Transport for NSW

Sydney Light Rail

PARSONS BRINCKERHOFF

CBD AND SOUTH EAST LIGHT RAIL PROJECT

ENVIRONMENTAL IMPACT STATEMENT

NOVEMBER 2013

VOLUME 1B - MAIN VOLUME

Parts D to E

NSW NOW The new state of business

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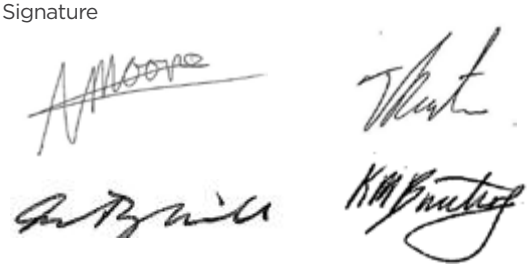
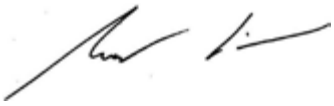
Prepared by:	Adam Moore Jarryd Barton Delyth Toghill Kathleen Bunting	Date: 08/11/2013	Signature 
Reviewed by:	Hugh Swinbourne	Date: 08/11/2013	Signature 
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CBD AND SOUTH EAST LIGHT RAIL PROJECT

ENVIRONMENTAL IMPACT STATEMENT

VOLUME 1B

PART D:
LOCAL ENVIRONMENTAL IMPACT ASSESSMENT

12. Local impacts: City Centre Precinct

Chapter 12 details the existing character and environment of the City Centre Precinct, as well as the key environmental impacts of the CBD and South East Light Rail Project ('the CSELR proposal' or 'the CSELR') in this precinct. The chapter focuses on the following key environmental issues: local traffic transport and access; local property and land use; noise and vibration; planted trees; visual and landscape character; built and non-Indigenous heritage; and socio-economics. Regional environmental impacts and other environmental issues are covered in Chapters 9–11 of this Environmental Impact Statement (EIS).

12.1 Key characteristics of the precinct

The City Centre Precinct (refer Figure 12.1) is home to Sydney's central business district (CBD), which is the State's economic hub, employing hundreds of thousands of people across many industries. The City Centre is also a key cultural destination, home to the Museum of Contemporary Art, Sydney Theatre Company, the historic Rocks area and a bustling night-time economy with a large number of pubs, clubs, hotels and restaurants. In recent years, small bars and pop-up shops have set up in the city's laneways, adding to the vibrant street culture.

George Street is the main civic spine running north and south through the City Centre Precinct. At the northern end of the city, George Street runs through the historic Rocks area and Circular Quay, with views of the Sydney Opera House and Sydney Harbour Bridge. Circular Quay is a popular gathering spot for workers, residents and tourists and is also the hub for ferry trips to Manly and other harbourside destinations. George Street is dotted with many examples of fine heritage buildings such as Sydney Town Hall, the Queen Victoria Building, The Strand Arcade, General Post Office (GPO) and Martin Place. There are also striking examples of modern architectural design, including the Apple Store and the Hilton Hotel, which are set amongst medium and high-rise commercial towers.

At the southern end of the City Centre Precinct are Haymarket and Chinatown, which are home to many ethnic groups, including large Chinese, Indonesian, Thai and Korean communities. The cultural diversity of this area is signalled with bi-lingual street signs. Haymarket has many high-rise apartment blocks, a thriving restaurant scene and a busy shopping district. It is also a popular place for students to live, given its proximity to Sydney University, the University of Technology Sydney (UTS) and Technical and Further Education (TAFE) NSW. Central Railway Station is located at the southern end of the City Centre Precinct and is a key transport interchange for buses, coaches and heavy rail services. With its sandstone Clock Tower, Central Railway Station is a highly recognisable Sydney landmark and meeting spot for locals and people visiting the city.

Figure 12.1 The City Centre Precinct

12.2 Key community concerns for the precinct

Based on consultations to date (refer Chapter 2), key community issues for the City Centre Precinct include:

- *Traffic impacts* — as a result of the proposed pedestrian zone on George Street and changes to the road and bus network in the CBD. Feedback suggested that removal of traffic in sections of the CBD could potentially create congestion in other areas. The introduction of light rail was also seen as generally increasing competition for limited road space in the CBD which could cause congestion.
- *Construction impacts* — in particular traffic congestion caused by diversions and associated noise and vibration impacts on businesses and sensitive receivers within the CBD. The need for more information on construction timeframes and hours was also raised, along with concerns about potential loss of business during construction.
- *Route selection* — which was raised by a small number of stakeholders. Some respondents raised the importance of George Street as a north-south traffic thoroughfare, and some suggested alternative routes encompassing Pitt Street or Elizabeth Street should be considered.
- *Access during construction* — which was identified by businesses and people who work and live in the CBD. In particular vehicle access to the pedestrian zone and loading docks during operation of the CSELR was raised in relation to businesses.
- *Urban design* — which was selected by a high number of respondents as a key issue for consideration in the CBD. Comments collected at the information sessions for the CSELR proposal in September 2013 indicated that people value the heritage values and visual aesthetic of sections of George Street and Circular Quay.

12.3 Local traffic, transport and access

12.3.1 Existing conditions

The following sections provide a summary of the existing local traffic, transport and access environment for the City Centre Precinct, based on Technical Paper 1 —*Transport Operations Report* in Volume 2 of this EIS.

Roads

Existing road network

The existing road network within the City Centre Precinct is shown in Figures 12.2a and b. The roads within the City Centre Precinct that would be directly affected by the CSELR proposal include George Street, Alfred Street, Rawson Place, Eddy Avenue, Chalmers Street and Elizabeth Street. A summary of the key network characteristics for each of these roads is provided in Table 12.1.

Table 12.1 Proposed CSELR route road network characteristics – City Centre Precinct

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 kerbside bus lanes as well as driveway access to a number of car parks; provision for limited on-street parking within kerbside bus lanes (time restricted); loading/unloading zones; a number of dedicated turning lanes at key intersections; and pedestrian and cyclist access. George Street is currently operating at capacity during peak times. 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 often include a large proportion of empty vehicles seeking a fare.
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. Traffic along this road is associated with taxi and bus service trips. Alfred Street is considered a key bus, rail and ferry interchange. Alfred Street also provides a connection between George and Pitt streets that facilitates access to the northern end of Pitt Street.
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 Railway Station precinct. A section of the corridor operates with three traffic lanes in each direction whilst the remaining sections caters for two traffic lanes with separate dedicated bus lanes. Short duration on-street parking is currently available along Rawson Place. Eddy Avenue operates as a bus/light rail (elevated on the station colonnade), heavy rail and coach interchange. The majority of traffic travelling along Rawson Place is associated with the Central Railway Station precinct and traffic connecting to key north, south and CBD corridors. The majority of traffic travelling along Eddy Avenue is associated with the Central Railway Station precinct. The street is an important connection linking eastern suburbs traffic on Foveaux and Chalmers streets with the CBD.
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 Railway Station precinct.

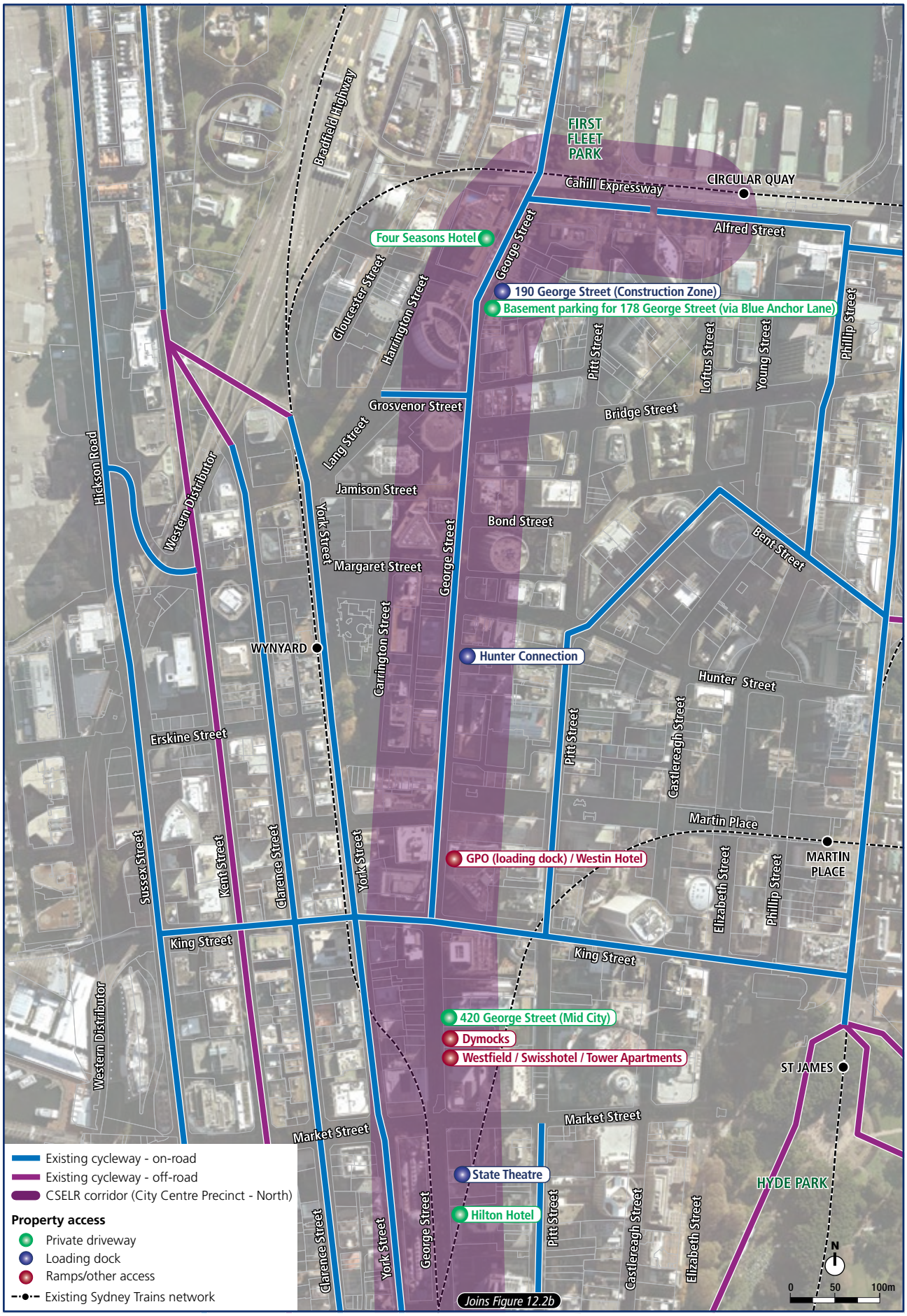
Source: *Table 2-10 of Technical Paper 1 – Transport Operations Report, Volume 2*

Existing 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 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 (refer to Technical Paper 1 — *Transport Operations Report*).

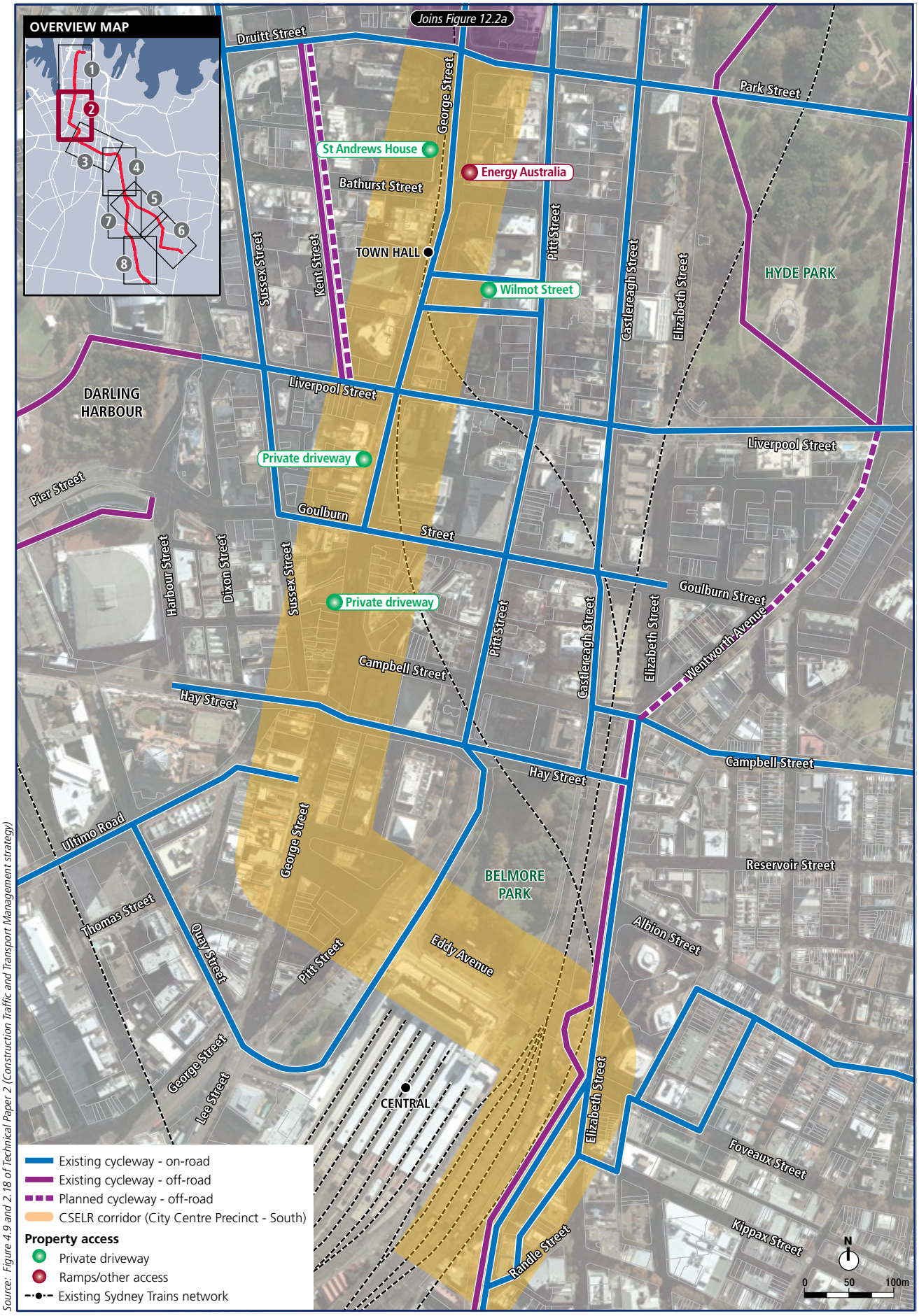
George Street plays a significant role in the transport system, as well as in Sydney's identity as the natural connection through the heart of the city. It forms the central spine through the CBD, linking key locations including Circular Quay, Town Hall and Railway Square.

Figure 12.2a City Centre Precinct – Existing, traffic transport and access



Source: Figures 4.9 and 2-18 of Technical Paper 2 (Construction Traffic and Transport Management strategy)

Figure 12.2b City Centre Precinct – Existing, traffic transport and access



Source: Figure 4.9 and 2.18 of Technical Paper 2 (Construction Traffic and Transport Management strategy)

Existing peak hour traffic volumes and composition

A summary of the existing peak traffic volumes travelling along George Street and Eddy Avenue is provided in Table 12.2. Both George Street and Rawson Place have traffic volumes in excess of 2,000 vehicles during both the morning and afternoon peaks. A large proportion of the traffic on George Street during the morning peak comprises city-bound movements (70 per cent), while the afternoon peak volumes on George Street are more evenly distributed. Eddy Avenue has a relatively even distribution of city-bound and outbound traffic movements during both the morning and afternoon peaks.

The composition of the traffic (i.e. types of vehicles) on George Street and Rawson Place is outlined in Figure 2.8 of Technical Paper 1. Light vehicles (including a significant proportion of taxis) make up the majority of vehicles travelling along both George Street and Rawson Place. Heavy vehicle movements (including deliveries, construction and service vehicles) make up a small proportion of the vehicles travelling along both George Street and Rawson Place. As shown in Figure 2.8 of Technical Paper 1, between 100 and 200 buses per hour move through these roads.

Table 12.2 Average weekday morning and afternoon peak traffic volumes – City Centre Precinct

INTERSECTION	MORNING PEAK TRAFFIC (AVERAGE NO. VEHICLES)			AFTERNOON PEAK (AVERAGE NO. VEHICLES)		
	CITY-BOUND	OUTBOUND	PEAK DIRECTION SPLIT	CITY-BOUND	OUTBOUND	PEAK DIRECTION SPLIT
Alfred Street (near George Street)[1]	153	232	40% city-bound	111	241	68% city-bound
George Street (near King Street)	573	435	57% city-bound	579	395	59% city-bound
George Street (near Ultimo Road)	1,361	577	70% city-bound	1,032	936	52% city-bound
Eddy Avenue (near Elizabeth Street)	1,230	1,218	50% city-bound	1,391	1,330	51% city-bound

Source: *Table 2-12 of Technical Paper 1 – Transport Operations Report, Volume 2*

Note 1: *Along Alfred Street, city-bound traffic is travelling west and outbound traffic is travelling east.*

Existing intersection performance

A summary of the existing performance of key intersections along George Street, Rawson Place and Elizabeth Street is provided in Table 12.3. Intersection performance in Table 12.3 is measured using the following indicators:

- *Level of service (LoS)* — a basic performance parameter used to describe the operation of an intersection; LoS ranges from A (indicating good intersection operation) to F (indicating over-saturated conditions with long delays and queues)
- *Degree of saturation (DoS)* — the ratio of demand flows to capacity; as DoS approaches 1.0, extensive queues and delays can be expected
- *Delay* — this represents the number of seconds a vehicle is delayed at an intersection.

As shown in Table 12.3, the intersections between Bridge Street/Grosvenor Street/George Street and Park Street/Druitt Street/George Street have the lowest LoS, with average delays greater than one minute during both the morning and afternoon peaks, reflecting that these intersections are generally operating at capacity during the peak periods.

Table 12.3 Existing intersection performance – City Centre Precinct

INTERSECTION	PEAK HOUR	EXISTING INTERSECTION PERFORMANCE		
		LOS	DOS	AVERAGE 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
	PM	C	0.95	37.1

Source: Table 2-13 of Technical Paper 1 – Transport Operations Report, Volume 2.

Parking and kerbside access

Existing on-street special kerbside uses and general parking supply were analysed for the City Centre Precinct. The main findings are summarised below. For the purposes of the parking assessment, the City Centre Precinct has been split into the following two sub-precincts:

- *CBD north* — comprising Alfred Street and the section of George Street located between Alfred Street and Park Street, as shown in Figure 12.2a
- *CBD south* — comprising the section of George Street located between Park Street and Rawson Place, as well as Rawson Place, Eddy Avenue and the section of Chalmers Street located between Eddy Avenue and Devonshire Streets, as shown in Figure 12.2b.

The distribution of kerbside parking restrictions within the CBD is outlined in Table 12.4 and shown in Figures 2.9 and 2.10 of Technical Paper 1.

The available loading and parking zones in the CBD corridor are all operating at effective capacity during peak periods. Existing parking supply within the CBD north and CBD south sub-precincts is discussed further in the following sections.

Table 12.4 Existing special kerbside uses and general parking supply – City Centre Precinct

KERBSIDE RESTRICTION	SPECIAL KERBSIDE USES AND GENERAL PARKING SUPPLY BY TIME PERIOD		
	PRE-MORNING PEAK[1]	INTERPEAK[1]	POST-AFTERNOON PEAK[1]
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 (≤ 1P)	20	41	20
Long stay parking (restricted)	7	22	43
Long stay parking (unrestricted)	0	0	0
Total – General Parking	**27**	**63**	**63**

Source: *Table 2-14 of Technical Paper 1 – Transport Operations Report, Volume 2*

Note 1: *Pre-morning peak = before 7.30 am; Interpeak = 10.00 am to 2.00 pm; Post-afternoon peak = after 6.30 pm.*

CBD north

The CBD north sub-precinct is characterised by high density commercial and hotel development. 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 6 am to 8 pm on Mondays to Fridays). At night, parts of these lanes are used as loading and taxi zones. Additional taxi zones include one eastbound on Alfred Street and another northbound at the Four Seasons Hotel. A westbound bus stop is also located on Alfred Street between Loftus Street and Pitt Street.

CBD south

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 of Technical Paper 1.

The dominant land uses in the CBD south sub-precinct are high density residential and commercial with retail and entertainment. The CBD south sub-precinct also includes the rail terminus of Central Railway Station and the bus interchange at Railway Square.

Along George Street, kerbside bus lanes generally operate between 6 am and 8 pm, Monday to Friday (although certain sections operate 24 hour bus lanes). At night and on weekends, on-street parking is generally permitted on both George Street south and Rawson Place.

There are a number of taxi and loading zones along the southern section of George Street located close to major land uses such as World Square, Town Hall Railway 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.

Property access

There are a number of property accesses (private car parking or loading docks) along the proposed CSELR alignment in the City Centre Precinct. The locations of existing property accesses along George Street are shown in Figures 12.2a and b and described in Table 12.5.

Table 12.5 George Street vehicular access and redevelopment sites

ACCESS TYPE	GEORGE STREET ACCESS
Private car park	• Four Seasons Hotel (west side, Essex Street to Alfred Street) porte cochere (a porch at the main or secondary entrance to a building where vehicles stop for passengers to depart or alight) 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, Kind 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 exits one-way westbound to George Street. • A private garage at 583 George Street (west side, between Liverpool and Goulburn Streets). • 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 located on George Street. Alternate access available via driveway to St Andrews Church on Bathurst Street.
Public car park	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).
Footpath/ramp access to street	• 478 George Street/State Theatre Annex (east side, Market Street-Park Street). • Hunter Connection – De Mestre Place (east side, Hunter Street – Wynyard Street).
Total number of accesses	14

Source: Table 2-15 of Technical Paper 1 – Transport Operations Report, Volume 2

The total daily traffic volumes recorded for key property accesses on George Street during a vehicle survey undertaken by City of Sydney (2010) are described in Table 12.6. As shown in Figures 12.2a and 12.2b and Table 12.6, a significant level of commercial usage of accesses occurs along George Street, particularly between King and Market streets. In the case of the Westfield loading dock, these vehicle movements include occasional deliveries by 19 metre long articulated trucks.

Currently when larger vehicles turn into the accesses listed in Table 12.6 off George Street, they are required to swing out across the adjacent traffic lane which presents a safety hazard. The major docks at Mid-City and Westfield utilise traffic controllers to halt pedestrian movements when vehicles are using the accesses due to the heavy pedestrian flows on George Street. When turning off George Street, vehicles provide additional low-level delays to buses, as the bus lanes are blocked by vehicles waiting to access driveways off George Street. This particularly occurs during periods of heavy pedestrian traffic, when traffic controllers are required to regulate vehicle access.

Table 12.6 Total daily traffic volumes for key property accesses on George Street

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

Source: Table 2-16 of Technical Paper 1 – Transport Operations Report, Volume 2.

Existing and future bus services

Current bus services

Bus services currently operating along key roads within the City Centre Precinct are outlined in Table 12.7.

Table 12.7 Existing bus services operating in the City Centre Precinct

ROAD	BUS SERVICES
George Street	There are currently 290 bus services operating along George Street (in the peak direction). In addition to these services, Sydney Sightseeing tourist coaches operate along the George Street corridor.
Alfred Street	Approximately 22 bus services run along Alfred Street, with services operating to the eastern, north-western, western and southern suburbs.
Rawson Place	There is currently one bus service which travels along Rawson Place (Route 555). All other buses from Eddy Avenue turn onto Pitt Street.
Eddy Avenue	A coach/light rail terminal is currently located on the colonnade on the southern side (Central Railway Station side) of the road. All other bus stops are located along the northern side. Coach services operate along a narrow island within Eddy Avenue then travel along Pitt Street. There are currently 18 coach bays used by Premier, Firefly, CDC, Murrays, Sydney Explorer, Selwoods Orange, Grand Touring, Port Stephens Coaches, Busways, Greyhound, emergency services and other sightseeing bus operators. All other bus services along Eddy Avenue either head north to Elizabeth Street or south to Pitt Street to access various destinations. The majority of the peak bus passenger services are associated with the University of NSW (UNSW) shuttle bus services.

Source: Table 2-11 of Technical Paper 1 – Transport Operations Report, Volume 2

Future bus services

As outlined in section 9.2.1, Transport for NSW proposes to make a number of changes to existing bus services within the Sydney CBD as part of the redesign of the Sydney bus network. These changes would involve a redesign of the existing Sydney CBD bus network to create an integrated public transport solution for this area through the coordination of light rail, heavy rail and bus services. It includes rationalisation of Sydney bus services to accommodate the introduction of the North West Rail Link, expansion of light rail services, and the pedestrianisation of George Street.

Changes to bus services and infrastructure in the CBD as a result of the redesign of the Sydney bus network, as well as traffic management changes and other impacts associated with these changes, will be addressed as part of the NSW Government's (2013c) *Sydney City Centre Access Strategy* (SCCAS, as discussed in section 3.2.3). Therefore, these changes do not form part of this EIS, with the exception of cumulative impact considerations (refer to Chapter 11).

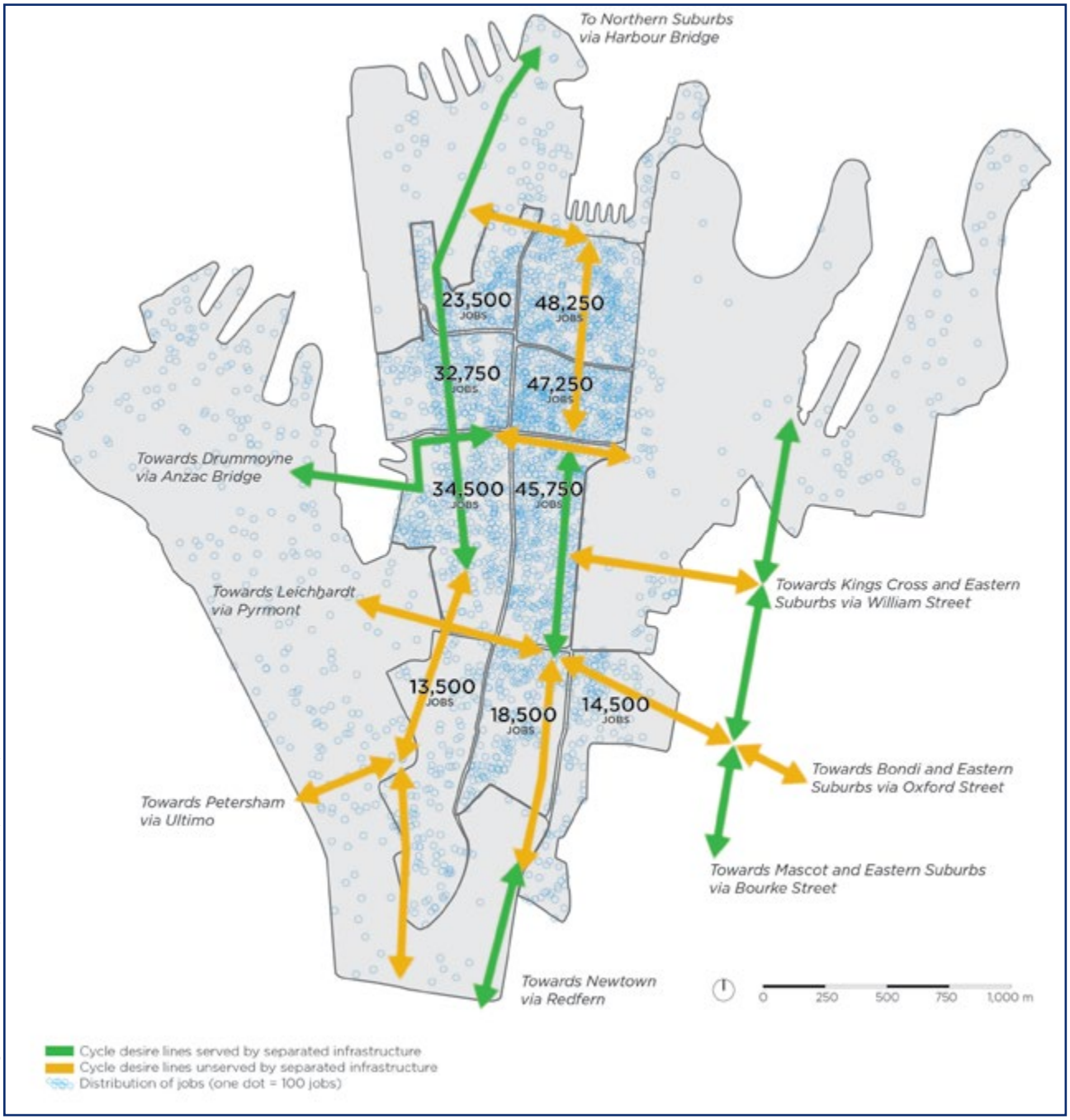
Cyclists

Current cyclist provisions

Several networks of on-road and off-road cycleways exist in the vicinity of the CSELR corridor. The bicycle network within the City Centre Precinct is shown in Figures 12.2a and b and described in Table 12.8. Key cycling desire lines into the Sydney CBD are shown in Figure 12.3.

