JACOBS AECOM
JOINT VENTURE

BaT project

Environmental Impact Statement

Technical Report 1 – Transport

August 2014

Jacobs AECOM Joint Venture

TECHNICAL REPORT 1
TRANSPORT

AUGUST 2014

Contents

1 Introduction

This technical report presents an assessment of the likely effects on traffic and transport as a result of the implementation of the Bus and Train project (the Project) for the purpose of responding to the terms of reference for an environmental impact statement (EIS) of the Project. This report provides an increased level of detail of the assessment that has been provided in **Chapter 4 – Traffic and transport** of the EIS.

This report presents the main transport impacts of the Project, including future transport considerations for both rail and bus passengers with and without the Project. It also presents the impact of the Project on pedestrians, cyclists, rail freight, ferry and road networks at the local and regional level, as well as the impacts on rail maintenance and the transport impacts during construction.

The Project would provide additional bus and rail infrastructure, including stations, through the Brisbane Central Business District (CBD) and relieve capacity constraints on the inner city public transport networks. In addition to providing passenger capacity benefits the Project would also improve public transport accessibility within the Brisbane inner city area. This would support the growth and economic development of the city and the wider South East Queensland region. The need for the Project is driven by:

Population and employment growth

Ensure public transport supports rather than constrains the planned growth in inner city employment, retail and residential activity:

- Provide sufficient capacity to support efficient, reliable, safe and sustainable public transport catering for the demand associated with the economic growth of the Brisbane CBD.
- Support growth of future development areas within the inner city.
- Support residential growth in the region by improving access to jobs, retail and recreation in the inner city.

Public transport patronage growth

Ensure public transport provides enhanced capacity and opportunity for mode shift to reduce traffic congestion into the Brisbane CBD:

- Rail trips are expected to double by 2021.
- Existing bus corridors into the CBD exceed designed capacity.

Transport network capacity constraints on the rail and bus networks

The commuter transport network (bus, rail and road traffic) to the inner city area of Brisbane currently suffers from congestion:

- Rail transport across the Merivale Bridge is close to reaching capacity in the commuter peaks and is predicted to be operating at capacity by 2021.
- Capacity for buses to access the CBD from the South East Busway is constrained.
- There is limited capacity on arterial roads to the inner city to support additional growth in peak period travel by car.
- Existing interchange stations impact on network performance because of overcrowding and high demand for services at a single location.

Increased transport network congestion and public transport overcrowding

Crowding on the public transport network occurs and will deteriorate significantly unless additional public transport capacity is provided. Commuter travel time reliability is at a tipping point due to congestion.

- Bus travel time reliability is currently highly variable due to congestion on the major approaches on a daily basis.
- Contribute to reducing competition for Brisbane CBD streets space to support the ongoing development of the Brisbane City Centre in line with the City Centre Master Plan.
- Provide an integrated solution to the lack of additional bus stops and layover areas so facilitating an increase of bus services to the Brisbane CBD.
- Relieve inner city traffic circulation conflicts and congestion.
- Relieve surface bus activity that contributes to pedestrian capacity, safety and amenity issues in the Brisbane CBD.

Service coverage requirements to meet the changing structure of inner city Brisbane

Improved accessibility within, and to the Brisbane CBD by public transport:

- The southern part of the CBD, which includes the Government precinct and the Queensland University of Technology (QUT) Gardens Point campus, does not have convenient access to a major public transport node.
- There is a poor spread of public transport stations across the CBD that is dominated by Central Station and the closely spaced King George Square Busway Station and Queen Street Bus Station (QSBS).
- Increase commuter public transport opportunities to the CBD from urban growth areas by addressing inner city transport constraints.

The Project aims to reduce the dependency on private transport (car) travel to the Brisbane CBD and increase the mode share of public transport.

1.1 The Project

1.1.1 Project design

Whilst a detailed description of the Project is contained in **Chapter 3 – Project description** of the EIS, features from a transport perspective are presented in this section.

The Project is a new link in South East Queensland's public transport network. It will combine a railway and a busway in a single, double-decked, 15m diameter tunnel beneath the Brisbane River and Brisbane's CBD. The five kilometre north-south tunnel will stretch from Dutton Park in the south to Victoria Park at Spring Hill in the north with new underground stations at Woolloongabba, George Street and Roma Street.

The Project is an extension of the existing rail network as well as a key link in the Brisbane busway network providing additional links between southern and northern sections of the bus and rail passenger networks. The Project will:

- significantly increase the public transport capacity across the Brisbane River
- offer faster, more frequent, direct and reliable bus and train trips to the CBD from across the region

- help manage congestion by reducing private vehicle travel through making public transport more attractive
- allow faster, more direct access to key destinations including universities, hospitals, sports stadiums, event areas, parklands and workplaces
- provide three new underground stations making interchanging between rail and bus services easier

The proposed stations are at Woolloongabba, George Street (southern CBD) and Roma Street (northern CBD). The stations have been positioned according to the vertical and horizontal rail alignment and the urban design and precinct planning requirements. The rail and bus alignments have been calibrated to minimise disruption to existing and future development, and to facilitate the desired station location amongst a broader range of engineering constraints.

The station entry locations with their associated deep shafts and vertical transport for the public, take in to account the preferred precinct planning objectives including the required proximity to existing bus and rail infrastructure in balance with the local site, cost and engineering constraints.

The new Woolloongabba Station supports the planned renewal of Woolloongabba Central, Kangaroo Point south and the Woolloongabba Priority Development Area (PDA).

The new George Street Station supports the ongoing development of Brisbane's CBD, including the proposed Queen's Wharf Brisbane development, and provides direct access to the government precinct at lower George Street as well as the education precinct at QUT.

The new rail and bus platforms at Roma Street will create an interchange hub and support the continued development of commercial and mixed-use activities in the northern quarter of the CBD.

1.1.2 Project construction

Chapter 3 – Project description of the EIS contains a detailed description of the project construction method. This section provides a brief description of the construction of the project.

The Project's reference design includes both major surface and underground works. Surface works at the northern and southern connections intersect with the existing operational rail and busway network which means there will be some complex urban brown-field rail and busway construction.

Surface works include:

- demolition/ removal of existing buildings and industrial infrastructure
- widening existing rail corridor boundaries
- altering road, pedestrian and public utility plants
- constructing new busway bridges and pedestrian connections
- introducing new rail infrastructure
- significantly altering existing rail infrastructure.

To minimise the impact on the existing and future rail network's operational capacity, delivery of surface works will be staged into manageable, safe and reliable increments that are acceptable to the Rail Manager, subject to the Rail Manager's corridor safety requirements and are acceptable to the operator of the busways.

The underground sections of the project, from the Southern Connection at Dutton Park to the northern connection at Victoria Park are complex. Some stations, station entries, and plant space require shafts and cut-and-cover elements which have been arranged as reinforced concrete structures, predominantly cast insitu, but with specific pre-cast elements.

To provide sufficient space for construction activities, major tunnel construction worksites have been planned at Dutton Park, for the southern connection and the northern connection in Victoria Park. The stations are projects in their own right, and a significant footprint will be required for these in their final state as well as during construction.

Spoil removal

An outline scheme for spoil removal from the construction worksites has been developed using the following criteria:

- sites where construction traffic can flow directly on and off freeways and major arterial roads are favoured
- minimal spoil quantities extracted from other sites

The majority of spoil will be generated from the tunnel boring machine (TBM) running tunnel sites at Dutton Park, however the northern connection will also generate significant volumes. The major spoil removal facilities will be located inside acoustic sheds to minimise noise and dust impacts. The intended disposal routes from the main tunnelling site at Dutton Park are via Ipswich Road.

The total estimated volume from the works, portal to portal, is approximately 1.78 million cubic metres insitu or approximately 4.3 million cubic metres of excavated spoil to dispose of off-site. These volumes are both the tunnel and the stations.

Track and rail systems

Track and rail systems are project-wide and therefore will generally be constructed as end-to-end installations. The activities will be planned to avoid construction conflicts with other station sites. The assumed sequence of track and rail systems is as follows:

- construction and installation of the track formation and tunnel track slabs
- sleeper and rail installation as required
- installation of overhead masts
- overhead electrical assemblies
- traction power supply and connection
- line-side signalling system installation and communications.

The timing of track installation works at the southern and northern Connections will rely on the availability of track possessions.

Station fit-out

The fit-out of the underground stations is complex, and therefore needs to be commenced as soon as the station structural shells are complete and the ongoing tunnel boring operations will allow.

Significant mechanical and electrical, control and ventilation systems will be required in addition to the normal station facility fit-out and finishes. The platform screen doors will be a late installation activity that needs to be synchronised with the control systems. All stations in the Project will include automatic gated ticket lines that will need testing and commissioning.

Commissioning and testing

Commissioning and testing will be required of the underground stations that includes testing and training in relation to station fire and life safety systems, day to day operations, and general passenger and vehicle control.

Other commissioning and testing tasks include the tunnel systems, driver training, surface works commissioning, systems commissioning and final commissioning including integration with the current rail and bus way network.

1.1.3 Project operation

The Project is a critical new link in South East Queensland's public transport network that will give trains and buses an additional Brisbane River crossing and provide a step change in both rail and busway capacity. The network design is multi-modal with connectivity in mind to enable passengers' flexibility to access more destinations via simple and convenient transfer.

Roma Street and Woolloongabba will become major interchanges, each servicing a different side of the river. Local services would run from these hubs, giving commuters more direct, frequent links to hospitals, sports stadiums, shops, parklands and workplaces. Whilst the focus of George Street will be to provide access directly into the heart of the CBD, frequent on-street bus services would provide connectivity for passengers to destinations beyond walking distance, including Riverside and Fortitude Valley.

Rail operations

The Project would deliver rail connectivity between the Gold Coast-Beenleigh lines to the south and the Exhibition Line to the north. The Project will only allow for revenue passenger rail services from the south. The rail connections to the north will only allow Gold Coast services to turn back, or access the stabling facilities at Mayne Yard.

The rail network design for the Project looks to build upon the sectorisation of the surface rail network recently implemented by Queensland Rail and TransLink. The introduction of the Project is based on connecting the southern sector of the Gold Coast and Beenleigh lines into the BaT tunnel.

Freight is an important part of operations on the Brisbane metropolitan rail network. While freight services will not be utilising the Project, infrastructure layouts on the southern approaches have the ability to minimise passenger service impact on freight capacity.

Bus operations

The bus network design for the Project is fully integrated into the existing busway network and provides a faster, more direct, grade-separated route to and through the Brisbane CBD than existing busways.

To the south, the Project connects to the Eastern Busway between Dutton Park and the Princess Alexandra Hospital (PA Hospital) busway stations, providing convenient access to the University of Queensland (UQ) and destinations including Griffith University campus at Nathan, Mt Gravatt and Carindale via the south east and eastern busway's. To the north, the Project connects to the Northern Busway just south of the Royal Brisbane Women's Hospital (RBWH), with convenient connections for buses onto Bowen Bridge Road to access Fortitude Valley and Newstead, the Inner Northern Busway

(INB) to serve the QUT campus at Kelvin Grove, the northern busway to Lutwyche and Chermside and the Inner City Bypass (ICB)/Legacy Way for fast connections to the Western suburbs.

1.1.4 EIS Terms of Reference and transport requirements

This technical report addresses the relevant transport matters raised in the Terms of Reference for an Environmental Impact Statement issued by the Co-ordinator General in accordance with the *Queensland State Development and Public Works Organisation Act 1971*.

The scope of the Transport investigations contained in this report meets the EIS terms of reference for relevant parts of section 9.12 and sections 10.32 to section 10.36.

1.2 Scope of the transport investigation

The Transport assessment includes:

- an analysis of the base year (2012) transport conditions within the study corridor and relevant adjacent areas with a particular emphasis on public transport
- an analysis of likely future trends in growth of population, employment and travel (including mode split) without the Project
- an analysis of likely future travel trends with the Project and comparisons back to the without Project case
- an assessment of the passenger and pedestrian throughput at all stations in the study corridor including the proposed new stations
- assessment of traffic impacts of the operational Project for the purposes of the EIS
- investigation and assessment of the effects of construction on road traffic.

1.3 Key transport stakeholders

Key transport stakeholders likely to be affected by the project have been consulted in the process of developing and assessing the project. The key transport stakeholders include:

- Department of Transport and Main Roads (TMR) including TransLink Division
- Brisbane City Council including Brisbane Transport
- Queensland Rail.

1.4 Broad approach and report structure

Section 2 describes the methodology used for this assessment including the transport forecasting methodology. The transport forecasting methodology is the basis of the travel demand analysis. It presents the modelling tools, as well as land use patterns which generate movement demand and then travel trends that have framed the basis of assumptions into the future. The assumed future year transport network and operations are also presented.

Section 3 outlines the base year (2012) conditions of the traffic and transport networks and services within and around the study corridor. (The study corridor was determined by the Coordinator-General and extends from Dutton Park in the south to Victoria Park (Herston) in the north). For each mode of transport, an overall assessment is presented of regional issues which affect the operations of that mode within the study corridor. This is followed by a description of the whole study corridor where required, and then a sub-corridor analysis. The specific transport networks or performance issues related to stations are also addressed.

The analysis generally follows a south to north alignment.

The future base transport conditions (no Project) are described in **Section 4.** The rail and bus operations with the Project are detailed in **Section 5**. The effects of the operating the project are presented in **Section 6**. **Section 8** resents the assessment of construction road traffic impacts.

This transport technical report is supported by a series of appendices:

- Appendix A: Technical terms
- Appendix B: Acronyms and abbreviations
- Appendix C: Transport section extracted from the Terms of reference for an environmental impact statement, Underground Bus and Train Project, January 2014

1.5 Use of data

In order to describe existing transport conditions, develop and validate the transport forecasting model and analyse local traffic effects, a range of observed traffic and transport data was collected. Data was used in various assessments covering all modes of travel within the transport network. These included rail load counts, public transport ticketing data, public transport timetables road traffic pedestrians and cyclists, as described in subsequent sections of the report. This wide range of data that has been used in the assessment includes:

- census data from the Australian Bureau of Statistics (ABS)
- Population and Information Forecasting Unit (PIFU) data
- National Institute of Economic and Industry Research (NIEIR) employment forecasts data
- Brisbane City Council's Brisbane Urban Growth (BUG) model
- TransLink Transit Authority data including timetables and route and stop information
- rail passenger survey sourced from Queensland Rail
- modelled transport demands using the BaT Project Model (a strategic transport model based on the BSTM-MM.

1.6 Limitations and disclaimer

This document is written solely for the purpose stated in the Contract between the Department of Transport and Main Roads (TMR) and the Jacobs-AECOM Joint Venture (the JV), and for the sole and exclusive benefit of TMR whose remedies are set out in the Contract. This document is meant to be read as a whole, and sections or parts thereof should therefore not be read or relied upon out of context.

All patronage forecasts were prepared using the Project Model which is based on the BSTM-MM and data as supplied by TMR. Traffic Modelling and Forecasting is not a precise science and are only an indication of what might happen in the future, and is expressly not a representation as to a future matter, and may not ultimately be achieved. They rely upon complex set of data and assumptions and numerous factors which can influence actual patronage, many being beyond the control or reasonable foresight of the forecaster. The JV has in preparing the forecasts, followed normal methodology and procedures, and exercised due care consistent with the intended level of accuracy, using its professional judgment and reasonable care. However, no warranty is given or should be implied as to the accuracy of the forecasts. Unless expressly stated otherwise, TMR Data supplied by TMR (TMR Data), upon which the JV's forecasts are based, have not been verified by the JV.

Whilst the JV has reasonably reviewed the TMR Data, the JV disclaims and will not assume responsibility for the accuracy or completeness of the TMR Data. If the information and data is subsequently determined to be incorrect, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in the report may change.

Any traffic forecast or other information contained this report is an opinion based on reasonable investigation as to a future event and is inherently subject to uncertainties. Inevitably, some assumptions used to develop our report will not be realised and unanticipated events and circumstances may occur. Therefore the JV cannot provide any form of assurance that the forecasts documented in the report will be achieved.

To the extent permitted by law, the JV disclaims any liability to TMR and to third parties in respect of the publication, reference, quoting, or distribution of this report or any of its contents to and reliance thereon by any third party.

1.7 Assessment carried out by others

This chapter has been informed by information provided by other organisations that are part of the Transport Planning and Operations Team of the Project:

- GCI Pty Ltd with respect to bus operations and planning
- URS Corporation with respect to rail operations and planning.

The information provided by these organisations has not been independently verified or audited by the JV. The JV acknowledges the contribution made by these organisations to the development of this chapter.

2. Study methodology

The purpose of this section is to provide a review of the technical approach used for transport modelling and planning tasks to be carried out for the Project. Key tasks were split into several streams and the methodologies and specifications are described in this section following the definition of areas of interest:

- patronage and revenue modelling forecasting, to inform the design and EIS
- rail operations assessment
- bus and busway operations assessment
- rail passenger simulation and station movement profiling, to inform the design
- station planning and architecture, to inform the design and the EIS
- the effects of the construction of the Project on the transport network.

The overall method to assess the transport effects of the Project utilised a comparative analysis of effects with and without the Project.

2.1 Areas of interest

2.1.1 The study corridor

The traffic and transport assessment is focussed on the study corridor as determined by the Coordinator-General. The study corridor depicted in **Figure 2-1** is proposed to contain the new infrastructure and is the focus of the assessment. However, project impacts outside the immediate study corridor, which may include spoil haulage and placement and construction traffic routes will also be identified and assessed. Benefits that may be achieved beyond the study corridor as a result of the project, including improved rail and bus services, will also be described.

LEGEND

- Existing busway station
- Existing rail station
- Existing busway
- Existing rail line
- Highway/main road
- Watercourse
- Suburb boundary

- Study corridor

Project Infrastructure

- Construction worksite
- Underground station
- Bus layover
- Dutton Park Station (upgraded)

Alignment

- Above ground
- Underground

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 2-1

Study corridor

N

0 0.5 1
Kilometres
1:30,000 (at A4)
Projection: GDA 1994 MGA56

Aerial Photo: Brisbane City Council 2012

G:\QENV2\Projects\QE06863\Spatial\ArcGIS\Figures\Final_EIS_Figures\04_Transport\Tech_Report\TranspTechRpt_Figure2-1_Project_Study_Corridor.mxd Date: 14/08/2014

2.2 Patronage forecasting method and assumptions

The BaT Project model draws upon TMR's existing strategic transport model, the Brisbane Strategic Transport Model – Multi Modal version (BSTM-MM), with significant updates to strengthen the model's ability to forecast public transport demands. This approach is in line with that adopted for the Cross River Rail (CRR) EIS (2011), and incorporates much of the same modelling processes as CRR.

This section provides an overview of the patronage modelling methodology, the BaT Project Model structure and the key assumptions for forecasting.

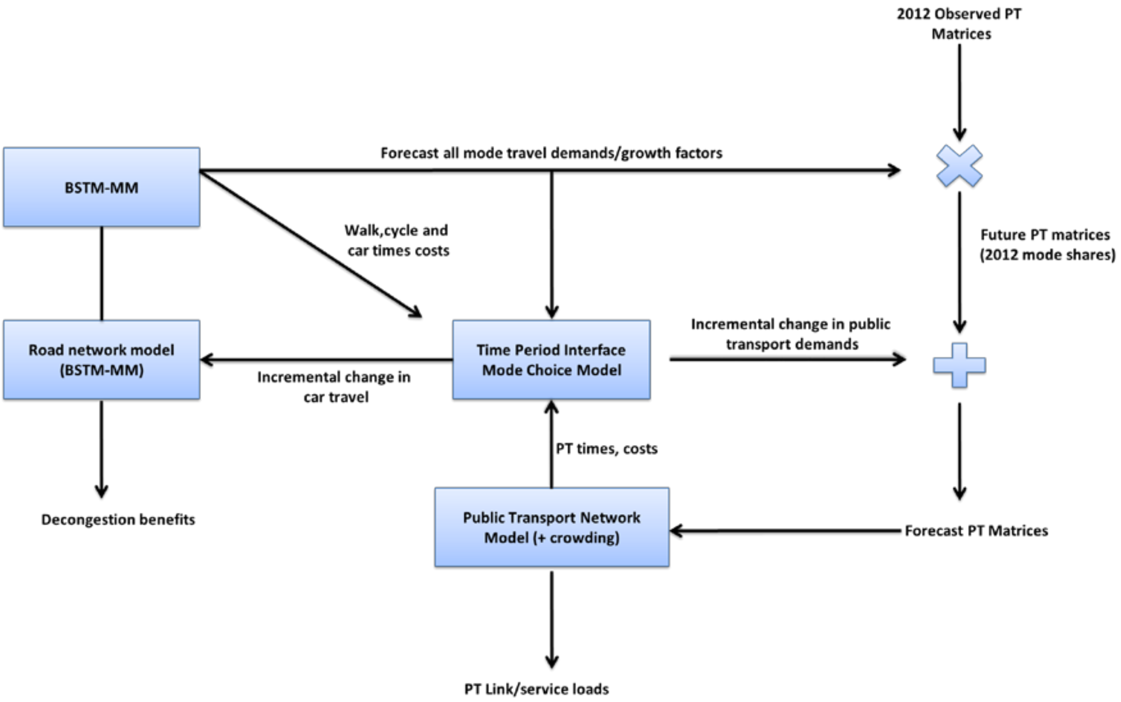
2.2.1 Model structure and methodology overview

The BaT Project Model operates by considering the travel choices available on an average weekday across the whole transport network within the study area, the Brisbane Statistical Division. The model incorporates travel in both the peak (AM, 7am to 9am and PM, 4pm to 6pm) and non-peak periods across the day and includes travel by car (both as driver and passenger), by public transport (bus, rail and ferry) and active modes (walk and cycle).

As discussed above, the BaT Project Model relies heavily on the BSTM-MM, incorporating a number of updates specifically designed to improve the model's ability to forecast public transport demands.

The structure of the model, including the linkage with the BSTM-MM is shown in **Figure 2-2**. Originally developed for the CRR EIS, this model structure provides an enhanced basis for forecasting public transport demands, making best use of base year observed public transport demands. This structure remains appropriate for forecasting public transport demands so the existing model structure was retained, with an essential set of model updates undertaken, particularly relevant to the Project, including the base year demand (changed from 2009 to 2012).

Figure 2-2 The Bus and Train Project Model structure



Starting on the right hand side of the figure, the 2012 observed public transport travel patterns (trip matrices) are factored up to the forecast year (assuming no mode share changes) based on the growth in all-mode demands forecast by BSTM-MM due to population, employment and enrolment growth[1].

Forecasts of changes in mode shares from the 2012 base (in either the without or with Project scenarios) due to future network changes are made in the Project mode choice model. The consequent incremental effects on future public transport demands are added to the factored public transport matrices, to give an overall forecast of public transport demands.

The time period model acts as an interface between the networks, which are for four separate time periods, and the mode choice model which is for 24 hours. (For each trip purpose, as required, this interface aggregates the network costs for each time period to 24 hours, and splits the 24 hour forecast trip demands between the four time periods.) In the BaT Project Model, the time period model for public transport journeys has been updated to reflect the most recent data (the 2010 public transport OD surveys and the 2012 boarding counts).

The inputs to the mode choice model are walk, cycle and road times and costs from BSTM-MM and public transport times and costs, allowing for crowding, from the Project's public transport network model.

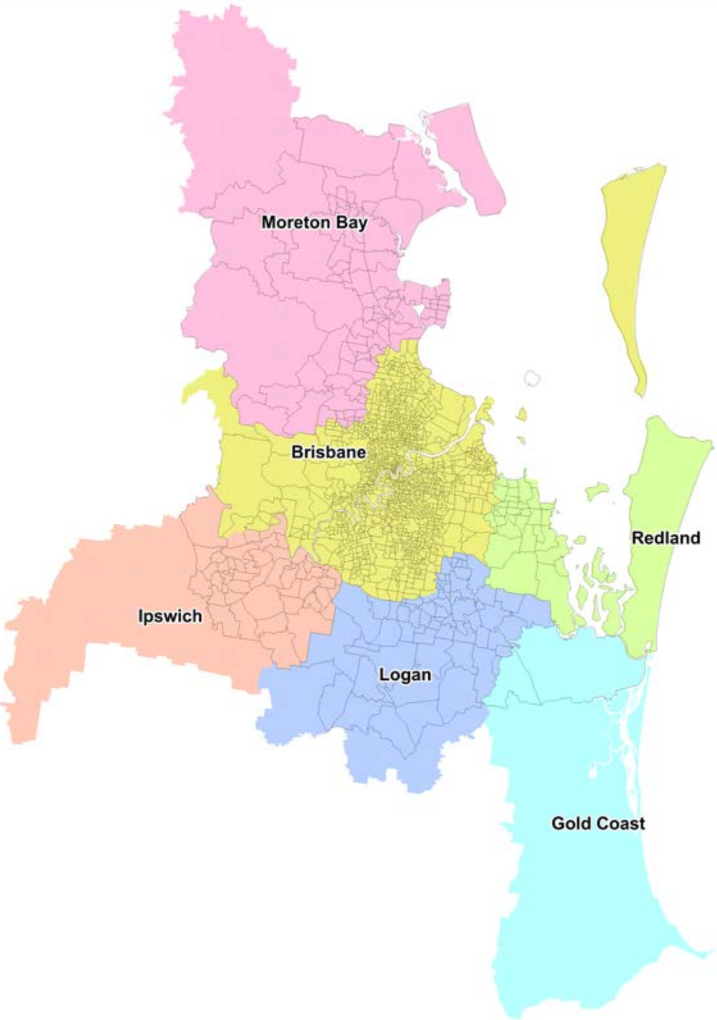
The BaT mode choice model also forecasts the changes in car mode shares, and the consequent incremental effects on future car demands are fed back to the BSTM-MM road network model to compute traffic decongestion benefits.

2.2.2 BaT Project Model study area

The BaT Project Model broadly covers the area of the Brisbane Statistical Division. This is illustrated in **Figure 2-3**, which presents the transport zone system for the entire study area (approximately 1500 zones). The study area as shown in **Figure 2-3** covers all of Brisbane City and Redlands, and parts of Moreton Bay, Ipswich, Logan and Gold Coast Cities.

[1] The demands are by trip purpose, for 24 hours.

Figure 2-3 BaT Project Model Study Area traffic zones



2.2.3 Forecasting assumptions

Population, employment and enrolment forecasts

Population, employment and enrolment data by traffic zone are the most influential factors driving forecast travel demand. The forecasts for these key statistics were provided by TMR's Policy and Planning Branch at the transport zone level for use in this project.

The headline population and employment forecasts at the Statistical Area 2 (SA2) level, labelled Regional Plan Review and Update (RPRaU), were provided to TMR from the Government Statistician (Population, 2013 edition, medium series) and South East Council of Mayors (SEQCoM, Draft 2014) respectively.

State school enrolment projections were provided by the Department of Education, Training and Employment (DETE) for each state school. Private and tertiary enrolments were calculated by factoring observed 2011 figures by relevant population by age group projections provided by the Government Statistician.

The headline forecasts for the entire study area are shown in **Table 2-1**. By 2031, the Brisbane Statistical Division is forecast to reach a population of 3.02 million (1.9 per cent per annum[2]). Total employment for the study area is forecast to reach 1.6 million (1.9 per cent per annum).

Table 2-1 Study area population, employment and enrolment[3] forecasts, 2012, 2021 and 2031

Data	2012	2021	Growth rate 2012-2021	2031	Growth rate 2021-2031
Population	2,076,000	2,568,000	2.4%	3,024,000	1.6%
Employment	1,126,000	1,357,000	2.1%	1,602,000	1.7%
Enrolments	464,000	583,000	2.6%	646,000	1.0%

These forecasts for Inner Brisbane that includes the CBD are shown in **Table 2-2** and **Table 2.3**. Both population and employment in Inner Brisbane is forecast to grow at a faster rate than the entire region as a whole. Employment growth in the CBD itself (Brisbane City SA2) is forecast at 1.9% p.a. between 2012 and 2021 and 1.6% p.a. between 2021 and 2031.

Table 2-2 Inner Brisbane SA2 population forecasts 2012, 2021 and 2031

Data	2012	2021	Growth to 2021	2031	Growth to 2031
Inner Brisbane total	57,900	92,300	5.3%	119,700	2.6%

Note: Inner Brisbane consists of the statistical local areas of Brisbane City, Fortitude Valley, Spring Hill, South Brisbane, West End, Newstead-Bowen Hills, Paddington-Milton, Kangaroo Point and Woolloongabba

The transport model requires the SA2 forecasts to be disaggregated to transport zone level (approximately 1500 zones across the study area). This process was undertaken by TMR, relying on detailed base year census data, available planning information and where necessary consultation with Brisbane City Council. As part of this project, TMR's Policy and Planning Branch, together with input from Brisbane City Council reviewed the detailed allocation of the above growth totals to individual transport zones in particular for the following SA2's:

- Brisbane City (particularly in relation to the allocation of growth to development areas such as 1 William Street, Queen's Wharf Brisbane Precinct and the Roma Street Precinct)
- Fortitude Valley and Spring Hill
- South Brisbane (distributing the large growth forecast for this SA2)
- Woolloongabba (both focussing on development along Vulture Street and on the GoPrint site immediately adjacent to the proposed Station)

Table 2.3 : Inner Brisbane SA2 employment forecasts 2012, 2021 and 2031

Data	2012	2021	Growth to 2021	2031	Growth to 2031
Inner Brisbane Total	270,800	332,400	2.3%	396,700	1.8%

Note: Inner Brisbane consists of the statistical local areas of Brisbane City, Fortitude Valley, Spring Hill, South Brisbane, West End, Newstead-Bowen Hills, Paddington-Milton, Kangaroo Point and Woolloongabba

[2] All growth rates presented in this report are expressed as compounding annual growth rates (CAGR)
[3] Full time equivalent enrolments

Network infrastructure assumptions

The transport model encompasses all travel on an average weekday, including travel by private or commercial vehicle (car as driver or passenger, medium and heavy commercial vehicles), public transport (bus, rail, and ferry), walk and cycle or a combination of the above.

The rail, bus and road network infrastructure across the study area for future years is based on current TMR and local government project commitments and was informed by documents including Queensland Transport and Roads Investment Program (QTRIP) 2013-14 to 2016-17 and the Transport Plan for Brisbane 2008-2026. **Table 2-4** below details the major network assumptions included or excluded in the transport model.

