

Lend Lease

**One Sydney Harbour - State
Significant Development 6960**

Stage 1B Basement Barangaroo
South - Transport Management and
Accessibility Plan (TMAP)

Rev F | 23 June 2016

This report takes into account the particular
instructions and requirements of our client.

It is not intended for and should not be relied
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is undertaken to any third party.

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Appendix A

LinSig Modelling Outputs

1 Introduction

This Transport Management and Accessibility Plan (TMAP) supports a State Significant Development Application (SSD 6960) submitted to the Minister for Planning pursuant to Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The Development Application (DA) seeks approval for construction of the Stage 1B Basement and associated works at Barangaroo South as described in the Overview of Proposed Development section of this report. The findings and methodology in this report is consistent with the site wide TMAP developed for the Barangaroo South Concept Plan.

1.1 Overview of Proposed Development

The Stage 1B Basement DA seeks approval for the construction of a four level basement to accommodate parking for the Stage 1B Residential Buildings (subject to separate SSD applications). The works include the excavation of rock, construction of basement structure, provision of common plant and services, loading docks, waste rooms and storage areas, as well as structural cores to the new ground floor level only and associated building services for the Stage 1B Residential Buildings. The proposed development also includes above ground elements such as temporary roads, car park & loading dock ramps and basement risers, temporary public domain and temporary landscaping works.

It is noted that site preparation works, including demolition, remediation and excavation of fill or contaminated rock, are covered under SSD 5897.

1.2 Site Location

Barangaroo is located on the north western edge of the Sydney Central Business District, bounded by Sydney Harbour to the west and north, the historic precinct of Millers Point (for the northern half), The Rocks and the Sydney Harbour Bridge approach to the east; and bounded to the south by a range of new development dominated by large CBD commercial tenants.

The Barangaroo site has been divided into three distinct redevelopment areas (from north to south) – the Barangaroo Reserve, Barangaroo Central and Barangaroo South.

The Stage 1B Basement DA Site area is located within Barangaroo South as shown in Figure 1. The Development Application Site is located on land generally known and identified in the approved Concept Plan MP06_0162 (as modified) as Blocks 4A and 4B and part of the public domain area between those blocks and Block 5.

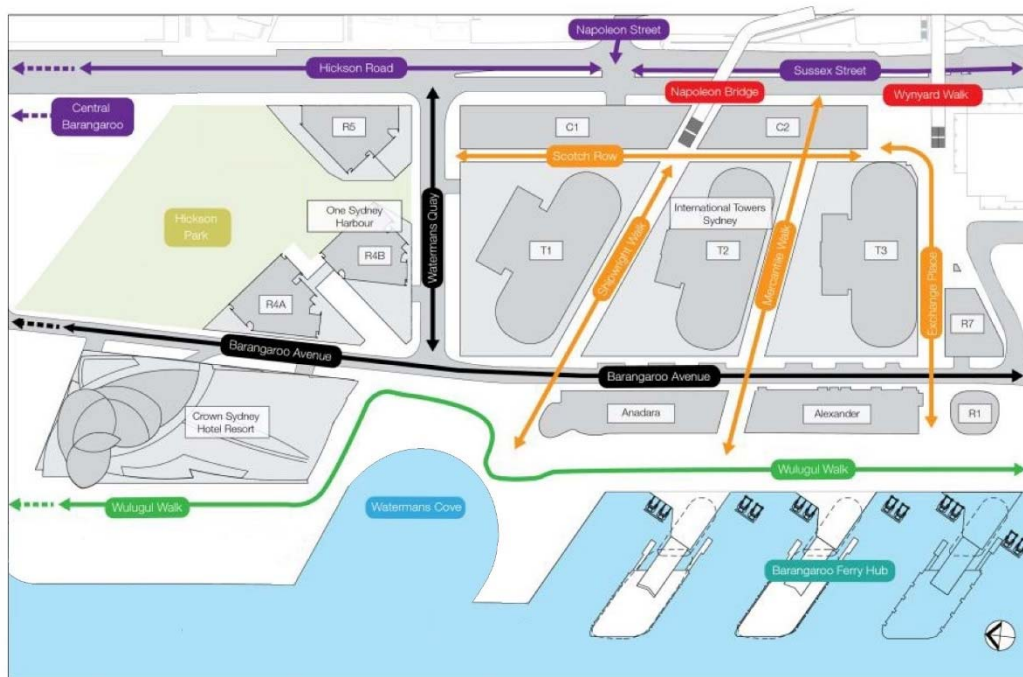


Figure 1 Site Location plan

2 Study Background

2.1 Scope of the Report

This report assesses the forecast construction and operational traffic generated during all stages of the development of the site and its likely impact to the road network, as well as pedestrian safety and amenity issues during the construction and operation of the subject development. It assesses the cumulative traffic impacts associated with the construction of the Stage 1B basement and the following surrounding developments:

Works directly related to Barangaroo South

- Stage 1A Basement Construction
- C4 Commercial Building
- C3 Commercial Building
- C5 Commercial Building
- R8/R9 Residential Buildings
- Concrete Batch Plant Operation
- Block 4 remediation works
- Block 5 remediation works
- Hickson Road remediation works
- City Walk Bridge
- R1 Building
- R7 Building
- C2/C6 kiosk
- Crown Sydney
- Stage 1B basement
- Stage 1B residential towers (buildings R4A, R4B, R5)

Works external to Barangaroo South

- Wynyard Walk
- Barangaroo Reserve and Northern Cove
- Barangaroo Central – Waterfront Promenade and Interim Public Domain Works
- Barangaroo Ferry Wharf

With respect to construction work external to Barangaroo South, assumptions have been made regarding expected vehicular activity based on documents submitted as part of the planning applications for each of these works.

As the anticipated construction period (and level of vehicle activity) for the Barangaroo Central precinct is currently unclear, these works have been excluded from the analysis.

2.2 Study Objectives

Specific issues addressed in the report respond to the Secretary's Environmental Assessment Requirements (SEARs) in relation to traffic and transport for the planning application, those being:

- *Demonstrate consistency with the Barangaroo Integrated Transport Plan and the Sydney City Centre Access Strategy.*
- *The EIS shall include a Traffic and Transport Impact Assessment that provides, but is not limited to, the following:*
 - *current daily and peak hour vehicle, public transport, pedestrian and bicycle movements and existing traffic and transport facilities provided on the road network;*
 - *daily and peak traffic movements likely to be generated by the development, including peak traffic movements;*
 - *assessment of the existing and future performance of key intersections providing access to the site, and any upgrades (road/intersections) required as a result of the development. The assessment of the existing and future road network operations needs to consider the cumulative impacts of traffic volumes and focus on intersections in the north-west quadrant of the CBD in the vicinity of Barangaroo. The assessment needs to be supported by appropriate modelling and analysis to the satisfaction of Roads and Maritime Services;*
 - *details of the proposed number of car parking spaces and compliance with appropriate parking codes. It should demonstrate a minimalist approach to the provision of on-site parking, and how traffic generation (number of vehicles and time of access) will be managed in response to capacity limitations on the road network;*
 - *pedestrian and cycle connections/circulation and required upgrades to meet the likely future demand within the precinct and connections to the external networks, particularly the cycle network identified in the Sydney City Centre Access Strategy;*
 - *existing public transport services and opportunities for greater usage for residents, workers and visitors;*
 - *details of sustainable travel initiatives for residents, workers and visitors, particularly for the provision of end-of-trip facilities;*
 - *assessment of proposed loading dock provisions and access arrangements to loading docks*
 - *details of existing and proposed vehicular access and car parking arrangements for residents, workers and visitors (cars, coaches/buses & taxi ranks), including compliance with parking codes and Australian Standards, and measures to mitigate any associated traffic impacts and impacts on public transport, pedestrian and cycle networks; and*
 - *details of access arrangements for emergency and service vehicles (including vehicle type and likely arrival and departure times of service vehicles).*

The EIS shall include an updated Transport Management and Accessibility Plan.

- *In relation to construction traffic:*
 - *assessment of cumulative impacts associated with other construction activities on the Barangaroo and Wynyard Precincts;*
 - *details of anticipated truck movements to and from the site;*
 - *details of access arrangements for workers to/from the site, emergency vehicles and service vehicle movements;*
 - *details of temporary cycling and pedestrian access during construction;*
 - *details of proposed construction vehicle access arrangements at all stages of construction; and*
 - *assessment of traffic and transport impacts during construction and how these impacts will be mitigated for any associated traffic, pedestrian, cyclist and public transport, including the preparation of a draft Construction Traffic Management Plan to demonstrate the proposed management of impact. This Plan needs to include vehicle routes, number of trucks, hours of operation, access arrangements and traffic control measures for all demolition/construction activities.*

3 Existing Traffic Conditions

3.1 Road Network

Sussex Street / Hickson Road form a wide road that runs along the western side of Sydney CBD, and bounds the east of the Barangaroo site. The Sussex Street section continues south from Napoleon Street to Hay Street. It is two-way north of King Street and one way southbound, south of King Street. Hickson Road forms the northern extension of Sussex Street and continues north from Napoleon Street to George Street at Dawes Point.

Napoleon Street provides a connection between Hickson Road and Kent Street / Margaret Street. It is a relatively wide road and has moderate downward slope from Kent Street to Hickson Road. Traffic signals were recently installed at the Hickson Road / Napoleon Street intersection, which provides for controlled vehicle movements out of the Barangaroo Stage 1A basement.

Shelley Street provides a connection between Sussex Street (to the north) and Erskine Street (to the south). In 2014 the road connection between Shelley Street and Sussex Street was closed to facilitate construction works on the Barangaroo Stage 1A site.

Lime Street provides a local road and pedestrian connection between King Street Wharf and Hickson Road via the western and northern edges of the Barangaroo site.

3.2 Pedestrian Conditions

In 2015 three major improvements to the pedestrian network in the Barangaroo precinct were opened to the public, those being:

- The City Walk Bridge – providing a grade separated pedestrian connection from the Westpac Plaza, across Sussex Street into the Barangaroo site. When Wynyard Walk opens, a connection will also be available from this bridge to the Napoleon Street footpath.
- Signalisation of the Hickson Road / Napoleon Street intersection providing controlled pedestrian crossing movements across all four legs of the intersection.
- Wynyard Walk Bridge - providing a grade separated pedestrian connection from the Westpac Place, across Sussex Street into Shelley Street.

In addition, other pedestrian facilities in the precinct include:

- Signal controlled pedestrian crossings across all approaches of the Sussex Street / Shelley Street intersection
- Adequate footpaths on both sides of Sussex Street, Hickson Road and Napoleon Street
- Pedestrian only routes through the Barangaroo Stage 1A precinct

3.3 Traffic Volumes

Traffic counts were undertaken in the Barangaroo precinct on Thursday 26 November 2015 and are presented in Table 1. These counts were compared with those undertaken by Arup on 25 July 2013 over the same time period.

Revised traffic counts were commissioned given the number of changes in the transport environment since the previous traffic counts were undertaken in July 2013, in particular the partial closure of George Street to accommodate the Sydney Light Rail construction. At the time of the traffic surveys, George Street was closed to general traffic between King Street and Market Street.

Other changes to the road environment since the previous July 2013 counts are as follows:

- Closure of Shelley Street north of Lime Street
- Opening of Barangaroo South Stage 1A public domain, including extension of Lime Street to connect with Watermans Quay and Hickson Road
- Signalisation of Hickson Road / Napoleon Street
- New bus routes on Hickson Road
- Occupation of Barangaroo South Stage 1A public domain and occupancy of T2 commercial building
- Opening of Barangaroo Point Reserve
- Changes to the CBD bus network associated with the construction of the light rail

Five signalised intersections in the vicinity of the Barangaroo worksite were surveyed. It should be noted that the survey was conducted on a Thursday outside of school holiday periods, and are therefore representative of traffic volumes in the precinct.

The locations of the intersections surveyed are displayed in Figure 2 below.

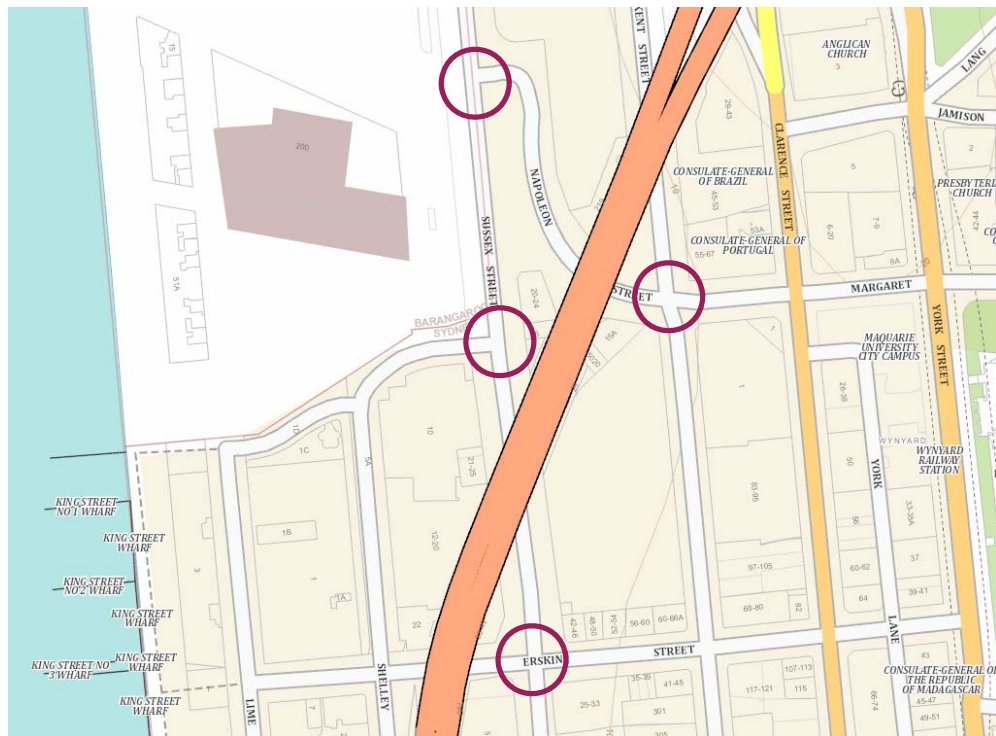


Figure 2 Traffic count locations

Table 1: Hickson Road / Sussex Traffic Volumes

Traffic Count Date	Road	Location	AM Peak Hour			PM Peak Hour		
			NB	SB	Total	NB	SB	Total
Nov 2015	Hickson Road	North of Napoleon Street	564	237	801	418	573	991
Jul 2013			601	254	855	380	606	986
% Change from 2013 to 2015			-6%	-7%	-6%	10%	-5%	1%
Nov 2015	Sussex Street	North of Shelley Street	698	474	1,172	512	569	1,081
Jul 2013			926	556	1,482	569	714	1,283
% Change from 2013 to 2015			-25%	-15%	-21%	-10%	-20%	-16%
Nov 2015	Sussex Street	North of Erskine Street	684	413	1,097	512	622	1,134
Jul 2013			650	518	1168	409	845	1,254
% Change from 2013 to 2015			5%	-20%	-6%	25%	-26%	-10%
Nov 2015	Sussex Street	South of Erskine Street	401	950	1,351	352	1,275	1,627
Jul 2013			578	907	1,485	316	1,364	1,680
% Change from 2013 to 2015			-31%	5%	-9%	11%	-7%	-3%

The results of the survey undertaken in November 2015 indicate that two-way traffic volumes in the Barangaroo precinct, specifically along Hickson Road, Napoleon Street and Sussex Street, have decreased compared to those surveyed in July 2013. This is the case for both the AM and PM commuter peak hours, and is illustrated in Figure 3 below.

When the directional traffic flows are reviewed, the northbound traffic along Sussex Street and Hickson Road has increased by between 10 and 25% in the PM peak but reduced in the AM Peak.

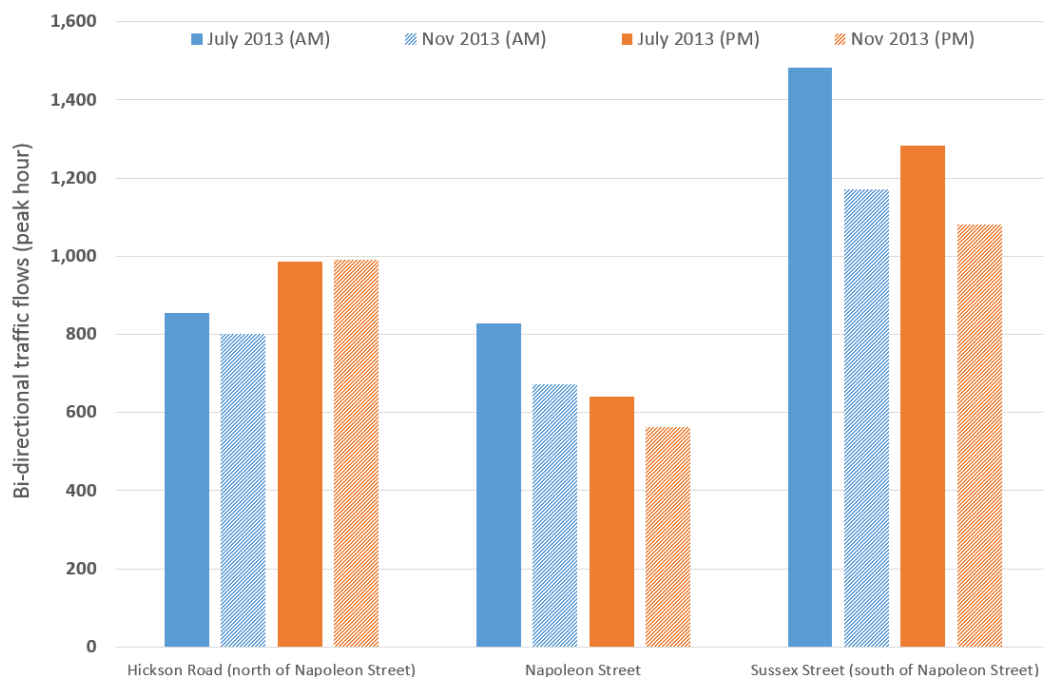


Figure 3 Changes in traffic volumes – 2013 vs 2015

The traffic surveys demonstrate that the partial closure of George Street (along with other changes in the road environment) has not resulted in any increases in traffic volumes along the Hickson Road corridor. Traffic volumes have instead declined in the key southbound direction – despite the reduced road capacity of George Street.

To ensure the traffic counts of November 2015 were reflective of current conditions, Arup undertook further traffic surveys on Wednesday 4 May 2016, coinciding with the closure of George Street between Bridge Street and Margaret Street. The results of the survey undertaken in May 2016 indicate traffic volumes in the Barangaroo precinct, specifically along Hickson Road, Napoleon Street and Sussex Street, have decreased compared to those surveyed in November 2015.

This is the case for both the AM and PM commuter peak hours, and is illustrated in Figure 3 below.

