy demand to key destinations and easy interchange access to light rail. Some existing CBD services have been changed to feeder routes for light rail, to avoid duplication of public transport services within the CBD.

The necessary balance between competing demands on kerbside uses and parking supply have been considered to ensure efficient use of public road space. Retention of existing parking and loading supply has been accommodated for where feasible and appropriate priority has been considered on streets immediately adjacent to the light rail corridor where commercial land uses are present for loading and short term parking.

The opportunity presented by the CSELR project is exciting – it will leave Inner Sydney with a fundamentally reformed urban transport system. Significant benefits and a range of impacts are the reality of any project of this scale, but the cost of doing nothing is far more significant than the challenge of introducing such a major shift in transport service provision. The benefits 400 cities⁷ globally have accrued through introduction of light rail system can be achieved in Sydney.

⁷ *International Association of Public Transport, 2013*

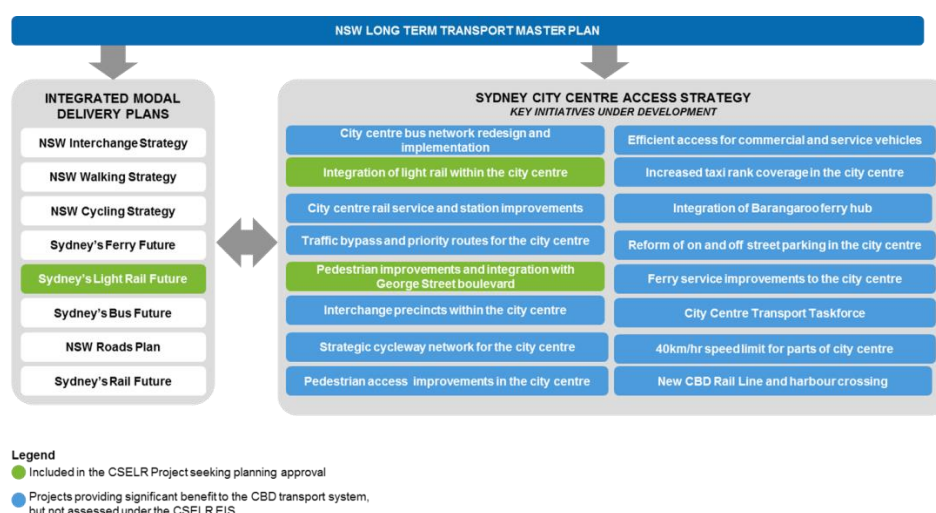
1. Introduction

1.1. Strategic Context

The NSW Government has developed a number of strategic priorities to guide infrastructure investment and service planning in New South Wales. At the highest level, strategic transport planning is led by the NSW Long Term Transport Master Plan, released in December 2012. The Master Plan guides transport planning and investment in the State, and includes 220 short, medium and long-term actions underpinned by a four-year investment framework of over \$50 billion in roads and public transport improvements.

The Master Plan is supported by specific modal plans and regional access strategies, depicted in Figure 1-1, that explore the specific design, implementation and operation of transport improvements. In Inner Sydney, integrated modal delivery plans are guiding the development of the Sydney City Centre Access Strategy – a suite of initiatives designed to dramatically improve the delivery of transport services in the congested heart of Sydney.

Figure 1-1: Transport for NSW Strategic Framework⁸



Two projects at the centre of the Sydney City Centre Access Strategy are the integration of light rail within the City Centre, as well as pedestrian improvements and integration with a George Street pedestrian zone. These projects have been extensively considered by the Government as potential solutions to many of Sydney's congestion challenges, and are explored in more detail in the next section.

However these improvements were not developed in isolation. Other access strategies support the Projects – including re-designed and improved bus networks, better interchange precincts in the City Centre and traffic bypass and priority routes for the City Centre. These bus changes are being prepared in parallel with development of the CSELR proposal and will be consistent with the Project, but are an independent initiative. The proposed changes will undergo a separate public consultation process. These will not, therefore, form part of the EIS for the CSELR proposal, with the exception of cumulative impact considerations.

⁸ Transport for NSW, unpublished data, 2013

The Project also aligns with a number of goals outlined in the NSW 2021 State Plan. Specifically, the Project is expected to align with:

- *Goal 1: Improve the performance of the NSW economy* - by creating construction jobs, improving journey times to support a more productive workforce and providing better connections to key job centres at Moore Park, UNSW and the Randwick health precinct;
- *Goal 2: Rebuild State finances* – by realising substantial economic benefits through a value-for-money project;
- *Goal 7: Reduce travel times* – by providing fast, convenient and reliable connections with reduced wait times for key destinations in the CBD and South East
- *Goal 8: Grow patronage on public transport by making it a more attractive choice and Goal 9: Improve customer experience with transport services* – by introducing a comfortable, frequent and reliable mode of transport to a currently congested part of Sydney;
- *Goal 19: Invest in critical infrastructure* – by delivering a key piece of infrastructure central to improving the transport system in central Sydney;
- *Goal 20: Build liveable centres* – with the CSELR anticipated to stimulate urban regeneration and consolidation;
- *Goal 27: Enhance cultural, creative, sporting and recreation opportunities* – by building a frequent and convenient mode of access to destinations such as the SCG, NIDA, Centennial Park and the Entertainment Quarter.

1.2. Sydney's Light Rail Future

The development of a strategy to improve access to the Sydney CBD has been a key policy question for Governments over recent years. The introduction of a light rail system to the CBD and surrounding suburbs has been considered as one potential solution to Sydney's congestion challenges.

To consider whether light rail is the appropriate solution for Sydney, the Government has undertaken an extensive program of investigation and consultation to assess the feasibility of light rail in three high priority corridors – the CBD, the University of Sydney and the UNSW. A shortlist of 11 route options were selected and investigated in consultation with councils, universities, business groups, Technical and Further Education (TAFE), hospitals, major sporting and entertainment precincts and other key groups.

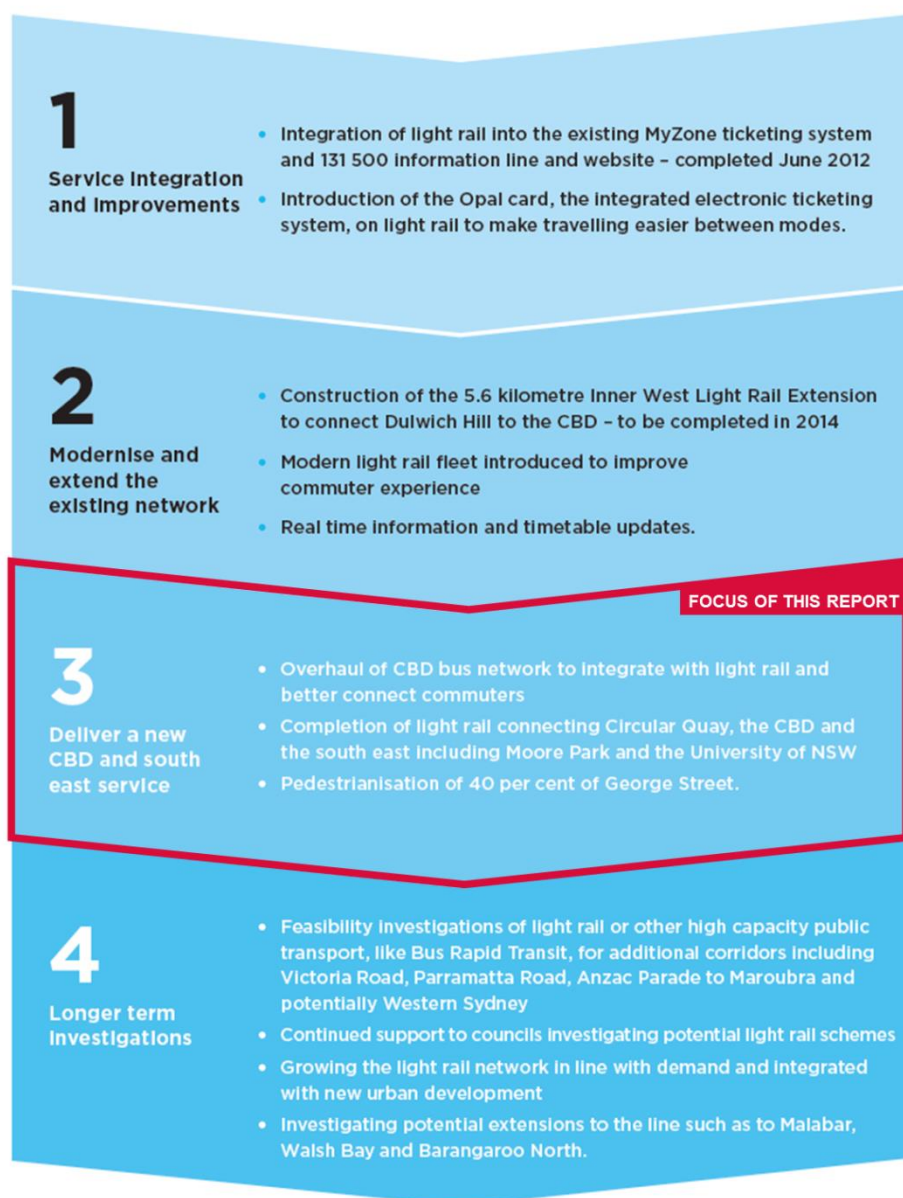
The 11 route options were developed and analysed, taking into account substantial work previously carried out. For each option, the following factors were considered:

- Ability to meet key objectives
- Costs and benefits
- Anticipated demand.

For the CBD to UNSW corridor it was also considered whether light rail or buses would be best suited to the corridor.

Ultimately, the Government decided to implement *Sydney's Light Rail Future*, which contains four stages to develop light rail as a high-quality and integrated element of Sydney's transport mix, described in Figure 1-2.

Figure 1-2: Stages of Sydney's Light Rail Future⁹



This report focuses on Stage 3 – the introduction of new light rail infrastructure in the CBD and South East and considers the broader traffic and transport implications of such a fundamental shift in the provision of transport for the region.

⁹ Transport for NSW, *Sydney's Light Rail Future*, 2012

1.3. Purpose of the report

Following the Government's decision to proceed with the CSELR project (CSELR or 'the Project'), detailed investigations were undertaken to determine the impact of the Project on what is a complex, congested and critical part of Sydney's transport network.

Booz & Company and AECOM were commissioned as Integrated Transport & Land Use Advisors supporting the Project Development Phase (Stage 2) of the Sydney Light Rail Program. The objective of this project phase was to better define the Project scope, develop a business case and eliminate enough uncertainty to allow the Project to proceed to delivery. Production of a Transport Operations Report (this report) was a key component of our work and would be a key input to development of the Environmental Assessment. It is intended to support Transport for NSW's application for planning approval to begin construction of the Project across a number of areas:

- The design of traffic and light rail integration within the CSELR corridor;
- Intersection analysis for all intersections in the corridor;
- Review and feedback on the Transport for NSW bus strategy in the Sydney CBD;
- Development of a bus network strategy for the remaining (non-CBD) project corridor;
- Development of a project parking and access strategy;

In summary, the report outlines a proposed approach for the redesigned traffic and transport system in the CBD and eastern suburbs to support the introduction of light rail, and move to a more evolved transport system that makes best use of available assets to provide a world-leading experience for customers.

This report identifies the substantial capacity, sustainability and reliability benefits that can accrue following construction of the CSELR project, but also seeks to quantify and mitigate the impacts of the Project on the broader traffic and transport system; such as the private traffic displaced from key streets in the CBD. To facilitate this process, a framework of impacts on the existing surface transport system was developed (presented in Table 1-1) for examination.

Table 1-1: CSELR Traffic & Transport Constraints¹⁰

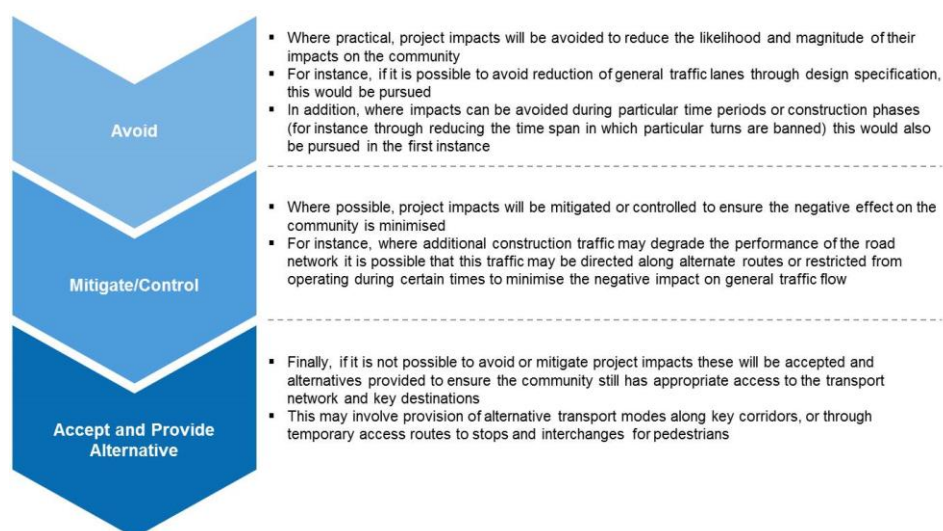
Category	Operational Constraints
<i>Network operations</i>	■ General traffic lanes occupied by light rail ■ Potential for increased competition for road space between private vehicles and public transport in some locations ■ Capacity of alternate streets to absorb displaced traffic ■ Continued operation of bus priority with changes to bus lanes ■ Light rail might impact east-west traffic flow
<i>Access</i>	■ Road operations changed which may limit access to some destinations ■ Potential for bus diversions that limit convenient and direct access to CBD rail stations for interchanging customers ■ Ability of local residents to access bus stops and local facilities ■ Footpath width and layout may constrain access to light rail stops
<i>Amenity</i>	■ Noise generated by light rail operations and passengers accessing light rail ■ Noise generated through diversion of traffic onto secondary streets

¹⁰ Booz & Company analysis

Category	Operational Constraints
<i>Customer Experience</i>	- Slower journey times for some customers - General traffic lanes occupied by light rail - Some customers might have to change a current one seat journey to a two seat journey due to changes in bus services
<i>Kerbside Uses</i>	- Loss of parking in some areas - Limitations on kerbside uses (taxi ranks, service deliveries etc.)
<i>Supporting Infrastructure</i>	- Footpath capacity in some locations - Ability to provide cycling infrastructure

These constraints were then quantified, and appropriate mitigation strategies developed within a framework of three categories – avoidance, mitigation or control and acceptance as presented in Figure 1-3. This report outlines the specific impact and their appropriate mitigation strategies through each of the sections described in Section 1.4.

Figure 1-3: Traffic & Transport Impact Management Framework¹¹



1.4. Report structure

The report contains 7 Chapters:

- This Chapter (Chapter One) outlines the proposed project and its role in the Government's strategic planning for the transport system, including:
 - The Government's strategic planning framework;
 - The current surface transport challenges facing the Inner Sydney Region;
 - The opportunity presented by light rail to solve some of those challenges.
- Chapter Two outlines the structure and performance of the existing traffic and transport system at a network level as well as across five precincts, including:
 - Road network, parking and access issues;
 - Design and performance of the existing bus network;
 - Current cycling infrastructure;

¹¹ Booz & Company analysis

- Current pedestrian infrastructure and flows; and
- Special events and their effect on the transport system.
- Chapter Three addresses the drivers of future transport network needs including:
 - Summarising anticipated future changes in demand that will accompany the introduction of CSELR;
 - Exploring land use changes and major developments expected to change travel patterns in the future; and
 - Summarising anticipated patterns of special events in the future, and how those might be managed at the strategic level.
- Chapter Four summarises the design of the future bus network in both the South East and CBD including coach and rail replacement bus requirements in the Central Station precinct.
- Chapter Five addresses specific aspects of the future state for the road network including:
 - The strategy development process and principles underpinning network design;
 - An explanation of the proposed future road network operations and analysis of anticipated network performance; and
 - Explanation of the proposed property access arrangements.
- Chapter Six develops the Project parking strategy to help the community understand the change in parking arrangements and other kerbside uses along the length of the corridor following introduction of light rail.
- Chapter Seven provides light rail stop precinct access plans for each light rail stop to demonstrate consideration and mitigation of the variety of multi-modal access constraints that may exist at each light rail stop.

1.5. The CSELR project

1.5.1. Overview

In December 2012, the NSW Government announced that it would extend light rail from Circular Quay to Kingsford and Randwick, through the heart of the Sydney CBD via George Street. The Project comprises 20 stops, and will integrate with both the bus network and heavy rail stations at Circular Quay, Wynyard, Town Hall and Central (Figure 1-4). Services will be provided by 45 metre low floor light rail vehicles, providing capacity for up to 300 customers (the equivalent of five standard length buses). The line will operate in a dedicated light rail lane, minimising competition with other modes of transport such as cars and buses. In addition, light rail will be given signal priority at intersections to deliver a 97% level of service reliability – substantially better than existing bus services.

Figure 1-4: Route of the CSELR project¹²



1.5.2. Project definition

The detailed project definition is documented and contained within the Supporting Documentation for Transport for NSW's State Significant Infrastructure Application made under Part 5.1 of the NSW *Environmental Planning & Assessment Act 1979*.

In summary the CSELR proposal comprises construction and operation of a light rail service from Circular Quay to Kingsford and Randwick via Surry Hills. The route of the CSELR proposal is illustrated in Figure 1-4. The key features of the proposal include:

¹² Transport for NSW, *Sydney's Light Rail Future*, 2012

- 13 kilometres of new light rail track from Circular Quay to Central and Kingsford and Randwick via Surry Hills and Moore Park (including track at the depot facilities)
- 'Turn up and go' services every three minutes during peak periods within the CBD
- A pedestrianised zone on George Street between Hunter and Bathurst Streets, with light rail vehicles (LRVs) operating wire-free in this zone
- 20 light rail stops along the alignment with platforms at all stops to accommodate 45 metre long light rail vehicles, except at Chalmers Street and Moore Park, where platforms will be provided to accommodate both 45 metre and 90 metre long light rail vehicles (double-length vehicles) running during special event services between Central Station and Moore Park
- Depot facilities adjacent to Royal Randwick Racecourse and at Rozelle for light rail vehicle stabling and/or general maintenance (including wash-down)
- Interchange with heavy rail, bus and ferry services in the CBD corridor at Circular Quay, Wynyard, Town Hall and Central stations
- Bus interchange at the Kingsford and Randwick stops
- Integration with the existing light rail system
- Special event services between Central Station and event venues such as Moore Park and Royal Randwick Racecourse
- A fleet of 30 electric-powered light rail vehicles, 45 metres long, featuring temperature control and accessible low-floor design
- Capacity for approximately 100 seated and 200 standing passengers
- Public domain improvements on George Street, as a result of the pedestrianised zone, including concepts for paving, street trees, lighting and furniture
- A new bridge structure overpassing the eastern distributor and an underground alignment in the form of a cut-and cover tunnel across Moore Park
- Special events sidings at Circular Quay, Eddy Avenue, Chalmers Street, Moore Park and Royal Randwick Racecourse and turn back facilities at the Circular Quay, Wynyard, Kingsford and Randwick

1.5.3. Current situation

The Sydney CBD has very high transport demand and limited capacity to accommodate the additional public transport required to serve future growth in customers without a step change in service provision. Over 180,000 people enter the Sydney CBD during the morning peak hour between 8:00am and 9:00am, with public transport accounting for 80 per cent of these trips. This is expected to grow to 225,000 trips in 2031. Buses carry the highest travel demand of the street-based modes, and to accommodate this demand growth, the bus system has and continues to grow; there are now over 192 bus routes across the City Centre, and on a typical weekday morning around 1,600 buses enter the CBD in just two hours¹³.

The sheer volume of buses entering the CBD is reaching a critical point in Sydney's highly congested urban environment, with the addition of further buses unlikely to provide substantially new capacity without degrading service provision. Light rail in Sydney's CBD has been studied by both the NSW Government and the City of Sydney in recent years as a potential solution to meet this demand, revitalise CBD streets and improve the public domain.

¹³ NSW Bureau of Transport Statistics, 2012

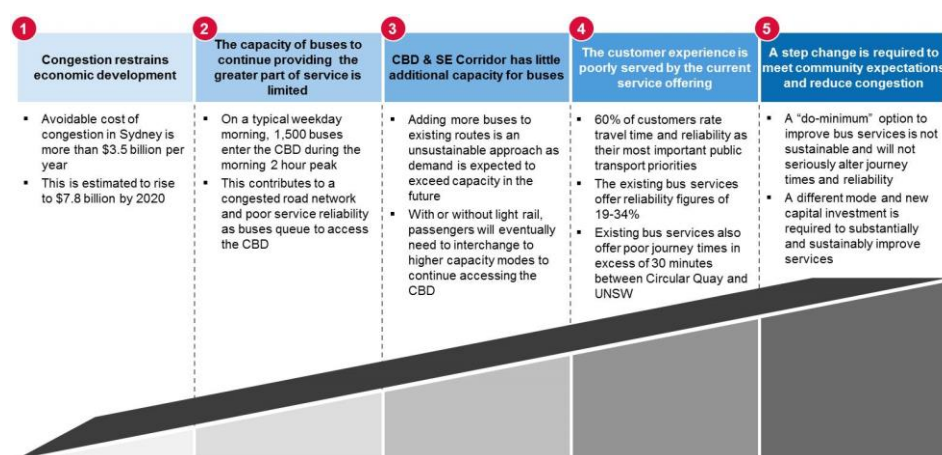
In addition, the UNSW corridor services several regional attractions, including the major sporting precincts at Sydney Football Stadium (SFS), Sydney Cricket Ground (SCG), Royal Randwick Racecourse, recreation and entertainment facilities of Centennial Parklands, and the Randwick Education and Health Specialised Centre including the UNSW and the Randwick precinct Hospitals. It serves high density centres in Surry Hills, Randwick and Kensington and is a corridor that currently relies exclusively on buses for public transport.

The UNSW campus and major events generate large travel demand in both directions during peak and off-peak periods. These features help to support high quality public transport as the infrastructure is more highly utilised than in a single direction peak service.

1.5.4. Current surface transport challenges

The Sydney CSE corridor is highly constrained, with the current public transport offering suffering from slow journey times and poor, variable reliability¹⁴. In addition, bus reliance in this corridor is a factor in levels of surface congestion estimated to cost the economy \$7.8 billion in 2020¹⁵. The current and forecast demand for public transport in this area is exceeding the levels that can be comfortably and reliably served with an on-road bus solution. Incremental expansion of supply through the addition of new bus routes and expansion of existing routes are expected to provide a solution only at the margins. Dealing with the fundamental lack of supply in this corridor requires a step-change in the provision of public transport.

Figure 1-5: Problems with the current public transport service offering in the CSE corridor¹⁶



1.5.4.1. Sydney's congestion is restraining economic development

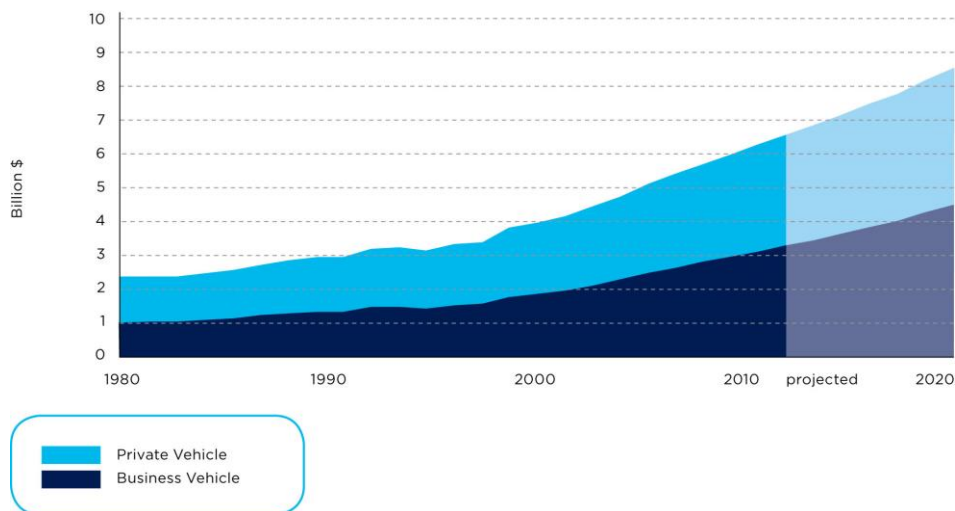
Cities offer immense opportunity for productivity growth; however poor planning, accessibility and management can also stifle productivity. The Bureau of Infrastructure, Transport and Regional Economics (BITRE) has estimated that the avoidable cost of congestion in Australia's capital cities is equivalent to one per cent of GDP and is forecast to more than double 2005 levels (\$9.4 billion) to reach \$20 billion per year by 2020 if nothing is done. Sydney has the highest level of congestion in Australia at about \$3.5 billion in 2005, a figure estimated to rise to \$7.8 billion by 2020, as shown in Figure 1-6.