Table 2-4 Future year network upgrade assumptions, 2021 and 2031

Project	Without (2021)	Without (2031)	With Project
RAIL			
European Train Control System (ETCS) Level 2	N	N	2021 & 2031
Network Stabling (outer)	Y	Y	-
Coomera – Helensvale Duplication	Y	Y	-
Clapham Yard Stabling (Stage 1)	Y	Y	-
Clapham Yard Stabling (Stage 2)	N	Y	-
Northern Connection (via Mayne Yard)	N	N	-
Salisbury to Flagstone rail (Salisbury to Boronia Heights)	N	N	-
CAMCOS	N	N	-
Beerburrum to Landsborough	N	Y	-
Landsborough to Nambour	N	N	-
North West Transport Corridor (Rail Line)	N	N	-
Kuraby to Loganlea 3rd Track	N	Y	-
RAIL			
South East Busway Extension - Eight Mile Plains to School Rd	Y	Y	-
Transitway – Gympie Rd	Y	Y	-
Missing Link (Northern Busway)	N	Y	-
Transitway – Old Cleveland Rd	Y	Y	-
Mains Road upgrade to 6 lanes inc bus lanes	N	N	-
Northern Busway - Kedron to Chermside	N	N	-
Eastern Busway – Carindale / Capalaba	N	N	-
ROAD (incl. Transit Lanes) and ACTIVE			
Pacific Mwy upgrade to 8 lanes (incl. removal of transit lanes)	Y	Y	-
Managed Motorways (on M1)	Y	Y	-
Centenary Mwy upgrade to 6 lanes - Moggill Rd to Toowong roundabout	Y	Y	-
Centenary Mwy upgrade to 6 lanes - Moggill Rd to Ipswich Mwy	N	N	-
Ipswich motorway upgrade (Rocklea to Darra) 6 lanes	Y	Y	-
Ipswich motorway upgrade (Centenary Mwy to Ipswich) 8 lanes	N	Y	
Kenmore Bypass – Western Freeway to Moggill Road	N	N	
Logan Mwy upgrade to 6 lanes (Ipswich Mwy to Gateway Mwy)	N	N	-
Gateway Mwy upgrade to 6 lanes (south of Deagon)	Y	Y	-
Kingsford Smith Drive - upgrade	Y	Y	-
Inner City Bypass Upgrade	N	Y	-
Kangaroo Point Ped/ Cycle Bridge	Y	Y	-
Gateway Motorway Extension (Park Ridge Connector)	N	N	-
Shafston Avenue - Lytton Road - Wynnum Road	Y	Y	-
North West Transport Corridor (Road)	N	N	-
Warrego Highway (Minden to Cunninghman Hwy)	N	Y	-

The only difference in the With Project network assumptions is the inclusion of the BaT tunnel (and associated ETCS L2) and new stations.

Economic assumptions

The increase in the cost of travel and user's sensitivity to costs are important drivers in travel behaviour. Compared to the base year prices, the transport model assumes:

- inflation – to grow at 2.5 per cent per annum
- Brisbane CBD parking charges – to grow 2.9 per cent per annum above the rate of inflation
- toll road charges – to grow in line with the rate of inflation
- public transport fares – to grow in line with the rate of inflation from 2015
- vehicle operating costs (fuel) – to grow in line with the rate of inflation
- value of time – to grow 1.5 per cent per annum above the rate of inflation (in line with assumed average weekly earnings growth of 4 per cent per annum).

Table 2-5 illustrates the net impact of these assumptions on the multipliers used for cost data in 2021 and 2031.

Table 2-5 Economic (cost) assumptions

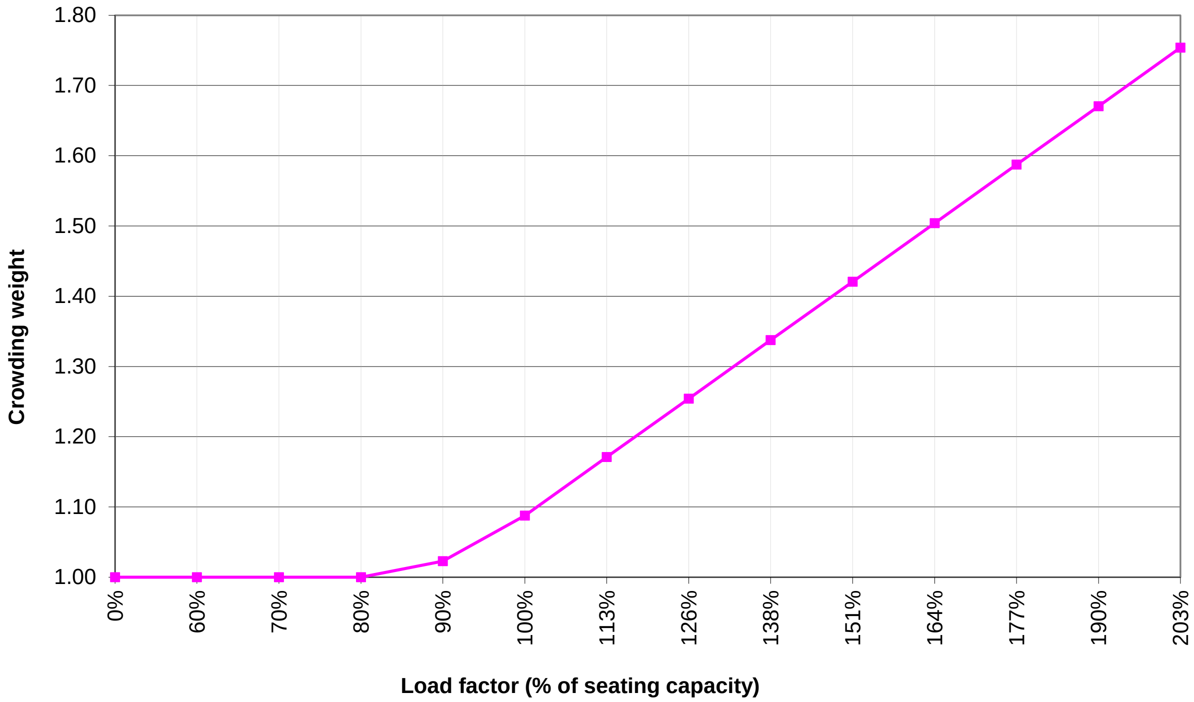
Data	Assumption	Applied model multiplier (from 2012)		
		2012	2021	2031
Rate of inflation	2.5% per annum	1		
Growth in average weekly earnings	4% per annum	1		
Growth in value of time	1.5% per annum	1	1.143	1.327
Growth in parking charges	2.9% per annum above inflation	1	1.292	1.718
Growth in fares	2012 to 2014 – actual increase 2015 onwards –with inflation	1	1.101	1.101
Growth in vehicle operating costs	With inflation	1	1	1

Crowding model

In representing crowding the model adopts a philosophy that the experience of using crowded services is disliked by passengers and that this can be represented by increasing the generalised cost weight on in-vehicle journey time above the normal value of 1.0, this additional weight being referred to as the 'crowding weight'.

The crowding weights incorporated in the BaT Project Model, based on a review of international practice undertaken for CRR, are illustrated in **Figure 2-4**. An example curve for the New Generation Rollingstock (NGR) rolling stock is shown, illustrating how the crowding multiplier on in-vehicle time increases as the seated load factor increases.

Figure 2-4 Example crowding curve – New Generation Rollingstock



2.2.4 BaT Project Model validation

Scope and process

For public transport trip making, the performance of the base year models are assessed against observed boarding and alighting data, inclusive of transfers. The following datasets were used to validate the 2012 BaT Project Model:

- Bus and Ferry – go card ticketing data by operator and time period. Note that detailed alighting data, nor accurate individual stop boarding data were not available for bus and ferry services, therefore validation was limited to the route level for these modes.
- Rail – Queensland Rail's Passenger Load Survey. Note that the Passenger Load Survey was conducted across three days, Tuesday to Thursday. As the model represents an average weekday, Monday to Friday, the observed counts were scaled down by 5% to be consistent with the trip data provided by TMR TransLink's Division. All values reported throughout this document reflect this reduced validation target.
- Traffic count data across key mode screenlines in 2012 was provided by TMR

A subset of the validation performance is shown below.

2012 Highway validation

The screenline performance of the 2012 base model compared to traffic counts is shown graphically in **Figure 2-5** for the AM peak period and for the entire day in **Table 2-6**. This data shows a good match across both the AM peak period (R-squared 0.9667) and the daily total.

Figure 2-5 2012 model performance – AM peak period highway screenline traffic validation

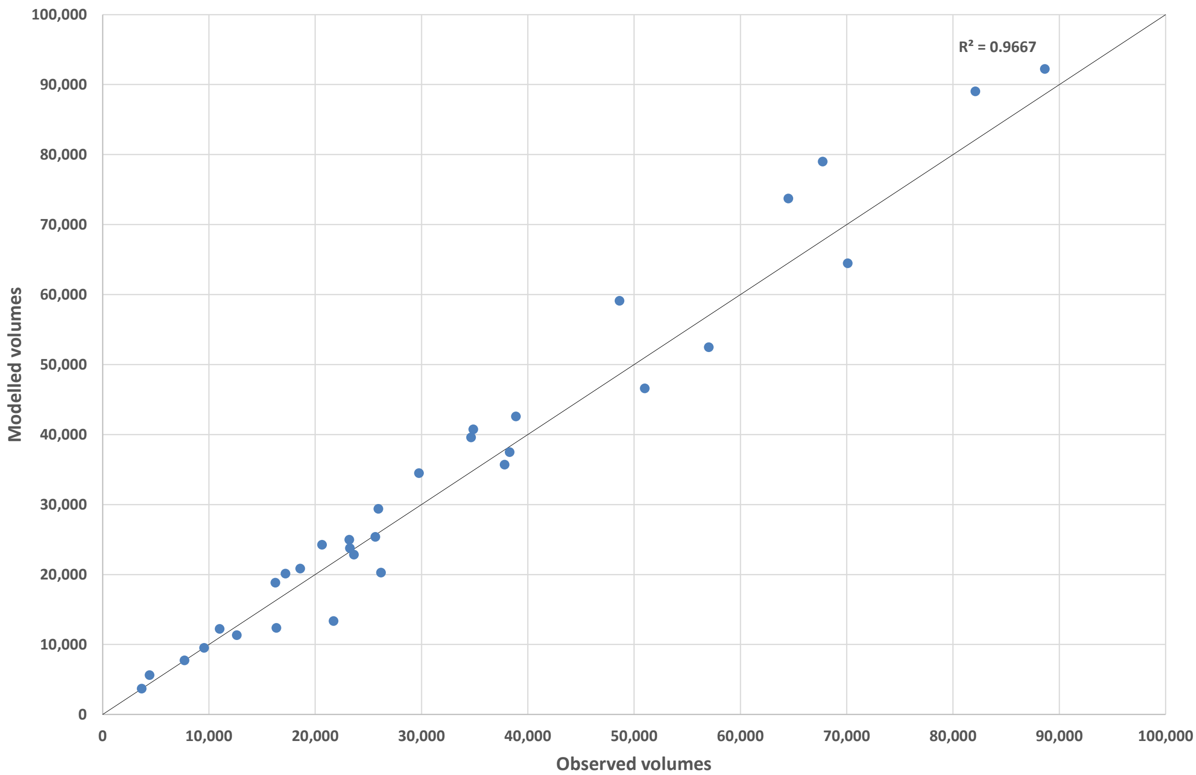


Table 2-6 2012 model performance – daily two way highway screenline traffic validation

Screenline	Observed	Modelled	Difference	%	GEH[4]
North of Caboolture	66,000	66,000	-600	-0.9%	0.6
Bruce Highway (Caboolture)	30,000	40,000	9,500	31.5%	12.3
Pine/ Caboolture Border	205,000	226,000	20,400	9.9%	10.7
South Pine River	450,000	494,000	43,200	9.6%	15.3
Cabbage Tree Creek	313,000	353,000	40,200	12.9%	16.9
Kedron Brook	454,000	477,000	22,800	5.0%	8.1
Airport	117,000	89,000	-28,800	-24.5%	21.8
Caboolture River	133,000	141,000	8,100	6.1%	5.3
Downfall Creek	239,000	263,000	24,300	10.2%	11.8
Enoggera Creek - Breakfast Creek	144,000	151,000	7,600	5.3%	4.8
CBD Circle (revised)	537,000	597,000	60,300	11.2%	19.4
Brisbane River	574,000	560,000	-13,700	-2.4%	4.4
Dutton Park to Norman Creek/ Brisbane River	364,000	307,000	-57,000	-15.6%	23.9
Dutton Park to Bulimba	144,000	138,000	-6,300	-4.4%	4.1

[4] The GEH statistic measures the goodness of fit of hourly traffic volumes, with lower values reflecting a higher degree of fit. It is expressed, comparing a modelled and observed *hourly* flow, as

$$GEH = \sqrt{2 * (Modelled\ flow - Observed\ flow)^2 / (Modelled\ flow + Observed\ flow)},$$

Daily volumes above have been converted to hourly flows by dividing by 17 (4 peak hours, 7 daytime off peak hours and 6 night time off peak hours)

Screenline	Observed	Modelled	Difference	%	GEH[4]
South Logan Motorway	261,000	280,000	18,500	7.1%	8.6
South of Gateway Extension	325,000	293,000	-32,200	-9.9%	14.0
East of Gateway Motorway	232,000	224,000	-8,100	-3.5%	4.1
Western	153,000	150,000	-2,800	-1.8%	1.7
Granard Road - Kessels Road	453,000	387,000	-66,000	-14.6%	24.7
Oxley Creek	239,000	223,000	-16,300	-6.8%	8.2
Brisbane - Logan Border	122,000	76,000	-46,300	-38.0%	35.7
Cleveland	157,000	126,000	-30,200	-19.3%	19.5
Brisbane / Redland Border	144,000	142,000	-1,400	-1.0%	0.9
Six Mile Creek	111,000	122,000	10,100	9.1%	7.2
Bremer River	121,000	119,000	-2,500	-2.1%	1.8
Intermediate West	52,000	52,000	-300	-0.5%	0.3
Intermediate West of Ipswich	77,000	80,000	3,000	3.9%	2.6
Logan River	236,000	261,000	24,700	10.5%	12.0
Intermediate South of Ipswich	25,000	25,000	0	0.0%	0.0
Ipswich	84,000	68,000	-15,900	-18.8%	14.0
Albert River	173,000	194,000	20,700	12.0%	11.7
Pimpama River/Tamborine	169,000	166,000	-2,500	-1.5%	1.5
Grand Total	**6,903,000**	**6,886,000**	**-17,400**	**-0.3%**	**1.6**

Public transport validation

The base year validation effort was focussed on public transport trip making, particularly for bus and rail. **Table 2-7** details the performance of the base year model in the AM peak and all day with respect of total trip making, by mode and in aggregate. This data shows a close overall match for bus and rail. Although the fit error for total ferry boardings is significantly higher in percentage terms, ferry trip making is a significantly smaller component of the total public transport task, with greater uncertainty over both the observed data and model performance.

Table 2-7 2012 model performance – total boardings by mode

Mode	AM Peak			Daily		
	Observed	Modelled	Difference	Observed	Modelled	Difference
Bus	58,700	60,900	3.7%	226,700	226,300	-0.2%
Rail	65,000	68,600	5.6%	287,600	293,700	2.1%
Ferry	3,700	2,800	-23.8%	19,500	11,000	-43.3%
Total	**127,400**	**132,300**	**3.8%**	**533,800**	**531,000**	**-0.5%**

Figure 2-6 and **Figure 2-7** presents further detail of the 2012 model performance during the AM peak period for bus boardings by operator and rail boardings by line respectively. These figures highlight the close match between the modelled and observed data, reflecting the robust estimate of base demand underpinning the model.

Figure 2-6 2012 model performance – AM peak period bus boarding by operator

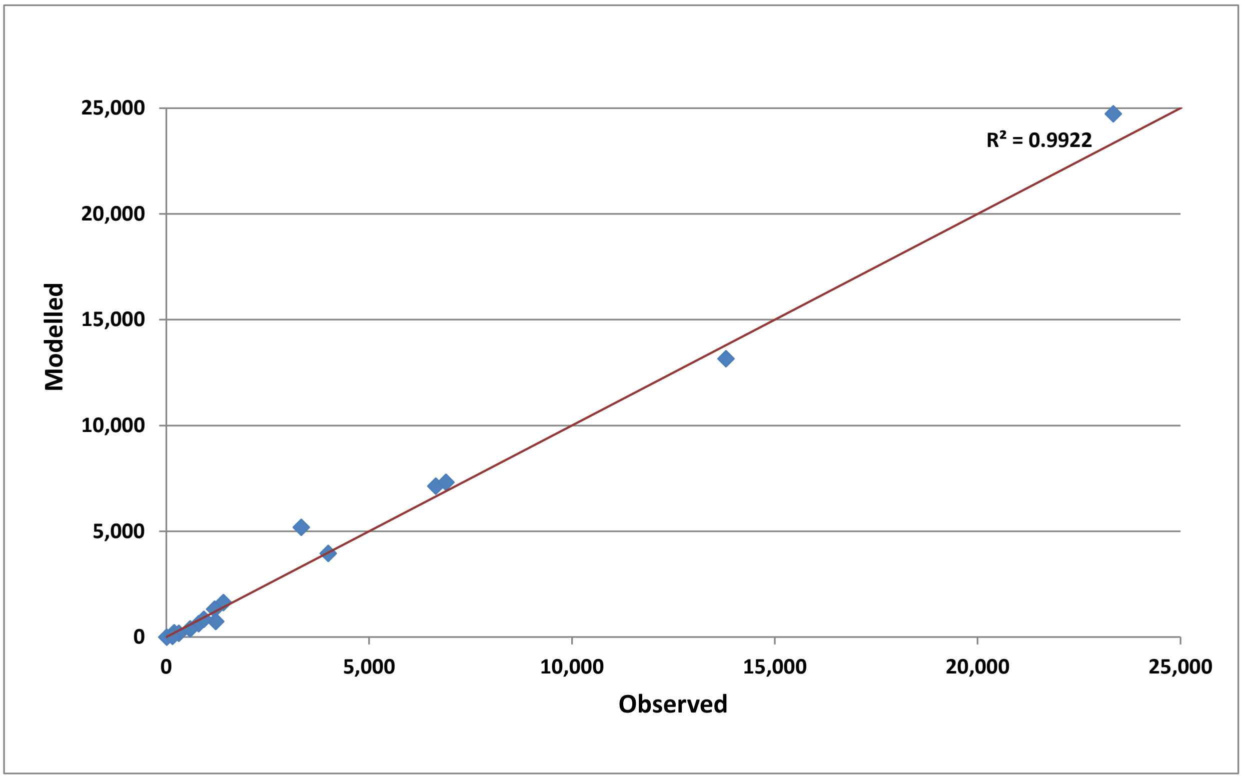
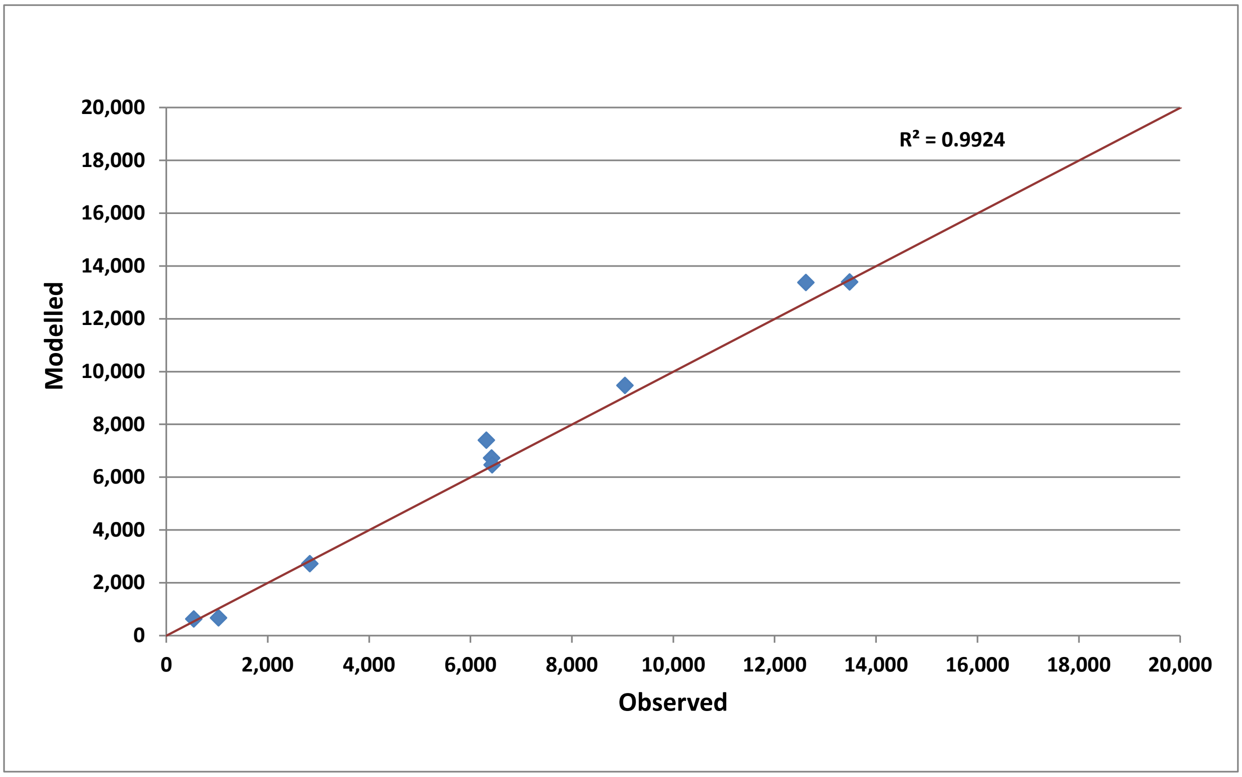
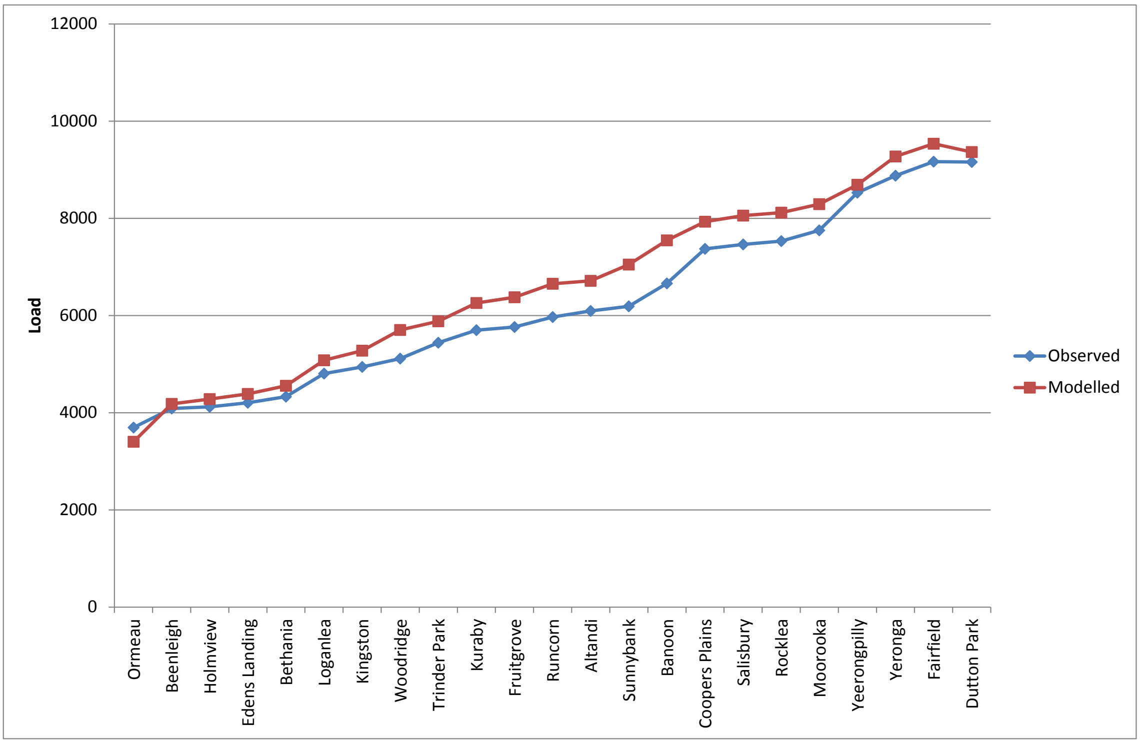


Figure 2-7 2012 model performance – AM peak rail boarding by line



Further comparisons of the model performance in regard to line for the Beenleigh-Gold Coast corridor, AM inbound in **Figure 2-8** This shows a close fit along the study corridor during the peak.

Figure 2-8 2012 model performance – AM peak rail line load, Gold Coast / Beenleigh line



2.2.5 Transport microsimulation modelling supporting bus operations

Microsimulation models were developed, using the VISSIM traffic modelling software, to provide input to the detailed design and bus operations of the Project and to better understand the benefits at a more detailed and localised level. The models comprised the Project's network (including the underground bus stations at Woolloongabba, George Street and Roma Street), the adjacent local road network and sections of the South East Busway.

These models were developed to gain a greater appreciation of the operations in three broad areas:

1) the operation of the underground bus stations including platform size, layout and operation as well as the expected capacity or throughout through the tunnel using different bus types, dwell time and bus station operation scenarios
2) the impacts the project would have at the interfaces with the external road network
3) the benefits to the existing South East Busway operation (including the Captain Cook Bridge) as a result of the Project

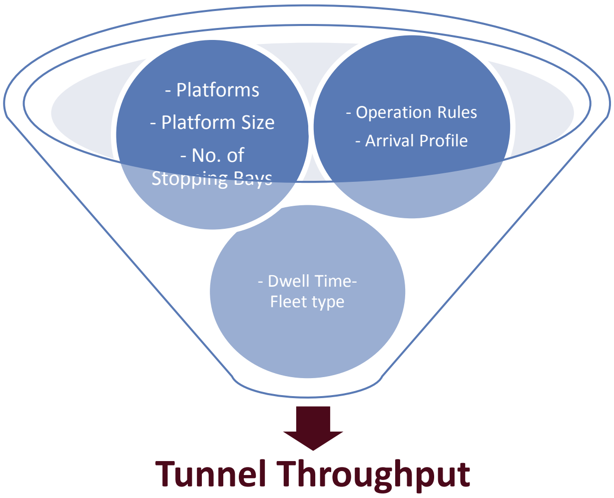
This section presents a broad outline of the scope of the microsimulation task and modelling approach.

2.2.6 Microsimulation modelling scope

Operation of the tunnel and stations

The initial operational assessment considered the tunnel from the Southern Connection to the Northern Connection. By isolating the tunnel from portal to portal, an assessment of the tunnel's maximum capacity was conducted without influence from the wider busway network. The key inputs that influenced the tunnel's throughput are identified in the figure below.

Figure 2-9 Inputs that control the tunnel bus throughput



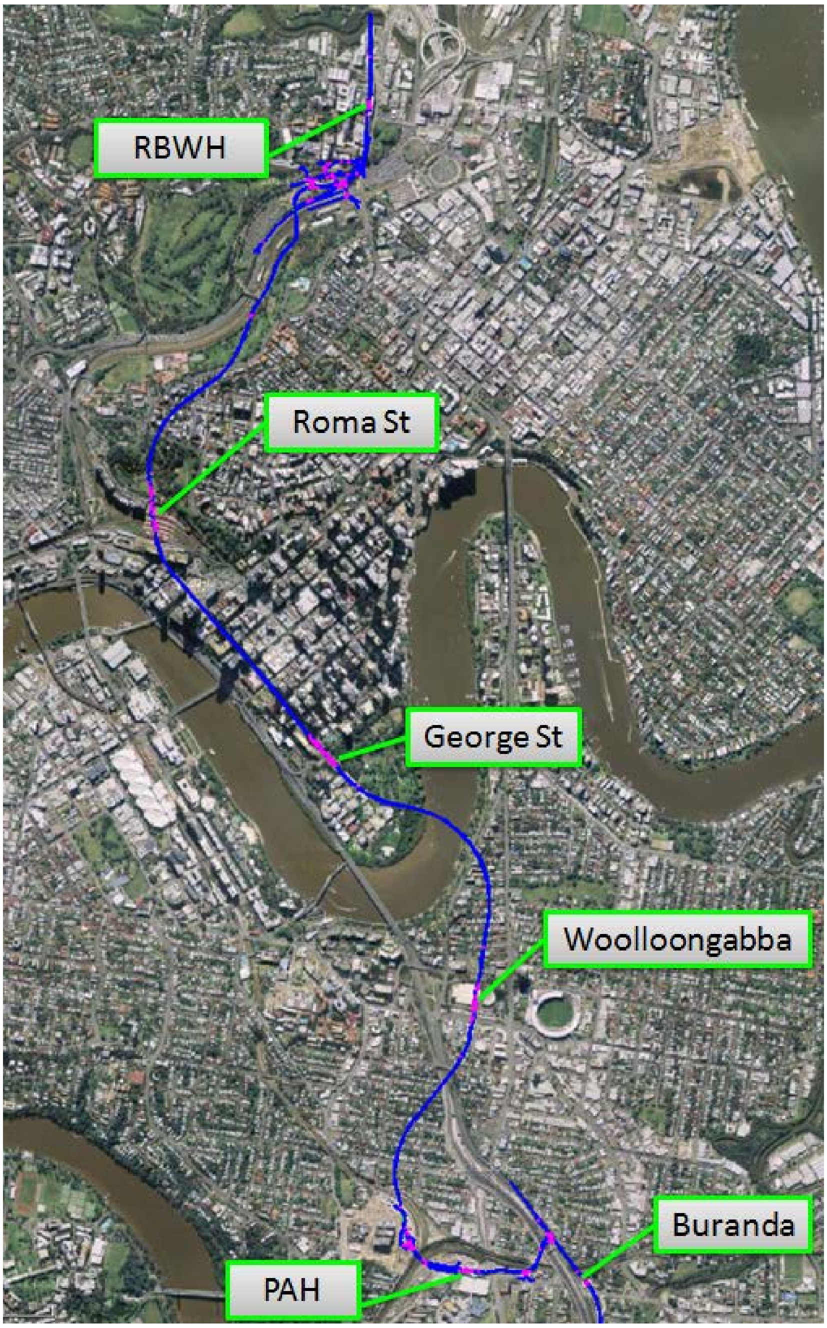
The key modelling outputs provided were:

- maximum bus station throughput
- maximum tunnel throughput
- bus station approach queuing

Project network interface impacts

Following the tunnel throughput assessment, investigation into the interaction of the Project's operation with the existing busway network was required. The extent of this assessment is shown in **Figure 2-10**.

Figure 2-10 Model network extents for the Busway Traffic Model



The network included:

- part of the South East Busway, Eastern Busway and the Northern Busway as well as the bus stations at Buranda, PA Hospital and RBWH
- ICB, Gilchrist Avenue off-ramp and Herston Avenue (RBWH precinct)

The broader model extent allowed for an assessment of the likely network constraints that may affect the arrival of buses accessing the tunnel. The key modelling outputs provided include:

- bus journey times
- bus station approach queuing

- bus station approach delay
- intersection delay and queuing

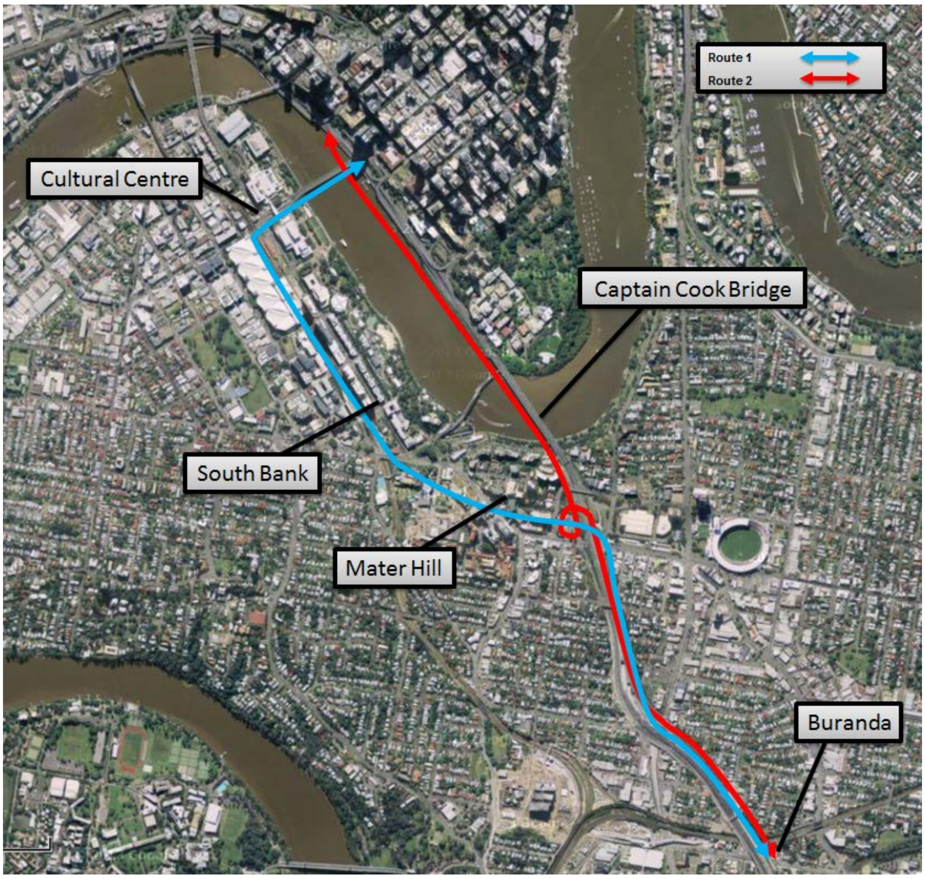
Impacts on the operations of the existing network as a result of the Project

The model was extended to include an analysis of the major southern CBD approaches via the South East Busway and Captain Cook Bridge. The modelling development assessed and quantified the existing and likely issues for these connections and the benefits that could potentially accrue from the introduction of the Project.