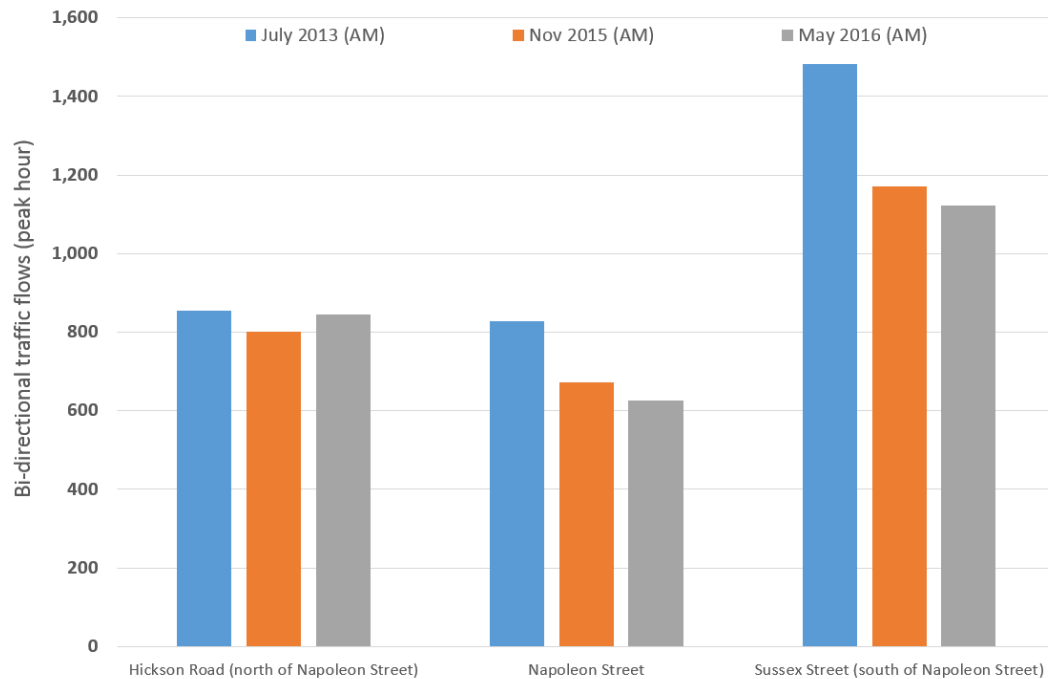


Figure 4 Changes in traffic volumes – AM Peak Hour

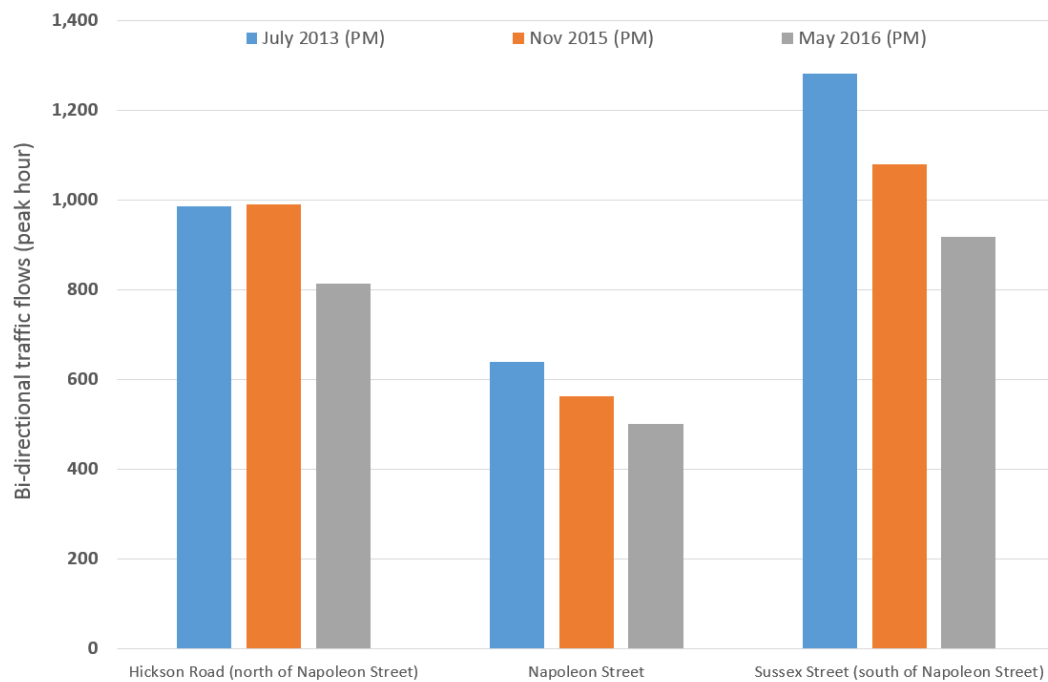


Figure 5 Changes in traffic volumes – PM Peak Hour

Significantly, since in the closure of the northern end of George Street in April 2016, traffic flows on Hickson Road have further declined compared to those recorded in November 2015. This indicates there has not been a redistribution of traffic away from George Street towards the Hickson Road corridor.

3.4 Construction Activity

The number of construction vehicles generated by the Barangaroo site over the course of a typical weekday is shown in Figure 6 below.

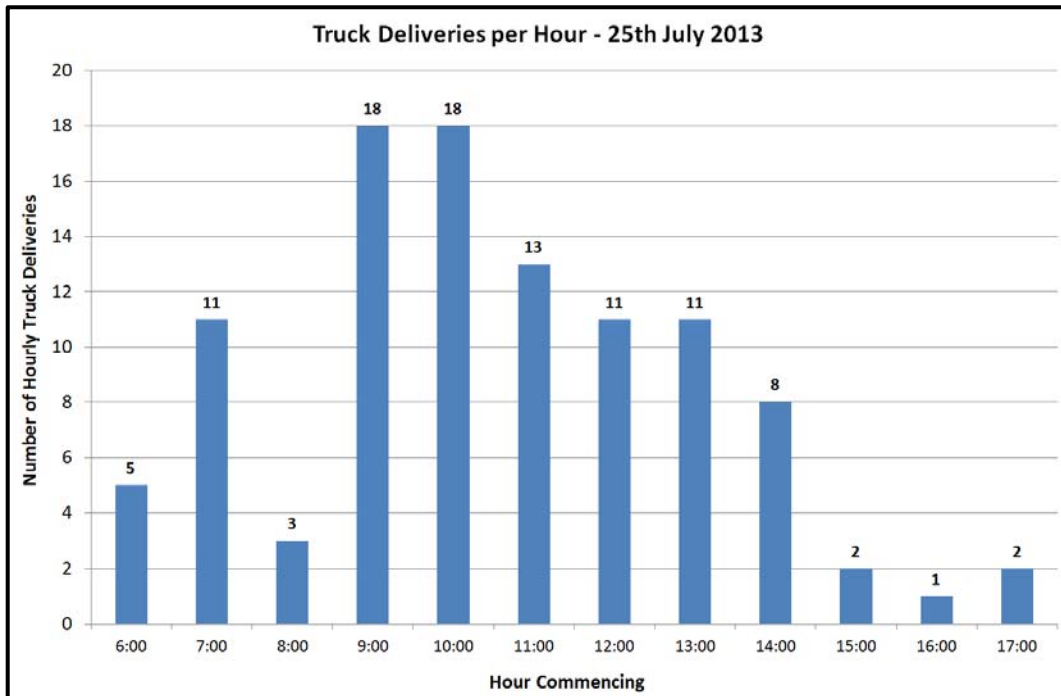


Figure 6 Typical daily profile of construction vehicle activity for Barangaroo South

This existing profile demonstrates the majority of vehicle activity takes place outside the commuter peak hours of 8am-9am and 5pm-6pm. Most notably, construction activity dissipates significantly after 3pm, with only 5% of the day's total trucks arriving after this time. 2 truck deliveries were recorded during the PM peak hour of 5pm – 6pm, equating to 2% of the daily vehicle activity.

4 Construction Traffic Assessment

4.1 Construction Program

4.1.1 Barangaroo South Works

Table 2 below outlines the concurrent developments within the Barangaroo South site, noting the start and finish dates by annual quarters.

Table 2: Construction Details of Barangaroo South Works

Project	Project Duration*		Overlaps with Stage 1B works?
	Start	Finish	
Stage 1a Basement Construction	Oct 2011	Sept 2015	✗
C3 Commercial Building	Mar 2014	Sept 2016	✗
C4 Commercial Building	May 2013	Oct 2015	✗
C5 Commercial Building	Oct 2013	June 2016	✗
C2 Building	Feb 2016	Apr 2017	✗
C1 Buildings	Sep 2017	Dec 2018	✓
R8/R9 Residential Buildings	Jun 2014	Nov 2015	✗
Batch Plant Operation	Sept 2013	Sept 2015	✗
Block 4 Remediation Works	May 2016	Mar 2019	✓
Block 5 Remediation Works	Sep 2016	Mar 2019	✓
Stage 1a Public Domain Works	Jul 2014	Mar 2016	✗
City Walk Link Bridge	Oct 2014	Jun 2015	✗
Building R1	July 2016	Mar 2017	✗
Building R7	Dec 2015	Oct 2016	✗
Stage 1C Remediation and Earthworks	Dec 2015	Mar 2018	✓
Crown Sydney	June 2016	Sep 2020	✓
Hickson Road Remediation	Nov 2016	Oct 2018	✓
Stage 1B basement	Jun 2017	Mar 2021	✓
Stage 1B residential towers	Dec 2019	Jul 2023	✓

* The above dates are indicative only and allow for future tenant fit out works within the individual buildings

4.1.2 Works External to Barangaroo South

The construction staging for works external to the Barangaroo South site are outlined in Table 3 below.

Table 3: Construction Details of Works Adjacent to Barangaroo South

Project	Project Duration		Overlaps with Stage 1B works?
	Start	Finish	
Wynyard Walk Bridge and Tunnel	Apr 2013	Dec 2016	✗
Barangaroo Reserve Main Works	Apr 2013	Jul 2015	✗
Barangaroo Ferry Wharf	Feb 2016	Nov 2016	✗
Barangaroo Central – Waterfront Promenade	Mar 2014	Jul 2015	✗
Sydney Metro	Jul 2017*	Dec 2023*	✓

* Indicative only

4.2 Construction Traffic Principles

The overall construction traffic management principles will be to ensure:

- Construction access driveways are designed to allow trucks to enter and leave the site in a forward direction;
- Construction access driveways are managed and controlled by site personnel;
- Safety for works and the public in the vicinity of the worksite is maintained;
- Designated truck routes for all access points are developed which minimises the impacts on the local road network;
- A safe, convenient and appropriate environment is established for pedestrians and cyclists at all times; and
- Appropriate capacity for pedestrians along the Hickson Road footpath is maintained.

4.3 Traffic Routes

The predominant traffic routes that construction vehicles utilise to Barangaroo are presented in Figure 7 through Figure 9 on the following pages, and summarised below.

From the north and north-west:

- Harbour Bridge – Western Distributor – Bathurst Street – Liverpool Street – Harbour Street – Shelley Street – Erskine Street – Sussex Street (inbound); and
- Hickson Road – Napoleon Street – Kent Street – Western Distributor – Harbour Bridge (outbound)

This southbound truck activity would occur during peak hours as there is no access for general traffic from the Harbour Bridge to York Street between 6.30am – 9.30am (Monday – Friday).

From the west and south-west:

- Anzac Bridge – Western Distributor – Sussex Street – Hickson Road (inbound); and
- Hickson Road – Sussex Street – Western Distributor – Anzac Bridge (outbound)

From the south and east:

- Eastern Distributor – Cross City Tunnel – Western Distributor – Wattle Street – Western Distributor – Sussex Street – Hickson Road (inbound); and
- Sussex Street – Harbour Street – Cross City Tunnel (outbound)

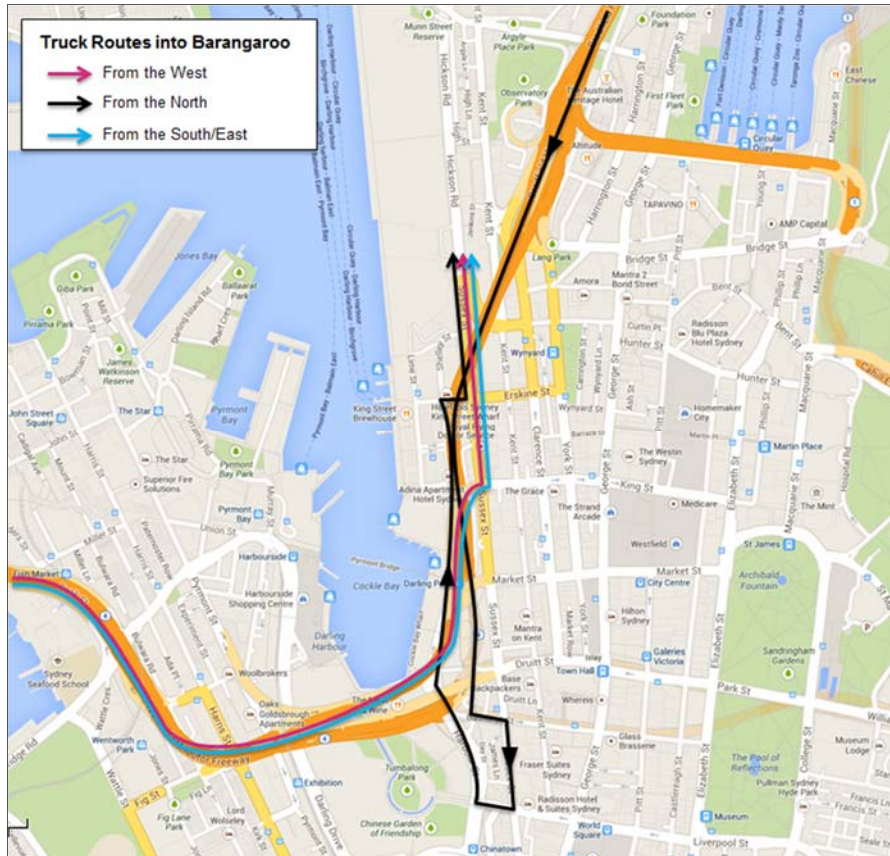


Figure 7: Inbound Traffic Routes to Barangaroo

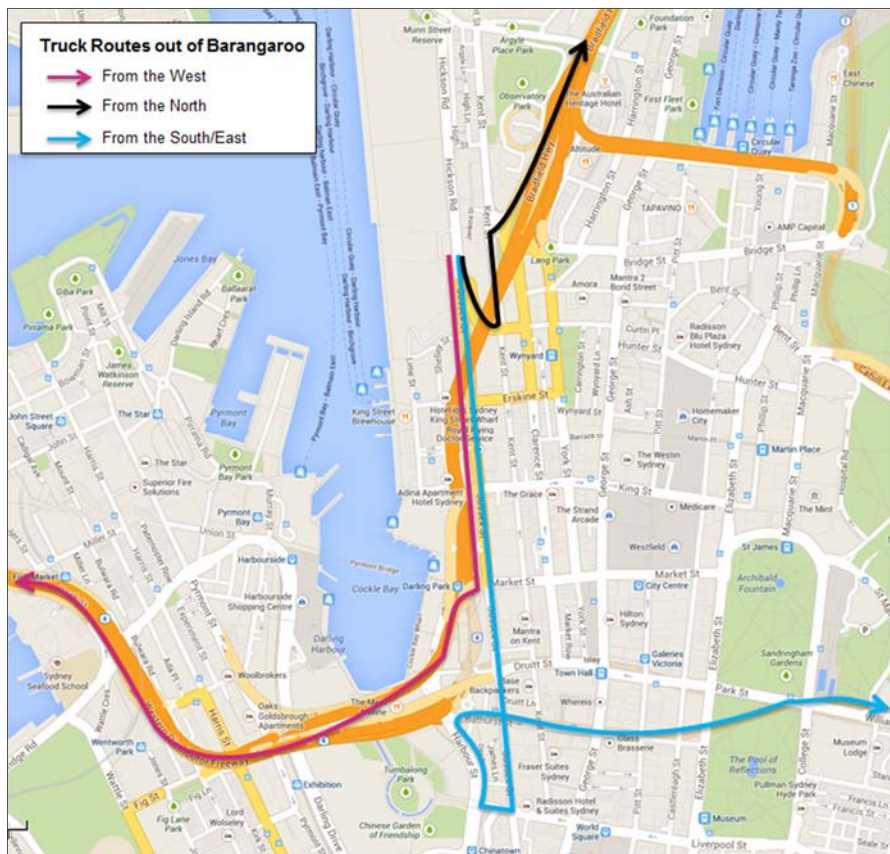


Figure 8: Outbound Traffic Routes from Barangaroo

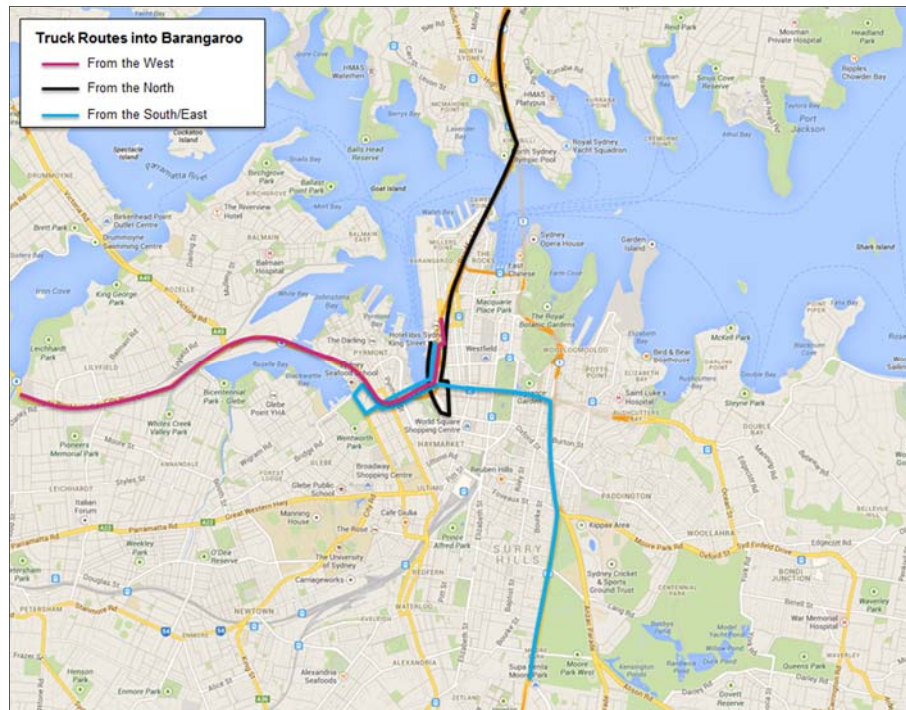


Figure 9: Construction Traffic Routes through the Sydney CBD

4.4 Forecast Traffic Movements

An assessment has been made of the cumulative impacts of construction activities in the precinct, based on the works described in Section 4.1 of this report.