¹⁴ NSW Bureau of Transport Statistics, *Public Transport Information and Priority System (PTIPS)*, 2011

¹⁵ Bureau of Infrastructure Transport and Regional Economics, *Estimating urban traffic and congestion cost trends for Australian cities Working Paper No. 71*, 2007

¹⁶ Transport for NSW, *Sydney's Light Rail Future*, December 2012; Booz & Company analysis

Figure 1-6: The economic cost of congestion 1980-2020¹⁷

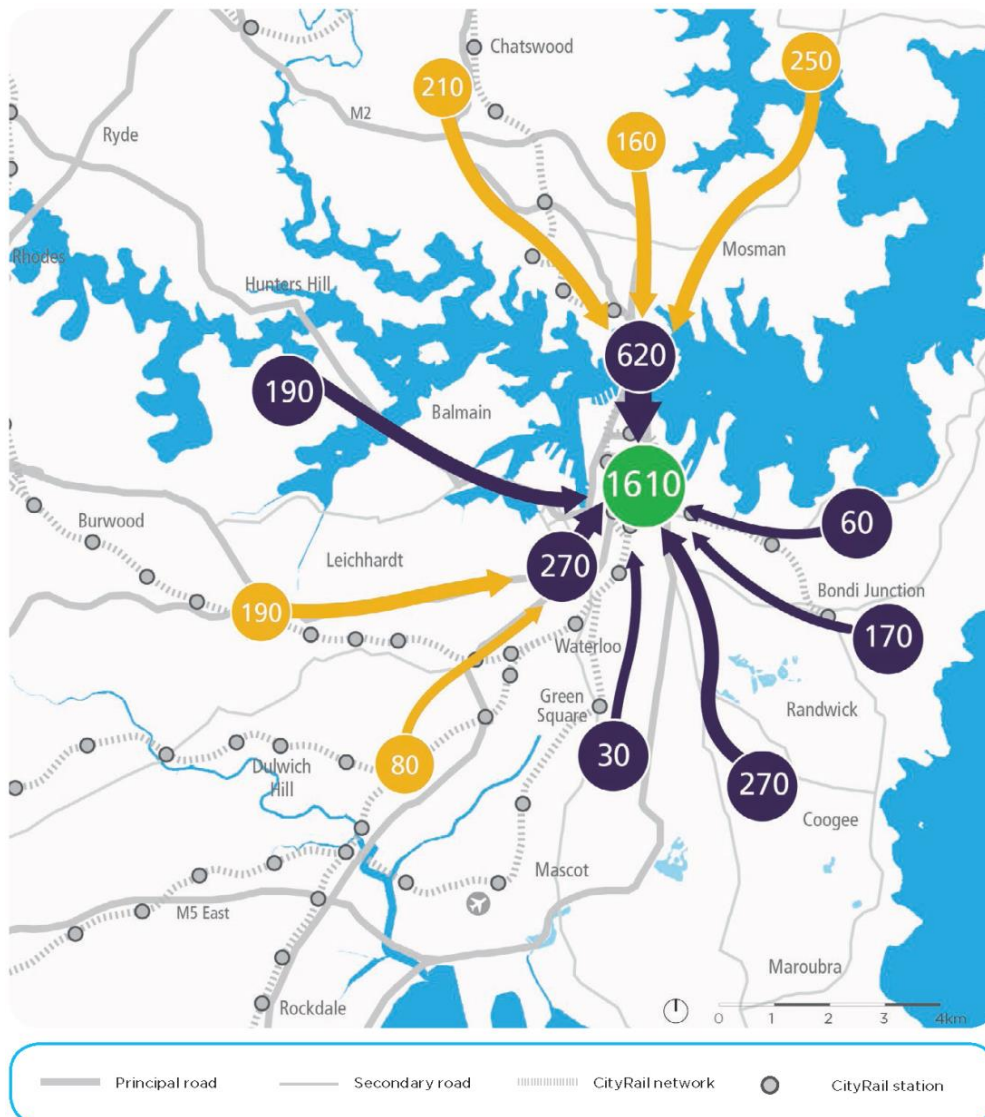


1.5.4.2. The capacity of buses to continue providing the lion's share of service is limited

While an important component of the transport mix, the sheer volume of buses in the city (shown in Figure 1-7), especially on major corridors such as the Harbour Bridge, York Street, George Street and Elizabeth Street, is now so great that service quality has begun to degrade on these routes on a regular basis. The capacity of buses to continue growing to meet an ever-increasing transport task has begun to be exhausted, with buses now caught in congestion on a regular basis.

¹⁷ Bureau of Infrastructure, Transport and Regional Economics, *Estimating urban traffic and congestion cost trends for Australian cities*, 2007

Figure 1-7: Bus volumes entering the CBD during the 2 hour morning peak¹⁸



As congestion impacts on journey times and reliability, this results in a poor experience for customers on buses, but also for pedestrians throughout the CBD and South East as they cope with the noise and exhaust caused by queuing buses.

For the South East corridor, buses travel in heightened congestion on the approach to the CBD at Oxford Street as well as on the approach to Martin Place on Elizabeth Street. Addition of further buses to these routes only perpetuates the congestion challenge as buses themselves consume road space and struggle to access limited kerbside stopping space in the CBD.

The presence of multiple major event venues in the South East places pressure on the public transport system to provide sufficient capacity to serve the peak loadings at the beginning and conclusion of these major events. Major events hosted at the SCG and SFS achieve a five to 20 per cent mode share to public transport compared to an average of 55 per cent at Sydney

¹⁸ Transport for NSW, *NSW Long Term Transport Master Plan*, 2012

Olympic Park which is served by a much higher capacity heavy rail link¹⁹. Provision of additional capacity to cope with the additional loads will be important if Sydney is to continue attracting hallmark events in the future. Additional capacity will have the added benefit of reducing the often heavy congestion in the area during major events.

Finally, the University of NSW is a major trip generator in the CSE Corridor, and requires a significant volume of buses to transport students and staff – primarily between Central Station and the Kensington campus. Currently, over 340 bus trips per day operate this route in both directions; but even with this volume of buses congestion is regularly experienced at the Eddy Avenue bus stand. The UNSW student population is expected to grow from 37,000 to about 50,000 – an increase of 43 per cent²⁰. Though the timeframe for reaching this number is uncertain, it is clear that requiring buses to continue providing the lion's share of transport capacity for UNSW is unsustainable.

1.5.4.3. The CBD and SE corridor does not have the capacity to support the growth of the existing bus transport system

A 'Do Minimum' option of simply adding more buses to existing routes to meet the expected increase in passenger demand is not sustainable due to capacity constraints within the road corridors and will not address customer concerns of journey time and reliability. While provision of additional capacity through a traditional on-road bus solution would be possible for cross regional routes the highly constrained road environment closer to the CBD is an unavoidable limitation on the performance of a bus solution. Indeed, as examined in the previous section, the addition of more buses in this environment would only contribute to congestion further degrading journey times and reliability.

A continuation of this approach will result in passengers eventually needing to interchange onto higher capacity public transport vehicles that serve the CBD – with or without light rail as a solution. Alternatively, road space between private and public transport will need to be reallocated to provide additional capacity for buses. This would have a substantial impact on private vehicles, with average speeds in the AM peak for key roads in the study area currently ranging from 20-28 km/h²¹. The performance of these roads for private vehicles could be expected to be further degraded if road space were reallocated to public transport. In either case, provision of additional capacity through transport services is constrained by the limited road space available on approach to the CBD. Provision of higher capacity services on or under the existing roads is necessary to substantially address the journey time and reliability concerns of customers.

While the CSELR project forms a part of the solution to this challenge, other projects currently being developed as part of the City Centre Access Strategy (such as the re-organised city bus network) will also seek to respond to the growing demands on the CBD transport system.

1.5.4.4. Customers deserve a better travel experience

Nearly 60 per cent of Transport for NSW's customers' rate travel time and reliability as the two most important public transport priorities. However, for Bus Contract Region 9 (the region serving the South East corridor) only 50 per cent of customers report satisfaction with service timeliness – a measure of the service on time performance – while 72 per cent of customers believe travel time is appropriate considering the distance travelled²².

¹⁹ Transport for NSW, NSW Long Term Transport Master Plan, 2012

²⁰ Transport for NSW, Sydney Light Rail Round 5.2 Demand Report, August 2013

²¹ Roads & Maritime Services, Key Roads Performance Report, 2012

²² Bureau of Transport Statistics, Transport Customer Survey, 2012

Analysis suggests the proportion of services arriving at the CBD within two to three minutes of their scheduled time is between 19 and 34 per cent²³ in the Anzac Parade and CBD corridor during the AM peak. This falls well below customer's expectations and highlights the degraded experience for customers in the South East corridor.

To drive additional patronage on public transport in this region, customer research commissioned by Transport for NSW has found that frequency, travel time and being on time are the three most important attributes for customers making decisions about travelling by bus. When asked what is most likely to increase bus patronage, customers identified reduced waiting time, reduced trip time and air-conditioning and heating as the key elements. Future decisions on transport planning in the area will need to take account of these elements to deliver a significant improvement to the experience of customers on public transport.

1.5.4.5. A step-change in the public transport network is needed.

Operating light rail in an area currently served by buses (the Study Area) would underpin a transition to a more efficient transport network. The traditional 'radial' service approach is based on providing a single seat for the duration of the journey. This approach provides a wide range of bus services connecting all parts of the city to its CBD or other major centres. However, it also results in a complicated bus network with high frequencies near the City Centre but low frequencies on the majority of routes further away from the CBD. Trips to local or regional centres are often difficult, as most bus services travel to the CBD.

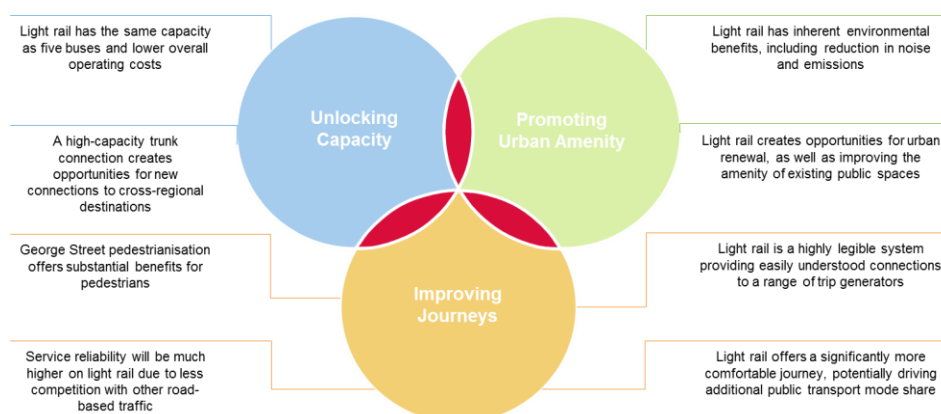
As the public transport system evolves, moving to a 'connected' or 'hub and spoke' network will improve service coverage, allow a higher service frequency and make public transport easier to understand for customers. With a connected approach, a grid-based bus network reallocation becomes possible where light rail and other major bus radial services are supported by local bus feeder services to provide easy connections to multiple destinations across the region's centres. This would improve service coverage, allow for a higher service frequency and make public transport easier to understand for customers. Experience in several major cities suggests this has a positive impact on transport network performance.

1.5.5. Opportunities to improve the surface transport system

Development of a fully integrated and customer-focused light rail system in the CBD and South East Sydney offers a variety of benefits to grow transit capacity and improve the customer experience. The introduction of light rail would add a reliable mode of transport to the network and increase service frequencies leading to a number of benefits summarised in Figure 1-8.

²³ Transport for NSW, *Sydney's Light Rail Future*, 2012; Booz and Company; AECOM; Bureau of Transport Statistics, 2012

Figure 1-8: Benefits of the CSELR System²⁴

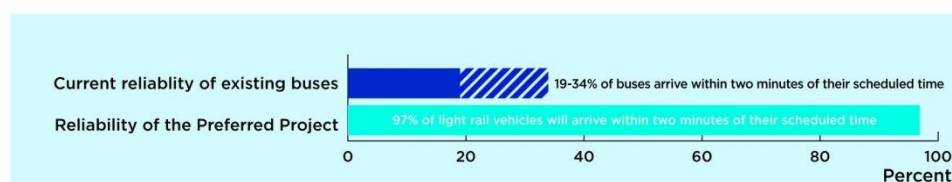


1.5.5.1. Improved journey times and reliability

It is anticipated that light rail will operate in a segregated environment, allowing it to avoid competition for limited road space with buses and private vehicles. This will facilitate comparable journey times during the off-peak and improved journey times for most customers on the CSELR corridor during the peak.

Importantly, light rail offers substantially improved service reliability compared to the existing bus solution. It is anticipated that 97 per cent of light rail services would arrive in the CBD within 2 minutes of their scheduled time (refer to Figure 1-9). The equivalent figure for the existing bus service is less reliable at around 19–34 per cent.

Figure 1-9: Reliability improvements of the CSELR²⁵



1.5.5.2. Additional capacity

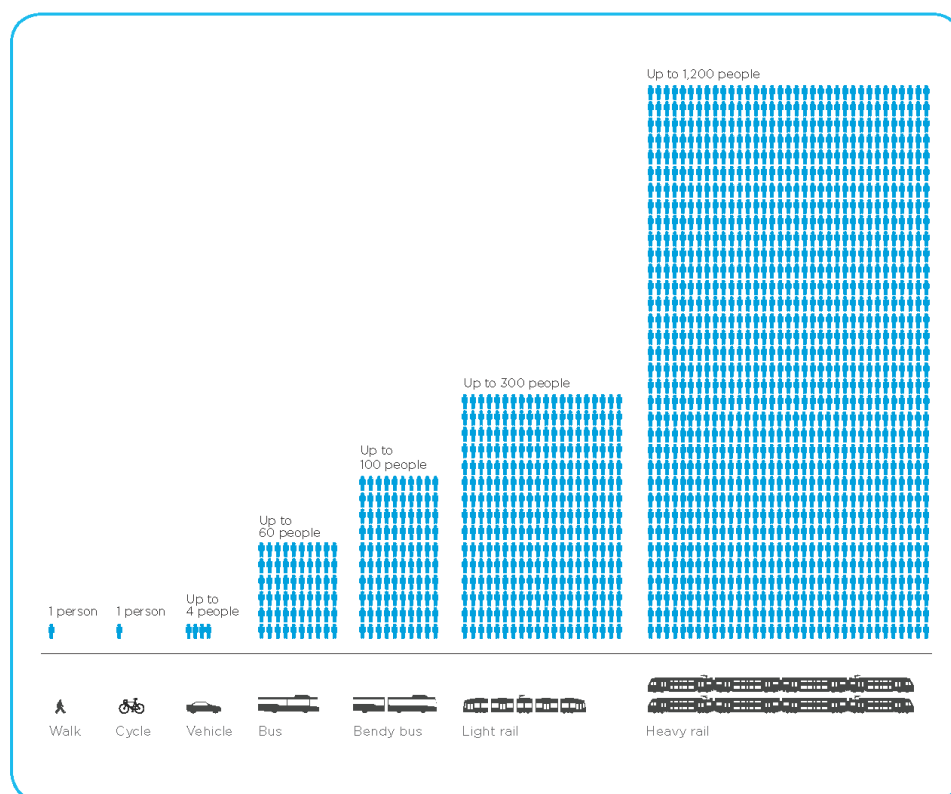
Modern light rail vehicles can provide as much as five times more capacity than a traditional bus, while consuming only about twice as much road space, as shown in Figure 1-10. In addition, the light rail solution is easily scalable for peaks in demand as two 45m LRVs have the potential to be coupled to move up to 18,000 people per hour in each direction²⁶ – to support public transport service to major events.

²⁴ Booz and Company analysis

²⁵ Transport for NSW, *Sydney's Light Rail Future*, 2012

²⁶ *Ibid*

Figure 1-10: Indicative capacity by mode²⁷



1.5.5.3. High frequency service at lower cost

Light rail typically provides ‘all-day, all-week’ services that can be relied upon to provide good frequencies across the weekday, weekend and evenings. The relatively low operating cost of light rail allows high off-peak service frequency and long hours of operation. This makes best use of the capital investment in light rail infrastructure and vehicles and provides a strong customer value proposition.

The CSELR Operations Adviser, Interfleet, advises that light rail services will run between Circular Quay and Moore Park (via Central) at peak period frequencies of 20 services per hour²⁸ (approximately 3 minute headway). These services would then split to serve:

- Randwick (via Alison Road, Wansey Street and High Street) – 10 services per hour
- Kingsford (via Anzac Parade) – 10 services per hour

Light rail’s improved reliability provides better frequencies when compared with the existing bus solution. Despite high timetabled frequencies for buses, their interaction with road congestion often results in “bunching” of services. This does not align favourably with customer needs. By contrast, light rail offers a true “turn up and go” service with reliable service spacing.

The preferred light rail network is proposed to operate across a long service span (hours of operation). This is achieved by first delivering a base network that works well all day, and then adding peak-only supplemental services commuters may require. Sustained frequencies across the day compare favourably with the existing bus solution.

²⁷ Transport for NSW, *Sydney’s Light Rail Future*, 2012

²⁸ Interfleet, *Operations Adviser Initial Light Rail Operational Services Plan*, 2013

In terms of operator benefits, while a light rail system has higher initial capital costs than a comparable bus solution it has relatively lower on-going operating costs achieved through less labour intensive operations²⁹. To provide similar frequencies and service coverage, a bus solution would require five vehicles and five drivers compared to the single driver required for light rail.

1.5.5.4. Improved access to key destinations

The introduction of light rail would enable a restructure of the surface public transport system (discussed in Section 1.5.4.5) that would deliver customers with improved quality of public transport service to a broader range of key destinations.

The restructured surface public transport system would be based on a high frequency trunk light rail route that integrates with the bus network. It would allow the reallocation of buses from a CBD-centric system to a transfer-based grid that better serves other key destinations with higher frequencies throughout the day and night. In particular, it is envisaged that the introduction of light rail would facilitate the reallocation of buses to serve growing cross-regional demand routes, as documented in Chapter 4 of this report.

The long service span of a light rail network provides sustained, easy access to key destinations in the CSE corridor. An all-day network is justified in active, mixed use, high density areas in which traffic and parking demand is intense. The CSE corridor includes a mix of significant trip attractors such as universities, hospitals, as well as shopping and nightlife districts. These land uses require good service at least 18 hours a day (if not longer), because while they may have some peaks in demand, they also generate trips across the day, night and weekend.

In addition, as highlighted in Section 1.5.5.3, the lower on-going costs of light rail enable efficiencies to be gained for the operator as the network is redesigned to provide greater coverage at lower cost.

1.5.5.5. A more legible and easier to understand system

In addition to providing improved access to key destinations, a high frequency trunk transit system provides a more legible and easier to understand public transport network. There are currently 192 bus services operating in the CBD, illustrating the complexity facing non-regular customers wishing to travel within the CBD, such as tourists and business travellers. Indeed the complexity of the existing network is so great, that even experienced commuters experience difficulty navigating the system – particularly when responding to service disruptions. Recent customer value proposition work by Transport for NSW identified the ease of use – including a legible, simple to use system as the most important attribute for 19% of customers. All customers rated this factor as important to a certain degree, as it built confidence in the ability of the system to deliver them to their destination.

²⁹Transport for NSW, *unpublished data*, 2012

2. Existing Situation

2.1. Overview

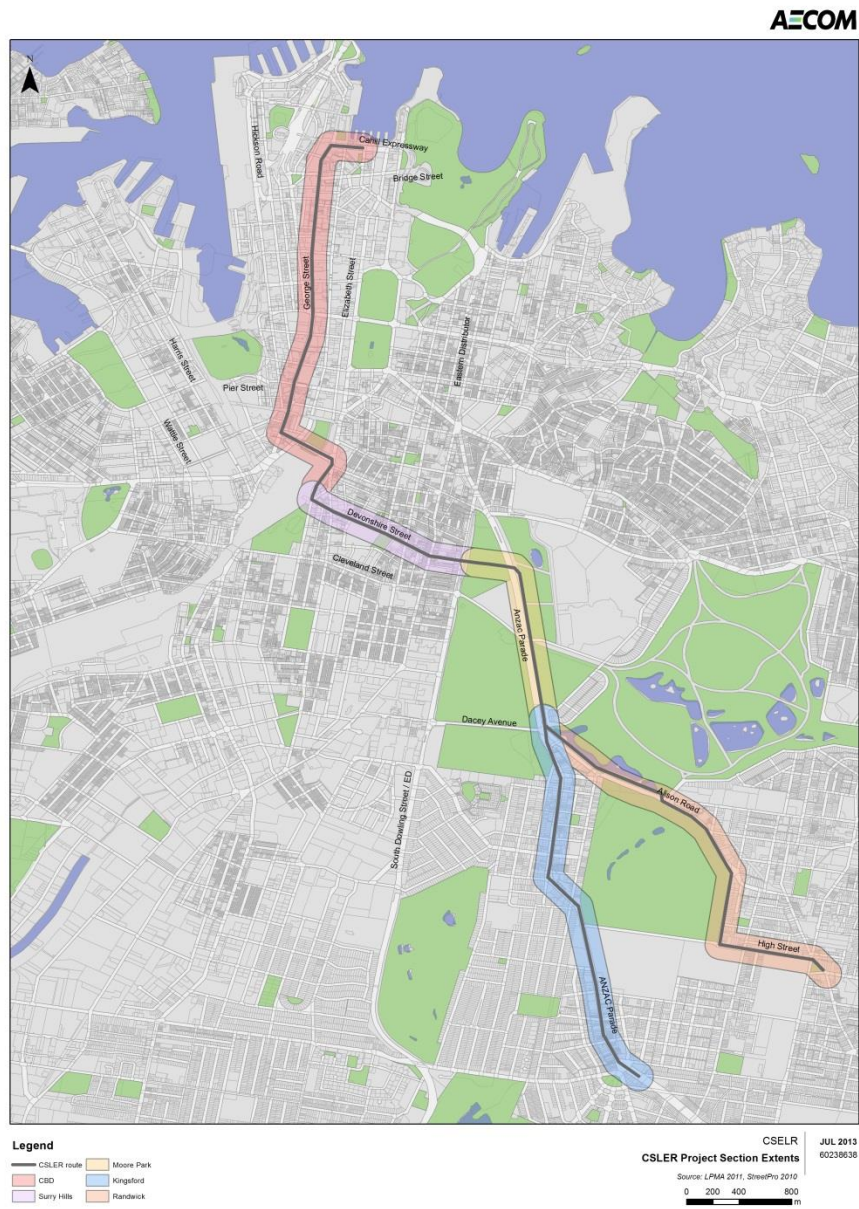
This section provides an outline of the existing traffic and transport situation along the proposed future CSELR corridor. It includes:

- A description of the existing road network and traffic volumes, including parking supply and access arrangements
- An outline of existing bus services focussing on the South Eastern region of the light rail corridor
- A summary of existing cycle networks within the light rail corridor
- An outline of existing pedestrian access arrangements and demand
- A description of existing special event access arrangements with a particular focus on Moore Park, Royal Randwick Racecourse, along with other events that could impact light rail operations and demand

Following assessment of existing bus and special event operations at a network level, all other transport operations have been assessed at the local level. To facilitate this assessment the CSELR corridor has been broken down into five key precincts as illustrated in Figure 2-1 and summarised below:

- The **CBD precinct** represents the CSELR corridor between Circular Quay to Chalmers Street, via George Street, Rawson Place, Eddy Avenue and Chalmers Street including the intersection with Devonshire Street.
- **Surry Hills precinct** represents the Devonshire Street section of the corridor to the east of the intersection with Chalmers Street and as far west as the mid-block pedestrian crossing at South Dowling Street in Moore Park.
- **Moore Park Precinct** represents the section to the east of the mid-block crossing at South Dowling Street and the section of Anzac Parade to the north of Alison Road.
- **Kingsford precinct** includes the intersection of Anzac Parade and Alison Road in the north to the Kingsford interchange in the south, including the suburb of Kensington.
- **Randwick precinct** represents the section along Alison Road, east of Anzac Parade, and includes the corridors along Wansey Road and High Street to the Randwick interchange.