The two key corridors buses use between the CBD and areas southeast of the Brisbane River that were modelled are shown in **Figure 2-11**:

- Route 1: Via the South East Busway, Mater Hill, South Bank, Cultural Centre and Victoria Bridge
- Route 2: Via Captain Cook Bridge and the Pacific Motorway.

Figure 2-11 Bus routes assessed in the existing network modelling



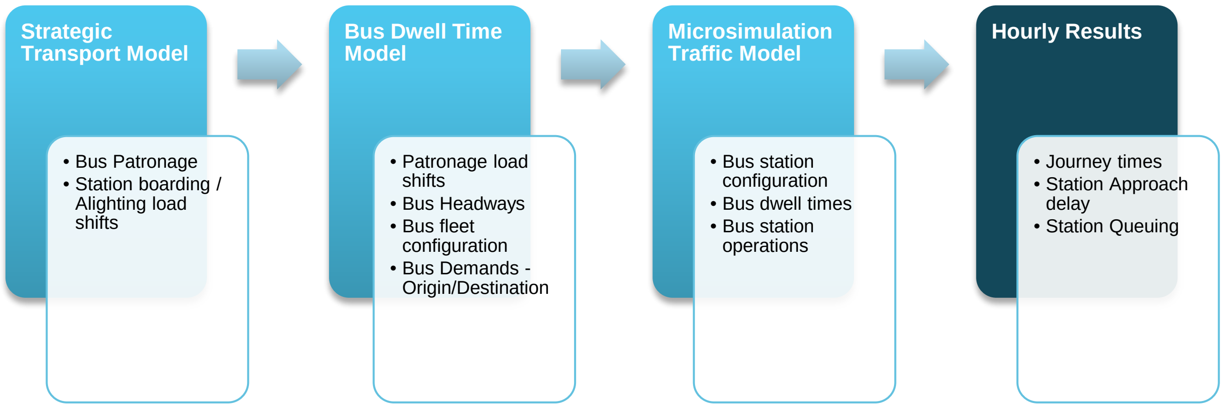
The key modelling outputs provided for the assessment were:

- bus journey times
- bus journey reliability
- bus station approach delay
- intersection delay

2.2.7 Overview of microsimulation modelling process

Figure 2-12 below describes an overview of the modelling process used in the BaT Busway Network modelling assessments.

Figure 2-12 Overview of modelling process



The following identifies the key inputs and assumptions used throughout the traffic microsimulation modelling.

2.2.8 Future years of assessment

The future years for assessment were 2021 and 2031 with 2021 representing the 'opening day' of the Project and 2031 representing 'plus ten years' of operation.

2.2.9 Modelling time period

The one hour morning and afternoon peak periods were assessed. To replicate congestion on the network before the peak hour started, all modelling used a half hour 'warm up' period.

2.2.10 Modelling results

To replicate variability for a given day, all modelling would be based on five random day seed runs. Hence, all results represent the average of these five individual seed runs.

2.2.11 Bus demands

The forecast bus demands for the future years were provided from the BaT Project Model. These outputs were converted into an Origin and Destination (OD) matrix and used in the microsimulation model.

2.2.12 Bus dwell times

The predicted bus dwell times at each station for the future years stemmed from the patronage and load shift proportions predicted from the Strategic Transport Model. These outputs were fed into the Bus Dwell Time Model to generate the average dwell times used in the microsimulation model.

Dwell time variability

The Bus Dwell Time Model produced an average dwell time only. To represent variability of a stopped bus, a standard distribution was applied. The Transit Capacity and Quality of Service Manual 2nd Edition (Transportation Research Board) recommends the use of one standard deviation to be 60 per cent of the dwell time.

This was deemed fit for purpose and this assumption was used in all the models with one exception. To better reflect the higher variability of dwell time expected to occur at the Cultural Centre, one standard deviation equal to 100 per cent of the average dwell time was used at this location.

Bus ticketing

Bus ticketing was a key input in the Bus Dwell Time Model. As a result, sensitivity testing of two key scenarios was conducted in the microsimulation modelling. The scenarios were:

- On-Board Ticketing: This scenario replicates the 'tap on / tap off' go card ticketing system currently used on the Brisbane Bus network.
- Off-Board (pre-paid) Ticketing: This scenario assumes implementation of new ticketing infrastructure at the bus stations to remove all on-board ticketing on the buses resulting in faster boarding times than the On-Board ticketing system.

As a result of this comparison, all the bus stations in the BaT Busway Network modelling would assume off-board ticketing in 2021 and 2031 due the improved boarding time.

2.2.13 Platforms and stopping positions

It was assumed that each of the bus stations would contain two independently operating platforms each with a discreet number of stopping bays.

The tunnel throughput assessment subsequently confirmed that the preferred layout for the bus stations would comprise two platforms in each direction of travel with each platform containing three stopping positions.

Figure 2-13 illustrates a typical platform containing 6 bus stopping bays. The first three bays, numbered 1 to 3, operate independently from the bays numbered 4 to 6.

2.2.14 Bus station operations

For the modelling at all bus stations, two rules governed how a bus could access a bus stopping bay. These rules were:

1) Enter in Order/ Exit in Order (EiO/EiO)
2) Enter when Ready/ Exit when Ready (EwR/EwR)

Figure 2-13 and **Figure 2-14** illustrate the difference between these two operating methods.

The EiO/ EiO does not permit buses pass or overtake each other at the bus station. As shown schematically in **Figure 2-13**, the bus about to enter Bay 2 'stacks' behind a stopped bus in Bay 3. Similarly the bus in Bay 4 must wait until the bus exits Bay 5 before being permitted to continue.

Unlike EiO/ EiO, EwR/ EwR allows for greater throughput within the station. It allows a bus to enter Bay 3 if a bus is stopped in Bay 1, only if Bay 2 is vacant. Similarly, a bus can exit Bay 4, (from behind Bay 6) only if Bay 5 is vacant. This can be seen schematically below in **Figure 2-14**.

Figure 2-13 Schematic of buses entering in order and exiting in order (EiO/ EiO)

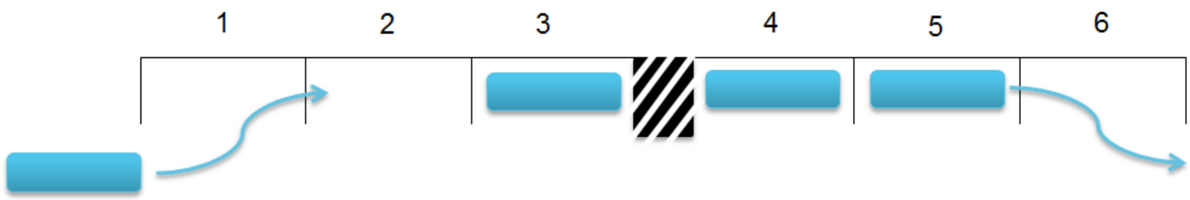
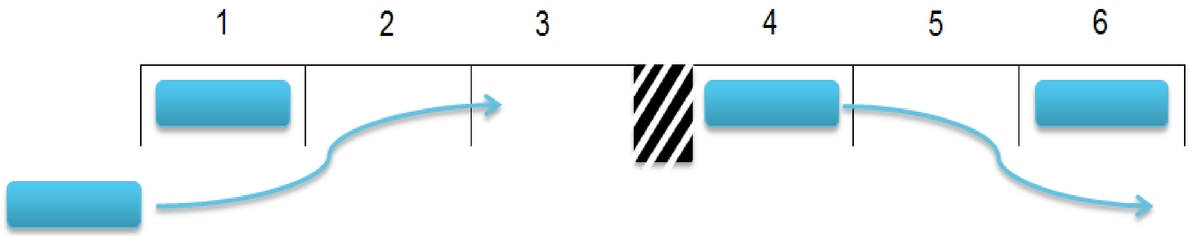


Figure 2-14 Schematic of buses entering when ready and exiting when ready (EwR/ EwR)



When compared to EwR/ EwR, EiO EiO allows less variation in bus movements within a station and consequently its operation is more predictable. EwR/ EwR on the other hand allows more flexibility of the operation at the bus station and has marginally higher throughput than the EiO/ EiO operation.

Table 2-8 Rules of operation at bus stations

Buranda	PAH	Mater Hill	South Bank	Cultural Centre	'Gabba	George	Roma	RBWH
Tunnel Throughput								
-	-	-	-	-	EiO/ EiO	EiO/ EiO	EiO/ EiO	-
BaT Busway Network								
EwR/ EwR	EwR/ EwR				EiO/ EiO	EiO/ EiO	EiO/ EiO	EwR/ EwR

Bus station operations logic (VISVAP)

As the aforementioned bus operation was not able to be replicated using the standard bus operation in VISSIM, a specific bus algorithm for controlling bus movements at the bus stations was developed. This was done using the VISVAP signal control software.

Both the BaT Busway Network models models used the VISVAP logic based feature to control buses at each station.

Mid cavern bus storage

During the tunnel throughput assessment, analyses of the impact of mid-cavern bus storage further defined bus operations within a bus station of the Project. An assessment quantified the change in tunnel throughput when buses destined for the forward platform's stopping bays were allowed to store in the mid-cavern versus when they were not. These scenarios were:

- mid-cavern bus storage allowed
- mid-cavern bus storage not allowed.

Figure 2-15 is a schematic representation of the scenario allowing mid-cavern storage. The figure shows a light blue bus 'stored' behind a stop line adjacent to Bay 3 while waiting to enter on of the occupied bays 4 to 6. In this scenario, the modelling allowed the dark blue bus (bay 3) to exit without interference from the light blue 'stored' bus. It also allowed a dark blue bus to enter behind the 'stored' bus into bay 2.

Figure 2-15 Mid-cavern storage allowed

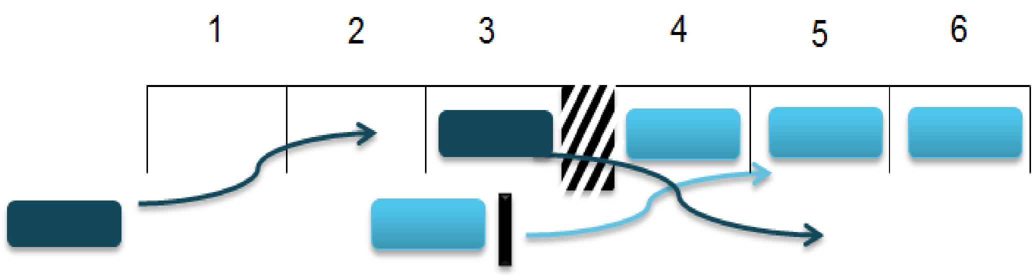


Figure 2-16 illustrates the scenario where mid cavern storage is disallowed. In this operation the light blue bus destined for bays 4 to 6 is denied the opportunity to 'store' mid-cavern and has to remain behind the stop line at the entrance to the bus station cavern. As a result the dark blue bus destined for the unoccupied bays 1 to 3 is not able to pass the light blue bus and is delayed.

Figure 2-16 Mid-Cavern storage not allowed

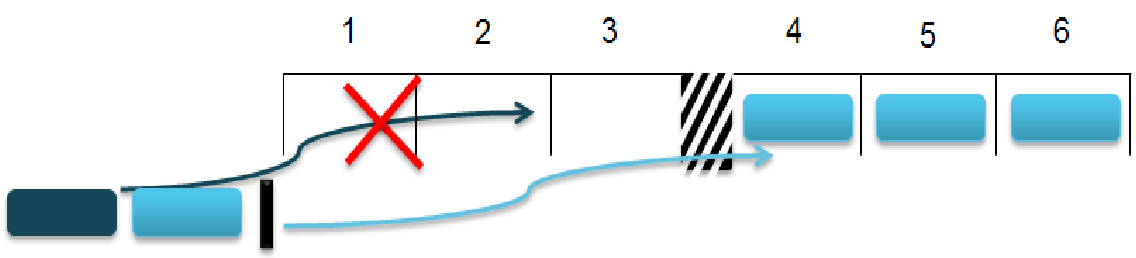


Table 2-9 details the change in tunnel throughput with the two mid-cavern storage scenarios. For all these tests constant dwell times were used. The conclusion from this test is that without mid-cavern storage the tunnel throughput could be reduced by up to 30 per cent.

Table 2-9 Tunnel throughput under various mid-cavern storage scenarios

Model	Hourly bus throughput
With mid-cavern storage	230
Without mid-cavern storage	162
Tunnel throughput reduction (%)	30%

Modelling also revealed the benefit of mid cavern storage applied only to stations with a two platform arrangement. When mid cavern storage was assessed with three platforms (each containing two stopping bays), a visual assessment identified the benefit decreased. Modelling showed egressing buses from the rear platform were often required to queue behind the stored mid-cavern buses destined for platform 1.

2.2.15 Traffic Signals

Tunnel throughput

No signals were used in the tunnel throughput assessment

Project busway network

The “internal” intersections on the busway at Southeast Busway/ Eastern Busway, Boggo Road/ Eastern Busway and Northern Busway/ Gilchrist Avenue were all modelled as fixed time signals. The cycle times for the two Eastern Busway intersections were approximately 70 to 90 seconds. As the proposed intersection at Northern Busway / Gilchrist Avenue required long clearance times to safely clear buses through the intersection, this intersection’s cycle time was modelled as 120 seconds.

The phasing splits and offset for all intersections were optimised based on the predicted bus demands.

The existing phasing at the Herston Road/ Bowen Bridge Road intersection were based on SCATS phasing provided by TMR. To replicate the predicted congestion for traffic exiting onto Bowen Bridge Road in the future, it was agreed that an underutilised green time factor of 50 per cent be applied to the signal times in 2021 and 2031.

Assessment

Signal phasing and split times for the Alice Street, Margaret Street and Elizabeth Street ramps with the Riverside Expressway were provided by TMR via Brisbane City Council. These were modelled as fixed time signals in the traffic model and remained constant across the morning and afternoon peaks in all scenarios.

The current southbound Pacific Motorway traffic exiting at the Vulture Street off-ramp is effectively metered by signals at Vulture Street and Stanley Street. The impact of these signals was important to the operation of the motorway however their exact operation was beyond the scope of this study. As a result, a single set of dummy fixed time signals were placed on the exit ramp in the models in order to induce the congestion observed onsite and replicate the journey times recorded during on-site observations.

Similar to the BaT busway network models, all ‘internal’ busway intersections were modelled with fixed time signals with cycle times of approximately 70 to 90 seconds. Each intersection phasing splits and offset were optimised based on predicted bus demands.

All PM signal operations were taken from the previously developed Cultural Centre model (2009) and were included in the model as fixed time signals.

2.2.16 Not in service buses (dead runners)

The BaT Busway Network model contained buses that are in-service (stop at stations) as well as buses that are out-of-service (buses that bypass stations). The volumes of these out-of-service or dead running buses were modelled based on the demands provided by the Strategic Transport Model. The final OD matrix provided was developed by TMR. To reduce the peakiness of the Strategic Model’s output, the matrix incorporated a smoothing effect.

2.2.17 Speed Limits

The following speed limits were used in the modelling:

- Project tunnel: 80km/h
- Project busway network: 50km/h
- Pacific Motorway: 80km/h
- Cultural Centre precinct: 50km/h
- ICB: 80km/h
- Herston Avenue (RBWH precinct): 50km/h

2.2.18 Pacific Motorway model construction

The following outlines the methodology and input used to create the Pacific Motorway in the microsimulation modelling.

Existing background traffic

STREAMS loop data for the Pacific Motorway mainline volumes were provided by TMR. These volumes were collected in September 2012 and 2013 and were considered appropriate for use in the base case calibration model. Pacific Motorway ramp volumes were determined using the SCATS data provided by TMR at the William Street intersections. The OD matrix was generated from the SCATS volumes using LinSig. LinSig is a traffic modelling software tool that has an inbuilt regression algorithm that estimates OD matrices. To create traffic conditions (average speeds and journey times) consistent with those observed during site inspections, an additional demand of 800 vehicles per hour was added to the Pacific Motorway northbound in the PM peak. A heavy vehicle proportion of 2 per cent was assumed for all background traffic.

Journey time calibration

In order to estimate bus journey times via the Pacific Motorway in 2021 and 2031 'with' and 'without' the Project, it was critical that congestion along the Pacific Motorway was modelled accurately in base case models. Accurately representing the throughput was fundamental to estimating the effect queuing of background traffic would have on buses delays in their trips between the Allen/ Vulture Streets ramps and the Brisbane CBD.

To this end a series of journey time measurements along the Pacific Motorway were undertaken, to be used in the calibration of the Base models. 2014 SCATS phasing data and SCATS counts at the Alice Street / William Street, Margaret Street / William Street and Elizabeth Street / William Street ramps were also obtained to create calibrated a 2014 base case models of the Pacific Motorway.

These base case models of the Pacific Motorway were used as a basis for developing the future 2021 and 2031 models.

Future background traffic

Strategic model volumes on the Pacific Motorway were provided for 2014, 2021 and 2031. The growth factor predicted between years in the strategic model was then applied to the base case STREAMS/ SCATS link volumes. The base case volumes were multiplied by this factor to generate the predicted 2021 and 2031 volumes. No growth was assumed at the Allen Street on ramp in the AM peak, as this is already at capacity in 2014. As no strategic model volumes were provided for the North Quay/ Ann

Street ramp it was assumed that growth was consistent with the growth experienced on the Pacific Motorway.

2.2.19 ICB model construction

The following outlines the methodology and input used to create the ICB, Gilchrist Avenue and Herston Road in the BaT Busway Network modelling.

Existing background traffic

The 2014 Gilchrist Avenue and Herston Road vehicle volumes were determined using the SCATS data provided by TMR. It was agreed that 100 vehicle trips would enter the RBWH multi deck car park in the AM and 100 vehicle trips would exit in the PM. A heavy vehicle proportion of 2 per cent was assumed for all background traffic.

Future background traffic

Forecast traffic volumes provided by the BaT Project Model for the ICB, Gilchrist Avenue and Herston Road were provided for 2014, 2021 and 2031. The growth factor predicted between years in the strategic model was then applied to the base case SCATS link volumes. The base case volumes were then multiplied by this factor to generate the predicted 2021 and 2031 volumes.

2.2.20 Fleet

Bus fleet type was a critical input in determining bus dwell times and hence operation of the busway networks. Two fleet types were used in the assessment, namely:

- 12.5m rigid buses
- 18m articulated buses

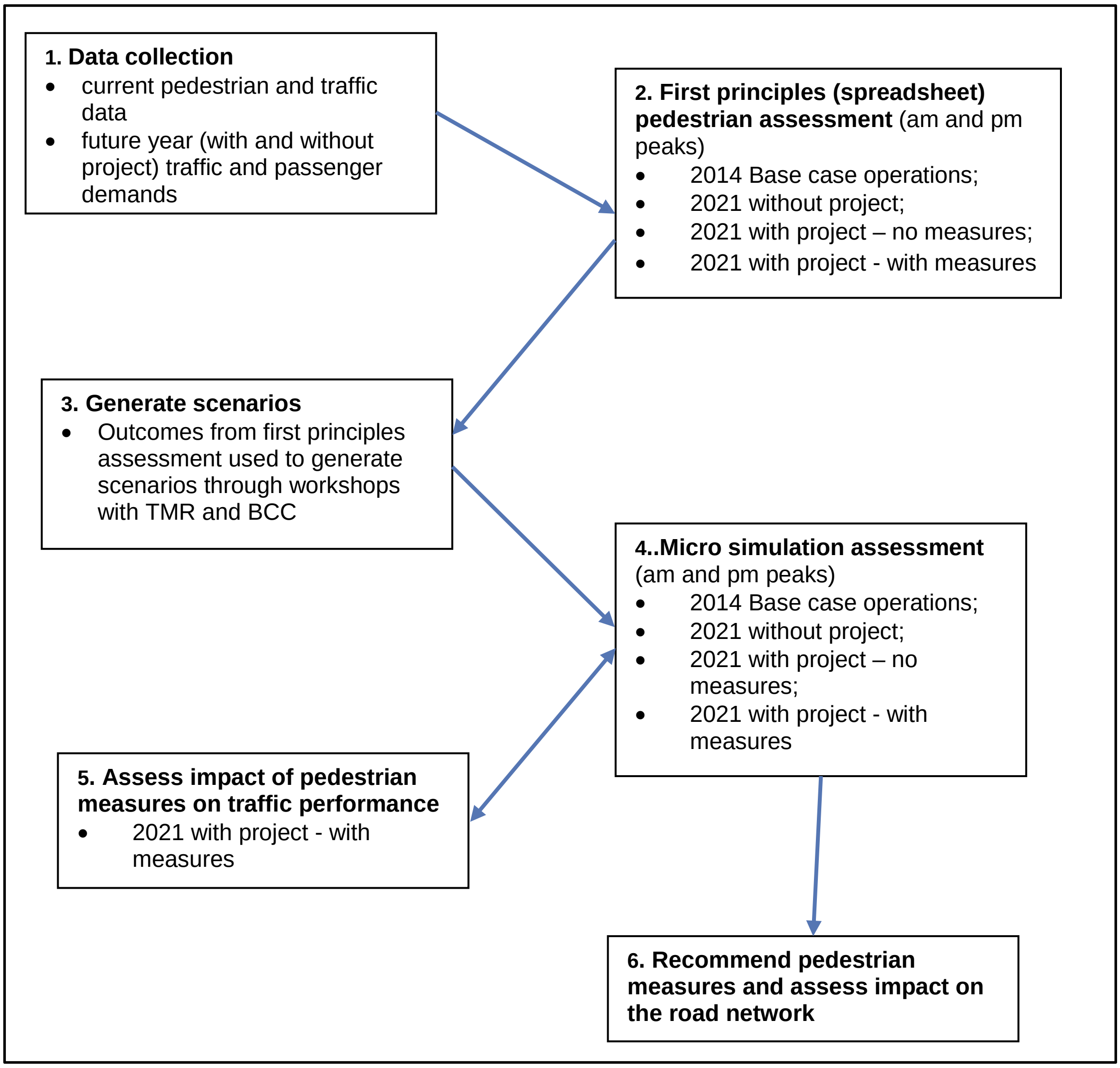
With the exception of the 2031 BaT Busway Network, all models used 12.5m rigid buses. As the current 2014 fleet, contained a significant number of rigid buses compared to articulated buses, this assumption also yielded the ‘likely’ scenario in 2021.

A preliminary assessment of the BaT Busway Network model identified that continuing this ‘rigid bus only’ assumption in 2031 would create unacceptable congestion and delay on the network. To address this decrease in network performance, it was assumed that articulated buses would be used to improve efficiency. For modelling purposes it was assumed that 39 per cent of peak bus services in the Project would be 18m articulated buses in 2031. The effect of this change improved the performance of the bus network back to acceptable levels.

2.3 Pedestrian assessment methodology

A methodology was developed to assess the potential impacts of the forecast pedestrian demands at the George Street, Roma Street and Woolloongabba Stations and to determine measures that would mitigate pedestrian impacts of the Project. The methodology incorporates a traffic assessment of the impact of pedestrian mitigation measures on the performance of the road network. An outline of the methodology is provided in **Figure 2-17**.

Figure 2-17 Pedestrian station precinct assessment method



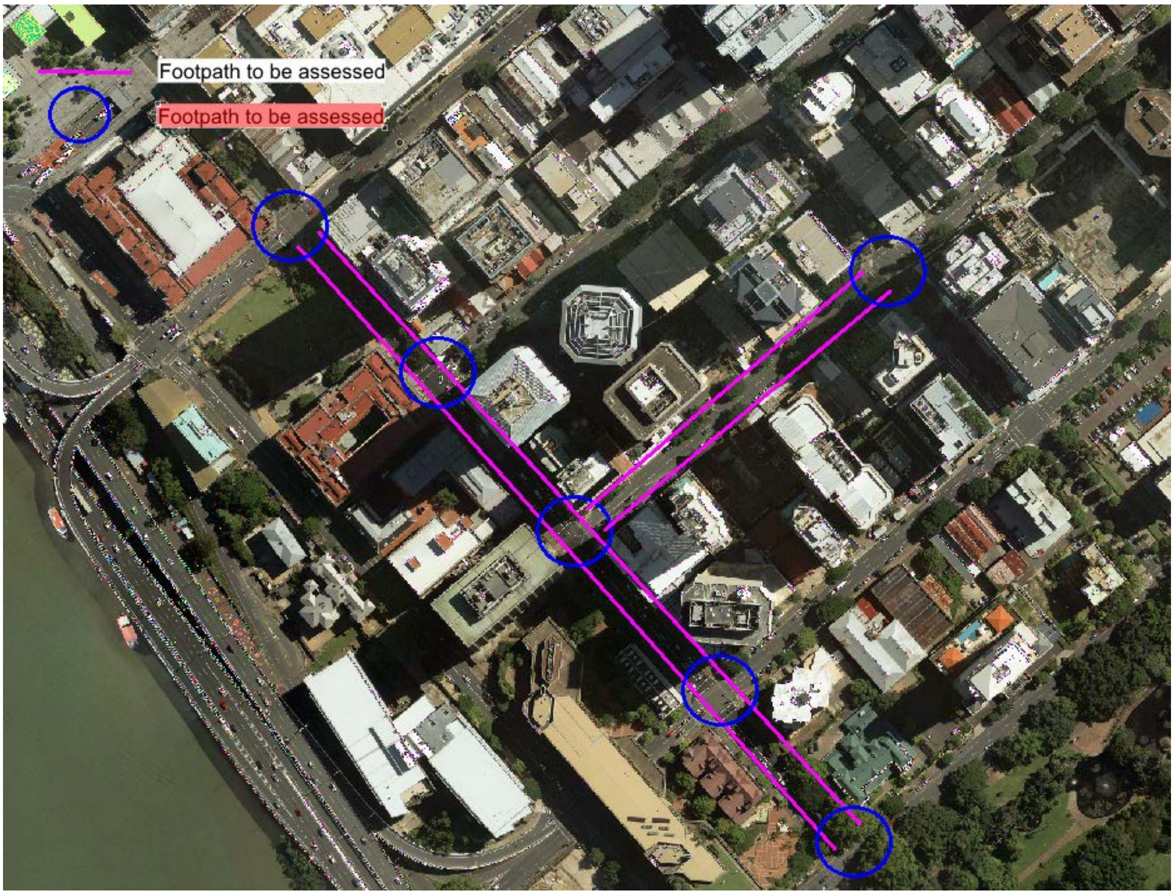
The pedestrian first principles analysis and simulation modelling was conducted for the following scenarios:

- 2014 AM & PM base case operations
- 2021 AM & PM 'without Project'
- 2021 AM, PM & event day (Woolloongabba Station only) with project' do nothing
- 2021 AM, PM & event day (Woolloongabba Station only) 'with project' with upgrades.

2.3.1 Study areas

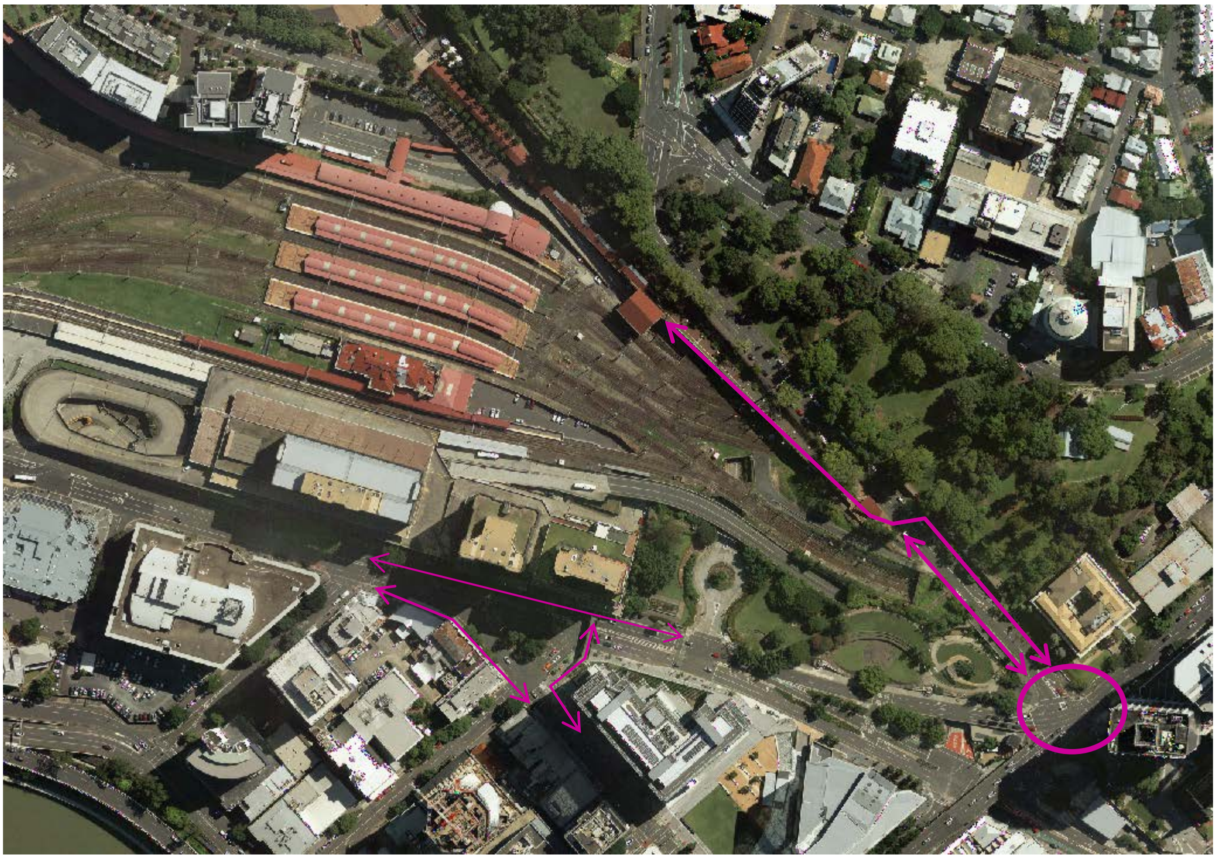
The study area for the George Street Station precinct is shown in **Figure 2-18**. Intersections and footpaths on George Street were assessed from Elizabeth Street to Alice Street, and on Mary Street from George Street to Albert Street.