The proposed construction timeframe for Stage 1B basement construction will extend into the period of the occupation of the Barangaroo South Stage 1A development and the opening of Barangaroo Reserve. As such, an assessment of the road network impact of these works during this time has also been undertaken.

4.4.1 Stage 1B Basement and Tower Construction

The works associated with the construction of the Stage 1B basement and towers are expected to occur between June 2017 and July 2023. Works are to be divided into stages as summarised in Table 4 below.

Table 4: Summary of Stage 1B construction works

Stage	Description	Works
A	Excavation after Remediation	The scenario includes excavation remaining spoil after remediation works which are conducted under the odour tents 2 Excavators, 2 Front End Loaders, 1 Dozer and 4 Anchoring rigs are assumed to operate in 15 minutes. In addition odour equipment is operational 24 hours a day, 7 days a week to maintain a negative pressure environment. In addition dump truck movements are assumed to be 4 movements in a 15 minute period
B	Rock Excavation	The scenario includes excavation of rock following completion of all spoil excavation & remediation works. Works will not be undertaken under an odour tent. 2 Excavators / rock-breakers, 2 Front End Loaders, 2 Diamond rock saws and 1 Dozer are assumed to operate in 15 minutes. Dump truck movements are assumed to be 4 movements in a 15 minute period
C	Piling Works	The scenario includes Piling using Auger Piling Rig on the perimeter and core for future buildings 4 Auger piling rigs, 2 attendant cranes and 2 boom truck and lift are assumed to operate in 15minutes. Also concrete trucks and normal delivery trucks assumed to be 6 movements in 15 minutes
D	Structure Construction	This scenario includes concreting and structural works. 2 concrete pumps, 2 forklifts, 2 compressors, 1 crane, a boom truck are assumed to operate in 15minutes. Also concrete trucks and normal delivery trucks assumed to be 8 movements in 15minutes.
E	Services / Fit-out	The scenario includes services reticulation, fit-out, finishes installation and commissioning. Assume 20 miscellaneous deliveries per day.

4.4.2 Construction Traffic Movements

The number of construction vehicles generated by works within the Barangaroo South site is based on recent advice from Lend Lease Buildings. The number of vehicle movements¹ expected during the peak hours has been determined based on the existing activity profile for the Barangaroo South (Stage 1A) site. Construction vehicle activity generated by works external to Barangaroo South has been forecasted based on the supporting planning documents to each of the project applications.

4.4.3 Operational Traffic Movements

The proposed construction timeline for the Stage 1B construction works coincides with the occupation of commercial and residential buildings within Barangaroo South (Stage 1A). These include:

- C3 commercial building
- C4 commercial building
- C5 commercial building
- R8/R9 residential buildings
- C2 commercial building
- R1 & R7 buildings
- Barangaroo Reserve

210 cars and 50 service vehicles are anticipated to be generated from these developments during peak hours following their occupation (including associated on-street parking).

4.4.4 Cumulative Traffic Movements

Table 5 on the following page provides a detailed summary of anticipated construction and development traffic movements associated with each project in the Barangaroo precinct. This demonstrates the peak traffic activity is anticipated to occur in September 2020, with 433 additional traffic movements during the AM peak hour (compared with the existing situation).

As illustrated in Figure 6, the majority of construction truck movements occur prior to the afternoon peak commuter period (5pm – 6pm). Therefore the analysis has considered the morning peak hour (8am – 9am) to determine the impacts arising from the Stage 1B works.

¹ For the purposes of this report, a traffic movement is defined as the one-way flow of a single vehicle at a particular location. A vehicle entering the site, and departing some time later, is considered as two traffic movements.

Forecast Vehicle Activity - Vehicle Movements per Hour

433

* Anticipated construction vehicle activity generated by Barangaroo South worksites are based on recent information provided to Arup by Lend Lease Buildings.

Forecast Vehicle Activity - Vehicle Movements per Hour

4.5 Road Network Impacts

The impacts of the additional traffic movements on the local road network generated by the construction and operation of the Barangaroo site are described in the sections below.

4.5.1 Traffic Distribution

Construction Traffic

Consistent with the forecasts adopted in previous construction traffic management plans for Barangaroo South works, 70% of construction vehicles are forecast to approach the worksite from the southern and western parts of Sydney. The remainder would approach from the northern direction (i.e. via the Harbour Bridge, Western Distributor and Harbour Street). For trucks returning to the north, they would utilise Napoleon Street and then turn left onto Kent Street to approach the Harbour Bridge. Margaret Street would not be used as a construction route during peak hours.

Development Traffic.

Traffic associated with the new development has been distributed across the road network based on Journey to Work Census data, consistent with the assumptions outlined in the MWT Modified Concept Plan – Transport Report, July 2008. This is summarised in Table 6 below.

Table 6 Development Traffic Distribution

Direction	Route	Distribution
North	Harbour Bridge	40.7%
East	Eastern Distributor	22.9%
	William Street	1.5%
	Oxford Street	4.1%
South	Harbour Street	8.6%
West	Western Distributor	21.8%
Sydney Inner	-	0.4%
Total		100%

4.5.2 Road Network Layout

The traffic modelling has considered the current road network layout in the Barangaroo precinct. This includes:

- The closure of the northern section of Shelley Street to vehicular traffic.
- The installation of traffic signals at the Hickson Road / Napoleon Street intersection, including the provision of a fourth leg at the intersection which provides egress from the Stage 1A basement car park.

During the construction of the Barangaroo Stage 1B development, the Hickson Road / Watermans Quay intersection will be priority controlled.

4.5.3 Traffic Modelling

This report examines in detail the future stage traffic operations of the five nearest and most relevant intersections to Barangaroo South construction site, namely:

- Hickson Road & Watermans Quay, **Priority Controlled (Future)**
- Napoleon Street & Hickson Road, **Traffic Signals**
- Sussex Street & Shelley Street, **Traffic Signals**
- Sussex Street & Erskine Street, **Traffic Signals**
- Napoleon Street, Margaret Street & Kent Street, **Traffic Signals**

Lane saturation flows within the LinSig model have been lowered at certain locations to consider the impact of queue spillback from upstream and downstream intersections. The results of the LinSig intersection modelling are summarised in Table 7 and detailed in Appendix A.

4.5.4 Intersection Operation

The effect of the estimated additional peak hour traffic during (for the combined construction and operational activities) has been investigated for each of the affected intersections during the AM peak hour. Negligible construction traffic movements are anticipated during the PM peak hour and therefore this has not been considered in the analysis. The modelling results for the future peak hour traffic movements are summarised in Table 7.

Table 7: Intersection Analysis

Peak	Intersection	Future Traffic Peak, 2020 (Excluding Stage 1B works)			Future Traffic Peak, 2020, (Including Stage 1B works)		
		LOS	DOS	AVD (sec)	LOS	DOS	AVD (sec)
AM	Sussex St / Erskine St	C	0.91	37	C	0.91	36
	Sussex St / Shelley St	D	0.98	46	D	0.99	51
	Hickson Rd / Napoleon St	E	0.94	58	E	0.95	61
	Kent St / Margaret St	B	0.61	21	B	0.62	21
	Hickson Rd / Globe St	A	0.49	2	A	0.51	2

LOS - Intersection Traffic Level of Service, DOS - Degree of Saturation, AVD - Average Delay per vehicle

The results of the LinSig intersection analysis forecast minimal changes in the operation of key intersections as a result of the construction of the Stage 1B development, when compared with the base case scenario. The additional construction vehicles associated with the Stage1B works has a negligible impact on forecast road network performance.

During the AM peak hour, when construction vehicles attributable to Stage 1B are expected to access the site, the road network generally operates satisfactorily. The addition of construction traffic movements associated with the Stage 1B works does not impact the overall operation of the local road network, and requires no further works to accommodate the levels of construction traffic anticipated.

4.6 Construction Vehicle Management

4.6.1 Hours of Operation

The proposed site hours of operation will be similar to the existing project approvals for Barangaroo South Stage 1A site. These hours, to be confirmed at a later date, will assist the site traffic movements being generated mainly outside the normal commuter peak traffic periods, such that their impacts on the surrounding road network are minimised.

4.6.2 Restriction to Construction Routes

Trucks will not be able to use York Street or Clarence Street in the AM peak between 6am and 10am due to existing restrictions.

4.6.3 Emergency Vehicle Access

Site entries are to be clearly signposted for the benefit of all approaching site traffic, in particular emergency services vehicles.

4.6.4 Access for Construction Workers

To reduce the impact on the local road network associated with construction work, no on-site parking is to be provided for construction workers. In this manner it is being treated like any other CBD construction project. The constrained parking environment surrounding the site, coupled with the relatively high cost of long term parking, will ensure the majority of construction workers arrive to the site via public transport.

Construction workers through their site inductions will be provided with travel advice about public transport, walking and cycling routes to the site.

4.6.5 Traffic Control Recommendations

The site traffic control recommendations for each worksite gate entry or exit point (including all appropriate signage) will be determined by means of a Traffic Control Plan to be prepared by an RMS accredited contractor closer to construction commencement.

Truck movements are to be staged and coordinated to prevent trucks circulating CBD streets whilst awaiting access to the site.

Construction vehicles will approach the site from areas outside the CBD using major arterial routes such as the M4, M5 etc.

The size of trucks proposed to access the site will be in accordance with Clause 300-3 of the Road Rules in terms of lengthy vehicle restrictions.

The vehicular traffic movements at each of the site entry or exit gates for traffic to and from Hickson Road will potentially need to be controlled by a flagman to ensure no potential traffic safety conflicts occur between the site truck traffic and pedestrians on the adjacent footpath.

Personnel will not be permitted to use stop/slow signage in Hickson Road or Sussex Street on weekdays between 7am and 9am and 4pm to 7pm.. However, personnel using stop/slow signage will be permitted on Hickson Road, north of the intersection of Hickson Road and Napoleon Street, when it is required to ensure safe truck access at designated site access points, provided that vehicles queue lengths generated as a result of the traffic control do not exceed more than six vehicles in either direction.

Any activity likely to impact the operational efficiency of the state road network and/or for works within 100m of traffic lights would be the subject of an application to the Transport Management Centre for a road occupancy licence.

4.7 Vehicle Site Access

Access for construction vehicles to the Barangaroo Stage 1B site will be via Hickson Road at the existing gatehouse, approximately 350m north of the Sussex Street / Napoleon Street intersection. This site access will be utilised until January 2019, after which it will move approximately 25m south along Hickson Road as illustrated in Figure 10 below.

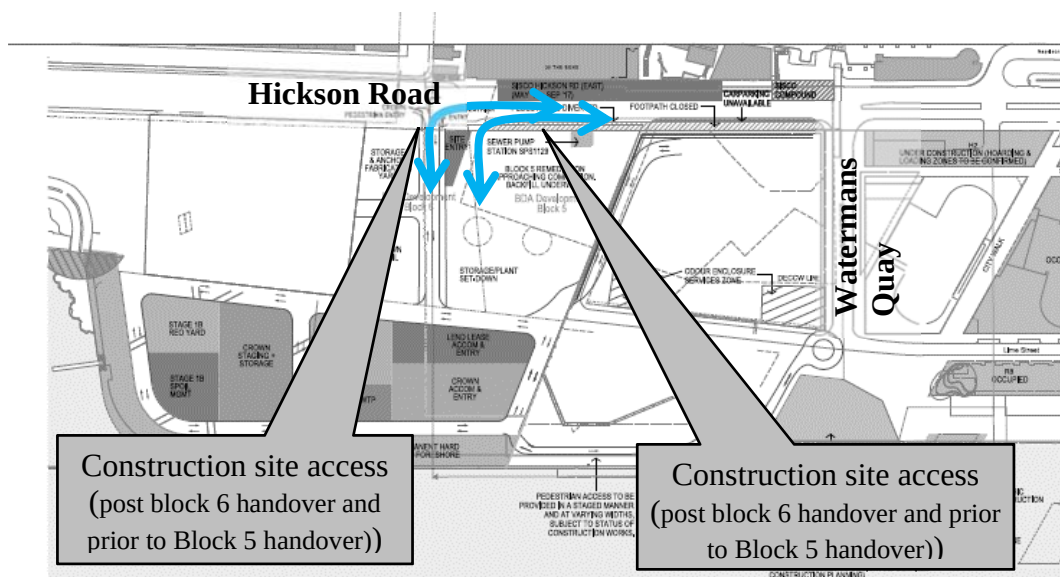


Figure 10 Site Access Diagram

Note: Locations shown are indicative only

4.8 Pedestrian and Cycling Management

There are a number of existing pedestrian routes which will facilitate movement for construction workers to and from the Barangaroo South site.

In July 2015 two major improvements to the pedestrian network in the Barangaroo precinct were opened to the public, those being:

- The City Walk Bridge – providing a grade separated pedestrian connection from Napoleon Street, across Sussex Street into the Barangaroo site
- Signalisation of the Hickson Road / Napoleon Street intersection providing controlled pedestrian crossing movements across all four legs of the intersection.

Recently site access for construction workers was improved through the completion of the Wynyard Walk bridge. This provides safe and efficient access for construction workers walking across Sussex Street. The Wynyard Walk tunnel is scheduled to open in the second half of 2016. The proposed works involves no changes to arrangements for pedestrians and cyclists along Hickson Road. Where works are required that may temporarily impact access for pedestrians and/or cyclists, appropriate traffic control measures will be implemented (in consultation with the road authority).

5 Operational Stage Assessment

5.1 Car Park

5.1.1 Basement Car Parking

The basement car parking in Stage 1B will be provided in accordance with the rates noted in the Barangaroo Concept Plan approval. These rates are consistent with those outlined in TMAP 2008.

The commercial car parking provision is limited in accordance with the rates proposed in the TMAP 2008 and support the 4% car mode share outlined in the Barangaroo Concept Plan.

Parking rates for the residential component of the basement are based on the number and mix of apartments and derived via the parking rates specified in the City of Sydney LEP2005. These rates are summarised below:

- 0.5 spaces / 1 bedroom unit
- 1.2 spaces / 2 bedroom unit
- 2.0 spaces / 3 bedroom unit

Retail parking is proposed based on rates specified in the City of Sydney LEP2005, based on the formula below:

$$\text{Max number of cars} = \frac{(\text{Total Other FSA})}{(\text{Total FSA})} \times \frac{(\text{Site Area})}{50}$$

The final basement car parking provision will be determined separately by each of the building project applications.

5.1.2 Loading Dock

A loading dock is proposed to service the site with multiple points of vertical lift connections to both ground level and to each of the buildings above the basement. This provides good efficiency in terms of the layout, manoeuvring space and the ability for different sized truck spaces to be managed for appropriate use. The loading dock services the residential and retail components related to the Stage 1B basement. The proposed loading dock configuration is shown in Figure 11.

The loading dock and access ramp system has been designed in accordance with Australian Standards 2890.2- 2002, Off-street commercial vehicle facilities.

Four loading bays are to be provided which may accommodate the largest design vehicle (City of Sydney garbage vehicle). Additional service bays are to be provided for smaller vans and couriers. This arrangement offers good flexibility with respect to the variety of service vehicle movements expected within the Stage 1B site, including waste collection, furniture removal and retail servicing. The number and range of truck sizes provided for will be based on a fully shared facility with managed arrival times. A benefit of the centralised loading dock for the development is that storage areas for staging of goods delivery will enable a quick turnaround of vehicles.

A loading dock manager, if required, would be present on-site to control the movement of services vehicles within the loading dock area. All service vehicles would report to the dock manager on arrival, who would then direct them to their allocated parking space.

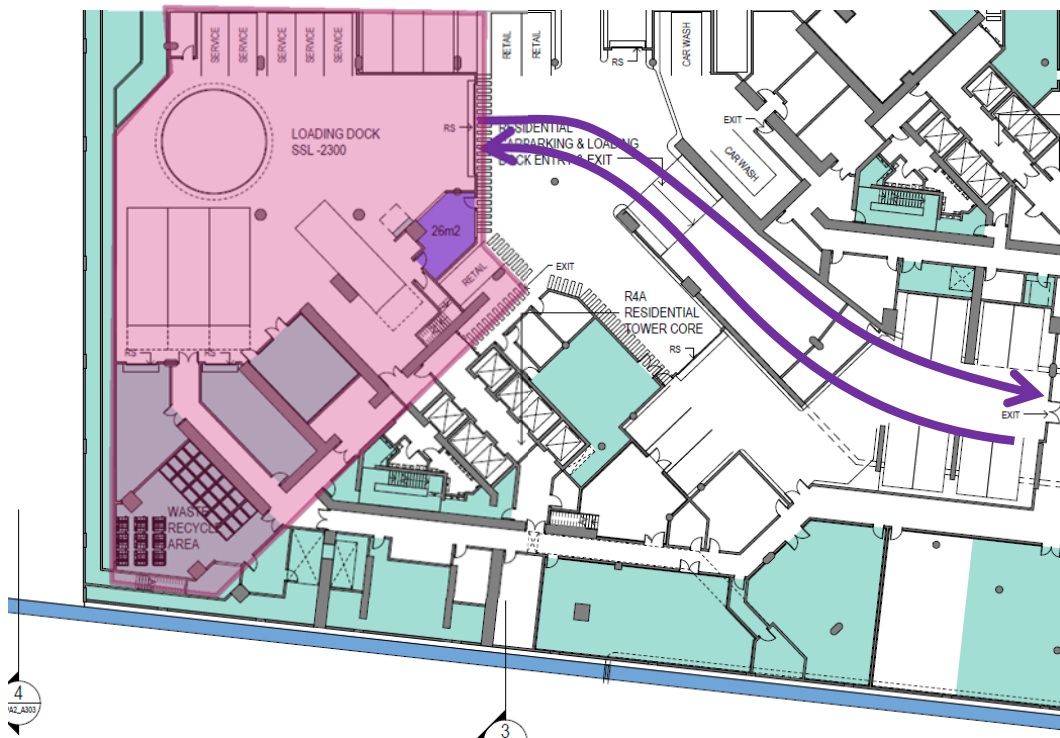
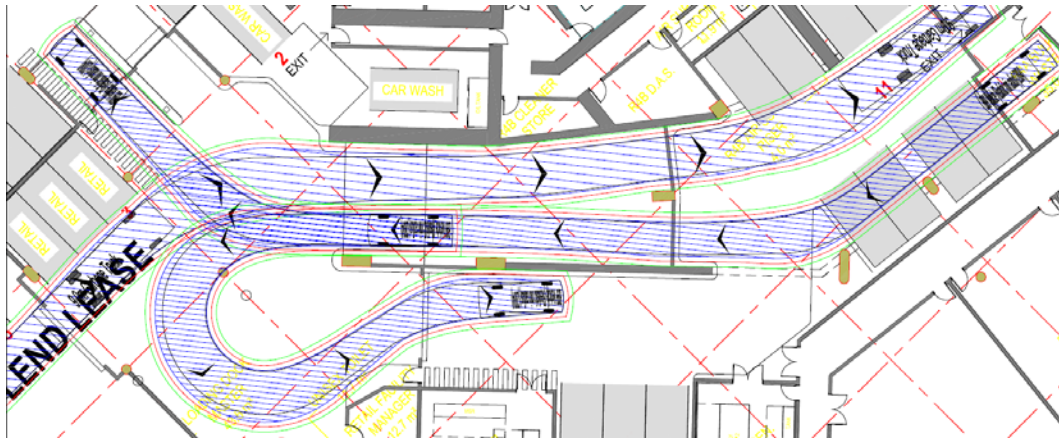


Figure 11 Indicative Loading Dock Configuration

To confirm vehicle manoeuvrability within the loading dock, a vehicle swept path analysis was undertaken. This analysed:

- A service vehicle passing a B99 vehicle (i.e. van) on the Stage 1B basement ramp (see Figure 12).
- Service vehicle manoeuvring within the loading dock (utilising the turntable to be provided); and
- Vertical clearance check to ensure the ramp has been designed with appropriate grades and transitions.