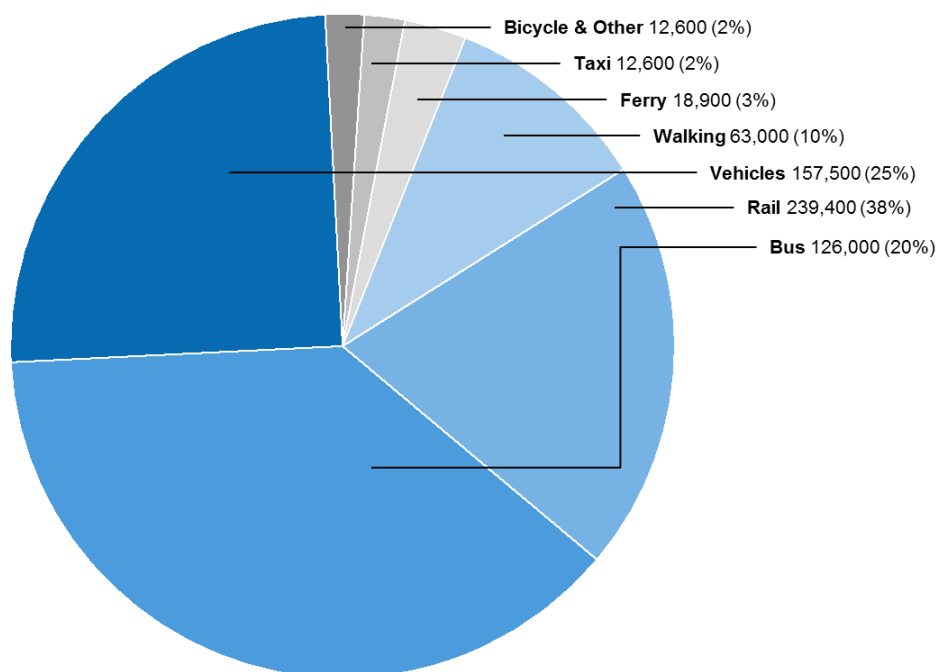
Figure 2-1: Precincts along the light rail corridor



2.1.1. Current transport task

Currently over 600,000 people enter the CBD during the day, with public transport accounting for 61 per cent of trips. Over one-third of the total travel demand (38 per cent) is carried by the underground heavy rail system which places pressure on constrained CBD stations, particularly at Town Hall and Wynyard. Figure 2-2 illustrates current transport mode share for commutes into the CBD during a typical day.

Figure 2-2: Current mode share for trips into the City Centre³⁰



The city's congested road network carries the remainder of trips, accommodating a mix of cars, buses, cyclists and pedestrians on relatively narrow streets. Of these street-based modes buses carry the highest travel demand in and out of the CBD, servicing 20% of total trips. Approximately 1,600 buses enter the CBD during the morning peak, congesting bus drop-off locations. As an example, at Railway Square there are 250 inbound buses in the two-hour peak period, which means a bus has to stop, unload/load, and depart almost every 30 seconds. The situation at Wynyard is similar: there are almost 600 inbound buses over the two-hour peak meaning approximately 12 seconds turnaround time per bus while entering the CBD from the Oxford/Flinders Street corridor there are approximately 270 inbound buses over the two-hour peak.

³⁰ Transport for NSW, *City Centre Access Strategy*, 2013

2.2. Key Assumptions

2.2.1. Intersection analysis

Existing intersection performance along the CSELR corridor has been evaluated using LinSig 3.2, a computer based modelling package designed for the assessment and design of traffic signal junctions either individually or as a network. The LinSig modelling results of existing intersection performance can be found in the relevant precinct chapter (Sections 2.5 - 2.9).

The main performance indicators for LinSig 3.2 include:

- Degree of Saturation (DoS) – the ratio between traffic volumes and capacity (v/c) of the intersection used to measure how close to capacity an intersection is operating. The DoS is a direct measure of the congestion level at the intersection. As DoS approaches 1.0, both queue length and delays increase rapidly. Satisfactory operations usually occur with a DoS range between 0.8-0.9 or below;
- Average Delay – duration, in seconds, of the average vehicle waiting time at an intersection; and
- Level of Service (LoS) – a measure of the overall performance of the intersection. For this purpose, average delay from Roads and Maritime Services (RMS) Level of Service (LoS) calculations has been used. These are listed below in Table 2-13.

Table 2-13: Intersection Level of Service Criteria³¹

Level of Service	Average Delay (secs/veh)	Traffic Signals and Roundabouts
A	Less than 14	Good Operation
B	15 to 28	Good with acceptable delays and spare capacity
C	29 to 42	Satisfactory
D	43 to 56	Operating near capacity
E	57 to 70	At capacity; at signals incidents will cause excessive delays
F	>70	Roundabouts require other control mode

2.2.2. Parking and kerbside access

The subsequent sections provide a description of the existing parking provision by precinct as well as identifying adjacent land uses for on-street parking (e.g. local residential, short stay retail, all-day transit etc.). A detailed assessment of parking demand is provided within the Project Parking Strategy outlined in Section 6.

The following definitions of various parking restrictions have been applied to each precinct:

- Short Stay Parking - clearly signed parking areas for short term period of parking (e.g.: ≤1P).
- Long Stay Parking (Restricted) - clearly signed parking areas for long term period of parking (i.e.: ≥2P).

³¹ Guide to Traffic Generating Developments (RMS, 2002)

-
- Long Stay Parking (Unrestricted) - general parking area outside of other restriction signs or the area with no parking restrictions apply.
 - Loading Zone- clearly signed parking areas set aside for short-term use by certain vehicles when loading or unloading goods in the course of business or when dropping off or picking up passengers.
 - Disability parking- parking for people with disabilities is in the form of separate appropriately signed and marked parking bays and by ensuring that time-limited bays have sufficient turnover to allow people with disabilities to access them. These parking bays have the effect of a 'No Parking' sign, with the exception of vehicles displaying the disabled persons parking or mobility permit.
 - Car Share, Hospital, Mail Zone - parking available only for these uses.
 - Taxi zone- parking area for taxis only.

2.3. Bus Services

Approximately 1,600 bus services enter the Sydney CBD during the two-hour morning peak, through the primary CBD cordon points at the Sydney Harbour Bridge, Anzac Bridge, Broadway, Oxford Street, William Street and Elizabeth Street.

In the South East CSELR Corridor, the bus network can be segmented into three broad service types:

- CBD All-Stop Services: stop frequently from their suburban origin to the CBD, operating all day in both directions and primarily using Oxford, Cleveland or Foveaux Streets to access the CBD. These services carry over 9,000 passengers in-bound during the AM Peak (more than 5,000 during the intense peak 1 hour);
- Cross-Regional Services: these services generally do not enter the CBD, but rather provide links between key centres, such as Bondi Junction and the Airport and operate all-day;
- CBD Express Services: stop frequently on suburban routes before reaching a key node (Kingsford town centre at Gardeners Road, and Randwick town centre at Belmore Road) and running direct to the CBD without stopping. These services operate during the peak periods only in the peak direction. The bulk of these services use the Eastern Distributor to access the CBD and operate contra-peak south along Elizabeth Street.

2.3.1. CBD bus issues

The substantial volume of buses entering the CBD which was illustrated in Section 1, combined with high volumes of general traffic (i.e. private vehicles, commercial and service vehicles), contribute to congestion on major streets in the City Centre, which deteriorates the reliability of bus services and negatively impacts the amenity for all road users.

George Street in particular carries up to 290 buses in the peak direction during the AM peak (7am – 9am) and this is expected to increase to over 310 by 2015. The congested bus network - combined with the demands of other road users - impacts on customer service and delays essential business functions.

As illustrated in Figure 2-3 below, the bus reliability issues for the combined inbound and outbound bus movements along the key corridors are most prominent during the AM peak. However, travel time reliability continues to be impacted throughout other times of the day. The lower activity lunch hour still demonstrates 2-3 minutes delays and the busier afternoon peak 3-4 minutes.

Figure 2-3: Average variance to bus timetable in minutes includes both directions (i.e. inbound & outbound combined)³²

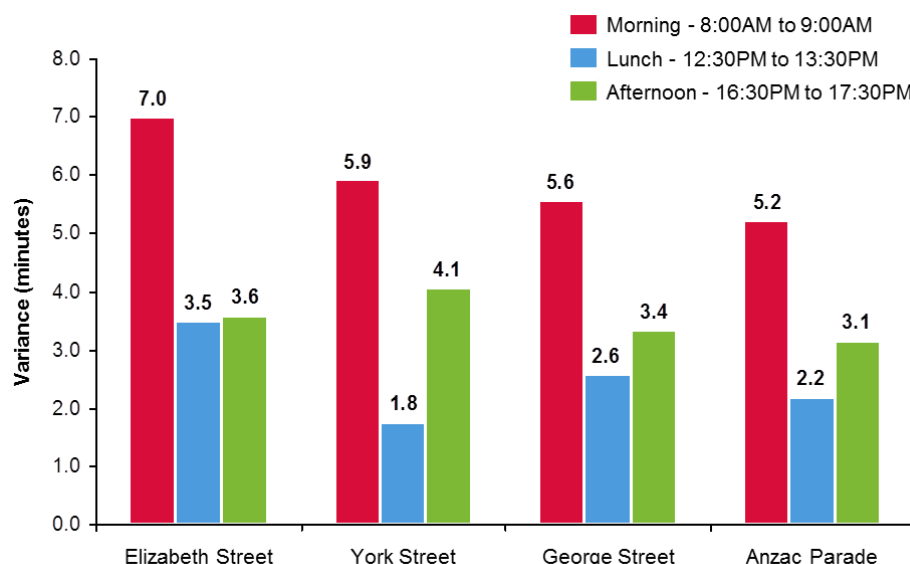


Figure 2-4 illustrates average bus variability during the AM peak hour along key access routes through the CBD which are on average between 5 – 7³³ minutes behind schedule. Key findings from the analysis by corridor are summarized as follows:

- Elizabeth Street – a large number of buses approaching the CBD from the east merge with general traffic on Elizabeth Street, causing high levels of congestion which results in bus services experiencing average delays of 7.0 minutes in the AM peak.
- York Street - many inbound buses from northern Sydney travel on the Harbour Bridge and through the CBD via York Street. Buses travelling along York Street experience average delays of 5.9 minutes in the AM peak.
- George Street - is a main corridor for western and southern region buses travelling through the CBD, along with the free shuttle bus (555). Buses travelling along George Street experience average delays of around 5.6 minutes in the AM peak.
- Anzac Parade - is a key corridor providing access in to the CBD for a large number of South Eastern Region buses. Buses travelling along the Anzac Parade corridor experience average delays of around 5.2 minutes in the AM peak.

The forecast growth in bus demand will increase bus congestion within the CBD putting more vehicles onto our roads and increasing congestion. The need to meet growing demand without further increases in bus volumes within the CBD and the associated increases in congestion and travel time variability are key drivers for the introduction of the CSELR project.

³² Public Transport Information and Prioritisation System (PTIPS) via internal systems made available to NSW BTS; Booz & Company Analysis.

³³ *Ibid*

Figure 2-4: CBD Buses - AM Peak Timetable Variance for Both Directions in Minutes by Street³⁴



³⁴ NSW BTS Public Transport Information and Prioritisation System (PTIPS) 2011; Booz & Company Analysis

Outside of the CBD the proposed CSELR project will operate through the South Eastern suburbs where buses are currently the primary public transport mode. This corridor is within Transport for NSW's Metropolitan Bus System Contract (MBSC) Region 9 which is the most heavily patronized bus region in the Sydney metropolitan area. The existing bus services reviewed as part of this study are illustrated within Figure 2-5 with the full range of regular bus routes in the South East region examined as part of the network planning for the CSELR project summarised in Table 2-1.

Table 2-1: Eastern Suburbs LRT Bus Services under examination³⁵

Route	Description	2011 Frequency (AM Peak hour)	Service Type
339	Clovelly-City	11	Suburban
410	Rockdale-Bondi Junction	2	Cross-Regional
400	Burwood-Bondi Junction	10	Cross-Regional
X39	Clovelly-City	8	CBD Express
370	Leichhardt-Coogee	5	Cross-Regional
372	Coogee-Railway Square	6	Suburban
373	Coogee-Circular Quay	12	Suburban
374	Coogee-City	7	Suburban
376	Maroubra Beach-Circular Quay	9	Suburban
375	Maroubra Beach-Sydney Uni	-	Suburban
377	Maroubra Beach-Circular Quay	4	Suburban
395	Maroubra Beach-Circular Quay	4	Suburban
396	Maroubra Beach-Circular Quay	3	Suburban
397	Maroubra South-Circular Quay	2	Suburban
M10	Maroubra Junction-Leichhardt	6	Cross-Regional
M50	Drummoyne-Coogee	6	Cross-Regional
X73	Coogee-City	15	CBD Express
X74	Coogee-Circular Quay	9	CBD Express
X77	Maroubra Beach-City	10	CBD Express
X96	Maroubra Beach-City	4	CBD Express
X97	Maroubra South-City	2	CBD Express
391	La Perouse-City	5	Suburban
392	Little Bay-Circular Quay	6	Suburban
393	La Perouse-Railway Square	8	Suburban
394	La Perouse-Circular Quay	9	Suburban
399	Little Bay-Circular Quay	2	Suburban
L94	La Perouse-Circular Quay	4	Suburban
X92	Little Bay-City	5	CBD Express
X94	La Perouse-City	5	CBD Express
X99	Little Bay-City	2	CBD Express
303	Eastgardens-Circular	7	Suburban
313	Coogee-Bondi Junction	2	Cross-Regional
314	Coogee-Bondi Junction	3	Cross-Regional
316	Eastgardens-Bondi Junction	2	Cross-Regional
317	Eastgardens-Bondi Junction	2	Cross-Regional
348	Wolli Creek-Bondi Junction	2	Cross-Regional
353	Eastgardens-Bondi Junction	4	Cross-Regional
357	Sydenham-Bondi Junction	3	Cross-Regional
343	Maroubra Beach-City	8	Suburban

The existing regular bus routes within the South East area can be segmented into three broad service types which are summarised together with their existing service numbers and average loadings in Table 2-2.

³⁵ Transport for NSW, unpublished data from Public Transport Project Model, 2013

Table 2-2: Existing Bus Service Types

Bus Service Type	Service Characteristics	Existing Bus Trips (2010 AM Peak Hour)	Average Loading (per Bus during 2010 AM Peak Hour)
1. CBD All-stop Services	- Stop frequently from their suburban origin to the CBD - Operate All Day in both directions - Primarily use Oxford, Cleveland or Foveaux Street to access the CBD from the South East	135	36
2. CBD Express Services	- Stop frequently on suburban routes before reaching a key node and running direct to the CBD without stopping - Typically operate during the peak periods only in the peak direction - The bulk of these services utilise the eastern distributor to access the CBD and operate contra peak south along Elizabeth Street	62	55
3. Cross-Regional Services	- Do not enter the CBD but rather provide links between key centres, such as Bondi Junction - Operate All Day	47	-

The bulk of existing bus services within the south east CSELR corridor are CBD All Stop services (135 trips per hour) which operate to the CBD throughout the entire day. This includes the existing Metro Bus Routes M10 and M50. These services are supplemented when demand increases during the peak period by express bus services (62 trips per hour) which generally pick up until Randwick or Kingsford and then run express into the northern end of the CBD via the Eastern Distributor (Note the X39 is the only express service in the study area not operating via the ED).

Existing bus services within the CSELR corridor operating to the CBD carry approximately 8,300 customers during the AM peak hour. The bulk of CBD bus customers (59%) in the CSELR corridor use the All-Stop services although the loadings per bus trip are significantly lower when compared to express services. The express CBD express services are currently experiencing the strongest growth in patronage, a trend anticipated to continue.

Cross regional services are also provided to create connections to other key centres as well as linking the numerous education, shopping and health precincts.

In addition to regular route services, express university buses are provided to the UNSW, school special services to Sydney Boys and Girls High School, and Special Event services are provided to the Moore Park precinct and Royal Randwick Racecourse during events. These are also discussed within this report.

2.4. Special Events

2.4.1. Overview

Special events are an important contributor to economic activity, with the NSW Events calendar generating an estimated \$600 million per annum in direct expenditure for NSW in 2011 and business events generating a further \$778 million³⁶. In addition, the events industry attracted 2 million overnight event visitors (staying, on average, 3 nights each), and 5.2 million day-trip event visitors. The economic value of events is substantial and proper planning and delivery of transport services for these events can have a serious impact on their success.

To inform planning for future special event transport operations, an assessment of events currently held at Moore Park, Royal Randwick and other major events within the corridor was undertaken to determine the role the CSELR project would have in the future. Additionally an assessment was undertaken of events currently held along the CSE corridor, primarily within the CBD, which impact transport operations. Detailed planning will be required in order to minimise the operational impact on the CSELR of these events, particularly given the fixed infrastructure nature of the light rail transport solution.

Due to the inner city location of the Moore Park precinct and the relatively low public transport mode share, it regularly experiences congestion associated with events in excess of 15,000 spectators. The precinct currently has a total supply of 5,800 off-street car spaces and one of the highest car parking spaces to venue capacity ratios in Australia³⁷ and relies heavily on event buses as the public transport solution.

Sydneysiders have demonstrated their willingness to use public transport to travel to events at the city's two major sports and entertainment precincts. A more balanced and sustainable approach to transport and access to this important event precinct can lead to positive urban amenity outcomes. CSELR provides the opportunity to improve the non-car transport mode share from 47% to around 70% which is more in line with what is achieved at Sydney Olympic Park and other major stadia in Australia³⁸.

2.4.2. Moore Park

2.4.2.1. Event and demand overview

Moore Park consists of three major precincts, Allianz Stadium, the SCG and Playbill venues (the entertainment quarter) holding a diverse array of events with varied transport requirements. The sporting stadiums receive the lion's share of patrons; however the Playbill venues (such as the Hordern Pavilion and Royal Hall of Industries) hold a greater number of smaller events. Key 2011 event statistics are summarised in Table 2-3 with a full breakdown of attendance and frequency for the Moore Park precinct presented in Figure 2-6.

³⁶ *Final Report of the Visitor Economy Taskforce, Destination NSW*

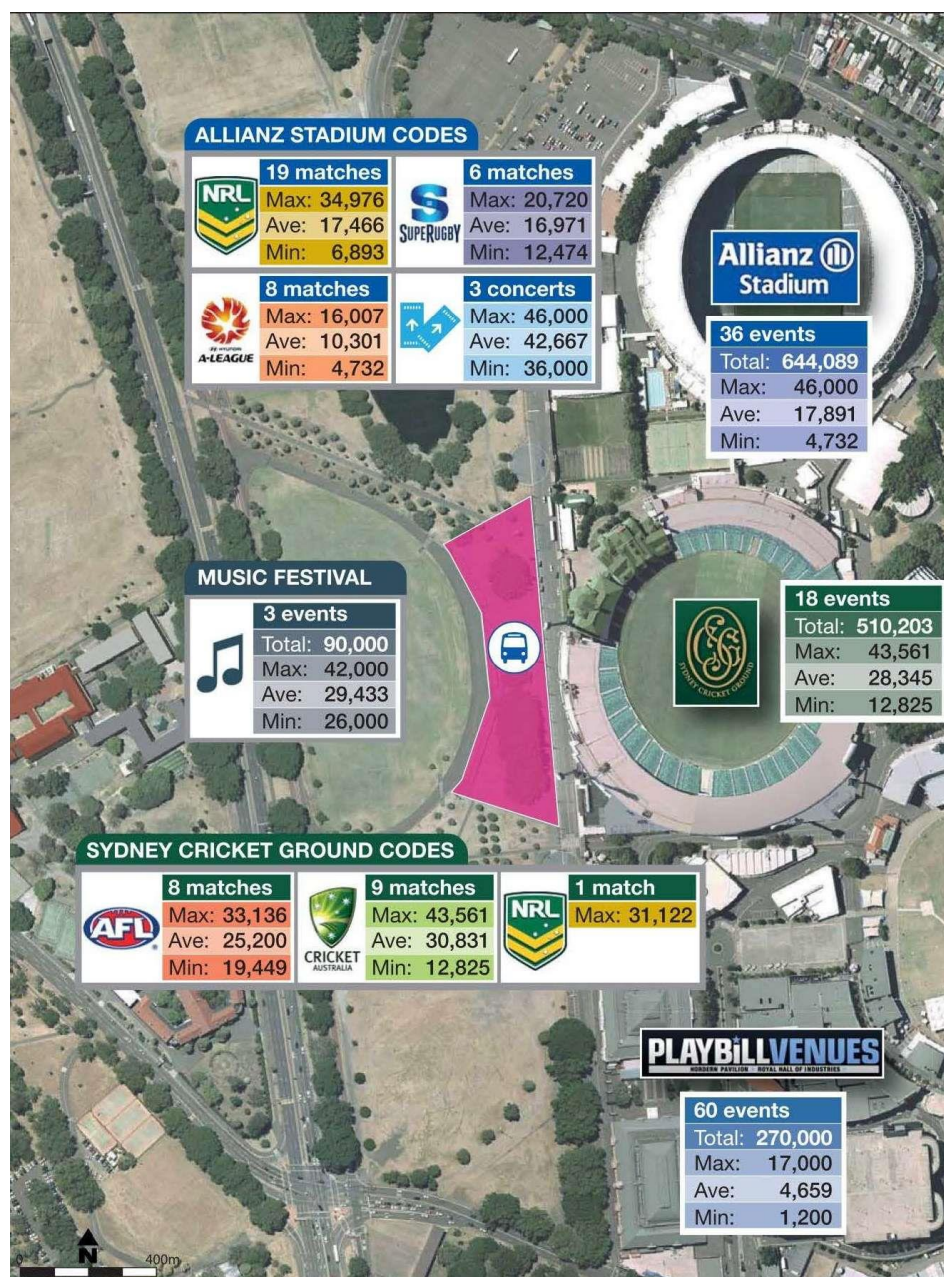
³⁷ *Parsons Brinckerhoff, Sydney Light Rail Program Moore Park Precinct – All Modes Study, June 2013*

³⁸ *Ibid*

Table 2-3: Moore Park 2011 Key Event statistics

	Sports Stadiums	Playbill Venues
Total Events	50	60
Total Attendance	1,150,000	270,000
Peak Attendance	46,000	17,000
Average Attendance	18,000	5,000

Figure 2-6: Moore Park 2011 Event Attendance and Frequency³⁹



³⁹ Transport for NSW special event bus data for 2011 and Moore Park Operations Plan (2004) as cited in Parsons Brinckerhoff, Sydney Light Rail Program Moore Park Precinct Study, January 2013

The majority of events at Moore Park are characterised by a 'bump in-bump out' demand profile with a large surge in demand for transport services prior to and, particularly, at the conclusion of events such as sports games or concerts. While pre-game entertainment and opening acts tend to spread the demand for transport as patrons arrive, 75% to 85% of attendees leave venues within 20 minutes of events finishing. Longer events such as cricket and the Australian Football League (AFL) experience higher numbers of patrons leaving before the event finishes.

2.4.2.2. Mode share

Across the spectrum of events held at the sporting stadiums walking, driving and event bus are the main modes with:

- 40% to 50% walking, including approximately 12,000 spectators estimated to walk to/from Central Station for a capacity event;
- 35% to 50% driving; and
- 5% to 20% catching an event bus.

Estimated event bus mode share for music festivals is significantly higher at 35%, likely due to the younger average age of music festival attendees when compared with other event types. Mode share data for the Playbill venues is unavailable however special event buses are not provided due to the relatively small crowd sizes. Estimated transport mode share is presented in Table 2-4.

Table 2-4: Moore Park 2011 Transport Mode Share⁴⁰

Mode of Transport	Music Festival ³	Cricket ¹	AFL ¹	Concert (Allianz Stadium) ³	NRL ²	Rugby Union ¹	Soccer ¹
Car (driver and passenger)	20%	40%	37%	35%	39%	42%	48%
Event bus	35%	18%	17%	12%	10%	6%	4%
Drop-off							
▪ Taxi/hire car/bus	2%	2%	2%	4%	2%	2%	2%
▪ Private car	1%	1%	1%	2%	1%	1%	1%
Walk	42%	39%	43%	47%	48%	49	45%
Total	100%	100%	100%	100%	100%	100%	100%

1. Estimated from 2011 event bus data, car park numbers and 2004/2005 Moore Park Event Operations Plan Study.
2. Estimated from surveys undertaken for match between the Sydney Roosters and the South Sydney Rabbitohs at Allianz Stadium on the evening of Friday 11 March 2011. The match was a local derby on the first round of the season and attracted an official crowd of 28,703 people.
3. Estimated from other events.