Figure 2-18 George Street Station study area



The study area for Roma Street is shown in **Figure 2-19**. Intersections and footpaths on Roma Street were assessed from Makerston Street to Parkland Crescent and on George Street between Roma Street and Herschel Street within the 'southern' model. The 'Albert' model assessed the intersection of Albert Street/ Turbot Street/ Roma Street, as well as the footpath towards the station entrance on Albert Street.

Figure 2-19 Roma Street Station study area



The study area for the Woolloongabba Station precinct is shown in **Figure 2-20**. The pedestrian modelling includes the overbridge, signalised crossing of Stanley Street and the uncontrolled crossing of the southern section of Stanley Street.

Figure 2-20 : Woolloongabba Station study area

2.3.2 Pedestrian demand generation

Surveys of pedestrian activity were carried out to prepare both the demand that serves as an input to the models, as well as providing an understanding of vehicular and pedestrian behaviour in the area. This data was also used for model calibration.

These demands were used to assess first principles performance and to derive Origin-Destination matrices, which were used in simulation modelling.

Input data for 2014

Pedestrian surveys were undertaken of the Roma Street and George Street study areas at the signalised crossings, and also at the points where illegal crossing (jaywalking within 30m of traffic signals) was identified as occurring. Surveys also were undertaken of the demand for the pedestrian overbridge at Roma Street.

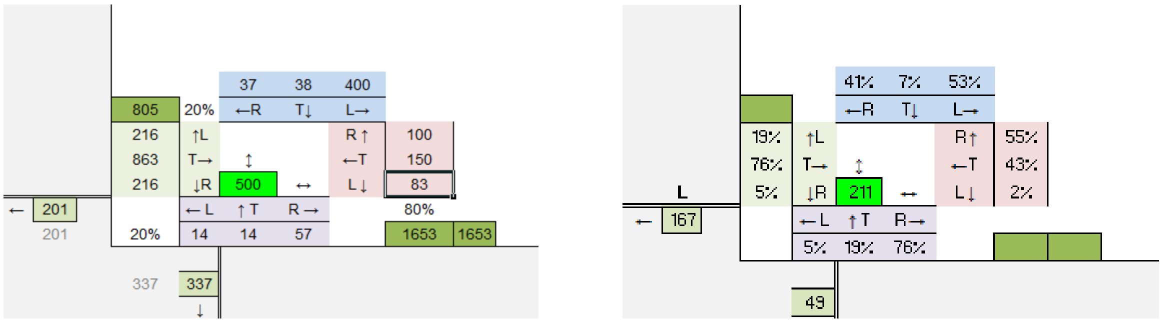
Traffic volumes at traffic signal controlled intersections in the study areas for each precinct were obtained from the Brisbane City Council SCATS database. To supplement and refine the turning volumes derived from SCATS counts additional vehicle turning counts were undertaken of the Roma Street precinct.

Origin-destination matrix methodology

The simulation modelling used origin-destination matrices that were derived using the industry standard probability-weighted demand approach, where the proportion of vehicles turning at each intersection is applied to the origin volume to derive the origin-destination pair.

For pedestrians, there was no sufficiently detailed origin-destination model for each study area. At each point where pedestrians make a turning decision, turning proportions were synthesised as shown in **Figure 2-21** to develop the origin-destination matrix.

Figure 2-21 Synthesis of turning counts for pedestrians



This process also determined the station and non-station pedestrian demands.

2021 without Project pedestrian demand

A background growth rate of 0.5 per cent per annum was used uniformly across vehicles and pedestrians. It was assumed that there was no change to the preference for particular routes or land uses with the Project.

2021 with Project pedestrian demand

Pedestrian demand associated with each of the stations were provided by the BaT Project Model. The distribution of pedestrian demands to the surface streets was included in the outputs from the BaT Project Model.

For Roma Street and Woolloongabba Stations, the forecast pedestrian demands include the pedestrian demands for the existing stations. The forecast pedestrian demands therefore replaced the 2021 without Project demands for these stations. For George Street, these demands were considered to be an additional land use, so were added to the 2021 without Project demands.

2.3.3 Performance assessment

Fruin level of service

The Level of Service (LoS) regime defined by John J. Fruin wase used to quantify pedestrian accessibility under each scenario. Fruin defines three areas of unique behaviour: walkways, stairs and queuing areas. For the surface streets considered in this analysis, queuing areas correspond to the waiting areas at signalised crossings, where the key performance metric is the space (m^2) per pedestrian. Walkways correspond to footpaths and signalised crossings, where the key performance metric is the flow rate, measured as the pedestrians per metre per minute (ped/ m/ min). **Table 2.10** and **Table 2.11** describes the LoS bands for walkways and queuing areas respectively.

Table 2.10 Fruin LoS for Walkways

LEVEL OF SERVICE	SPACE (m2 / ped)		FLOW RATE (ped / m / min)		SPEED (m/sec)		
	Min	Max	Min	Max	Min	Max	Average
A	3.25		0.1	23.0		1.24	1.24
B	2.32	3.25	23.0	32.8	1.24	1.27	1.26
C	1.39	2.32	32.8	49.2	1.27	1.14	1.21
D	0.93	1.39	49.2	65.6	1.14	1.02	1.08
E	0.46	0.93	65.6	82.0	1.02	0.64	0.83
F		0.46	82.0	inf	0.64		0.64

Source: Chapter 8 – Designing *for Pedestrians, "Pedestrian Planning & Design", John J. Fruin*

Table 2.11 Fruin LoS for Queuing Areas

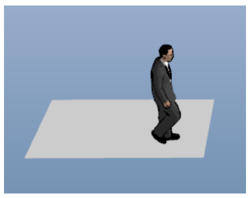
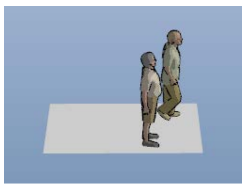
LEVEL OF SERVICE	SPACE (m2 / ped)		INTER-PERSON SPACING	
	Min	Max	Min	Max
A	1.21		4	
B	0.93	1.21	3.5	4
C	0.65	0.93	3	3.5
D	0.28	0.65	2	3
E	0.19	0.28		2
F		0.19		

Source: Chapter 8 – Designing *for Pedestrians, "Pedestrian Planning & Design", John J. Fruin*

In **Table 2.11**, the inter-person spacing is the number of 'person-spaces' between pedestrians. Under LoS E, the maximum inter-person spacing is 2, which indicates that two more pedestrians could stand in the empty space between each pair of pedestrians.

The Fruin Levels of Service are displayed in **Figure 2-22** and **Figure 2-23** to indicate what each LoS represent for each criterion. The accompanying diagram represents a view of the density based on a 3m by 2m area (delineated by the grey shaded section).

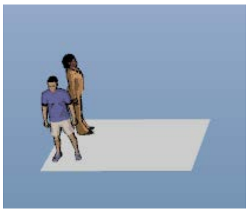
Figure 2-22 Description of LoS for walkways

Fruin LoS	Walkway Criteria	
A	Normal walking speed can be freely selected and slower pedestrians can be easily overtaken. Cross conflicts can be easily avoided.	
B	Sufficient space is available to select normal walking and to bypass other pedestrians in primarily one-directional flows. Where there are reverse-direction or crossing movements, minor conflicts will occur.	
C	Restricted ability to select normal walking speed and freely pass others. High probability of conflict where crossing movements & counter-flows exist. Conflict avoidance requires frequent adjustment of walking speed and direction. Flow is reasonable fluid, however considerable friction and interaction between pedestrians is likely to occur.	

Fruin LoS	Walkway Criteria	
D	Restricted walking speed; overtaking slower pedestrians is difficult. Counter-flows and crossing movements severely restricted. Some probability of reaching critical density causing temporary stoppages.	
E	Walking speed & passing ability is restricted for all pedestrians. Forward movement is possible only by shuffling. Counter-flows and crossing movements extremely difficult. Flow volumes approach limit of walking capacity.	
F	Severely restricted walking speed; frequent unavoidable contact with others; reverse or cross movements are virtually impossible. Pedestrian flow is sporadic & unstable.	

Source: Chapter 8 – Designing *for Pedestrians, "Pedestrian Planning & Design", John J. Fruin*

Figure 2-23 Description of LoS for queuing areas

Fruin loS	Queueing Criteria	
A	Space is provided for standing and free circulation through the queuing area without disturbing others.	
B	Space is provided for standing and restricted circulation through the queue without disturbing others.	
C	Space is provided for standing and restricted circulation through the queuing area by disturbing others. It is within the range of the personal comfort body buffer zone established by psychological experiments.	
D	Space is provided for standing without personal contact with others, but circulation through the queuing area is severely restricted, and forward movement is only possible as a group.	

Fruin loS	Queueing Criteria	
E	Space is provided for standing but personal contact with others is unavoidable. Circulation within the queuing area is not possible. This level of area occupancy can only be sustained for short periods of time without physical and psychological discomfort.	
F	Space is approximately equivalent to the area of the human body. Standing is possible, but close unavoidable contact with surrounding standees causes physical and psychological discomfort. No movement is possible, and in large crowds the potential for panic exists.	

Source: Chapter 8 – Designing for Pedestrians, "Pedestrian Planning & Design", John J. Fruin

Walkway platoon clearance

In the first principles analysis, an additional metric was used to describe the behaviour observed on site. Pedestrians were observed to walk in platoons on walkways due to the pulsing nature of traffic signals. The Walkway Platoon Clearance per cent metric is calculated as the volume of pedestrians in a cycle divided by the capacity of the walkway or pinch point in a cycle. Where points exceeded 100 per cent it was noted that pedestrians chose to minimise personal space rather than wait longer for the opportunity to cross. This metric is comparable to a volume/capacity ratio. **Table 2.12** shows an evaluation of the walkway platoon clearance percentages as observed on site visits.

Table 2.12 Walkway Platoon Clearance per cent

Walkway Platoon Clearance %	Pedestrian Behaviour
0 – 79%	Pedestrians can either move through a walkway section with minimal delays, some weaving may be required.
80 – 110%	Pedestrians are required to weave and to accept lower space preferences.
110 – 130%	Walkway is above capacity, waiting required in both directions. Pedestrians may decide to choose alternate path to avoid congestion. Pedestrians may take safety risks to avoid this walkway if no viable alternative is provided.
>130%	Due to the number of footpaths often available in a city environment, pedestrians are not likely to wait at a footpath with this level of congestion. Pedestrians would either take another path, leave at a different time, or take safety risks to avoid waiting.

Level of service trigger point

For planning purposes, a mid-band LoS D was assumed to be a trigger point for further investigation, which is accepted within the industry. Site visits to George Street and Roma Street indicated that people's preference for personal space was consistent with a LoS D, and that pedestrians may take safety risks to preserve their personal space under more constrained conditions, such as crossing roads illegally.

2.3.4 Pedestrian simulation software

The combination of VISSIM and VISWALK was used to simulate pedestrians in each of the station precincts. VISWALK is a software plugin for the traffic simulation software, VISSIM, and uses

Helbing's Social Force Model as an algorithm to predict the behaviour of pedestrians. For all of the calibration parameters, the standard VISSIM and VISWALK values were used, except for:

- Number of observed pedestrians, which was increased to improve the routing behaviour of pedestrians
- Pedestrian reaction time, which was increased to improve the routeing behaviour of pedestrians
- Routing cell size, which was decreased within recommended limits to improve pedestrian behaviour in congested walkways
- Side preference (George Street model, congested walkways only) was set to a preference for the left hand side.

For all scenarios, performance is reported on the average of five random seeds to ensure the stability and fairness of results.

Pedestrian software limitations

VISSIM and VISWALK are industry standard software that have been used on similar projects internationally. The software, however, has limitations. The pedestrian behaviour is based on the Social Force Model, which is a mathematical approximation of the route-choice behaviour of pedestrians. As densities on walkways increase, avoidance forces may not be enough to form the lanes that are observed with pedestrians, leading to higher friction, delays and density than could be likely to occur. Compared with vehicles, pedestrians make more avoidance decisions, and their behaviour is more difficult to model accurately.

2.3.5 Pedestrian modelling assumptions

The following assumptions were used in both the first principles and micro-simulation assessment:

- Base year is 2014 with pedestrian volumes sourced through pedestrian surveys
- Background growth of pedestrian activity was assumed to be 0.5 per cent per annum
- 2021 pedestrian demands for the Project were obtained from the BaT Project Model. The 2021 'with project' scenario was assumed to have both background growth and increased demands from the Project.
- A 40 storey office building will be assumed to be co-developed with the George Street Station. The 40 storeys are assumed to include 4 floors of car park/other non- leasable uses. The remaining floors are assumed to have 1,200m2 GFA.
  - Given that the co-development of the office building indicates an opening date of approximately 2021, the building is not likely to be fully occupied. We have assumed that 70 per cent of leasable floor area is occupied by 2021.
  - Using work for a comparable office tower – Collins Square in Sydney – the following pedestrian density and movement assumptions were made: $9m^2$ GFA / office worker, each office worker takes an average of 4 pedestrian trips per day, peak hour trips are 18.1 per cent of daily trips.
  - Pedestrian trips are 80 per cent in, 20 per cent out during AM peak, and 20 per cent out, 80 per cent in during PM Peak.
  - During peak periods, 60 per cent of the office demand is catered for by the George Street Station.
  - The BaT Project Model distribution was used for the office trips.

- The AM demand for the George Street underpass was derived from the BaT Project Model. The PM demand was assumed to be in the same order of magnitude, but in the opposite travel direction.
- This work excludes any infrastructure or specific pedestrian demands associated with the proposed Queen's Wharf Brisbane development as such information was not available at the time of carrying out this assessment. However, the assessment includes pedestrian demands to the Queen's Wharf Brisbane area as forecasted by the BaT Project model that allowed for an assumed level of activity for the relevant zones.
- changes proposed by Brisbane City Council to Albert Street have not been taken into consideration
- there was no forecasted change in bus services or patronage at the Elizabeth Street bus stop near George Street
- The proposed midblock crossing on Mary Street was assumed to be signalised for this assessment.
- The demand for the pedestrian overbridge of Roma Street to the Roma Street Station (with the Project) was assumed to be the following (in response to improved wayfinding signage):
  - 80 per cent of pedestrians from George Street south-east of Tank Street and 80 per cent of Tank Street
  - 50 per cent of demands from George Street between Tank Street and Herschel Street
  - 30 per cent of the demand from Herschel Street.
  - 30 per cent of existing bridge demands (to consider demands for retail space and existing walking patterns)
  - Total demand for overbridge is forecast to be approximately 30 per cent above existing use.
- During normal peak operations, it was assumed that the volume of traffic using the southern section of Stanley Street is less than 50vph, as this road mainly caters for service vehicles.
- There was no mode shift assumed from cars to buses or trains in the 2021 'with project' scenario.

2.3.6 Simulation model results

Results from the simulation model were recorded in both a visual and numerical capacity to allow for comparison between scenarios and determine the upgrade measures required to achieve a satisfactory LoS for pedestrians.

For the intersection performance, the following statistics were recorded:

- **Demand:** The sum of the number of pedestrians per hour that desire to use the signalised crossings at an intersection.
- **Max No. peds/queuing space:** The maximum number of pedestrians at any queuing space at the intersection.
- **Max queue density m^2/ped:** The maximum density for any queuing space at the intersection. Not necessarily the queuing space with the most pedestrians. For comparison purposes, a density of $1m^2$/ ped is a comfortable but busy queuing area, and $0.4m^2$/ ped is a busy and potentially uncomfortable – comparable to Elizabeth Street/ George Street during peak periods.
- **Queue LoS:** The Fruin LoS for space at a queuing area for the area with the largest density (smallest m^2/ped).
- **Max crossing density m^2/ ped:** The maximum density for any crossing at the intersection. A density of $2m^2$/ ped is a comfortable but busy crossing, with pedestrians required to weave. A

density of 0.7 corresponds to a congested crossing, where pedestrians naturally form 'streams' to reduce points of conflict.

- **Crossing LoS:** The Fruin LoS for space at a walkway for the crossing with the largest density (smallest m^2/ ped).

For walkways performance, the following statistics were recorded:

- **Demand:** The number of pedestrians per hour that desire to use this walkway. For walkways that extend along several intersections, this demand is taken to be the largest of these.
- **Average density m^2/ped:** The largest average density across the walkway. An average density of $3m^2$/ ped is a busy but comfortable walkway, where pedestrians may need to slow down to wait for groups to clear at pinch points. An average density of $1m^2$/ ped is a congested walkway, where delays may require pedestrians to slow significantly to reduce conflicts.
- **Average LoS:** The Fruin LoS for space at a walkway for the walkway with the largest density (smallest m^2/ ped).

The average travel time was also reported for each station, with results in the format hh:mm:ss.

2.3.7 Pedestrian simulation model calibration and validation

The simulation models were calibrated to reflect both the demand and behavioural aspects in the precinct.

The calibration of vehicles was tested using the GEH Statistic, which evaluates the difference between the modelled and survey turning count flows. The GEH Statistic is calculated using the following formula:

$$GEH = \sqrt{\frac{2 \times (Modelled - Observed)^2}{(Modelled + Observed)}}$$

The tolerance limits prescribed by the Roads and Maritime Services' Traffic Modelling Guidelines (2013) include:

- GEH < 5 Minimum 85 per cent of observations to be within tolerance limits; and
- Turn or link flows with GEH > 10 require explanation in reporting.

The turning counts for vehicles for the simulation models were recorded and evaluated against the above criteria.

For pedestrians, there is no relevant Australian government guidance regarding the calibration of pedestrians in a simulation model. The differences between the surveyed and modelled flows at the signalised crossings has been provided.

George Street Station precinct

For vehicles, all GEH statistics were below 3.1. For the AM model, 100 per cent were below GEH 1.0, and for the PM model, 92 per cent were below GEH 1.0.

Table 2.13 shows the pedestrian flows, and the difference between the surveyed and modelled flows on a per minute basis. The largest difference between flows is 4 ped/ min, and generally the modelled flows are larger than the surveyed flows.

Table 2.13 George Street Station pedestrian hourly flows (2014)

Signalised crossing	AM peak			PM peak		
	Surveyed	Modelled	Difference	Surveyed	Modelled	Difference
George/ Elizabeth (NE)	1496	1711	4 ped/ min	312	215	-2 ped/ min
George/ Elizabeth (SE)	423	247	-3 ped/ min	1035	1199	3 ped/ min
George/ Elizabeth (SW)	411	483	1 ped/ min	345	450	2 ped/ min
George/ Charlotte (NW)	87	93	0 ped/ min	590	614	0 ped/ min
George/ Charlotte (NE)	2024	2223	3 ped/ min	142	226	1 ped/ min
George/ Charlotte (SE)	215	152	-1 ped/ min	2092	2026	-1 ped/ min
George/ Mary (NW)	176	168	0 ped/ min	138	105	-1 ped/ min
George/ Mary (NE)	1124	931	-3 ped/ min	132	199	1 ped/ min
George/ Mary (SE)	166	149	0 ped/ min	854	855	0 ped/ min
George/ Margaret (NW)	72	173	2 ped/ min	48	158	2 ped/ min
George/ Margaret (NE)	980	997	0 ped/ min	300	351	1 ped/ min
George/ Margaret (SE)	77	23	-1 ped/ min	925	993	1 ped/ min
George/ Margaret (SW)	258	212	-1ped/ min	119	203	1 ped/ min
George/ Alice (NW)	6	81	1 ped/ min	20	86	1 ped/ min
George/ Alice (NE)	755	833	1 ped/ min	1013	1090	1 ped/ min
George/ Alice (SE)	59	106	1 ped/ min	93	298	3 ped/ min
George/ Alice (SW)	276	348	1 ped/ min	465	600	2 ped/ min

The differences between the surveyed and modelled pedestrian flows are within the normal variation in pedestrians in a peak hour due to random arrival patterns.

The simulation models were also calibrated to the pedestrian and vehicle behaviour obtained from site visits.

Roma Street Station precinct

For vehicles, all GEH Statistics were below 3.6. In the AM peak, the largest GEH was 3.6, and 85 per cent of GEH Statistics were below GEH 1.0. In the PM peak, the largest GEH was 1.5, and 97 per cent of GEH Statistics were below 1.0.

Table 2.14 shows the pedestrian flows, and the difference between the surveyed and modelled flows on a per minute basis. The largest difference between flows is 4 ped/ min, and generally the modelled flows are larger than the surveyed flows.

Table 2.14 Roma Street Station pedestrian hourly flows (2014)

Signalised crossing	AM peak			PM peak		
	Surveyed	Modelled	Difference	Surveyed	Modelled	Difference
Roma/ Makerston (W)	321	452	2 ped/ min	345	526	3 ped/ min
Roma/ Makerston (E)	972	985	0 ped/ min	804	707	-2 ped/ min
Roma/ Makerston (S)	341	289	-1 ped/ min	317	326	0 ped/ min
George/ Herschel (E)	991	1161	3 ped/ min	94	205	2 ped/ min
George/ Herschel (S)	473	584	2 ped/ min	259	365	2 ped/ min
Pedestrian Overbridge	657	641	0 ped/ min	1006	1049	1 ped/ min
Roma/ Parkland (W)	352	242	-2 ped/ min	361	229	-2 ped/ min
Roma/ Parkland (N)	206	194	0 ped/ min	232	232	0 ped/ min
Roma St Illegal Crossing	133	139	0 ped/ min	226	228	0 ped/ min
Albert/ Turbot (N)	478	606	2 ped/ min	457	513	1 ped/ min
Albert/ Turbot (E)	449	583	2 ped/ min	383	595	4 ped/ min

The differences between the surveyed and modelled pedestrian flows are within the normal variation in pedestrians in a peak hour. The simulation models were also calibrated to the pedestrian and vehicle behaviour obtained from site visits.

Woolloongabba Station precinct

For Woolloongabba Station, calibration to count data was not undertaken for the following reasons:

- the weekday demand is forecasted to more than double, such that the behaviour in the area is likely to change significantly after the introduction of the station
- the order of magnitude of demand for Woolloongabba is also less than 25 per cent of the demands for the other stations, such that the main considerations at this station are safety rather than capacity
- traffic modelling undertaken indicates that the performance of Stanley Street is constrained, so no changes to the signal operation have been proposed. Accordingly, no assessment of impacts to traffic is required.

The Woolloongabba Station model were calibrated to the pedestrian movement behaviour observed at Roma Street.

2.4 Traffic assessment methodology

The traffic modelling of intersection quantifies the changes in traffic operating conditions for inclusion in the assessment. To assess the impact of construction traffic associated with the George Street Station (2021 operation and construction worksite), Woolloongabba (construction worksite), and surrounding road network, local area network models were built using the software tool, LinSig

To assess the impact of construction traffic associated with the Southern Connection, Roma Street, Northern Connection construction work sites and the cumulative impact assessment to spoil placement sites road intersection models were built using the software tool, SIDRA Intersection

2.4.1 LinSig software

To determine impacts on the road network during construction at George Street and Woolloongabba construction worksites and for the year of opening (2021) of the George Street Station, LinSig software was used. LinSig is a powerful network based traffic model that is designed to understand road capacities for a series of linked intersection (networks). LinSig has the ability to assess lane by lane movements, pedestrian impacts on traffic, and optimal phase times and offsets. It contains an inbuilt matrix estimation tool that generates OD matrices based on known counts and critically has the ability to assign traffic (based on delay) on a lane by lane basis. Signal phase times and offsets between intersections allows LinSig to optimise for capacity by ensuring green time progression for platoons of vehicles.

LinSig models road network lane by lane. This allows LinSig to determine the impacts of lane closures (during construction periods) and/or dedicated construction traffic lanes. This allows LinSig to determine the impacts during construction and critically help to identify mitigation measures to minimise these impacts. The intersection analyses will quantify the construction impacts as well as individual intersection performance along the network. Typical outputs from this analysis included:

- Intersection and network performance metrics (vehicle delays, average speed, journey time, intersection LoS, Degree of Saturation and queuing).
- Identification of appropriate mitigation or enhancement measures during construction of the new bus stations.

Information required for traffic assessment

Data used for the assessment included the following to calibrating the existing base case models are:

1) Classified counts (surveyed/ SCATS/ STREAMS) – preferably disaggregated by vehicle type and by tuning movements
2) Intersection signal plans – IDM phase timings are critical to calibration. Signal plans/ phase times to be broken down into 15 minute intervals
3) Traffic signal phase times (need to be recorded in parallel with the surveyed/ SCATS/ STREAMS counts (ie same peak to peak times)
4) Known maximum saturation flow of each lane. (if unavailable AUSTROAD values could be used for assumed values)
5) Queue lengths at intersections
6) Intersection layouts
7) Aerial photography

This information was also used for the intersection assessed using SIDRA Intersection

2.5 Construction road traffic impact assessment

The methodology for the construction road traffic impact assessment is presented in **Chapter 8** of this report.

3. Description of the existing transport network and its performance

This chapter starts by outlining the current transport policies at all levels of government and the transport network and operations ownership and responsibilities in South East Queensland. Trends in pricing and fares and parking are also presented.

The base year (2012) conditions of the traffic and transport networks and services within and around the study corridor relating to passenger rail, freight rail, bus, ferry, active transport and road traffic are then described.

3.1 Current transport policies and responsibilities

3.1.1 Transport policies

Australian (Federal) transport policy

The Department of Infrastructure and Regional Development administers policy and programmes relating to transport, for the Federal Government. The Department provides policy advice to the Minister for Infrastructure and Regional Development, conducts research and analysis, provides safety information and advice and performs regulatory functions.

The Department's core purpose including its overarching policy goals is:

- providing funding for transport infrastructure
- promoting safe and secure transport solutions
- providing a framework for competition between and within transport modes
- promoting a transport system that is accessible, sustainable and environmentally responsible
- funding community infrastructure in rural, regional and local government areas through finance assistance
- facilitating engagement on local government issues and innovative thinking and practices to support new approaches to infrastructure financing
- providing programs which support and strengthen the economic development and sustainability of regions
- promoting good governance in Australian territories through the maintenance and improvement of the overarching legislative framework for self-governing territories, and laws and services for non-self-governing territories
- ensuring value for money outcomes for natural disaster reconstruction projects, and
- ensuring information about relevant Government policies and programs is disseminated effectively across Australia.

Queensland (State) transport policy

The South East Queensland Regional Plan 2009-2031 (SEQ Regional Plan) (Department of State Development, Infrastructure and Planning, 2009) proposes that a major contribution to supporting sustainable population growth is investment in rail and busway.

The Queensland Transport and Roads Investment Program 2014-15 to 2017-18 (QTRIP) presents the current transport and road projects that the Queensland Government plans to deliver over the next four years to meet future infrastructure needs. This program indicates that once construction funding has been confirmed, the Project will appear in future QTRIP publications.

Brisbane City Council

Brisbane City Council has developed the Transport Plan for Brisbane (2008 to 2026) (BCC, 2008) which performs the function of an Integrated Local Transport Plan, under the region's Integrated Regional Transport Plan.

The plan recognises that the city's economic growth and the lifestyle of its residents depend upon an efficient transport system. The transport plan includes investment in public transport, walking and cycling with an efficient road network. The transport plan responds to and references:

- South East Queensland Regional Plan and Infrastructure Plan and Program
- TransApex transport policy (a ring road/bypass strategy for inner Brisbane)
- Brisbane's draft City Shape Implementation Strategy
- City Centre Master Plan .

The plan focuses on transport corridors, which are the major arterial routes through the city. The plan:

- defines the specific transport projects Brisbane City Council will make in an area
- directs planning work to major road corridors and the roads that feed into them
- considers how to manage travel demand in those corridors, looking at a range of projects to manage congestion, such as additional road space, more public transport, walking and cycling facilities and/or improved signal coordination.

The Transport Plan for Brisbane also sets mode share targets for the transport system. The plan suggests that by 2026, public transport should be catering for around 13 per cent of all trips in Brisbane (24 hours). It proposes that 75 per cent of all motorised trips to the CBD in peak hours should be on public transport.

The Brisbane Long Term Infrastructure Plan 2012-2031 (BLTIP) is Brisbane City Council policy document for identifying actions to deliver infrastructure strategies for Brisbane. In preparing the BLTIP, Brisbane City Council recognised that Brisbane's infrastructure program needs to meet the service needs of the community and contribute to achieving the broader economic, social and environmental aspirations of the city. The BLTIP recognises that public transport is critical to maintain the liveability of the city and it outlines a number of public transport actions that should be implemented throughout Brisbane. These actions generally include the introduction of services or capacity increases and would be supported by the Project.

The City Centre Master Plan (CCMP) was released by Brisbane City Council in March 2014 and sets the vision and strategic framework to guide growth within the Brisbane CBD and surrounds. The CCMP identifies that the Brisbane's CBD needs to be well-connected with safe and efficient access between the various transport hubs and the health, knowledge, cultural and government hubs. In particular, the CCMP identifies the Project as one of six priority projects that are intended to commence within the next five years. In addition to being identified as one of the six priority projects, the Project would be likely to support the successful implementation of a number of the other priority projects through the improved access to high quality public transport within the Brisbane CBD.

The CCMP also identifies the needs to deliver improvements to the inner-city bus network 'unlock the bus networks' to improve bus access to the city centre through the improved bus connection from the South East Busway to the city centre via the Cultural Centre busway station and Captain Cook Bridge and increasing underground bus capacity. The BaT project would support this need by reducing capacity constraints at the Cultural Centre busway station and on the Captain Cook Bridge through the provision of an alternate cross river route and a new underground station at George Street.

3.1.2 Ownership and responsibilities of the transport system

Australian (Federal) government

The primary responsibility for road and rail infrastructure lies with the States. The Australian Government has an overall role in the safety and efficiency of the national transport systems. The Government also funds transport projects directly through its Infrastructure Investment Programme. Through the Infrastructure Investment Programme, the Australian Government proposes to invest $50 billion on road and rail, including delivering programs and projects across the National Land Transport Network.

Queensland (State) government

State Transport policy is managed by the TMR that was formed in April 2009 with the merger of the former Queensland Transport and Department of Main Roads.

TMR aims to move and connect people, places, goods and services safely, efficiently and effectively across Queensland. TMR plans, manages and oversees the delivery of an integrated transport system for road, rail, air and sea that supports sustainable economic, social and environmental outcomes in Queensland.

TransLink is a division of TMR, whom are responsible for leading and shaping Queensland's overall passenger transport system. TransLink Division facilitates passenger transport services for Queenslanders and aim to provide a single integrated transport network accessible to everyone.

TMR works closely with Queensland Rail, port authorities, other state and federal government departments, local governments, industry and the community to ensure a coordinated, consultative and integrated approach to addressing and resolving transport and road challenges.

TMR is responsible for the operation and maintenance of the State Controlled road network in Queensland.

Queensland Rail is a statutory authority in accordance with the *Queensland Rail Transit Authority Act 2013* and is responsible for rail passenger transport operations and passenger rail network ownership.

Queensland Rail operates passenger rail services on the suburban rail network across much of South East Queensland. This network extends from the centre of Brisbane south to Varsity Lakes on the Gold Coast, north to Gympie, east to Cleveland and west to Rosewood (west of Ipswich) and covers approximately 689km of track and encompassing 146 stations (not including Exhibition).

The Queensland Rail Traveltrain rail network plays an important role in connecting regional Queensland. These services extend along the Queensland coastline from Brisbane (Roma Street) to Cairns and west to Charleville, Longreach and Mount Isa.

Aurizon is the entity created following the separation of the Queensland Rail’s freight, network and services businesses from Queensland Rail passenger services. Aurizon has a significant focus on coal and mineral haulage across Queensland, New South Wales and Western Australia. QR National’s freight haulage operations span the entire east coast of Australia, and west to Perth.

Brisbane City Council (Local government)

Brisbane City Council is the responsible local authority for the maintenance and operations of all roads, footpaths and bikeways within the study corridor with the exception of the State Controlled Road network. Brisbane City Council also operates most of the buses within the Council boundary through its commercial arm, Brisbane Transport and also manages scheduled passenger ferry services on the Brisbane River on behalf of TransLink.