The results of the swept path analysis are shown in Appendix B, and demonstrate that the design of the vehicle access ramp and loading dock adequately addresses the requirements outlined in Australian Standards 2890.2- 2002, Off-street commercial vehicle facilities.



5.2 Basement Access Arrangements

Following the completion of the Stage 1B development, traffic signals will be installed at the Hickson Road / Watermans Quay intersection. This will improve traffic circulation and efficiency by providing for controlled vehicles movements between Hickson Road and Watermans Quay. The detailed design of the intersection, including the phasing and lane arrangements, would take place closer to the construction date and be subject to consultation with the Road Authority and RMS.

Access arrangements for the Stage 1B basement are illustrated in Figure 13.



Vehicles entering the basement at the shared residential/loading dock access will be directed to their final location through appropriate signage and line-marking. Entry to both the loading dock and residential car park would be controlled via boom gates and/or roller doors to prevent unauthorised vehicles accessing these areas.

5.3 Future Road Operations

5.3.1 Description

The operation of the road network following the full development of the Barangaroo precinct (including the Barangaroo Central and Barangaroo Reserve sites) has been modelled using the LinSig analysis software. The study has considered the operation of the following intersections:

- Hickson Road & Watermans Quay, **Traffic Signals (Future)**
- Napoleon Street & Hickson Road, **Traffic Signals**
- Sussex Street & Erskine Street, **Traffic Signals**
- Napoleon Street, Margaret Street & Kent Street, **Traffic Signals**

5.3.2 Modelling Assumptions

Existing models were calibrated to the observed situation and then forecasted to two additional scenarios for the AM and PM peak period: the future case excluding Stage 1B works and the future case including the Stage 1B works. The following points describe the key modelling assumptions made:

- A global heavy vehicle average of 4.57% was assumed across the network, as an equivalent passenger car unit (PCU) of 2.
- Coordination of intersection phasing was optimised by LinSig
- Dead green time was used in LinSig to model certain locations to incorporate the impacts of a heavily congested or restricted movement – specifically queue spillback from upstream and downstream intersections
- Base saturation flows were input based on the Austroads Guide to Traffic Management (AGTM03-09 Traffic Studies and Analysis)
 - Environment Class C assumed due to high activity nature in the CBD area surrounding the site
 - All dedicated left and right turn movements classified as a restricted turning lane (Type 3) due to high activity nature in the CBD area surrounding the site. Type 3 refers to restricted turning lanes in the Austroads Guide to Traffic Management (AGTM03-09 Traffic Studies and Analysis, pg. 75)

5.3.3 Traffic Distribution

Traffic associated with the new development has been distributed across the road network based on Journey to Work Census data, consistent with the assumptions outlined in the MWT Modified Concept Plan – Transport Report, July 2008. This is summarised in Table 8 and Figure 14,

Table 8 Development Traffic Distribution

Direction	Route	Distribution
North	Harbour Bridge	40.7%
East	Eastern Distributor	22.9%
	William Street	1.5%
	Oxford Street	4.1%
South	Harbour Street	8.6%
West	Western Distributor	21.8%
Sydney Inner	-	0.4%
Total		100%



Figure 14 Arrival and Departure Traffic Routes

Source: Barangaroo Integrated Transport Plan, Figure 7

5.3.4 Traffic Generation

Based on the adopted traffic generation rates used for previous planning applications for the Barangaroo development, Stage 1B would generate 109 vehicle movements in the AM peak hour and 70 vehicle movements in the PM peak hour, as summarised in Table 9 below. Given the retail uses will be ancillary to the residential development, it is expected this will generate minimal traffic movements

Table 9 Stage 1B Traffic Generation

Land Use	Variable	Variable Number	AM Peak Hour (8am – 9am)				PM Peak Hour (5pm – 6pm)			
			trip rate	no of trips	In	Out	trip rate	no of trips	In	Out
Residential	dwelling	775 [^]	0.14	108	22	86	0.09	69	55	14
Retail	car space	3 [^]	0.40	1	1	0	0.40	1	0	1
Sub Total				109	23	86		70	55	15

[^] To be confirmed, final provision to be determined by each of the building project applications

It is important to note that the quantum of traffic generated by the residential uses is based on the total number of dwellings provided and is independent of the number of resident parking bays. The parking provision for residential uses responds to the level of car ownership expected.

Car ownership levels for residents of the Sydney Inner SLA have been steadily increasing over the past decade, rising from 0.81 cars/dwelling in 2001 to 0.87 cars/dwelling in 2011. This is similar to the trends seen across much of Sydney, with cars becoming more affordable as tariffs fall with a larger stock of cheaper new cars and increasing household income.

The census data also shows that while car ownership has risen over the past decade, private vehicle use for journey to work trips has *decreased*. This indicates that car ownership does not necessarily lead to car usage in the busy commuter peak periods, for areas well served by public transport such as Barangaroo.

This trend is illustrated in Figure 15.

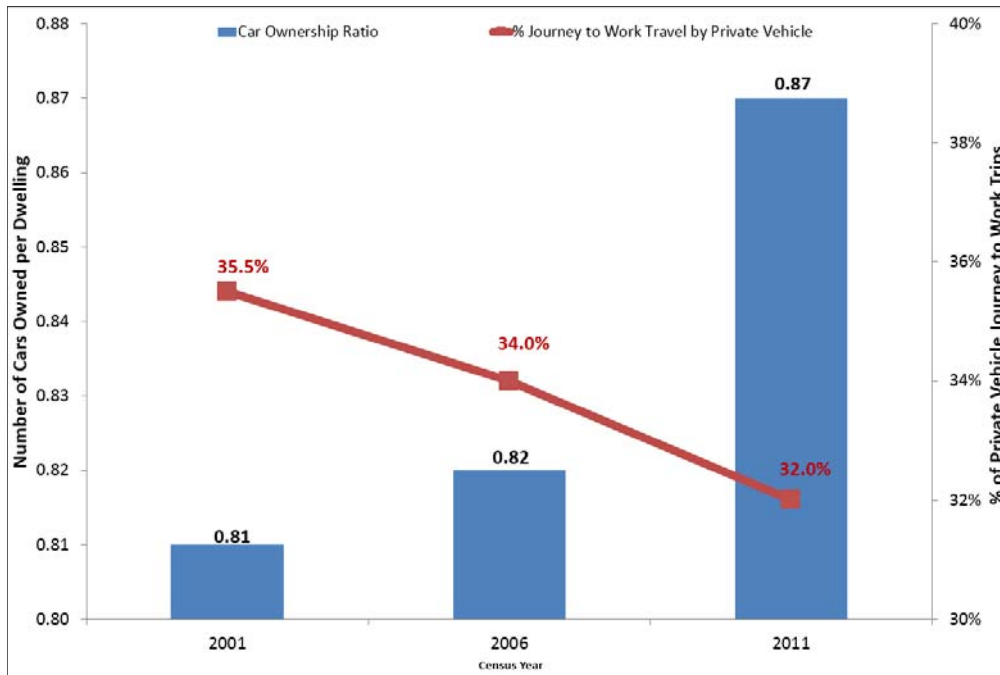


Figure 15 Trends in car ownership and private vehicle usage, Sydney SLA

5.3.5 Intersection Operation

A corridor traffic model (using the LinSig 3.2 software package) was developed to assess the future road network performance arising from the development of the Barangaroo precinct – including the development of the Stage 1B site. This modelling software allows intersections to be modelled in a single network and provides signal optimisation to reflect future traffic conditions within the Barangaroo precinct.

The road network performance has been measured against three parameters, those being:

- Level of Service (LOS)
- Degree of Saturation (DOS)
- Average Vehicle Delay (AVD)

The performance of intersections in an urban environment is measured in terms of its Level of Service (LoS). Levels of service ranges from A (very good) to F (over capacity with significant delays). This is described in the RTA Guide to Traffic Generating Developments as summarised in Table 10. Across the Sydney CBD road network, it is not uncommon for intersections to operate at Level of Service E or F (at capacity) during commuter peak hours.

Table 10 Intersection level of service

Level of Service	Average Vehicle Delay (seconds)	Traffic Signals and Roundabouts	Priority Intersections ('Stop' and 'Give Way')
A	< 14	Good operation	Good operation
B	15 to 28	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity and accident study required
E	57 to 70	At capacity. At signals, incidents will cause excessive delays. Roundabouts require other control mode	At capacity; requires other control mode
F	>71	Unsatisfactory with excessive queuing	Unsatisfactory with excessive queuing; requires other control mode

Another common measure of intersection performance is the degree of saturation, which provides an overall measure of the capability of the intersection to accommodate additional traffic. A DOS of 1.0 indicates that an intersection is operating at capacity.

The results of the traffic modelling are summarised in Table 11 below. Full analysis is provided as an Appendix A.

Table 11 Traffic Modelling Results

Peak	Intersection	Without Stage 1B Development			With Stage 1B Development		
		AVD (sec)	LOS	DOS	AVD (sec)	LOS	DOS
AM	Sussex Street / Erskine Street	42	C	0.91	41	C	0.91
	Hickson Road / Napoleon Street	36	C	0.95	41	C	0.96
	Kent Street / Margaret Street	25	B	0.87	30	C	0.94
	Hickson Road / Watermans Quay	20	B	0.91	21	B	0.91
PM	Sussex Street / Erskine Street	60	E	0.98	63	E	0.98
	Hickson Road / Napoleon Street	55	D	0.98	64	E	0.99
	Kent Street / Margaret Street	45	D	0.94	47	D	0.95
	Hickson Road / Watermans Quay	8	A	0.76	8	A	0.76

LOS - Intersection Traffic Level of Service, DOS - Degree of Saturation, AVD - Average Delay per vehicle

A key finding of the analysis is that there are minimal changes in the operation of the local road network as a result of the Stage 1B development. The traffic analysis indicates the transport network in the Barangaroo precinct could accommodate the increased movements arising from the development of the site. This is consistent with the findings of the traffic modelling recently conducted for the modification of the Barangaroo Concept Plan (MP06_0162).

It is recognised that significant vehicle queuing currently occurs in the southbound direction on Sussex Street in the PM Peak hour as a result of more congested traffic operating conditions in the vicinity of the cross traffic movements at the King Street and Market Street intersections. It should be recognised that this is an existing issue which is not the direct result of the proposal.

The operation of the future signalised intersections on Hickson Road will be dependent on the operating conditions of intersections further downstream on Sussex Street. Essentially they will act as 'slave' in the Sussex Street road network, with intersections at King Street and Market Street acting as the 'masters'.

In this context, the road network impacts of the proposal are considered acceptable.

5.4 Pedestrian Accessibility

The site will be well serviced by a number of pedestrian routes which link with the wider Barangaroo precinct. A number of zebra crossings are proposed which are located on major pedestrian desire lines to facilitate the safe movement of pedestrians to and from the site.

5.4.1 Pedestrian Desire Lines

The main pedestrian desire lines for residents of the Stage 1B development will be to/from the commercial development in the southern end of the site and Wynyard public transport hub. Appropriate at-grade pedestrian crossing facilities (either pedestrian signals or zebra crossings) are planned throughout the precinct to ensure pedestrians are provided with safe and efficient road crossing opportunities along key desire lines as shown in Figure 16.

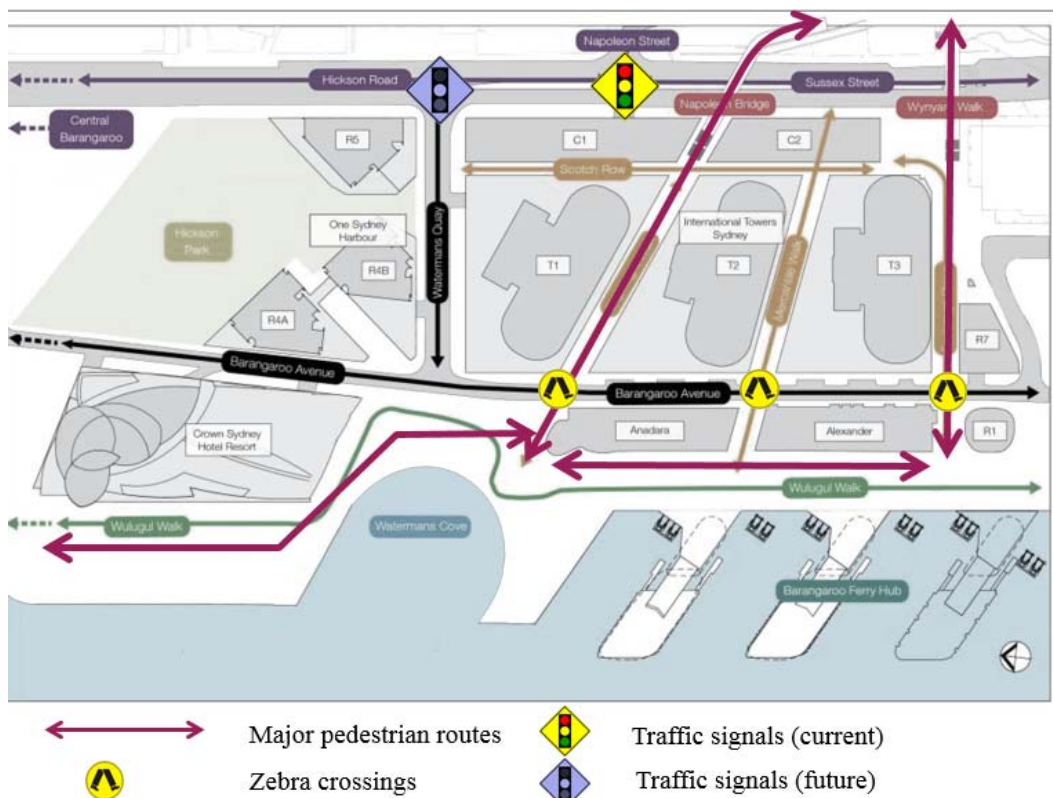


Figure 16 Major Pedestrian Routes

5.4.2 Pedestrian Linkages

For the ultimate Barangaroo development the following pedestrian linkages are proposed:

Wynyard Walk:

The NSW Government has commenced work on Wynyard Walk (previously Barangaroo Pedestrian Link), a direct pedestrian link between the new Barangaroo development and Wynyard Station and transport interchange. The Wynyard Walk will provide a high level of access to public transport for the growing western corridor of the CBD, including Barangaroo and the King Street Wharf. Wynyard Walk will allow people to access Barangaroo from Wynyard Station in approximately six minutes. The Wynyard Walk bridge (over Sussex Street) opened in 2015, with the new tunnel connection to open in 2016. The proposed route for Wynyard Walk is shown in Figure 17.



Figure 17 Wynyard Walk (Source: REF April 2012, Transport for NSW)

City Walk Bridge:

A new pedestrian link bridge over Sussex Street/Hickson Road located close to the intersection of Hickson Road and Napoleon Street which links into the Wynyard Walk. The facility will enhance connectivity between Barangaroo South and the Wynyard Station precinct. The bridge opened in July 2015. An overview of the City Walk Bridge alignment is presented in Figure 18.

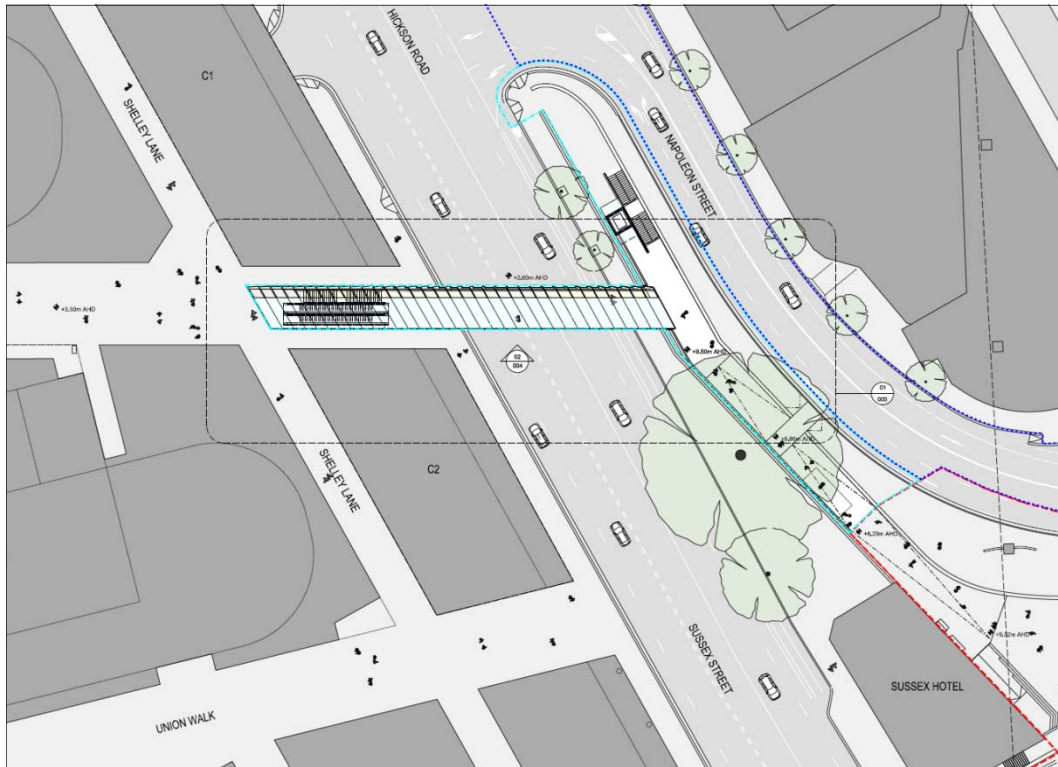


Figure 18 City Walk Bridge

A number of additional pedestrian connections are proposed to service the Barangaroo Central and Barangaroo Reserve precincts. This includes new pedestrian bridges over Hickson Road at High Street and Jenkins Street, as well as a permeable internal pedestrian network which provides connections to Barangaroo South. These are consistent with the connections identified in the Barangaroo Integrated Transport Plan as illustrated in Figure 19.