Walking

Significant numbers of customers walk to Moore Park, many of which walk to access rail services at Central Station. Upwards of 10,000 people attending a typical cricket or AFL game arrive on foot, of which approximately 30% travel along Fitzroy and Foveaux streets from Central Station. The walk between Central Station and Allianz Stadium is 1.65 km or approximately 25 minutes.

⁴⁰ Parsons Brinckerhoff, Sydney Light Rail Program Moore Park Precinct Study, January 2013

Driving

A typical cricket match currently attracts upward of 12,000 attendees arriving by car. Maximum car parking capacity is estimated at 5,700 spaces spread between a number of locations including on-grass, temporary and permanent facilities. Permanent parking facilities are available and supplemented by on-grass parking as follows:

Permanent parking:

- SFS Members Car Park (~700 spaces); and
- Entertainment Quarter (~2,000 spaces).

Temporary parking:

- Kippax and Area 2 on-grass parking areas (~2,500 spaces); and
- Sydney Boys High School (~500 spaces)

Vehicles leaving Moore Park following an event cause congestion on the surrounding road network, frequently resulting in egress times from the precinct of 50 to 75 minutes.

Special event buses

Event bus mode share varies significantly by event type with music festivals, cricket and AFL matches boasting the highest shares.

Routes operate between Moore Park and Central, Circular Quay, Goulburn Street car park and the UNSW however not all routes service every event. Further information on event bus operations is provided in Section 2.4.2.3.

2.4.2.3. Special event bus operations

Special event buses operate during sporting events, concerts and music festivals. In 2011 over 6,000 bus trips operated to serve special events at Moore Park accruing approximately 20,000 service kilometres. The routes and levels of service offered differ by event based on expected attendance levels and travel patterns of the attendees. A summary of event bus services to Moore Park is presented in Table 2-5.

Table 2-5: Event Bus Services to Moore Park⁴¹

Route Number	Destination	Stops/Route	Event Type
1	Central	Connecting to suburban rail, Airport Line and intercity trains	All
3	Circular Quay	Via Flinders Street, Oxford Street and Elizabeth Street – connecting to North Shore buses at Wynyard and ferries	All
3	Martin Place	Stops also at St James and Museum	All
15A	Castle Hill	Stops at The Hills Centre, Baulkham Hills, M2 Barclay Road, M2 Oakes Road	AFL and Rugby Union
18	Dural	Stops at Round Corner, Glenhaven, Cherrybrook, West Pennant Hills, Beecroft	AFL and Rugby Union

⁴¹ Parsons Brinckerhoff, *Sydney Light Rail Program Moore Park Precinct – All Modes Study*, June 2013

Route Number	Destination	Stops/Route	Event Type
30	TG Milner Sportsground Marsfield	Stops also at Chatswood and St Leonards	Rugby Union
40	Kings Cross		AFL
50	Warringah Mall	Stops at Balgowlah, Seaforth, Mosman, Cremorne and Neutral Bay	Rugby Union, Rugby League
52	Goulburn Street Car Park	To augment car parking at Moore Park	AFL
60	Randwick Racecourse	To augment car parking at Moore Park	AFL, Rugby League
62	University of NSW	To augment car parking at Moore Park	AFL
80	Chatswood		Rugby Union

For instance, Route 3 buses are offered at Manly Sea Eagles National Rugby League (NRL) games held at the SFS to cater for supporters transiting from the north shore and northern beaches. Available 2011 statistics on special event buses to and from Moore Park are provided in Table 2-6.

Table 2-6: Moore Park Average Event Bus Statistics (2011)⁴²

	Music Festival	Cricket	AFL	Concert	NRL	Rugby Union	Soccer
Bus Trips	256	208	176	193	63	61	20
Service Kilometres	986	673	575	603	197	200	61
Passengers Forward	4,987	4,416	3,551	5,126	1,346	979	339
Route 1	4,987	3,767	2,854	4,894	1,289	881	381
Route 3	-	834	232	348	271	123	-
Route 52	-	-	409	-	-	-	-
Route 62	-	-	226	-	-	-	-
Passengers Return	6,862	5,315	4,180	5,166	1,360	959	383
Route 1	6,862	4,039	2,876	3,930	1,278	772	431
Route 3	-	1,640	568	1,236	388	187	-
Route 52	-	-	446	-	-	-	-
Route 62	-	-	290	-	-	-	-

⁴² Transport for NSW annual special event bus data for 2011. Average values shown for each measure. Average total passengers may not equal the sum of each route as Route 3 supports only selected events.

Buses disembark passengers at a specially designed high-capacity bus hub located adjacent to the SCG and short walking distance from Allianz Stadium and the Entertainment Quarter (shaded in Figure 2-6). Following large events passenger queues extend toward Driver Avenue and into the Area 2 parking area.

2.4.3. Royal Randwick

2.4.3.1. Event and demand overview

Historically Royal Randwick Racecourse has only been heavily utilised by major events on designated race days. In 2011 this comprised 12 race days ranging in size from around 5,000 to over 25,000 attendees for the Randwick Derby and the Epsom Handicap. However there is a growing trend toward hosting significant non-racing events at Royal Randwick, for example UNSW bi-annual examinations, and the annual Future Music festival which began in 2006. It is expected this trend will continue following the development of the site as discussed in Section 3.1.2.4.

Figure 2-7: Alison Road at Royal Randwick⁴³



Race days are characterised by a greater 'spread' in their transport demand profile when compared with other major sporting and music events, with a much less pronounced peak demand in both the access and egress periods. In addition, races tend to be held on weekends and rarely coincide with the regular commuter peak making events at Randwick easier to manage from a transport perspective.

2.4.3.2. Mode share

Event bus mode share for Saturday race days averages 8% of total attendance. Mode share increased for race days with higher attendance; those with greater than 15,000 attendees averaged 11% bus share. Additionally, mode share is typically higher on the return leg away from Randwick. Taxis play a particularly significant role as a mode of access on race days.

Event bus mode share was significantly higher at the Future Music Festival, averaging 33% overall comprised of 27% on the forward leg and 40% on the return leg. This higher mode share is likely a result of the lower average age of attendees to the music festival.

⁴³ ATC, Sydney Carnival 2012 Coordinating Instructions: Traffic and Pedestrian Management, April 2012

2.4.3.3. Special event bus operations

Special event buses operate to support transport to Saturday race days and Melbourne Cup day. Saturday race days attract on average 14,000 attendees, with major race days attracting up to 25,000 patrons. Additionally, event buses have supported the annual Future Music Festival which in 2011 had over 40,000 attendees.

In 2011 nearly 1,400 bus trips served events at Royal Randwick accruing approximately 6,500 service kilometres. A shuttle service, the Route 32, is offered between Central Station (Eddy Ave) and the racecourse. Buses disembark passengers at the Alison Road bus terminus at the northern edge of the site, as marked in Figure 2-7.

2011 statistics on special event buses to and from Royal Randwick are provided in Table 2-7.

Table 2-7: Royal Randwick Average Event Bus statistics (2011)⁴⁴

	Music Festival	Races
Bus Trips	471	73
Service Kilometres	2,090	371
Passengers Forward	11,234	787
Route 32	11,234	787
Passengers Return	16,874	1,992
Route 32	16,874	1,992

2.4.4. Events impacting CSELR operations

Sydney regularly hosts cultural events including parades, running festivals and religious celebrations which impact traffic flows along the CSELR corridor. These events are concentrated in the CBD and predominantly impact traffic along George Street. Existing annual events impacting the CSELR corridor are listed in Table 2-8, however historically there have been additional events such as a parade in 2012 to celebrate the Sydney Swans winning the AFL Premiership.

Table 2-8: Annual Events Directly Impacting the CSELR

Indicative Month	Event	Comment
January	Australia Day Wheelchair Race	Course runs west along Alfred Street at Circular Quay
January	Chinese New Year Twilight Parade	Parade down George Street between Park and Goulburn Streets
March	St Patricks Day Parade	Parade down George Street between Park and Bathurst Streets
April	Anzac Day Parade	Parade down George Street between Martin Place and Bathurst Street
May	May Day March	Parade down George Street between Park and Bathurst Streets
May	SMH Half Marathon	Course runs west along Alfred Street at Circular Quay
June	MS Walk / Run	Short section of the run along George Street near Martin Place
June	Procession of the Blessed Sacrament	Procession moves down George Street between Bridge and Hunter Streets
September	Sydney Running Festival	Course runs west along Alfred Street at Circular Quay, and east through the pedestrian section of Circular Quay

⁴⁴ Transport for NSW unpublished special event bus data for 2011. Average values shown for each measure.

Indicative Month	Event	Comment
November	Sydney Christmas Parade ⁴⁵	Parade down George Street between Hunter and Liverpool Streets
December	New Year's Eve	Closure of George Street between Grosvenor and Alfred Streets, closure of Alfred Street at Circular Quay
N/A	Olympic / Sporting Parades	I.e. Sydney Swans celebratory parade 2012

Buses are typically diverted during these events, from George Street to Elizabeth Street. Following the construction of the CSEL, the operational impact of these events could be minimised by shutting the impacted portion of the line and supplementing with buses travelling along an alternate route. Detailed planning is required to minimise the impact of these events and is revisited in Section 3.3 of this report. In addition to planned events, detailed operating plans will be developed to respond to the impact of unplanned events (such as major accidents or emergency service operations in the corridor) that temporarily suspend operations of the CSEL.

2.4.5. Other events impacting demand

In addition to special events held at Moore Park and Royal Randwick, Sydney hosts a number of other special events which will impact demand for transport along the CSEL corridor to varying degrees. A list of events indirectly impacting the CSEL is presented in Table 2-9. Many of these events are held in the Sydney CBD and surrounding areas, such as the Rocks, Botanic Gardens or Domain, and draw in attendees from across Sydney. Operational management of these events following introduction of light rail is explored in Section 3.3 of this report.

Table 2-9: Annual Events Indirectly Impacting the CSEL

Indicative Month	Event	Impact
January	Sydney Festival – Festival First Night	High
January	Sydney Festival	Medium
February	Opera in the Domain	Low
February	Tropfest	High
March	Good Life Music Festival	High
March	Mardi Gras Parade	Medium
March	Mardi Gras Party	Medium
May	Vivid Festival	Medium-High
May	Mother's Day Classic	Low
June	Sydney Film Festival	Low
July	Reserve Forces Day	Low
August	City 2 Surf	High
October	Navy International Fleet Review	Low
October	International Motor Show	Low
December	Carols in the Domain	Low
N/A	Major Sporting Events	Medium

⁴⁵ Continuation of this event subject to review by the City of Sydney

2.5. CBD precinct

Sydney's CBD is the commercial heart of the city with substantial office-based daytime employment. It is a key retail and entertainment destination and, also, has a growing residential population. As a result the CBD road network supports high levels of peak travel demand, as well as a broader range of travel markets. It also represents the core of Sydney's predominantly radial public transport system. The CBD precinct runs from Alfred Street in Circular Quay to Chalmers Street, via George Street, Rawson Place, Eddy Avenue and up to the intersection of Chalmers Street / Devonshire Street (Refer to Figure 2-1). Eddy Avenue / Chalmers Street within the precinct is a complex area home to the major New South Wales rail network terminus of Central Station and a major bus interchange at Railway Square, Eddy Avenue and Chalmers Street.

2.5.1. Road network

The key roads within the CBD precinct that will be directly impacted by the CSELR include:

- George Street
- Alfred Street
- Rawson Place/Eddy Avenue
- Chalmers Street/Elizabeth Street

A summary of the key network characteristics for each of these roads is provided in Table 2-10.

Table 2-10: CBD precinct road network characteristics

Road	Key Characteristics
George Street	George Street is a major two-way collector road under the care and control of City of Sydney. It operates in a north-south direction through the Sydney CBD and it provides access between the Sydney City precincts. George Street is a key bus corridor, with kerb side bus lanes as well as driveway access to number of car parks; limited on-street parking; loading/unloading zones; dedicated turning lanes at key intersections; and pedestrian and cyclist access.
Alfred Street	Alfred Street is a local road under the care and control of City of Sydney. The section between George Street and Pitt Street operates as a two-way road with two westbound lanes and a single eastbound lane. The section of the road east of Pitt Street operates in a one-way westbound direction. The major traffic along this road is associated with taxi and bus service trips. Alfred Street is considered a key bus / rail and ferry interchange.
Rawson Place/Eddy Avenue	Rawson Place/Eddy Avenue is a two way east-west running local road under the care and control of City of Sydney. This is the one of the key access roads to the Central Station precinct. A section of the corridor operates with three traffic lanes in each direction whilst the remaining sections caters for two traffic lanes and separate dedicated bus lanes are provided. A provision for short duration on-street parking is available along Rawson Place. Eddy Avenue operates as a bus/light rail (elevated on the station colonnade), heavy rail and coach interchange.
Chalmers Street/Elizabeth Street	Chalmers Street is a four lane local road running one-way northbound and Elizabeth Street is a four lane local road running one-way southbound with a dedicated kerbside bus lane and parking lane (from Redfern Street to Foveaux Street). This road connects the suburbs of Redfern, Surry Hills, Sydney CBD, and the southern suburbs and provides access to the Central Station precinct.

Traffic operating patterns

The Sydney CBD is a highly constrained urban environment with substantial levels of congestion on virtually all corridors. In particular, George Street, as the primary north-south corridor through the CBD for pedestrians, general traffic, taxis, busses and commercial vehicles, is a highly congested. It supports 290 buses in the peak direction during the morning peak hour, which is anticipated to grow further to over 310 buses per hour by 2015.

George Street plays a significant role in the transport system, as well as in Sydney's identity as the natural connection through the heart of the city. It forms the central spine through the CBD, linking key locations such as Circular Quay, Town Hall and Railway Square.

Table 2-11 provides a summary of the key characteristics and constraints associated with existing general traffic and public transport operations of the CSELR corridor along the key roads within the CBD precinct.

Table 2-11: CBD precinct existing operational characteristics

Road	Constraints	Description
George Street	General Traffic	George Street is currently operating at capacity. The general traffic taxis and buses travelling along George Street contribute to a high level of traffic congestion within this precinct. Taxi volumes are significant and include a large proportion of empty vehicles seeking a fare.
	Bus Services	There are numerous bus services operating along George Street in dedicated bus lanes. There are 290 bus services in the peak direction along the corridor. Tourist Coach Buses: currently Sydney Sightseeing tourist coaches operate along the George Street corridor
Alfred Street	General Traffic	Alfred Street provides a connection between George and Pitt Streets that facilitates access to the northern end of Pitt Street. As such, traffic is mainly local access and taxi trips.
	Bus Services	Approximately 22 bus services run along Alfred Street, with services operating to the eastern, north western, western and southern suburbs.
Rawson Place	General Traffic	The majority of traffic travelling along this route is associated with the Central Station precinct and traffic connecting to key north, south and CBD corridors.
	Bus Services	Currently one bus service travels along Rawson Place (Route 555). All other buses from Eddy Avenue turn onto Pitt Street.
Eddy Avenue	General Traffic	The majority of traffic travelling along this route is associated with the Central Station precinct and it is an important connection linking eastern suburbs traffic on Foveaux and Chalmers Streets in to the CBD.
Eddy Avenue	Bus/Coach/light rail Services	Currently there is a coach/ light rail terminal located on the colonnade on the southern side (Central Station side) of the road. Coach services operate along a narrow island within Eddy Avenue then travel along Pitt Street. There are currently 18 coach bays that are used by Premier, Firefly, CDC and Greyhound operators. All other bus services along Eddy Avenue either head north to Elizabeth Street or south to Pitt Street utilising stops on Eddy Avenue. The majority of peak bus passenger demand is associated with the UNSW shuttle bus services.

Peak hour traffic composition and volumes

A summary of the peak traffic volumes travelling along George Street and Eddy Avenue is provided in Table 2-12, with network composition illustrated in Figure 2-8.

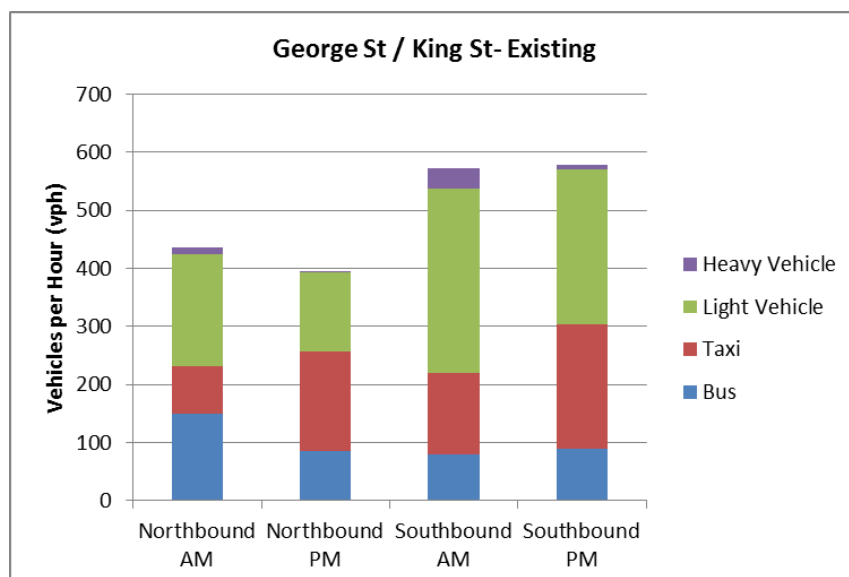
Both George Street and Rawson Place have traffic volumes in excess of 2,000 vehicles during both the AM and PM peak. Along George Street, during the AM peak a large proportion (70 per cent) of these are inbound, whereas the PM peak volumes are more evenly distributed. Eddy Avenue has a relatively even distribution of inbound and outbound traffic during both the AM and PM peak. As illustrated in

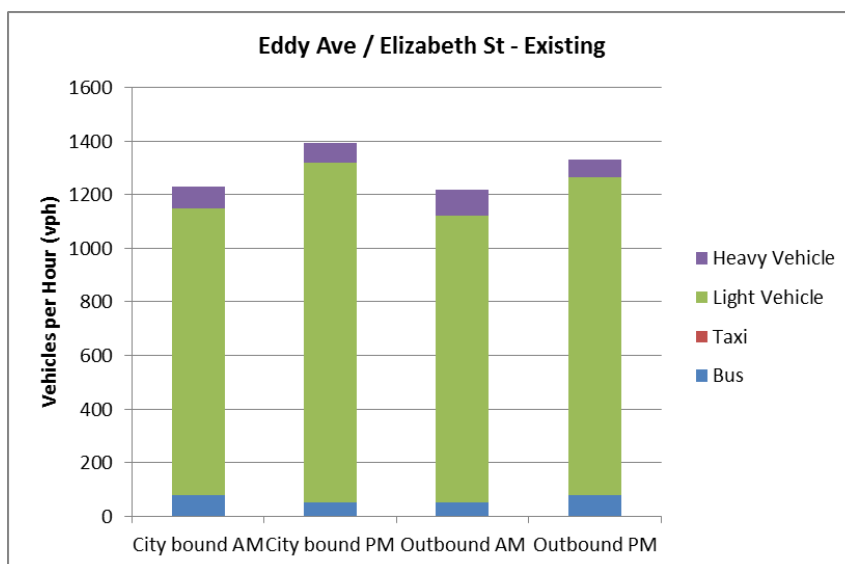
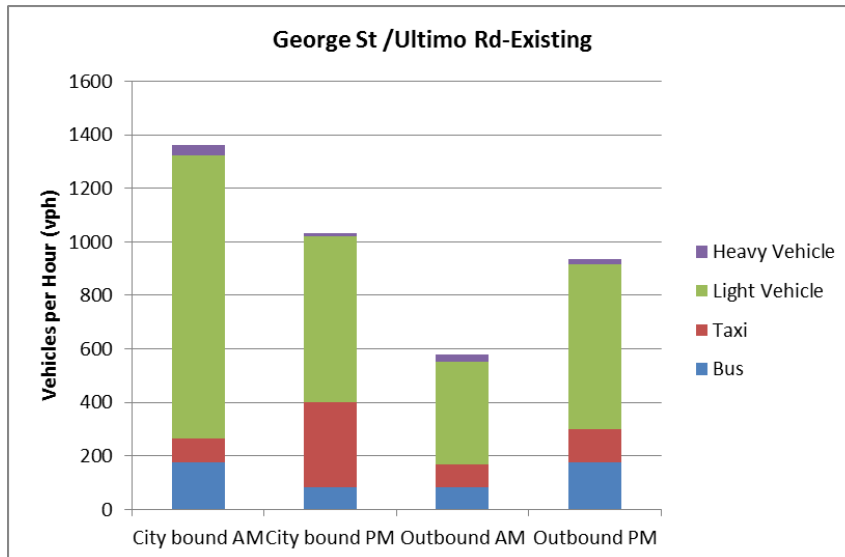
Figure 2-8 the majority of vehicles on the CBD precinct corridors are light vehicles, including a significant proportion of taxis.

Table 2-12: CBD precinct average weekday AM and PM peak traffic volumes

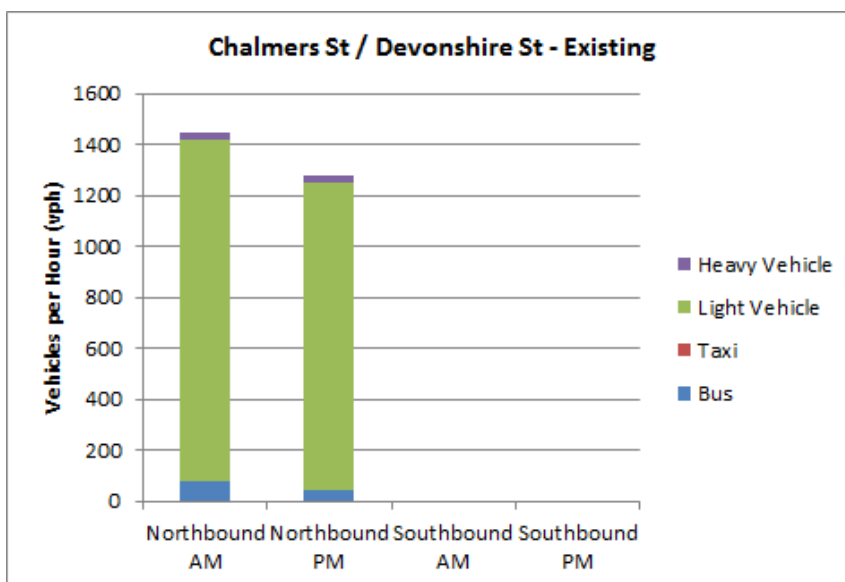
Intersection	AM Peak			PM Peak		
	City Bound	Out Bound	Peak Direction Split	City Bound	Out Bound	Peak Direction Split
Alfred Street (near George St)	153	232	60% out bound	111	241	68% out bound
George Street (near King Street)	573	435	57% city bound	579	395	59% city bound
George Street (near Ultimo Rd)	1361	577	70% city bound	1032	936	52% city bound
Eddy Ave (near Elizabeth Street)	1230	1218	50% city bound	1391	1330	51% city bound

Figure 2-8: CBD precinct existing traffic composition





* No surveyed taxi volumes available



* No surveyed taxi volumes available

Intersection performance

A summary of the performance of key intersections along George Street, Rawson Place and Elizabeth Street is provided in Table 2-13. The AM and PM peak key intersection performance results include an overall intersection Level of Service (LoS), intersection delay and Degree of Saturation (DoS) from the base case models. The results are focused on those corridors currently experiencing capacity constraints. Refer to Section 2.2 for the global assumptions used in the intersection analysis.

Table 2-13: CBD precinct key intersection performance⁴⁶

Intersection	Peak Hour	Existing		
		LoS	DoS (volume/capacity)	Av. Delay (seconds)
Bridge Street / Grosvenor Street / George Street	AM	F	1.00	96.8
	PM	F	1.00	81.1
Hunter Street / George Street	AM	D	0.72	43.7
	PM	B	0.64	26.4
Market Street / George Street	AM	C	0.87	35.6
	PM	D	0.88	52.2
Park Street/Druitt Street/ George Street	AM	E	0.90	63.5
	PM	E	0.91	62.2
Bathurst Street / George Street	AM	D	0.92	45.2
	PM	D	0.91	51.9
Rawson Place / George Street	AM	D	0.76	52.7
	PM	E	0.87	59.9
Elizabeth Street / Foveaux Street / Eddy Avenue	AM	C	0.93	37.2

As illustrated in Table 2-13, the intersections between Bridge Street / Grosvenor Street / George Street and Park Street/Druitt Street/ George Street have the lowest level of service, with average delays greater than 1 minute during both the AM and PM peak.