3.1.3 Pricing and fares

The cost of travel, which include public transport fares, and user's sensitivity to costs are important drivers in travel behaviour. Consequently, the public transport fare and its structure influences the patronage demand for bus and rail travel including services associated with the Project.

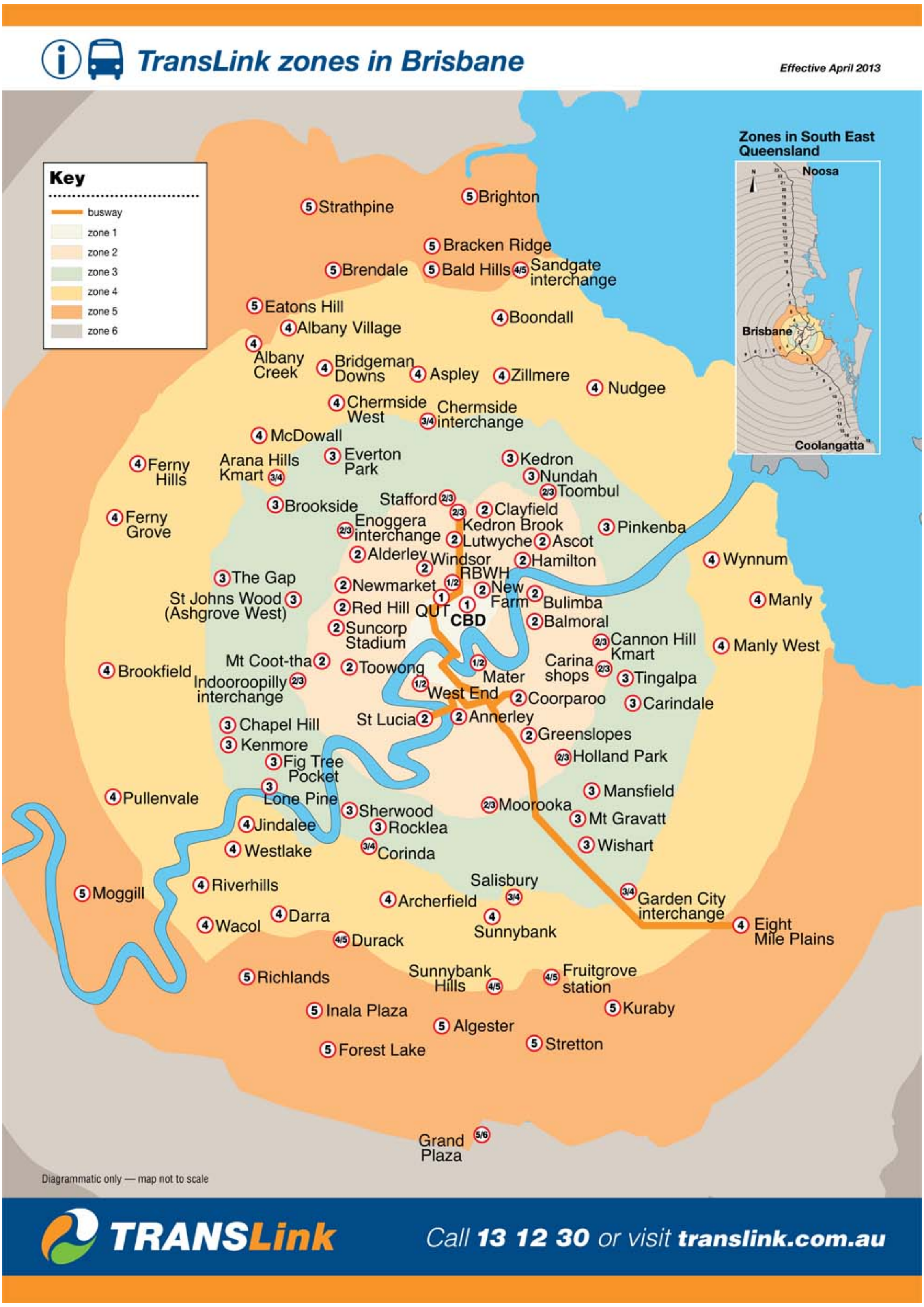
Public transport in South East Queensland is provided by TransLink. TransLink has developed a consistent region-wide zone and fare structure which covers 23 zones. The Brisbane CBD is the heart of the network and is zone 1. The network extends as far north as Gympie, south to Coolangatta and west to Helidon (west of Ipswich). Fare zones covering Brisbane are illustrated in **Figure 3-1**.

Fares are calculated at either at adult or concession rate and based on the number of zones traversed through during a journey. Fares also vary between 'paper' and electronic (go card) payment methods, with an off peak discount applied for electronic (go card) transactions only.

Since January 2010 the cost of public transport fares in South East Queensland have increased. From 2010 to 2012 the increase was by 15 per cent per year. For 2013 and 2014 the fare increase has been 7.5 per cent per year.

The current (2014) adult paper fare within one zone is $5.20, while the equivalent peak fare on go card is $3.53 and the off peak go card fare is $2.83. The current (2014) adult go card fares within five zones (for example Strathpine, Moggill or Kuraby to the Brisbane CBD) are $6.28 (peak) and $5.03 (off peak). Concession fares are half the equivalent adult fare. As a mechanism to encourage use of the public transport system the fare structure provides free travel after nine weekly journeys for go card users.

Figure 3-1 Fare zones in Brisbane



Source: www.translink.com.au, 2014

3.1.4 Road pricing

The current State Government and Brisbane City Council transport policy does not support distance or cordon based road pricing as a policy position. The current private transport cost base including taxation arrangements and route-specific tolls are expected to remain unchanged for the foreseeable future.

3.1.5 Parking in the study corridor

Access, parking and servicing for new development

Parking for new development within the Study Corridor will be set by Brisbane City Council Code A012 of the Transport, Access, Parking and Servicing Code of the Brisbane City Plan 2014 (Brisbane City Council, 2014), which states:

Development in the City core and City frame provides maximum car-parking rates in compliance with the standards in the Transport, access, parking and servicing planning scheme policy.

The Transport, access, parking and services planning scheme policies states the parking standards for multiple unit dwelling development as:

- City core:
  - Maximum 0.5 space per 1 bedroom dwelling
  - Maximum 1 space per 2 bedroom dwelling
  - Maximum 1.5 spaces per 3 bedroom dwelling
  - Maximum 2 spaces per 4 and above bedroom dwelling
  - 1 visitor space for every 20 dwelling units
  - Parking may be provided in tandem spaces where 2 spaces are provided for 1 dwelling.
  - At least 50 per cent of visitor parking is provided in communal areas, and not in tandem with resident parking.
- City frame:
  - Minimum 0.9 spaces per 1 bedroom dwelling
  - Minimum 1.1 spaces per 2 bedroom dwelling
  - Minimum 1.3 spaces per 3 or above bedroom dwelling
  - Minimum 0.15 spaces per dwelling for visitor parking
  - Parking may be provided in tandem spaces where 2 spaces are provided for 1 dwelling.
  - At least 50 per cent of visitor parking is provided in communal areas, and not in tandem with resident parking.

Parking must be designed to be safe and convenient to use to encourage their use in preference to on-street parking. However the policy states that parking in the City Centre must achieve a balance between controlling congestion and providing sufficient short term shopping and business parking to keep the City Centre viable. Long term parking within the City Centre is strongly discouraged, particularly in the case of purpose built car parks. Note that parking rates in the City Centre and Frame are maximum rates (that is parking is capped to a maximum of one space per 200m² for any development other than dwellings) and as such no parking may be provided in these developments.

Outside of the City Centre and City Frame, minimum parking rates apply which are generally intended to cater for user car parking needs within the development.

Despite maximum parking rates and discouragement of long term commercial/retail parking, the continued intensification and development of the CBD is expected to continue to generate vehicle trips onto the CBD road network, in particular loading and servicing trips.

Off street parking prices in central Brisbane

A 2011 Colliers International survey of global city centre parking charges found that Brisbane was the ranked 14th in the world in terms of most expensive unreserved monthly parking rates and equal 14th for daily parking rates. Compared to other Australian cities, Brisbane is on par with Melbourne as the second most expensive city for daily parking charges (after Sydney) at around $40 per day (Colliers International, 2011).

There are over 25,000 off-street spaces in the Brisbane CBD and within the Brisbane CBD there are over 10,000 publicly accessible commercial car parks available (Brisbane City Council, 2009).

Brisbane City Council operates two off-street car parks in the city, at King George Square and Wickham Terrace, with the rest of the market dominated by Secure Parking and Wilson's.

Despite the apparent high cost of commercial car parking in the Brisbane CBD there is strong use of these facilities with the majority of car parks operating close to capacity on weekdays. Consequently, there is a lack of car parking spaces that could accommodate additional commuter trips by car to the CBD.

On street parking controls

Within large parts of the study corridor, on street parking and loading is controlled under traffic areas as listed in **Table 3-1**. The extent of these traffic areas is shown in **Figure 3-2**.

Table 3-1 Traffic areas and parking restrictions within the study corridor

Traffic area name	Suburbs included	Parking restrictions
Brisbane Central Traffic Area	Bowen Hills, Fortitude Valley, Spring Hill, Kelvin Grove, Newstead, Kangaroo Point (north), South Brisbane, West End (north), Woolloongabba (west), Petrie Terrace	Maximum two-hour parking 7.00 am to 6.00 pm Monday to Friday and 7.00 am to 12.00 Noon Saturday Resident permits excepted
Gabba Traffic Area	Woolloongabba (east), Kangaroo Point (south), East Brisbane,	Maximum two-hour parking 7.00 am to 7.00 pm Monday to Friday Maximum 15 minute parking on event days from 7.00 am to 10.00 pm Resident permits excepted
Dutton Park Traffic Area	Highgate Hill (south), Dutton park, Buranda (west) Fairfield (north)	Maximum two-hour parking 7.00 am to 7.00 pm Monday to Friday (excluding public holidays) Maximum four-hour parking 7.00 am to 7.00 pm Monday to Friday (excluding public holidays) on all disability parking bays. Resident permits excepted
Lang Park Traffic	Milton, Paddington, Petrie Terrace, Red	15 minute parking only (residents

Traffic area name	Suburbs included	Parking restrictions
Area	Hill	excepted) from midday to 10pm on event days only

On street parking in central Brisbane

The Brisbane Central Traffic Area is a regulated parking area covering the CBD and nearby suburbs, for example, Fortitude Valley, West End, South Brisbane, Spring Hill and Newstead. Within the Brisbane Central Traffic Area a two hour parking limit applies, except as signed or where meters operate, and as permitted by the road rules.

Short term (up to and including 3 hours) on-street parking bays in the CBD are charged at up to $4.40 per hour during weekdays (7.00 am to 7.00 pm). Where four hour or longer parking is available (such as in the city frame area) a fee of $2.70 per hour applies, up to a maximum daily charge of $10 on weekdays ($6 on weekends).

Parking restrictions apply Monday to Friday 7.00 am to 10.00 pm and Saturday and Sunday 7.00 am to 7.00pm.

The Gabba Traffic Area

A two-hour (2P) parking limit applies in The Gabba Traffic Area from 7.00 am to 7.00 pm Monday to Friday on all unsigned roads. During events at The Gabba, a 15-minute parking limit applies on all unsigned roads from 7.00 am to 10.00 pm on the day of the event.

Dutton Park Traffic Area

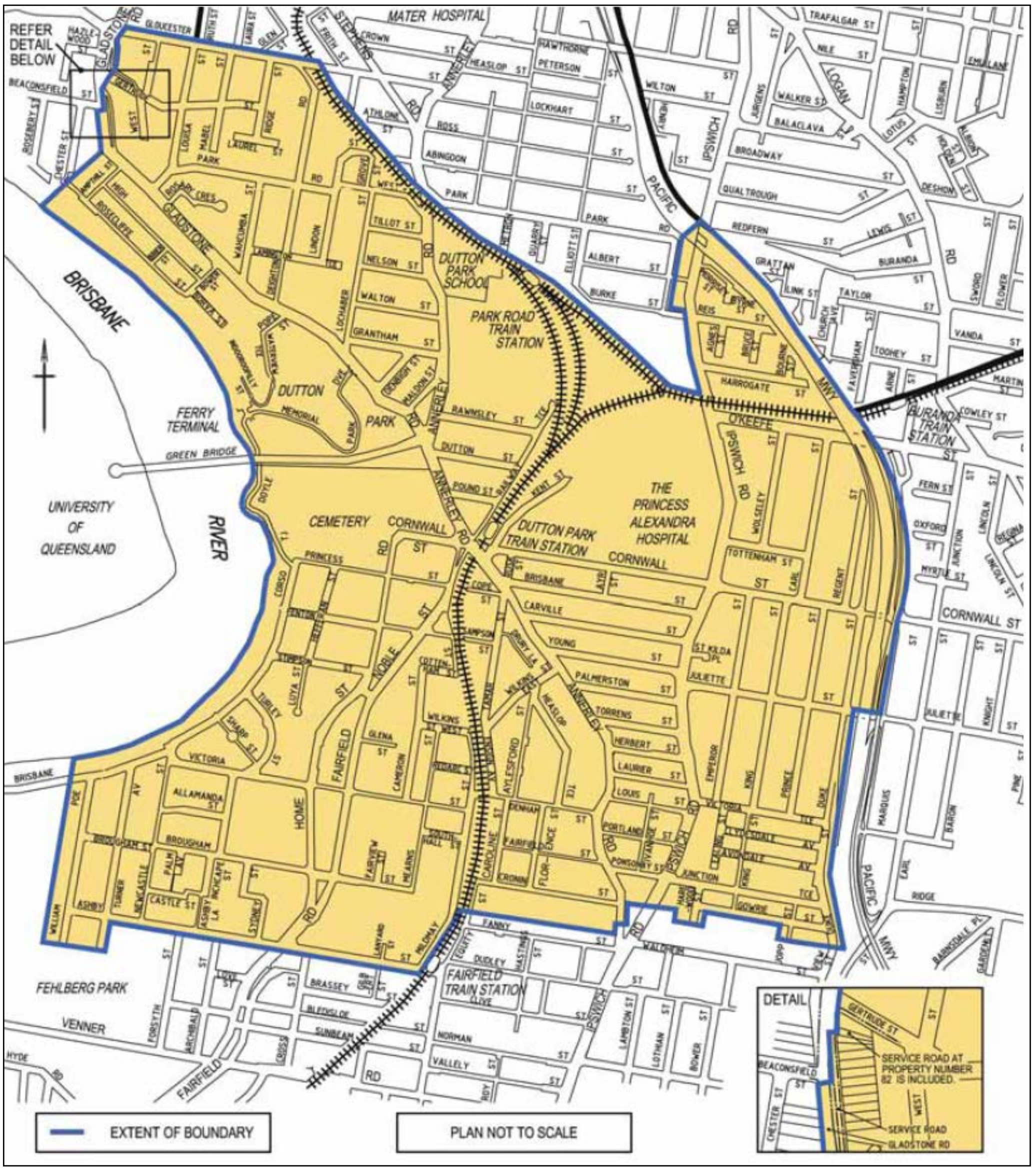
The extent of the Dutton Park Traffic area is illustrated **Figure 3-3**. The Dutton Park Traffic area operates between 7.00 am and 7.00 pm, Monday to Friday (excluding public holidays):

- a two-hour parking limit applies to all unsigned roads within the area
- a four-hour parking limit applies to disability parking bays
- bays and 30-minute parking zones are provided near business precincts.

Figure 3-2 Brisbane Central Traffic Area map

Source: BCC (www.brisbane.qld.gov.au)

Figure 3-3 Dutton Park Traffic Area map



Source: BCC (www.brisbane.qld.gov.au)

Lang Park Traffic Area

The Lang Park Traffic Area covers part of the study corridor near Roma Street. This parking control zone applies between midday and 10pm on event days only.

3.2 Passenger rail – the regional rail network

The South East Queensland passenger rail network comprises more than 689km of track and includes 146 stations (not including Exhibition). The network (refer to **Figure 3-4**) extends from the centre of Brisbane, south to Beenleigh and Varsity Lakes on the Gold Coast, north to Ferny Grove, Shorncliffe, Caboolture and Gympie, east to Cleveland and west to Ipswich and Rosewood.

Queensland Rail in partnership with TransLink provides 73 train services for the weekday morning peak hour through the Brisbane CBD. These rail services operate on suburban lines and main lines forming two independent sectors, namely:

- mains sector: Services operating on the main lines, including Nambour, Caboolture, Ipswich, Rosewood and Springfield lines
- suburbans sector: Services operating on the suburban lines, including Shorncliffe, Airport, Doomben, Ferny Grove, Cleveland, Beenleigh and Gold Coast lines.

Generally, passenger rail services in Brisbane are medium to long-distance commuter services, with heavy use during the morning and evening peaks and moderate use during the daytime off-peak period.

The rail service plan illustrated in **Figure 3-5** is for the existing (2014) timetable. The service plan allows 70 trains into the Brisbane CBD during the morning peak one-hour[5] period. These services include:

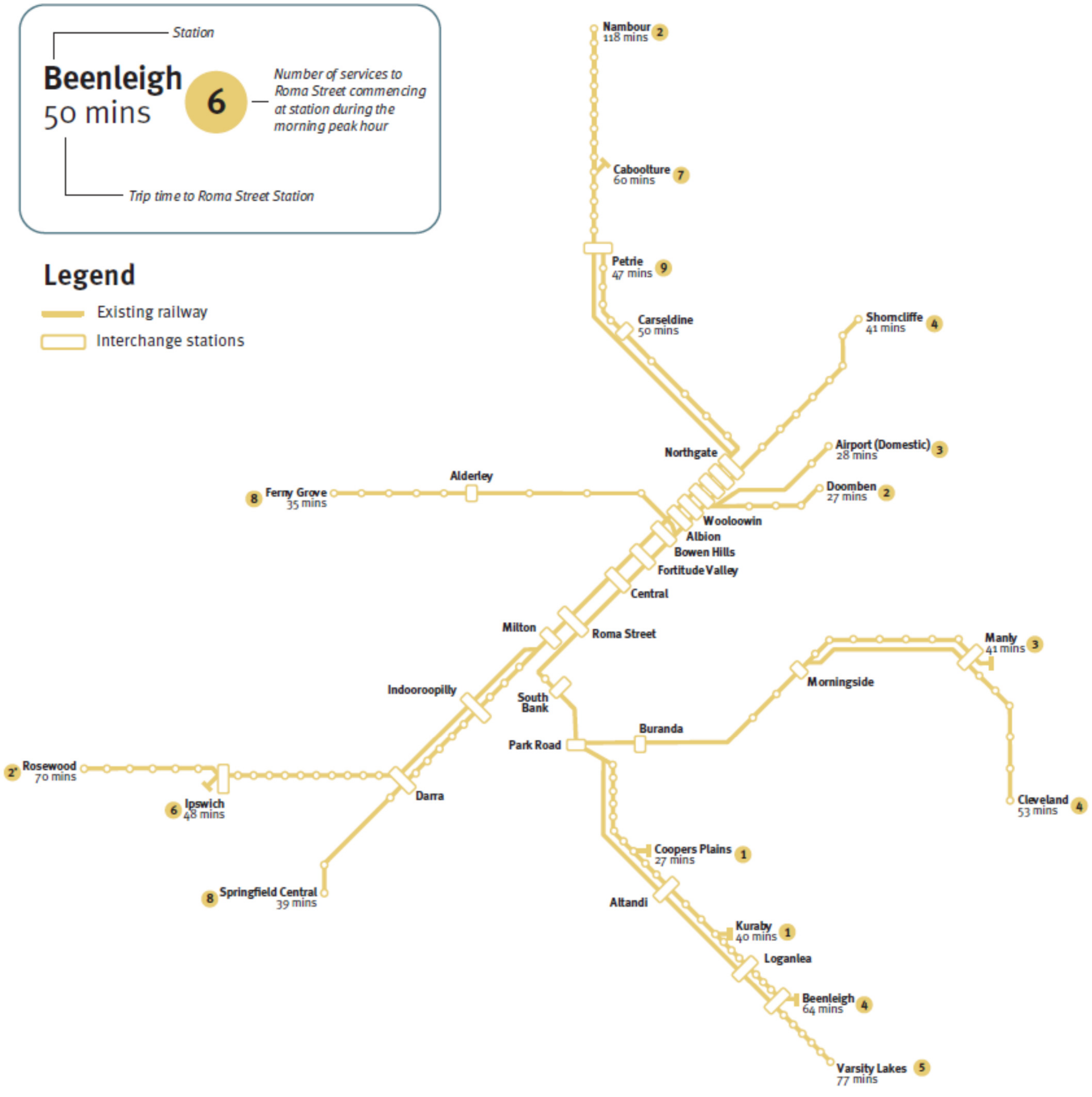
- assessing core hour morning peak arrivals at Roma Street Station (between 07:30 and 08:29), there are 18 trains per hour from the north on the main lines: two Nambour services, seven Caboolture services, and nine Petrie services.
- assessing core hour morning peak arrivals at Roma Street Station (between 07:30 and 08:29), there are 17 trains per hour from the north on the suburban lines: eight Ferny Grove services, four Shorncliffe services, three Airport services, and two Doomben services.
- assessing core hour morning peak arrivals at Roma Street Station (between 07:30 and 08:29), there are 16 trains per hour from the west on the main lines: two Rosewood services, six Ipswich services, and eight Springfield services. There is also a Rosewood-Ipswich shuttle service that connects to a core peak hour Ipswich service.
- assessing core hour morning peak arrivals at Roma Street Station (between 07:30 and 08:29), there are 19 trains per hour from the south and east over the Merivale Bridge: five Varsity Lakes services, four Beenleigh services, one Kuraby service, one Coopers Plains service, four Cleveland services, and four Manly services.

[5] Arriving at Roma Street Station between 7.30 AM and 8.29 AM during weekdays

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 3-4

South East Queensland rail network



* An additional shuttle service is provided to Ipswich.

FIGURE 3-5

Brisbane 2014 morning peak hour (towards Brisbane CBD) rail service levels

3.2.1 Passenger rail services

All rail services merge onto the rail corridor through the Brisbane CBD with all services stopping at all four stations from Bowen Hills to Roma Street (inclusive). The frequency of services (by line) stopping within this section of the rail network during the morning peak hour are summarised in **Table 3-2**.

Table 3-2 Peak direction train services during the morning peak one hour

Line	Trains per hour
Sunshine Coast line	2
Caboolture (including Petrie) line	16
Airport line	3
Doomben line	2
Shorncliffe line	4
Ferny Grove line	8
Beenleigh (including Coopers Plains and Kuraby) line	6
Gold Coast line	5
Cleveland (including Manly) line	8
Ipswich (including Rosewood) line	8
Springfield line	8
Total	**70**

As well as the inner city tunnels and stations, the approach routes to the inner city railway lines and station are also constrained which limits capacity into the inner city itself. For example, services from Milton (on the four-track western line) and Park Road (that is Beenleigh, Gold Coast and Cleveland trains on the three-track southern line) must merge together to access the CBD via only four tracks to the south-west of Roma Street Station. This limits the ability to fully exploit the capacity potential on these approach corridors individually.

Capacity across the Brisbane River is constrained as long-distance express trains from the Gold Coast as well as suburban trains from Beenleigh and Cleveland must all use a single in-bound track across the Merivale Bridge. Of the 19 trains per hour approaching Roma Street from the south, over the Merivale Bridge, in the morning peak, five trains per hour are longer distance express trains from the Gold Coast. This capacity constraint on the bridge and access into Roma Street Station restricts growth on these services.

In summary the main constraints on the rail network within the Central Section of the study corridor include:

- single platform faces at Fortitude Valley and Bowen Hills. This limits the maximum number of trains to 26 trains per hour (assuming 2 minutes headway and 20 seconds dwell time)
- trains blocking both the suburban and main lines trying to access Mayne yard. Delays in accessing the yard could cause these tracks to become blocked
- the existing CBD area routes inbound to Roma Street are limited to one from Milton (Western line) and one from Park Road (Beenleigh, Gold Coast and Cleveland) requiring to merge together to access the CBD area from the south of the CBD
- dwell times in the CBD area, such as Central, also constrain the ability to maximise the signalling capacity within the CBD area

- crew changes at Bowen Hills and the need for trains terminating at Roma Street and Bowen Hills to reach Mayne Yard for stabling.

3.2.2 Rail patronage

The number of passengers using the rail system during the morning and evening peak periods out of the daily 24-hour total of 214,500 passengers is shown in **Table 3-3**. The table also illustrates that about half of rail passengers use the rail system during the peak periods – that is four hours of a week day. The evening peak period use of the rail system is less than the morning peak period. This is as the evening peak periods are always less intense as leaving times have a higher variability than starting times with a high proportion of people starting work and education between 8.00am and 9.00am and finishing time being influenced by various work patterns.

Table 3-3 Base year (2012) peak period rail users

Period	Rail users
AM two-hour peak (7.00am to 9.00 am)	59,500
PM two hour peak (4.00pm to 6.00pm)	54,300
Daily	214,500

Source: BaT Project Model

The number of boarding and alighting passengers at inner city rail stations in the 2012 two hour morning peak period number about 59,500. Of these 53,200 board or alight at the Brisbane CBD stations of Central Station and Roma Street Station. Central Station dominates for alighting passengers with over 24,600 passengers (53 per cent of the rail alightings that occur in the CBD). Central Station is the principal destination for rail passengers to and from the CBD.

Inner city stations[6] cater for less than 15 per cent of boarding passengers as the majority of passengers board trains outside the inner city in the morning peak period. About 50 per cent of passengers board trains to the north of the inner city whilst 50 per cent of passengers board trains to the south and/or west of the CBD (including the Ipswich line).

3.2.3 Rail station activity in the Brisbane CBD and CBD fringe

Table 3-4 presents the number of passenger boarding and alighting movements during the 2012 two year morning peak period. During the morning peak two hour period, approximately 40,000 rail passenger board and alight trains in the Brisbane CBD at Central Station and Roma Street Station. Central Station dominates this activity with almost 70 per cent of CBD boarding and alighting activity occurring there.

Another 13,000 passenger boardings and alightings occurs at the Brisbane CBD fringe rail stations of South Bank, South Brisbane and Fortitude Valley. This illustrates that almost 90 per cent rail passengers traveling in the morning peak period access CBD or CBD fringe stations.

[6] Inner city stations are Fortitude Valley, Central, Roma Street, South Brisbane and South Bank stations

Table 3-4 Base year (2012) AM peak two hour rail activity at CBD and CBD fringe stations

Station	Two hour morning peak period alighting and boardings
Roma Street	12,600
Central Station	27,400
CBD Total	**40,000**
South Bank	5,000
South Brisbane	3,100
Fortitude Valley	5,000
CBD and CBD fringe total	**53,100**

Source: BaT Project Model

3.2.4 Station activity in the study corridor

Stations in the study corridor are shown in **Figure 3-6**. A description of each station, its location, context and current level of activity can be found in the following section. The forecasts of existing mode of access data used in the report was predicted based on 2007 Origin Destination Survey, which may not represent the current interchange behaviour.

Dutton Park Station

Dutton Park Station is located under Annerley Road, on the Beenleigh Railway line, 5.9km south of Central Station (refer to **Figure 3-6**). The station consists of two side platforms, one for northbound and one for southbound travel. The northbound platform is 160m long and is accessed by an elevated ramp and stair structure from the eastern side of Annerley Road. The southbound platform is 150m long and is accessed by a ramp from Kent Street. Station facilities (ticket office and amenities) are located on the northbound platform. To the west of the northbound platform is a third, dual gauge rail used by express passenger trains (to and from the Gold Coast and Sydney) as well as freight trains to the north and east, including the Port of Brisbane.

In the peak one-hour (peak direction) there are up to six inbound services to the Brisbane CBD stopping at this station. Off-peak, two services per hour in each direction are provided. Train services generally commence at 5.15am at Dutton Park Station with the last service at 12.15am (later on Friday and Saturday nights).

Dutton Park Station has relatively low levels of passenger use, with around 2,400 boardings and alightings as shown in **Table 3-5**. Activity in the morning peak is higher than the evening peak with morning activity dominated by alighting movements.

Table 3-5 Base year (2012) Dutton Park Station usage – two hour peak period

Time Period	Boardings	Alightings	Total
Daily	900	1,500	2,400
AM (7.00 to 9.00am)	200	500	700
PM (4.00 to 6.00pm)	200	200	300

Source: BaT Project Model

Table 3-6 illustrates the modes of access and egress at Dutton Park Station. This shows that the majority of morning peak boarders (over 75 per cent) arrive on foot with around 25 per cent by car. Alighters in the morning peak are all walking to their final destination and this reflects the land use in the Dutton Park precinct of the hospital, Boggo Road Urban Village, schools and UQ across the Brisbane River.

Table 3-6 Dutton Park Station existing (2012) modes of access

Access Mode	Boardings		Alightings		Total	
	Passengers	Proportion	Passengers	Proportion	Passengers	Proportion
Bus	0	0%	0	0%	0	0%
Car	50	24%	0	0%	50	7%
Rail	0	0%	0	0%	0	0%
Walk/ cycle	170	76%	500	100%	670	93%
Total	220	100%	500	100%	720	100%

Source: BaT Project Model

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 3-6

Rail stations in the study corridor

G:\QENV2\Projects\QE06863\Spatial\ArcGIS\Figures\Final_EIS_Figures\04_Transport\Tech_Report\TranspTechRpt_Figure3-6_RailwayStations_StudyCorridor.mxd Date: 14/08/2014

Park Road Station

Park Road Station is located in the inner suburb of Dutton Park and is 5.1km south of Central Station. Dutton Park Station is located only 800m to the south (refer to **Figure 3-6**). Park Road Station serves a wide range of suburban and interurban railway lines via four platforms. Park Road serves as the interchange point between inter-city express services from the Gold Coast, and suburban services from the Cleveland/ Manly and Beenleigh/ Coopers Plains lines.

Each platform has stair and lift access to a pedestrian over-bridge which also links roads and footpath networks on both the north and south sides of the station.

Park Road Station had over 9,700 boardings and alightings on a typical weekday in 2012. **Table 3-7** illustrates station activity by time period. This shows that the morning peak was slightly busier than the evening peak and that boardings and alightings are closely matched in the morning. This does not carry through to the evening peak, potentially due to peak spreading of alighting trips into other time periods (eg school travel occurring before this period and late-working commuters travelling after this time period). Transfers to busway services associated with UQ play a part in this with return trips from the university being more dispersed into the off-peak.

Table 3-7 Base year (2012) Park Road Station usage – two hour peak period

Time period	Boardings	Alightings	Total
Daily	5,500	4,200	9,700
AM (7.00 to 9.00am)	1,300	1,400	2,700
PM (4.00 to 6.00pm)	1,500	800	2,300

Source: BaT Project Model

The existing mode share for access to Park Road Station is presented in **Table 3-8**.

Table 3-8 Park Road station existing (2012) modes of access

Access mode	Boardings		Alightings		Total	
	Passengers	Proportion	Passengers	Proportion	Passengers	Proportion
Bus	930	74%	1,000	73%	2,000	73%
Car	90	7%	0	0%	90	3%
Rail	60	5%	100	6%	140	6%
Walk/ cycle	200	14%	300	21%	500	18%
Total	1,300	100%	1,400	100%	2,700	100%

Source: BaT Project Model

There were no observed crowding issues on the platforms or access walkways on a typical weekday morning peak.