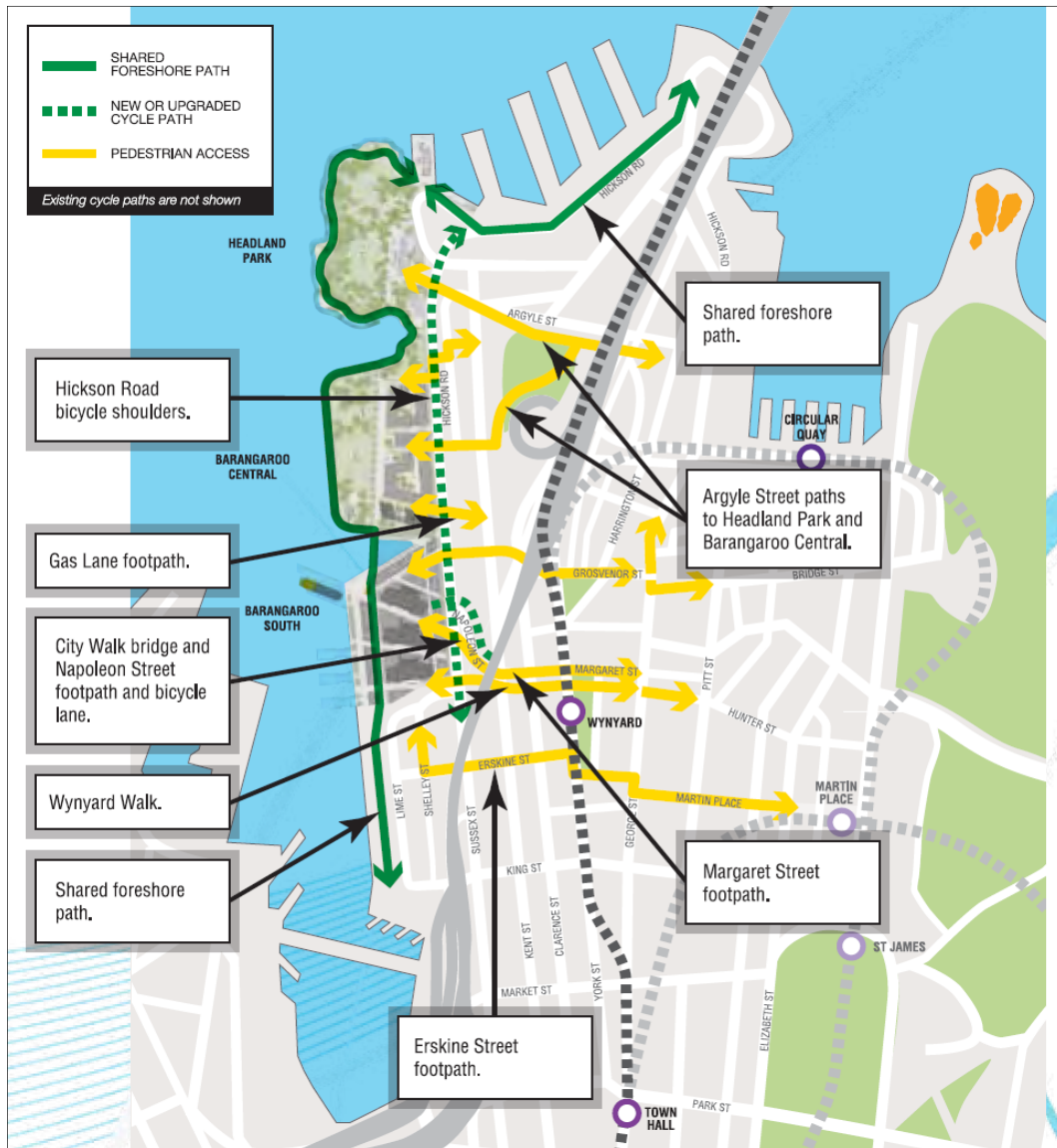


Figure 19 Pedestrian Routes

Source: Barangaroo Integrated Transport Plan, Figure 5

5.5 Public Transport Accessibility

5.5.1 Heavy Rail

The NSW Long Term Transport Masterplan released in December 2012 outlines a 20 year plan and includes the following rail projects for Sydney:

- North West and South West Rail Lines
- Sydney Metro
- Wynyard Station improvement works

North West Metro

Although the Metro scheme has been cancelled by the NSW Government, the metro corridor under Barangaroo South is being maintained.

Wynyard Station

A significant number of work trips into Barangaroo are anticipated to occur by rail, with Wynyard Station to act as the major transport hub. Actions relating to Wynyard Station in the Sydney City Centre Access Strategy include:

- Better interchange facilities for rail and bus passengers at the station and at Barangaroo.
- Station refurbishment.
- Station upgrade in the longer term.

In May 2014 the NSW Government announced a \$100 million upgrade of Wynyard Station. The works include an upgrade to the CBD station's concourse and platforms, new lighting, tiling and signage to improve wayfinding.

Transport for NSW has engaged the Novo Rail Alliance to design and deliver \$10 million worth of early works for the station. Subject to planning approvals, major construction for the Wynyard Station upgrade commenced in mid 2015 and is expected to finish in 2016. Key features of the works include:

- New, premium fixtures and finishes, such as lighting, tiling and painting;
- Widened paid concourse and ticket gates;
- Reduced clutter on the concourse and platforms;
- Upgraded existing and new platform stairs to improve pedestrian circulation and reduce queuing;
- New wayfinding and signage to make it easier for customers to move in and around the Station;
- Improving operational reliability through upgraded services and removal of redundant services; and
- Renovated back of house areas, including new and relocated Station Manager's office.

South West Rail Link

The South West Rail Link opened to the public in early 2015 and includes:

- A new 11.4-kilometre rail line from Glenfield to Leppington
- Two new stations located at Edmondson Park and Leppington, including commuter car parking
- A train stabling facility at Rossmore
- An upgrade of the existing Glenfield Station and bus/rail interchange, including new commuter car parking construction of Glenfield North and Glenfield South rail flyovers

Sydney Metro

Sydney Metro is the next major rail project identified in Sydney's Rail Future. Sydney Metro scope has been developed to meet the Project objectives and deliver key elements of Stages 4 and 5 of Sydney's Rail Future.

In June 2014 the NSW Government announced the Sydney Metro concept, including the Sydney Harbour Crossing and Western Extension to Bankstown proposals. The project would extend rapid transit under Sydney Harbour, through the central business district (CBD) of Sydney and west to Bankstown, with capacity to run up to 30 trains per hour in each direction through the city on the new line.

The Project represents a major increase in the capacity of Sydney's rail network, providing a 60 per cent increase in the number of trains in the peak periods and catering for an extra 100,000 customers per hour. Sydney Metro would significantly improve reliability across the rail network by addressing current and emerging constraints such as train crowding, platform and station crowding, and network complexity.

Sydney Metro Northwest is currently under construction and includes eight new fully accessible railway stations and 4,000 commuter car parking spaces. Metro services will start in the first half of 2019 with a train every four minutes in the peak, or 15 trains an hour.

In June 2015 the NSW Government announced a new station would be constructed at Barangaroo as part of the Sydney Metro project. Based on patronage modelling undertaken by Sydney Metro, delivery a new station at Barangaroo will in the morning peak, reduce entries and exits at both Wynyard Station and Martin Place station by approximately 5,000 passengers. This station will significantly improve public transport access for people traveling to and from the Barangaroo precinct.

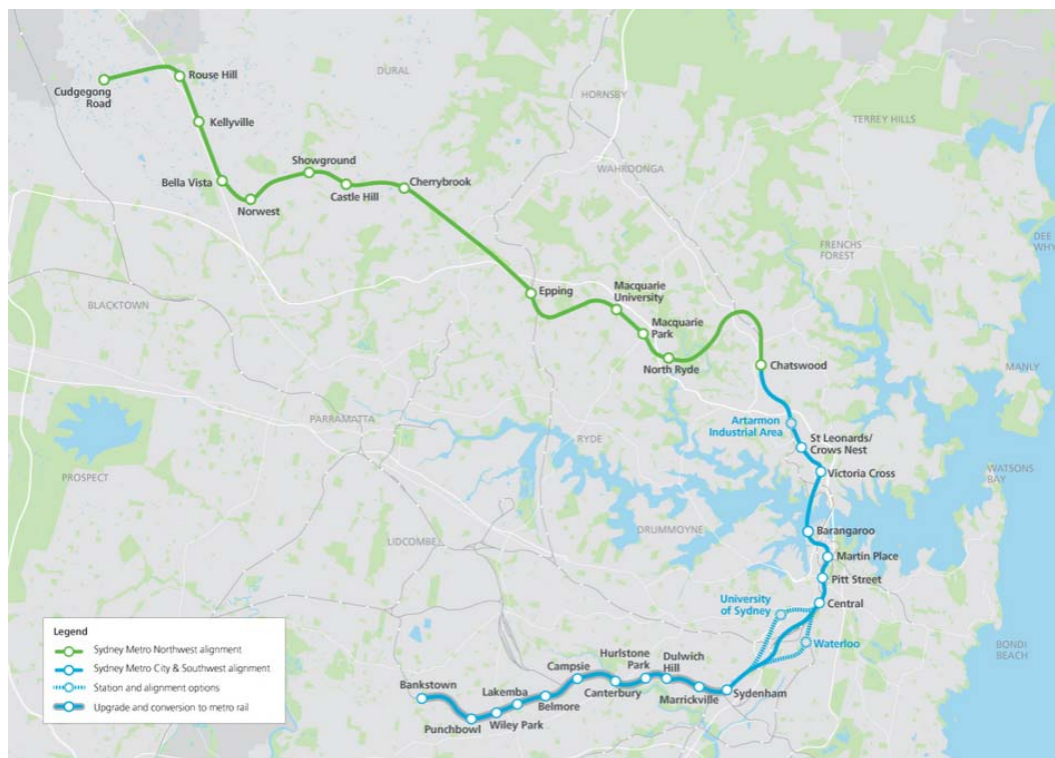


Figure 20 Sydney Metro Project

Source: Transport for NSW

5.5.2 Bus Services

The Sydney City Centre Access Strategy outlines a redesigned bus network which improves bus reliability and address congestion and capacity constraints. Some of the key proposals relevant to the Barangaroo development include:

- New bus routes will run to Barangaroo and Walsh Bay via the city centre, Napoleon Street and Hickson Road
- The major bus stop precinct serving Barangaroo will be in the area surrounding Wynyard Station on York, Clarence and Kent Streets.
- Approximately every second bus service on key Inner West bus routes entering the city centre via Broadway will only operate to Central. This will reduce the number of buses unnecessarily entering the city centre. The remaining services will continue to the northern end of the city centre via Elizabeth Street northbound and Castlereagh Street southbound.
- Bus routes servicing the Eastern Suburbs will utilise Elizabeth Street. Passengers travelling to Barangaroo will alight at Martin Place and walk through the city and across Wynyard Walk

The future city centre bus network is summarised in Figure 21.

Locations for new bus stops to serve the future routes along Hickson Road and Sussex Street are currently being investigated by Transport for NSW. These stops would be in close proximity to Barangaroo South and provide good accessibility for commuters and visitors travelling to the precinct. Please note temporary bus stops will be placed along Hickson Road during light rail construction.

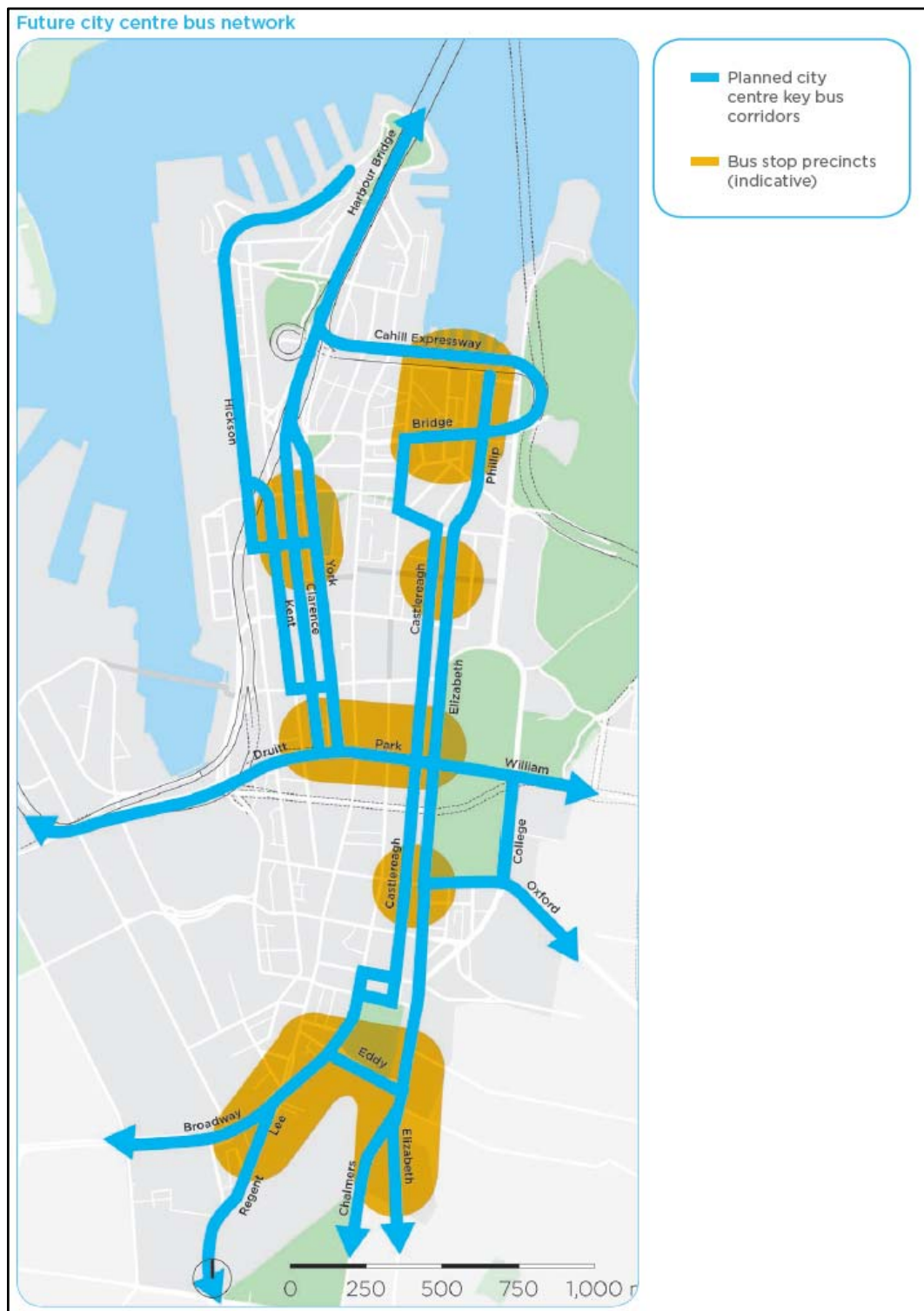


Figure 21 Future City Centre Bus Network

Source: Sydney City Centre Access Strategy (NSW Government, 2013)

In July 2015 the NSW Government announced a series of bus routes will directly service the Barangaroo precinct. These services all run along Hickson Road adjacent to Barangaroo South, terminating at Walsh Bay, and include:

- Route 311
- Route 324
- Route 325

These services are to be operational from 4 October 2015, and are illustrated in Figure 22 below.

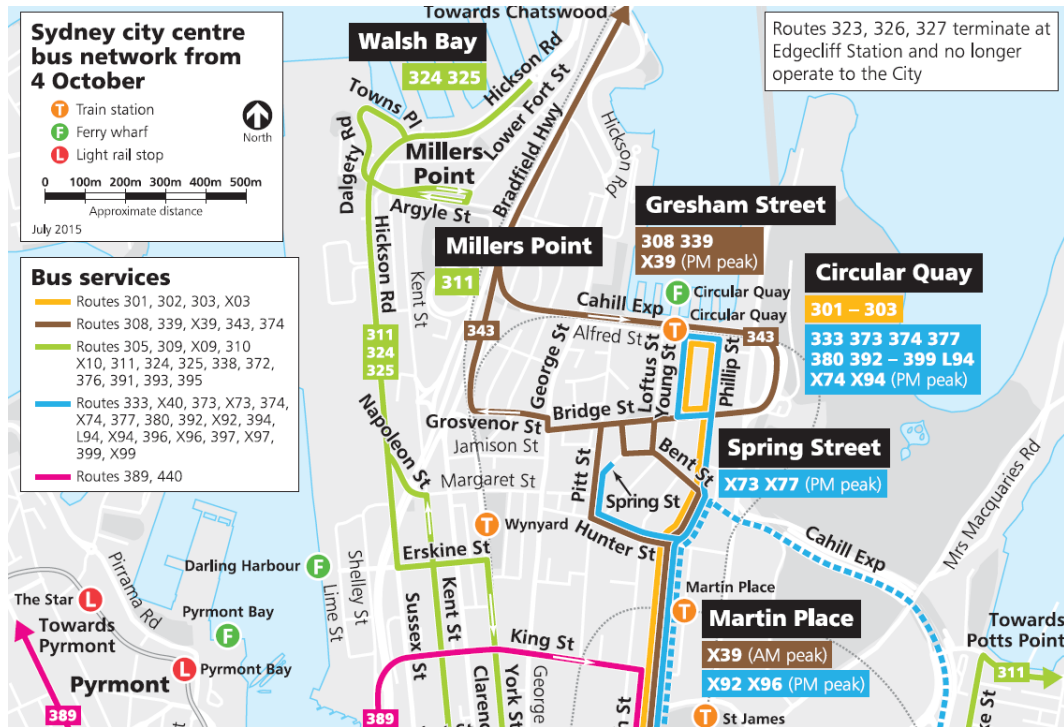


Figure 22 Bus services post 4 October 2015

5.5.3 Ferry

Existing commuter ferry services providing access to Barangaroo and the CBD arrive and depart from King Street Wharf (number 3) and Circular Quay.

The Sydney City Centre Access Strategy commits to constructing a new ferry hub at Barangaroo, delivered in time for major tenants moving in to the development. This new wharf will support the commercial development of the precinct, with new ferry services anticipated from the east and north, as well as the existing western ferry catchments.

The new ferry hub will service the new development and connect ferry users to the western and midtown parts of the city centre via the Wynyard Walk link. It will reduce capacity constraints on the Circular Quay terminal and will bring additional ferry services and routes directly to Barangaroo. The Barangaroo Ferry Hub proposal initially commits to the construction of two wharves. However provision is made within the design for the construction of a third wharf based on future demand and uptake.