Cycle counts for 2013 collected by the City of Sydney at King Street show that approximately 1,850 bicycle trips are made on this corridor on an average weekday.

Figure 12.3 Key cycling desire lines into the Sydney CBD



Source: Figure 2-19 of Technical Paper 1 (Transport Operations Report)

Table 12.8 Existing cyclist facilities within the City Centre Precinct

LOCATION	ROUTE TYPE	DESCRIPTION
George Street	On-road	The section from Goulburn Street to Hickson Road is considered an existing on-road cycle route under City of Sydney's bicycle route map.
Rawson Place	Not an official bicycle route	Rawson Place is not considered a bicycle route under City of Sydney's bicycle route map.
Eddy Avenue	Not an official bicycle route	Eddy Avenue is not identified as a bicycle route under City of Sydney's bicycle route map.
Chalmers Street	On-road/off-road	A section of Chalmers Street (north of Devonshire Street) is considered 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 Railway Station and other residential and retail land uses. There is a direct connection between Central Railway Station and Moore Park through the 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.

Source: Table 2-19 of Technical Paper 1 – Transport Operations Report, Volume 2

Future cyclist provisions

The draft SCCAS (NSW Government 2013c) identifies a number of strategic cycleway corridors to improve cycling access around the Sydney City Centre. The proposed strategic cycleway network within the Sydney CBD is illustrated in Figure 12.4 and includes:

- extending the existing bi-directional separated Kent Street cycleway to Liverpool Street and implementing related improvements through The Rocks to connect to the Harbour Bridge
- constructing the Liverpool Street cycleway between Darling Harbour and Castlereagh Street
- establishing a bi-directional separated north-south cycleway along Castlereagh Street (between Hay Street and King Street), and Pitt Street (between King Street and Circular Quay) (including a short east-west cycleway connection along King Street (one block between Pitt Street and Castlereagh Street). (In most instances, the separated cycleway will be constructed within the lane currently designated for parking/loading to maximise traffic lanes and capacity.)
- extending the east-west cycleway along Park Street to connect with the Castlereagh Street cycleway.

A number of future expansions to the strategic cycleway network are also identified including links to Barangaroo (from the Kent Street cycleway), along the Cahill Expressway and from Castlereagh Street to link with Taylor Square along Oxford Street. The alignments of these proposed routes are yet to be determined.

The proposed strategic cycleway network provides cycleway access within and through the CBD, generally avoiding George Street and thus interaction with light rail operations. However it would cross the CSELR alignment on George Street at the intersections with King Street and Liverpool Street.

Figure 12.4 Proposed strategic cycleway network within Sydney CBD

Source: *Sydney City Centre Access strategy - for further consultation (Transport for NSW 2013)*

Strategic cycleway network
Strategic cycleway network - routes to be determined
Existing separated cycleway - identified for removal

Pedestrians

Existing pedestrian volumes

Walking is the main mode of transport in the CBD. Existing pedestrian access along the proposed CSELR alignment is facilitated by footpaths, marked and signalised pedestrian crossings and kerb ramps. The pedestrians making trips within City Centre Precinct currently experience numerous challenges which include excessive delays at signalised intersections, crowded and narrow footpaths, footpath interruptions, delivery lanes and undulating topography.

Existing pedestrian access within the City Centre Precinct is summarised in Table 12.9, while existing pedestrian volumes are shown in Figure 2.12 of Technical Paper 1. The locations on George Street with the highest pedestrian volumes include:

- Martin Place — approximately 8,000 movements during peak periods (two-way flows)
- King Street — approximately 5,500 movements during peak periods (two-way flows)
- Park Street — approximately 4,700 movements during peak periods (two-way flows).

Pedestrians make up the predominant mode of transport passing through the locations listed in Table 12.9 (as shown in Figures 2.13 to 2.17 of Technical Paper 1), particularly in the northern section of Alfred Street and George Street where they account for as much as 70–80 per cent of total traffic.

Table 12.9 Existing pedestrian access within the City Centre Precinct

LOCATION	DESCRIPTION	PEDESTRIAN ACCESS TYPE
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 and Vivid Sydney).	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 interchanges which attract significant volumes of pedestrians.	Pedestrian connections through the Strand, Mid City, the Queen Victoria Building, Hilton, Galleries Victoria, Hunter Connection, Martin Place, World Square (etc.) are the major surface and sub-surface connections along George Street. Existing pedestrian facilities such as sealed footpaths, pedestrian crossings at signalised intersections (approximately 17 signalised intersections), and kerb ramps exist to facilitate pedestrian movements across George Street.
Rawson Place	Pedestrian activities associated with Rawson Place are mainly influenced by Central (train/ bus) terminal commuters and Sydney Central YHA.	The pedestrian facilities such as footpaths, pedestrian crossings at signalised intersections (George Street/ Rawson Place and Eddy Avenue/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 heavy rail, light rail and bus transport modes and highly influenced by commuter activity.	Footpaths on both sides, pedestrian crossings at signalised intersections (Eddy Avenue/Pitt Street and Eddy Avenue/Elizabeth Street), mid-block crossing and kerb ramps exist to facilitate pedestrian movements across Eddy Avenue. In addition, pathways through Prince Alfred Park provide good connections with areas to the south of Cleveland Street.
Chalmers Street/ Elizabeth Street	Pedestrian activity in Chalmers Street is mainly associated with commuter activity, small cafes and businesses.	Chalmers Street and Elizabeth Street are active pedestrian corridors due to their close proximity to Central Railway Station and other residential and retail land uses. Sealed 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.

Source: Table 2-17 of Technical Paper 1 – Transport Operations Report, Volume 2

Existing pedestrian intersection performance

An assessment of pedestrian Level of Service (LoS) at key existing intersections within the proposed George Street pedestrian zone was undertaken based on the available footpath space and peak hour pedestrian flows. The results of this assessment are summarised in Table 12.10.

As shown in Table 12.10, 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.

Table 12.10 Existing pedestrian LoS – City Centre Precinct

INTERSECTION	PEDESTRIAN LOS			
	NORTH-WEST CORNER	NORTH-EAST CORNER	SOUTH-EAST CORNER	SOUTH-WEST 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

Source: Table 2-18 of Technical Paper 1 – Transport Operations Report, Volume 2.

Special events

Existing special events within the proposed CSELR corridor

Sydney regularly hosts cultural events including parades, running festivals and religious celebrations, which affect traffic flows along the CSELR corridor. These events are concentrated in the CBD and predominantly impact traffic along George Street. A list of these events is provided in Table 12.11. During these events, buses are typically diverted from George Street to Elizabeth Street.

Table 12.11 Annual events within the proposed CSELR corridor – City Centre Precinct

INDICATIVE MONTH	EVENT	COMMENT
January	Australia Day Wheelchair Race	Course runs west along Alfred Street at Circular Quay
	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 March	March down George Street between Bathurst Street and Martin Place
May	May Day March	March down George Street between Park and Bathurst Streets
	Sydney Morning Herald Half Marathon	Course runs west along Alfred Street at Circular Quay
June	MS Walk/Fun Run	Short section of the run along George Street near Martin Place
	Procession of the Blessed Sacrament	Procession moves down George Street between Bridge and Hunter Streets

Table 12.11 cont.

INDICATIVE MONTH	EVENT	COMMENT
September	Sydney Running Festival	Course runs west along Alfred Street at Circular Quay, and east through the pedestrian section of Circular Quay Railway Station
October	Moveable Feast	Closure of George Street between Park and Bathurst Streets
November	Sydney Christmas Parade	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	e.g. Sydney Swans celebratory parade 2012

Source: Table 2-8 of Technical Paper 1 – Transport Operations Report, Volume 2.

Special events currently affecting transport demand within the Sydney CBD

In addition to the events listed in Table 12.11, Sydney also hosts a number of other special events that affect transport demand along the proposed CSELR corridor to varying degrees. A list of these events is provided in Table 12.12. Many of these events are held in the Sydney CBD and surrounding areas, such as the Rocks, Botanic Gardens or Domain, and attract attendees from across Sydney.

Table 12.12 Annual events affecting travel demand within the proposed CSELR corridor – City Centre Precinct

INDICATIVE MONTH	EVENT	IMPACT
January	Sydney Festival – Festival First Night	High
	Sydney Festival	Medium
February	Opera in the Domain	Low
	Tropfest	High
March	Good Life Music Festival	High
	Mardi Gras Parade	Medium
	Mardi Gras Party	Medium
May	Vivid Festival	High
	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
	International Motor Show	Low
December	Carols in the Domain	Low
N/A	Major sporting events	Medium

Source: Table 2-9 of Technical Paper 1 – Transport Operations Report, Volume 2.

12.3.2 Impacts during operation

A detailed operational traffic and transport assessment for the CSELR proposal was undertaken by Booz & Company and AECOM. A comprehensive technical report is available as Technical Paper 1 — *Transport Operations Report* in Volume 2. The following sections summarise the findings in relation to local operational impacts on traffic, transport and access in the City Centre Precinct.

Integration with the existing road network

The CSELR proposal would be integrated within the existing surface street environment and, as such, would require a number of significant changes to be made to the way in which the road network is designed and operated.

The key functional changes and high level operational characteristics proposed within the City Centre Precinct as part of the CSELR proposal are shown in Figure 12.5a and Figure 12.5b and described in the following sections.

Alfred Street

The section on Alfred Street between George Street and Pitt Street currently operates as a two-way road with two westbound lanes and a single eastbound lane. Most traffic along this road is associated with taxi and bus movements, with some local access traffic to the northern end of Pitt Street. There are no local driveway accesses within this section.

With the CSELR proposal, the section between Pitt Street and George Street on Alfred Street would become a pedestrianised zone providing a shared zone for pedestrian and light rail vehicles. Vehicle access would be restricted to service and emergency vehicles with access to service vehicles permitted during restricted hours. Signalised pedestrian crossing facilities would be provided on all arms of existing signalised intersections to provide controlled crossing points of the light rail alignment. This would provide protection and improved amenity and accessibility for visually, hearing or mobility impaired pedestrians.

George Street

George Street would form the north–south spine for light rail through the CBD. Significant changes to the functional characteristics of George Street would be required to accommodate light rail. A major change would be the pedestrianisation of George Street between Hunter and Bathurst streets. The functional changes along George Street both outside and within the pedestrian zone are outlined below.

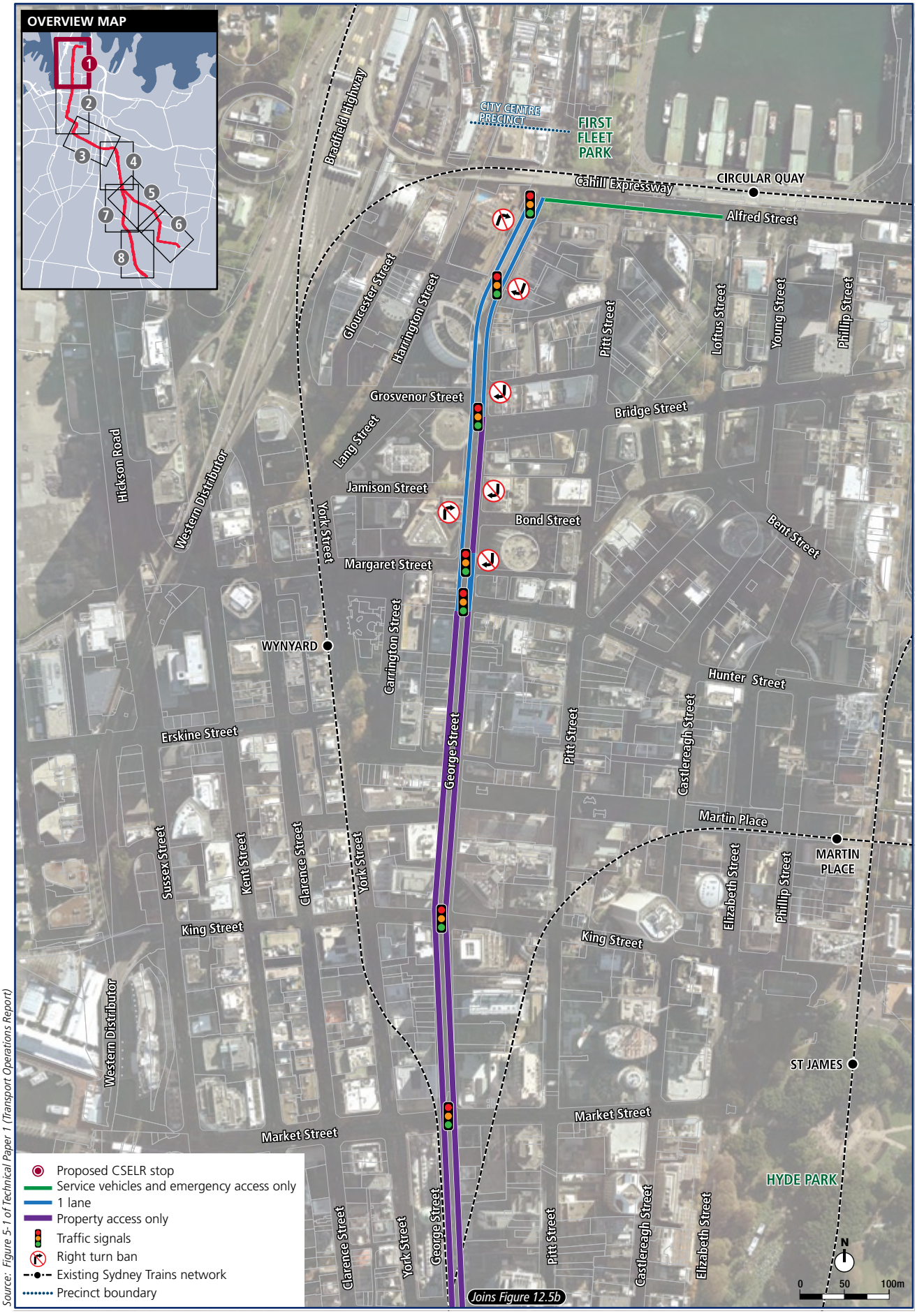
Outside of the proposed pedestrian zone

Outside of the pedestrian zone, the standard George Street cross-section would consist of a single kerbside traffic lane in each direction with centre-running light rail. The reallocation of existing traffic lanes to dedicated light rail running would reduce the importance of George Street as a route for through-running traffic.

Where cross-sectional widths permit, additional traffic lanes would be provided, particularly on the approach to intersections to ensure turning vehicles do not unnecessarily delay through-traffic. Those locations that would deviate from the single traffic lane cross-sections are detailed below:

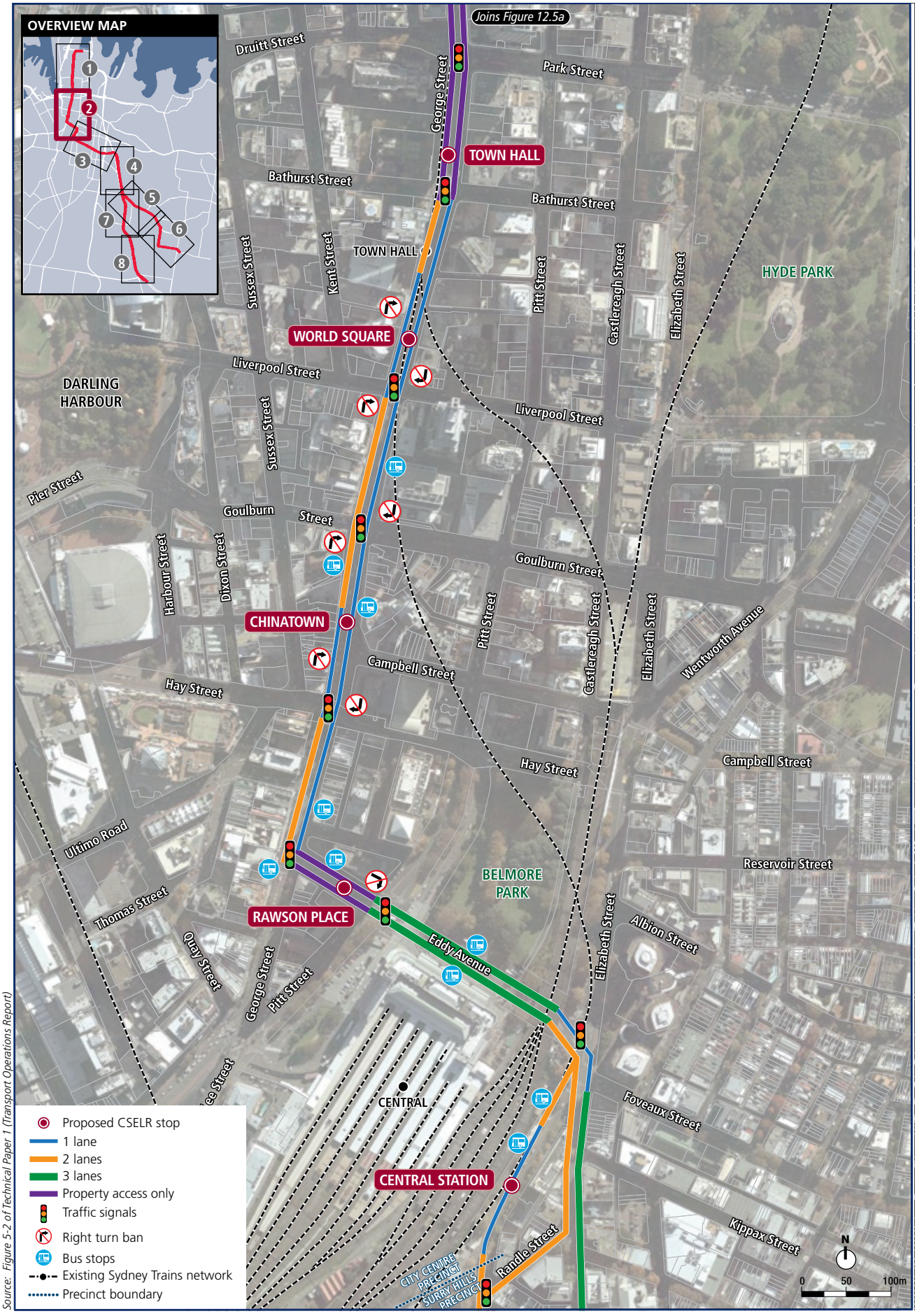
- Between Rawson Place and Hay Street, two northbound and a single southbound traffic lane would be provided on George Street.
- Between Hay Street and Liverpool Street, two northbound lanes would be provided on George Street.
- The northbound approach to Bathurst Street would operate with two right-turn lanes.
- Between Hunter and Grosvenor Streets, a single northbound lane and no southbound lane would be provided (due to the limited cross-sectional width which would be unable to accommodate two-way traffic movements past the proposed Grosvenor Street stop).

Figure 12.5a Functional changes to the road network – City Centre Precinct



Source: Figure 5.1 of Technical Paper 1 (Transport Operations Report)

Figure 12.5b Functional changes to the road network – City Centre Precinct



Source: Figure 5-2 of Technical Paper 1 (Transport Operations Report)

Within the proposed pedestrian zone

A pedestrian and vehicle shared zone is proposed on George Street, between Bathurst and Hunter streets and adjacent to the proposed CSELR corridor. This shared zone would allow vehicles to use an area of the pedestrian zone to travel down the side of the CSELR corridor (at a maximum speed of 10 kilometres per hour) to access driveways and loading areas, where vehicles would be able to park to service properties on either side of George Street.

Where the shared zone is adjacent to building entrances and street furniture, the urban design would guide vehicles away from pedestrian conflict points to maintain safe sight distances.

At signalised intersections and stop lines, vehicle queuing and turning movements would be controlled. Signposting and traffic restrictions would be determined by the relevant roads authority and could be flexible depending on policy. Taxis and hire cars exiting the Hilton Hotel would be permitted to turn left into the Park Street bus lanes, whilst general traffic would proceed southbound to Bathurst Street. Vehicles could be discouraged from travelling further than one block by signposting.

Vehicle restrictions would ensure only local access, service delivery and emergency vehicles are permitted within the shared zone. The detailed streetscape design of George Street would include defined areas for pedestrians and light rail vehicles through visual cues, such as changing pavement types. This would be important to provide a safe environment for all road users. Signalised pedestrian crossing facilities would be provided on all arms of existing signalised intersections to provide controlled crossing points of the light rail alignment. This would provide protection and improved amenity and accessibility for visually, hearing or mobility impaired pedestrians.

Pitt Street and Hunter Street complementary works

As a result of the pedestrianisation of Alfred Street, access to properties along the northern section of Pitt Street (between Hunter Street and Alfred Street) would be via Loftus Street and the narrow laneway of Reiby Place. To improve access from the west and reduce the total traffic volumes on Reiby Place (which has a substandard footpath and is used by pedestrians connecting through to Circular Quay station) alternative access would be required.

This alternative access could be achieved through the conversion of Pitt Street to two-way operation between Alfred Street and Bridge Street as shown in Figure 5.3 of Technical Paper 1. Introduction of a northbound traffic lane in Pitt Street would enable direct property access to the northern end of Pitt Street. It would require the following changes to traffic operations:

- provision of a turning circle at the northern terminus of Pitt Street
- conversion of a southbound traffic lane in Pitt Street to carry northbound traffic
- modification to the intersection of Pitt Street with Bridge Street to accommodate two-way movement in the northern section of Pitt Street.

Hunter Street is also proposed to be converted from one-way operation (westbound) to two-way operation between Pitt Street and George Street. This would provide enhanced traffic connectivity to the east and west via a ‘dogleg’ movement between Hunter and Margaret streets.

Hunter Street is currently four lanes wide on approach to George Street, but with future pedestrianisation of George Street south of Hunter Street and a single traffic lane north of Hunter Street, only one of these four available lanes would be required to accommodate traffic movements during the operational phase of the CSELR proposal. Two-way operation of Hunter Street would therefore maximise the utilisation of road space, whilst still providing an enhanced pedestrian environment and the opportunity to provide loading/parking on Hunter Street to offset losses to this type of kerbside activity along George Street.

Rawson Place

With the implementation of the CSELR proposal on George Street and the redesign of the city centre bus network, Rawson Place would become a major interchange for bus and light rail passengers. To facilitate efficient bus and light rail movements, Rawson Place would be closed to general traffic and would only accommodate westbound bus movements, service vehicles, emergency vehicles and the proposed light rail vehicles (LRVs).

The functional changes to Rawson Place have been designed to complement the redesign of the Sydney bus network and to provide the required bus stopping and turn around capacity required to operate reliable bus services to the CBD.

Existing local traffic that uses Rawson Place would be diverted via Pitt and Barlow streets, whilst through-traffic would divert via alternative corridors, such as Elizabeth and Goulburn streets.

Buses would be provided with a bus stopping lane adjacent to the proposed Rawson Place light rail platform (i.e. providing cross platform interchange) and an additional passing lane to the north. Traffic signals at the eastern end of Rawson Place would provide controlled access for turning buses into Rawson Place from Pitt Street and Eddy Avenue. At the western end of Rawson Place, traffic signals would permit buses to turn left into George Street and across the light rail alignment. Both sets of traffic signals would provide convenient pedestrian access to Rawson Place and across George and Pitt streets.

Due to the volume of bus services in this precinct, additional stops for city-bound bus services would be provided on the western side of Pitt Street, just north and south of Rawson Place. These stop locations would enable bus passengers to transfer to light rail without crossing any roads.

Eddy Avenue would not be able to be used by the bus routes that stop adjacent to Rawson Place on Pitt Street as it would not be possible to turn right from Pitt Street into Eddy Avenue from the kerbside lane or north of Rawson Place. This restriction would be consistent with the changes proposed as part of the redesign of the city centre bus network.

Eddy Avenue

The CSELR proposal would occupy the southern side of Eddy Avenue, utilising the existing bus only lanes through the southernmost arch of the rail bridge. The CSELR tracks would occupy the current kerbside coach stops, which would be relocated between the light rail tracks and traffic lanes (as shown in Figure 5.1b). A dedicated 4.5 metre wide island coach platform would be accessed from the existing Eddy Avenue traffic lanes, with retention of the existing six traffic lanes (three in each direction).

By relocating coaches away from the kerb, any conflict between coach and LRV movements would be removed. A turnback track would be accommodated alongside the colonnade to optimise operations and enable LRVs to turnback during special events and short running of services.

Pedestrian access to the coach station island platform would be provided via the existing Eddy Square pedestrian crossing at the eastern end. A new crossing at the western end would be provided to allow pedestrian movement between the existing coach booking office and the coach platform.

Chalmers, Elizabeth and Randle streets

The proposed Chalmers Street light rail stop would be located on the western side of Chalmers Street, which would reduce the number of traffic lanes available to buses and general traffic. Three platform faces would be provided, with the easternmost track and platform face only utilised during special event operations. This would provide additional capacity to enable a light rail shuttle service with 90 metre long vehicles to operate between the Moore Park and Central Station stops.

Outside of special event operations, the easternmost track would operate as a bus lane to provide bus priority during most times of the day and maximise usage of the available road space. A 45-metre long northbound bus stop would be integrated with the northern end of the Chalmers Street light rail stop to provide convenient interchange between bus and light rail. During special events, this bus stop would not be available for regular bus services.

The existing bus stop in Chalmers Street near Devonshire Street would also be retained. This stop would be used during special events, and would be the boarding location for passengers previously using the Chalmers Street stop (near Eddy Avenue).

A single northbound general traffic lane would be provided on Chalmers Street along with the shared light rail/bus lane. Traffic utilising this lane would only be permitted to turn left into Eddy Avenue at the major intersection of Eddy Avenue/Elizabeth Street/Foveaux Street. Access to existing properties on Chalmers Street would be retained.