Central Station

Central Station lies in the northern area of the Brisbane CBD approximately 200m north-west of the Brisbane General Post Office (refer to **Figure 3-6**). It is the hub of the South East Queensland Rail passenger network. The station serves all suburban and interurban railway lines via six platforms arranged as three double sided islands. Each island platform has escalator, stairs and lift access to the main station concourse above as well as stair access down to a pedestrian subway link to ANZAC Square.

Central Station is the busiest on the Queensland Rail City network. During the morning peak hour, there are 70 trains in total stopping at Central Station **Table 3-9** presents the base year (2012) rail boardings and alightings by time period at Central station. There were over 95,000 passenger movements (boardings, alightings and transfers) on a typical weekday. There is a strong tidal flow of passenger movements at Central Station with very heavy alightings in the morning peak and few boardings. In the evening peak, there are large numbers of boardings and few alightings. Central Station experiences relatively short and intense peak flows with congestion on platforms and at access stairs a noticeable issue at such times.

Table 3-9 Base year (2012) Central Station usage – two hour peak period

Time period	Boardings	Alightings	Total
Daily	48,200	46,900	95,100
AM (7.00 to 9.00am)	2,600	24,800	27,400
PM (4.00 to 6.00pm)	24,300	2,600	26,900

Source: BaT Project Model

The existing mode share for access during the morning peak period at Central Station is presented in **Table 3-10**. This shows that walk access is by far the dominant mode of access with car and bus based modes being minor modes of access. Central Station has very little interchange – either bus-rail or rail-rail.

Table 3-10 Central station existing (2012) modes of access

Access mode	Boardings		Alightings		Total	
	Passengers	Proportion	Passengers	Proportion	Passengers	Proportion
Bus	300	12%	200	1%	500	1%
Car	0	0%	0	0%	0	0%
Rail	50	1%	26	0%	52	0%
Walk/cycle	2,300	87%	24,600	99%	26,900	99%
Total	2,600	100%	24,800	100%	27,400	100%

Source: BaT Project Model

Roma Street Station

The Roma Street Station is part of the Roma Street Transit Centre, a multi-modal transport hub comprised of the Roma Street Station, Roma Street Busway Station and Roma Street intercity coach station, as well as a range of food, hotel, office and retail uses (refer to **Figure 3-6**). The transit centre was constructed in the early 1980s and lies in the north-western part of the CBD.

Roma Street Station serves all suburban and interurban passenger railway services (70 services per hour in the morning peak) via six in-service platforms (Platforms 4 to 9) with limited use of the dual gauge Platforms 2 and 3. Each platform is accessible by stairs, lifts and escalators off a central pedestrian subway.

In addition to the suburban rail services, Roma Street also caters for interstate and long distance rail services.

Roma Street Station is the second busiest on the Queensland Rail City network with more than 40,000 passenger movements (boardings, alightings and transfers) on a typical weekday. **Table 3-11** presents the base year (2012) rail boardings and alightings by time period at Roma Street Station. This table shows that the peak periods dominate passenger activity at Roma Street with around 50 per cent of daily activity in the peak four hours.

Table 3-11 Base year (2012) Roma Street Station usage – two hour peak period

Time Period	Boardings	Alightings	Total
Daily	22,200	21,200	43,400
AM (7.00 to 9.00am)	2,800	9,800	12,600
PM (4.00 to 6.00pm)	8,600	2,200	10,800

Source: BaT Project Model

Roma Street Station has an important interchange function. The existing mode share for access during the morning peak at Roma Street Station is presented in **Table 3-12**. Around 70 per cent of boarding passengers in the morning peak transfer from another rail service and a further 15 per cent of boarding passengers transfer from a bus service.

Table 3-12 Roma Street Station existing (2012) modes of access

Access mode	Boardings		Alightings		Total	
	Passengers	Proportion	Passengers	Proportion	Passengers	Proportion
Bus	400	15%	3,300	34%	3,700	30%
Car	0	0%	0	0%	0	0%
Rail	1,900	68%	1,900	19%	3,800	30%
Walk/ cycle	500	17%	4,600	47%	5,100	40%
Total	2,800	100%	9,800	100%	12,600	100%

Source: BaT Project Model

Specific issues at this station include crowding at the main ticket gate line within the subway. Another key problem exists at the station exits approaching Roma Street itself, where the exit closest to the northern end of George Street is a narrow set of double doors with narrow stairs, a narrow footway and no formal pedestrian crossing (refer to **Figure 3-7**).

Figure 3-7 Roma Street Station entrance facing Roma Street/ George Street intersection

3.2.5 Train passenger loads

Modelled train loadings on the existing passenger network (expressed as a percentage of seated train capacity) are reported in **Table 3-13**. The seated load distance threshold for inbound and outbound travel is that passengers should not have to stand for trips longer than 20min from the CBD.

This assessment shows that during the morning and evening peak periods significant crowding is now prevalent on inner city sections of the rail network with numerous line segments experiencing passenger demands close to, or exceeding seated capacity, for the whole two-hour peak period[7]. Train loads are generally heavier in the morning peak (in the peak direction) than the evening peak (in the peak direction). This is because education and work-based trips coincide in the morning peak period (7.00am to 9.00am), whereas education based trips are predominantly undertaken before the start of the evening peak period (4.00pm to 6.00pm).

This information on line loadings illustrates the significant use of South Bank and South Brisbane stations reported in **section 3.2.3**. In the morning peak period prior to South Bank Station line loadings are at 94 per cent in the northbound direction towards the Brisbane CBD. After the South Brisbane Station line loadings are reported as 58 per cent. This illustrates that maximum loads are achieved on the approach to the CBD fringe as that is when passengers start alighting and so maximum loads decline.

Table 3-13 Base year (2012) average line loadings between stations in the study corridor

Time period	Northbound	Southbound	Two-way
Fortitude Valley-Central			
Daily	24%	25%	25%
AM (7.00 to 9.00am)	20%	75%	47%
PM (4.00 to 6.00pm)	77%	27%	54%
Central Station-Roma Street			
Daily	21%	23%	22%
AM (7.00 to 9.00am)	55%	27%	42%

[7] A load factor of 100% means that all seats are occupied on average for the two-hour time period and would mean that the average number of passengers matches the available number of seats over 2 hours. It does not attempt to provide an indication of the passenger load on any individual train service within that two hour period.

Time period	Northbound	Southbound	Two-way
PM (4.00 to 6.00pm)	24%	69%	45%
Roma Street-South Brisbane			
Daily	25%	30%	27%
AM (7.00 to 9.00am)	58%	81%	51%
PM (4.00 to 6.00pm)	27%	36%	61%
South Brisbane-South Bank			
Daily	31%	33%	32%
AM (7.00 to 9.00am)	74%	35%	62%
PM (4.00 to 6.00pm)	28%	93%	69%
South Bank-Park Road			
Daily	38%	37%	37%
AM (7.00 to 9.00am)	94%	22%	72%
PM (4.00 to 6.00pm)	29%	106%	78%
Park Road-Dutton Park			
Daily	38%	39%	39%
AM (7.00 to 9.00am)	96%	21%	71%
PM (4.00 to 6.00pm)	28%	112%	80%

Source: BaT Project Model

Note: Line loading is expressed as a percentage of seated capacity

3.2.6 Rail performance issues

Rail capacity

The Brisbane CBD rail configuration presents finite capacity at the heart of the network. Between Roma Street and Bowen Hills, the railway is comprised of only four tracks with a combined maximum capacity of 44 trains per hour, in each direction (88 trains per hour in total). The main lines have a theoretical maximum capacity of 20 trains per hour (each direction) while the suburban lines have a higher capacity of 24 trains per hour, per direction due to dual platform faces at Central and Roma Street Stations allowing one train to approach the station while another (in the same direction) is at the station or preparing to depart.

As well as the inner city tunnels and stations, the approach routes to the inner city railway lines and stations are also constrained, limiting capacity into the inner city. For example, services from Milton (on the four-track western line) and Park Road (ie Beenleigh, Gold Coast and Cleveland trains on the three-track southern line) must merge to access the Brisbane CBD via only four tracks to the south-west of Roma Street Station. This limits the ability to fully exploit the capacity potential on these approach corridors individually.

Capacity across the Brisbane River in particular is constrained. Express trains from the Gold Coast as well as suburban trains from Beenleigh and Cleveland must all use a single in-bound track across the Merivale Bridge. Of the 19 trains per hour in the morning peak approaching Roma Street from the south, over the Merivale Bridge, five trains per hour are longer distance express trains from the Gold Coast. This capacity constraint on the bridge and access into Roma Street Station restricts growth on these services. These rail capacity constraints in the inner city rail network are shown in **Figure 3-8**.

The Department of Transport and Main Roads through TransLink and Queensland Rail are delivering the Brisbane Inner Rail Solution that aims to improve capacity of the inner city rail network out to around 2020. This includes timetable changes introduced in early 2014. As part of the Brisbane Inner Rail Solution, an Early Capacity Works package will deliver initiatives targeted at increasing capacity during the peak periods by:

- enabling peak spreading – providing passengers with more services during the shoulder peak
- minimising dwell times – the time the train is stopped at a station
- optimising internal train capacity – more people per train
- increasing capacity of the existing network – allowing more trains to run more safely and reliably
- increasing train services – up to the limit of the existing infrastructure.

Level of service – on time reliability

Incidents occur on the rail network that are beyond the control of Queensland Rail and result in delay to services. Such incidents may include on-board medical emergencies, security incidents, vehicles striking level crossing boom gates and severe weather activity. The reliability of the network is dependent on the performance of the central section of the network between Roma Street and Bowen Hills. This critical section of the network lacks resilience and so can impact on the performance of whole network. Operational issues may also delay rail services.

Queensland Rail aim to have more than 94.5 per cent of peak period services arrive on time[8]. All services, including peak and off-peak, are measured on time when they arrive within three minutes and 59 seconds of their scheduled time (5 minutes and 59 seconds on interurban services; ie Gold Coast, Rosewood and Nambour). For the most recently published data (for the financial year 2013/ 14 quarter 3) 95.4 per cent of trains were recorded as operating on time. 9

Rail level of service – load factor

The combination of the high number of boardings in the limited morning peak period and the high rate of growth in peak period patronage, results in overcrowding being reported on many services. This is particularly evident on the longer distance Gold Coast services, with utilisation of morning peak services in 2012 at 126 per cent of service capacity. Passengers on these long distance services are required to stand for long periods of time – greater than 20 minutes from the CBD and so breaching network standards.

During the same period, some northern services were operating at or above full capacity approaching Bowen Hills Station. Overcrowding on the rail network will impact the time for loading and unloading of trains at all stations, exacerbating the limited capacity issues in the inner city.[10]

Accessibility to rail stations from the whole CBD

The Brisbane CBD is served by two rail stations, Central and Roma Street, located on the northern side of the CBD. This means that the southern areas of the CBD that includes the Government precinct, the QUT Gardens Point campus and the Riverside and Eagle Street office precincts are more than a 15 minute walk from a rail station. This results in high volumes of pedestrians walking across the CBD from both Central Station and Roma Street Station and across the Brisbane River from South Bank and South Brisbane stations.

[8] Source: http://www.queenslandrail.com.au
[9] Source: http://www.queenslandrail.com.au
[10] Source: Source: URS (2014) BaT Railway Network Planning and Operations (Reference Project), Technical Report, Project: 42565548 TMR 10213. pp 16-7

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 3-8

Capacity constraints in the Brisbane inner-city rail network

3.3 Bus services – the regional network

With around 249,000 bus users on an average weekday in the Brisbane Statistical Division, buses are the largest mode of public transport and cater for just less than 50 per cent of total public transport trips across the region (Brisbane Statistical Division).

Brisbane's south and inner north are serviced mostly by grade-separated busways that provide access to the CBD. The busway network consists of:

- South East Busway, extending from the Brisbane CBD to Eight Mile Plains
- Northern Busway, including the Inner Northern Busway, extending from the Brisbane CBD to Kedron
- Eastern Busway, extending from the UQ to Langlands Park, Coorparoo.

The Brisbane bus network is primarily CBD centric with over 500 bus services per hour entering the CBD in the morning peak. There are three busways within the study corridor, namely the Inner Northern Busway, Eastern Busway and South East Busway. They carry around two-thirds of these buses into the CBD. The South East Busway carries over 350 buses per hour inbound at its busiest point at Woolloongabba while the Inner Northern Busway carries over 120 buses per hour inbound at Roma Street in the morning peak.

Peak period bus operations in Brisbane consist of peak period only routes and increased frequencies of the all-day services that greatly supplement the standard all-day services. The peak only routes offer single-seat express journeys into the Brisbane CBD. From the south-east, most of these peak-only express services use the Captain Cook Bridge to enter the CBD rather than the inner South East Busway route via the Melbourne Street portal and the Victoria Bridge. Since 2008, growth in bus services into the CBD from the south has been accommodated on the Captain Cook Bridge as the South East Busway has been operating at capacity.

Across inner Brisbane and the study corridor there is a general lack of dedicated bus-rail interchange infrastructure with three exceptions being Roma Street, Park Road and South Bank as shown in **Figure 3-9**. There is also limited on-street bus priority in the Brisbane CBD with buses using many key roads, especially Adelaide, Elizabeth, Edward and Ann streets, and are consequently susceptible to pedestrian and traffic congestion in peak periods, resulting in poor journey time reliability on many routes.

3.3.1 Bus services in the study corridor

Central Brisbane is the hub of the Brisbane bus network and the principal destination for bus commuters in Brisbane. A wide range of bus operating patterns service the inner city including all stops inner suburban buses, limited stops buses from middle-outer suburban locations and express-running, peak-only 'rocket' type services.

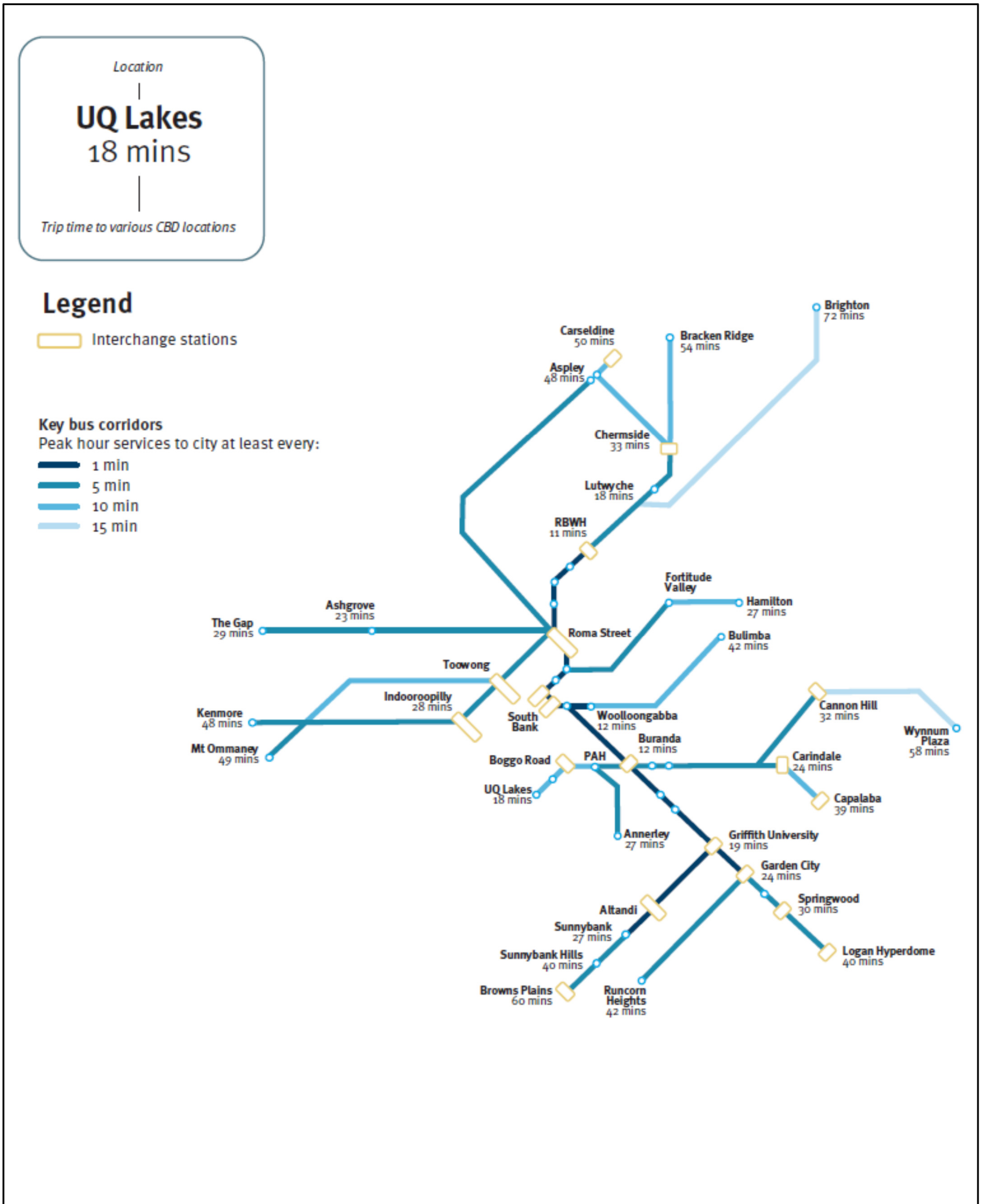
The busway network and stations within the study corridor are shown on **Figure 3-10**.

Many buses start or terminate their routes at the Queen Street Bus Station (QSBS) or the Cultural Centre Busway Station. There is no opportunity for layover within these stations. The closest layover areas that can be accessed from the busway are at Hope Street, Countess Street and Woolloongabba and Queen's Wharf Road. These layover areas are often full in peak periods (as well as before the afternoon peak), meaning that buses can be required to circulate the city streets prior to entering into service. This adds to operating costs and increases congestion.

The strategic inner city bus termination and interchange locations are:

- Roma Street – busway station fully integrated with the railway station allowing for bus-rail and bus-bus interchange
- King George Square Busway Station – principally serviced by high frequency, all-day BUZ routes and provides bus-bus interchange and termination for some bus services from the west
- QSBS – located beneath Queen Street Mall and the Myer Centre, it principally provides a termination for services from the south and west with bus-bus interchange opportunities. Buses that serve both King George Square and Cultural Centre busway stations typically pass through the QSBS, but do not stop.
- Cultural Centre Busway Station – primarily where the South East Busway routes and the South Brisbane and West End routes converge and the termination point for some northern services, it provides the widest range of access to bus services across Brisbane and acts as a significant bus-bus interchange a much lower level of interchange with rail services at the nearby South Brisbane rail station
- Adelaide Street – provides bus-bus and bus-rail interchange opportunities near Central Station. The Adelaide Street bus stops cater for most of the key east-west services from Fortitude Valley and West End as well as a range of other services from across the northern and western network.
- Elizabeth Street – principally provides a termination for rocket services from the south and east with some bus-bus interchange occurring.

While bus access to the inner city including the Brisbane CBD is generally good, there are parts of the CBD south of Elizabeth Street such as the Government precinct, QUT Gardens Point campus and the Riverside and Eagle Street Pier areas that experience infrequent and irregular bus services, during the off-peak periods. For example the popular City Loop service provides a good LoS (every 10 to15 minutes) during work hours Monday to Friday, however, it does not serve the precinct outside of this time.



- Bus travel times are estimates assuming current travel speeds on-road.

FIGURE 3-9

Key bus corridors and interchange locations

LEGEND

- Existing busway station
- Existing busway
- Study corridor

Project Infrastructure

- Underground station
- Dutton Park Station (upgraded)

Alignment

- Above ground
- Underground

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 3-10

Busway routes and stations in the study corridor

N

0 0.5 1
Kilometres
1:30,000 (at A4)

Aerial Photo: Brisbane City Council 2012

Projection: GDA 1994 MGA56

G:\QENV2\Projects\QE06863\Spatial\ArcGIS\Figures\Final_EIS_Figures\04_Transport\Tech_Report\TranspTechRpt_Figure3-10_BuswayStations_StudyCorridor.mxd Date: 14/08/2014

3.3.2 Bus patronage and bus station and stop activity

The number of passengers using the bus system during the morning and evening peak periods out of the daily 24-hour total of 248,700 bus users is shown in **Table 3-3**. This table also illustrates that about 45 per cent of bus passengers use the bus system during the peak periods – that is four hours of a 24 hour day.

Table 3-14 Base year (2012) peak two hour period bus users

Period	Bus users
AM two-hour peak (7.00am to 9.00am)	58,000 (23.3%)
PM two hour peak (4.00pm to 6.00pm)	49,500 (19.9%)
Daily	248,700

Source: BaT Project Model

Bus station and bus stop activity in the study corridor

There is a significant demand for bus usage to and from the Brisbane CBD and the CBD fringe in the peak periods. The total bus station and bus stop activity in the CBD and CBD fringe is comparable to rail with over 50,000 boardings and alightings occurring. This accounts for almost half of the public transport activity in the period. However, unlike rail, this is occurring across a greater number of stations/ stops and a wider area.

Table 3-15 illustrates the forecast usage of Brisbane CBD and CBD fringe bus stops in the morning peak period. This shows that in the morning peak period there are almost 37,000 bus boardings and alightings in the CBD with on-street bus stops catering for almost half of this demand.

There is also significant activity in the Brisbane CBD fringe busway stations to the south of the river with around 15,000 bus passengers boarding and alighting bus services. Many of these passengers, particularly from South Bank and Mater Hill, then access the CBD by walking across the Goodwill Bridge.

Table 3-15 Base year (2012) AM peak two hour bus patronage at CBD and CBD fringe

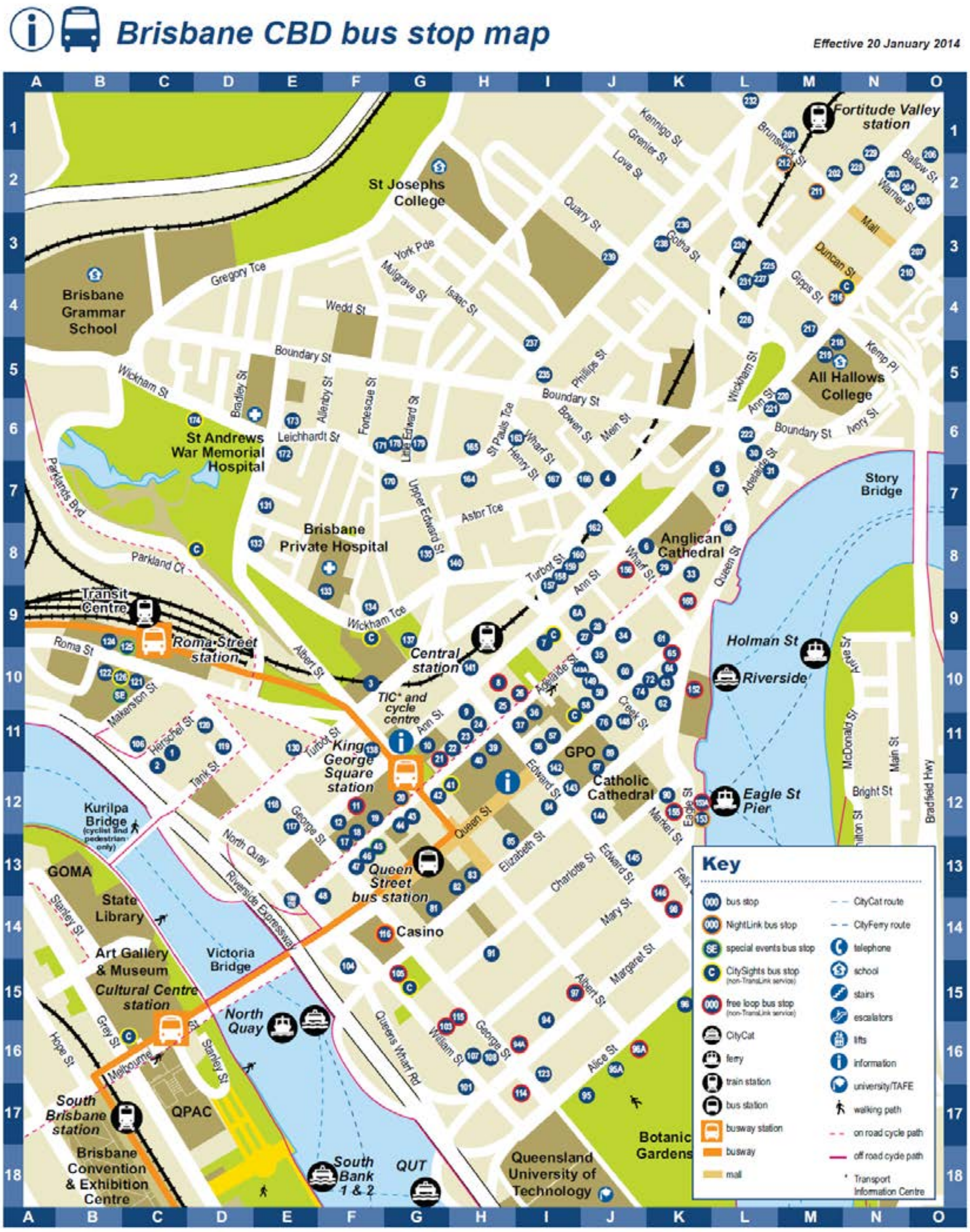
Station	Two hour morning peak period alighting and boardings
Roma Street	5,300
QSBS	4,300
KGS	10,300
CBD streets	16,900
CBD Total Bus	**36,800**
Cultural Centre	6,500
South Bank	4,400
Mater Hill	3,800
Total Bus (CBD and CBD Fringe)	**51,500**

Source: BaT Project model

Brisbane CBD Street bus stops

Bus stops are located on most streets within the Brisbane CBD as shown on **Figure 3-11**. While Adelaide Street is the major bus stop and thoroughfare for bus within the CBD, many other stops are located on other streets, such as George Street, Elizabeth Street, Edward Street, Queen Street, Ann Street, Creek Street and Alice Street. In addition to the stops for regular services, the CBD street bus stops provide for the CityGlider, NightLink, special events, CitySights and free loop services. The majority of bus boarding and alighting activity occurs along Elizabeth Street, Adelaide Street and Ann Street between Edward Street and George Street.

Figure 3-11 CBD Bus Stops



Roma Street Station bus services and facilities

The Roma Street Busway Station is located adjacent to and part of the Roma Street Rail Station. This busway station is comprised of two busway platforms (Platform 1 outbound and Platform 2 inbound) accessed directly off the main pedestrian subway to the rail platforms.

From Roma Street Busway Station, key outbound services include:

- Western bus services along Coronation Drive or Milton Road (eg 444 and 446 to Indooroopilly, Kenmore and Moggill)
- North-west bus services along Caxton Street/La Trobe Terrace (eg 385 and 61 (Maroon City Glider) to The Gap via Paddington)
- Northern services along Kelvin Grove Road (eg 345 to Aspley) and Northern Busway/Gympie Road (eg 333 to Chermside, 330 to Bracken Ridge and 340 to Carseldine).

Inbound services from Roma Street travel to either KGS, or QSBS approximately 200m beyond KGS station or to on-street stops within the CBD. The majority of services that stop at KGS, then pass through QSBS (without stopping) and continue to Cultural Centre Busway Station where the majority of services from Roma Street terminate. The key exceptions are route 66 (to Woolloongabba), route 61 (Maroon City Glider to Stones Corner) route 222 (to Carindale) and route 111 (to Eight Mile Plains).

The completion of the Inner Northern Busway through Roma Street Station in 2007 has significantly enhanced bus-rail integration and interchange opportunities within Brisbane, with both high frequency bus services and rail services serving the same station. Seamless transfer is now possible between both modes, making many more public transport journey combinations more attractive.

The existing mode share for access during the morning peak period at Roma Street Station is presented in **Table 3-16**. This shows that rail access is by far the dominant mode indicating that rail to bus interchange is prominent at Roma Street.

Table 3-16 Roma Street Station existing (2012) modes of access – 2012

Access mode	Boardings		Alightings		Total	
	Passengers	Proportion	Passengers	Proportion	Passengers	Proportion
Bus	400	9%	300	22%	700	13%
Car	0	0%	0	0%	0	0%
Rail	3,300	82%	400	33%	3,700	70%
Walk/cycle	300	9%	600	45%	900	17%
Total	4,100	100%	1,200	100%	5,300	100%

Source: BaT Project Model

Additional bus stops for local buses are located on Roma Street itself, approximately 100m west of the station. These cater for local services (including the interchange between rail and on-street bus). Observations in peak hours did not reveal any major bus-bus or bus-rail interchange at this location however the outbound bus stop on the southern side of Roma Street was observed to be well used in the evening peak with passengers waiting on the footway.

Central Station bus services and facilities

Central Station does not provide any dedicated opportunities for integrated interchange with the bus network. Passengers who wish to transfer to bus are required to use the on-road bus stops on Ann

Street, Edward Street, Creek Street or Adelaide Street. The busway network does not serve Central Station directly.

The city centre free loop stops at several key Brisbane CBD destinations including on streets near to the Queen Street Mall, City Botanic Gardens, Riverside Centre, QUT and King George Square. The city centre free loop operates every 15 minutes between 7.00am and 6.00pm in each direction. The passenger demand for the city centre free loop is currently observed to be high in the peak periods with buses operating at capacity. The service covers the areas of the CBD that are currently not well served by rail or all-day/ everyday bus services.

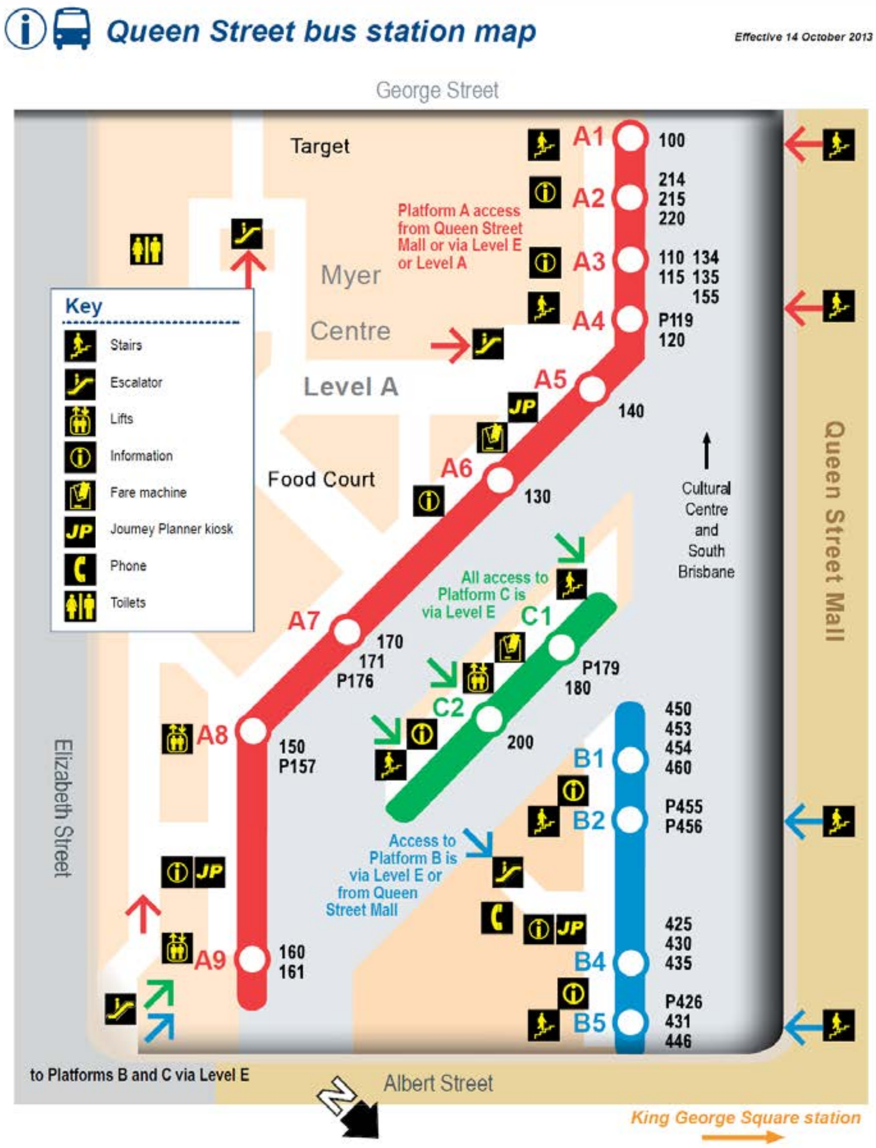
Queen Street Bus Station services and facilities

The QSBS is located under Queen Street Mall and the Myer Centre and has surface access in Reddacliff Place, allowing access to the Victoria Bridge, and tunnel access to King George Square Bus Station. Designed as a terminus station it was opened in 1988. It is in need of modernisation and is not well-suited to two-way, through-running operations within it. The QSBS consists of three platforms with 15 stops and caters for 35 different bus services. Key services that stop at QSBS include:

- southern Bus Services along Coronation Drive or the South East Busway (eg 100 to Forest Lake and 160 to Garden City)
- western bus services along Moggill Road and Coronation Drive (eg 430 to Fig Tree Pocket and 453 to Mt Ommaney)
- some eastern bus services along Old Cleveland Road and Wynnum Road (eg 220 to Wynnum and 200 to Carindale).