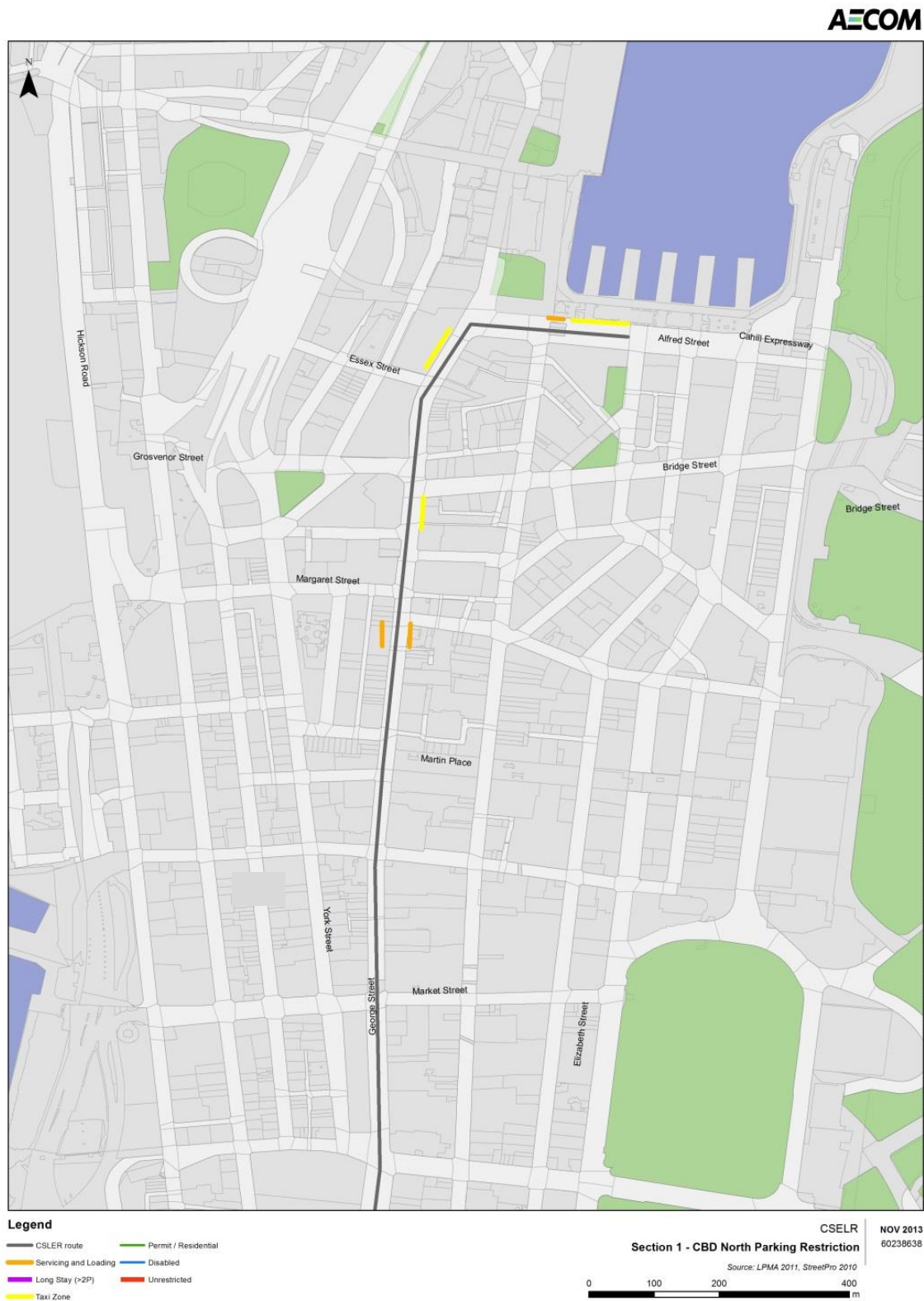
2.5.2. Parking and kerbside access

The existing kerbside parking restrictions in the CBD precinct are shown in Figure 2-9 and Figure 2-10.

The northern section of the CBD, from Circular Quay at Alfred Street along George Street to the intersection of George Street and Park Street, is characterised by high density commercial and hotel development as well as retail and food and beverage uses. Kerbside lanes between Essex Street at Circular Quay and Park Street at Town Hall are used as bus lanes throughout the day (operation hours vary by location with multiple hours and days- generally 6am -8pm Mondays to Fridays). At night, parts of these lanes are used as mail, loading and taxi zones. A westbound bus stop is also located on Alfred Street between Loftus Street and Pitt Street. Additional taxi zones include one eastbound on Alfred Street and another northbound at the Four Seasons Hotel.

⁴⁶ Source: LinSig modelling undertaken as part of ITLU Milestone Option Assessment

Figure 2-9: CBD north parking restrictions 47



⁴⁷ AECOM, 2013

The southern section of the CBD corridor runs from the intersection of George Street and Park Street to the intersection of Chalmers Street and Devonshire Street via Rawson Place / Eddy Avenue as shown in Figure 2-10. The dominant land uses are high density residential and commercial as well as retail and entertainment along with the major rail terminus of Central Station and major bus interchange at Railway Square. On George Street there are existing kerbside bus lanes which are operational generally during the hours between 6am – 8pm Monday – Friday (certain sections operate 24 hour bus lanes), which will be replaced by the introduction of light rail. At night and on weekends the majority of on-street parking is permitted on both George Street south and Rawson Place. There are also some strategically located taxi and loading zones along the southern section of George Street close to major land uses such as World Square, Town Hall Station and various hotels located between Park Street and Ultimo Road and Central Railway Station at Eddy Avenue-Chalmers Street. Eddy Avenue provides space for buses and taxis whilst Chalmers Street has on-street parking on the eastern side with bus and taxi stops on the western side.

Figure 2-10: CBD south parking restrictions



Table 2-14: CBD precinct special kerbside uses and parking supply

CBD Kerbside Restriction	Special Kerbside Uses and Parking Supply by Time Period		
	Pre-AM Peak	Inter Peak	Post-PM Peak
Car Share, Hospital, Mail Zone	4	4	4
Disability Parking	5	5	5
Loading Zone	6	42	39
Taxi Zone	15	19	26
Total – Special Kerbside Uses	30	70	74
Short Stay Parking ($\leq 1P$)	20	41	20
Long Stay Parking (Restricted)	7	22	43
Long Stay Parking (Unrestricted)	0	0	0
Total – General Parking	27	63	63

The special kerbside uses and general parking supply in the CBD precinct by time of day is illustrated in Table 2-14. The available loading and parking zones in the southern section of the CBD corridor are all operating at effective capacity during peak periods. Further discussion on the Project parking strategy to mitigate impacts on existing supply can be found in Section 6.

2.5.3. Property access

Currently there are a number of property accesses (private car parking or loading dock) along the light rail corridor within the CBD precinct. Existing property accesses along George Street are shown in Table 2-15.

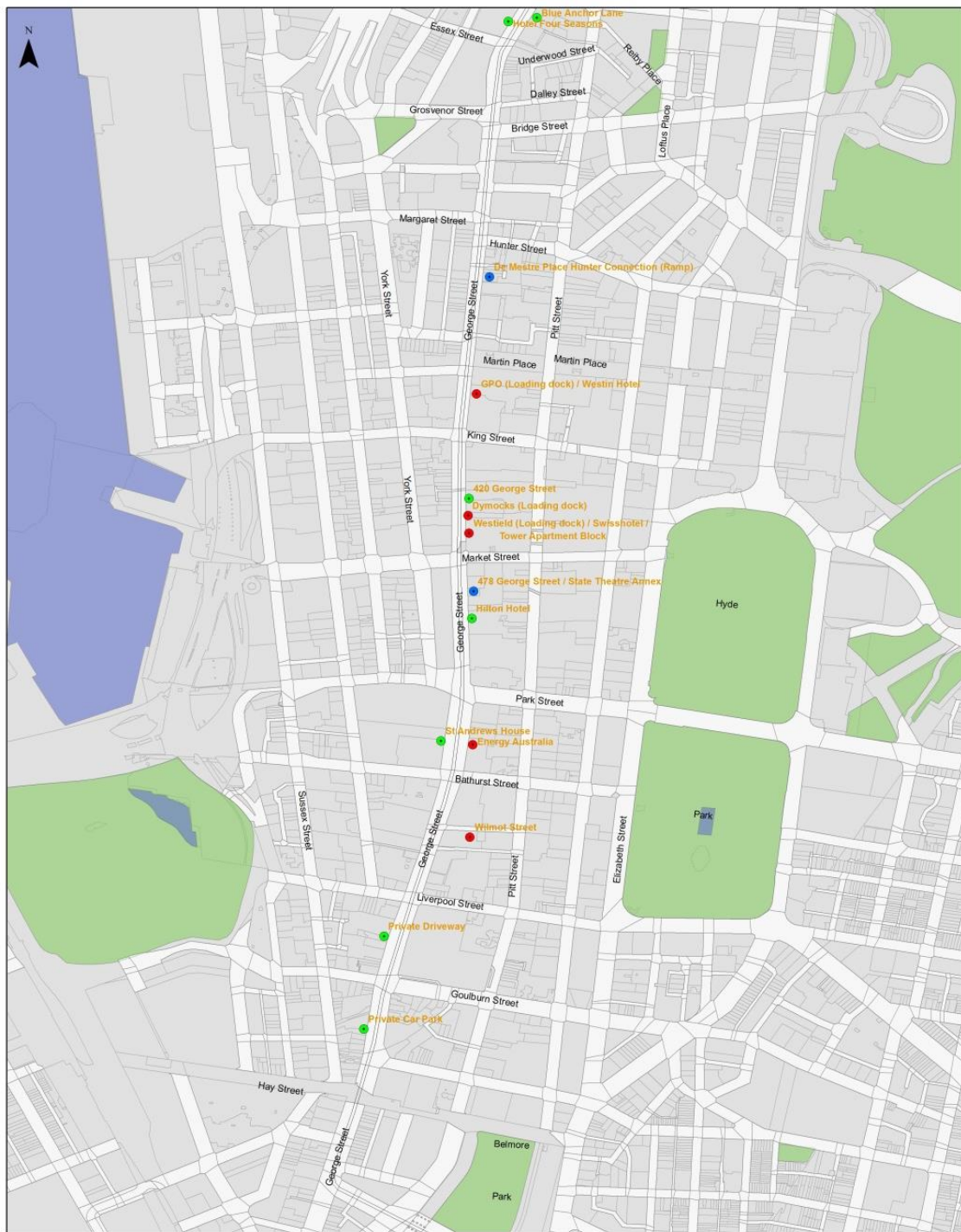
Table 2-15: George Street vehicular accesses and redevelopment sites

Access Type	George Street Accesses
Private car park access	■ Four Seasons Hotel (west side, Essex Street to Alfred Street) porte cochere is located on George Street, with a back of house, coach/ car drop off zone located on Harrington Street. ■ 176-186 George Street (east side, access through Blue Anchor Laneway) ■ Westin Hotel /GPO car park (east side, King Street and Martin Place) ■ Private car park and loading dock on 420 George Street (east side between King Street and Market Street) ■ Swissotel and Tower Apartment car park shared with Myer loading dock (east side, Market Street - King Street) ■ Hilton Hotel Valet parking currently exits one way westbound to George Street ■ A private garage at 583 George Street (west side between Liverpool and Goulburn Street) ■ A private car park next to Central Baptist Church (west side- Goulburn Street - Campbell Street) ■ St Andrews House-(Park Street to Bathurst Street) - Existing access with lockable bollards is located on George Street. Alternate access available via driveway to St Andrews Church on Bathurst Street.
Public car park access	■ Nil
Courier/delivery loading dock access	■ Dymock's loading dock (east side King Street - Market Street) ■ Energy Australia building loading dock (east side, Park Street to Bathurst Street) ■ A Loading dock access via Wilmot Street (Between Bathurst Street and Liverpool Street)

Access Type	George Street Accesses
Footpath/ramp access to street	■ Hunter Connection - De Mestre Place (east side, Hunter Street - Wynyard Street) ■ 478 George Street /State Theatre Annex (east side, Market Street-Park Street)
Total Identified	14

Figure 2-11 highlights the key traffic generating driveways accesses along George Street corridor. The total vehicle counts identified from the key driveways, based on the City of Sydney vehicle survey are outlined in Table 2-16.

Figure 2-11: CBD precinct property accesses



- Legend**
- Private driveway
 - Loading dock
 - Ramps / Other access
 - Light rail alignment

Driveway Access - Sydney CBD - George Street Corridor
Source: LPMA 2011, City of Sydney Council 2012

CSELR
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Table 2-16: Total vehicle counts for key accesses along George Street⁴⁸

Driveway Access	Total Daily Volumes
Westfield Loading Dock/Swissotel car park	355
420 George Street (Mid City) car park	170
Hilton Hotel car park	649
GPO Loading Dock/Westin Hotel car park	123

Figure 2-11 and Table 2-16 highlight a significant level of commercial usage of driveways along George Street particularly focused in the block between King and Market Streets. In the case of the Westfield loading dock these vehicle movements include occasional deliveries by 19m articulated trucks.

Currently, when larger vehicles turn into these driveways off George Street they are required to swing out across the adjacent traffic lane which presents a potential safety hazard. The major docks at Mid-City and Westfield also utilise traffic controllers to halt pedestrian movements when vehicles are accessing the driveways due to the heavy pedestrian flows on George Street. When turning off George Street vehicles provide additional low level delays to buses, particularly when periods of heavy pedestrian demand require the traffic controllers to regulate their access.

2.5.4. Pedestrians & cyclists

Pedestrian access

In the Sydney CBD, walking is the predominant mode of transport used for accessing the various centres and land uses. Existing pedestrian access along the light rail route within the CBD is facilitated by footpaths, marked and signalised pedestrian crossings and kerb ramps as summarised in Table 2-17. Pedestrians walking within the CBD precinct experience numerous challenges which include excessive delays at signalised intersections, crowded and narrow footpaths, footpath interruptions, driveway crossovers and undulating topography.

⁴⁸ City of Sydney – George Street Driveway counts 4 August 2010

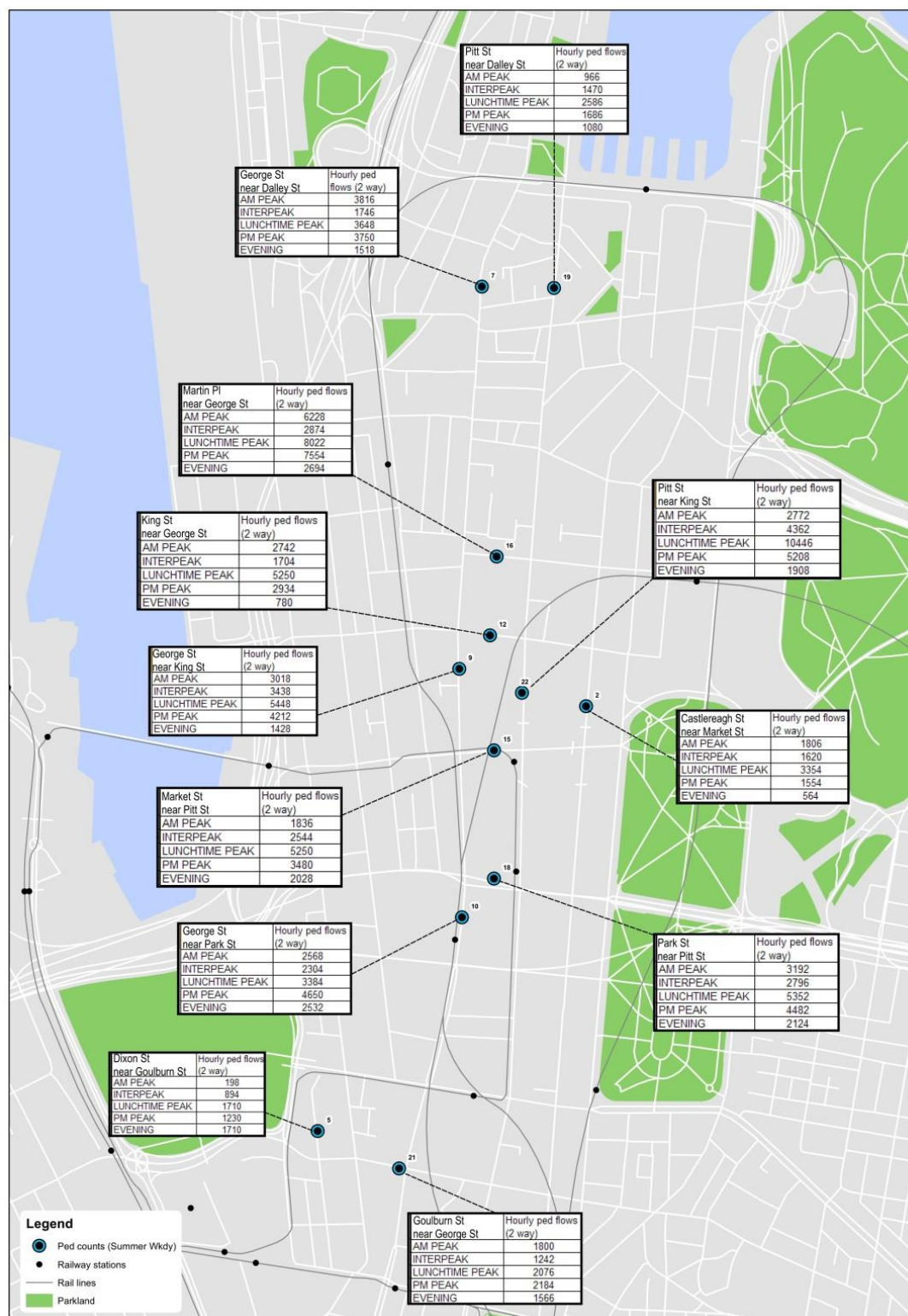
Table 2-17: Existing pedestrian access within the CBD precinct

Precinct	Corridor Location	Description	Pedestrian Access Type
CBD	Alfred Street	Circular Quay pedestrian mall, Wharf and public transport interchange which attract significant volumes of pedestrians along Alfred Street. Alfred Street is closed to traffic during major events (e.g.: Sydney New Year's Eve celebrations, Vivid Sydney etc.) period.	Alfred Street is a major passenger transfer location between rail, ferry and bus transport modes. There are signalised intersections, sealed footpaths, a pedestrianised mall and kerb ramps to facilitate the pedestrian movements.
	George Street	George Street is a major hub for employment and businesses specialising in commercial, retail, entertainment and cultural activities as well as major commuter interchange which attract a significant volumes of pedestrians.	Pedestrian connections other than at intersections include the Strand, Mid City, QVB, Hilton, Galleries Victoria, Hunter Connection, Martin Place, World Square etc. Existing pedestrian facilities such as footpaths, pedestrian crossings at signalised intersections (approx. 17 x signalised intersections), and kerb ramps to facilitate pedestrian movements across George Street.
	Rawson Place	Pedestrian activities associated with Rawson PI are mainly influenced by Central Station (train / bus) commuters and Sydney Central YHA.	The pedestrian facilities such as footpaths, pedestrian crossings at signalised intersections (George Street / Rawson PI & Eddy Ave / Pitt Street), and kerb ramps are provided to facilitate pedestrian movements across Rawson Place.
	Eddy Avenue	Eddy Avenue is a major passenger transfer location between Sydney Trains, light rail and bus transport modes and highly influenced by commuter activity.	Footpaths on both sides, pedestrian crossings at signalised intersections (Eddy Ave / Pitt Street and Eddy / Elizabeth Street), mid-block crossing and kerb ramps are to facilitate pedestrian movements across Eddy Ave. In addition, pathways through Prince Alfred Park provide good connections with areas to the south of Cleveland Street.
	Chalmers Street/ Elizabeth Street	Pedestrian activity associated with Chalmers Street is mainly influenced by commuter activity, small cafes and businesses.	Chalmers Street and Elizabeth Street are active pedestrian corridors due to their close proximity to Central Station and other residential and retail land uses. Footpaths, pedestrian crossings at signalised intersections and kerb ramps are provided to facilitate pedestrian movements across Chalmers and Elizabeth Streets. A designated pathway along Alfred Street Park attracts significant number of pedestrians to the area.

Pedestrian volumes

Figure 2-12 illustrates the existing pedestrian volumes at selected intersections within the precinct.

Figure 2-12: Existing Pedestrian Volumes within the CBD precinct⁴⁹



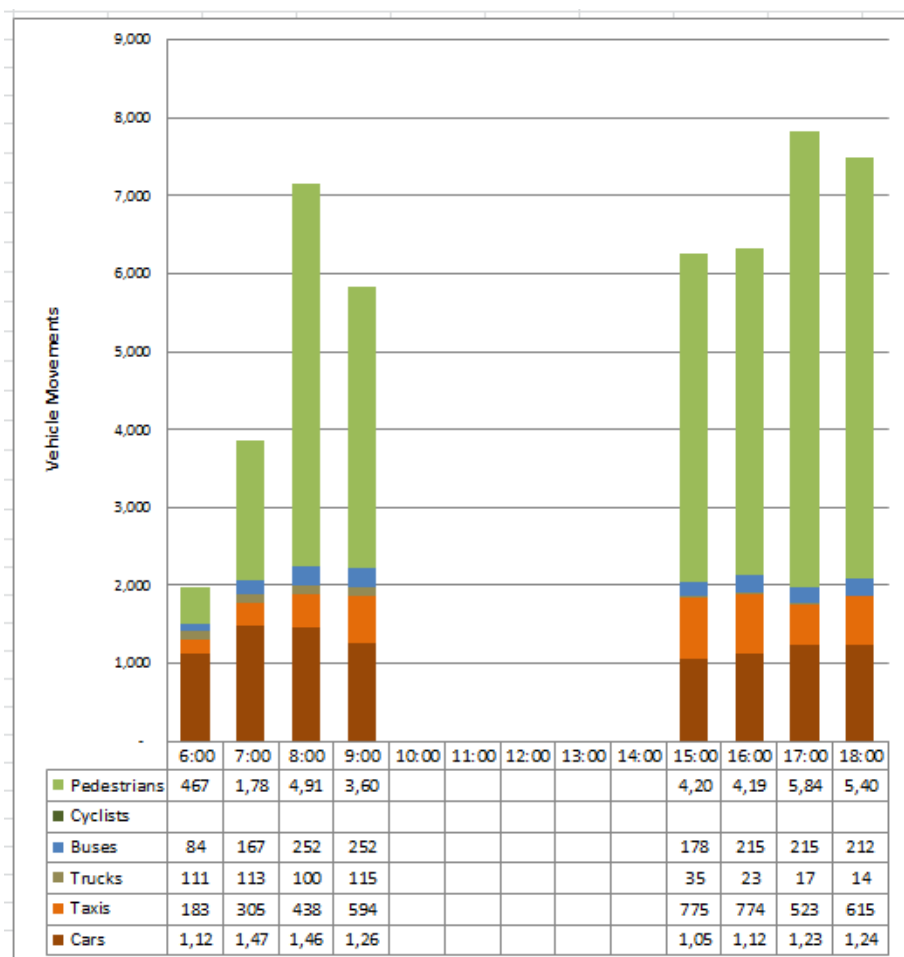
⁴⁹ City of Sydney, 2010

As illustrated in Figure 2-12 the points along George Street with the highest pedestrian numbers include:

- Martin Place (approx. 8,000 peak period 2-way flows)
- King Street (approx. 5,500 peak period 2-way flows)
- Park Street (approx. 4,700 peak period 2-way flows)

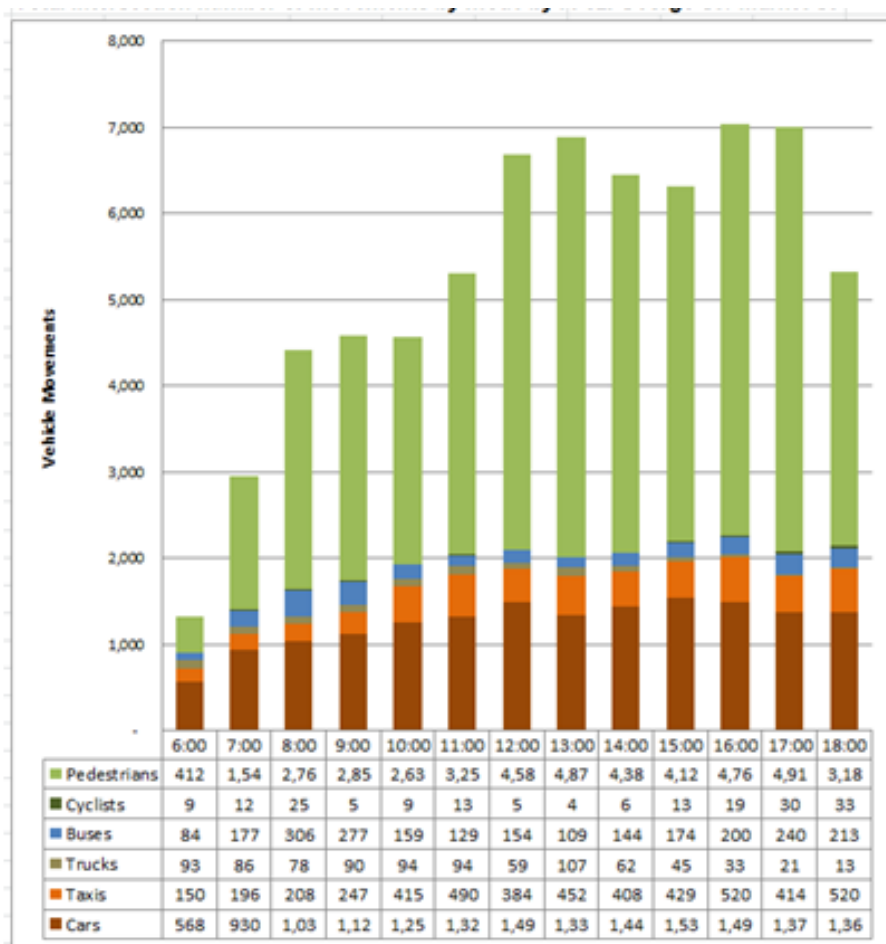
Within the CBD, Transport for NSW has undertaken a number of surveys that highlight the volume of pedestrians in relation to other traffic passing through selected intersections. This analysis for the sites located along the CSELR corridor is shown below in Figure 2-13.