To offset the reduction in northbound traffic lanes within Chalmers Street, Randle Street would be reversed from one-way southbound to one-way northbound. Two northbound traffic lanes would be provided which would continue into Elizabeth Street (which currently operates as southbound only). Traffic utilising the additional northbound traffic lanes in Elizabeth Street would not be permitted to make a left turn into Eddy Avenue at the major intersection of Eddy Avenue/ Elizabeth Street/Foveaux Street. Provision of two northbound traffic lanes could be provided in Elizabeth with the loss of only one southbound lane through kerb and lane adjustments.

The above traffic operations in Chalmers, Elizabeth and Randle streets would require advance signage on approach to the newly signalised Chalmers Street/Randle Street/Devonshire Street intersection to direct drivers to either Eddy Avenue via Chalmers Street or Elizabeth Street via Randle Street. Signalisation of this intersection would be required to ensure conflicting light rail, traffic and pedestrian movements are separated, whilst providing improved pedestrian access to the Central Railway Station and light rail transport hubs.

Due to the two-way movements in Elizabeth Street, direct access to Randle Lane from the north would not be possible, but would be maintained via Rutland, Chalmers and Randle streets.

These modifications to the precinct's operation would also require a change to the existing parking provisions which are detailed below (refer to the Operational impacts to parking and kerbside access sub-section).

Light rail stop access and egress

Access to light rail stops would need to cater for all modes (including pedestrians, cyclists, buses, heavy rail, light rail and cars) and provide an easily accessible, legible and attractive public transport system. Detailed access plans for each of the proposed light rail stops within the City Centre Precinct (including any key actions to address potential multimodal access, or customer safety issues, or to improve access) is provided in section 7.3 of Technical Paper 1.

Operational impacts on property access

George Street

As outlined in section 12.3.1, there are a number of property accesses (private car parking or loading docks) situated along the proposed CSELR alignment on George Street. The locations of key traffic generating driveways with access to George Street are shown in Figures 12.2a and 12.2b and described in Table 12.5.

General traffic access to the pedestrianised section of George Street (between Bathurst Street and Hunter Street) would be under restrictions to be developed as part of the SCCAS. No entry controls would be implemented within the pedestrian zone, with appropriate exceptions for residents, light commercial deliveries, emergency vehicles and taxis.

All existing property accesses along George Street would be maintained during the operational phase of the CSELR proposal; however, certain restrictions are likely to apply. These would be developed and implemented by the relevant roads authority and could include:

- access restrictions implemented by the City of Sydney to provide for appropriate safety and amenity for pedestrians, which would be determined by City of Sydney, in consultation with Transport for NSW
- limitations on driveway access along the proposed CSELR corridor to left-in left-out only, where feasible.

The above access restrictions would result in increased travel distances for some service vehicles as their approach routes would be affected by the right turn bans. Any access restrictions required for the CSELR proposal would be subject to further consultation between the affected parties, Transport for NSW and City of Sydney. A case by case consideration of each affected property access would be undertaken during detailed design (in consultation with the affected parties) to determine the access restrictions required along the proposed CSELR route.

Vehicles entering or leaving private driveways have the potential to affect light rail operations and represent a safety hazard when undertaking turning movements across the CSELR alignment. Measures that Transport for NSW proposes to manage these impacts are outlined in section 12.3.4.

Rawson Place

Access to Rawson Lane from Rawson Place would not be possible during the operation of the CSELR proposal due to the establishment of the Rawson Place light rail stop. It has been observed that current service vehicles are able to turn around within the laneway. Access to Sydney Central YHA and for service and emergency vehicles on Rawson Lane would be maintained but would require some reversing of trucks.

Eddy Avenue

Loading dock access on the southern side of Eddy Avenue would require management across the CSELR alignment through time restricted access and/or audio visual warnings. Suitable treatment measures to address this issue would be identified during detailed design.

Chalmers and Elizabeth streets

The existing access to the Sydney Trains car park located opposite Devonshire Street would be integrated with the new traffic signals proposed at this location.

Operational impacts on emergency vehicle access

Access for emergency vehicles would be maintained at all times. Emergency vehicle access is required to all building frontages along George Street. In the event of fire, access for snorkel appliances for building evacuation and/or fire fighting would require the ability to position vehicles at the building frontage. The CSELR proposal would be designed to make provision for these access requirements for emergency vehicles.

Operational impacts on cyclists

An overview of the potential impacts of the CSELR proposal operations on cyclists travelling along key roads directly affected by the CSELR proposal is provided in Table 12.13.

Table 12.13 Impacts on cyclists during the operation of the CSELR proposal – City Centre Precinct

ROAD	IMPACTS ON CYCLISTS
George Street	George Street would no longer be promoted as a bicycle route, with cyclists directed to alternative existing north-south corridors such as Pitt Street, Castlereagh Street and York Street. Existing City of Sydney bicycle routes crossing George Street would be maintained. The CSELR proposal presents an opportunity to provide additional priority to east-west cycle movements crossing George Street.
Chalmers Street/ Elizabeth Street	Chalmers Street is currently identified as having both on and off-road cycle routes. Transport for NSW proposes to realign the off-road cycle route, segregating cyclists from pedestrians whilst maintaining the important north-south link between Belmore Park and Prince Alfred Park.

Source: Adapted from Tables 5-1 to 5-4 of Technical Paper 1 – Transport Operations Report, Volume 2

The proposed light rail stops and associated pedestrian/cyclist improvements around the CSELR alignment would create significant opportunities to encourage cycling for short trips to key destinations (including employment, residential, health and educational precincts in the vicinity of the light rail stops).

Whilst cycle routes along the proposed CSELR alignment would be impacted, all affected cycle routes would be relocated. In addition, the reduction in private vehicle trips that could occur as a result of implementing light rail would create an improved cyclist environment in the wider network. The strategic bicycle network within the Sydney CBD is shown in Figure 12.4.

As shown in Figure 12.4, the proposed strategic cycleway network provides cycleway access within and through the CBD generally avoiding George Street and thus interaction with CSELR operations. The crossing points at King Street and Liverpool Street would be signalised and managed as part of the overall traffic management strategy in this area. The as yet undetermined route between Prince Alfred Park and Elizabeth Street would not be precluded by the CSELR proposal. Broader consideration of cycle routes within the City Centre Precinct is being undertaken as part of the SCCAS and, therefore, is not part of the CSELR proposal or this EIS.

Operational impacts on pedestrians

An overview of the potential impacts of the CSELR proposal on pedestrians travelling along key roads directly affected by the CSELR proposal is provided in Table 12.14.

Table 12.14 Impacts on pedestrians during the operation of the CSELR proposal – City Centre Precinct

ROAD	IMPACTS ON PEDESTRIANS
George Street	The pedestrian environment along George Street would be transformed with the introduction of the CSELR proposal. The pedestrian zone between Hunter Street and Bathurst Street would improve connectivity by removing conflicts and barriers to pedestrian movements.
Eddy Avenue	Eddy Avenue would continue to provide a major pedestrian connection for the transfers between Sydney Trains, NSW Trains and bus services, in particular during special event modes. However, with the introduction of the CSELR, the major passenger interchange would occur at the Central Station light rail stop on Chalmers Street. The main bus interchange for Central Station would be located at Rawson Place.
Chalmers Street/ Elizabeth Street	Pedestrian activity along Chalmers Street is primarily associated with commuter traffic crossing Chalmers Street, at Devonshire Street and Elizabeth Street, to access the Sydney Trains network. The proposed CSELR alignment and associated local network changes would ensure the existing and future pedestrian desire lines receive priority to cross Chalmers Street.

Source: Adapted from Tables 5-1 to 5-4 of Technical Paper 1 – Transport Operations Report, Volume 2

With the introduction of the CSELR proposal, trips made by light rail would generate additional pedestrian flows along the proposed CSELR alignment. A number of pedestrian facility improvements would be provided on the CSELR corridor as part of the proposal, while existing pedestrian access points would be retained.

The pedestrianisation of Alfred Street and George Street (between Hunter and Bathurst streets) would provide safe pedestrian access, with only residents, light commercial deliveries (during restricted hours), emergency vehicles and taxis permitted to access the pedestrian zone.

Pedestrian analysis was undertaken for the pedestrian zone, with the results provided in Table 12.15. The results demonstrate the improved LoS pedestrians would experience as a result of the CSELR proposal.

A number of intersections that currently experience extensive congestion and crowding at LoS F (such as George Street/Market Street) would operate at LoS C or better, which would result in improved pedestrian amenity, safety and reduced journey times. This would be a significant improvement given up to 80 per cent of the total traffic that passes through these intersections is pedestrians.

Priority improvements, by way of signalised pedestrian crossing facilities, would be provided on all arms of existing signalised intersections to provide controlled crossing points of the light rail tracks. This would provide protection and improved amenity for visually, hearing or mobility impaired pedestrians.

Further pedestrian improvements would be developed as part of the SCCAS (as described in section 3.2.3) to ensure integration with the CSELR proposal.

Table 12.15 Pedestrian peak hour LoS analysis – City Centre Precinct

INTERSECTION	CORNER OF INTERSECTION	PEDESTRIAN INTERSECTION PERFORMANCE			
		EXISTING		WITH CSELR	
		LOS	WAITING AREA (SQUARE METRES)	LOS	WAITING AREA (SQUARE METRES)
Hunter Street/ George Street	NW	D	25	D	25
	NE	E	20	D	25
	SE	F	20	C	60
	SW	E	25	C	45
King Street/ George Street	NW	D	20	C	35
	NE	D	20	C	35
	SE	E	20	C	45
	SW	D	25	A	80
Market Street/ George Street	NW	E	25	C	50
	NE	F	20	C	45
	SE	F	20	C	60
	SW	F	20	C	60
Park Street/ George Street	NW	C	25	A	55
	NE	C	25	A	60
	SE	C	25	A	115
	SW	C	30	A	130

Source: *Table 5-13 of Technical Paper 1 – Transport Operations Report, Volume 2*

Operational impacts on buses

As outlined in section 9.2.1, Transport for NSW proposes to make a number of changes to existing bus services within the Sydney CBD as part of its redesign of the city centre bus network. Prior to the construction of the CSELR proposal, the following existing bus services would be relocated in accordance with the redesign of the city centre bus network:

- *George Street* — The majority of north-south services along George Street would be transferred to the Elizabeth Street/Castlereagh Street corridor.
- *Rawson Place* — City-bound bus services currently using George Street would be rerouted to Pitt Street and Elizabeth Street. Outbound bus services would be rerouted via Pitt Street and Rawson Place. The Rawson Place light rail stop would become the major interchange between bus and light rail services for the southern CBD.

- *Eddy Avenue* — Coach operations would no longer be permitted on the southern kerb of Eddy Avenue within the segregated section and would be relocated to the northern side of the light rail tracks. The existing right turn bus only movement from Elizabeth Street to the southern rail bridge arch would no longer be permitted.
- *Chalmers and Elizabeth streets* — Under normal light rail operation, the bus only lanes would continue along Chalmers Street or Randle Street; however, during special event mode operations, the bus only lane would cease on approach to the Randle Street intersection. The existing Elizabeth Street southbound bus lane would remain unaffected by the proposed two-way operation of traffic north of Randle Street.

The future bus service changes proposed in the redesign of the Sydney bus network have been developed in parallel with the development of the CSELR proposal. Therefore, these changes would be consistent with the CSELR proposal to ensure a fully integrated transport solution. Changes to bus services and infrastructure in the CBD as a result of the redesign of the city centre bus network, as well as traffic management changes and other impacts associated with these changes, would be addressed as part of the SCCAS (as discussed in section 3.2.3). Therefore, these changes do not form part of this EIS, with the exception of cumulative impact considerations (refer to Chapter 11).

The operation of tourist coaches along George Street would not be precluded by the CSELR proposal; however, no coaches would be permitted within the pedestrian zone on George Street.

Operational impacts on parking and kerbside access

The number of on-street special kerbside uses and general parking spaces that would be permanently impacted by the CSELR proposal is provided in Table 12.16. As shown in Table 12.16, the number of parking spaces affected by the proposal would vary throughout the day due to parking restrictions. For example, some parking spaces are located within a clearway (i.e. not available for use in the peak direction) or comprise part-time loading zones.

The key parking supply impacts within the City Centre Precinct would include:

- Existing pre-morning peak (before 7.30 am) parking supply (27 spaces) would be limited due to clearways in operation along George Street.
- Short stay and long stay (restricted) parking during the interpeak (between 10.00 am and 2.00 pm) would primarily be impacted by the proposed light rail stops at Rawson Place and Chalmers Street.
- Parking impacts associated with the CSELR proposal would be greatest during the post-afternoon peak (after 6.30 pm) due to the significant increase in parking supply once the operation of the George Street clearways cease.

Further discussion on impacts to existing parking and kerbside access within the City Centre Precinct is provided in the following sections.

Table 12.16 On-street special kerbside uses and general parking supply permanently impacted by the CSELR proposal – City Centre Precinct

KERBSIDE RESTRICTION	SPECIAL KERBSIDE USES AND PARKING SUPPLY IMPACTED WITHIN THE CITY CENTRE PRECINCT BY TIME PERIOD					
	PRE-MORNING PEAK[1]		INTERPEAK[1]		POST-AFTERNOON PEAK[1]	
	NUMBER OF SPACES IMPACTED	NUMBER OF SPACES RETAINED	NUMBER OF SPACES IMPACTED	NUMBER OF SPACES RETAINED	NUMBER OF SPACES IMPACTED	NUMBER OF SPACES RETAINED
Car share, hospital, mail zone	4	0	4	0	4	0
Disability parking	5	0	5	0	5	0
Loading zone	6	0	42	0	39	0
Taxi zone	10	5	14	5	21	5
Total – Special Kerbside Uses	**25**	**5**	**65**	**5**	**69**	**5**
Short stay parking (≤1P)	20	0	41	0	20	0
Long stay parking (restricted)	7	0	22	0	43	0
Long stay parking (unrestricted	0	0	0	0	0	0
Total – General Parking	**27**	**0**	**63**	**0**	**63**	**158**

Source: *Adapted from Tables 2-14 and 6-5 of Technical Paper 1 – Transport Operations Report, Volume 2*

Note 1: *Pre-morning peak = before 7.30 am; Interpeak = 10.00 am to 2.00 pm; Post-afternoon peak = after 6.30 pm.*

George Street

On-street parking

The central running light rail tracks and pedestrian zone between Bathurst and Hunter streets would remove the opportunity to provide extensive parking along George Street. The only potential for such parking is off-peak parking along the western kerb of George Street between Rawson Place and Pitt Street.

Loading and taxi zones

To accommodate the CSELR proposal, the existing loading zones along George Street would be removed. Network changes to George Street intersections would provide an opportunity to minimise impacts on adjacent businesses/properties by relocating loading zones to the additional kerb provided at the cross streets (for example, converting obsolete turning bays for movements onto George Street into parking). Locations where such opportunities could be provided include:

- *George Street north* — There is potential to relocate the taxi zone near the Four Seasons Hotel, north of Essex Street, to the north of Alfred Street.
- *Essex Street* — There is opportunity to reclassify short stay parking on the southern kerb as a northern CBD loading zone.
- *Bridge Street* — The dedicated left turn lane into George Street would become obsolete due to the removal of southbound traffic lanes. This would present an opportunity to enhance the footpath and provide a taxi zone on Bridge Street.

- *Margaret Street* — George Street northbound would be reduced to a single lane, providing an opportunity to convert the kerbside left turn lane into parking/loading.
- *Hunter Street* — The existing four lanes would be reduced to two lanes at the George Street intersection, providing an opportunity for additional parking/loading to be provided on both sides of Hunter Street.
- *King Street* — West of George Street, the eastbound right turn lane into George Street would become obsolete. This would present an opportunity for additional kerbside parking and loading to be established along the southern kerb. It is noted, however, that this would need to be considered alongside other modal initiatives for King Street, such as the potential future extension of the King Street cycleway east to Elizabeth Street.
- *Market Street* — The removal of the monorail (which does not form part of the CSELR proposal) and left turn lane into George Street would present an opportunity for additional loading capacity on one side of Market Street to the east of George Street. The provision of new loading or parking at this location would need to be balanced against the need for potential future pedestrian footpath capacity enhancements, as this location has been shown to experience significant pedestrian volumes and low LoS for pedestrians.
- *Park Street* — The dedicated left turn lane into George Street would become obsolete creating a potential opportunity for parking and loading to be established along the southern kerb of Park Street. The implementation of any future changes to kerbside activity on Park Street would need to be coordinated with delivery of the city centre bus network redesign, as well as consideration of bus stop capacity requirements.
- *Bathurst Street* — The left turn lane onto George Street would become obsolete creating opportunities for additional parking/loading spaces to be established.
- *Ultimo Road* — Dual turning lanes onto George Street would become obsolete as George Street would have only one lane in each direction. Therefore, there is an opportunity to create new parking/loading spaces along the northern kerb.

Opportunities to adopt the above road changes would be investigated further (consistent with other changes proposed as part of the SCCAS) in consultation with NSW Roads and Maritime Services and City of Sydney Council during detailed design.

Rawson Place

The closure of Rawson Place would necessitate the removal of short stay parking and loading zones along this road. However, there would be opportunities to relocate the loading zones to the following locations:

- Pitt Street, south of Eddy Avenue
- Barlow Street, east of George Street
- George Street, south of Rawson Place.

Eddy Avenue

No on-street parking or loading/unloading zones are currently available along the affected section of Eddy Avenue. Therefore, no on-street parking or loading/unloading zones would be affected by the CSELR proposal along Eddy Avenue.

The proposed CSELR alignment along the southern kerb of Eddy Avenue would preclude the provision of taxi zones in this location. However, there is the potential to utilise space within the median separating the westbound traffic lanes and CSELR tracks for a taxi zone.

Chalmers and Elizabeth streets

The location of the Central Station light rail stop on Chalmers Street would reduce the available carriageway width and preclude on-street parking north of Randle Street. The existing provision of short and long stay parking available along Chalmers Street south of Devonshire Street would be retained.

The existing taxi zones are located within the construction footprint for the proposed Central Station light rail stop. There is the potential to relocate the existing taxi zone on Chalmers Street to south of Devonshire Street.

Operational impacts on special events

A list of CBD events which currently affect traffic along George and Alfred streets is provided in Table 12.11 (refer to section 12.3.1). Due to the fixed nature of the proposed light rail infrastructure, these events (which currently force diversions of existing bus services) may require partial or full closure of the CSELR within the CBD.

To minimise the impact of CBD special events on CSELR operations, events along George Street would be further considered by Transport for NSW and City of Sydney to determine alternative routes for such events. In cases where events must retain use of the CSELR corridor, CSELR operations would be impacted and may need to be supplemented with bus services.

The current CSELR design includes a cross-over at Town Hall which may facilitate short-running of light rail services between Central Station and Town Hall if events are held on George Street north. Under these circumstances, replacement bus services may not be required, as sufficient regular bus services exist on adjacent streets (supplemented by heavy rail services on the City Circle line). However, if the event requires the full closure of the CSELR between Eddy Avenue and Circular Quay, replacement bus services may be required to provide sufficient capacity and accessibility to destination along the CBD CSELR alignment. Under these circumstances, replacement bus services would be anticipated to operate north-south via Elizabeth Street/Castlereagh Street.

The need for alternative transport arrangements would be assessed through the normal processes involving Transport for NSW, the Transport Management Centre, Roads and Maritime Services, Destination NSW, the City of Sydney and event organisers taking into account:

- the nature of the event
- the timing and location of the event
- the magnitude of demand expected to be attracted to the event
- the capacity of the base public transport system to cater for the event, including the ability of other modes to 'scale up' to provide additional capacity
- other conflicting events that may increase the load experienced by the transport system
- the presence of integrated ticketing or other arrangements that improve the efficiency of the transport system at times of ultra-peak loadings.

12.3.3 Impacts during construction

A detailed construction traffic and transport assessment for the CSELR proposal was undertaken by Booz & Company and AECOM. A comprehensive technical report is available as Technical Paper 2 — *Construction Traffic and Transport Management Plan,* in Volume 2. Key findings in relation to impacts of the CSELR during construction in the City Centre Precinct are described in the following sections.

Construction traffic management

The Construction Traffic and Transport Management Strategy for the CSELR proposal assumes maximum worksite footprints would be required during the civil works and that early works utility adjustments could be undertaken within the same construction footprint. This assumption has been made to assess the worst-case traffic and transport impacts — assuming the full length of the CSELR corridor as an active worksite and all proposed road closures in place concurrently and managed accordingly. However, as a general principle to improve legibility for users, it has also been the objective of the Construction Traffic and Transport Management Strategy to minimise the number of required changes to the road network. As such, wherever appropriate, the Construction Traffic and Transport Management Strategy aligns with the proposed operational network configuration. Impacts during more specific construction scenarios are summarised below.

Overarching construction traffic management strategies for the City Centre Precinct

Overarching construction traffic management strategies that would be adopted for the City Centre Precinct comprise the following:

- The functional changes to the road network proposed for the operational phase of the CSELR proposal (as outlined in section 12.3.2) would be implemented during construction, where appropriate and compatible with the construction requirements. These changes would include:

  - the diversion of bus services, moving towards the end state bus arrangements identified in the redesign of the city centre bus network, with the exception of bus services from the South East suburbs (which would continue to operate) and Rawson and Chalmers streets, which would be closed to buses during construction
  - the closure of minor side road junctions and laneways, where they are proposed to be closed during the operational phase of the CSELR proposal
  - enhancements to the east-west capacity of cross streets, where possible and as required to mitigate the long-term (operational) changes to traffic patterns.
- Minimise traffic disruptions by undertaking intersection works during weekends.
- Provide clearly defined pedestrian paths and fencing to separate the pedestrian path from the worksite and prevent random crossings.
- Review traffic signal operations for turning movement conflicts with pedestrians crossing at intersections and vehicles on access lanes and accessing worksites.
- Minimise the number of traffic changes to maximise the legibility of the road network for the public, businesses and emergency services to simplify network operations.
- Maintain access past the worksites on George Street for local access and emergency services. These access corridors may be via open access lanes outside the worksite boundary or via controlled access lanes through the worksite. Pull–off areas, between gaps in barriers would be provided to allow construction vehicles to stand clear of the open access lanes. In sections of the corridor where this is not feasible and delivery requirements dictate vehicles to stand for an extended time (e.g. while unloading track sections) these deliveries would be made outside business hours. Generally, open access lanes would be achievable in the south CBD sub-precinct due to the wider road cross-section. The controlled access lanes through the worksite would be managed by traffic controllers. The location of the lanes would be shifted within the roadway to suit the current work zone. Generally controlled access lanes are proposed in the north CBD sub-precinct between Alfred Street and Bathurst Street. Through-traffic in the CBD would be discouraged by public education, signs, traffic controllers and enforcement.
- Maintain property access based on a hierarchy of frequency of use and subject to agreement with property owners and business operators:
  - Infrequent access would be managed by traffic controllers on an ad hoc basis and/or scheduled deliveries outside work hours.
  - An access lane would be maintained for properties with frequent deliveries, such as the Westfield loading dock and car park access requirements such as 420 George Street.
  - Where feasible an open access lane would be retained for 24-hour property access. Where this is not feasible, traffic controllers would manage property access via controlled access lanes, 24 hours per day, or as otherwise required to meet the needs of frontage properties.
- Construction activities at major intersections would be staged to maintain key traffic movements (e.g. at Grosvenor Street/Bridge Street and at Pitt Street/Eddy Avenue). Other intersections would be closed during weekends and traffic diverted to alternate routes. The closure of these intersections would be conditional on the alternate route remaining open (e.g. Hunter Street westbound would remain open while Bridge Street westbound is closed).
- Disruptive major works would be scheduled to target times of lower traffic movement (e.g. Christmas New Year/January) consistent with managing pedestrian movements, which may be higher at holiday times (e.g. in The Rocks/Circular Quay, Chinatown areas).

Traffic management during proposed intersection works

All intersection works within the City Centre Precinct would be undertaken during weekends to minimise impacts on traffic movements. An assessment of traffic volumes in the CBD has shown that peak weekend traffic volumes are approximately 88 per cent of peak weekday traffic movements. However, it is acknowledged that events often occur in the CBD during the weekend and, as such, any weekend work would require careful planning and close liaison with the City of Sydney.

Major intersection works would be staged at the following locations to maintain key traffic movements:

- *Grosvenor Street/Bridge Street intersection* — The Grosvenor Street eastbound movement would be maintained at all times (as shown in the Bridge Street/Grosvenor Street intersection staging plan provided in Appendix B.1 of Technical Paper 2).

- *Pitt Street at Eddy Avenue/Rawson Place* — Through movements on Pitt Street would be maintained. Completion of these intersection works would be a prerequisite to enable diversion of bus routes from George Street to Pitt Street (as shown in the Pitt Street/Eddy Avenue intersection staging plan shown in Appendix B.2 of Technical Paper 2).

Other intersections would be closed during weekends (during the time periods specified in section 6.10.1) and traffic diverted to alternate routes. The closure of these intersections would be conditional on the following alternate routes remaining open:

- Hunter Street westbound would remain open while Bridge Street is closed.
- Bathurst Street would remain open while King Street is closed.
- Liverpool Street would remain open while Park Street westbound is closed.

Table 4.2 of Technical Paper 2 summarises the individual intersections within the City Centre Precinct and any corresponding conditions or works associated with the closure of each intersection. The proposed detour routes for intersection closures are shown in Appendix D of Technical Paper 2.

Local road network changes during construction

The local road network changes proposed within the City Centre Precinct during construction are summarised in Table 12.17. Further discussion on the proposed road network changes is provided in section 4.2 and Appendix C of Technical Paper 2.

Table 12.17 Local road network changes proposed during construction – City Centre Precinct

ROAD	PROPOSED CHANGES TO LOCAL ROAD NETWORK
Alfred Street	Alfred Street would be closed to traffic between Loftus Street and George Street to allow the proposed Circular Quay construction compound to be connected to the CSELR worksite.
Pitt Street	Pitt Street would be converted to provide two-way traffic movements north of Bridge Street to allow for local property access. Access from the east would be via Loftus Street and Reiby Place. The proposed changes to traffic movements on Pitt Street are shown in Figure 4-10 of Technical Paper 2. Northbound vehicles on Pitt Street would be able to turn around prior to the worksite and exit southbound. The proposed turning head would accommodate up to medium sized trucks. For larger vehicles, a three point turn would be required. The turning head would be located within Herald Square, which would impact on the pedestrian footpath, but would not require property acquisition.
George Street	George Street currently provides a connection for CBD traffic into The Rocks. During construction, alternate routes would include: • Sussex Street – Hickson Road (in both directions), which would also service the Overseas Passenger Terminal via the upper level concourse or access controlled road opposite Argyle Street • Kent Street to Argyle Street or Lower Fort Street (inbound) to Cumberland Street or Harrington Street • Cumberland Street or Harrington Street (outbound) to Grosvenor Street/Bridge Street or Jamison Street. A precinct access map for The Rocks is provided in Appendix A of Technical Paper 2. George Street would be closed to southbound traffic at Albert Street. A temporary roundabout is proposed at the George Street/Alfred Street intersection to accommodate these vehicles. The geometry of the roundabout would limit vehicle size to a small/medium truck up to 8.8 metres long. Larger trucks would need to make a three point turn using the driveway access to the Circular Quay construction compound under traffic control. Hickson Road – as the main access route to The Rocks – would experience an increase in congestion, which would likely occur at the traffic signals under the Harbour Bridge which control a section of one-way traffic movement. A review of current peak hour traffic exiting The Rocks southbound at Alfred shows about 400 peak hour vehicles. If it is assumed all of this traffic travels north along Hickson Road to exit The Rocks, a total of approximately 600 vehicles per hour could be expected on Hickson Road. Based on the available green time at the signals, sufficient capacity could be maintained. In addition, the travel demand management measures put in place during construction would further reduce demand from existing levels. Initial network modelling has shown that, during construction of the CSELR proposal, traffic speeds along Hickson Road would remain at similar levels to existing conditions, thus suggesting that sufficient capacity would be maintained along Hickson Road.
Blue Anchor Lane	Blue Anchor Lane is located to the east of George Street. A road plate would be required across the construction zone to access the north-bound travel lane to the west of George Street.