Generally, buses terminating at the QSBS will gain access via the Victoria Bridge. A number of the western bus services will travel outbound via North Quay to access Coronation Drive rather than travelling across the Victoria Bridge and stopping at the Cultural Centre.

Figure 3-12 Queen Street Bus Station



King George Square Busway Station services and facilities

KGS Busway Station is located underneath King George Square in the centre of Brisbane CBD. The station opened in 2008 with busway connections to the Roma Street Busway Station and the QSBS.

Passengers can access the station from Adelaide Street and Ann Street. The station has twelve stops on two platforms with access to these stops via an underground concourse. The station has 12 stops on two platforms. During the morning peak period 21 different bus routes stop at the station that consist of 120 buses per hour. Platform screen doors are provided so that passengers do not hail buses but wait behind automatic doors on the stop that is assigned to their bus.

KGS Busway Station is the busiest bus station in the CBD in terms of the number of boarding and alighting passengers with 10,300 using it during the morning peak period in 2012.

Woolloongabba Busway Station services and facilities

Woolloongabba includes significant bus infrastructure and is a key part of the south-east Brisbane bus network. The South East Busway passes through the suburb, catering for high frequency bus services from the south-east most of which do not stop at the Woolloongabba Busway Station. A spur off the South East Busway includes the Woolloongabba Busway Station, which caters for numerous buses travelling along the Ipswich Road, Logan Road and Stanley Street corridors to the south and east of the busway station.

The suburb is served by a wide range of buses including:

- high frequency and local services operating on the Woolloongabba spur of the South East Busway and serving Woolloongabba Busway Station (eg 61 (Maroon City Glider) 66, 200, 220)
- high frequency services via the mainline South East Busway but not travelling through or stopping at Woolloongabba Busway Station (eg 111, 130, 140, 150, 555)

Woolloongabba Busway Station accommodates over 110 stopping bus services per hour (two-way) during the morning and evening peak periods with 75 of these services being inbound in the morning peak period. These bus services consist of 28 different routes from the CBD (and UQ) to destinations as far afield as Wynnum, Carindale, Garden City (Upper Mt Gravatt), and Forest Lake. Furthermore a range of non-stop buses pass through the Woolloongabba Busway spur and on the South East Busway itself, 200m west of the station.

The existing mode share for access during the morning peak period at the Woolloongabba busway station is presented in **Table 3-17**.

Table 3-17 Woolloongabba Station existing (2012) modes of access – 2012

Access mode	Boardings		Alightings		Total	
	Passengers	Proportion	Passengers	Proportion	Passengers	Proportion
Bus	600	50%	600	55%	1,200	52%
Car	-	-	-	-	-	-
Rail	-	-	-	-	-	-
Walk/cycle	600	50%	500			
Total	1,200	100%	1,100	100%	2,300	100%

Source: BaT Project Model

During events at the Gabba Stadium, special event shuttle buses are used. Over 100 buses travel to a range of destinations, including the CBD, from the assigned departure points, including the busway platforms and on-street stops on Wellington Road, Stanley Street and Mains Street. This event services continue until one hour from the end of events.

Due to the large numbers of buses and pedestrians on the roads after events at the stadium, Stanley Street and Vulture Street (immediately surrounding the stadium) are closed for up to one hour after each major event. Ipswich Road operates under traffic control to ensure priority for pedestrians crossing towards the busway station, and South Bank busway and rail station, which is 1.5km away.

Park Road and Boggo Road stations bus services and facilities

The Park Road Rail Station and the Boggo Road Busway Station are integrated into one interchange with a common over bridge and station access points.

Key services operating from the Boggo Road Busway Station include the:

- 29 (Woolloongabba to UQ)
- 66 (RBWH to UQ)
- 104 (Corinda to PA Hospital)
- 105 and 108 (Indooroopilly to CBD)
- 107 (City to Fairfield)139 (Sunnybank to UQ)
- 169 (Eight Mile Plains to UQ)
- 209 (Carindale to UQ).

These services combine to provide up to 51 bus services per hour to UQ (some 2km to the west) in the morning peak and 14 services per hour in the morning peak to the PA Hospital approximately 600m west from Park Road station. It is worth noting that walk access from Park Road railway station to the PA Hospital is currently an indirect 900m walk due to the presence of railway infrastructure and as such a bus transfer via the busway provides a more attractive access option from Park Road Station.

In addition to busway services, several on-street bus services travel along Annerley Road, approximately 250m west of Park Road station which combine to create a frequency of up to 10 buses an hour inbound in the morning peak. This is comprised of the following bus routes:

- 105, 107, 108 (all services from Yeronga/Fairfield to CBD)
- 112 (Mt Gravatt to CBD)
- 202 (Carindale to CBD).

The existing mode share for access during the morning peak period at the Boggo Road busway station is presented in **Table 3-18**.

Table 3-18 Boggo Road station existing (2012) modes of access – 2012

Access mode	Boardings		Alightings		Total	
	Passengers	Proportion	Passengers	Proportion	Passengers	Proportion
Bus	30	3%	30	3%	60	4%
Car	11	1%	0	0%	10	0%
Rail	1,000	95%	900	90%	2,000	92%
Walk/cycle	11	1%	70	7%	80	4%
Total	1,100	100%	1,000	100%	2,100	100%

Source: BaT Project Model

PA Hospital Busway Station services and facilities

The PA Hospital Busway Station is located on the Eastern Busway and provides direct access to the PA Hospital precinct, via both surface level pathways and a purpose designed elevated walkway connection direct to the main Hospital entry point. As part of the Eastern Busway, the PA Hospital Busway Station is the stop before the Boggo Road Busway Station. As a result, the two busway stations have the same services, including frequency of services during the morning peak.

Additional bus services adjacent to the PA Hospital Busway Station on Ipswich Road combine to create a morning inbound peak frequency of up to 15 buses per hour. A street level stop is also located beneath the PA Hospital Busway Station that is currently only serviced by 104 – Corinda to PA Hospital, all-stops service.

Dutton Park Station bus services and facilities

Dutton Park is well served by buses on several routes with stops on Annerley Road (200m north and 55m south of station), Noble Street, Fairfield Road and Cornwall Street providing informal bus-rail interchange opportunity. Very little interchanging was observed on site in March 2014.

Bus stops located on Cornwall Street serve inbound and outbound services for bus routes 198 and 202. Route 198 undertakes a loop between PA Hospital, Brisbane State High School, West End, Highgate Hill and Dutton Park. Route 202 operates between the City and Carindale via Dutton Park, Stones Corner and Carina Heights.

A bus stop on Annerley Road 60m south of the station serves routes 112 and 116 outbound between the City and Mount Gravatt or Moorooka. A bus stop on Nobel Street is located 90m south of station. This bus stop is sheltered and serves bus routes 104, 105, 107, 108, 196 and 197 for outbound passengers.

Two more bus stops are located on Annerley Road 200m north of the station for inbound and outbound services. The outbound bus stop is serviced by bus routes 104, 105, 107, 108, 112, 116, 192, 196, 198 and 202 with bus routes 192 and 196 servicing the inbound bus stop. Formal pedestrian crossings are available at Annerley Road/ Noble Street and Annerley Road/ Gladstone Road intersections located north and south of the bus stops on Annerley Road.

3.3.3 Bus passenger loadings in the study corridor

Modelled bus loadings on the existing passenger network (expressed as a percentage of seated bus capacity) are reported in **Table 3-19**. This assessment shows that during the morning and evening peak periods some modest passenger crowding on buses of around 80 per cent was evident on the approaches to the inner city sections of the bus network. Once buses are within the inner city the passenger loadings on the buses reduce as passengers are at destinations. For example the section of busway between Woolloongabba and Allen Street is the highest points of loading, because after that location, passengers start getting off buses because they have reached their destination. Passenger loadings on the Victoria Bridge are low as the Cultural Centre Busway Station is a terminus for many services.

Table 3-19 Base year (2012) average bus passenger loadings

Time period	Northbound	Southbound	Two-way
Busway Victoria Bridge			
Daily	18%	20%	19%
AM (7.00 to 9.00am)	27%	33%	30%
PM (4.00 to 6.00pm)	29%	45%	38%
Captain Cook Bridge			
Daily	43%	22%	33%
AM (7.00 to 9.00am)	55%	41%	54%
PM (4.00 to 6.00pm)	45%	32%	33%
Busway Melbourne Street - South Bank			
Daily	23%	30%	26%

Time period	Northbound	Southbound	Two-way
AM (7.00 to 9.00am)	32%	45%	37%
PM (4.00 to 6.00pm)	34%	63%	51%
Busway South Bank – Mater Hill			
Daily	27%	35%	31%
AM (7.00 to 9.00am)	42%	51%	45%
PM (4.00 to 6.00pm)	35%	72%	57%
Busway Allen Street - Mater Hill			
Daily	32%	41%	37%
AM (7.00 to 9.00am)	52%	61%	55%
PM (4.00 to 6.00pm)	39%	82%	64%
Busway Woolloongabba – Allen Street			
Daily	34%	38%	36%
AM (7.00 to 9.00am)	52%	60%	54%
PM (4.00 to 6.00pm)	40%	62%	58%
Busway Woolloongabba spur			
Daily	29%	41%	35%
AM (7.00 to 9.00am)	49%	53%	50%
PM (4.00 to 6.00pm)	26%	79%	58%
Busway PA Hospital to Dutton Park			
Daily	31%	33%	32%
AM (7.00 to 9.00am)	40%	54%	45%
PM (4.00 to 6.00pm)	38%	44%	41%

Source: BaT Project Model

3.3.4 Bus performance issues

Congestion on the bus network

The bus network experiences difficulties getting buses into and out of the CBD in some areas. Although the busway provides buses with a dedicated right of way, this does not extend all the way to the CBD, being the destination of greatest demand for commuting trips. Buses must mix with general traffic on major roads and city streets and compete for time and/ or space with other road users at major intersections. There is limited kerb space for extra bus stops, and there are severe limits on layover space resulting in more dead-running of buses. These factors undermine bus travel time, reliability and operational efficiency.

Congested busways

As shown in **Table 3-20**, Brisbane's busway infrastructure has reached capacity, causing bottlenecks at key points. Many of the capacity constraints on the busway network are highly visible, for example, during peak hours, queues of buses can be observed on key entries into the CBD such as the Victoria Bridge and the approach to the Melbourne Street portal.

The most heavily trafficked section of the South East Busway is between Woolloongabba junction and the Allen Street exit to the Pacific Motorway, carrying 379 buses per hour in the morning peak period. The bus and passenger volumes carried on parts of the busway network are recognised as among the highest found anywhere in the developed world.

Table 3-20 Base year (2012) AM peak one hour bus demands and capacity

Link	Buses/ hour*	Estimated capacity**
South East Busway (between Woolloongabba junction and Allen Street exit)	379	300 (126%)
Victoria Bridge	225	180 (125%)

** All buses that have their final stop in CBD between 7:30am and 8:30am (Source: TTA)*

*** per lane including station/stops (Source: BACICS)*

Particular congestion and operational constraints are now apparent on the South East Busway, including:

- bus queuing and delays around the Melbourne Street (South Brisbane) busway tunnel portal caused by interaction with on-street surface traffic. There are also safety and efficiency issues at this location – the Melbourne Street portal is too narrow for longer buses to turn into and out of the tunnel simultaneously and this slows flows
- bus queues and delays around the intersection of Melbourne Street and Grey Street that is located immediately between the Melbourne Street busway portal and the Cultural Centre Busway Station
- congestion within the Cultural Centre Busway Station which causes buses to queue over the Victoria Bridge – this is a major bus hub and termination point for high frequency services from the north and west
- bus congestion at the Allen Street busway exit (onto the Captain Cook Bridge) at Woolloongabba, caused by general traffic congestion on the bridge – a major CBD approach route from the south
- the short platforms and dwell times at Mater Hill Busway Station.

Bus congestion on CBD streets

Bus capacity issues also arise on CBD streets. Constraints also exist in terms of on-street stopping space and layover as reported in the Bus Access Capacity-Inner City Study (BACICS), 2008, Inner City Bus Study (TMR, 2012) and the CBD Kerb-side Study (TMR-BCC, 2007), and have continued to be a constraint since then.

In the 2012 morning peak, approximately 220 buses per hour used Elizabeth Street and 120 buses per hour used Adelaide Street in the northeast direction. **Table 3-21** illustrates the bus capacity issues of the Captain Cook Bridge, Elizabeth Street and Adelaide Street. Particular congestion and operational constraints include:

- bus queues on the Margaret Street and Elizabeth Street off-ramps from the Riverside Expressway
- the approach to Buranda Busway Station in the morning peak period due to dwell times at the station
- the capacity of inner city bus stops is an issue for buses using the Captain Cook Bridge, with morning peak period buses often queuing in Elizabeth Street back from its intersection with George Street onto the Riverside Expressway off-ramp. This queue is due to delays accessing the bus stops in Elizabeth Street at the Myer Centre

- buses have capacity constraints getting to the Captain Cook Bridge at Woolloongabba. As buses do not have an exclusive lane to access the Pacific Motorway at the Stanley Street on-ramp and are competing with general traffic from Stanley Street, buses frequently queue back in Allen Street to the point of blocking the busway
- buses accessing the many bus stops and layover spaces in the Brisbane CBD results in bus activity contributing to traffic congestion in the CBD
- increasing pedestrian activity within the Brisbane CBD is creating more conflict between pedestrian and bus needs

Table 3-21 Base year (2012) AM peak one hour bus demands and capacity

Link	Buses/ hour*	Estimated capacity**
Captain Cook Bridge	221	250 (88.4%)
Elizabeth Street	219	120 (103%)
Adelaide Street (eastbound)	153	120 (128%)

** All buses that have their final stop in CBD between 7:30am and 8:30am (Source: TTA)*

*** per lane including station/stops (Source: BACICS)*

The ability of the street bus network to accommodate growth in buses is increasingly limited.

Limited bus layover and bus stop space

Bus layover space in the inner city is limited, with a range of on-street spaces already dedicated for buses including sections of Alice Street, William Street, Queen's Wharf Road and Wickham Street as well as off street space at Woolloongabba (South East Busway), Countess Street (INB), the QSBS, Centenary Place, Warner Street and Ballow Street (both Fortitude Valley), Hope Street (West End), and Ernie's roundabout (Herston). This is now limiting the ability of TransLink to provide for more terminating bus services in the Brisbane CBD.

Kerb space in the CBD is at a premium with different functions such as commercial and passenger loading, parking, taxi ranks, bus stops and bus layover, CityCycle and emergency services all competing for kerb space.

There are many bus stops in the CBD, particularly on Adelaide Street, Elizabeth Street, Ann Street, George Street and Queen Street. Due to competing demands for kerb space there is little available of kerb space for additional bus stops.

Demand for bus services

Analysis supplied by TransLink for the period January to March 2012, indicated that 45 per cent of services that terminated in the Brisbane CBD in the morning peak had total boardings which exceeded seat capacity. Of the prepaid morning peak rocket services that terminated in the CBD in the same period, 29 per cent of services had total boardings that exceeded seating capacity[11].

Although there has been a recent softening in demand for public transport, overcrowding remains a problem on some key routes.

[11] Independent Review of Cross River Rail, p28

Bus travel time reliability

Overall the bus network is currently experiencing high levels of demand with congestion occurring on several routes causing delays and reliability concerns. Some parts of key bus corridors, such as the Woolloongabba (busway) junctions, Mater Hill Station, the busway intersection with Melbourne Street and the Cultural Centre-Victoria Bridge-North Quay connection on South East Busway could now be considered over-capacity in peak times.

The bus capacity issues and consequent congestion on the busway and the CBD streets means that unreliable bus travel times are experienced for bus journeys to and from the CBD during the commuter peaks.

3.4 Ferry services – operations and performance

Passenger ferries cater for a very small component of trips within the South East Queensland Region accounting for less than 2 per cent of total daily (weekday) public transport trips.

CityCats operate between Northshore Hamilton and UQ, generally every 15 minutes in each direction throughout the day (Monday to Sunday). City Ferries operate cross river and inner city distributor type ferry services within the study corridor generally every 10-30 minutes in each direction. The number of ferries operating per hour are shown in
Table 3-22.

Table 3-22 Ferry services in the Inner City

Bus services	Peak Direction (one way)	Monday – Friday off peak (one way)	Saturday	Sunday
CityCat	7	4	4	4
Cross River Ferry/ inner City Ferry (Holman to Eagle Street to Thornton Street)	4	4	4	4
CityHopper (Sydney Street to North Quay)	2	2	2	2
Total ferries per hour (each way)	13	10	10	10

The main ferry terminals within the study area are at Riverside and Eagle Street (the main terminals for the eastern part of the CBD), QUT (for the southern CBD) and North Quay (for the north-western part of the CBD.

The ferry terminal nearest to Central Station is Riverside, located on Eagle Street some 550m to the south-east of Central Station. There is little interchange function between ferry and rail. The nearest to ferry terminal to Queen Street Bus Station is North Quay, located approximately 200m to the west. Due to the walk distances involved ferry-rail interchange is very limited.

The number of passengers using the ferry system during the morning and evening peak periods out of the daily 24 hour total of 8,842 passengers is shown in **Table 3-23**. This table also illustrates that about 50 per cent of ferry passengers use the ferry system during the peak periods – that is four hours of a 24 hour day.

Table 3-23 Base year (2012) peak period ferry users

Period	Ferry users
AM two hour peak (7.00am to 9.00am)	2,900 (26.1%)
PM two hour peak (4.00pm to 6.00pm)	2,900 (26.1%)
Daily	11,100

Source: BaT Project Model

3.5 Pedestrian and bicycle facilities

This section describes the regional and local pedestrian and cycle network within the study corridor. Existing pedestrian links have been mapped where they intersect with the rail network to enable a description of the wider cross corridor pedestrian connectivity to be made. A more detailed description of pedestrian access and connectivity at stations is also included based on site visit observations.

3.5.1 Pedestrian and cycle networks

Pedestrian and cycle facilities in the study corridor are centred on the Brisbane CBD catering to both leisure and commuter based trips. In the Brisbane CBD, the footpath network generally follows the road network which is characterised by a grid pattern, with east-west roads spaced approximately 100m apart and north-south roads spaced approximately 220m apart. This road and footpath network pattern results in frequent intersections across the CBD in a north-south direction, but long city blocks running in an east-west direction with few mid-block crossings. In some parts of the city, cross-block links create additional pedestrian only paths through these long city blocks. Examples include the Brisbane Arcade between Queen Street and Adelaide Street and Post Office Lane between Elizabeth Street and Queen Street. The walking environment along the footpath network in the CBD ranges from generous and wide to narrow, cluttered and congested.

Brisbane City Council pedestrian counts suggest that the top five intersections for pedestrian movements in the city centre are clustered near to Central Station. These five represent 45 per cent of the total morning peak city centre pedestrian movements. The intersection of Edward and Adelaide Street recorded the highest pedestrian movements, explained by its strategic location proximate to Central station, QSBS and KGS Busway Stations, Adelaide Street bus stops and Queen Street Mall.

The Brisbane City Council data also identifies pedestrian activity and traffic incidents. This reveals that nearly half (43 per cent) of all pedestrian incidents occurred along three streets – Adelaide Street (19 per cent), Ann Street (14 per cent) and Edward Street (10 per cent). These streets carry the highest level of pedestrian traffic and form key connections between the city centre and the major public transport hubs of Central Station and Adelaide Street bus stops.

A pedestrian assessment was carried out in 2014 for the Project on a number of streets of relevance to the Project's CBD infrastructure. This study assessed pedestrian numbers and queuing to determine the LoS on key streets and intersections, including:

- George Street, between Elizabeth and Alice streets
- Roma Street
- the intersections of George Street with Elizabeth, Charlotte, Mary, Margaret and Alice streets
- the intersections of Roma Street with Albert, Hershel and George streets.

During the morning peak hour peak (8.00am to 9.00am) the study found that:

- pedestrian movement was heaviest travelling south along the northern side of George Street, resulting in significant pedestrian congestion (LoS E and F) on the north-east corners of all intersections between Elizabeth Street and Alice Street
- heavy pedestrian movements on streets near to the Roma Street Transit Centre, including up to 1,200 pedestrians along the northern side of Roma Street
- footpaths and crossings near to the Roma Street Transit Centre were able to accommodate pedestrian movements without causing any crowding issues
- safety issues were observed, including 133 illegal crossings on Roma Street
- pedestrian numbers heading southbound on Roma Street and George Street were greater than those heading southbound on Albert Street, indicating that more people are likely to use the southern access from the Roma Street Transit Centre rather than the northern access.

Key off-road cycle links that are generally shared with pedestrians in the south and north areas of the study corridor are shown in **Figure 3-13** and **Figure 3-14**. This includes a range of rail and busway corridor crossings which are detailed in the **Table 3-24**.

Table 3-24 Pedestrian access across rail and busway in the central study corridor

Location/ description	Crossing type and width	Comments
Victoria Park land bridge	22m to 27m pedestrian/ cycle over rail bridge	This bridge is a well used 'green bridge' for pedestrians and cyclists linking Spring Hill with Herston over the Exhibition Railway lines and the ICB.
Brisbane Grammar School pedestrian bridge	1.5m pedestrian over rail bridge	This is a narrow footbridge over a long section of railway yards and the ICB adjacent to Brisbane Grammar School linking the school with playing fields to the north.
Brisbane Grammar School pedestrian bridge	Pedestrian over rail bridge	This is a footbridge accessed by stairs over the railway and Northern Busway from the Grammar Schools to an ancillary Grammar School building. It is not suitable as a public route.
College Road (north of Roma Street Station)	30m wide road over rail (and cycleway) bridge	This bridge spans both the exhibition railway line and the 4m wide shared use Normanby Link path. The bridge itself includes six traffic lanes and two footways each 3 m+ in width. There are no formal cycle lanes on College Road.
Countess Street (west of Roma Street Station)	Rail over road bridge with 23m wide road underneath	This rail over road bridge spans five traffic lanes and footpaths on each side of the carriageway. There are no cycle lanes on Countess Street.
Caxton Street Link (west of Roma Street Station)	8m wide pedestrian over rail bridge	This is a new pedestrian bridge over the Inner Northern Busway and the western and southern railway lines, west of Roma Street Station providing a link from Caxton Street and the Suncorp Stadium precinct to Roma Street and the Transit Centre precinct.
Bicentennial Pedestrian/ cycle way (north of South Brisbane Station)	Pedestrian/ cycleway underneath Merivale (rail) Bridge	This is a major shared use path for both cyclists and pedestrian which runs parallel to the river connecting the CBD with western suburbs including UQ.
South East Freeway Bikeway	Cycleway over the south east busway.	Cycleway runs parallel to the South East Freeway and spans over a number of major roads and the South East Busway.

Location/ description	Crossing type and width	Comments
Annerley Road (north of Park Road Station)	Two rail over road bridges	Four general traffic lanes, two cycle lanes exist under this rail bridge along with footpaths on both sides of the carriageway.
Merton Road pedestrian bridge (north of Park Road Station)	2m wide pedestrian over rail bridge	This bridge is only for pedestrian and cyclist use connects Merton Road to the north with Boggo Road to the south.
Park Road and Boggo Road Station pedestrian bridge	2m wide pedestrian over rail bridge	This pedestrian bridge across the railway and busway connects Park Road bus and train station with Quarry Street to the north and Boggo Road to the south.

Key cycle and pedestrian only routes in study corridor include:

- routes through the City Botanic Gardens
- Bicentennial bikeway (under the Riverside Expressway)
- the Normanby and Victoria Park bikeways (including the Victoria Park Land Bridge)
- the Riverside bikeway and boardwalk parallel to Eagle Street
- the Goodwill Bridge
- the Kurilpa Bridge
- South East Bikeway, known as the V1 (cycles only).

TMR proposes to construct The North Brisbane Bikeway that will link Brisbane's CBD to the northern suburbs. This project will be completed in stages. The following stage is planned to be complete by the end of 2015:

- A 710m pathway from Victoria Park at Gilchrist Avenue, Herston to O'Connell Terrace, Bowen Hills, via the heritage listed Victoria Park, RNA showgrounds and Bowen Park.
- This stage will utilise the existing underpass (culvert) at Bowen Bridge Road.
- This stage will be a dedicated bikeway.

This stage will be delivered in two sections. Section 1 is from Gilchrist Avenue to Gate 6 of the RNA Showgrounds. Section 2 is from Gate 6 of the RNA Showgrounds to O'Connell Terrace.

Data from Brisbane City Council indicates that within the study corridor there are currently heavy cycling movements in Roma Street, Roma Street Parkland, Adelaide Street (fed primarily from the Bicentennial Bikeway, which extends to Newstead in the north-west and Toowong in the south-west) and Edward Street south.

LEGEND

- Existing busway station
- Existing rail station
- Existing busway
- Existing rail line
- Off road bicycle paths and on road bicycle lanes
- Study corridor

Project Infrastructure

- Underground station
- Dutton Park Station (upgraded)

Alignment

- Above ground
- Underground

Aerial Photo: Brisbane City Council 2012

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 3-13

Existing cycle network - south

N

0 0.25 0.5
Kilometres
1:15,000 (at A4)
Projection: GDA 1994 MGA56

G:\QENV2\Projects\QE06863\Spatial\ArcGIS\Figures\Final_EIS_Figures\04_Transport\Tech_Report\TranspTechRpt_Figure3-X_Existing_PedestrianCycle_Network_MapBk.mxd Date: 12/08/2014

LEGEND

- Existing busway station
- Existing rail station
- Existing busway
- Existing rail line
- Off road bicycle paths and on road bicycle lanes
- Study corridor

Project Infrastructure

- Underground station

Alignment

- Above ground
- Underground

Aerial Photo: Brisbane City Council 2012

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 3-14

Existing cycle network - north

N

0 0.25 0.5
Kilometres
1:15,000 (at A4)
Projection: GDA 1994 MGA56

G:\QENV2\Projects\QE06863\Spatial\ArcGIS\Figures\Final_EIS_Figures\04_Transport\Tech_Report\TranspTechRpt_Figure3-X_Existing_PedestrianCycle_Network_MapBk.mxd Date: 12/08/2014

3.5.2 Dutton Park Station pedestrian and cycle facilities

Pedestrian access to Dutton Park Station platforms are via ramps from the Annerley Road Bridge with a width of approximately 1.8m. A second access exists for platform one from Kent Street. The only wheel chair access is via the ramps to both platforms, with no lifts provided at this station.

The major pedestrian constraint at present is the width of footway on the eastern side of Annerley Road, where the northbound platform access ramp joins the footway. At this point, the footway is less than 2m wide. This footway is the main route for cyclists between the UQ and the PA Hospital/ South East Bikeway, as well as catering for walk trips to the station.

To the north, the residential catchment is accessed directly from the eastern side of Annerley Road with good access to the station.

To the south-east, access to the station is via Annerley Road, with formal direct road crossing opportunities around 130m and 350m to the south.

To the south-west, access to the station is more difficult, with a three stage pedestrian crossing at Annerley Road and Noble Street. This then leads to a narrow footway (less than 2m wide) along the western side of Noble Street where the residential catchment is located.

Dutton Park is also at the crossroads of several cycle routes, namely:

- an existing cycle route between Annerley Road/ Gladstone Road and the UQ via the Eleanor Schonell Bridge
- a strategic cycle route between Dutton Park Station at Annerley Road and the PA Hospital/ Boggo Road precinct and onwards to the South East Bikeway via a bridge beside the busway overpass over Ipswich Road.

The key issue for cycling in this area is the missing links in the cycle network, particularly between the intersection of Annerley Road/ Gladstone Road and the intersection of Annerley Road/ Rusk Street/ Cornwall Street. The Annerley Road bridge over the railway line is a particular pinch point where the PA Hospital/ South East Bikeway link meets Annerley Road. The lack of a safe, direct convenient crossing from the west side of Annerley Road/ Gladstone Road intersection (ie from Eleanor Schonell Bridge) to the eastern side of the railway line is considered the most important strategic missing link.

3.5.3 Park Road and Boggo Road rail and busway station – pedestrian and cycle facilities

All Park Road Station platforms and busway platforms are connected by way of lifts and stairs to a pedestrian overbridge which provides connections to Boggo Road in the south and Quarry Street in the north. The pedestrian network around the station precinct is somewhat disjointed, disconnected and constrained by the presence of three railways.

There is a second pedestrian overbridge 70m to the west of the main station access bridge linking Merton Road and Boggo Road (adjacent to Dutton Park School).

To the north of the station, pedestrian access is predominantly by way of footpaths alongside residential streets. This area of the station catchment is predominantly low density residential. The station itself is at the end of Quarry Street, a small cul-de-sac with no through vehicle connection and provides a somewhat hidden ‘front entrance’ to the station.

To the east, access to the station is via an off-road pedestrian path between Quarry Street and Elliott Street, which is narrow and unattractive with little natural surveillance and poor quality footway. At present there is no direct pedestrian or cycle access between the station and the major employment generating PA Hospital, only 500m south-east due to the presence of the railways and lack of crossings.

Access to the south is available via the station's pedestrian overbridge and through the Boggo Road precinct.

There is a range of cycle routes and paths around the station. To the west of the station, cycle provision already exists along Annerley Road in the form of formal cycle lanes. At the top of Annerley Road (southern end) these cycle lanes connect to the Eleanor Schonell (cycle, pedestrian and bus) Bridge across to UQ.

To the south-east of the station, a cycle way exists adjacent to the Eastern Busway, in the vicinity of the PA Hospital. This cycleway ends just north of Dutton Park Station with no dedicated facilities between this cycleway and the Eleanor Schonell cycleway on the opposite side of Annerley Road, towards UQ.

3.5.4 Woolloongabba Busway Station pedestrian and cycle facilities

Woolloongabba Busway Station is surrounded on all four sides by heavily trafficked arterial roads, namely Stanley Street, Vulture Street, Main Street/ Ipswich Road and the Pacific Motorway (M3). With no grade separated crossings (except for under and over the M3), all trips to the surrounding precincts involve crossing one of these wide heavily trafficked roads at signals.

To the south, an existing mid-block pedestrian crossing provides access from the busway station to the Stanley Street retail strip albeit there are six lanes of traffic to cross (including a service road).