Figure 2-13: George St / King St- Total Intersection number of movements by mode by hour⁵⁰



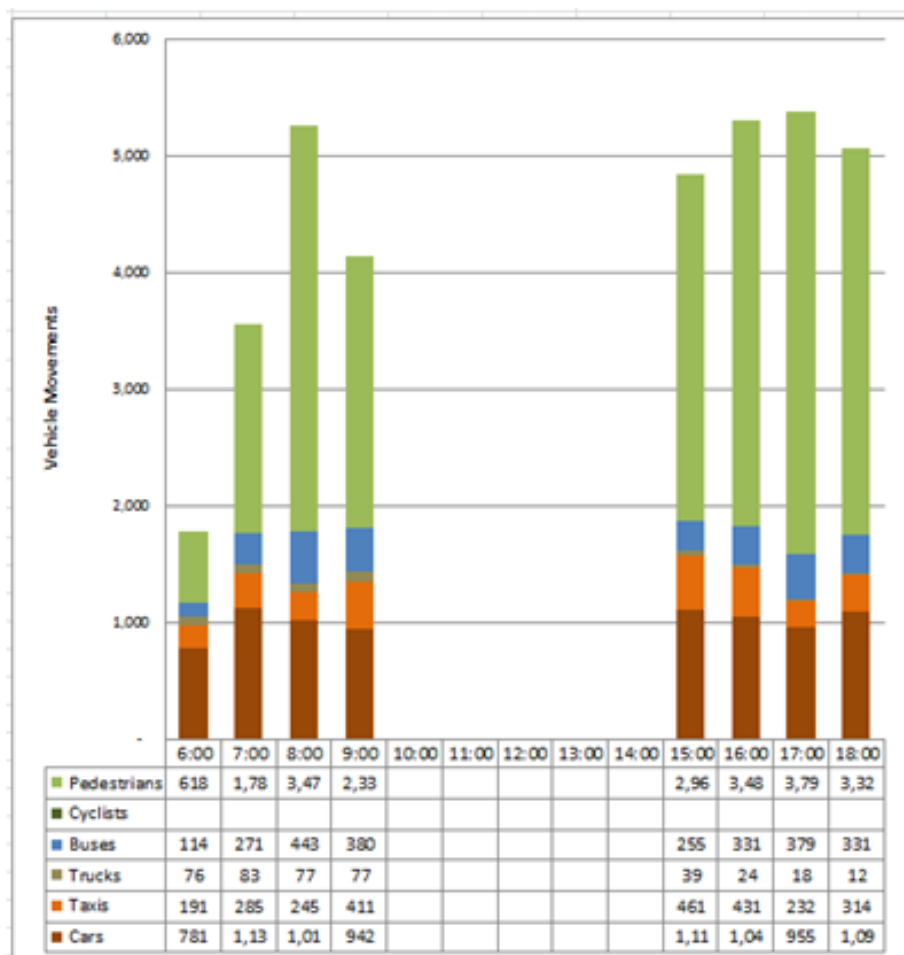
⁵⁰ Transport for NSW, 2013

Figure 2-14: George St / Market St- Total Intersection number of movements by mode by hour⁵¹



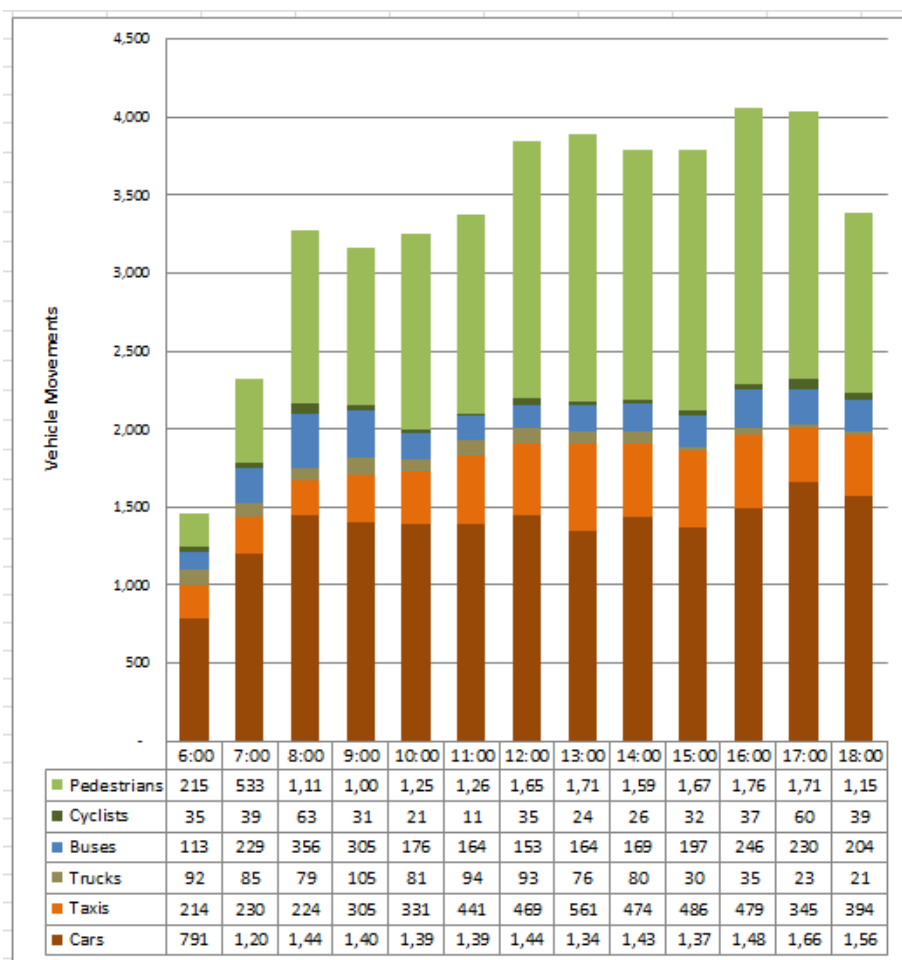
⁵¹ Transport for NSW, 2013

Figure 2-15: George St / Druiitt St- Total Intersection number of movements by mode by hour⁵²



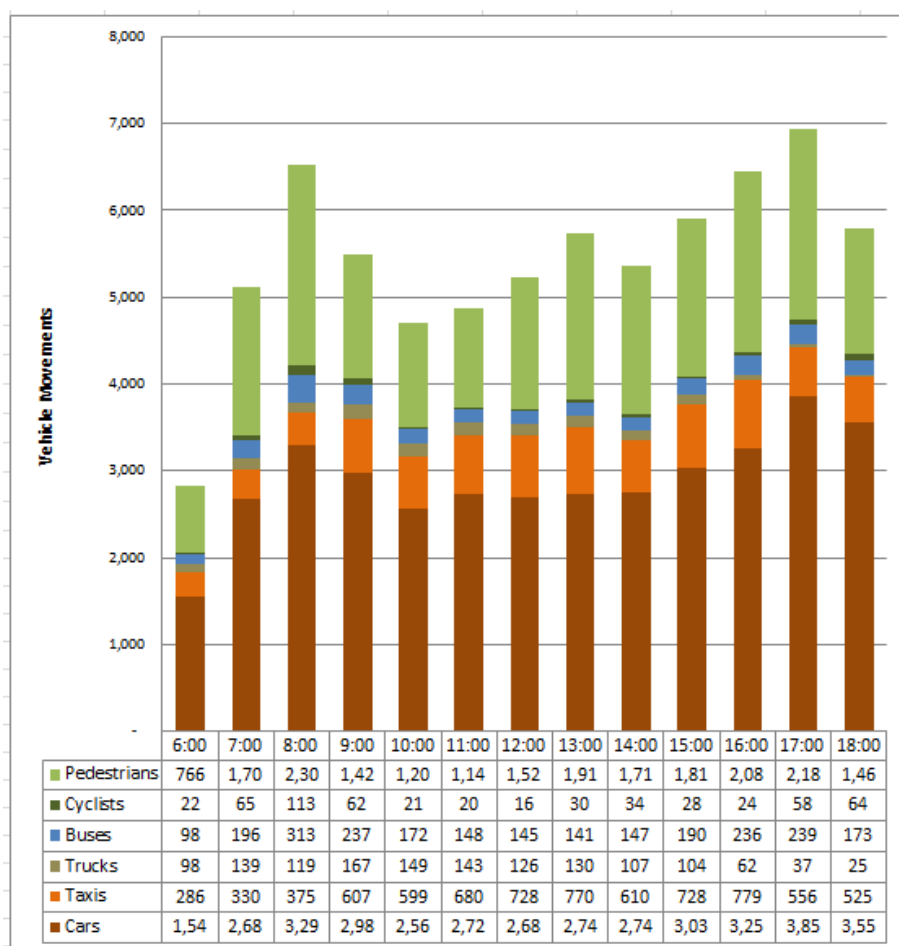
⁵² Transport for NSW, 2013

Figure 2-16: George St / Rawson PI- Total Intersection number of movements by mode by hour⁵³



⁵³ Transport for NSW, 2013

Figure 2-17: Elizabeth St / Eddy Ave/ Foveaux St- Total Intersection number of movements by mode by hour⁵⁴



The above analysis demonstrates that pedestrians make up the predominant mode at key intersections, particularly in the northern section of Alfred Street and George Street where they account for as much as 70%-80% of total traffic.

Intersection performance

Pedestrian Level of Service (LoS) assessment at key existing intersections within the proposed pedestrianised zone has been undertaken based on the available footpath space and peak hour pedestrian flows. The results of this analysis are shown below in Table 2-18.

⁵⁴ Transport for NSW, 2013

Table 2-18: Pedestrian Level of Service

Intersection	Pedestrian Level of Service			
	NW corner	NE corner	SE corner	SW corner
Hunter Street / George Street	D	E	F	E
King Street / George Street	D	D	E	D
Market Street / George Street	E	F	F	F
Park Street/Druitt Street/ George Street	C	C	C	C
Bathurst Street / George Street	D	B	B	E

The above results clearly demonstrate a number of intersections along the George Street corridor suffer from severe levels of congestion that may result in increased journey times and safety issues due to overcrowded footways.

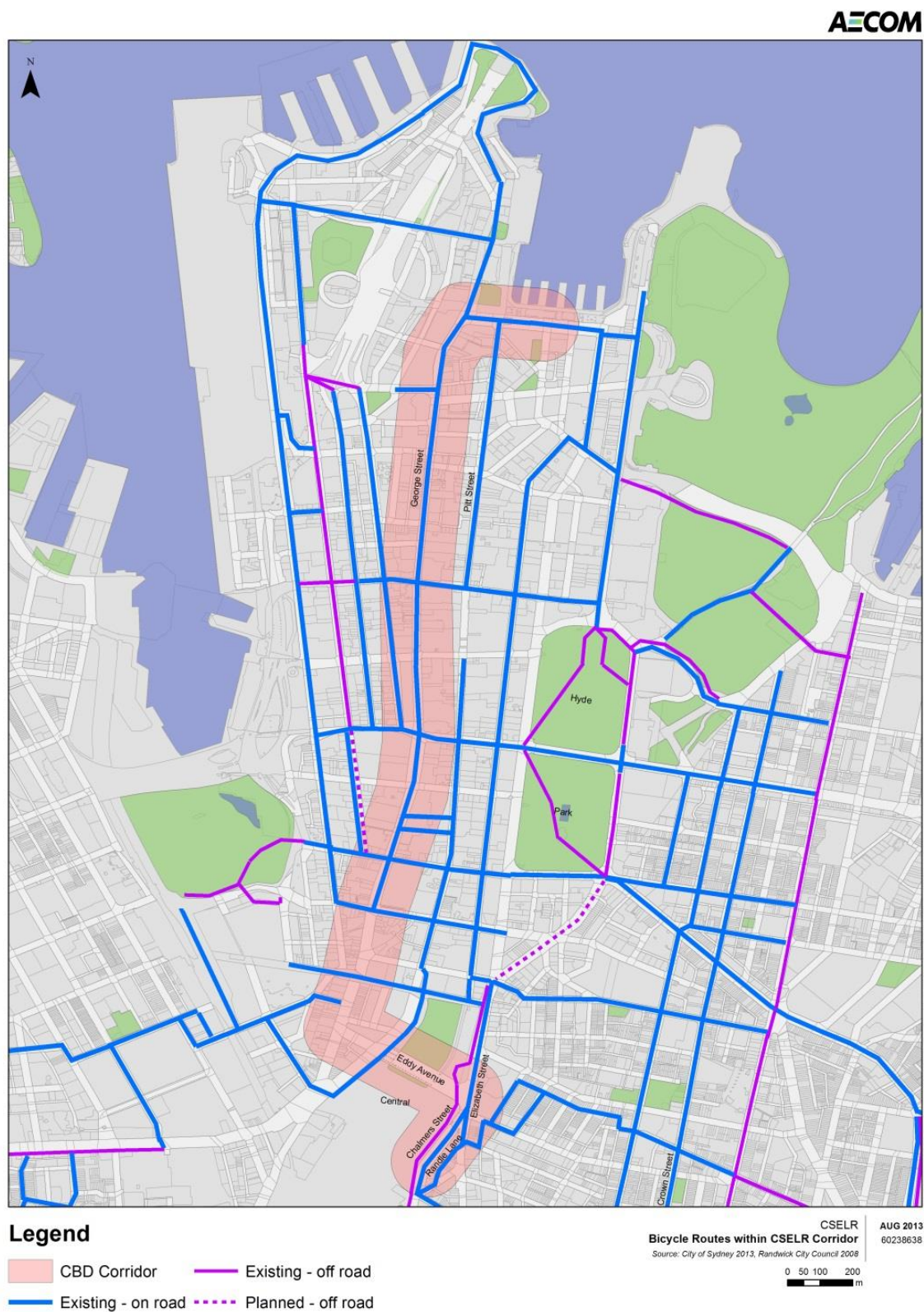
Bicycle access

Under the City of Sydney Cycle Strategy and Action Plan 2007-2017, the Council is committed to making cycling a major mode of transport along with walking and public transport to develop a sustainable transport system. The NSW Government, in the NSW 2021 plan has also expressed its commitment to double the mode share for cycling by 2016. The City of Sydney Cycle Strategy indicates that the current percentage of trips between 2 and 5 kilometres in length undertaken by bicycle is approximately 25%, of which the most common purpose of the trips is recreational cycling. There are several networks of on-road and off-road cycleways in the vicinity of the proposed light rail corridor. Figure 2-18 presents the bicycle network within the CBD precinct.

The overall estimated mode share for bicycle trips in the Greater Metropolitan Area is 3.37%⁵⁵.

⁵⁵ Bureau of Transport Statistics, *Sydney Cycling Survey 2012 Methods and Findings*, 2013

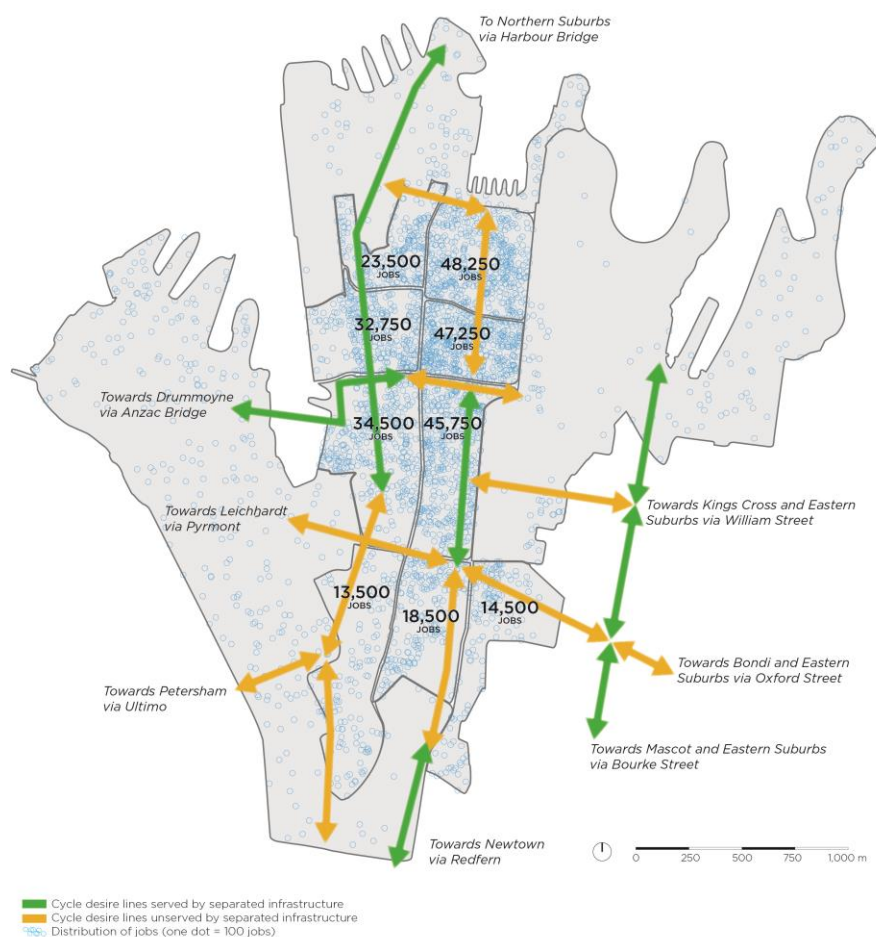
Figure 2-18: Existing bicycle network in the CBD precinct⁵⁶



⁵⁶ Source: City of Sydney, Sydney Cycle Map (available from <http://sydneycycleways.net/maps-and-tools/maps-routes-sydney-cycling-map>)

Key cycling desire lines into the CBD are illustrated in Figure 2-19.

Figure 2-19: Cycle Gateways Job Density



Source: Transport for NSW unpublished data

Cycle counts for 2013 collected by the City of Sydney at King Street show approximately 1,850 bicycle trips on this corridor on an average weekday. The existing bicycle networks in place within the CBD precinct are outlined below in Table 2-19.

Table 2-19: Existing bicycle routes along Key roads within the CBD precinct

Precinct	Corridor Location	Bicycle Route Type	Description
CBD	George Street	On-road	The section from Goulburn Street to Hickson Road is considered as an existing on-road cycle route (within bus lanes) under the City of Sydney bicycle route map.
	Rawson Place	Not an official bicycle route	Rawson Place is not considered as a bicycle route within the current City of Sydney's bicycle route map.
	Eddy Avenue	Not an official bicycle route	Eddy Avenue is not identified as a bicycle route within the current City of Sydney's bicycle route map.
	Chalmers Street	Off-road	A section of Chalmers Street (north of Devonshire Street) is considered as an existing on road bicycle route by the City of Sydney. An off-road route runs parallel to Chalmers Street, connecting Prince Alfred Park and Belmore Park via a signalised crossing on Eddy Avenue. Chalmers Street is an active pedestrian / cyclist corridor due to the proximity to Central Station and other residential and retail land uses. There is a direct connection between Central Station and Moore Park through Chalmers Street and Devonshire Street corridors.
	Elizabeth Street / Randle Lane	On-road	The section of Elizabeth Street between Campbell Street and Randle Lane is considered an existing on-road cycle route by the City of Sydney. Randle Lane provides a one-way southbound route to the Chalmers Street and Devonshire Street intersection.

2.6. Surry Hills precinct

The Surry Hills precinct runs from the intersection of Chalmers Street and Devonshire Street along Devonshire Street up to the mid-block crossing at South Dowling Street as shown in Figure 2-1. Devonshire Street's dominant land uses are medium and high density residential terraces and apartment buildings, along with smaller commercial (office) premises and ground floor cafes, restaurants and retail. Ward Park is located on the southern side of Devonshire Street, approximately 100 metres west of Crown Street. St Peter's Church is also situated on Devonshire Street.

2.6.1. Road network

The key road within the Surry Hills precinct that will be directly impacted by the proposed light rail corridor is Devonshire Street which has the key characteristics as presented in Table 2-20.

Table 2-20: Surry Hills precinct road network characteristics

Road	Key Characteristics
Devonshire Street	Devonshire Street is an east-west running two-way two lane local road under the care and control of City of Sydney and mainly serves the suburb of Surry Hills. There are provisions for intermittent parking along both sides and a number of property accesses along the corridor. The Devonshire Street corridor includes traffic signal control at Elizabeth Street and Crown Street. The remaining side road accesses along Devonshire Street are priority controlled. The City of Sydney bicycle route map designates Devonshire Street as a signed on-road bicycle route, however no major fixed infrastructure is provided. The corridor features pavement marking and a 40km/hr posted speed limit to the east of Riley Street and 50km/hr to the west.

Traffic operating patterns

Traffic and transport operations in this area are characterised by the interaction of public and private transport through key links entering and bypassing the CBD such as Cleveland Street, Eddy Avenue, Elizabeth Street and Chalmers Street.

Devonshire Street is one of a number of east-west connections through Surry Hills towards Moore Park. The traffic travelling along Devonshire Street is mainly generated by the medium - high density residential terraces and apartments, along with smaller commercial (office) premises, cafes, restaurants and retail facilities within Surry Hills.

Table 2-21 provides a summary of the key characteristics and constraints associated with existing general traffic and public transport operations along Devonshire Street.

Table 2-21: Surry Hills precinct existing operational characteristics

Road	Constraints	Description
Devonshire Street	General Traffic	Traffic on Devonshire Street is mainly generated by local land uses. Devonshire Street does also provide an alternative east-west corridor to Cleveland Street for through traffic. There are provisions for intermittent parking along both sides and a number of property accesses provided along the corridor mainly serving residential and small business uses.
	Bus Services	The section of Devonshire Street east of Crown Street is part of an existing bus route (Route 355) and bus stops are provided at Crown Street and Bourke Street for eastbound travel.