Table 12.17 cont.

ROAD	PROPOSED CHANGES TO LOCAL ROAD NETWORK
Dalley Street	The entrance to Dalley Street would be closed at George Street during construction, with entry/exit movements provided via Pitt Street. A temporary turn-around facility would be required at the western end of Dalley Street. The width of the street is adequate for two-way movements, although removal of kerbside parking could be considered to provide additional capacity.
Jamison Street	The George Street entrance to Jamison Street would be closed during construction and access and egress would be provided via York Street. Two-way movements on Jamison Road and a turn-around facility would be provided for vehicles. Temporary changes (as shown in Appendix C of Technical Paper 2) would be required to the York Street/Jamison Street signalised intersection to facilitate access and egress to Jamison Street.
Angel Place	Angel Place would be closed at George Street with proposed entry and exit provided via Pitt Street.
Barrack Street	Barrack Street is located to the west of George Street. It is currently one-way eastbound, with access via York Street. The exit to George Street would remain open during construction. A temporary turn for access to Wynyard Ramps would be provided.
De Mestre Place	De Mestre Place is proposed to operate as left-turn entry and exit to George Street. De Mestre Place currently services the Hunter Connection loading docks. Based on the likely driveway geometry and available lane width, it may be necessary to limit the size of trucks to a maximum of 8.8 metres in length. This would be adequate for typical small to medium sized trucks, which currently service the lane and would be confirmed in discussions with business owners, if required.
Bond Street	Bond Street would be closed at George Street, with turnaround provided to facilitate entry and exit to Pitt Street.
Temperance Lane	Temperance Lane would be closed to traffic and no access would be provided.
Wilmot and Central Streets	The existing one-way movement on Wilmot Street and Central Street would be reversed with Wilmot Street becoming one-way westbound to George Street (left-out only) and Central Street becoming one-way eastbound from George Street (left-in only). This would require a southbound lane to be maintained on George Street for circulation between Wilmot Street and Central Street. The width of this southbound lane and turning geometry would limit truck sizes to 8.8 metres. This limitation would need to be agreed with businesses using the lane and the NSW Police.
Ultimo Road	Ultimo Road is proposed to be limited to let in left-out traffic movements via the northbound access lane on George Street. Pedestrian access would be maintained to existing signal crossings or traffic controllers would be provided for short-term works.
Hay Street	The existing Inner West Light Rail intersects the CSELR at the Hay Street intersection; two turnouts would be constructed to facilitate future interoperability. The operation of the Inner West Light Rail would be maintained during weekday hours, with the intersection constructed over five weekends, when there would be disruptions to services. Pedestrian movements at the intersection would be managed by traffic controllers, particularly at weekends when Darling Harbour and Paddy's Markets generate increased activity.
Campbell Street	Campbell Street is proposed to be limited to left-out from the southbound access lane on George Street. Peak hour right turn movements out of this intersection are currently limited to 70–100 vehicles which have an alternative northbound route via Pitt Street.
Rawson Place	Rawson Place would be closed to all traffic.
Rawson Lane	It is proposed to close Rawson Lane at Rawson Place, which is consistent with the operational phase of the proposal. City of Sydney has indicated its concurrence with this approach during consultation. Service vehicles have been observed to turn within Rawson Place, although larger vehicles may need to reverse in and out. Access to Sydney Central YHA, emergency and service vehicles would be maintained on Rawson Lane.
Eddy Avenue	Eddy Avenue (and Chalmers Street) are closely linked to Central Railway Station and associated interchange between heavy rail, bus, coach, taxis and light rail. The proposed Eddy Avenue works would remove existing coach parking along the southern kerbline at the railway frontage. The Eddie Avenue coach facilities are proposed to be relocated to the Western Forecourt on Lee Street and Chalmers Street. The existing bus operations along Eddie Avenue would continue during construction, in particular the university express services would be maintained on Eddie Avenue during construction works along Eddy Avenue.

Table 12.17 cont.

ROAD	PROPOSED CHANGES TO LOCAL ROAD NETWORK
Randle and Elizabeth streets	It is proposed to reverse the operation of Randle Street and provide two northbound lanes in Elizabeth Street (as shown in its operational configuration in Figure 4-21 of Technical Paper 2) to facilitate northbound traffic movements during the closure of Chalmers Street. This change would require works to be undertaken at the following intersections prior to the commencement of the main works in Chalmers Street: • Elizabeth Street/Eddy Avenue/Foveaux Street • Devonshire Street/Randle Street/Chalmers Street • Randle Street/Elizabeth Street. The intersection of Randle Street and Elizabeth Street would require adjustment of the layout to accommodate dual left turn movements onto Elizabeth Street, especially for buses travelling from Chalmers Street to Elizabeth Street. The proposed changes to the above intersections are shown in Appendix C of Technical Paper 2.

Construction impacts on property access

Existing properties with access to car parking or loading docks adjacent to the proposed CSELR alignment are shown in Figure 12.2a and Figure 12.2b. Potential construction impacts to these property accesses are described in section 4.2 of Technical Paper 2 and summarised in the following sections.

Generally, loading dock and servicing access for existing premises would be maintained wherever possible. Indicative local access plans for the City Centre Precinct are provided in Appendix C of Technical Paper 2. These plans detail how access could be maintained for those properties with existing access to car parking or service vehicle loading docks adjacent to the proposed CSELR alignment. Consultation with property owners would be undertaken to fully understand servicing requirements; however, measures would need to include:

- provision of an access corridor and sufficient manoeuvring space for vehicles turning into driveways (where these would not conflict with current worksite activity)
- scheduling deliveries outside work hours
- managing access through the worksite by traffic controllers. To maintain this access, open access lanes or controlled access lanes would be provided on George Street. When determining required lane widths, consideration would need to be given to the potentially constrained environment due to barriers or pedestrian fencing on both sides and the geometry required for vehicles to access each driveway. As a minimum, these lanes are to be in accordance with the Roads and Maritime Services manual *Traffic Control at Worksite Manual Version 4.0.*

Businesses on Alfred Street

There are no properties with driveways to Alfred Street. Goldfields House — which has frontage to the southern side of Alfred Street — has a construction access driveway on George Street. This driveway would not be required once refurbishment of the building is completed (anticipated to be prior to the start of CSELR works at this location). Businesses on the northern side of Alfred Street would be serviced from either Pitt Street or Alfred Street to the east of Loftus Street.

Four Seasons Hotel

The Four Seasons Hotel has a *port cochere* on the western side of George Street. The hotel also has a back of house arrivals area on Harrington Street for tourist coaches. The following two options could provide access to the hotel during construction:

- providing a northbound lane within George Street
- temporarily relocating *port cochere* activities to Harrington Street.

It is likely that the provision of a northbound lane in George Street would have the least impact on the hotel's operations (to be further confirmed through consultation with Four Seasons Hotel). Therefore, this has been assumed as the preferred option for the purposes of this assessment. During construction, all vehicles exiting the hotel would be required to travel north via George Street through The Rocks. The northbound lane would be established between Essex Street and Alfred Street by removing kerb indents and an existing taxi bay. Access into this lane would be via Essex Street. Depending on the stage of work, it would be feasible to retain some taxi parking

adjacent to the access lane. When work on the track slab is occurring at the site frontage, an alternate taxi parking area could be made available on Harrington Street.

Goldfields House

Goldfields House is located at the corner of Alfred Street/Herald Square and George Street. This building is currently being refurbished and has temporary access to George Street. The site has access to Pitt Street for car parking and loading. There is no proposed access to George Street in the approved development application for this development.

190 George Street

190 George Street (opposite Essex Street) is currently being redeveloped with hoardings erected on the George Street frontage. There is currently no driveway to George Street. A potential construction access is provided via Crane Place (a small narrow laneway adjacent to the site); however, there is no driveway crossover to George Street. A construction zone on George Street has been approved until 2015. The requirement for access to George Street would be confirmed in discussions with the building owners. Access to and from Essex Street would be feasible, given the site location opposite Essex Street, with a crossing maintained through the worksite.

George Street, between Barrack and Market streets

This section of the CBD construction zone has the highest demand for access to properties. Surveys have indicated approximately 300 vehicles arrive and 290 vehicles depart this zone between 7 am and 7 pm (City of Sydney 2010). A breakdown of the vehicle movements by driveway (i.e. Westfield, 420 George Street/Mid City and Dymocks) is provided in Table 12.18.

Table 12.18 Vehicle movements associated with driveways located on George Street, between Barrack and Market streets

ACCESS	VEHICLE MOVEMENTS (VEHICLES PER DAY)		VEHICLE TYPES
	VEHICLES IN	VEHICLES OUT	
Westfield	201	186	Cars, utes and vans (76%) Small to large rigid trucks (23%) Articulated trucks (a few per day)
420 George Street/ Mid City	77	104	Cars, utes and vanes (67%) Small to large ridged trucks (33%)
Dymocks	22	0	No data available

Source: Table 4-3 of Technical Paper 2 – Construction Traffic and Transport Management Plan, Volume 2

Access to Westfield, 420 George Street/Mid City and Dymocks would be maintained through the provision of a southbound lane on the eastern side of George Street, between King Street and Market Street. The location of the access lane would be varied to suit the current work location. Access to 420 George Street, Dymocks and GPO/Westin Hotel would likely be restricted to 8.8 metre long vehicles due to geometry constraints and the available lane width. The 8.8 metre vehicle restrictions would be adequate for typical mail vanes and medium sized trucks. The site also has other driveways accessed from Pitt Street, which may offer a viable alternative, where exit movements could be maintained.

Further south, on approach to the Market Street intersection the road cross-section widens for the right turn lane from George Street to Market Street. The driveway to the Westfield loading docks, Tower Apartments and Swisshotel is located in this section of George Street. The wider access lane would enable larger vehicles to service the Westfield loading dock; however, these would need to be limited to 12.5 metre rigid trucks.

Hilton Hotel (exit only)

An 'exit only' driveway access onto George Street would be provided for the Hilton Hotel, between Market and Druitt Streets. An alternate option of providing an on-street facility at the Pitt Street frontage for pick-up/set-down of patrons was considered. However, the driveway access could be maintained to George Street, with a southbound controlled access lane provided between Market and Pitt Street. Taxis and hire cars exiting the hotel would be permitted to turn left into the Park Street bus lanes, whilst general traffic would proceed southbound to Bathurst Street.

Energy Australia loading dock access

An existing loading dock access to the Energy Australia building is located on George Street south of Park Street. This building is currently vacant and the dock was gated at the time of inspection. The building has a separate car park access off the Bathurst Street frontage. However, the loading dock access to George Street would be maintained during construction. The wider cross-section of George Street at this location permits a southbound controlled access lane to be maintained.

St Andrews/Town Hall forecourt driveway

A driveway is located on the western side of George Street which provides access to the St Andrews/Town Hall House forecourt areas. Lockable bollards prevent access during the day. This access would not be maintained during construction. Alternate access is provided via a gated driveway located on Bathurst Street, west of George Street. It is proposed that this access would be used, subject to prior agreement with St Andrew's Cathedral staff.

478 George Street (former Mick Simmons building)

A development application for 478 George Street proposes a new 16 storey office building with retail on the lower level and upgrades to the existing State Theatre Annex Building. Access to this site is via a work zone in a temporary, indented parking bay in the George Street footpath, which permits vehicles to stand and unload materials without obstructing the George Street bus lane.

During the construction of the CSELR proposal, this work zone for 478 George Street would not be available on major event days (including New Years Eve, New Years Day, Australia Day, etc.) and no construction activity would occur during December. The controlled access lane would be available for access to the indented work zone; however, the building owners and contractor would be consulted to coordinate work and access requirements, particularly for the time when the CSELR works are being undertaken within this section of George Street.

Off-street car park off George Street

A small off-street car park is currently accessed via a driveway adjacent to the Central Baptist Church on the western side of George Street. Access to the northbound lane would be available with left-in left-out access.

Car park and loading facilities on Rawson Place and Eddy Avenue

Access to a small number of car parking spaces and loading facilities at the Eddy Avenue frontage to Central Railway Station is proposed to be maintained by progressively shifting driveway crossovers as construction work proceeds. Access to these driveways is proposed to be facilitated from the kerbside lane of Eddy Avenue.

Sydney Trains car park on Chalmers Street

Access to the existing driveway for the Sydney Trains car park adjacent to the Devonshire Street portal would be retained with entry via Chalmers Street (south) and exit via Randle Street.

Access to minor side roads

Access to Beattie Lane via Randle Street would be maintained; although, reversal of Randle Street would affect approach routes.

Construction impacts on parking

As a primary north-south bus route, on-street parking on George Street has been removed together with the majority of driveway access, where properties have viable alternate frontages. No provision for on-street parking or loading along the proposed CSELR alignment would be maintained during construction.

As discussed in section 12.3.2, network changes to George Street intersections would provide an opportunity to minimise impacts on adjacent businesses/properties by relocating loading zones to the additional kerb provided at the cross streets (for example, converting obsolete turning bays for movements onto George Street into parking). An outline of locations where such measures could be accommodated is provided in section 12.3.2.

As discussed in section 6.8.1, all construction workers would be expected to park off-site or use public transport with shuttle bus transfers of the construction workforce at shift change-over to prevent an increase in demand for on-street parking. A traffic management plan would be prepared to provide further details on car parking arrangements and minimise impacts on the surrounding network during construction of the proposal.

Construction impacts on public transport access

Bus services

As discussed in section 9.2.1, all existing bus services would be relocated from George Street prior to construction of the CSELR proposal as part of the redesign of the city centre bus network. As a result, bus passengers would need to access the CBD via new corridors to the east and west of George Street on York, Clarence, Elizabeth, Castlereagh streets and Park/Druitt Streets.

As outlined in section 6.10.6, the proposed future redesign of the Sydney bus network would interface with the construction of proposal at the following four key locations:

- Chalmers Street
- Eddy Avenue
- Rawson Place
- Park Street/Druitt Street/George Street intersection.

Local bus diversions that would be implemented to manage the impact on bus operations at the above four locations are described in Table 12.19. An assessment of bus stop capacity would be undertaken for those stops located on high-activity corridors to confirm that they do not exceed capacity during construction.

Table 12.19 Proposed local bus arrangements to manage bus operation impacts – City Centre Precinct

ROAD	PROPOSED LOCAL BUS ARRANGEMENTS TO MANAGE BUS OPERATIONS IMPACTS
Chalmers Street	At Chalmers Street, buses divert northbound via Randle Street to avoid the closed section of Chalmers Street adjacent to Central Railway Station. Bus stops on Chalmers Street would be maintained, with the bus stops relocated south of Devonshire Street to provide sufficient capacity for buses to divert to Randle Street. Exact locations of these bus stops are subject to further investigation and consultation with the operators and City of Sydney.
Eddy Avenue	At Eddy Avenue, all bus services would be retained and sufficient general traffic lanes maintained to facilitate the continued operation of buses through this precinct during construction. The staging of works at the pedestrian crossing outside Central Railway Station would cater for the demand for UNSW bus services (westbound buses in Eddy Avenue would use the bus stop within the main traffic lanes near the signalised pedestrian crossing) and would provide safe access to these bus stops. The bus stops within the coach area would not be available.
Rawson Place	At Rawson Place, Route 555 is the only currently operating service directly impacted. The redesign of the city centre bus network also proposes to operate a significant volume of Broadway/Inner West buses via Rawson Place and George Street southbound. This would not be possible during construction, so buses anticipated to make this movement would travel north and southbound via Pitt Street to Railway Square.
Park Street/Druitt Street/George Street intersection	The eastbound and westbound movement of buses through this intersection would be maintained during the weekday. However, eastbound bus routes would be diverted via Bathurst Street or King Street during the staged weekend intersection works. Utility relocation and civil works required within the intersection would be managed under the intersection closure detour arrangements shown in Appendix D of Technical Paper 2.

The rerouting of bus services would require modification of traffic controls at adjacent intersections to facilitate bus manoeuvrability. This would include elements such as new 'No topping' signs to lengthen the No Stopping zones at intersections and may require some realignment of kerblines at intersections. Some precincts would require construction and installation of traffic facilities before the commencement of the early works to accommodate bus diversions. These works would themselves result in impacts on bus management during construction. Key potential issues are described in the following sections.

Occupancy

The forecast bus occupancy across all corridors during construction is estimated to be 60 per cent. The only gateway nearing full bus capacity during construction is the Eastern Distributor, while other gateways have the bus capacity to absorb diverted commuters from either terminating routes or alternative routes to the City Centre.

Bus stop capacity

In order to accommodate the likely bus volumes in the City Centre during construction, sufficient kerb space and length would be required. All analysed bus stops have adequate capacity for the required activity within the city centre during construction, with some bus stops closer to exceeding capacity than others. Any modifications to existing bus stops outside the CBD during the construction period would need to provide sufficient capacity for the number of bus services operating.

Layover facilities

Initial investigations undertaken by Transport for NSW have identified the need for 21 existing and new layover facilities in the City Centre. These were assessed for capacity to accommodate for terminating buses in the City Centre. Initial plans would be implemented subject to separate approvals, with the modification of excluding Rawson Place during construction for outbound buses. These services would instead be diverted to Pitt Street, and would continue across Lee Street and stop at Railway Square. Bus stops would need to be provided on Pitt Street to cater for bus layovers as required.

Heavy rail services

Access to the key heavy rail interchange hubs of Wynyard, Town Hall and Central Railway Stations would be retained, with existing controlled crossing points through worksites maintained.

Existing light rail services

The existing Inner West Light Rail intersects the CSELR at the Hay Street intersection; two turnouts would be constructed to facilitate future interoperability. The operation of the Inner West Light Rail would be maintained during weekday hours, with the intersection constructed over approximately five weekends, when there would be disruptions to services. During such disruptions, signage, traffic controllers and shuttle bus transfers for Inner West Light Rail passengers would be provided where the installation of turnouts, and commissioning of signalling at the junction requires weekend closure of the existing light rail service and access to Central Railway Station. Short running of the Inner West Light Rail tracks during weekend closures would require shuttle bus transfers to connect to Central Railway Station. Buses may be permitted to use Hay Street between Pitt Street and George Street and turn left onto George Street during this time, to permit light rail passenger transfers.

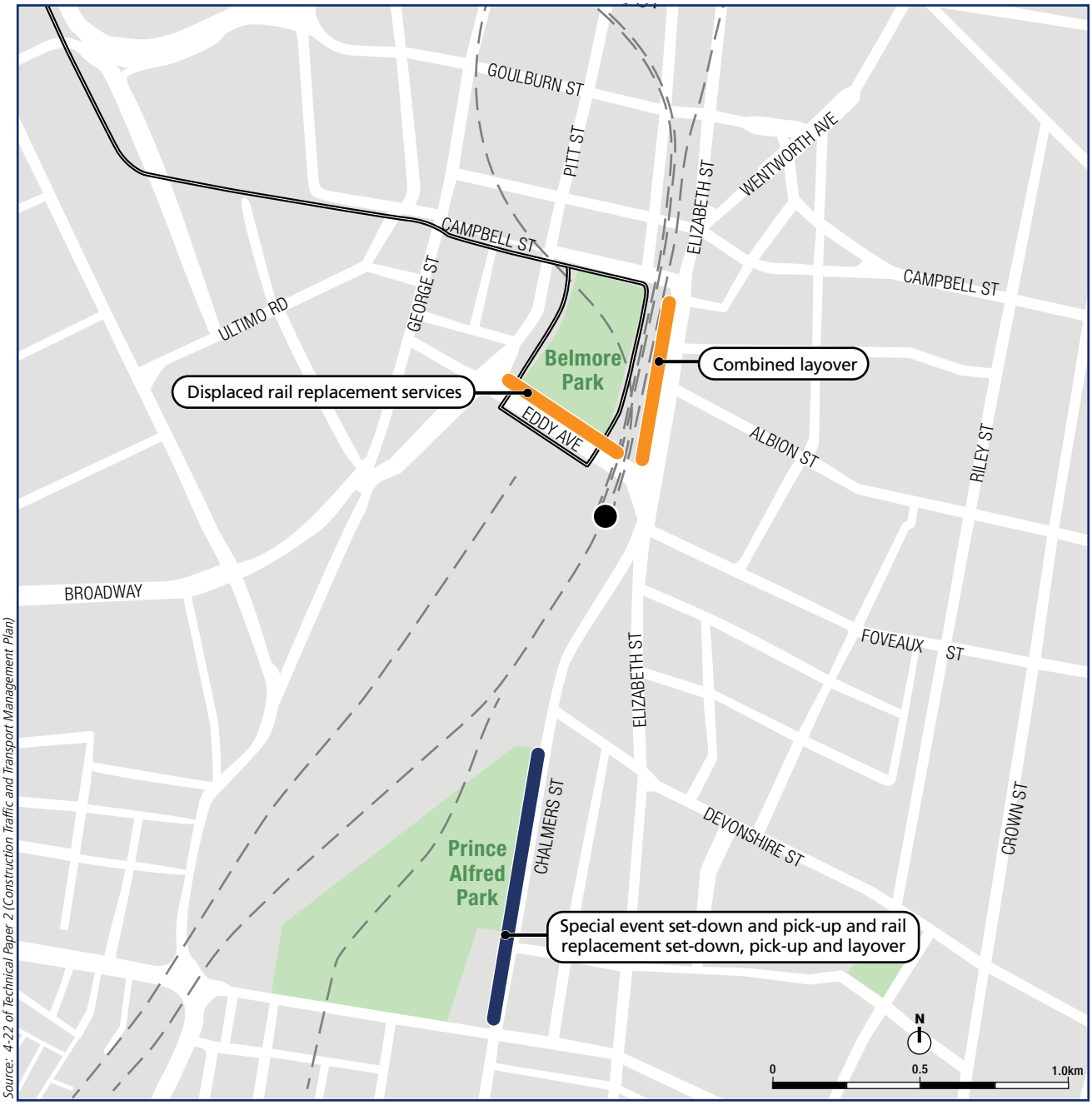
Special event and rail replacement bus services

Special event buses currently operate between Central Railway Station and the Moore Park Sports and Entertainment Precinct and Royal Randwick racecourse. At present, the buses pick-up and set-down passengers along Chalmers Street, between Devonshire Street and Elizabeth Street. However, with the proposed CSELR construction closing off Chalmers Street to traffic, these services would be required to move south of Devonshire Street. This arrangement would continue to provide a good connection for heavy rail passengers exiting Central Railway Station from the Devonshire Street portal.

In addition to special events buses, rail replacement buses also operate via Chalmers Street, and during the construction phase these would also require relocation south of Devonshire Street. This location would not have sufficient capacity to accommodate these dual uses.

Wherever possible, rail replacement works would be scheduled during weekends when no special events are proposed. Where this is not possible, special events would continue to pick-up and set-down passengers at Chalmers Street south of Devonshire Street, while rail replacement buses would need to be relocated to Elizabeth Street, north of Eddy Avenue as shown in Figure 12.6. In addition, changes to Sydney Trains maintenance schedules would be required to minimise the passenger transfer requirement at Central Railway Station.

Figure 12.6 Special events bus operation at Chalmers Street with rail replacement buses – City Centre Precinct



Source: 4-22 of Technical Paper 2 (Construction Traffic and Transport Management Plan)

Construction impacts on pedestrians and cyclists

During construction, pedestrians would be protected in narrow footpath sections by fencing, to physically separate pedestrians from traffic lanes.

Where existing controlled pedestrian crossing facilities occur, pedestrian access through the worksite would be provided. This would be controlled by traffic controllers. Existing crossing widths at mid-block crossing points, such as at Martin Place, may be reduced to allow reduced construction periods. This would be feasible without reducing pedestrian LoS due to the greatly reduced traffic volumes (i.e. construction and service vehicles only) on George Street. Traffic controllers would only be required to stop pedestrian movements infrequently.

North-south cycle movements on George Street could be moved to one of the following existing on-road cycle corridors as defined by the City of Sydney:

- Pitt Street (on-road, two-way)
- York Street (on-road, southbound only)
- Clarence Street (on-road, northbound only)
- Kent Street segregated cycleway (two-way).

East-west cycle movements may be more restricted during the construction phase. While cyclists may dismount and use the Circular Quay foreshore or Herald Square to George Street/The Rocks, a temporary cycle route on Bridge Street could act as an alternative on-road cycleway to Alfred Street to support east-west movements.

Bridge Street would provide two westbound traffic lanes during construction of the CSELR proposal, which may permit an on-road cycle lane within the existing roadway. During intersection staging works, the lane would not continue through the intersection to Grosvenor Street due to the need to divert the two traffic lanes with restricted alignment around staged worksites. During these closures, Hunter Street is to remain open for westbound movement, which would also require temporary diversion of cyclists to this route. The potential use of Bridge Street would be compatible with longer term operational plans which identify Bridge Street as a future cycle route (on-road, two-ways east of Pitt Street).

King Street (on-road, eastbound only) provides the next west to east crossing opportunity for cyclists.

Construction impacts on emergency vehicles

Access for emergency vehicles would be maintained at all construction sites. Emergency services would be advised of all planned changes to traffic arrangements prior to applying the changes. Advice would include information about upcoming traffic switches, anticipated delays to traffic, extended times of work, locations of road possession or any likely major disruptions.

There would be a number of locations along the George Street worksite where no access lanes would be provided external to the worksite (as shown in the George Street corridor plans contained in Appendix C of Technical Paper 2). In these locations, access to the block would be facilitated by traffic controllers to the location of the emergency. However, during certain loading/unloading and construction activities no clear path would be provided through the length of the block to permit through travel. At these times, emergency services would be advised in advance of the required alternate routes.

Construction impacts on taxis

All taxi ranks would be displaced from George Street during construction, many of which are off-peak or late night ranks only. This impact would be consistent with the functional changes to the road network proposed for the operational phase of the CSELR proposal (as outlined in section 12.3.2).

As discussed in section 12.3.2, network changes to George Street intersections would provide an opportunity to relocate impacted taxi zones to the additional kerb provided at the cross streets (for example, converting obsolete turning bays for movements onto George Street into parking). An outline of locations where such measures could be accommodated is provided in section 12.3.2.

Construction impacts on special events

As outlined in section 12.3.2, Sydney regularly hosts cultural events which impact traffic flows along the CSELR corridor. These events are concentrated in the CBD and predominantly impact traffic along George Street. A list of these events is provided in Table 12.11.

In addition to the events listed in Table 12.11, Sydney also hosts a number of other special events which impact demand for transport along the proposed CSELR corridor to varying degrees. A list of these events is provided in Table 12.12. Many of these events are held in the Sydney CBD and surrounding areas, such as the Rocks, Botanic Gardens or Domain, and attract attendees from across Sydney.