A planning application for the construction and operation of a ferry hub was lodged to the Department of Planning and Environment in December 2014. The proposal has been approved.

An illustration of the proposal is shown in Figure 23 below.

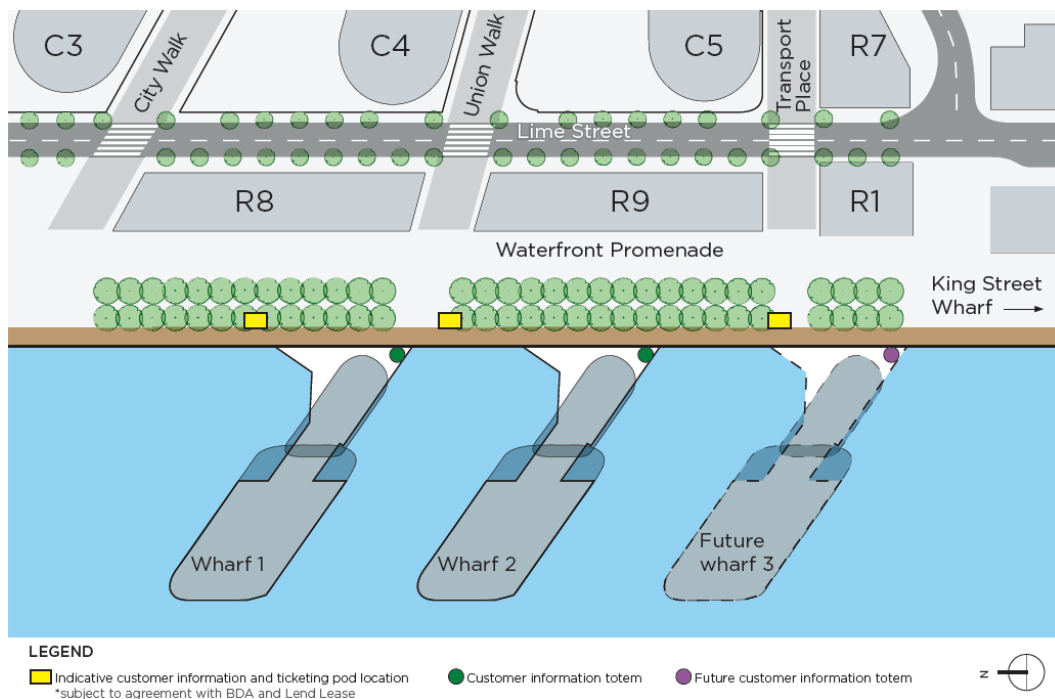


Figure 23 Barangaroo Ferry Wharf

Source: Barangaroo Ferry Hub Submission Report (Transport for NSW, 2015)

5.5.4 Light Rail

In December 2012, the NSW Government released 'Sydney's Light Rail Future'. This document details plans for expanding the existing light rail network to the Sydney CBD and South Eastern Sydney as well as the completion of the Inner West Light Rail extension. It could be expected that public transport patronage to Barangaroo from the inner west would shift mode from bus and rail as a result of these extensions.

Inner West Light Rail Extension

The first stage of the inner-west light rail extension is a 5.6km extension running between Lilyfield and Dulwich Hill as shown in Figure 24. It will run from the current light rail terminus at Lilyfield, along the disused freight rail corridor, to Dulwich Hill. The extension opened in March 2014.

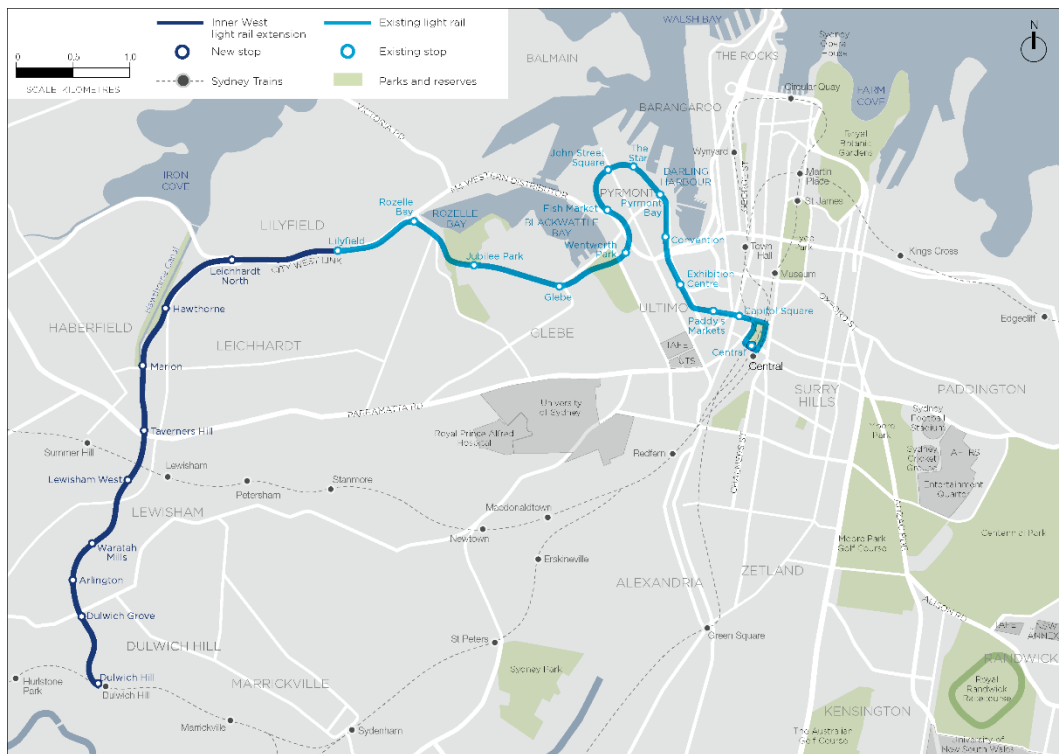


Figure 24 Inner-West Light rail extensions

CBD and South East Light Rail The CBD and South East Light Rail link will connect Circular Quay to the University of New South Wales via Anzac Parade and Alison Road. The integration of existing and planned light rail networks would further enhance patronage by this mode to Barangaroo. This link will include the pedestrianisation of a 1 kilometre section of George Street, between Bathurst and Hunter Streets. Construction commenced in 2015.



Figure 25 CBD and South East Light Rail Route Map

5.6 Cycling

5.6.1 External Bicycle Network

The Sydney City Centre Access Strategy outlines the future city centre cycleway network to encourage growth in cycling and reduce pressure on the public transport system. Measures proposed include:

- Extending the Kent Street cycleway south to Liverpool Street
- Construction of a bi-directional cycleway on Liverpool Street
- Construction of a bi-directional cycleway on Castlereagh Street and Pitt Street, providing a new north-south connection through the CBD
- Extending the existing King Street cycleway to Castlereagh Street
- Extending the east- west cycleway along Park Street to Castlereagh Street

The Strategy's strategic cycleway network map (see Figure 26) indicates future cycleway connections into Barangaroo to be via the Pyrmont Bridge cycleway and the Harbour Bridge cycleway. These new links are yet to be determined.



Figure 26 Strategic Cycleway Network Map

Source: Sydney City Centre Access Strategy (NSW Government, 2013)

The primary route for riders travelling to the Stage 1B site from the north (via the Sydney Harbour Bridge cycleway) will be via the new cycleway along Napoleon Street. This is consistent with the City of Sydney cycling strategy. An alternative route exists via Argyle Street, Dalgety Road and Hickson Road. Many cyclists will find this route attractive given the low traffic volumes and the available road space.

Napoleon Street will form a link for cyclists travelling between the Stage 1B basement and the existing separated cycleway on Kent Street. An on-road bicycle lane has recently been installed for eastbound riders (uphill), with a mixed traffic environment in the westbound direction. This is consistent with the scheme identified in the Barangaroo Integrated Transport Plan.

A bi-directional separated cycleway is envisaged on the eastern side of Hickson Road, up to the intersection with Towns Place. This is currently under investigation by Lend Lease in conjunction with the road authority and other stakeholders. Beyond this point, the existing single direction on-road cycle lane will facilitate the movement of cyclists onwards towards The Rocks and Circular Quay. It is assumed the cycleway will commence at Shelley Street, which will provide a link to the new Transport Place.

5.6.2 Internal Bicycle Network

Cycling within Barangaroo will be confined to the internal road network, i.e. along Watermans Quay and Barangaroo Avenue. These will function as mixed traffic streets given the relatively low levels of vehicular traffic and anticipated 40km/hr speed limit. On-road bicycle symbols can be provided at minimum 200m intervals towards the centre of the travel lane to signify to drivers the presence of cyclists along these routes. The route along Barangaroo Avenue will connect with a recreational cycle route which continues through Barangaroo Central and into Barangaroo Reserve.

The foreshore promenade will primarily act as a pedestrian pathway however cycling will not be prohibited. A low speed environment will be promoted where cyclists will be required to give way to pedestrians at all times. This will be similar to the operation of the adjacent King Street Wharf and Darling Harbour.

Access for cyclists to the Stage 1B site will be via the vehicle access ramp at the western end of Watermans Quay, designated as a recreational bicycle route. The low vehicle speeds (signposted speed limit expected to be 40km/h) and traffic volumes along Watermans Quay make this a suitable cycling route.

The planned internal cycle network is outlined in Figure 27.

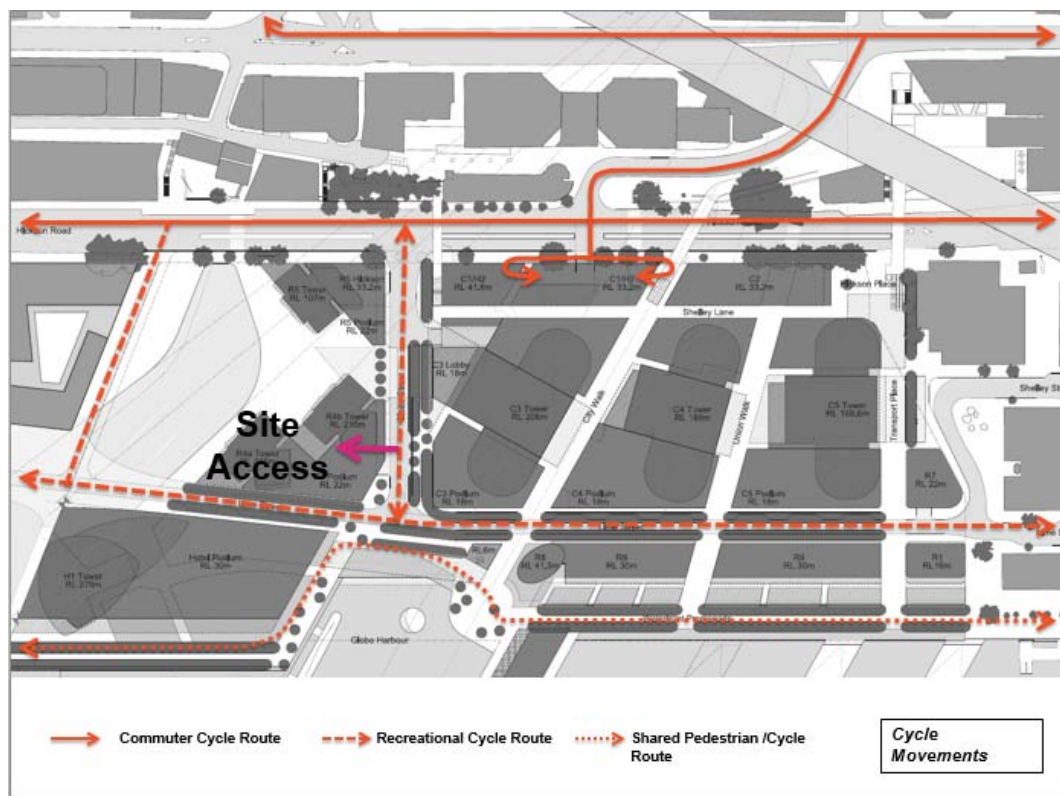


Figure 27 Internal Bicycle Network

6 Summary

This transport assessment supports a State Significant Development Application (SSD 6960) seeking approval for construction of the Stage 1B Basement and associated works at Barangaroo South.

Access to the basement car park for all vehicle types (residential, retail and service vehicles) is to be via the western end of Watermans Quay. The primary vehicular access route into and out of the site will be via Sussex Street, Hickson Road and Watermans Quay.

Parking will be provided in this application in accordance with the rates noted in the Barangaroo Concept Plan approval. The final basement car parking provision will be determined separately by each of the building project applications.

A loading dock is proposed to service the site with multiple points of vertical goods lift connection to both ground level and to each of the buildings above the basement. A number of loading bays are to be provided which may accommodate the largest design vehicle. In addition, a further six service bays are to be provided for smaller vans and couriers. This arrangement offers good flexibility with respect to the variety of service vehicle movements expected within the Stage 1B site, including waste collection, furniture removal and retail servicing.

The cumulative impacts of construction and development traffic activity associated with all works currently planned in the precinct have been assessed. The assessment concludes that the traffic impacts arising from the works proposed under the Development Application can be appropriately managed.

Appendix A

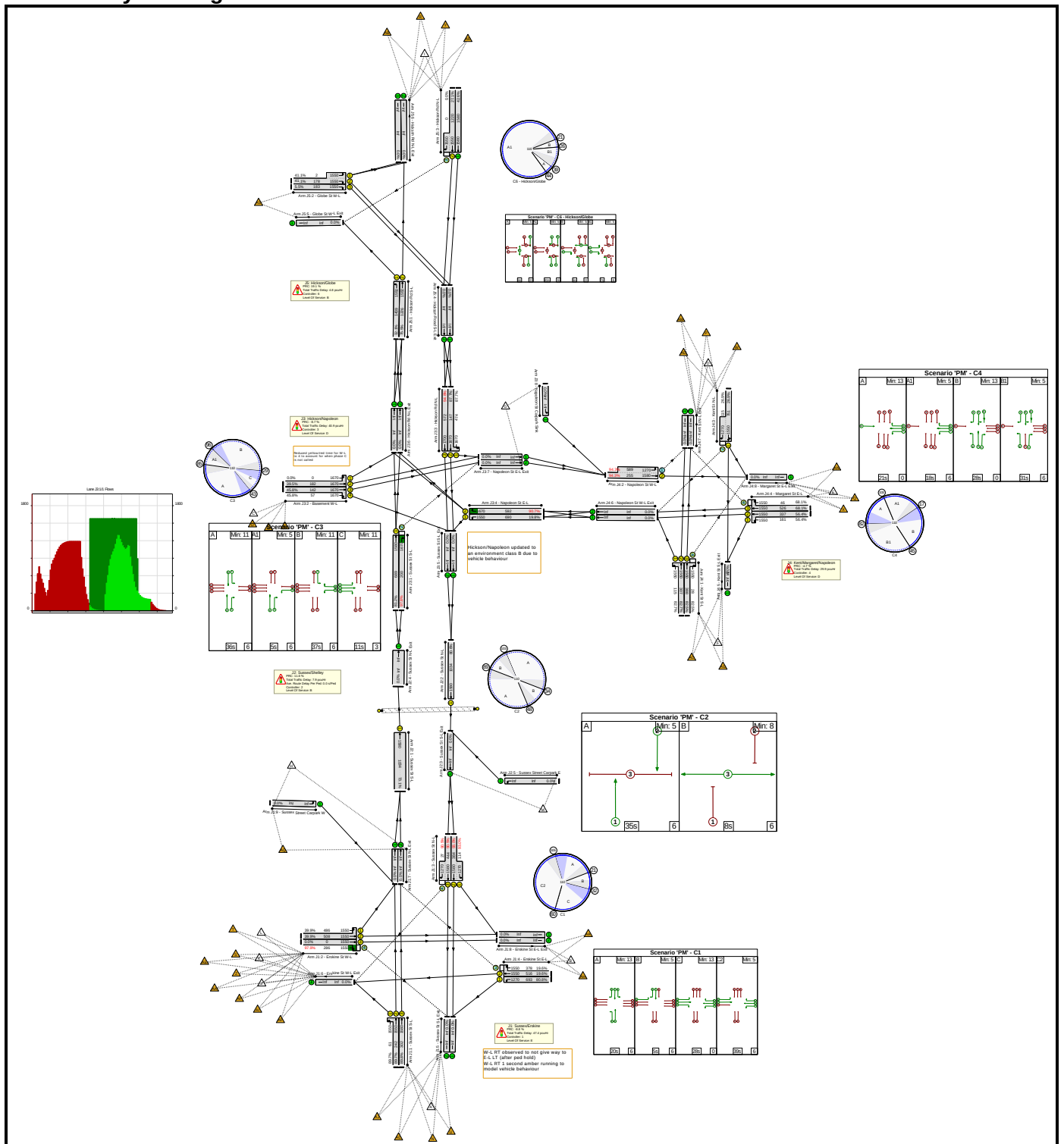
LinSig Modelling Outputs

Basic Results Summary

Basic Results Summary

Scenario 1: 'PM' (FG1: 'Flow Group 1', Plan 1: 'Network Control Plan 1')