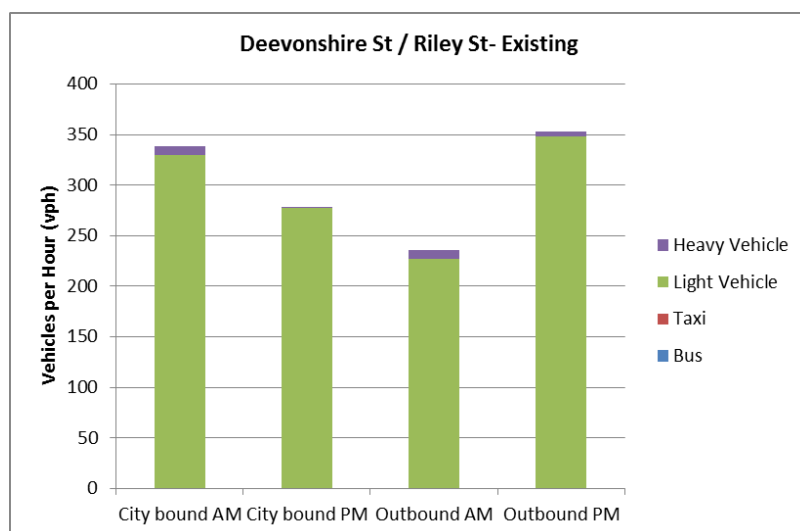
Peak hour traffic composition and volumes

A summary of the peak traffic volumes travelling along Devonshire Street is provided in Table 2-22, with vehicle compositions illustrated in Figure 2-20. Total traffic volumes along Devonshire Street are around 574 vehicles during the AM Peak and 631 vehicles during the PM peak. As illustrated in Figure 2-20 the majority of vehicles travelling along Devonshire Street are light vehicles.

Table 2-22: Surry Hills precinct average weekday AM and PM peak traffic volumes

Key Intersection	AM Peak			PM Peak		
	City Bound	Out Bound	Peak Direction Split	City Bound	Out Bound	Peak Direction Split
Devonshire Street (near Riley Street)	338	236	59% inbound	278	353	44% out bound

Figure 2-20: Surry Hills precinct existing traffic composition



*Note: No surveyed taxi volumes available

2.6.2. Parking and kerbside access

On-street parking is widespread within the wider Surry Hills precinct, comprising multiple restrictions, serving the mix of land uses identified. A loading zone is located east of Waterloo Street and another east of Holt Street. Between Chalmers Street and Elizabeth Street, Devonshire Street has several kerbside loading zones as well as a mail zone and late night taxi zone.

As illustrated in Table 2-23 and Figure 2-21 the Surry Hills precinct currently caters for a range of private vehicle parking.

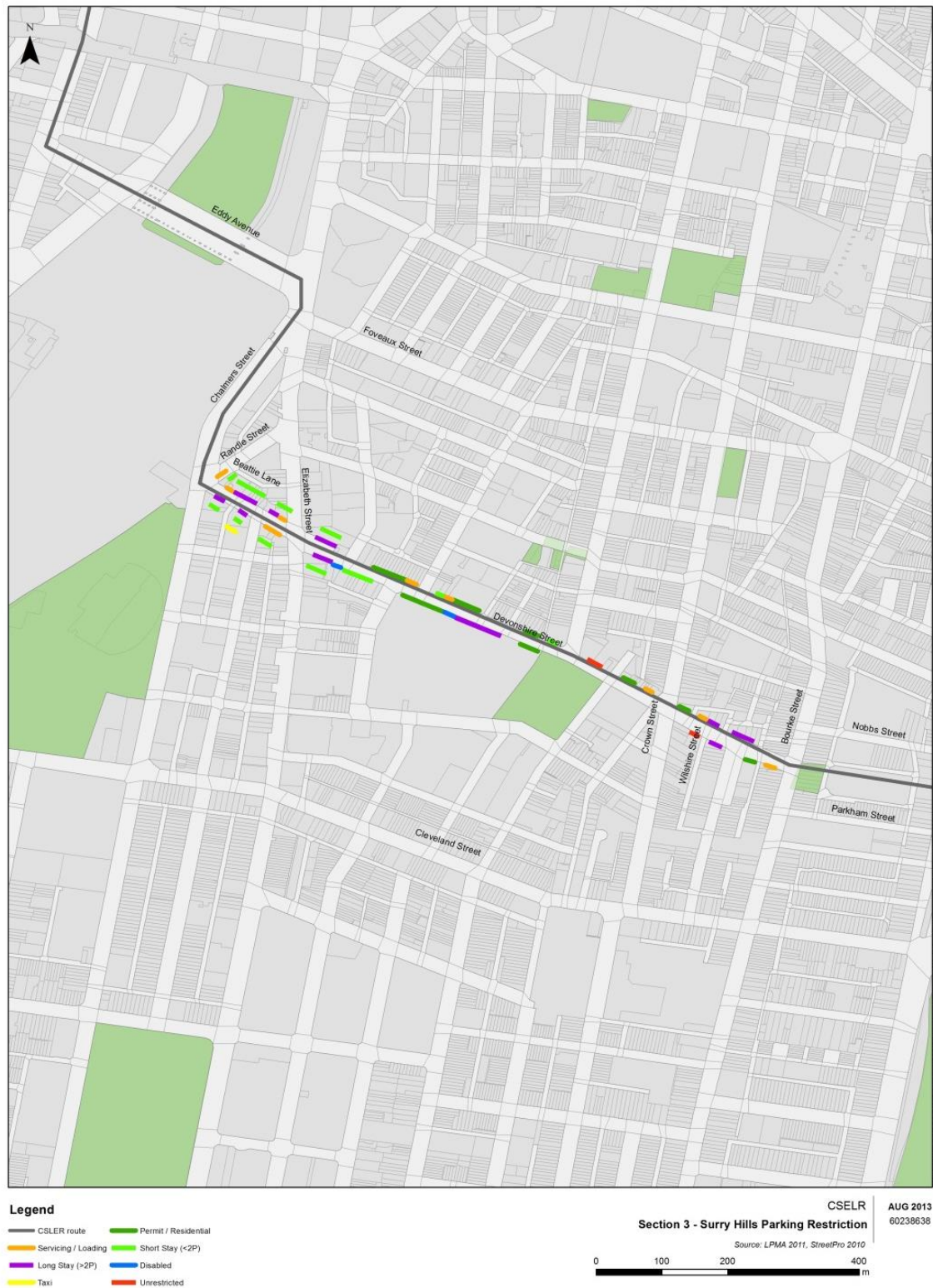
Table 2-23: Surry Hills special kerbside uses and parking supply

Surry Hills Kerbside Restriction	Special Kerbside Uses and Parking Supply by Time Period		
	Pre AM Peak	Inter Peak	Post PM Peak
Car Share, Hospital, Mail Zone	3	3	3
Disability Parking	5	5	5
Loading Zone	15	15	15
Taxi Zone	0	0	0
Total – Special Kerbside Uses	23	23	23
Short Stay Parking ($\leq 1P$)	54	72	72
Long Stay Parking (Restricted)	48	48	48
Long Stay Parking (Unrestricted)	26	8	8
Total – General Parking	128	128	128

Further discussion on existing parking demand and the project parking strategy to mitigate impacts on existing supply can be found in Section 6.

Figure 2-21: Surry Hills precinct existing parking restrictions⁵⁷

AECOM



⁵⁷ AECOM, 2013

2.6.3. Property access

Existing property accesses along Devonshire Street are as shown in Figure 2-22.

Figure 2-22: Surry Hills precinct property accesses

AECOM



A total of nine vehicle accesses and driveways are present on Devonshire Street. The majority (seven) are located on the northern side. The majority of these are small local businesses with the exception of St Patrick's Business College and some residential off-street parking driveways.

2.6.4. Pedestrians & cycling

Pedestrian access

Devonshire Street is considered as an active pedestrian corridor due to its close proximity to Central Station through Chalmers Street and the residential and retail land uses. The Devonshire Street pedestrian tunnel connecting Central Station to Lee Street on the western side provides an important pedestrian access route to the CBD and education precincts. A designated pathway along Ward Park also provides a dedicated pedestrian connection to the area.

Existing pedestrian access along the light rail route within the Surry Hills precinct is facilitated by footpaths, marked and signalised pedestrian crossings and kerb ramps as shown in Table 2-24.

Table 2-24: Existing pedestrian access within the Surry Hills precinct

Precinct	Corridor Location	Description	Pedestrian Access Type
Surry Hills	Devonshire Street and South Dowling Street	The pedestrians on this corridor are mainly generated by Central Station, medium - high density residential terraces and apartments, commercial premises, cafes, restaurants and retail facilities.	Existing pedestrian facilities on Devonshire Street include footpaths on both sides, 3 x marked pedestrian crossings (east of Steel Street, Riley Street and Marlborough Street) and crossings at the signalised intersection of Crown Street / Devonshire Street. It is noted that the footpath capacity is restricted in a number of areas due to trees and tree roots and provision of kerb ramps are limited on this corridor. The Devonshire Street tunnel provides pedestrian access underneath Central Railway Station to Lee Street on the western side. A mid-block crossing at South Dowling Street and a pedestrian bridge over Eastern Distributor provides direct connection between Surry Hills and Moore Park.

Bicycle access

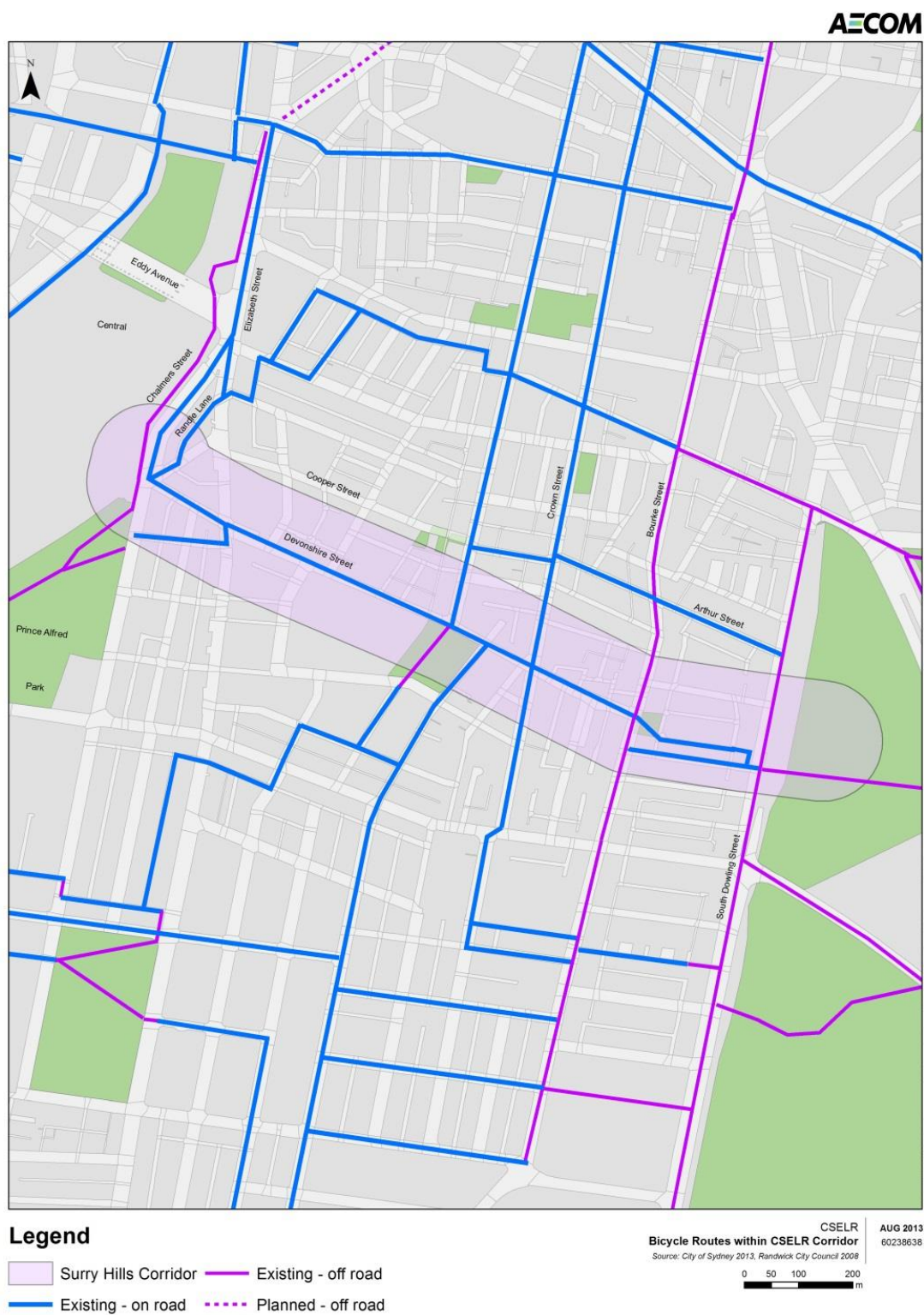
The existing bicycle networks in place within the Surry Hills precinct are outlined below in Table 2-25.

Table 2-25: Existing bicycle routes along key roads within the Surry Hills precincts

Precinct	Corridor Location	Bicycle Route Type	Description
Surry Hills	Devonshire Street	On-road	Devonshire Street is an active pedestrian / cyclist corridor. The City of Sydney bicycle route map designates Devonshire Street as an existing on-road bicycle route. This route connects with an off-road cycle path running perpendicular to Devonshire Street, on the western side of Bourke Street. The direct connection between Central Station and Moore Park via Devonshire Street is currently a strong desire line.
	Cooper / Arthur Street	On-road	The City of Sydney designates Arthur Street as an on-road cycle route between Riley Street and South Dowling Street. At Riley Street, Arthur Street links with Cooper Street. Between Riley Street and Elizabeth Street, the City of Sydney does not identify Cooper Street as a current on-road cycle route, however line marking and signage indicates a suitable route.
	Bourke Street	Off-road	Bourke Street provides an off-road cycle route between Lachlan Street in Waterloo and Cowper Wharf Road in Woolloomooloo. Bourke Street connects with several east-west on-road cycle routes that provide direct access to the Sydney CBD. These include; ▪ Devonshire Street ▪ Campbell Street ▪ Oxford Street ▪ Liverpool Street
	Riley Street	On-road	Riley Street is designated as an on-road cycle route between Devonshire Street in Surry Hills and Cathedral Street in Woolloomooloo. Like Bourke Street, Riley Street connects with several east-west routes that provide direct access to the Sydney CBD.

Table 2-25 and Figure 2-23 present the bicycle network within the Surry Hills precinct.

Figure 2-23: Existing bicycle network in the Surry Hills precinct⁵⁸



⁵⁸ City of Sydney, Sydney Cycle Map

Bicycle counts for 2013 collected for Bourke Street by City of Sydney shows that approximately 1500 bicycles use the Bourke Street corridor on an average weekday, with some of these potentially accessing via Devonshire Street.

2.7. Moore Park Precinct

The Moore Park precinct represents the section of the alignment to the east of the mid-block crossing at South Dowling Street and the section of Anzac Parade south of Moore Park Road and north of Alison Road. The mid-block crossing at South Dowling Street and the pedestrian bridge over the Eastern Distributor provides a direct connection between Surry Hills and Moore Park. The Anzac Parade corridor is an important north-south transport link between the eastern suburbs and the CBD. The section of Anzac Parade within the Moore Park precinct includes the Moore Park sports and entertainment area, which is a significant land use and trip generator for large volumes of private vehicles, public transport and pedestrian trips, particularly during special events. The precinct also represents a very active pedestrian and cyclist corridor. The pedestrian / cyclist facilities consist of pathways across Moore Park and an off road pedestrian / cycle path along Anzac Parade.

2.7.1. Road network

The key roads within the Moore Park precinct that will be impacted by the proposed light rail corridor include:

- The section of Anzac Parade south of Moore Park Road up to the intersection of Alison Road / Anzac Parade detailed in Table 2-26.

Table 2-26: Moore Park precinct road network characteristics

Road	Key Characteristics
Anzac Parade	Anzac Parade is a major north-south State arterial road under the care and control of Roads and Maritime Services (RMS) running through the suburbs of Moore Park, Kensington and Kingsford. The section of Anzac Parade south of Moore Park Road and north of Alison Road is a divided two-way six lane road with an additional segregated bus way in operation on the eastern side which runs parallel to the road. Dedicated turning lanes are provided at intersections at Lang Road and Alison Road. A northbound entry ramp to the Eastern Distributor is located at the intersection at Moore Park Road and a southbound exit ramp is located south of Moore Park Road. The existing posted speed limit is 70km/hr except the section where the 40 km/hr school zone is applicable for Sydney Girls and Boys High School. Bus services utilise the dedicated bus roadway adjacent to Moore Park between Alison Road and Moore Park Road, as well as general traffic lanes along Anzac Parade. There is no provision for on-street parking along this section of Anzac Parade. An off road shared pedestrian/bicycle path also runs in parallel to Anzac Parade from Moore Park Road to Alison Road. The path is located along the eastern side of the corridor, which then continues along Alison Road to the south. The Moore Park precinct consists of various sporting and entertainment land uses such as the Sydney Football (Allianz) Stadium, the Sydney Cricket Ground and Playbill venues (the entertainment quarter). Additional events are also held at Centennial Park such as Listen Out (Park Life), Australian Garden Show, etc. The diverse array of events in this precinct have varied transport requirements.

Traffic operating patterns

Anzac Parade is a strategic link within the eastern suburbs road network and currently operates at degraded levels of performance for general traffic during weekday peak travel periods. Recent data describes average vehicular travel speeds of 28km/h for Anzac Parade during the AM peak period.

Anzac Parade experiences two way traffic volumes of approximately 3,700 vehicles in both the AM and PM peak hours. Currently, the corridor experiences a high level of congestion with large delays to vehicles at the intersections of Dacey Avenue/Alison Road, Cleveland Street/Lang Road, Moore Park Road and Oxford Street. It is the large east-west cross movements from the eastern suburbs that conflict with the Anzac Parade corridor at these intersections ultimately causing significant delays.

A segregated bus way from Alison Road to Moore Park Road provides priority to a number of bus routes. These selected buses however, still experience delays while crossing the Cleveland Street, Lang Road and Moore Park Road intersections.

Table 2-27 provides a summary of the key characteristics and constraints associated with existing general traffic and public transport operations of the light rail corridor along Anzac Parade between south of Moore Park Road and north of Alison Road.

Table 2-27: Moore Park precinct existing operational characteristics

Road	Constraints	Description
Anzac Parade	General Traffic	Anzac Parade provides a significant connection for bus and general traffic accessing the Sydney CBD. The corridor also facilitates access to areas west of the City and Anzac Bridge and to the north via the ED and Sydney Harbour Tunnel. The traffic along this road is mainly generated by the traffic accessing the City from the suburbs of Moore Park, Kensington, Kingsford, Randwick, Eastlakes, Maroubra, Chifley, Malabar and Little Bay.
	Bus Services	A segregated bus way running in parallel to Anzac Parade corridor from Moore Park Road to Alison Road is a major bus route for number of city services (including express and cross regional bus services). The dedicated bus way caters for approx. 80 bus services during peak hours.

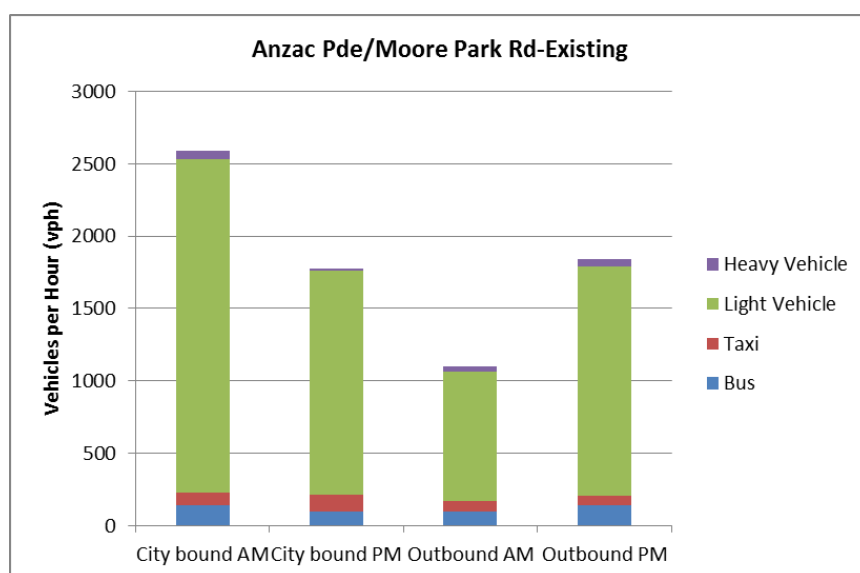
Peak hour traffic composition and volumes

A summary of the peak traffic volumes travelling along Anzac Parade between south of Moore Park Road and the intersection of Alison Road / Anzac Parade is provided in Table 2-28, with vehicle compositions illustrated in Figure 2-24.

Table 2-28: Moore Park precinct average weekday AM and PM peak traffic volumes

Key Intersection	AM Peak			PM Peak		
	City Bound	Out Bound	Peak Direction Split	City Bound	Out Bound	Peak Direction Split
Anzac Parade (at Moore Park Road/entry to the Eastern Distributor)	2588	1101	70% inbound	1774	1844	51% out bound

Figure 2-24: Moore Park precinct existing traffic composition



Intersection performance

A summary of the performance of key intersections along Anzac Parade is provided in Table 2-29. The AM and PM peak intersection performance results include an overall intersection LoS, intersection delay and DoS from the base case models. The results are focussed on those intersections that represent the key constraints. Refer to Section 2.2 for the global assumptions used in the intersection analysis.

Table 2-29: Moore Park precinct key intersection performance⁵⁹

Intersection	Peak Hour	Existing		
		LoS	DoS (vehicle/capacity)	Av. Delay (seconds)
Anzac Parade / Lang Road	AM	F	0.98	73.5
	PM	F	1.01	128.0

The intersection of Anzac Parade and Lang Road currently performs at LoS F with average delays greater than 70 seconds during both the AM and PM peak hours.

⁵⁹ Source: LinSig modelling undertaken as part of ITLU Milestone Option Assessment

2.7.2. Parking and kerbside access

Currently there are no parking provisions available along the Anzac Parade section of the Moore Park precinct.

2.7.3. Property access

A total of three vehicular driveways to the Sydney Girls and Boys High Schools are present on the western side of Anzac Parade within the Moore Park precinct. However, the proposed light rail alignment does not impact on these accesses as the light rail alignment runs along the eastern side of Anzac Parade.

2.7.4. Pedestrians & cyclists

Pedestrian access

Existing pedestrian access within the Moore Park precinct is facilitated by footpaths, pathways through parks including a designated pathway across Moore Park, an off-road pedestrian / cycle path along the eastern side of the road, mid-block signalised crossings, crossings at the signalised intersections and kerb ramps. Table 2-30 identifies the existing pedestrian access types along the light rail route within the Moore Park precinct.

Table 2-30: Existing Pedestrian Access within the Moore Park precinct

Precinct	Corridor Location	Description	Pedestrian Access Type
Moore Park	Anzac Parade	The section on Anzac Parade between Moore Park Road and Alison Road is considered as an active pedestrian area due to its proximity to the Sydney Boys and Girls High schools, and Moore Park sporting and entertainment venues. The Moore Park sport and entertainment venue consists of various sporting and entertainment land uses such as Allianz Stadium, the SCG and Playbill venues which contribute significant pedestrian trips, particularly during special events. The mid-block signalised crossings and signalised intersections provide opportunities for pedestrians to cross Anzac Parade. The staged mid-block crossing at South Dowling Street and pedestrian bridge over Eastern Distributor provides direct connection to Moore Park from Surry Hills and the CBD precincts.	Existing pedestrian facilities include: ▪ segregated shared path on the eastern side and footpath on western side, a ▪ signalised mid-block crossing in the vicinity of Sydney Girls and Boys High Schools, ▪ signalised mid-block crossing near the near Alison Road bus stop, ▪ two signalised intersections and kerb ramps to facilitate pedestrian movements across Anzac Parade

Bicycle access

There are several networks of on-road and off-road cycleway in the vicinity of the proposed light rail corridor along Anzac Parade. Figure 2-25 presents the bicycle network within the Moore Park precinct. Cycle counts for 2012 collected by Roads and Maritime Services at Anzac Parade near Lang Road show that approximately 1,277 cyclists use this corridor on an average weekday.

Figure 2-25: Existing bicycle network within the Moore Park precincts⁶⁰



⁶⁰ Randwick City Council, *Cycling and Walking Map for Randwick City*

The existing bicycle networks in place within the Moore Park precinct are outlined below in Table 2-31.

Table 2-31: Existing bicycle routes along key roads within the Moore Park precinct

Precinct	Corridor Location	Bicycle Route Type	Description
Moore Park	Anzac Parade	Off-road path	The section of Anzac Parade from Moore Park Road to Alison Road is identified as an off-road cycle route under the City of Sydney/Randwick City Council's bicycle route network maps.

2.8. Kingsford precinct

The Anzac Parade corridor within the Kingsford precinct consists of major land uses such as the University of New South Wales, medium to high density residential apartments, single dwelling houses along with smaller commercial (office) premises, cafes, restaurants, retail shops and service stations. The precinct also contributes to a very active pedestrian and cyclist corridor through the provision of pathways through parks and off-road pedestrian / cycle paths along Anzac Parade.