As outlined in section 6.10.14, wherever possible, agreement would be sought with event organisers to avoid Class 1 and 2 events occurring concurrently, where such events are identified to have a cumulative impact on travel demand around the CSELR construction corridors. To this effect, a calendar of all events would be kept during the construction period and coordination of these events and approval to proceed would be provided through a Network Coordination Liaison Group. All special events would be assessed and approved by Roads and Maritime Services and the Transport Management Centre, in consultation with the Department of Premier and Cabinet.

Special events may require adjustment to times of operation and routes used by haulage or delivery operations, as well as variations to approved road occupancy licence (ROL) conditions during construction. The ROL approval would identify time and day restrictions, where potential conflicts are known at the time of submission.

The construction contractor(s) would be responsible for incorporating known special events into the construction program and detailed responses and contingencies into the construction traffic management plan, subject to further inputs from other stakeholders such as City of Sydney, State Emergency Services and Roads and Maritime Services.

For special events which typically utilise George Street and Circular Quay, consultation with City of Sydney would be undertaken in order to develop management measures and possible re-routing of events in the CBD.

12.3.4 Management and mitigation

Operation

As discussed in section 9.2.4, a network management plan would be developed for the CSELR proposal during detailed design to identify key management measures that would be implemented to minimise impacts to journey times and congestion levels during CSELR operations.

Overarching traffic, transport and access management strategies that would be adopted during the operational phase of the CSELR proposal are described in section 9.2.4. The following additional management and mitigation measures would be implemented to further minimise traffic, transport and access impacts within the City Centre Precinct during the operation of the CSELR:

- General traffic access to the pedestrianised section of George Street (between Bathurst Street and Hunter Street) would be restricted through the introduction of appropriate vehicle restrictions. However, appropriate exceptions to this control would be provided for local access, service delivery and emergency vehicles to access driveways and loading zones (at a maximum speed of 10 kilometres per hour).
- The detailed streetscape design of the George Street pedestrian zone would include defined areas for pedestrians and LRVs through visual cues, such as changing pavement types.
- Within the George Street pedestrian zone, signalised pedestrian crossing facilities would be provided on all arms of existing signalised intersections to provide controlled crossing points of the light rail alignment.
- Pedestrian access to the proposed Eddy Avenue coach station island platform would be provided via the existing Eddy Square pedestrian crossing at the eastern end. A new crossing at the western end would be provided to allow pedestrian movement between the existing coach booking office and the coach platform.

- All existing property accesses along George Street would be maintained during the operational phase of the CSELR proposal; however, certain restrictions are likely to apply. These would be developed and implemented by the relevant roads authority and could include:
  - access restrictions implemented by the City of Sydney to provide for appropriate safety and amenity for pedestrians, as determined by City of Sydney, in consultation with Transport for NSW
  - limitations on driveway access along the proposed CSELR corridor to left-in left-out only, where feasible.
- Any access restrictions required for the CSELR proposal would be subject to further consultation between the affected parties, Transport for NSW and the appropriate local council (City of Sydney Council). A case by case consideration of each affected property access would be undertaken during detailed design (in consultation with the affected parties) to determine the access restrictions required along the proposed CSELR alignment.
- The existing access to the Sydney Trains car park located opposite Devonshire Street would be integrated with the new traffic signals proposed at this location.
- Loading dock access on the southern side of Eddy Avenue would require management across the light rail alignment through time restricted access and/or audio visual warnings. Suitable treatment measures to address this issue would be identified during detailed design.
- Access for emergency vehicles would be maintained at all times.
- George Street would no longer be promoted as a bicycle route, with cyclists directed to alternate existing north-south corridors such as Pitt, Castlereagh and York streets. Existing City of Sydney bicycle routes crossing George Street would be maintained. The CSELR proposal presents an opportunity to provide additional priority to east west cycle movements crossing George Street.
- Opportunities to relocate impacted loading and taxi zones from George Street to the additional kerb provided at the cross streets (for example, converting obsolete turning bays for movements onto George Street into parking) would be further investigated during detailed design (consistent with other changes proposed as part of the SCCAS), in consultation with City of Sydney.
- The existing provision of short and long stay parking available along Chalmers Street south of Devonshire Street would be retained.
- The key actions specified in the detailed access plans for each of the proposed light rail stops, included in section 7.3 of Technical Paper 1 — *Transport Operations Report* (addressing potential multimodal access, customer safety, or to improvements to access) would be further considered during detailed design.

Construction

As discussed in section 9.2.4, a construction network management plan would be developed during detailed design to identify appropriate traffic management measures and establish a framework for coordinating their implementation during the construction of the CSELR proposal. The construction network management plan would identify key measures that would be implemented during construction to minimise impacts to journey times and congestion levels.

Overarching traffic, transport and access management strategies proposed during the construction of the CSELR proposal are described in sections 6.10 and 9.2.4 of the EIS.
The following additional management and mitigation measures would be implemented to further minimise construction traffic, transport and access impacts within the City Centre Precinct:

- The end state transport arrangements (i.e. traffic environment during the operational phase of the proposal, as described in section 12.3.3) would be implemented prior to construction, where appropriate and compatible with construction requirements. This could include the diversion of bus services in accordance with the SCCAS, closure of minor side road junctions and laneways (where access is proposed to be permanently removed), and enhancements to the east-west capacity of cross streets within the CBD (where possible).
- Intersection works would be undertaken on weekends.

- Works at major intersections would be staged to maintain key traffic movements (e.g. Grosvenor Street/Bridge Street and Pitt Street/Eddy Avenue). Works at other intersections would be undertaken during weekend intersection closures, with traffic diverted to alternative routes. The closure of these intersections would be conditional on the alternate route remaining open (e.g. Hunter Street westbound would remain open while Bridge Street westbound is closed).
- Major disruptive works would be scheduled to occur during times of lower traffic movement (e.g. during the Christmas/New Year period). Measures required to manage pedestrian movements during such works would be reviewed to determine their adequacy in coping with increased pedestrian activity during the public holiday period.
- Property access would be maintained, based on the following hierarchy (corresponding to the current frequency of use) and subject to agreement with the affected property owners and business operators:
  - Properties with infrequent access requirements would be managed through the use of traffic controllers on an ad hoc basis and/or the scheduling of deliveries to occur outside of work hours.
  - Access to properties with frequent deliveries (e.g. the Westfield loading dock) would be maintained via an access track.
  - Where feasible, a lane would be retained for 24 hour property access. Where this is not feasible, a 24-hour traffic controller would manage property access.
- The local road network changes outlined in Table 12.17 would be implemented to manage impacts to traffic.
- Loading dock and servicing access for existing premises would be maintained wherever possible. Consultation with property owners would be undertaken to fully understand servicing requirements.
- Access arrangements proposed in section 12.3.3 would be implemented, in consultation with property owners/businesses and City of Sydney.
- Local bus diversions outlined in Table 12.19 would be implemented to manage the CSELR proposal's impact on bus operations at Chalmers Street, Eddy Avenue, Rawson Place, and the Park Street/Druitt Street/George Street intersection. An assessment of bus stop capacity would be undertaken for those stops located on high-activity corridors to confirm that they do not exceed capacity during construction.
- Access to the key heavy rail interchange hubs of Wynyard, Town Hall and Central Railway Stations would be retained, with existing controlled crossing points through worksites also maintained.
- Wherever possible rail replacement works would be scheduled during weekends when no special events are proposed. Where this is not possible, special events would continue to pick-up and set-down passengers at Chalmers Street south of Devonshire Street, while rail replacement buses would need to be relocated to Elizabeth Street, north of Eddy Avenue as shown in Figure 12.6.
- Clearly defined pedestrian paths and fencing would be provided to separate the pedestrian paths from the worksite and prevent random crossings.
- Traffic signal operations would be reviewed to identify turning movement conflicts with pedestrians crossing at intersections and vehicles on access lanes and accessing worksites.
- The number of traffic changes would be minimised (where possible) to maintain the legibility of the road network for the public, businesses and emergency services to simplify network operations.
- Access corridors for emergency services would be maintained along the George Street worksite. Pull-off areas (between gaps in barriers) would be provided to allow construction vehicles to stand clear of the access lane. Where this is not feasible and delivery requirements dictate vehicles to stand for an extended time (e.g. while unloading track sections) these deliveries would be made outside business hours. Through-traffic would be discouraged by public education, signs, traffic controllers and enforcement.
- The coordination of construction activity at redevelopment sites without access to alternate street frontages to George Street (e.g. 383 George Street) would be agreed with the building owners and contractors prior to the start of work. It may be feasible to target light rail track works over the Christmas New Year period, when contractors may not be on-site.

12.4 Local property and land use

12.4.1 Existing conditions

Existing land use patterns, land use features and an overview of the potential future developments within the City Centre Precinct area are described below. Figure 12.7a and Figure 12.7b identify the major existing land uses in the City Centre Precinct adjacent to the proposal.

Existing property and land use within the vicinity of the proposal

The City Centre Precinct includes a variety of land uses. The precinct contains the retail core of the Sydney CBD, extensive areas of office development, hotels and entertainment facilities, as well as the civic area centred on Town Hall. The northern end of the precinct around Circular Quay is dominated by a range of high density commercial tower buildings and retail uses focusing on entertainment and tourist opportunities. The Rocks, located to the west of George Street, also provides key tourism, retail and night time uses within the northern end of the city.

The central portion of the City Centre Precinct has a strong retail focus, as well as a mix of commercial, residential and civic buildings. While already densely established, the central part of the precinct has recently undergone significant redevelopment, including several large-scale retail/residential developments such as the redevelopment of the Westfield complex in Pitt Street Mall.

The southern portion of the City Centre Precinct denotes a shift from the primarily commercial and retail focus of the northern end of the CBD, to a less dominating built form. This portion of the City Centre Precinct provides for a wide range of retail and restaurant uses, capitalising on attractors such as the Capitol Theatre, the Sydney Entertainment Centre to the west of the precinct and the Chinatown district, centred on Dixon Street and Sussex Street. This area of the City Centre Precinct also contains Central Railway Station – a major interchange facility that has attracted a wide range of residential uses, hotels and associated activities.

Adjoining the City Centre Precinct are a number of major attractions and transport trip generators including the UTS, Darling Harbour, Paddy's Market and Barangaroo (currently under development).

Photographs of the typical land uses within the City Centre Precinct are shown in Figures 12.8 to Figure 12.11.

Planning controls

The Sydney Local Environmental Plan 2012 (Sydney LEP) defines the land use zoning within the City Centre Precinct (refer to Figure 12.12a and Figure 12.12b), with the exception of:

- the north-western section of the precinct, which is captured by the *Sydney Cove Redevelopment Authority Scheme*
- part of the south-west section of the precinct, which is captured by the *State Environmental Planning Policy (Major Development) 2005.*

The land within the City Centre Precinct is generally zoned 'B8 – Metropolitan Centre'. This zone aims to provide a diversity of compatible land uses characteristic of Sydney's global status. These uses serve the workforce, visitors and wider community whilst also providing opportunities for a range of business, office, retail, entertainment and tourist premises. An area of 'B4 – Mixed Use' land is also located towards the south-eastern end of the precinct and currently denotes an interface between the commercial centre of the CBD and the residential area of Surry Hills to the east.

Building height controls permitted under the Sydney LEP within the precinct extend up to 235 metres towards the centre of the precinct. A number of areas to the east of George Street are affected by requirements to maintain sun access to Hyde Park. This indicates that future redevelopment within the City Centre Precinct is more likely to occur along the George Street spine rather than along alternative streets such as Castlereagh Street and Elizabeth Street. The existing land uses and permissible building heights also indicate the potential for increased densities across the precinct and around stop locations, in particular the southern portion of the precinct for future mixed use and commercial developments.

Figure 12.7a City Centre Precinct (South) – Land use and property

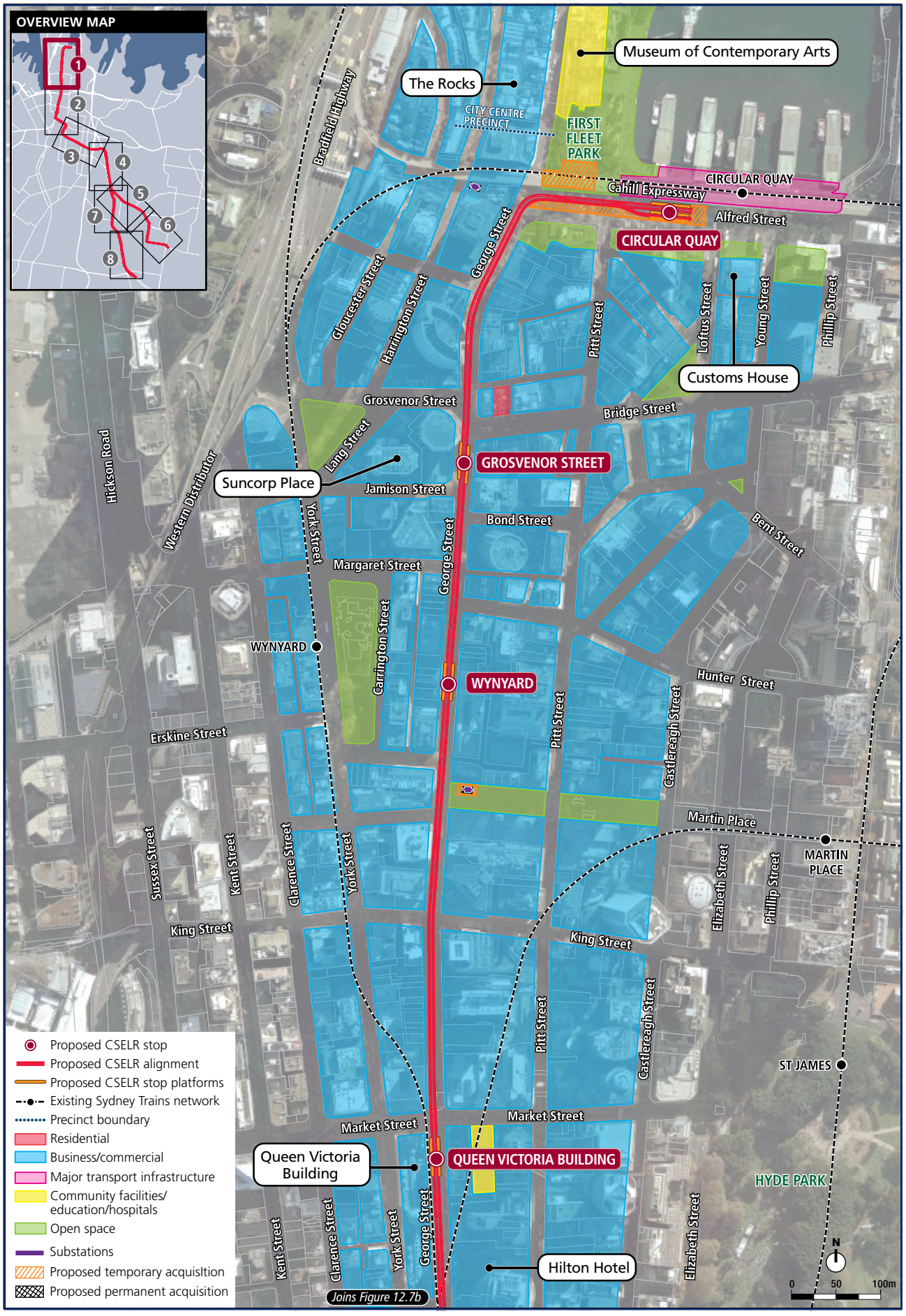


Figure 12.7b City Centre Precinct (South) – Land use and property

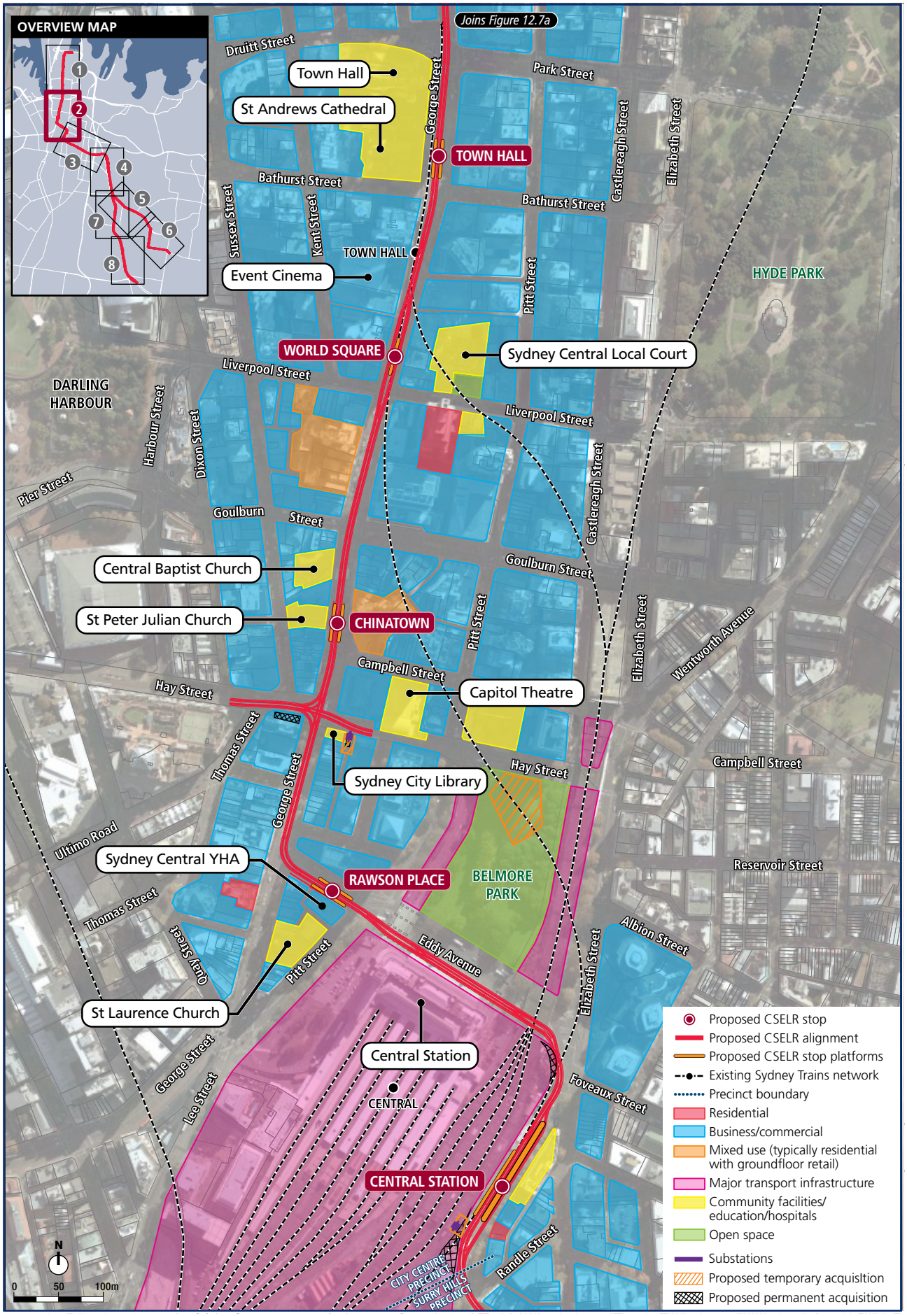


Figure 12.8 Photograph of the existing land use along Alfred Street looking towards the proposed Circular Quay stop including commercial buildings and Circular Quay Railway Station

Source: Parsons Brinckerhoff 2013

Figure 12.9 Photograph of the existing land use along George Street looking towards the proposed Grosvenor Street stop, predominantly consisting of commercial uses

Source: Parsons Brinckerhoff 2013 Planning controls

Figure 12.10 Photograph of the existing land use along George Street looking towards the proposed Town Hall stop, predominantly consisting of commercial uses

Source: Parsons Brinckerhoff 2013

Figure 12.11 Photograph of the existing land use along Chalmers Street looking towards the proposed Central Station stop, predominantly consisting of commercial uses in addition to Central Railway Station and the Sydney Dental Hospital

Source: Parsons Brinckerhoff 2013

Figure 12.12a City Centre Precinct – Existing land use zoning

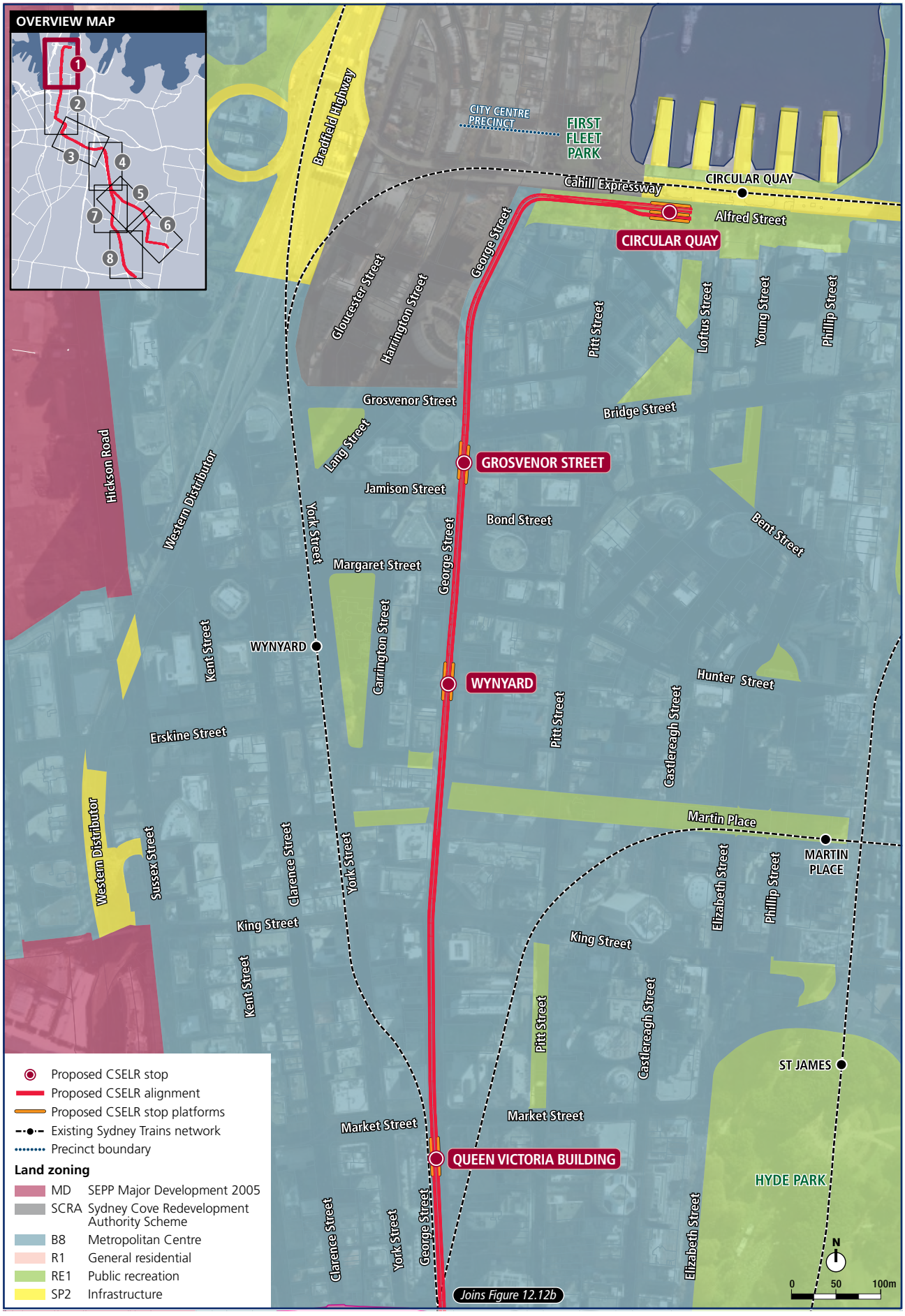
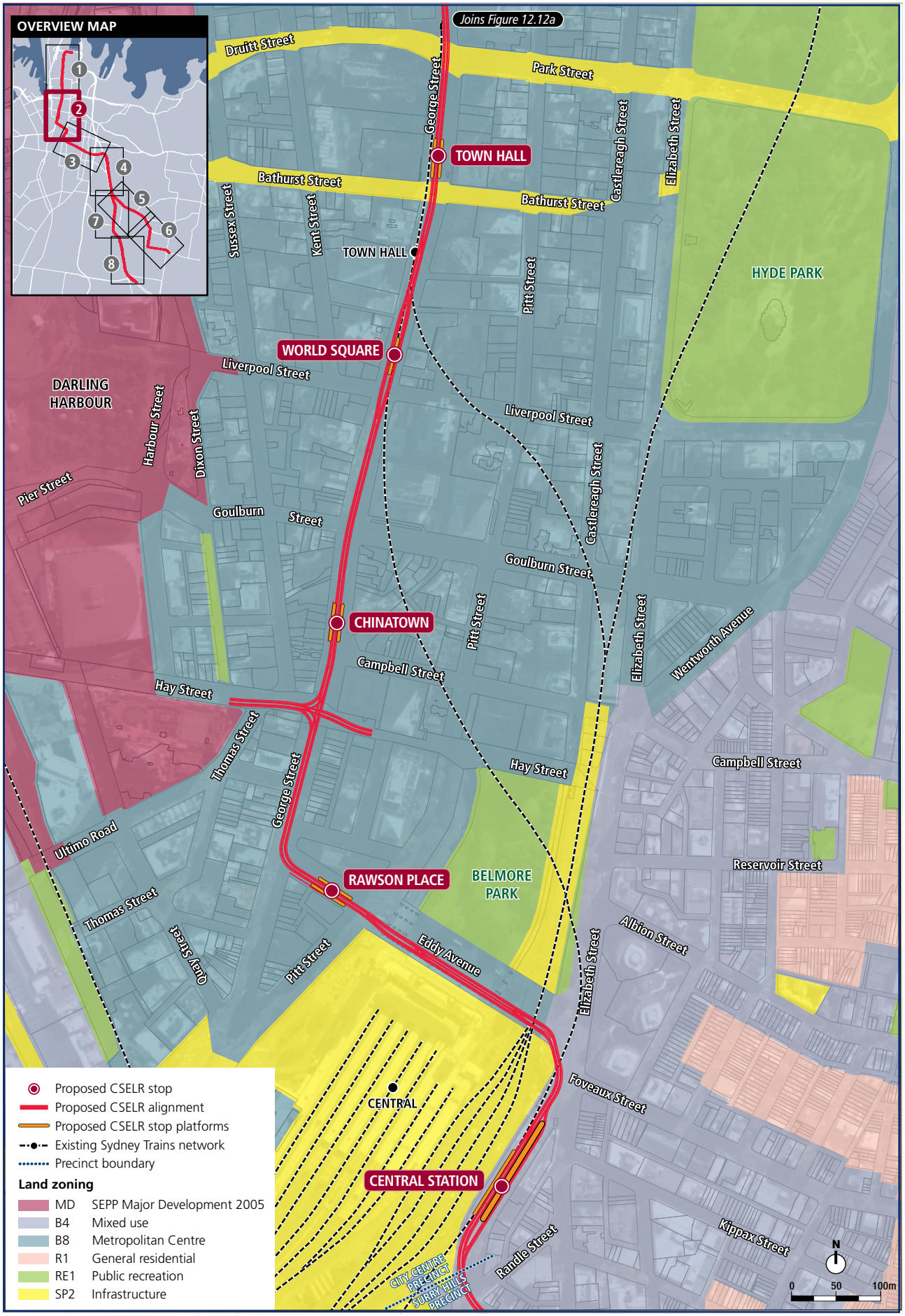


Figure 12.12b City Centre Precinct – Existing land use zoning



Potential future land uses within the vicinity of the proposal

An overview of the planned future development in the wider Sydney region is described in Chapter 9. As shown in Figure 9.15, a series of future urban land uses have been identified within the vicinity of the City Centre Precinct. The major developments that are currently underway or are proposed to be developed that would impact on the existing land use within the City Centre Precinct are listed below and described further in the following sections:

- Barangaroo
- Wynyard Walk
- APDG Site commercial redevelopment
- Sydney International Convention, Exhibition and Entertainment Precinct
- UTS — City campus master plan
- Central Park
- Three City Squares
- Belmore Park master plan
- Central to Eveleigh redevelopment precinct.