Network Layout Diagram

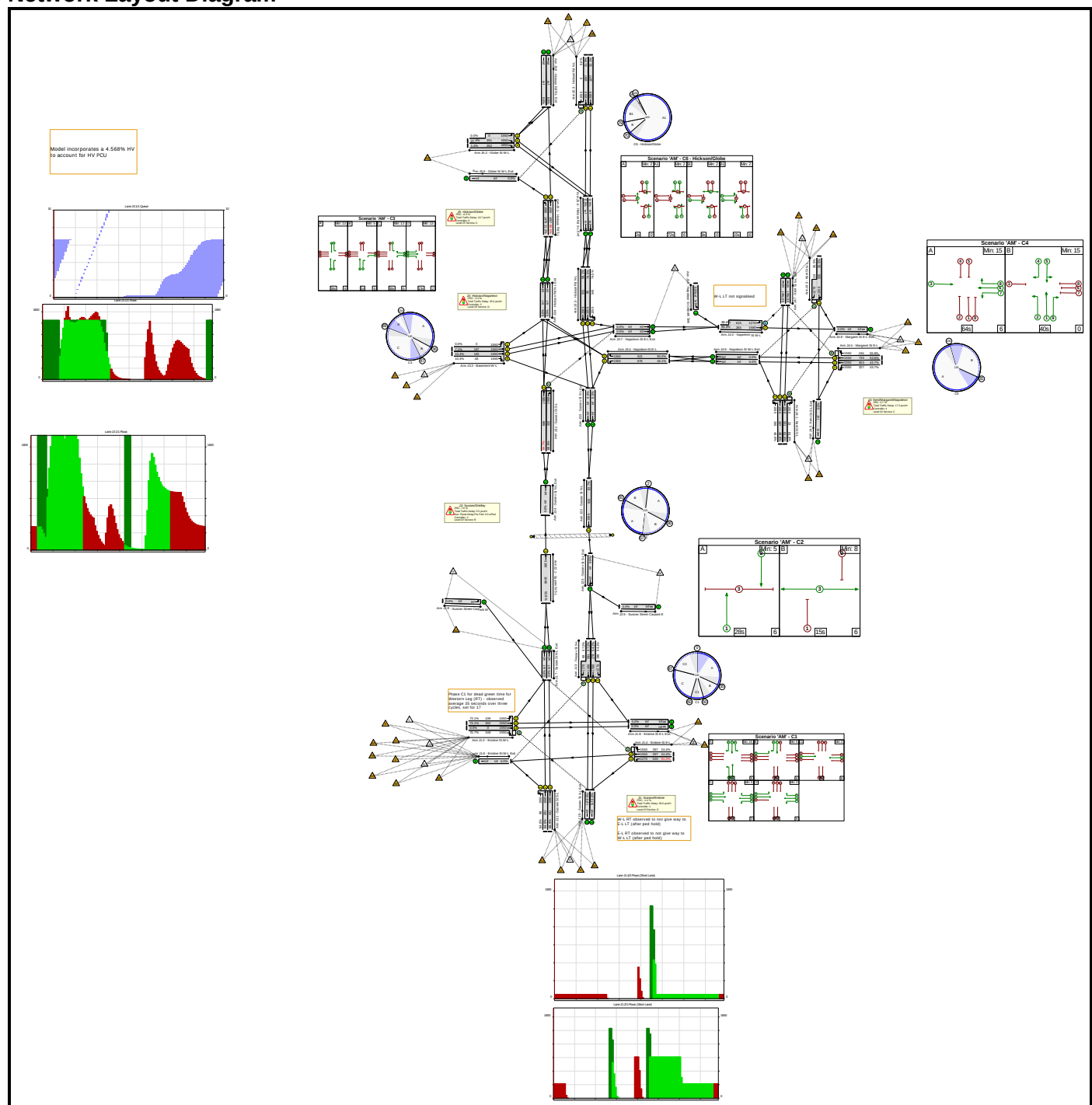


Basic Results Summary

Network Results

Item	Lane Description	Lane Type	Demand Flow (pcu)	Sat Flow (pcu/Hr)	Deg Sat (%)	Av. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)
Network	-	-	-	-	97.9%	-	-
J1: Sussex/Erskine	-	-	-	-	97.9%	-	-
1/2+1/1	Sussex St S-L Left Ahead	U	272	1550:1550	89.7 : 89.7%	90.5	11.4
1/3	Sussex St S-L Ahead	U	271	1580	89.8%	91.1	11.6
2/2+2/1	Erskine St W-L Left Ahead	U	397	1550:1550	39.9 : 39.9%	11.9	5.2
2/3+2/4	Erskine St W-L Right Ahead	U+O	280	1550:1550	0.0 : 97.9%	134.5	15.5
3/2+3/1	Sussex St N-L Ahead Left	U	463	1580:1270	93.0 : 93.0%	69.9	16.4
3/3+3/4	Sussex St N-L Ahead Right	U+O	426	1580:1270	90.5 : 90.5%	59.9	15.5
4/1	Erskine St E-L Left	U	560	1270	80.8%	33.5	15.9
4/2+4/3	Erskine St E-L Ahead Right	U+O	175	1550:1550	19.6 : 19.6%	12.9	1.6
J2: Sussex/Shelley	-	-	-	-	80.6%	-	-
1/1	Sussex St S-L Ahead	U	756	1580	73.1%	16.1	7.8
2/1	Sussex St N-L Ahead	U	834	1580	80.6%	19.5	18.6
Ped Link: P1	Shelley	-	0	-	0.0%	Inf	Inf
J3: Hickson/Napoleon	-	-	-	-	97.8%	-	-
1/1	Sussex St S-L Ahead	U	560	1580	81.2%	34.1	18.5
1/2	Sussex St S-L Right	O	196	1670	97.8%	154.5	12.0
2/2+2/1	Basement W-L Left Ahead	U	72	1670:1670	39.5 : 0.0%	61.9	2.4
2/3+2/4	Basement W-L Right Ahead	U	91	1670:1670	45.8 : 45.8%	62.0	2.8
3/2+3/1	Hickson Rd N-L Ahead Left	U	545	1670:1670	87.7 : 87.7%	40.5	15.1
3/3	Hickson Rd N-L Ahead	U	542	1700	94.8%	76.8	22.5
4/1	Napoleon St E-L Left	U	137	1550	19.8%	16.9	1.8
4/2	Napoleon St E-L Right	U	537	1670	90.7%	40.4	19.8
J4: Kent/Margaret/Napoleon	-	-	-	-	94.3%	-	-
1/2+1/1	Kent St S-L Left Ahead	U	349	1550:1550	82.7 : 82.7%	58.5	11.9
1/3+1/4	Kent St S-L Ahead Right	U+O	343	1550:1550	82.5 : 82.5%	60.8	12.0
2/2+2/1	Napoleon St W-L Left Ahead	U+O	795	1580:1270	94.3 : 94.3%	45.4	27.6
3/1+3/2	Kent St N-L Ahead Right Left	U+O	233	1550:1270	26.9 : 26.9%	17.6	3.4

Scenario 1: 'AM' (FG1: 'Flow Group 1', Plan 1: 'Network Control Plan 1')
Network Layout Diagram



Basic Results Summary

Network Results

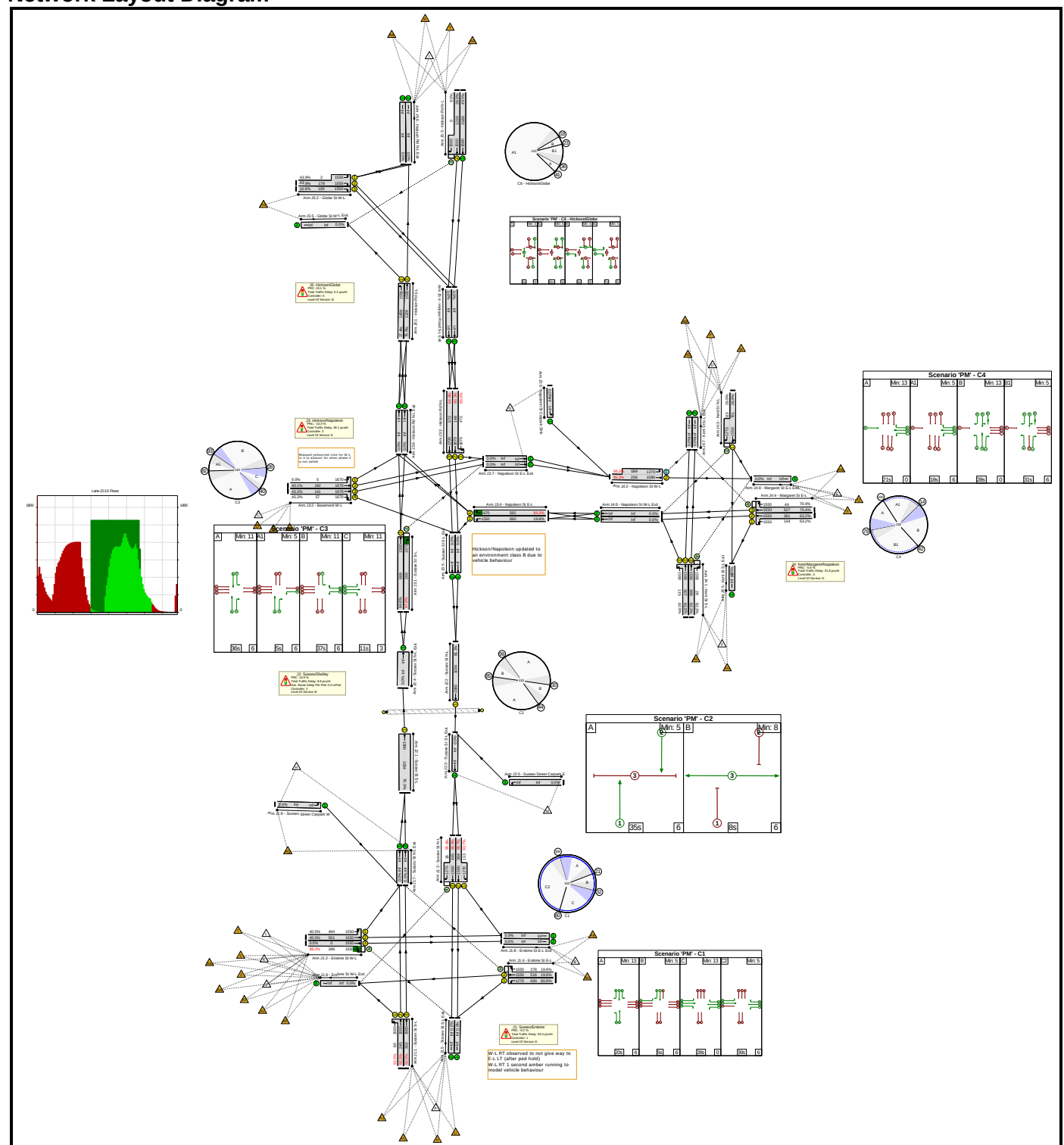
Item	Lane Description	Lane Type	Demand Flow (pcu)	Sat Flow (pcu/Hr)	Deg Sat (%)	Av. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)
Network	-	-	-	-	94.7%	-	-
J1: Sussex/Erskine	-	-	-	-	91.2%	-	-
1/2+1/1	Sussex St S-L Left Ahead	U	243	1550:1550	64.0 : 64.0%	49.2	7.1
1/3	Sussex St S-L Ahead	U	297	1580	68.9%	49.1	9.2
2/2+2/1	Erskine St W-L Left Ahead	U	542	1550:1550	73.1 : 73.1%	29.9	13.1
2/3+2/4	Erskine St W-L Right Ahead	U+O	246	1550:1550	0.0 : 70.7%	55.5	7.9
3/2+3/1	Sussex St N-L Ahead Left	U	257	1580:1270	54.1 : 54.1%	34.7	2.9
3/3+3/4	Sussex St N-L Ahead Right	U+O	377	1580:1270	57.2 : 57.2%	24.2	5.2
4/1	Erskine St E-L Left	U	474	1270	91.2%	63.8	17.9
4/2+4/3	Erskine St E-L Ahead Right	U+O	167	1550:1550	24.4 : 24.4%	21.1	2.6
J2: Sussex/Shelley	-	-	-	-	83.7%	-	-
1/1	Sussex St S-L Ahead	U	882	3160	52.9%	7.6	2.9
2/1	Sussex St N-L Ahead	U	697	1580	83.7%	18.5	11.4
Ped Link: P1	Shelley	-	0	-	0.0%	Inf	Inf
J3: Hickson/Napoleon	-	-	-	-	94.7%	-	-
1/1	Sussex St S-L Ahead	U	653	1580	94.7%	47.4	18.6
1/2	Sussex St S-L Right	O	229	1550	68.9%	36.8	6.8
2/2+2/1	Basement W-L Left Ahead	U	14	1550:1550	7.1 : 0.0%	52.1	0.4
2/3+2/4	Basement W-L Right Ahead	U	22	1550:1550	10.4 : 10.4%	51.9	0.5
3/2+3/1	Hickson Rd N-L Ahead Left	U	475	1550:1550	74.5 : 74.5%	17.5	7.6
3/3	Hickson Rd N-L Ahead	U	309	1580	58.1%	31.5	8.4
4/1	Napoleon St E-L Left	U	312	1550	46.1%	18.5	5.3
4/2	Napoleon St E-L Right	U	469	1550	90.0%	53.0	17.5
J4: Kent/Margaret/Napoleon	-	-	-	-	86.8%	-	-
1/2+1/1	Kent St S-L Left Ahead	U	228	1550:1550	48.8 : 48.8%	38.1	5.4
1/3+1/4	Kent St S-L Ahead Right	U+O	373	1550:1550	63.8 : 63.8%	36.8	10.1
2/2+2/1	Napoleon St W-L Left Ahead	U+O	762	1580:1270	86.8 : 86.8%	22.4	29.6
3/1+3/2	Kent St N-L Ahead Right Left	U+O	219	1550:1270	35.5 : 35.5%	31.8	4.2

Basic Results Summary

4/2+4/1	Margaret St E-L Left Ahead	U	363	1550:1550	43.7 : 43.7%	18.6	6.4
4/3+4/4	Margaret St E-L Ahead Right	U+O	498	1550:1550	53.6 : 53.6%	17.6	9.2
J5: Hickson/Globe	-	-	-	-	90.5%	-	-
1/1	Hickson Rd S-L Left	U	166	1580	11.2%	1.4	0.1
1/2	Hickson Rd S-L Ahead	U	956	1550	90.5%	28.6	30.8
2/2+2/1	Globe St W-L Right Left	U	96	1550:1550	27.4 : 0.0%	42.1	2.6
2/3	Globe St W-L Right	U	5	1550	1.4%	38.4	0.1
3/1	Hickson Rd N-L Ahead	U	346	1580	32.1%	9.6	4.5
3/2+3/3	Hickson Rd N-L Ahead Right	U+O	337	1550:1550	31.9 : 0.0%	9.6	4.4
C6 - Hickson/Globe	C1	PRC for Signalled Lanes (%):	-1.4	Total Delay for Signalled Lanes (pcuHr):	30.05	Cycle Time (s):	110
	C2	PRC for Signalled Lanes (%):	7.6	Total Delay for Signalled Lanes (pcuHr):	5.45	Cycle Time (s):	110
	C3	PRC for Signalled Lanes (%):	-5.2	Total Delay for Signalled Lanes (pcuHr):	24.99	Cycle Time (s):	110
	C4	PRC for Signalled Lanes (%):	3.7	Total Delay for Signalled Lanes (pcuHr):	17.20	Cycle Time (s):	110
	C5	PRC for Signalled Lanes (%):	0.0	Total Delay for Signalled Lanes (pcuHr):	0.00	Cycle Time (s):	110
		PRC for Signalled Lanes (%):	-0.5	Total Delay for Signalled Lanes (pcuHr):	10.66	Cycle Time (s):	110
		PRC Over All Lanes (%):	-5.2	Total Delay Over All Lanes(pcuHr):	88.35		

Scenario 1: 'PM' (FG1: 'Flow Group 1', Plan 1: 'Network Control Plan 1')

Network Layout Diagram



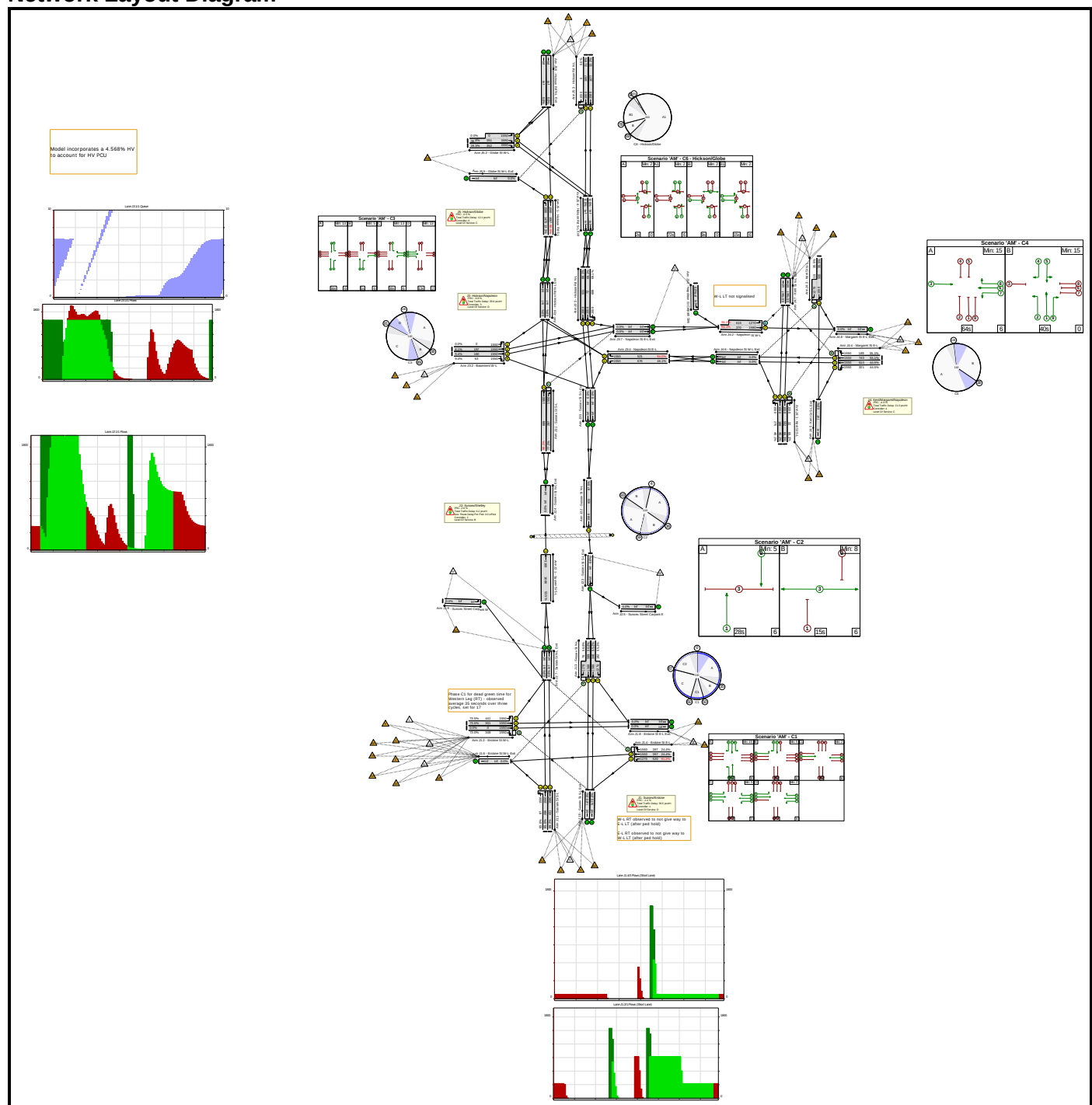
Basic Results Summary

Network Results

Item	Lane Description	Lane Type	Demand Flow (pcu)	Sat Flow (pcu/Hr)	Deg Sat (%)	Av. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)
Network	-	-	-	-	99.3%	-	-
J1: Sussex/Erskine	-	-	-	-	98.2%	-	-
1/2+1/1	Sussex St S-L Left Ahead	U	281	1550:1550	92.3 : 92.3%	99.9	12.5
1/3	Sussex St S-L Ahead	U	279	1580	92.5%	100.9	12.8
2/2+2/1	Erskine St W-L Left Ahead	U	403	1550:1550	40.5 : 40.5%	11.9	5.3
2/3+2/4	Erskine St W-L Right Ahead	U+O	281	1550:1550	0.0 : 98.2%	137.1	15.7
3/2+3/1	Sussex St N-L Ahead Left	U	466	1580:1270	93.7 : 93.7%	73.3	17.6
3/3+3/4	Sussex St N-L Ahead Right	U+O	428	1580:1270	90.9 : 90.9%	62.1	16.6
4/1	Erskine St E-L Left	U	560	1270	80.8%	33.5	15.9
4/2+4/3	Erskine St E-L Ahead Right	U+O	175	1550:1550	19.6 : 19.6%	12.9	1.6
J2: Sussex/Shelley	-	-	-	-	81.1%	-	-
1/1	Sussex St S-L Ahead	U	779	1580	75.3%	18.8	7.7
2/1	Sussex St N-L Ahead	U	839	1580	81.1%	20.2	18.1
Ped Link: P1	Shelley	-	0	-	0.0%	Inf	Inf
J3: Hickson/Napoleon	-	-	-	-	99.3%	-	-
1/1	Sussex St S-L Ahead	U	583	1580	84.6%	33.2	19.4
1/2	Sussex St S-L Right	O	196	1670	97.9%	151.1	12.0
2/2+2/1	Basement W-L Left Ahead	U	73	1670:1670	40.1 : 0.0%	62.1	2.4
2/3+2/4	Basement W-L Right Ahead	U	90	1670:1670	45.3 : 45.3%	61.9	2.8
3/2+3/1	Hickson Rd N-L Ahead Left	U	560	1670:1670	90.3 : 90.3%	46.9	17.2
3/3	Hickson Rd N-L Ahead	U	542	1700	94.8%	76.8	22.5
4/1	Napoleon St E-L Left	U	137	1550	19.8%	16.9	1.8
4/2	Napoleon St E-L Right	U	588	1670	99.3%	80.8	29.0
J4: Kent/Margaret/Napoleon	-	-	-	-	95.3%	-	-
1/2+1/1	Kent St S-L Left Ahead	U	350	1550:1550	82.9 : 82.9%	58.8	11.9
1/3+1/4	Kent St S-L Ahead Right	U+O	342	1550:1550	82.3 : 82.3%	60.5	11.9
2/2+2/1	Napoleon St W-L Left Ahead	U+O	805	1580:1270	95.3 : 95.3%	49.5	28.4
3/1+3/2	Kent St N-L Ahead Right Left	U+O	233	1550:1270	26.9 : 26.9%	17.6	3.4