2.8.1. Road network

The key roads within the Kingsford precinct that will be impacted by the proposed light rail corridor include:

- Anzac Parade between Alison Road and up to nine ways (Gardeners Road/Rainbow Street intersection)

A summary of the key network characteristics for each of these roads is provided in Table 2-32.

Table 2-32: Kingsford precinct road network characteristics

Road	Key Characteristics
Anzac Parade	Anzac Parade is a major north-south State arterial road under the care and control of Roads and Maritime Services (RMS) running through the suburbs of Moore Park, Kensington and Kingsford. The section between Alison Road and Nine Ways is a divided two-way four lane road with additional dedicated kerbside bus/parking lanes along the entire north-south length of the corridor. A number of dedicated turning lanes are provided at key intersections. The road is used by numerous bus services to Sydney CBD and other cross-regional connections along the dedicated bus lanes which operate in the peak direction by time of day. Bus services also utilise the dedicated bus roadway adjacent to Moore Park between Alison Road and Moore Park Road, as well as general traffic lanes along Anzac Parade. There is provision for on-street parking and loading/unloading zones within the bus lane during the off-peak hours. The precinct is characterised by medium density residential apartment buildings and detached dwellings as well as education facilities, the UNSW.

Traffic operating patterns

Anzac Parade provides a direct link to the eastern suburbs road network and currently operates at capacity during weekday peak hour periods. Anzac Parade experiences high volumes of two way traffic, approximately 5,700 vehicles per hour north of Alison Road in both the AM and PM peak hours. Currently, the corridor experiences a high level of congestion with large delays to vehicles at the major intersections of Dacey Avenue/Alison Road and High Street. Bus only lanes along the main carriageway from Gardeners Road to Alison Road provide priority to buses in both peaks. However, the buses still experience significant delays at signalised intersections along Anzac Parade.

Table 2-33 provides a summary of the key characteristics and constraints associated with existing general traffic and public transport operations of the preferred light rail corridor along Anzac Parade between Alison Road and up to Nineways (Gardeners Road/Rainbow Street intersection).

Table 2-33: Kingsford precinct existing operational characteristics

Road	Constraints	Description
Anzac Parade	General Traffic	The route provides a significant connection for general traffic accessing the Sydney CBD. The traffic along this road is mainly generated by the trips to UNSW and the City from the eastern suburbs including Moore Park, Kensington, Kingsford, Randwick, Eastlakes, Maroubra, Chifley, Malabar and Little Bay.
	Bus Services	The Anzac Parade corridor is a major bus route for city services (including express) and cross regional bus services. Dedicated peak hour bus lanes along Anzac Parade provide priority to buses in the peak direction (approx.80 bus services during peak hours). During off-peak hours, the bus lanes are utilised for time-restricted parking. Parking is permitted along Anzac Parade outside of the weekday peak periods (6am-10am & 3pm-7pm).

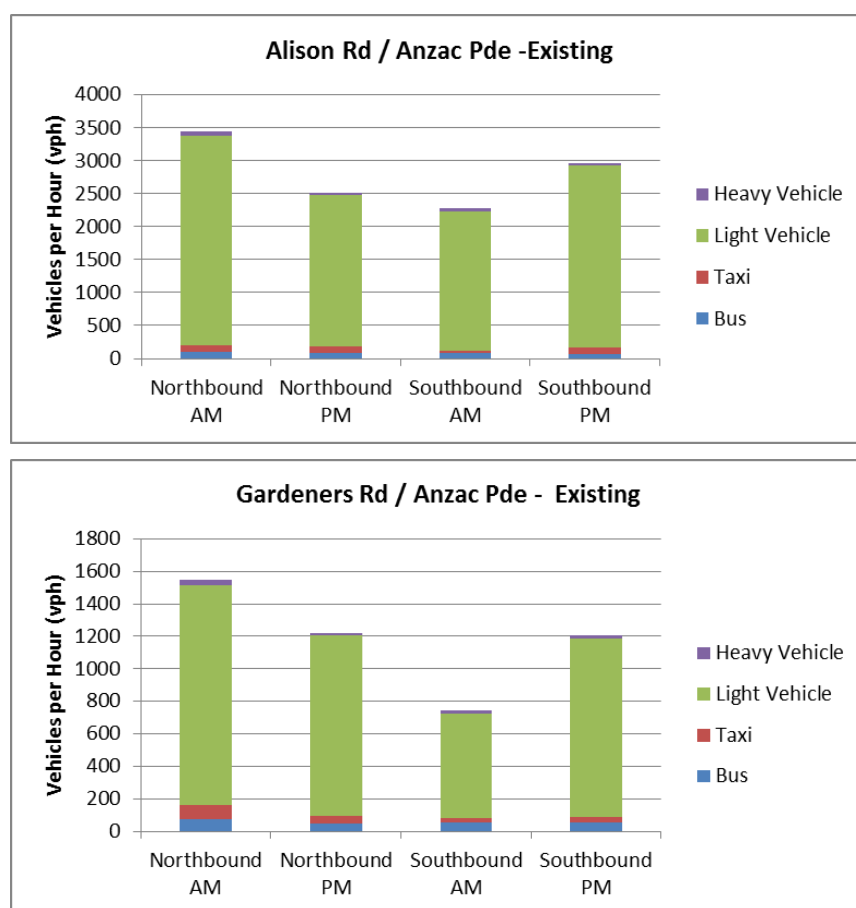
Peak hour traffic composition and volumes

A summary of the peak traffic volumes travelling along Anzac Parade is provided in Table 2-34, with vehicle compositions illustrated in Figure 2-26. Anzac Parade carries significant traffic volumes. As illustrated in Figure 2-26 the majority of vehicles travelling along Anzac Parade are private light vehicles.

Table 2-34: Kingsford precinct average weekday AM and PM peak traffic volumes

Key Intersection	AM Peak			PM Peak		
	City Bound	Out Bound	Peak Direction Split	City Bound	Out Bound	Peak Direction Split
Anzac Parade/Alison Road	3448	2284	60% city bound	2515	2966	54% out bound
Anzac Parade/Gardeners Road	1548	746	67% city bound	1220	1208	50% city/out bound

Figure 2-26: Kingsford precinct existing traffic composition



Intersection performance

A summary of the performance of key intersections along Anzac Parade is provided in Table 2-35. The AM and PM peak intersection performance results include an overall intersection LoS, intersection delay and DoS from the base case models. The results are focussed on those intersections that represent the key constraints. Refer to Section 2.2 for the global assumptions used in the intersection analysis.

Table 2-35: Kingsford precinct key intersection performance⁶¹

Intersection	Peak Hour	Existing		
		LoS	DoS (vehicle/capacity)	Av. Delay (seconds)
Anzac Parade / High Street (Anzac Parade Alignment)	AM	B	0.83	28.0
	PM	D	0.94	44.3
Anzac Parade / Dacey Avenue / Alison Road	AM	F	0.98	73.5
	PM	D	0.90	50.2

The intersection of Anzac Parade and Alison Road / Dacey Avenue has the lowest level of performance with average delays greater than 60 seconds and poor Level of Service during the AM peak hour.

⁶¹ Source: LinSig modelling undertaken as part of ITLU Milestone Option Assessment

2.8.2. Parking and kerbside access

For the purpose of parking assessment, the Kingsford precinct has been split into two sections:

- Anzac Parade North –runs from the intersection of Alison Road / Dacey Avenue south along Anzac Parade to High Street (refer to Figure 2-27).
- Anzac Parade South - runs from the intersection of Anzac Parade and High Street along Anzac Parade to Nine Ways (refer to Figure 2-28).

Anzac Parade North

This section of Anzac Parade is characterised by medium density residential apartment buildings and detached dwellings as well as sporting facilities (ES Marks Athletics Field, Moore Park Golf Course), street level retail and food premises. Kerbside bus lanes run the entire north-south length of the corridor, with on-street parking permitted in signed locations outside of the weekday peak periods (6am-10am & 3pm-7pm).

The number of parking spaces along Anzac Parade north is provided in Table 2-36.

Table 2-36: Anzac Parade North special kerbside uses and parking supply

Anzac Parade North Kerbside Restriction	Special Kerbside Uses and Parking Supply by Time Period		
	Pre AM Peak	Inter Peak	Post PM Peak
Car Share, Hospital, Mail Zone	1	1	1
Disability Parking	0	0	0
Loading Zone	0	0	0
Taxi Zone	0	0	0
Total – Special Kerbside Uses	1	1	1
Short Stay Parking (≤1P)	4	52	31
Long Stay Parking (Restricted)	7	7	0
Long Stay Parking (Unrestricted)	73	94	119
Total – General Parking	84	153	150

Further discussion on existing parking demand and the project parking strategy to mitigate impacts on existing supply can be found in Section 6.

Figure 2-27: Anzac Parade North existing parking restrictions⁶²



⁶² AECOM, 2013

Anzac Parade South

The land uses in the Anzac Parade South precinct include medium and high density residential apartment buildings as well as education facilities (the UNSW and the National Institute of Dramatic Art), street level retail, restaurants and cafes. Kerbside bus lanes run the entire north-south length of the precinct with on-street parking permitted in signed locations after hours.

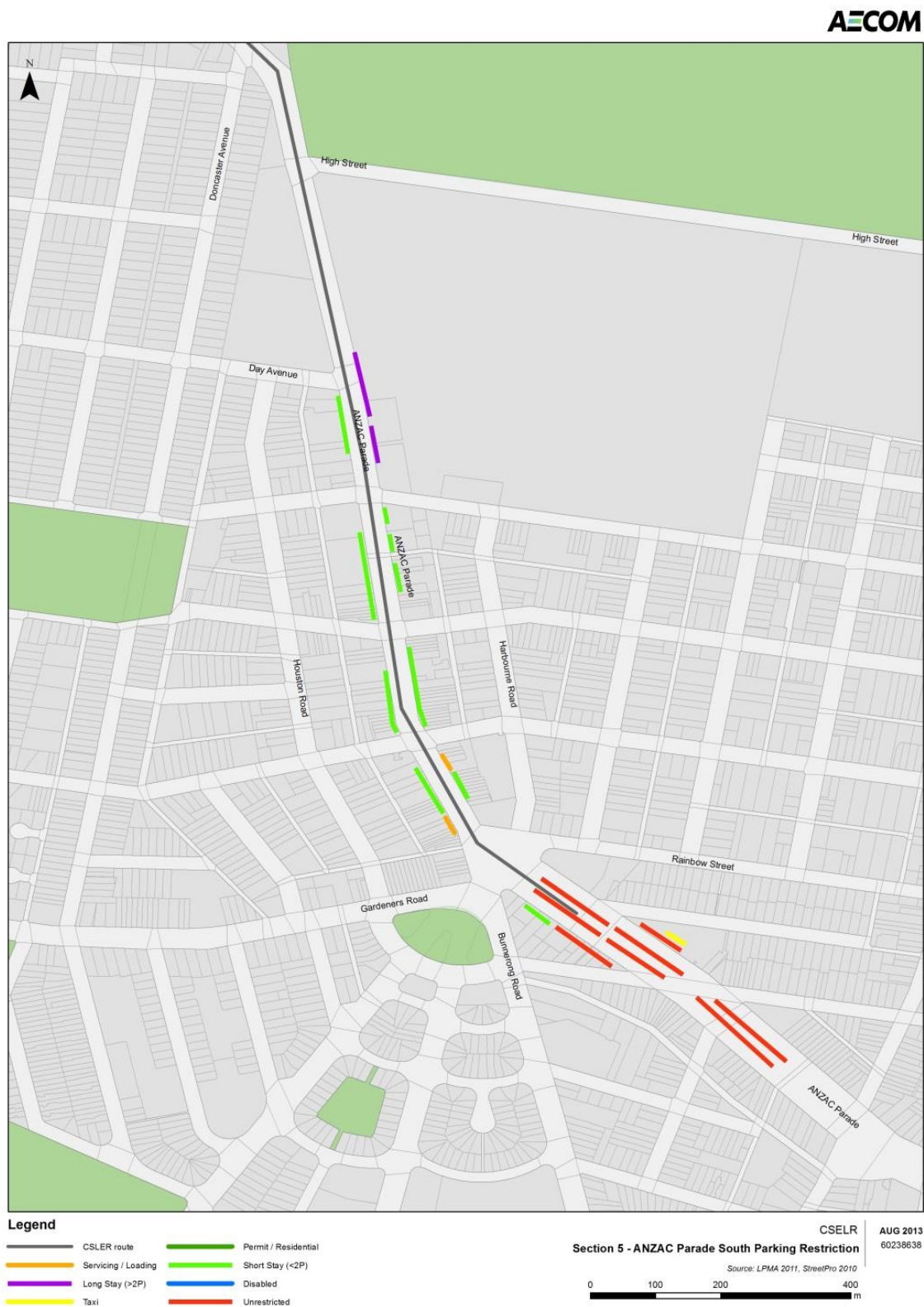
As outlined in Table 2-37 the Anzac Parade South precinct has a number of private vehicle parking spaces along with 4 loading zones.

Table 2-37: Anzac Parade South special kerbside uses and parking supply

Anzac Parade South Kerbside Restriction	Special Kerbside Uses and Parking Supply by Time Period		
	Pre AM Peak	Inter Peak	Post PM Peak
Car Share, Hospital, Mail Zone	0	0	0
Disability Parking	0	0	0
Loading Zone	4	4	2
Taxi Zone	2	2	2
Total – Special Kerbside Uses	6	6	4
Short Stay Parking ($\leq 1P$)	32	68	25
Long Stay Parking (Restricted)	20	20	4
Long Stay Parking (Unrestricted)	173	173	232
Total – General Parking	225	261	261

Further discussion on existing parking demand and the project parking strategy to mitigate impacts on existing supply can be found in Section 6

Figure 2-28: Anzac Parade South existing parking restrictions⁶³



⁶³ AECOM, 2013

2.8.3. Property access

There are a number of property accesses along the light rail corridor within the Kingsford precinct as shown in Figure 2-29.

Figure 2-29: Kingsford precinct property accesses



Within the Kingsford precinct major driveway accesses are predominantly to high density units, found in concentration at the northern end of the precinct. There are also numerous lower density residential accesses, four service stations and access to two local businesses along the corridor. All movements are restricted to left-in-left-out arrangements through physical separation by a central median.

2.8.4. Pedestrians & cyclists

Pedestrian access

Existing pedestrian facilities within the Kingsford are described in Table 2-38. The precinct contributes to a very active pedestrian and cyclist corridor.

Table 2-38: Existing Pedestrian Access within the Kingsford precinct

Precinct	Corridor Location	Description	Pedestrian Access Type
Kingsford	Anzac Parade	The Anzac Parade corridor consists of residential and commercial properties, small businesses, sporting grounds, a high school and UNSW campus. The walking trips from the surrounding public transport stops around the university result in a significant number of pedestrians on the network during a typical peak hour.	Existing pedestrian facilities such as sealed footpaths, 5 x signalised mid-block crossings, crossing at 7 x signalised intersections and kerb ramps are to facilitate pedestrian movements across Anzac Parade

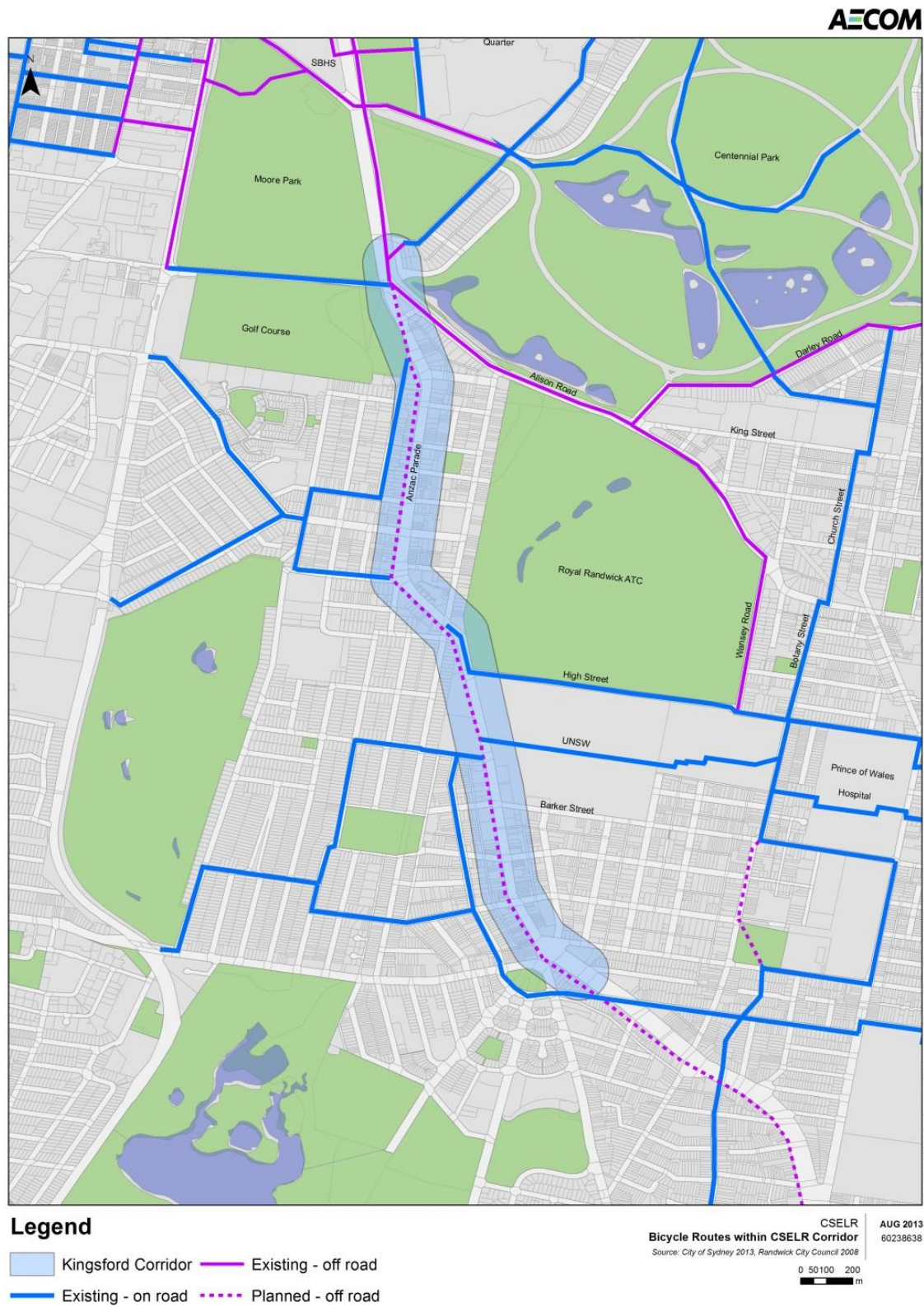
Bicycle access

Within the Kingsford precinct there are no dedicated bicycle facilities, although cyclists are permitted to use the available bus lanes. The existing bicycle networks in place within the Kingsford precinct are outlined below in Figure 2-30 and Table 2-39.

Table 2-39: Existing bicycle routes along key roads within the Kingsford precincts

Precinct	Corridor Location	Bicycle Route Type	Description
Kingsford	Anzac Parade	On-road - partially	A section of Anzac Parade from Cleveland Street to Dacey Ave is identified as an off-road cycle route and the remaining sections are considered as a planned off-road route by Randwick City Council.

Figure 2-30: Existing bicycle network within the Kingsford precincts⁶⁴



⁶⁴ Randwick City Council, *Cycling and Walking Map for Randwick City*

2.9. Randwick Precinct

The Randwick precinct runs from the Anzac Parade / Alison Road intersection to the High Street / Belmore Road / Avoca Street intersection as shown in Figure 2-1. The alignment follows Alison Road, Wansey Road and High Street.

The land uses in this precinct include detached dwellings and apartment buildings, as well as major trip generators such as UNSW, Royal Randwick Racecourse and the Prince of Wales Hospital.

2.9.1. Road network

The key roads within the Randwick precinct that will be directly impacted by the proposed light rail corridor include:

- Alison Road
- Wansey Road
- High Street

A summary of the key network characteristics for each of these roads is provided in Table 2-40.

Table 2-40: Randwick precinct road network characteristics

Road	Key Characteristics
Alison Road	Alison Road is a divided two-way collector road under the care and control of Randwick City Council. The section between Doncaster Avenue and Darley Road is operating with three traffic lanes in each direction and the remaining sections have parking permitted on the kerb side. The land uses in this precinct include detached dwellings and apartment buildings, as well as major trip generators such as Royal Randwick Racecourse, the Prince of Wales Hospital and the UNSW. Limited on-street parking is provided between Anzac Parade and Darley Road. On-street parking around Royal Randwick Racecourse is located predominantly on the eastern edge of Alison Road. Bus stops, on-street parking and property accesses are common along the rest of the corridor. An off-road pedestrian / cycle path also operates along this route. The connection to the bus way is provided via the Doncaster Avenue intersection.
Wansey Road	Wansey Road is a two-way local road under the care and control of Randwick City Council. The major traffic on Wansey Road is mainly generated by the residential properties, UNSW campus as well as some traffic accessing the Prince of Wales Hospital. There are provisions for parking available along both sides and a number of property accesses provided along the corridor. The side road accesses along Wansey Road are priority controlled. The Randwick City Council bicycle route map designates Wansey Road as an off-road pedestrian/bicycle route, which runs along the western side of the corridor.
High Street	High Street between Wansey Road and Belmore Road is a two-way local road with a single lane in each direction. Parking and bus stops are provided along the kerbside in both directions. There are two signalised intersections and two marked pedestrian crossing within this section of High Street. The road provides a connection for cross regional bus services and general traffic between Randwick and UNSW / Anzac Parade. The High Street corridor provides the major access to the Randwick Health Campus, including access to Prince of Wales Hospital, most notably the Children's Hospital emergency department. Access to the Adult and Children's Hospitals are currently via two separate porte cocheres, accessed via High Street.

Traffic operating patterns

Alison Road is a major link connecting the eastern suburbs road network and currently operates at capacity during weekday peak travel periods. Recent data describes average vehicular travel speeds of 21km/h for Alison Road during the AM peak period. A separated bus way is in operation on the northern side, which runs in parallel to Alison Road. The connection to the bus way is provided via the Doncaster Avenue intersection.

Table 2-41 provides a summary of the key characteristics and constraints associated with existing general traffic and public transport operations of the preferred light rail corridor along the key roads within the Randwick precinct (i.e., Alison Road, Wansey Road, High Street).

Table 2-41: Randwick precinct existing operational characteristics

Road	Constraints	Description
Alison Road	General Traffic	Traffic is generated mainly by land uses such as Royal Randwick Racecourse, Randwick TAFE, the Prince of Wales Hospital and the UNSW as well as the residential dwellings and apartments within the Randwick precinct.
	Bus services	A separated bus way is in operation on the eastern side, which runs parallel to Alison Road. The connection to the bus way is provided via the Doncaster Avenue intersection.
Wansey Road	General Traffic	The major traffic on Wansey Road is generated by the residential properties, UNSW campus as well as some traffic accessing the Prince of Wales Hospital. The side road accesses along Wansey Road are priority controlled.
	Bus Services	Wansey Road is not an official bus route identified in the eastern region bus route map. However, the 891 UNSW bus service currently utilises this corridor when out of service.
High Street	General Traffic	High Street provides a connection for cross regional bus and general traffic between Randwick and UNSW / Anzac Parade. The general traffic along this corridor is associated with the Prince of Wales Hospital, Children's Hospital emergency department and UNSW.
	Bus Services	High Street provides an important east west connection for 10 different bus routes, including university express services.

Peak hour traffic composition and volumes

A summary of the peak traffic volumes travelling along Anzac Parade, Alison Road and High Street is provided in Table 2-42, with vehicle compositions illustrated in Figure 2-31. Anzac Parade and Alison Road have by far the highest traffic volumes. As illustrated in Figure 2-31 the majority of vehicles travelling along Alison Road and High Street are light vehicles.

Table 2-42: Randwick precinct average weekday AM and PM peak traffic volumes

Key Intersection	AM Peak			PM Peak		
	City Bound	Out Bound	Peak Direction Split	City Bound	Out Bound	Peak Direction Split
Alison Road (near High Street)	2880	1987	59% inbound	2114	3114	60% out bound
High Street (near Belmore Rd)	409	357	53% inbound	258	523	67% out bound

Figure 2-31: Randwick precinct existing traffic composition