Barangaroo

The Barangaroo development is a large-scale urban development of the former Darling Harbour east area located along the harbour between King Street Wharf and Walsh Bay. The Barangaroo redevelopment site covers an area of about 22 hectares of disused container wharves on the western side of the Sydney CBD. The site is owned by the NSW Government and managed by the Barangaroo Delivery Authority (BDA). Development of the site is valued at over $6 billion and will transform the existing site through the provision of new parkland, residential and commercial developments. The site has been divided into three distinct zones which are:

- *Barangaroo south* — This 7.5 hectare extension of the Sydney CBD will incorporate high-rise retail, corporate offices and housing. This area of the site is currently under development in partnership with Lend Lease. The first building is scheduled for completion in 2015, with full completion of this zone by 2020. This zone is proposed to include a 6-star hotel, some 800 apartments, 320,000 square metres of office space, and up to 33,000 square metres of mixed retail and leisure.
- *Barangaroo central* — The development brief for this zone is currently being progressed with public consultation commencing in April 2013. It is expected this zone will include low-rise residential, commercial and civic buildings.
- *Headland Park (Barangaroo north)* — Landscaped with parklands and pedestrian pathways, this zone would provide a new parkland of approximately six hectares and would include a cultural centre and approximately 300 underground car parking spaces. This zone of the development is scheduled to be completed by 2015.

Residential, retail and commercial buildings for the overall development site are anticipated to cater for up to 23,000 workers and 2000 residents.

Wynyard Walk

Wynyard Walk is a new, underground pedestrian link from Wynyard Station to Barangaroo, passing under the intersection of Kent Street to Napoleon Street. Key features of Wynyard Walk include:

- a new western entrance to Wynyard Station (Clarence Street portal) to provide direct access to Wynyard Walk, the Kent Street tunnel and the station concourse
- a new 3.5 metre high by nine metre wide underground pedestrian link from Wynyard Railway Station to the intersection of Kent and Napoleon streets (approximately 180 metres long)
- a new paved pedestrian plaza at the intersection of Kent and Napoleon streets that will include landscaping, street furniture, lighting and public art
- a pedestrian bridge over Sussex Street, with lifts and escalators connecting to the Barangaroo development.

Wynyard Walk is designed to have capacity for approximately 20,000 pedestrians per hour and to cater for pedestrian movements between Barangaroo and Wynyard Railway Station. Major work on the Wynyard Walk project commenced in late 2012. Wynyard Walk is expected to be completed and opened in late 2015.

APDG site commercial redevelopment

The APDG site commercial development comprises the redevelopment of an existing commercial building block bounded by Alfred Street, Pitt Street, Dalley Street and George Street at Circular Quay. The redevelopment includes the demolition of existing buildings and redevelopment of new commercial, residential and retail towers with improved connections through the site and public domain improvements.

The APDG site commercial redevelopment has already commenced construction and the timing of the remaining development and completion is currently unknown.

Sydney International Convention, Exhibition and Entertainment Precinct (SICEEP)

Darling Harbour was initially developed as a tourist destination as part of NSW's bicentennial celebrations. The area is now a major tourist destination, providing restaurants, shopping and night-time entertainment to the west of the CBD. The area is also home to the Sydney's Convention, Exhibition and Entertainment Centres. These facilities are proposed to be demolished and replaced by a new facility by 2016 as part of the wider Darling Harbour South Master Plan.

The redevelopment aims to create an integrated entertainment facility in the heart of Sydney with additional commercial, retail, hotel and residential floor space. The new International Convention Centre Sydney would compete more effectively in the global convention and exhibition market, further enliven the southern part of Darling Harbour and improve linkages with surrounding areas, especially Chinatown.

The redevelopment of the SICEEP is proposed to include:

- a 40,000 square metre exhibition space
- over 8,000 square metres of meeting rooms space
- convention space capacity for more than 12,000 people
- a ballroom capable of accommodating over 2,000 people
- an entertainment facility with a capacity of 8,000 persons
- up to 900 hotel rooms in a hotel complex to be located at the northern end of the precinct
- an outdoor event space for up to 27,000 people at an expanded Tumbalong Park.

The scheduled completion date for core cultural facilities is 2016, with the remaining retail, commercial, hotel and residential development expected to be completed by 2021.

UTS – City Campus Master Plan

The UTS is currently undertaking a $1 billion investment and redevelopment program of the UTS city campus. The redevelopment of the university commenced in 2008. The City Campus Master Plan proposes the creation of a series of new buildings, major upgrades to existing campus buildings and improved pedestrian connections and open spaces. To date, a number of redevelopments have been completed, including extensions and upgrades to three campus buildings, a new sports facility and a new housing development for up to 720 students.

Three new faculty buildings and extensions to several existing buildings are also proposed to be completed in the future. Planning for the final phases of the City Campus Master Plan has commenced. The final completion date is anticipated to be between late 2018 and early 2019.

Central Park

The Central Park development occupies approximately six hectares of the former Carlton and United Brewery site on Broadway to the south-west of the Sydney CBD. The development is proposed to provide a range of residential accommodation in addition to some commercial office space, shops and cafés. The development proposal comprises a range of retail and commercial office facilities and approximately 2,000 apartments. In addition to the residential and commercial aspects of the redevelopment, the plan provides for a series of new parks, community facilities and improvements to city infrastructure.

The first stage of this development is currently underway and is anticipated to be completed in late 2013. This will provide for two residential towers and deliver approximately 600 apartments in addition to approximately 14,000 square metres of retail space. The final stages of the development are anticipated to be completed between late 2013 and mid-2014.

Three City Squares

The City of Sydney's *Sustainable Sydney 2030: The Vision* (City of Sydney 2008) identifies as one of its 10 project ideas, the 'three city squares' concept. This concept would utilise the current north-south 'central spine' of George Street to prioritise movements for public transport, cyclists and pedestrians, linking city squares at Circular Quay, Town Hall and Central Railway Stations. The 'city squares' would provide opportunities for activity, service and civic hubs for the City Centre Precinct communities of residents, workers and visitors. The linked city squares would also provide opportunities for active public spaces for large public gatherings and celebrations.

Belmore Park master plan

The City of Sydney is currently in the process of finalising a draft master plan for Belmore Park (not yet released). The Master Plan has been prepared to create a future vision of the park and its surrounding area to guide future development and upgrade to the park. The Master Plan is being developed with consideration to a number of wider strategic documents including the *Sydney 2030 Vision* (City of Sydney 2008), the *Draft New South Wales Long Term Transport Master Plan* (NSW Government 2012a) and *Sydney's Light Rail Future* (NSW Government 2012b).

The Belmore Park Master Plan identifies that the expanded light rail network would further increase the importance of Belmore Park as a legible and easily navigable urban space linking the Central Station precinct and wider CBD. The Belmore Park Master Plan presents the opportunity to ensure Belmore Park not only addresses current access issues with the park but becomes an integral part of the Central Station transport interchange precinct, providing good access between the park and public transport services.

Consultation between Transport for NSW and the City of Sydney would continue to be undertaken during the refinement of the CSELR design to allow for appropriate integration of the proposed light rail with the proposed revitalisation of Belmore Park.

Central to Eveleigh redevelopment precinct

On 12 July 2013, the NSW Government announced a new strategy to extend the Sydney CBD beyond its existing southern boundary identifying a new urban renewal site to the south of Central Railway Station along the Central to Eveleigh rail corridor. The identified Central to Eveleigh corridor would present a major urban renewal opportunity for the Sydney CBD. The strategy identifies that the renewal potential of the three kilometre long corridor could accommodate over one million square metres of new floorspace with opportunities to create improved public domain and cross city links between the south-eastern and south-western CBD precincts.

The renewal of the corridor would provide opportunities for the following land uses:

- high density housing and employment
- major international and domestic tourism investment, including hotel development
- expansion of tertiary education facilities including the University of Sydney and UTS
- integrated transport, commercial and residential developments.

The NSW Government is proposing to release an expression of interest in late 2013 for the concept plan development of the site. Timing for the overall redevelopment of the site is within 15 to 20 years.

Circular Quay Strategic Framework – Stage 1 Report

In collaboration with various government agencies and other private sector groups, the Sydney Harbour Foreshore Authority is currently finalising a Strategic Framework for the future of Circular Quay. The Circular Quay Strategic Framework will aim to provide a strong direction for the future development of the Circular Quay precinct, and will include guidelines for public and private projects as well as physical, functional, commercial, cultural and environmental principles.

The Strategic Framework for Circular Quay is anticipated to include 38 current or planned government projects in the area between the Sydney Opera House forecourt and Dawes Point Park under the Sydney Harbour Bridge. Eight guiding principles will be established to guide development projects, to be applied across the Circular Quay precinct. The Strategic Framework will identify nine key priorities, that, 'when delivered in an ordered manner alongside the current commitments, can significantly improve the precinct'. This will include several public domain priorities including the 'de-cluttering of the precinct to minimise the infrastructure footprint' (Priority 3). Section 4 of the strategic framework will also identify the 'Priorities for Action', which include the CSELR proposal.

The CSELR has considered the relevant aspects of the Strategic Framework, including the appropriate location of stops within the Circular Quay precinct (including integration with existing facilities such as access to the overseas passenger terminal), minimising the overall infrastructure footprint, protection of view corridors, removing and reducing visual clutter and avoiding barriers.

Transport for NSW would continue to review the proposal during detailed design, with the aim of continuing to meet the aims and priorities of the Strategic Framework

12.4.2 Impacts during operation

Direct operational impacts on land use and property

The permanent footprint of the CSELR proposal would be largely within the existing road corridor along Alfred Street, George Street, Rawson Place/Eddy Avenue and Chalmers Street. Whilst the CSELR proposal would result in a change to the type of transport use along these streets (i.e. typically cars and buses), the current land use would generally be maintained as a transport corridor. Some permanent changes to existing accesses to local properties would also occur as part of the CSELR proposal. These changes are detailed in section 12.3.2.

As identified in section 5.3 and on Figure 12.7a and Figure 12.7b, some portions of land would be required to be permanently acquired as a result of the proposal. For the City Centre Precinct, these comprise:

- an easement covering a small portion of land adjacent to Harrington Street which would be required to accommodate the proposed Circular Quay substation
- an easement towards the western end of Martin Place to accommodate the proposed Martin Place substation, which would be located below ground (Existing pedestrian access through Martin Place would not be affected.)
- an easement covering a small portion of land within Parker Lane which would be required to accommodate the proposed substation near the Chinatown stop
- three small portions of land owned by Sydney Trains on Elizabeth Street, Eddy Avenue and Chalmers Street (near Devonshire Street) to accommodate the light rail corridor, the proposed Central Station stop, Eddy Avenue turnouts and the Chalmers Street substation. The location of the proposal in this location would result in the loss of a small area of existing pedestrian footpath on the eastern side of Central Railway Station.

No property severance impacts are anticipated to occur within the City Centre Precinct and access to existing services from the surrounding area is not anticipated to be impacted by the proposal.

Land use integration and amenity during operation

The proposal is anticipated to result in a mixture of both positive and potentially adverse land use and amenity impacts within the City Centre Precinct.

Changes to the traffic movement regime within the CBD, primarily as a result of the pedestrianisation of George Street between Hunter Street and Bathurst Street, could potentially result in changes to the mix of activities undertaken within this area in the long term. The pedestrian zone would have positive effects on amenity associated with the removal of general traffic, which would lead to a noticeable reduction in noise and vehicle emissions and a reduction in vehicle and pedestrian accidents (refer to section 12.5 and section 12.9, respectively). These amenity improvements would allow opportunities for potential changes in the mix of activities at

the ground floor level of existing buildings. Opportunities would include the potential increase and redevelopment of retail shops, cafes, restaurants and increased night-time activities, assisting with activation of the City Centre outside of normal business hours. In addition, stop locations outside of the pedestrian zone would provide potential for change in the mix of street level activities at these locations, including smaller retail-type developments.

The provision of a new major transport facility along the 'central spine' of the CBD would provide potential for a greater diversity of retail and commercial activity and redevelopment throughout the precinct in the long term, by providing access for businesses to a potentially larger customer base (refer to section 12.9). This development potential may be limited in the short-term due to the physical design of many buildings; however, as noted previously (section 12.4.1), current land use zoning within the precinct allows for a range of increased density developments, in particular around stop locations towards the southern end of the City Centre Precinct.

Operation of the CSELR proposal would potentially adversely affect the amenity of some adjoining land uses due to noise from light rail operations (although this is anticipated to be limited due to existing background noise levels) and potential visual intrusion of the LRVs, stops and associated infrastructure including overhead wiring (outside of the proposed wire-free zone); however, the CSELR is generally anticipated to provide a positive benefit to amenity in the City Centre Precinct due to the overall reduction in traffic along George Street.

The proposed changes to traffic movements within the CBD could also potentially result in adverse amenity effects in adjacent areas, including increased traffic volumes and noise impacts on the adjoining street network. These impacts are discussed and assessed in greater detail in sections 12.3 and section 12.5 respectively.

Operational impacts on future land uses and developments

A number of future transport and development sites have been identified along the corridor of the proposal (refer to section 12.4.1). Each of these sites is currently at a different stage of planning development assessment and may be affected by, or impact upon, the CSELR proposal. Operation of the CSELR proposal is anticipated to influence these future land uses by:

- encouraging and facilitating increased intensity of land use in the vicinity of each of the stops, including retail, commercial and high density residential development that would benefit from increased residential and employment populations able to utilise the light rail network
- encouraging ongoing refinement of planning controls that allow for increased population densities to meet the NSW Government requirements for urban consolidation around transit-orientated developments
- encouraging increased public transport use by providing a series of opportunities for transport interchanges throughout the precinct with existing transport options including the Sydney Trains network and the Sydney Ferries network
- providing the opportunity for workers and residents to access the urban renewal sites that are currently being developed (such as Barangaroo or Central Park), assisting and/or improving the ongoing viability of these developments.

Overall, the proposal is also anticipated to integrate positively with the identified urban renewal and urban development projects that were identified in section 12.4.1 by providing a public transport facility that can meet the needs of the anticipated residential and employment populations these developments are planned to generate.

All future developments along the CSELR proposal corridor that have not yet commenced, and in particular developments proposed for sensitive land uses, would be required to consider the potential impacts of the proposal on that development and the potential impacts of that development on the CSELR proposal.

12.4.3 Impacts during construction

Direct construction impacts on land use and property

Construction of the proposal would require the temporary use of land outside of the permanent CSELR proposal footprint, but within the identified construction footprint (as identified in Chapter 6 and Figures 6.2a to 6.2h) for a range of activities. Within the City Centre Precinct, the areas of temporary land take for proposed construction compound sites would comprise:

- temporary site compounds in Circular Quay, First Fleet Park and Belmore Park
- construction of pedestrian crossings to light rail stops, which would impact on the existing pedestrian footpaths in these locations
- construction of the proposed substations at Circular Quay, Martin Place, Parker Lane and Chalmers Street.

The location of these temporary land uses are shown on Figures 12.7a and Figure 12.7b. The use of these sites would be subject to consultation with the owner of these sites including City of Sydney and private land owners as required.

Amenity impacts on existing land uses during construction

The proposed worksite along the length of the CSELR alignment along George Street, Rawson Place, Eddy Avenue and Chalmers Street, in addition to the proposed construction compounds located in Circular Quay, First Fleet Park and Belmore Park, would affect the amenity of adjoining land uses within the City Centre Precinct throughout the construction period. The effects would result from a combination of the local impacts of construction noise, dust, general disturbance and disruption to access arrangements to properties affected by the construction activities. This would have an adverse effect on those businesses that rely heavily on pedestrian traffic (retail outlets, cafes, tourist shops) and open space areas such as Circular Quay, First Fleet Park or Belmore Park. Residential land uses would also experience disturbance from construction activities, particularly those undertaken at night (where required).

Although amenity within the City Centre Precinct would be affected, this is unlikely to influence land use changes in the short or long-term. The construction sequencing for the works within the City Centre Precinct outlined in Chapter 6 would also provide opportunities to undertake potentially intrusive construction activities (such as activities that generate a substantial amount of noise) during appropriate times of the day to minimise impacts to surrounding land uses.

A number of potentially sensitive land uses within the CBD may also be impacted by the CSELR proposal. These include child care centres, medical centres, churches and education centres. Further detail regarding the potential amenity impacts resulting from the construction of the CSELR proposal are discussed as part of the noise assessment and socio-economic assessment of the City Centre Precinct in section 12.5 and section 12.9 respectively.

12.4.4 Management and mitigation

To minimise the land use and property impacts of the CSELR proposal within the City Centre Precinct, consultation would occur with the surrounding businesses, the community and commuters to advise them in advance of proposed works and any temporary access arrangements that may be required.

Consultation would also be undertaken with other agencies such as the City of Sydney, utilities providers and other potential stakeholders (such as stakeholders associated with future developments within the vicinity of the CSELR proposal) prior to and throughout construction of the proposal to identify mitigation measures to identify potential conflicts, and opportunities for minimising impacts to existing land uses.

The overall construction footprint would be refined during detailed design to identify areas where the CSELR proposal footprint can be minimised to reduce impacts on existing land uses. Detailed staging of the proposal would also be determined during detailed design and would aim to minimise the time that affected land uses are impacted during construction.

12.5 Noise and vibration

Technical Paper 11 — *Noise and Vibration Impact Assessment* in Volume 6 of the EIS includes a full noise and vibration assessment of the CSELR proposal, prepared by SLR. This section provides a summary of the findings of this assessment in relation to the City Centre Precinct.

12.5.1 Existing noise conditions

The primary influence on the existing ambient noise environment within the City Centre Precinct is road traffic noise; although the general urban 'hum' from mechanical plant and pedestrian activities are also key influences. There are also a number of major construction worksites in operation in the CBD, including at the Barangaroo and Central Park developments. Existing noise levels are generally higher in the CBD than in the surrounding suburbs, particularly in the evening and night-time periods.

To outline the existing noise environment and determine likely impacts, noise catchment areas (NCAs) were defined. Figures 12.13a and 12.13b summarise the extent of NCAs considered for the City Centre Precinct, as well as noise monitoring locations (BG01, BG02 and BG12).

The City Centre Precinct includes three NCAs as shown in Figure 12.13a and Figure 12.13b. Noise and vibration sensitive receptors within the City Centre Precinct include residences (including hotels, hostels and apartments); commercial premises; and numerous other special uses such as childcare centres, places of worship, cinemas and theatres, museums, libraries, parks, education facilities/schools, recording studios and medical centres. A list of these receptors is presented in Table 3 of Technical Paper 11.

Table 12.20 presents results of the background (unattended) noise monitoring at locations BG01, BG02 and BG12. The background monitoring results are presented in the form of the Rating Background Level (RBL) and average (L_{Aeq}) noise levels for the day, evening and night-time periods. These noise levels display a diurnal trend, with noise levels at night lower than during the day and evening periods. However, the City Centre Precinct has a less marked diurnal trend than other areas of the alignment. In George Street in particular, average noise levels in the evening only decrease from daytime levels by 1–2 dB before 10 pm. Also during the night-time, average noise levels are up to 68 dBA.

Table 12.20 Unattended noise monitoring results – City Centre Precinct

NOISE MONITORING LOCATION (REFER FIGURES 12.13A AND 12.13B)	NOISE LEVEL (dBA)[1]					
	DAYTIME (7AM TO 6PM)		EVENING (6PM TO 10PM)		NIGHT-TIME (10PM TO 7AM)	
	RBL	L_{Aeq}	RBL	L_{Aeq}	RBL	L_{Aeq}
BG01 (Four Seasons Hotel)	63	69	62	67	57	65
BG02 (Hilton Hotel)	64	73	62	71	56	68
BG 12 (812 George Street)	58	70	56	69	52	66

Source: *Table 5 in Technical Paper 11 – Noise and Vibration Impact Assessment, Volume 6*

Note: *dBA = A-weighted decibels*

Attended monitoring at BG01 and BG02 was also undertaken to measure the noise sources that influence the existing noise environment. The results of the attended monitoring confirmed the influence of road traffic noise, buses, trains, construction works, café and pedestrian noise sources within the City Centre Precinct. The highest maximum noise levels (L_{Amax}) were observed for brake and horn noise from buses (up to 96 dBA), sirens (up to 95 dBA) and road traffic (up to 91 dBA).

12.5.2 Impacts during operation

Potential noise and vibration impacts in the City Centre Precinct were assessed in relation to the following:

- airborne operational noise (i.e. audible noise generated through the normal operation of the CSELR)
- operational vibration (i.e. vibration caused through the normal operation of the CSELR)
- ground-borne operational noise (i.e. low frequency noise causing vibration of building walls or other structures, heard as a low rumbling)
- operational noise from substations and stops
- changes in road traffic noise.

These issues are discussed in turn in the following subsections.

Predicted airborne operational noise impacts

Airborne operational noise is noise that propagates through the air. It would be created by light rail operations on the surface track, originating from the wheel-rail interface, as well as operation of warning bells and auxiliaries such as air-conditioning units and power converters.

Noise from the operation of the light rail line has been assessed in accordance with guidance provided by the NSW Environment Protection Authority (EPA) in the *Rail Infrastructure Noise Policy* (RING) (EPA, 2013). To assess and manage potential noise from light rail proposals the guideline provides non-mandatory airborne noise triggers for residential and other sensitive receptors. Where rail noise levels are above the noise triggers the noise assessment is required to identify feasible and reasonable mitigation to achieve a desired objective of airborne noise within the trigger levels.

Noise from stops and electrical substations has been assessed in accordance with the *NSW Industrial Noise Policy* (INP) (EPA 2000) with guidance on sleep disturbance criteria taken from the online Application Notes to the INP.

Figure 12.13a City Centre Precinct (North): noise catchment areas and noise monitoring locations

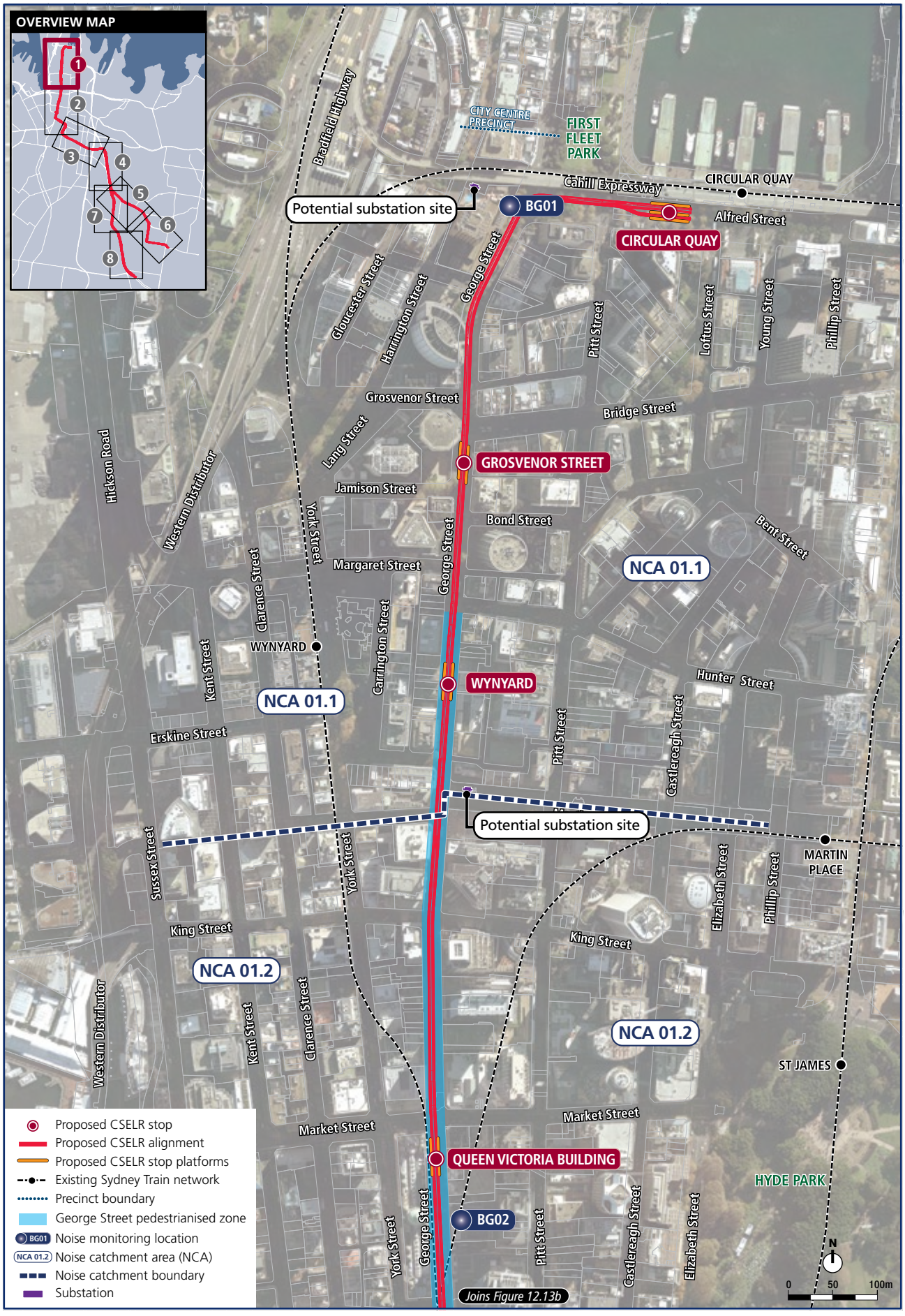
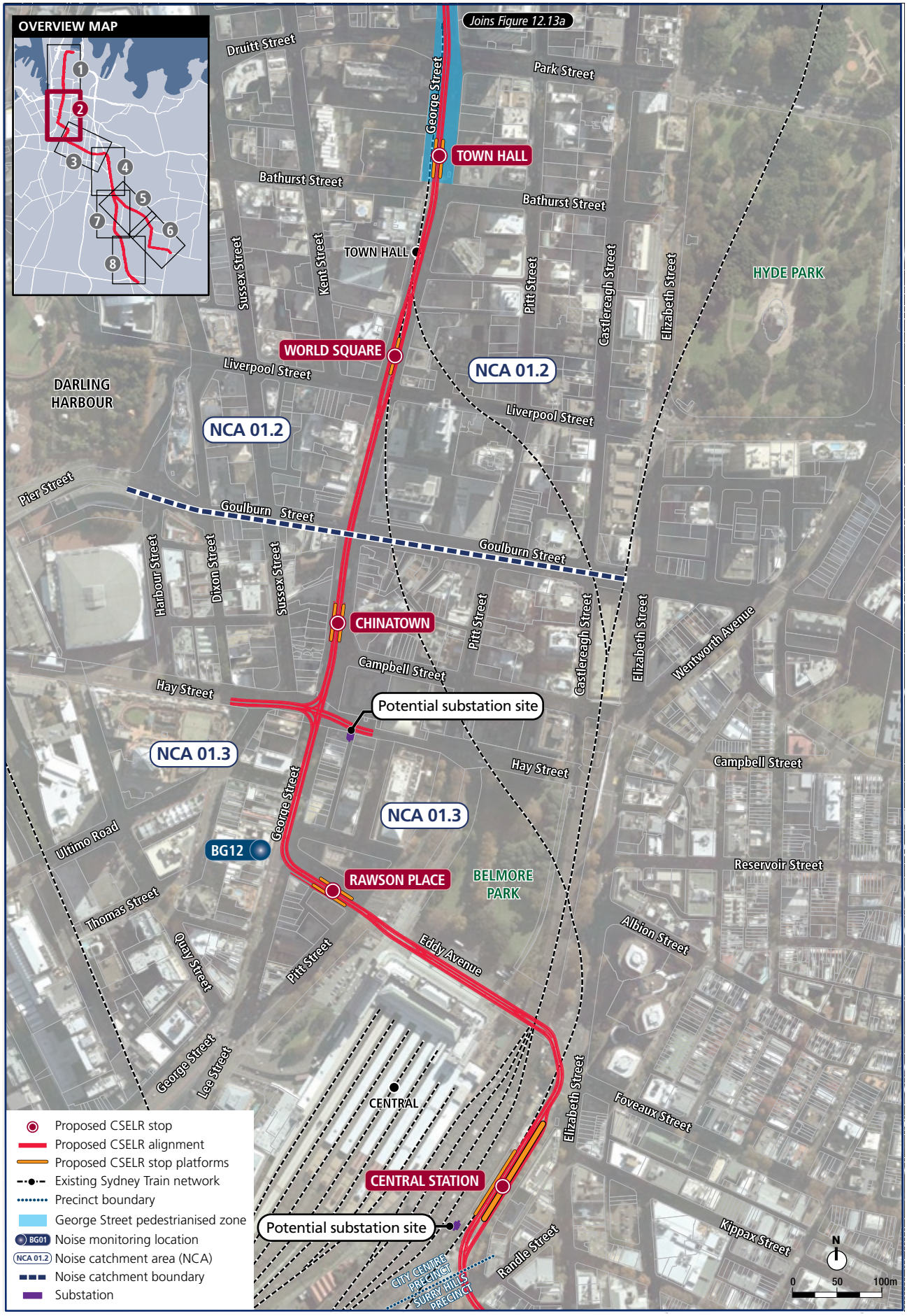


Figure 12.13b City Centre Precinct (South): noise catchment areas and noise monitoring locations



Residential receptors

Predicted noise levels at residential receptors in the City Centre Precinct that would experience the highest airborne noise levels during a regular daily service are summarised in Table 12.21 for the following two scenarios, without noise mitigation:

- 2021 scenario (at opening)
- 2036 scenario (future operations, 15 years after opening).