Basic Results Summary

Scenario 1: 'AM' (FG1: 'Flow Group 1', Plan 1: 'Network Control Plan 1') Network Layout Diagram



Basic Results Summary

Network Results

Item	Lane Description	Lane Type	Demand Flow (pcu)	Sat Flow (pcu/Hr)	Deg Sat (%)	Av. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)
Network	-	-	-	-	96.2%	-	-
J1: Sussex/Erskine	-	-	-	-	91.2%	-	-
1/2+1/1	Sussex St S-L Left Ahead	U	249	1550:1550	65.0 : 65.0%	49.5	7.4
1/3	Sussex St S-L Ahead	U	298	1580	69.2%	49.2	9.2
2/2+2/1	Erskine St W-L Left Ahead	U	545	1550:1550	73.5 : 73.5%	30.1	13.2
2/3+2/4	Erskine St W-L Right Ahead	U+O	254	1550:1550	0.0 : 73.0%	57.1	8.4
3/2+3/1	Sussex St N-L Ahead Left	U	297	1580:1270	55.2 : 55.2%	33.1	3.3
3/3+3/4	Sussex St N-L Ahead Right	U+O	369	1580:1270	56.0 : 56.0%	22.7	4.9
4/1	Erskine St E-L Left	U	474	1270	91.2%	63.8	17.9
4/2+4/3	Erskine St E-L Ahead Right	U+O	167	1550:1550	24.4 : 24.4%	21.1	2.6
J2: Sussex/Shelley	-	-	-	-	87.5%	-	-
1/1	Sussex St S-L Ahead	U	892	3160	53.5%	7.1	3.0
2/1	Sussex St N-L Ahead	U	729	1580	87.5%	22.0	12.2
Ped Link: P1	Shelley	-	0	-	0.0%	Inf	Inf
J3: Hickson/Napoleon	-	-	-	-	96.2%	-	-
1/1	Sussex St S-L Ahead	U	663	1580	96.2%	54.2	20.4
1/2	Sussex St S-L Right	O	229	1550	77.2%	48.8	8.3
2/2+2/1	Basement W-L Left Ahead	U	16	1550:1550	8.1 : 0.0%	52.3	0.5
2/3+2/4	Basement W-L Right Ahead	U	20	1550:1550	9.4 : 9.4%	51.7	0.5
3/2+3/1	Hickson Rd N-L Ahead Left	U	525	1550:1550	69.1 : 69.1%	14.3	7.9
3/3	Hickson Rd N-L Ahead	U	362	1580	68.1%	36.6	10.8
4/1	Napoleon St E-L Left	U	312	1550	46.1%	18.4	5.3
4/2	Napoleon St E-L Right	U	490	1550	94.0%	65.6	20.2
J4: Kent/Margaret/Napoleon	-	-	-	-	94.1%	-	-
1/2+1/1	Kent St S-L Left Ahead	U	214	1550:1550	46.1 : 46.1%	37.7	5.0
1/3+1/4	Kent St S-L Ahead Right	U+O	387	1550:1550	66.3 : 66.3%	37.7	10.7
2/2+2/1	Napoleon St W-L Left Ahead	U+O	833	1580:1270	94.1 : 94.1%	35.6	33.2
3/1+3/2	Kent St N-L Ahead Right Left	U+O	219	1550:1270	35.5 : 35.5%	32.0	4.2

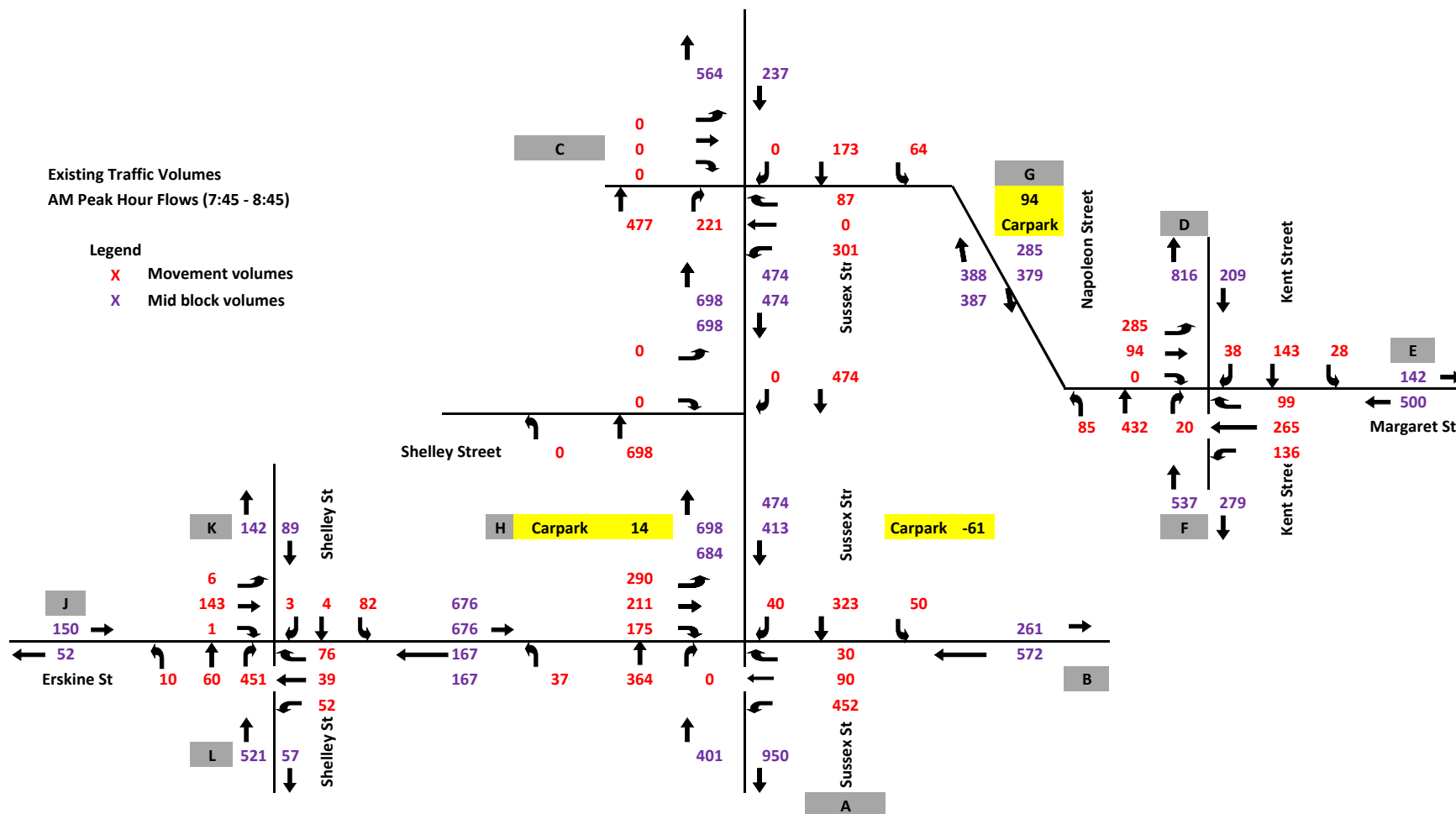
Appendix A

LinSig Modelling Outputs

Existing Traffic Volumes
AM Peak Hour Flows (7:45 - 8:45)

Legend

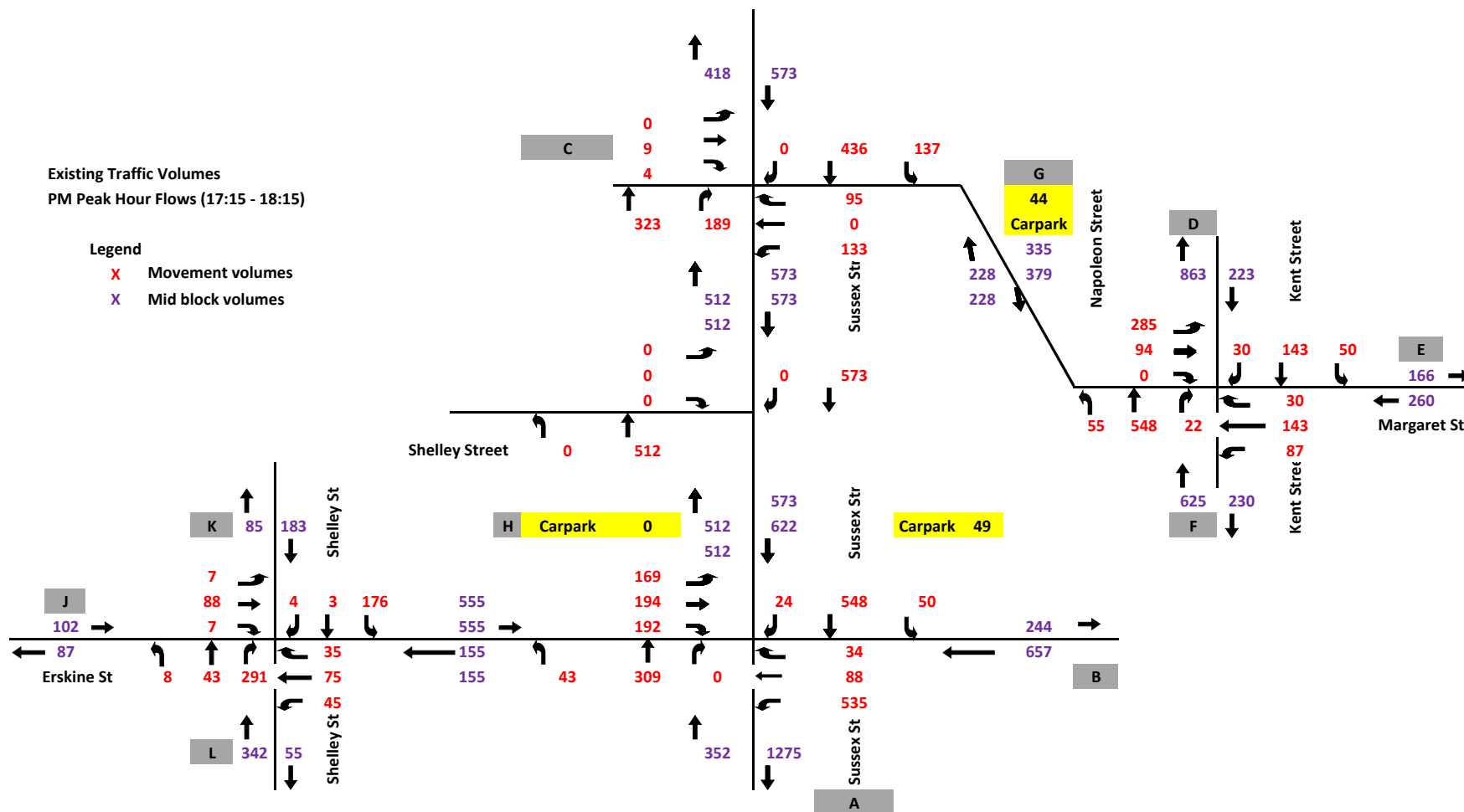
- X Movement volumes
- X Mid block volumes



Existing Traffic Volumes
PM Peak Hour Flows (17:15 - 18:15)

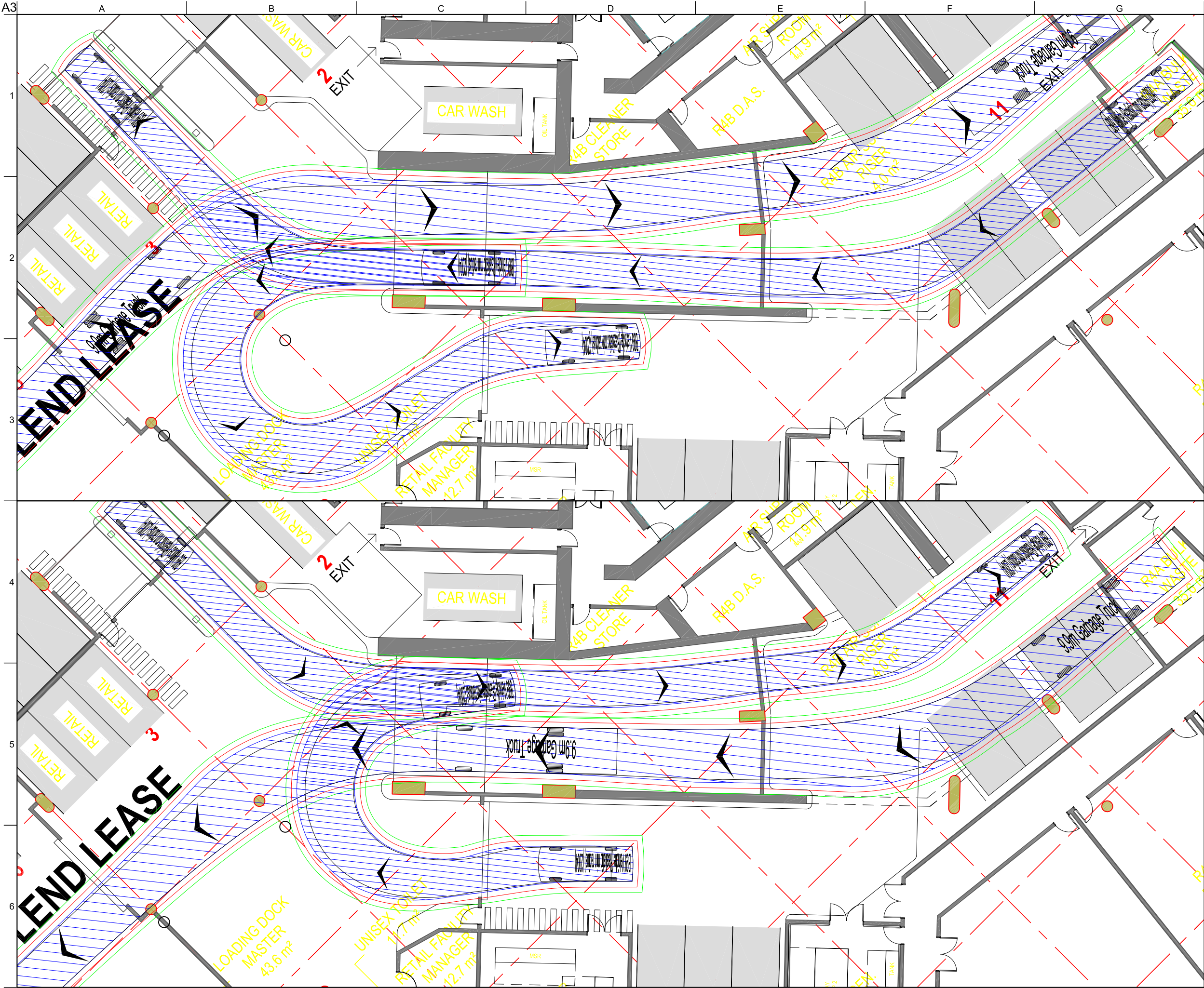
Legend

- X Movement volumes
- X Mid block volumes



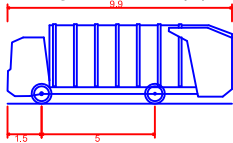
Appendix C

Vehicle Swept Path Analysis

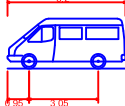


- Legend
- Body Envelope
 - 300mm Envelope
 - 600mm Envelope
 - Wheel Envelope

Design Vehicle(s)



9.9m Garbage Truck
Overall Length 9.900m
Overall Width 2.500m
Overall Body Height 3.500m
Min Body Ground Clearance 0.304m
Track Width 2.500m
Lock to Lock Time 4.00 sec
Curb to Curb Turning Radius 10.000m



B99 Vehicle (Realistic min radius) (2004)
Overall Length 5.200m
Overall Width 1.940m
Overall Body Height 2.200m
Min Body Ground Clearance 0.312m
Track Width 1.840m
Lock to Lock Time 4.00 sec
Curb to Curb Turning Radius 6.250m

E	30/06/15	JRT	JDM	AMH
Updated drawings				
D	19/03/15	JRT	JDM	AMH
C	11/12/14	JRT	JDM	AMH
B	17/10/14	JRT	JDM	AMH
A	14/10/14	JRT	JDM	AMH
Issue	Date	By	Chkd	Appd

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Client
Lend Lease

Job Title
Stage 1B Basement

Drawing Title
Turning Paths
Garbage vehicle
passing B99 vehicle
Main Access Ramp

Scale at A3
1:200

Discipline
Transport

Drawing Status

Draft

Job No 222061-19	Drawing No SKT002	Issue E
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