This table is intended to indicate worst-case noise levels at the facades of residential receptors nearest to the alignment. Where the receptor is a multi-storey building, the predicted noise levels are representative of the most affected storey. At all locations, the worst-case noise levels are due to the proximity of the alignment to adjacent receptors on straight sections of track between stops where the LRVs would be operating at their highest speeds.

The predicted noise levels demonstrate that night-time and maximum rail noise levels would not be expected to change between the at-opening 2021 and future 2036 operating scenarios. Furthermore, the daytime rail noise levels between 2021 and 2036 are predicted to increase by no more than 1 dB.

Where exceedances of the average and maximum (L_{Aeq} and L_{Amax}) noise trigger levels under the applicable guideline (the RING, EPA 2013) are predicted, they are indicated in Table 12.21 in bold.

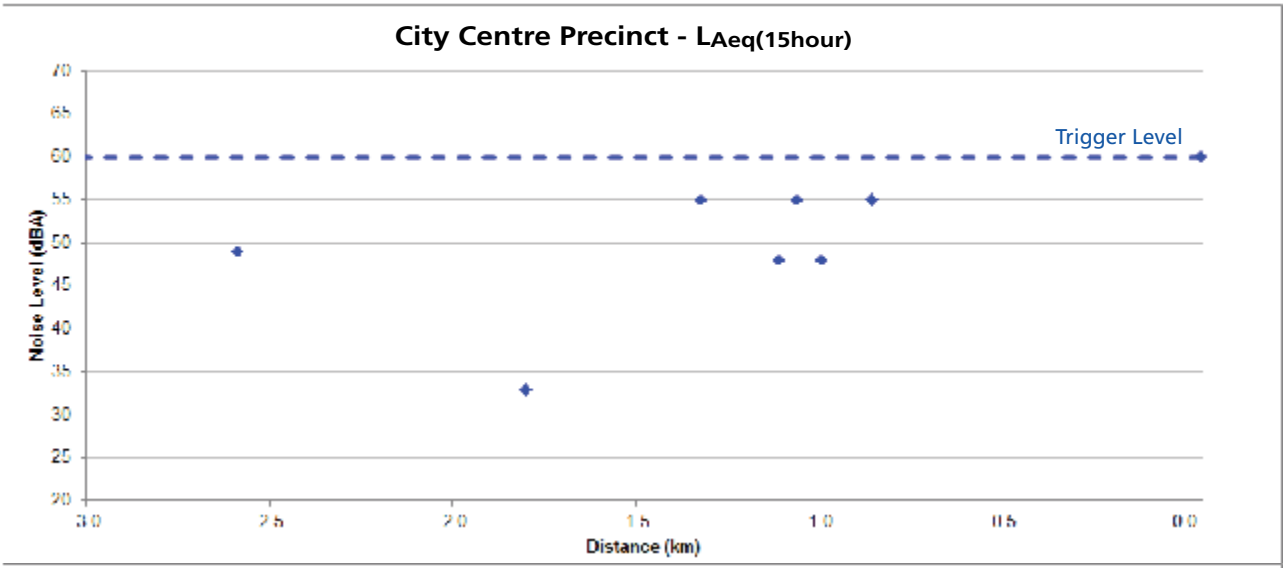
Table 12.21 Predicted worst-case airborne operational noise levels at residential receptors – without mitigation (City Centre Precinct)

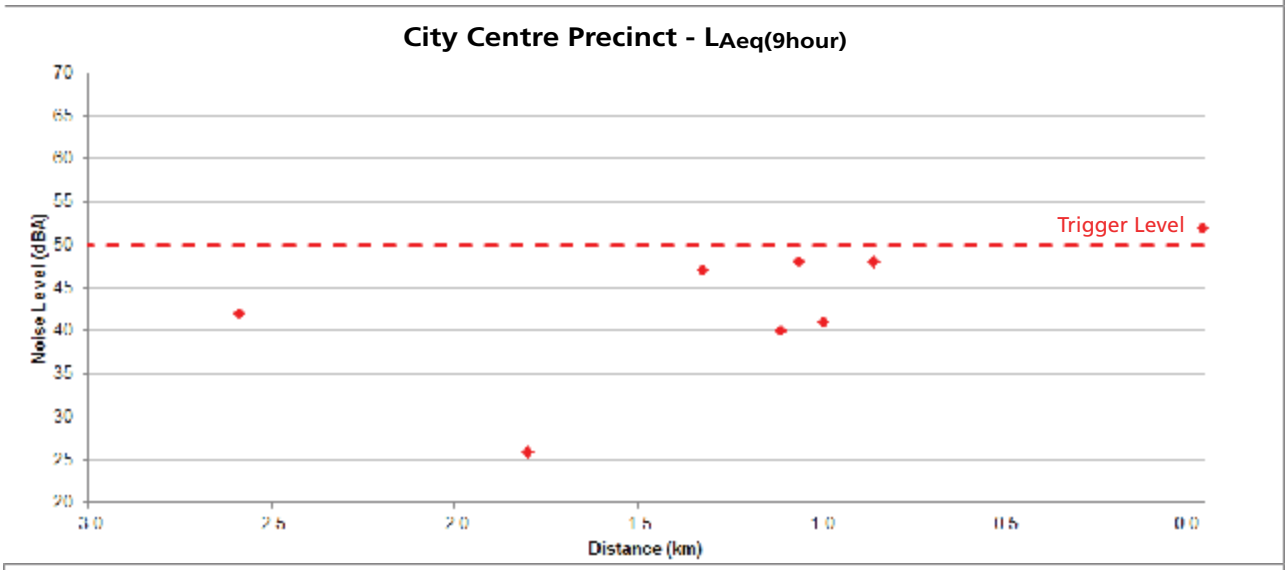
NCA (REFER FIGURES 12.13A AND 12.13B)	WORST-CASE PREDICTED NOISE LEVEL (dBA)					
	2021 AT-OPENING SCENARIO			2036 FUTURE SCENARIO		
	DAYTIME $L_{Aeq(15hr)}$	NIGHT-TIME $L_{Aeq(9hr)}$	L_{Amax}	DAYTIME $L_{Aeq(15hr)}$	NIGHT-TIME $L_{Aeq(9hr)}$	L_{Amax}
RING trigger level (dBA)	60	50	80	60	50	80
NCA01.1	49	42	70	49	42	70
NCA01.2	55	48	72	55	48	72
NCA01.3	59	52	77	60	52	77

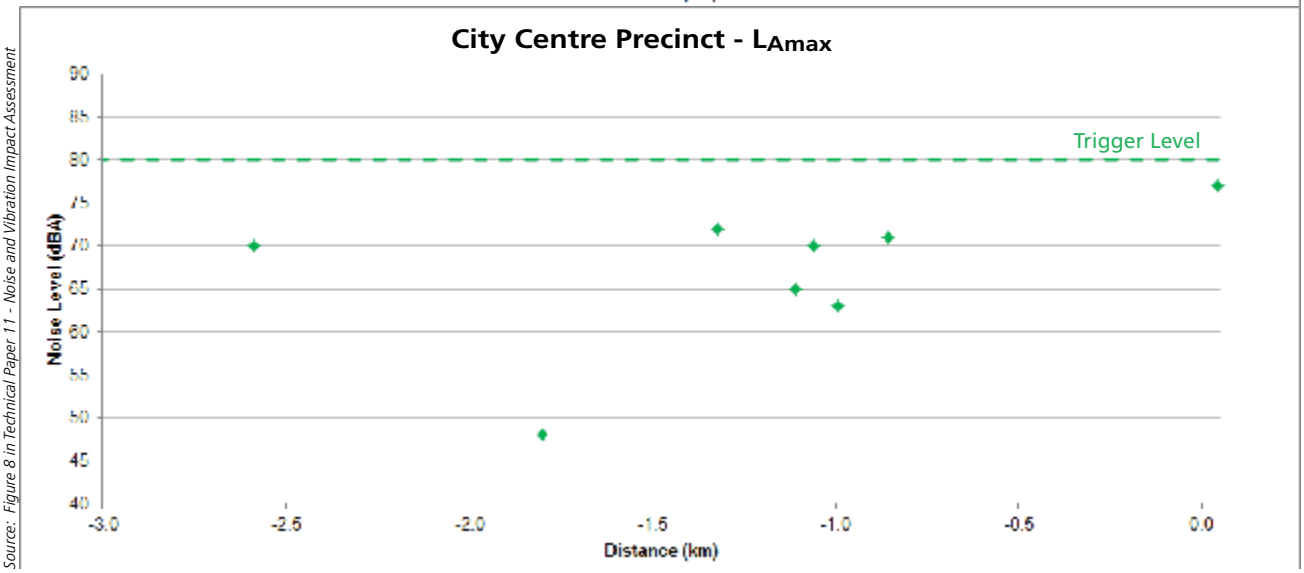
Source: Table 12 in Technical Paper 11 – Noise and Vibration Impact Assessment, Volume 6

These results are shown graphically for the 2036 future scenario in Figure 12.14, where the dashed line indicates the applicable noise trigger level and the dots represent individual residential receptors. The distance is measured in kilometres along the proposed CSELR alignment from Central Railway Station. More detailed noise contour plots for the 2036 future scenario are included in Appendix D of Technical Paper 11 in Volume 6.

Figure 12.14 Plots of predicted residential operational airborne noise for the 2036 future scenario (without mitigation)







Source: Figure 8 in Technical Paper 11 - Noise and Vibration Impact Assessment

As indicated in Table 12.21 and Figure 12.14 above, air-borne operational noise is predicted to comply with the RING trigger levels at all except one of the assessed residential receptors in the City Centre Precinct. The affected receptor is identified as a residential apartment block on Chalmers Street.

In the 2036 future scenario, operational L_{Aeq} noise levels at the residential apartment block on Chalmers Street are predicted to be up to 59 dBA and 52 dBA during the daytime and night-time, respectively. Daytime noise levels comply with the noise trigger level but night-time noise levels exceed the night-time noise trigger level by up to 2 dB. No exceedance of the L_{Amax} trigger level is predicted.

The background monitoring indicated that existing noise levels in this area are above the predicted light rail noise contribution, with existing average (L_{Aeq}) daytime, evening and night-time noise levels of 63 dBA, 62 dBA and 59 dBA, respectively. Existing maximum noise levels associated with road traffic movements are also above the predicted light rail maximum noise levels. Given that the exceedance predicted is 2 dBA and the predicted light rail noise contribution is likely to be below the existing noise levels, acceptance of this isolated exceedance is recommended.

Other noise sensitive receptors

Noise levels were also predicted for all other identified noise sensitive receptor locations adjacent to the proposed CSELR alignment in the precinct. For the majority of the City Centre Precinct receptors, compliance with the relevant external noise trigger levels was predicted. Those locations where the predicted noise levels exceed the adopted trigger levels (without mitigation) are summarised in Table 12.22. The predicted exceedances of the noise trigger levels are shown in bold.

Table 12.22 Predicted airborne operational noise trigger level exceedances at other sensitive receptors – without mitigation (City Centre Precinct)

SENSITIVE RECEPTOR	TYPE	EXTERNAL NOISE TRIGGER LEVEL (dBA)	MAXIMUM PREDICTED NOISE LEVEL (dBA)	
			2021 AT-OPENING SCENARIO	2036 FUTURE SCENARIO
		$L_{Aeq(1hr)}$	$L_{Aeq(1hr)}$	$L_{Aeq(1hr)}$
Event Cinemas	Cinema	55	**59**	**59**
Metro Theatre	Theatre/Auditorium	50	**59**	**59**
Haymarket Library	Library	60	**62**	**62**

Source: *Table 14 in Technical Paper 11 – Noise and Vibration Impact Assessment, Volume 6*

Note : *Noise levels at all other sensitive receptors (non-residential) are predicted to comply with the noise goals.*

In all cases, the existing ambient noise levels are likely to be similar to or higher than the predicted light rail noise levels.

Special event services

Special event services would not be expected to cause operational noise impacts within the City Centre Precinct, as services would run between the Central Station stop and either Moore Park or the Royal Randwick racecourse.

Light rail noise within the existing environment

Based on the baseline noise survey and the current road transport adjacent to the CSELR alignment, the existing noise in the City Centre Precinct is typically already above the predicted average and maximum light rail noise levels. Whilst the CSELR would introduce a new noise source to the environment, the potential noise impacts would be limited to whether the light rail noise would be audible above road traffic noise and other localised noise sources.

The RING noise trigger levels take into account that existing roadways can be turned into light rail routes. Consequently, where the CSELR is designed and operated to comply with the RING, the proposal is considered to be managing light rail noise to:

- preserve the long-term amenity at receptors adjacent to an existing transportation corridor
- minimise the potential influence of CSELR on total transportation noise.

Further discussion on changes in road traffic noise with the CSELR, is provided in below (refer to the sub-section entitled changes in operational road traffic noise).

Noise from warning bells

LRVs are fitted with warning bells. For the CSELR, the warning bells would only be used in the event of emergencies or where the driver considers there is a danger to public safety. Warning bells would not form part of normal rail operations (i.e. they would not be used on approach or departure from stations, or at level crossings). The RING does not require assessment of warning bells where their use is infrequent and only in emergency situations.

Notwithstanding this, warning bells are directional and can give rise to maximum noise levels up to 77 dBA at 10 metres immediately in front of the LRV. At locations to the side of the LRV the maximum noise levels would generally be less than 70 dBA.

Whilst the noise from warning bells is distinctive in character and is likely to be noticeable at receptors in locations immediately adjacent to where a bell is sounded, the infrequent use of warning bells would most likely result in negligible noise impacts.

Predicted operational vibration impacts

Operational vibration from the CSELR proposal was assessed in relation to the human disturbance criteria in *Assessing Vibration: a technical guideline* (Department of Environment and Conservation (DEC) 2006). Where vibration levels are within the human disturbance criteria they would also comply with criteria for limiting damage to buildings and structures. Additional assessment was undertaken in relation to potential impacts on vibration sensitive equipment.

Indicative predictions of vibration dose value (VDV) are detailed for each precinct in Technical Paper 11 (refer Table 19). No exceedances of the human comfort VDV criteria were predicted adjacent to the CSELR alignment. For the City Centre Precinct, the maximum VDV is estimated to be 0.03 metres per second$^{1.75}$, which is well below the VDV criterion of 0.1 metres per second$^{1.75}$.

One potential exceedance of the 82 dBV screening criterion for potential vibration sensitive equipment was predicted at the Sydney Dental Hospital in the City Centre Precinct as shown in Table 12.23 below.

The property owners would be consulted further during the detailed design phase of the proposal to confirm if this site contains vibration-sensitive equipment, and the form of mitigation required to avoid vibration impacts (refer mitigation discussion in section 12.5.4).

Table 12.23 City Centre Precinct – potential exceedances of screening criteria for vibration sensitive equipment

ADDRESS	DESCRIPTION	MAXIMUM 1/3 OCTAVE BAND FACADE VIBRATION LEVEL (dB RE 10^{-9} METRES PER SECOND)
2 Chalmers Street, Surry Hills	Sydney Dental Hospital	95

Source: *Table 20 in Technical Paper 11 – Noise and Vibration Impact Assessment, Volume 6*

Predicted operational ground-borne noise impacts

Ground-borne operational noise would result from the transmission of vibration from LRV wheel/rail interaction from the track via the ground. In some circumstances, this vibration energy may be transmitted into building structures and cause floors and/or walls to faintly vibrate and re-radiate the energy as airborne noise. This noise has a low frequency rumbling characteristic of train passbys. It is most commonly of concern in railway tunnel situations where there is an absence of airborne noise to mask the ground-borne noise emissions.

In comparison to conventional heavy rail or underground rail projects, ground-borne noise is less of an issue for light rail projects as the LRVs generally operate on the surface at lower speeds than heavy rail systems. The RING states that ground-borne noise levels are relevant only where they are predicted to be higher than the airborne noise from railways, and where the levels are expected to be audible within habitable rooms.

The CSELR alignment in the City Centre Precinct would be on or adjacent to existing roads which, along with airborne noise from the LRVs, are expected to generate airborne noise that would be higher than ground-borne noise at many receptors. In the George Street pedestrian zone, light rail speeds would be lower (maximum of 20 kilometres per hour), which would also minimise potential ground-borne noise.

Where necessary, ground-borne noise can be controlled by specifying trackforms that incorporate vibration-isolating components. In the City Centre Precinct, the assessment assumed standard trackform would be used through the majority of the pedestrian zone along George Street where speeds would be low. It would also probably be used in Eddy Avenue at Central Station where there are no particularly sensitive receptors. High-resilience trackform was assumed in other areas of the City Centre where sensitive receptors line the route. The high density of receptors in the CBD means that ground-borne noise may be masked in the front room of buildings, but may be noticeable in rooms set back from the facades.

Very high attenuation trackform may be required to control ground-borne noise at particularly sensitive receptors at the locations in Table 12.24. This would be assessed in more detail at detailed design stage, and mitigation confirmed in consultation with the owners of these facilities (as explained in section 12.5.4).

Table 12.24 Ground-borne noise sensitive receptors – City Centre Precinct

ADDRESS	DESCRIPTION	GROUND-BORNE NOISE LEVEL L_{ASmax}[1] (dBA) (CRITERION)[2]
505–525 George Street, Sydney	Event Cinemas	47 (35 dBA)
744 George Street, Sydney	Haymarket Library	46 (40–45 dBA)
624 George Street, Sydney	Metro Theatres	37 (NR25 or approximately 30 dBA)
13 Campbell Street, Haymarket	Capitol Theatres	39 (NR25 or approximately 30 dBA)
1–51 Foveaux Street, Surry Hills	Australian Institute of Music (AIM)	23 (NR15 or approximately 20 dBA)

Source: *Table 24 in Technical Paper 11 – Noise and Vibration Impact Assessment, Volume 6*

Note 1: *L_{ASmax} refers to the maximum noise level not exceeded for 95 per cent of rail pass-by events and is measured using the 'slow' response setting on a sound level metre*

Note 2: *Predicted noise levels include nominal 5 dB attenuation due to resilient track forms*

Noise from operation of substations

Up to four substations (for running LRVs) are proposed within the City Centre Precinct, as summarised in Table 12.25 below and shown on Figures 12.13a and 12.13b. Table 12.25 also indicates the associated noise sensitive receptors, controlling noise goals and predicted average noise levels from the substation operations.

The results confirm that the predicted noise levels comply with the applicable noise goals for the Circular Quay, Martin Place and Chalmers Street substations. A substation may be required at the Hay Street junction of the light rail to accommodate future interoperability with the Inner West Light Rail network. For this substation, an exceedance of the night-time amenity goal was predicted, due to the close proximity of the substation to the rear of the library building. The design of this substation (as with all substations) can and would need to comply with the identified controlling noise criteria.

Table 12.25 Predicted noise levels from substation operations – City Centre Precinct

SUBSTATION	RECEPTOR TYPE	OPERATIONAL NOISE (dBA)		COMMENTS
		L_{Aeq} CONTROLLING NOISE GOAL[1]	PREDICTED L_{Aeq} NOISE LEVEL	
Circular Quay	Residential	55	54	Complies with the noise goal
Martin Place	Commercial	65	<64	Complies. This substation is underground and hence noise impacts will be less than shown.
Hay Street	Other (Library)	60	63	Exceeds the noise goal – mitigation required
Chalmers Street	Residential	56	45	Complies with the noise goal

Source: *Table 41 in Technical Paper 11 – Noise and Vibration Impact Assessment, Volume 6*

Note 1: *Under NSW Industrial Noise Policy*

Operational noise at light rail stops

At the proposed light rail stops, the proposed public address (PA) systems would be the only notable operational noise source. The short-term nature of PA noise means that it is unlikely to contribute significantly to average (L_{Aeq}) noise levels at any location. In addition, the PA systems would include ambient noise sensing microphones to adjust the broadcast volume relative to the ambient noise level, preventing announcements at excessive volumes and reducing the volume at times when the background noise is low. For these reasons, the PA systems at stops can be designed to comply with the applicable INP intrusiveness and sleep disturbance noise criteria.

Notwithstanding likely compliance with the INP criteria, PA systems at stops have the potential to cause annoyance to nearby residents, depending on the frequency and time of day of announcements. Subjective noise impacts from PA systems at the Circular Quay to Rawson Place stops are likely to be minor, as the noise from PAs would become part of the urban noise environment. Residential receptors in the CBD area are located in multi-storey apartment buildings, with generally good noise attenuation across the facade. Generally, residents of the CBD are likely to be more used to higher levels of ambient noise than residents of more suburban areas. Notwithstanding this, there is potential for annoyance if the noise from PA systems is audible inside residences.

At the Central Station stop, residents would be familiar with noise from PA system announcements from the existing station. For this reason the subjective impact of noise from the light rail stop would be minimal.

Proposed mitigation to address the issue of subjective noise impacts from PA systems at the Circular Quay to Rawson Place stops is outlined in section 12.5.4.

Changes in operational road traffic noise

As described in section 5.2.7 and section 12.3.2, the CSELR proposal would result in some changes in road traffic flows in the City Centre, primarily as a result of pedestrianisation of part of George Street. This section summarises the potential change in operational road traffic noise as a consequence of the re-routing of traffic and other traffic modifications. The CSELR would be expected to increase road traffic noise in some areas where traffic is re-routed, but would decrease road traffic noise in other areas, including within the George Street pedestrian zone.

At locations where road traffic crosses the proposed light rail alignment, there is potential for a change in noise character due to impact noise associated with road vehicles crossing the discontinuity in the road surface. These intersection locations would generally require road traffic to be travelling at relatively low speeds. This factor, in conjunction with the embedded rail trackform, would minimise noise impacts as far as possible.

The noise impact of changes to bus routes and daily bus movements is outside the scope of this assessment, as explained in Chapter 1 (section 1.6).

The applicable guideline for the assessment of road traffic noise is the *NSW Road Noise Policy* (RNP) (Department of Environment, Climate Change and Water (DECCW) 2011), which notes that an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person. Where existing residences and other sensitive land uses are potentially affected by additional traffic on existing roads due to land use developments, any increase in the total traffic noise level should be limited to 2 dB above the corresponding 'no build option'.

Predicted increases in operational road traffic noise

In the City Centre Precinct, there are 20 locations where the potential increase in road noise levels as a consequence of the CSELR is greater than 2 dB in either the morning or evening peak, based on the change in traffic numbers and assuming no changes in speeds. These locations and the estimated increase in road traffic noise are shown in Table 12.26.

Table 12.26 Locations with potential noticeable increase in road traffic noise – City Centre Precinct

LOCATION	ESTIMATED CHANGE IN L_{Aeq} (dB) AM PEAK	ESTIMATED CHANGE IN L_{Aeq} (dB) PM PEAK
Castlereagh Street, between Market Street and King Street	2.6	2.0
Castlereagh Street, between Hosking Place and Hunter Street	2.0	-0.1
Hunter Street, between Castlereagh Street and Pitt Street	1.3	2.1
Bridge Street, between George Street and Bridge Lane	0.9	2.3
Pitt Street, between Bridge Street and Abercrombie Lane	0.3	2.7
Pitt Street, between Bond Street and Abercrombie Lane	1.5	3.9
Pitt Street, between Bond Street and Spring Street	2.0	0.9
Pitt Street, between Curtin Place and Hunter Street	2.6	2.6
Hunter Street, between Pitt Street and George Street	2.3	2.4
York Street, between Market Street and Mullins Street	3.0	3.1
York Street, between Market Street and King Street	3.2	1.5
Margaret Street, between York Street and Carrington Street	-1.5	2.5
Margaret Street, between Wynyard Lane and Carrington Street	-2.1	2.1
Margaret Street, between Wynyard Lane and George Street	-2.0	2.1
King Street, between York Street and Clarence Street	0.0	2.2
Clarence Street, between Druitt Street and Market Street	3.1	-0.4
Clarence Street, between Market Street and King Street	2.9	-0.2
Clarence Street, between King Street and Barrack Street	2.2	-0.1
Clarence Street, between Barrack Street and Erskine Street	2.2	-0.1
Clarence Street, between Erskine Street and Margaret Street	2.5	-0.2

Source: Table 46 in Technical Paper 11 – Noise and Vibration Impact Assessment, Volume 6

The road sections with potential increases in road traffic noise are not on the CSELR route. The locations identified above are mixed use, but mainly comprise commercial or office spaces on the lower levels of multi-storey buildings, as these are generally most exposed to noise. The predicted potential increase in noise levels in peak times is up to 3.9 dB, but is generally less than 3 dB. Noise impacts would be expected to be substantially less than this outside of peak times. These predicted noise levels would also be speed dependent. Detailed analysis of likely traffic speeds was not possible at the time of the assessment, and if speeds in the area are reduced, the estimated noise levels could be lower than those predicted.

Predicted decreases in operational road traffic noise

The biggest change in road traffic noise due to the CSELR proposal would occur in the George Street pedestrian zone, where road traffic noise would significantly decrease with implementation of the CSELR. The road traffic noise assessment also considered how this change would be offset by the predicted LAeq noise levels due to LRV operations in the pedestrianised area of George Street. The results are summarised in Table 12.27.

In the existing situation, the traffic noise is due to road vehicles; whereas in the future situation the traffic noise would be due to light rail movements. Noise from other sources (such as pedestrians, service vehicles and road traffic travelling east-west) was not included. Near cross roads, road traffic noise would continue to contribute to the noise environment. Away from cross roads, the future noise environment would depend on the specific uses of the location, the urban design and the future planning of the area.

Table 12.27 Summary of predicted change in traffic noise levels in George Street pedestrian zone

GEORGE STREET	TRAFFIC NOISE LEVEL (dBA)[1]					
	L_{Aeq}(PERIOD)			L_{Amax}		
	EXISTING	FUTURE	CHANGE	EXISTING	FUTURE	CHANGE
Daytime 7.00am–6.00pm	69–73	50•55	~20	90–95	70–75	~20
Evening 6.00pm–10.00pm	67–71	50–55	~20	90–95	70–75	~20
Night 10.00pm–7.00am	65–68	43–48	~20	90–95	70–75	~20

Source: *Table 49 in Technical Paper 11 – Noise and Vibration Impact Assessment, Volume 6*

Note: *L_{Amax} and L_{Aeq} noise levels are considered representative of a location on the existing George Street footpath, away from future east-west road intersections.*

The predicted results show that with the CSELR (including pedestrianisation of George Street), both average and maximum traffic noise levels in the George Street pedestrian zone are expected to be up to around 20 dB less than the existing situation. This would be a noticeable benefit to the acoustic environment in this area of the CBD. At any single location, the reduction would depend on the proximity to east-west roads that would continue to carry road traffic.

Table 12.28 shows six other locations in the City Centre Precinct (in addition to the pedestrian zone) where a potential noticeable decrease in road traffic noise has been identified. These changes would also be a noticeable benefit to the acoustic environment in these areas of the CBD.

Table 12.28 Other City Centre Precinct locations with potential noticeable decrease in road traffic noise

LOCATION	ESTIMATED CHANGE IN L_{Aeq} (dB) AM PEAK	ESTIMATED CHANGE IN L_{Aeq} (dB) PM PEAK
George Street, between Hunter Street and Curtin Place	-5.2	-0.4
George Street, between Bond Street and Curtin Place	-11.9	-6.7
George Street, between Bond Street and Jamison Street	-9.1	-6.9
George Street, between Bridge Street and Jamison Street	-13.5	-9.6
Grosvenor Street, between Cumberland Street and Gloucester Street	-0.1	-3.9
Margaret Street, between Wynyard Lane and Carrington Street	-2.1	2.1

Source: *Table 47 in Technical Paper 11 – Noise and Vibration Impact Assessment, Volume 6*

12.5.3 Impacts during construction

People are usually more tolerant to noise and vibration during the construction phase of projects than during full operations. This response results from recognition that the construction emissions are of a temporary nature — especially if the most noise-intensive construction impacts occur during the less sensitive daytime period. For these reasons, acceptable noise and vibration levels are normally higher during construction than during operations.

Construction often requires the use of heavy machinery which can generate high noise and vibration levels at nearby buildings and receptors. For some equipment, there is also limited opportunity to mitigate the noise and vibration levels in a cost-effective manner and hence the potential impacts should be minimised by using feasible and reasonable management techniques.

At any particular location, the potential impacts can vary greatly depending on factors such as the relative proximity of sensitive receptors, the overall duration of the construction works, the intensity of the noise and vibration levels, the time at which the construction works are undertaken and the character of the noise or vibration emissions. At this stage of the CSELR proposal development, only an indicative construction methodology is available, as detailed in Chapter 6. The construction noise and vibration impact assessment therefore focused on potential worst-case impacts based on various assumptions regarding the likely construction techniques and staging. Assumptions are detailed in sections 12 to 15 of Technical Paper 11 in Volume 6.

Potential noise and vibration impacts in the City Centre Precinct were assessed in relation to the following:

- construction airborne noise (general CSELR alignment and stops)
- construction road traffic noise
- construction ground-borne noise
- construction vibration.

These issues are discussed in turn in the following subsections.

Predicted construction airborne noise

Construction noise has been assessed in accordance with the *Interim Construction Noise Guideline* (ICNG, DECC 2009b). Airborne construction noise was predicted for the likely construction activity categories and scenarios (without mitigation), as detailed in Table 12.29 for the City Centre Precinct.

Table 12.29 Summary of airborne noise scenarios considered – City Centre Precinct

CONSTRUCTION ACTIVITY	SCENARIOS	SCENARIO SOUND POWER LEVEL (dB)	APPROXIMATE DURATION OF WORKS AT ANY LOCALITY[1]
Construction compounds	Establishment of construction compounds and worksites	105	Intermittent activity, up to 3 years at some locations
	Deliveries of demountable office facilities	105	
	Installation of temporary boundary fencing	99	
	Establishing stockpiles and materials storage areas	111	
	Delivery of construction plant and equipment	111	
Substation installation	Excavation	118	8 months[3]
	Foundation preparation	110	
	Delivery and placement of substation	105	
Mainline works	Excavation	118	2 weeks
	Base preparation and binding	108	2-3 weeks
	Reinforcement placement	103	2 weeks
	Concrete and baseplate placement	110	6–7 weeks[2]
	Track, welds and topping slab	110	5-6 weeks
	Overhead wiring footing excavation	114	1–2 weeks
	Overhead wiring footing placement and post erection	109	1–2 weeks
Structures – stops	Excavation of existing pavement	119	1 week
	Formwork and reinforcement	109	2–3 weeks
	Footings	105	2 weeks
	Concreting	109	1 week
	Finishing works	115	2–3 weeks
	Street reconfiguration	113	3–4 weeks

Source: *Table 55 in Technical Paper 11 – Noise and Vibration Impact Assessment, Volume 6*

Note 1: *Work estimate assumes one shift per day and based on typical 200 metre length of corridor and with a 2 x platform stop, and may not be over consecutive days (i.e. shorter periods of work adding up to total duration specified).*

Note 2: *Work estimate assumes Appitrack machine not used for this work. Appitrack would be anticipated to reduce duration to around 1 2 weeks at each location.*

Note 3: *Limited information is currently available on this activity. Therefore, assessment of this activity has been based on high level assumptions with respect to proposed duration.*

The majority of works would be completed during the standard daytime construction hours of Monday to Friday 7.00 am to 6.00 pm and Saturdays 8.00 am to 1.00 pm; however, to minimise disruption in the City Centre Precinct, some works would be required on a 24 hourly basis.

At this early stage in the proposal, out of hours works are included in the assessment for all proposed works in order to inform the scheduling of construction activity and management of noise during the detailed design phase. It is anticipated that the finalised requirements for out of hours works would be determined at a later design stage.

The predicted construction airborne noise impacts in the City Centre Precinct (exceedances of the adopted noise management levels or NMLs) associated with the activities and scenarios in Table 12.29 are summarised in Table 12.30 below.

Table 12.30 Summary of airborne construction noise level exceedances of NMLs – City Centre Precinct

RECEPTOR TYPE	WORST-CASE NML EXCEEDANCE AT NEARBY RECEPTORS (dB) (LEAST NOISE INTENSIVE SCENARIO – MOST NOISE INTENSIVE SCENARIO)	
	STANDARD CONSTRUCTION HOURS	OUT OF HOURS WORKS
Residential	3–18	1–29
Commercial	1–30	1–30
Other sensitive	0–54	0–54

Source: Table 56 in Technical Paper 11 – Noise and Vibration Impact Assessment, Volume 6

Due to the close vicinity of the works, moderate to high exceedances of the NMLs were predicted at the nearest residences to the works during standard construction hours (exceedances up to 18 dB) and out of hours work (exceedances of up to 29 dB). Commercial and other sensitive receptors were also predicted to be subject to high NML exceedances of over 20 dB.

Within the City Centre Precinct, the most noise intensive works would be road excavation activities, which may require use of a rockbreaker. These activities are not expected to last for longer than a total of two weeks at any single receptor during the mainline construction works. Receptors near to the proposed stop locations would also be likely to be impacted by additional excavation activities, which are expected to last for no longer than one week during stop construction.

Predicted $L_{A1(1minute)}$ noise levels at the nearest noise sensitive receptors (refer Appendix E of Technical Paper 11) indicate that the sleep disturbance screening criterion is likely to be exceeded when night works are occurring adjacent to residential receptors for the majority of works scenarios. This level of noise is typical for construction works using noise intensive equipment in built up areas. The applicable guideline ICNG only requires the proposal to consider maximum noise levels where construction works are planned to extend over more than two consecutive nights.

As discussed further in section 12.5.4, various mitigation measures are proposed to minimise the predicted NML exceedances, including sleep disturbance.

Predicted construction road traffic noise

Construction road traffic noise has been assessed in accordance with the NSW *Road Noise Policy* (RNP). This section provides an assessment of the construction related traffic on the public road network. Additional heavy construction vehicle movements on public roads would predominantly be required during daytime hours. Within the City Centre Precinct, a number of roads are proposed to be used as construction haulage and access routes, as described in Chapter 6 and summarised in Table 12.31. The additional road traffic is not predicted to create a discernible increase in road traffic noise at any locations in the City Centre Precinct, as the increases are all well under 2 dB.

Table 12.31 Construction road noise traffic assessment - City Centre Precinct

HAULAGE ROUTE	ROAD	PREDICTED TRAFFIC NOISE INCREASE (dB)[1]
West Movement 1	Cleveland Street	0.1
	City Road	0.1
	Parramatta Road	0.1
	Pitt Street	0.2
	Chalmers Street	0.2
	Elizabeth Street	0.2
West Movement 2	Pitt Street	0.2
	Parramatta Road	0.1
	Wattle Street	0.2
	William Henry Street	0.2
	Pier Street	0.2
	Castlereagh Street	0.2
	Goulburn Street	0.1
	Harris Street	0.1
	Allen Street	0.4
	Pyrmont Bridge Street	0.2
	M4 Western Distributor	0.1
West Movement 3	M4 Western Distributor	0.1
	Hickson Road	AADT not available
	George Street (Nth)	0.1
North Movement 1	George Street (Nth)	0.1
	Hickson Road	AADT not available
	Margaret Street	0.2
	York Street	AADT not available
	Bradfield Highway	0.0
North Movement 2	Loftus Street	AADT not available
	Bridge Street	AADT not available
	Cahill Expressway	0.1
South Movement	Elizabeth Street	0.2
	Cleveland Street	0.1
	South Dowling Street	0.0

Source: *Table 65 of Technical Paper 11*

Note 1: *Existing traffic noise levels based on Annual Average Daily Traffic (AADT) data available from the Roads and Maritime Services website: http://www.rta.nsw.gov.au/trafficinformation/downloads/aadtdata_dl1.html*

Additional assessment for night-time truck movements on public roads would be undertaken at the detailed design stage when the finalised traffic plan is determined. The maximum noise levels would be expected to be comparable with existing heavy vehicles using sub-arterial roads.

Predicted construction ground-borne noise

Ground-borne construction noise is likely to be audible during rock breaker activities at the nearest residential and commercial buildings to the works; however airborne noise levels associated with the rock breaker works are likely to be much higher than the ground-borne noise levels and, therefore, more prominent. For this reason, further assessment of ground-borne noise at these receptors is not considered warranted.

Notwithstanding the above, buildings with higher levels of external to internal sound insulation may mitigate airborne construction noise levels sufficiently such that internal ground-borne noise levels are dominant. As a result, additional assessment was undertaken in relation to potential ground-borne noise impacts at the commencement of construction at the cinema and theatre buildings located in the City Centre Precinct. Results are presented in Table 12.32.

Table 12.32 Predicted ground-borne construction noise impacts at nearest internal areas of cinemas and theatres in the City Centre Precinct

STREET	DESCRIPTION	TYPE	INDICATIVE DISTANCE TO NEAREST WORKS (M)	PREDICTED GROUND-BORNE NOISE (dBA)
624 George Street	Metro Theatre	Theatres/Auditoriums	18	57
49 Market Street	State Theatre	Theatres/Auditoriums	51	36
1 Angel Place	City Recital Hall - Angel Place	Theatres/Auditoriums	54	35
13 Campbell Street	Capitol Theatre	Theatres/Auditoriums	78	28
505-525 George Street	Event Cinema	Cinema	19	56
505 Pitt Street	Actors College of Theatre and Television	Recording studio	44	39
136 Chalmers Street	Tom Mann Theatre	Theatres/Auditoriums	125	<20
262 Pitt Street	Pilgrim Theatre	Theatres/Auditoriums	110	20
1-51 Foveaux Street	Australian Institute of Music (AIM)	Recording studio	74	29

Source: Table 66 in Technical Paper 11 – Noise and Vibration Impact Assessment, Volume 6

The most potentially affected receptors are the Metro Theatre and the Event Cinemas on George Street. Noise from rockbreaking could be audible at these sites during quieter periods of movies or shows. While cinemas and theatres/auditoriums are considered sensitive receptors, during film screenings and shows, ambient noise levels are relatively high. In cinemas, noise from adjacent screenings can sometimes be audible. Therefore the predicted ground-borne construction noise levels may be considered acceptable, considering the temporary nature of construction works. A range of mitigation options are available for addressing these impacts, as discussed in section 12.5.4.

Within the City Centre Precinct, the identified recording studios are set back from adjacent proposed works zones. The predicted ground-borne noise level at the nearest internal area of the Actors College of Theatre and Television building is 39 dBA. Internal noise levels within recording studios are typically required to be low to avoid interfering with quiet recordings.

Based on the predicted ground-borne noise levels, the internal noise levels due to rockbreaking may be audible at all recording studios listed in Table 12.32. Further assessment during detailed design is therefore required to assess the likely construction noise levels at the most affected recording rooms of all recording studios and to establish receiver specific noise goals, taking into account the type of recordings undertaken, and the existing external to internal noise insulation. Consultation with the owners or operators of recording studios would be required to establish times of particular sensitivity to ground-borne noise impacts.

Predicted construction vibration

The propagation of vibration emitted from a source would be site-specific, with the level of vibration potentially experienced at a receptor dependent upon the vibration energy generated by the source, the predominant frequencies of vibration, the localised geotechnical conditions and the interaction of structures and features which can dampen vibration.

For most of the proposed construction equipment, the separation distance(s) between the proposed works and the nearest receptors would typically be sufficient to comply with the safe working distances required in order to avoid 'cosmetic damage' from construction vibration (under the applicable British Standard BS 7385 Part 2 — 1993 — *Evaluation and measurement for vibration in buildings).* However, some items of construction equipment are proposed to be operated within 20 metres of residential receptors and within the recommended safe working distances. Mitigation and management measures to address potential impacts of this are discussed in section 12.5.4.

In relation to human comfort (response) to vibration, for most construction activities, vibration emissions would be intermittent in nature. For this reason, higher vibration levels that occur over shorter periods are permitted under BS 6472-1. Vibration at the nearest receptors is likely to be perceptible at times during the works. Some items of construction equipment are proposed to be operated within 20 metres of residential receptors and within the recommended safe working distances for 'human comfort' from construction vibration. There is, therefore, potential for ground vibration levels to exceed the human comfort criteria depending on the duration and nature of the construction activity. Any exceedances would be expected to be of short duration. Mitigation and management measures to address potential impacts of this are discussed in section 12.5.4.

Under the British Standard (BS7385), heritage buildings are assessed in the same way as other buildings (unless they are structurally unsound). Therefore, the above assessment also applies to heritage buildings along the CSELR alignment.

12.5.4 Management and mitigation

Airborne operational noise

As described in section 12.5.2, one residential receiver location in the City Centre Precinct was predicted to exceed the RING operational noise trigger level by up to 2 dB. Acceptance of any exceedances of the noise trigger levels of 2 dB or less is proposed at locations where road traffic noise dominates and is unlikely to decrease. This approach is proposed in the City Centre Precinct, which is exposed to high levels of road traffic noise not related to the CSELR proposal.

Mitigation of exceedances of the airborne noise trigger levels for other sensitive receivers in the City Centre Precinct is not considered reasonable or necessary on the basis that the light rail noise emissions would be less than existing road traffic noise levels in all cases.

The predicted noise levels in this assessment and the determination of as-required noise mitigation would be verified during the detailed design phase of the proposal.

Ground-borne operational noise and vibration

Some potential exceedances of operational vibration criteria have been identified at locations that potentially contain vibration sensitive equipment, including the Sydney Dental Hospital in the City Centre Precinct. Ongoing consultation and collaboration with the owners and operators of vibration sensitive equipment would be required throughout the detailed design stage to achieve appropriate vibration outcomes at these facilities.

Where necessary, ground-borne noise is controlled by specifying trackforms that incorporate vibration-isolating components. These could take the form of a resilient rail fastener, booted sleeper, floating track slab or a combination of approaches. The resilience is usually in the form of elastic/resilient pads or mats (or moulded rubber elements in the resilient baseplates/fasteners). There are many different designs available from different manufacturers. For the purpose of this assessment, three broad categories of embedded trackform were considered: standard, high-resilience and very high attenuation, as discussed below. These trackforms are shown indicatively in Figure 12.15.

The standard trackform includes rails that are continuously supported in a moderately stiff visco-elastic material. This trackform would be used in areas not sensitive to ground-borne noise and vibration.

High-resilience trackforms incorporate one or two resilient layers, with the rail either continuously or discretely supported. The stiffness of the resilient layers is less than for the standard trackform, resulting in attenuation of vibration and ground-borne noise at frequencies above the resonance of the track system.

Very high attenuation trackforms include floating slab track, where an isolating mat, blocks or springs are located under the track slab. These systems have a very low dynamic stiffness and provide very high vibration and groundborne noise attenuation. Floating slab track can result in increased air-borne noise emissions relative to other track-forms, as the slab vibrates resulting in a low-frequency rumbling noise. Some alternatives to floating slab track have been designed that aim to achieve similar vibration attenuation, without the increased airborne noise impacts.

The final trackform design and associated mitigation measures would be addressed in the detailed design to be undertaken by the successful contractor. Based on the definition design and the location of sensitive receptors, the assessment of ground-borne noise has considered the proposed extents of the three trackform categories shown in Figure 12.15. Standard trackform would be employed through the majority of the pedestrianised zone along George Street where speeds would be low, and at other locations removed from particularly sensitive receptors. High-resilience trackforms may be required to minimise ground-borne noise impacts at locations where sensitive receptors line the alignment.

To manage potential ground-borne operational noise impacts on sensitive receivers, consultation with the receptors identified in Table 12.24 (which equates to Table 24 in Technical Paper 11) would be required during the detailed design phase to confirm the sensitivity of these locations to ground-borne operational noise. Investigations would establish the internal noise level achieved by these buildings at present, the location of sensitive spaces within each building and the level to which any theatres or recording studios are isolated. More detailed investigations would be conducted including measurement of existing internal and external noise and vibration levels, including ground-borne noise and vibration levels due to the existing road traffic, and light and heavy rail in the CBD. These investigations would inform the required resilient trackform design in these locations and confirm the appropriateness of the ground-borne operational noise design goals.

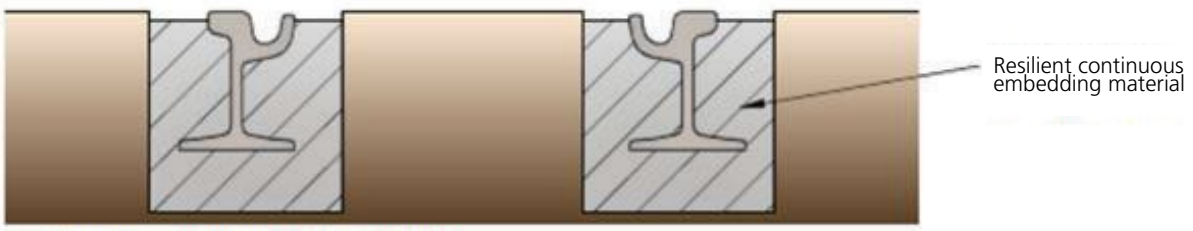
All vibration and ground-borne noise levels and recommended mitigation measures in this assessment would be verified during the detailed design phase.

Operational noise from substations and stops

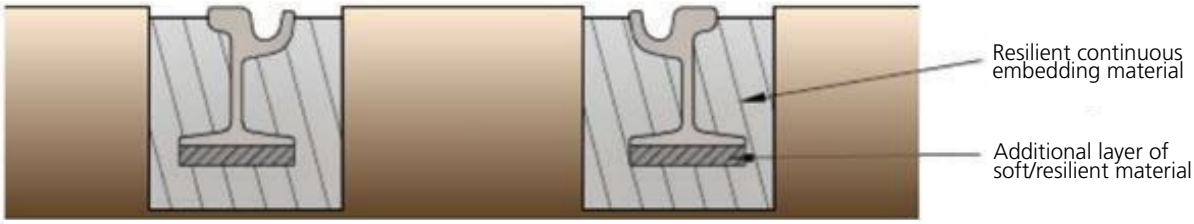
Noise from new electrical substations would be controlled by inclusion of shielding or enclosures to comply with the INP at all locations.

Noise from PA systems at the stops would be controlled to comply with the INP intrusiveness and sleep disturbance criteria at all locations to minimise potential impacts at the nearest receptors to the stops. The detailed design of the PA systems would include noise mitigation measures. The need for announcements at stops in residential areas would also be reviewed, particularly during the more sensitive night-time periods.

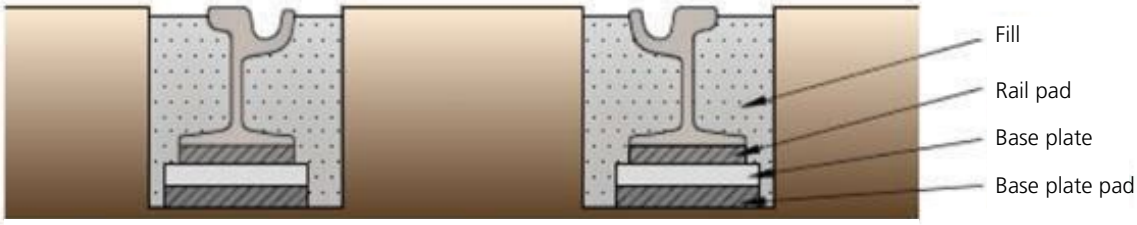
Figure 12.15 Indicative embedded rail trackforms



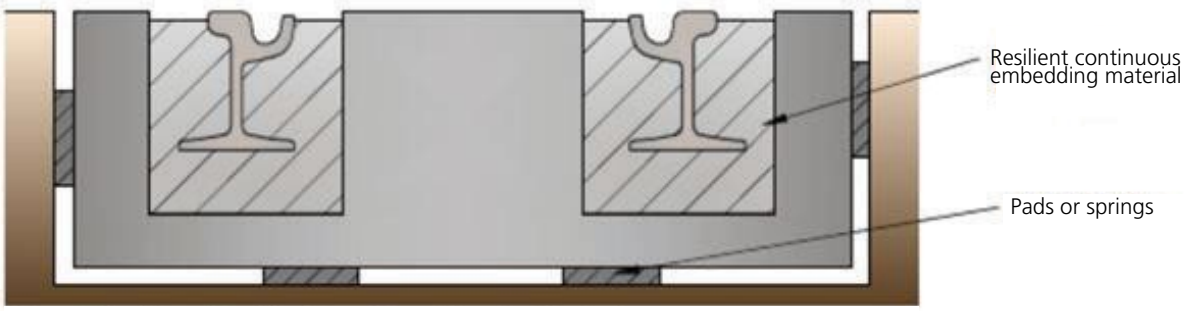
Continuously supported embedded rail



High-resilience continuously supported embedded rail



High-resilience discretely supported embedded rail



Very high attenuation floating slab with embedded rail

Changes in operational road traffic noise

Based on the forecast morning and evening peak traffic flows, road traffic noise levels may increase by a noticeable level (up to 4 dB) in some areas of the City Centre. A detailed analysis of traffic speeds has not been undertaken, and the full estimated change in noise levels may not be realised if speeds change along with the traffic numbers at any individual location. In general, the predicted light rail noise levels are below the existing ambient level at the affected receptors.

The nature of the proposal means there is limited scope for noise mitigation at these locations. Changes in road pavement would make a negligible difference to engine noise from slow moving or stop-start traffic. Noise barriers are not feasible in the CBD and would not benefit upper level residential receptors.

In the absence of any practicable mitigation measures, acceptance of the identified potential road traffic noise impacts during peak periods is proposed. It is also important to consider the overall impact of the CSELR proposal on road traffic noise, which would significantly decrease in some of the areas of the City Centre Precinct (as described in section 12.5.2)

Construction noise and vibration

Construction noise mitigation measures and plan

The ICNG and the Transport for *NSW Construction Noise Strategy* (Transport for NSW 2012b) describe strategies for construction noise mitigation and control that are applicable to the CSELR proposal. The strategies are designed to minimise, to the fullest extent practicable, noise during construction.

A construction noise and vibration management plan would be developed to document all necessary measures to manage and mitigation potential noise and vibration levels during standard daytime and out of hours construction activities. In general this would include some or all of the following:

- For construction concentrated in a single area, such as at the stops, worksites, substation construction sites, bridge sites and stabling/maintenance facility locations, temporary acoustic fencing/barriers around the site perimeter should be considered where feasible and reasonable to mitigate off-site noise levels. Note: Noise walls may be effective for receptors at or near ground level but would not be effective for receptors overlooking the sites.
- Given the potentially high noise levels at residential receptors, adherence to daytime construction hours is recommended for excavation, demolition or rock breaking activities, and for activities concentrated in a single area (i.e. activities that do not move along the alignment, and do not require out of hours activities for safety reasons or to minimise disruption to road networks).
- Night works should be programmed to minimise the number of consecutive nights work impacting the same receptors.
- Consultation would be undertaken with local schools and other educational facilities prior to noise intensive works to ensure impacts are minimised during examination periods and/or other critical periods in the school calendar (where works are predicted to exceed the relevant construction noise management level for this receiver). Consultation with nearby childcare centres is to be undertaken to potentially avoid noisy works during rest periods at the centres.
- Simultaneous operation of noisy plant in close proximity to sensitive receptors would be avoided.
- Equipment which is used intermittently is to be shut down when not in use.
- Where possible, the offset distance between noisy plant items and nearby noise sensitive receptors should be as great as possible.
- Where possible, equipment with directional noise emissions should be oriented away from sensitive receptors.
- Regular compliance checks for noise emissions from all plant and machinery used for the proposal would be undertaken to indicate whether noise emissions from plant items are higher than predicted. This would also identify defective silencing equipment on the items of plant.
- Ongoing noise monitoring would be undertaken during construction at sensitive receptors during critical periods to identify and assist in managing high risk noise events.