To the east, access to the Logan Road commercial precinct is by way of a three stage crossing of Ipswich Road/ Main Street and Stanley Street traversing 14 lanes of traffic, making for an intimidating walk trip. There is also a lack of pedestrian signals on the southern side of Ipswich Road/ Vulture Street intersection. The alternative is to navigate around all three other sides of the intersection.

To the west there is no footpath on the northern side of Stanley Street, west of Leopard Street/ southbound Pacific Motorway on-ramp. This means all pedestrians heading west from the Woolloongabba precinct, including the busway stations, must cross to the south side of Stanley Street to access Stanley Street (west) and the Mater Hospital precinct.

Walking routes during events at the Gabba Stadium are constrained. The Police and traffic control officers close Vulture Street, Stanley Street and marshal pedestrian and vehicle activity on and across Ipswich Road and Main Street to safely accommodate large numbers of pedestrians as well as event shuttle buses.

The surrounding network of arterial roads is relatively hostile to cyclists that lack cycle lanes or off-road paths, with the exception of a short section of on-road cycle lane on Stanley Street. Also of importance is the presence of the South East Bikeway (on the western side of the Pacific Motorway) which is a good quality, well used cycle link between the southern suburbs and the Brisbane CBD (via the Goodwill Bridge). Access from the South East Bikeway to the Woolloongabba precinct is only via the arterial road network and provides a lower level of service to cyclists.

3.5.5 George Street precinct pedestrian and cycle facilities

The land use along and adjacent to George Street (south-east of Elizabeth Street) is dominated by offices and particularly Government buildings. George Street also provides a pedestrian linkage to the QUT Gardens Point Campus that is located further south-east of George Street. Office buildings that front on to George Street typically have entrance foyers and cafes, some of which have outdoor dining facilities. George Street provides pedestrian access to land uses, typically offices, located on Charlotte Street, Mary Street and Margaret Street. An entrance to the major retail land use of the Myer Centre and hence connectivity to the Queen Street Mall and the QSBS is located close to the intersection of George Street with Elizabeth Street.

This land use and connectivity leads to high weekday pedestrian usage of George Street as pedestrians access offices and the two major trip generators, the Queen Street Mall and the QUT Gardens Point Campus.

Figure 3-15 Intersections of George Street with Elizabeth Street and Mary Street

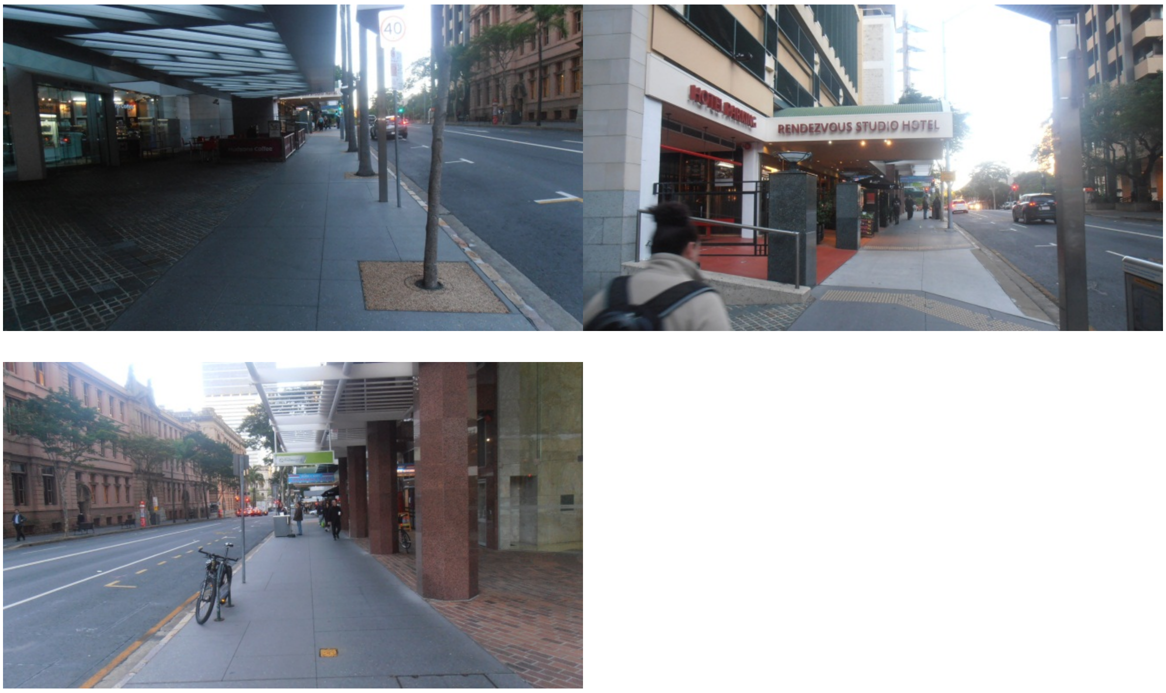
Effective pedestrian widths

On site measurements show that the existing kerb to building width of the footpath is approximately 4.5m between Elizabeth Street and Charlotte Street. The building to street furniture width (including outdoor dining facilities) is approximately 3m. The clear pedestrian width is reduced to 1m due to significant activity associated with outdoor dining and also queues of people to the Frisky Goat and Cool Beans cafés during the morning peak period. This is illustrated in **Figure 3-16** prior to the morning peak period.

Figure 3-16 Footpath between Elizabeth Street and Charlotte Street

Between Charlotte Street and Mary Street the total footpath width is 3.5m and 2.4m taking account of street furniture. In this section a clear pedestrian width of 2.4m is generally maintained as it is not typically impacted by other activities such as queuing to shops and cafes due to additional space available beyond the total footpath width of 3.5m. Refer **Figure 3-20**.

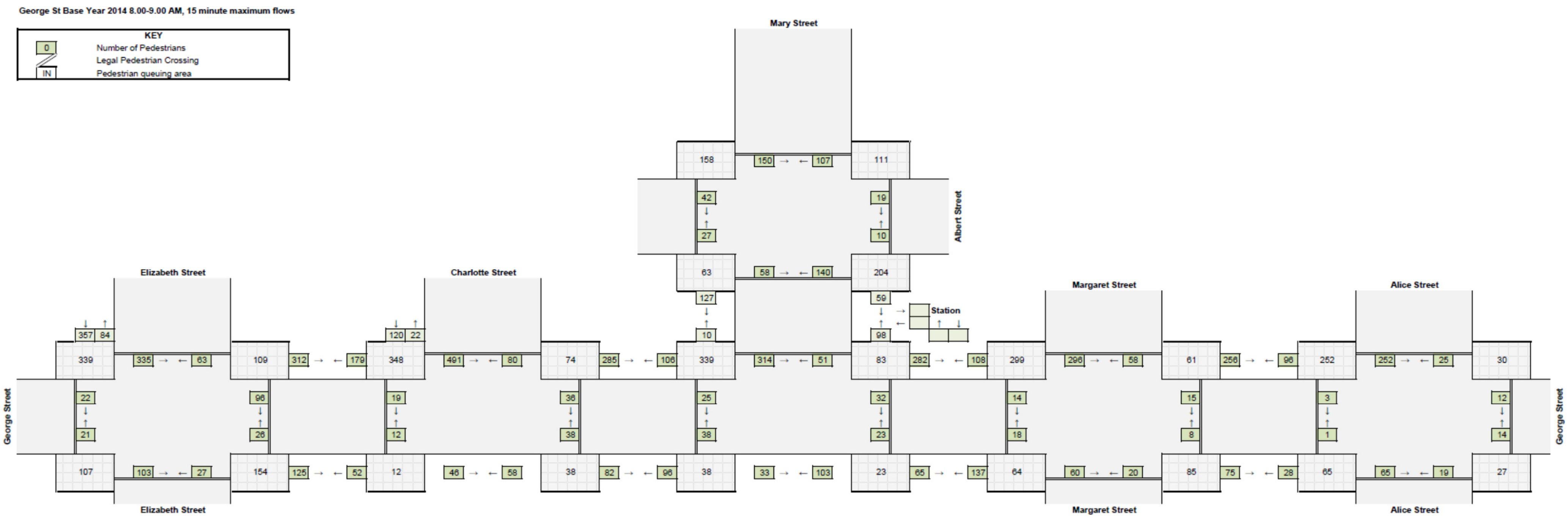
Figure 3-17 Footpath between Charlotte Street and Mary Street



Note: total width 3.5m, width less street furniture 2.4m. The total width is to the ‘Hudsons’ hoarding, the red area of the Rendezvous Studio Hotel, and the columns associated with the Capitol Hill building. Street furniture is limited to trees, roads signs and rubbish bins)

Figure 3-18 and **Figure 3-19** present the pedestrian volumes on George Street walkways and pedestrian crossings during the peak 15 minutes of the am and pm peak hours respectively. These figures also present the number of pedestrians in queuing areas at intersections.

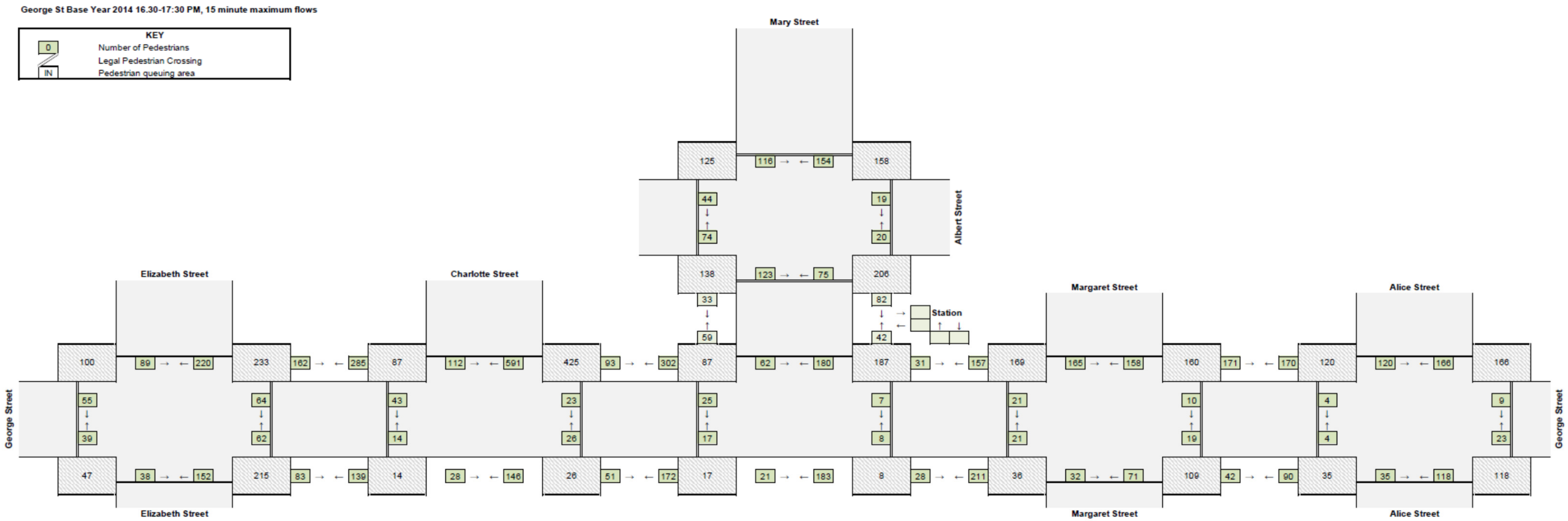
Figure 3-20 and **Figure 3-21** present the consequent LoS for pedestrians on George Street for the am and pm peak hours respectively.



BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 3-18

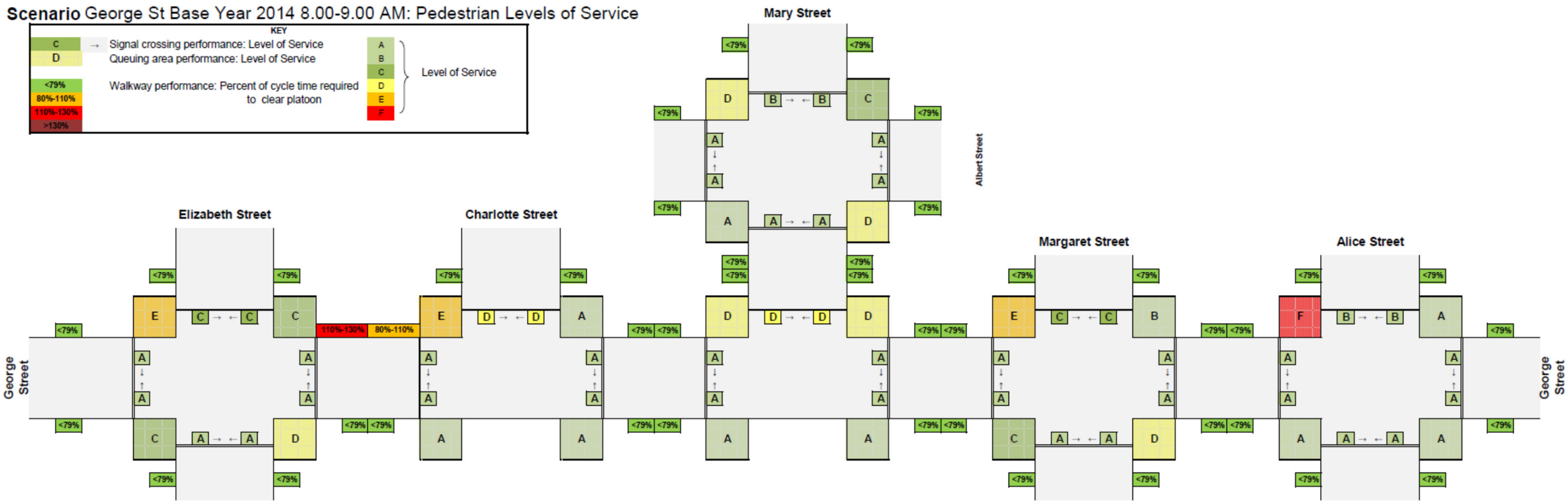
George Street current (2014) 15 minute maximum pedestrian volumes – AM peak hour



BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 3-19

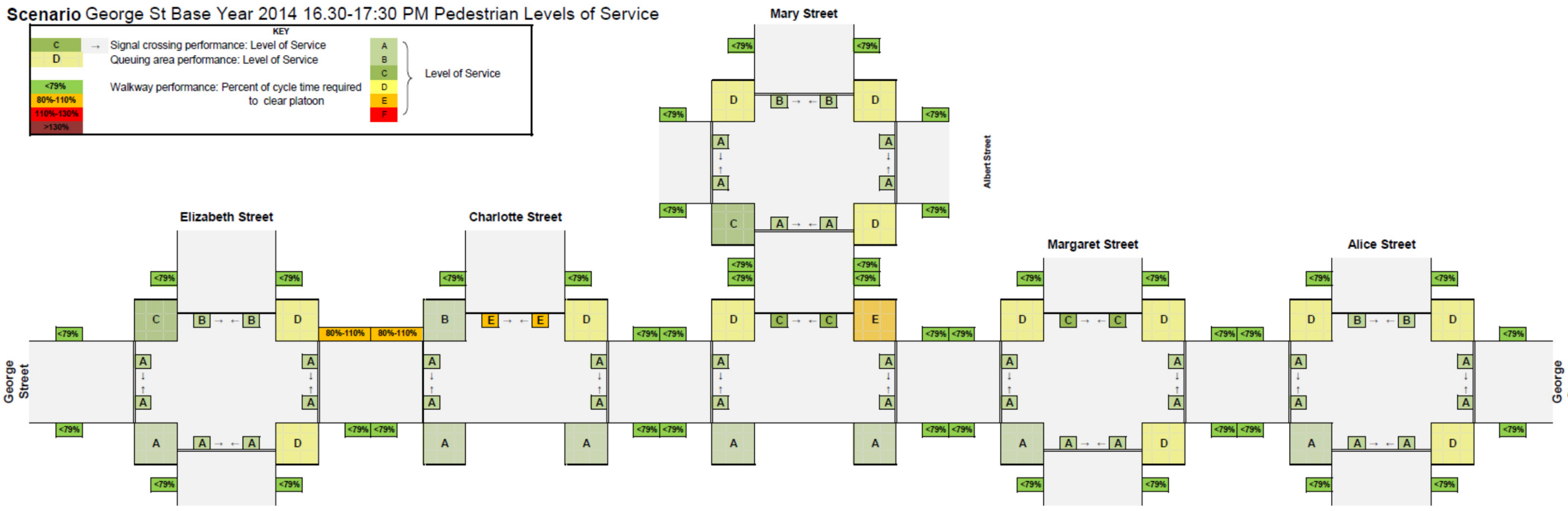
George Street current (2014) 15 minute maximum pedestrian volumes – PM peak hour



BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 3-20

George Street current (2014) pedestrian level of service – AM peak hour



BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 3-21

George Street current (2014) pedestrian level of service – PM peak hour

These figures illustrate that there is a significant high demand for footpath space along George Street that creates pedestrian LoS of E and F:

- use of the northern side (CBD side) is greater than the southern side (river side)
- almost 500 pedestrians in the maximum 15 minute period in the morning peak use the northern footpath between Elizabeth Street and George Street. This compares with around 175 pedestrians using the southern footpath
- there are high levels of pedestrians travelling northbound towards Queen Street Mall during the PM peak and southbound towards government office and QUT during the AM peak
- whilst pedestrian movements are tidal the contra direction creates friction and is about a third of the volume of the peak direction
- pedestrian activity in the pm peak is a little less than in the morning peak period
- the traffic signals generate dense queues of pedestrians waiting to cross the intersecting roads of George Street. These queues generate dense platoons of pedestrians walking along the northern footpath. There is minimal relief to this characteristic between Elizabeth Street and Alice Street
- the walkway between Elizabeth Street and Charlotte Street is also operating over capacity (walkway platoon clearance measure greater than 80 per cent)
- the footpath on the northern side of George Street between Elizabeth Street and Margaret Street is congested, with queues potentially interfering with pedestrians' ability to cross at the lights
- pedestrian movement was heaviest on the northern (CBD) side of George Street, resulting in LOS E and F on the north-east corners of intersections between Elizabeth Street and Alice Street
- queuing areas along the northern sides of intersections perform at LoS F – requiring between 5 to 15m^2 overflow area for people to queue comfortably.

Cycle facilities

There is minimal provision for cyclists on George Street between Elizabeth Street and Alice Street. Bicycle awareness road markings are provided on this section of George Street but there are no on-road or off-road cycle lanes. A CityCycle station is located at the intersection of George Street with Mary Street.

3.5.6 Roma Street Station pedestrian and cycle facilities

Walking is a major means of access to Roma Street Station with approximately 40 per cent of passengers accessing the rail network and busway station at Roma Street via a walk trip. The majority of the remaining 60 per cent are passengers that interchange between rail and bus services and do not exit the station. Observations during the morning peak revealed some issues with the current pedestrian network and access arrangements around the station.

It was estimated, from site observations that over 90 per cent of passengers exiting Roma Street Station were bound for destinations to the south with the remaining 10 per cent exiting to the north via the access near to Platform 10.

The main access routes to Roma Street Station are along George Street or along and across Roma Street to the south-east. A secondary access routes provides a pedestrian connection via platform 10 to Roma Street Parklands and Albert Street. From Albert Street, Spring Hill and the King George Square precinct of the CBD can be walked to. A further description of the main access routes is outlined as follows:

- To the south George Street is a key link from the station to the major employment areas to the south of the station including the legal and administration precinct. Access to George Street is possible only by crossing Roma Street by one of three means – an at-grade signalised crossing at Makerston Street, jaywalking 'mid-block', or by utilising the existing overbridge.

- Roma Street is the main access route to the west of the station (including the areas around Petrie Terrace and Caxton Street) as well as land uses immediately east of the station including around King George Square. While lightly used in general, this route is heavily used when events are held at Suncorp Stadium. This route is relatively unattractive as it is flanked by car parks, busy roads and rail/ busway bridges, with no shelter/shade and with narrow footways (less than 2m effective width in sections).
- To the east of the station, along Roma Street itself, there were few observed pedestrians. This could be attributed to the relatively poor quality of the walking environment between the station and Albert Street/ King George Square (via Roma Street). The route has very limited street activity; it is flanked by building 'rear ends' and blank facades and suffers from a lack of shelter/shade.
- To the north, the key issue identified was the lack of clear, direct access to Spring Hill despite its proximity.

The key pedestrian access issues observed at Roma Street frontage of the station:

- lack of clear, direct, safe and legible pedestrian route from the station entrance and George Street, a key route and desire line for pedestrians
- significant barriers at the station entrances (to Roma Street) including narrow doorways and stairs, indirect routing, poor orientation location of landscaping and kiosks etc.
- significant barriers immediately beyond the station entrances (to Roma Street), namely the level difference between the station concourse level and the street level (approx 1m), lack of a direct *Disability Discrimination Act 1992* compliant route and relatively narrow pavement width/ limited waiting space and several obstructions including post boxes and telephone boxes
- significant traffic barrier formed by Roma Street itself and the lack of direct crossing facilities. The existing signalised crossing is not on the key pedestrian desire line and requires pedestrians to undertake a 50m to 60m detour if walking towards George Street. The existing overbridge is not well signposted from within the station, requires two level changes (up escalators, and then down stairs) and indirect routing.
- high levels of jaywalking immediately in front of station were observed as a result of the above route deficiencies
- a key barrier is the intersection of George Street and Herschel Street. In the morning peak large numbers of pedestrians gather on the north-western corner of the intersection and are subject to long delays at the intersection due to the complicated signal phasing arrangement. The bus right turn is in direct conflict with the aforementioned pedestrian crossing and any time allocated to the bus phase results in further delays for pedestrians. This leads to pedestrian frustration and jaywalking. When the pedestrian phase is activated the timing is very short, at some 10 seconds of green time and a further 10 seconds of clearance time. The heavy left turn vehicle flow from George Street into Herschel Street is in direct conflict with the path of the pedestrians crossing during the short green time leading to both driver and pedestrian frustration. The current intersection layout and signal timings inevitably causes delays, congestion and potential road safety concerns for all road user – ie both George Street left turning traffic, buses on George Street and pedestrians on the western side of George Street.

The major arterial roads surrounding Roma Street Station have varying degrees of provision for cyclists. For example, Roma Street in front of and west of the station has no on-road cycle provision, however east of the station there is a short section of marked on-road cycle lanes.

A two-way segregated cycleway (Copenhagen Lane) on George Street between Herschel Street and Turbot Street provides access to Tank Street and the Kurilpa pedestrian/ cycle Bridge. The Bicentennial Bikeway (under the Riverside Expressway) at Herschel Street, is located some 150m from Roma Street Station. The nearby Normanby cycle link connects to Roma Street Station through Roma Street Parklands to the northern suburbs. This is an important cycle route that is part of an off road connection from Roma Street to Herston.

No dedicated bicycle parking is provided at Roma Street Station. However, the Brisbane City Council-run King George Square cycle centre is approximately 400m to the south-east and a CityCycle bike hire station is located outside the station entrance on Roma Street.

Pedestrian volumes and level of service – Roma Street entrance

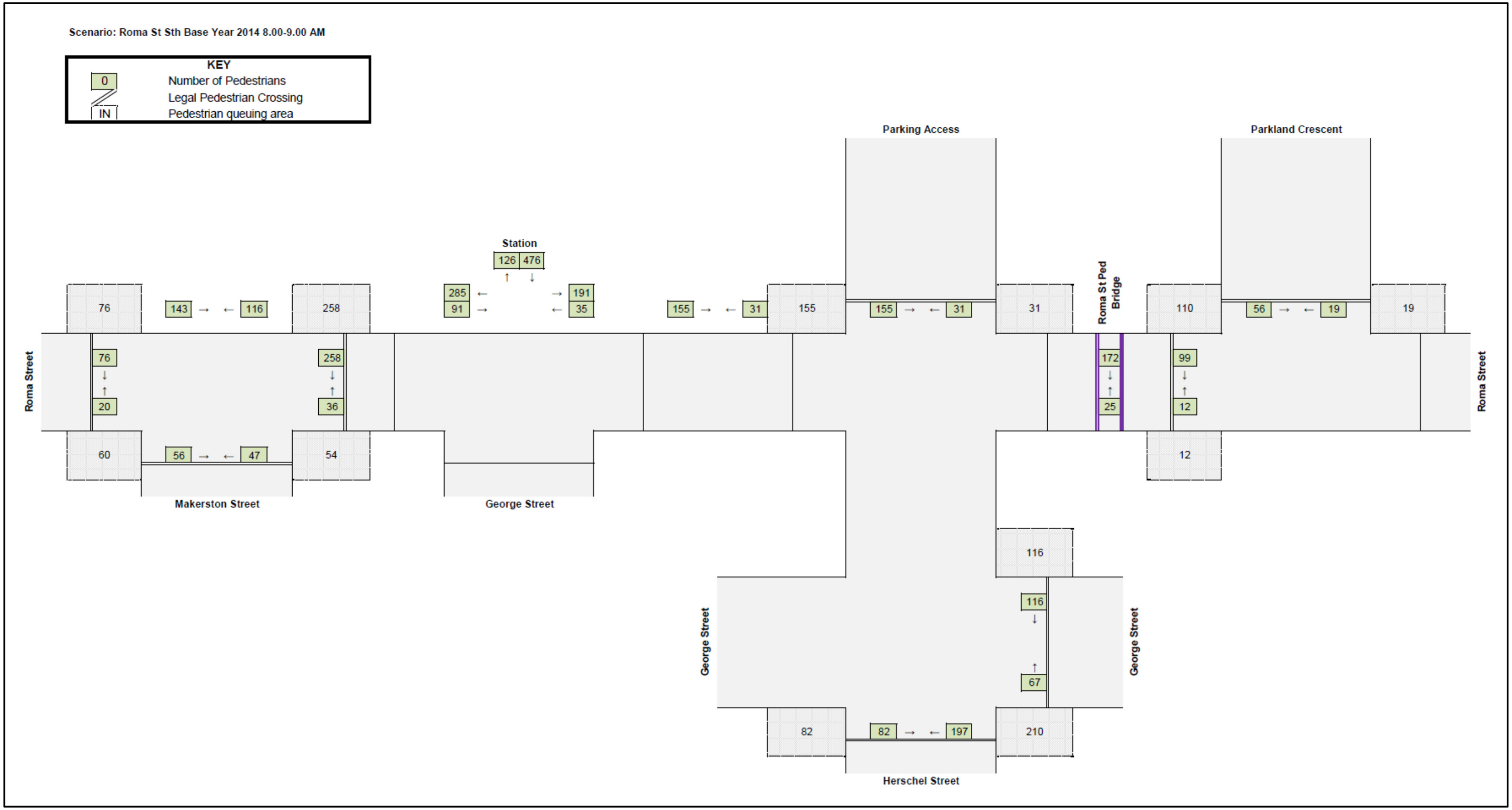
Figure 3-22 and **Figure 3-23** present the pedestrian volumes on Roma Street walkways and pedestrian crossings during the peak 15 minutes of the am and pm peak hours respectively. These figures also present the number of pedestrians in queuing areas at intersections.

Figure 3-24 and **Figure 3-25** present the consequent LoS for pedestrians on Roma Street for the am and pm peak hours respectively.

Pedestrian volumes and level of service – Albert Street entrance

Figure 3-26 and **Figure 3-27** present the pedestrian volumes on Albert Street walkways at the secondary entrance of Roma Street Station and pedestrian crossings during the peak 15 minutes of the am and pm peak hours respectively. These figures also present the number of pedestrians in queuing areas at intersections.

Figure 3-28 and **Figure 3-29** present the consequent LoS for pedestrians on Albert Street walkways at the secondary entrance of Roma Street Station for the AM and PM peak hours respectively.



BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 3-22

Roma Street current (2014) 15 minute maximum pedestrian volumes (Roma Street entrance) – AM peak hour

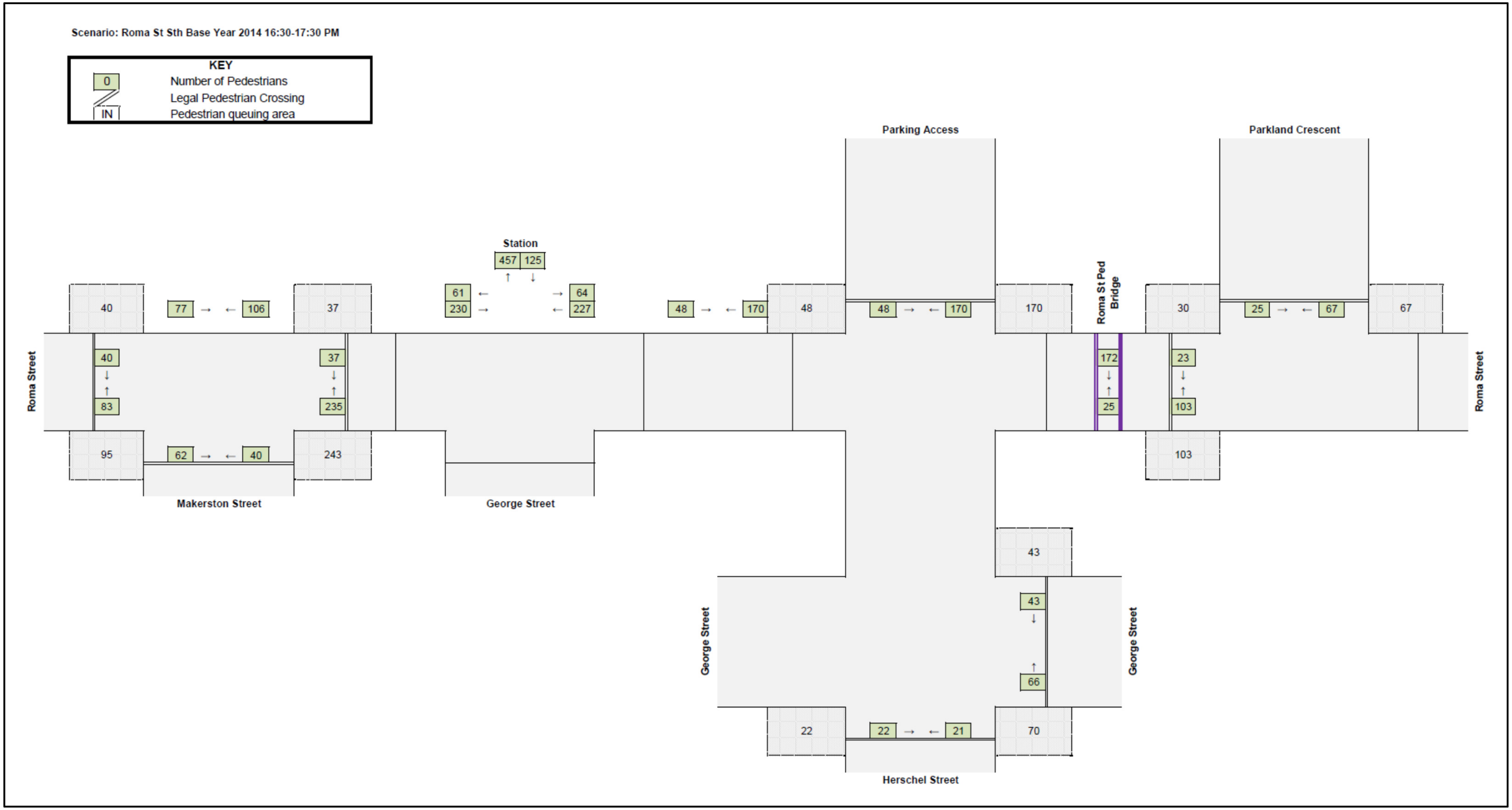
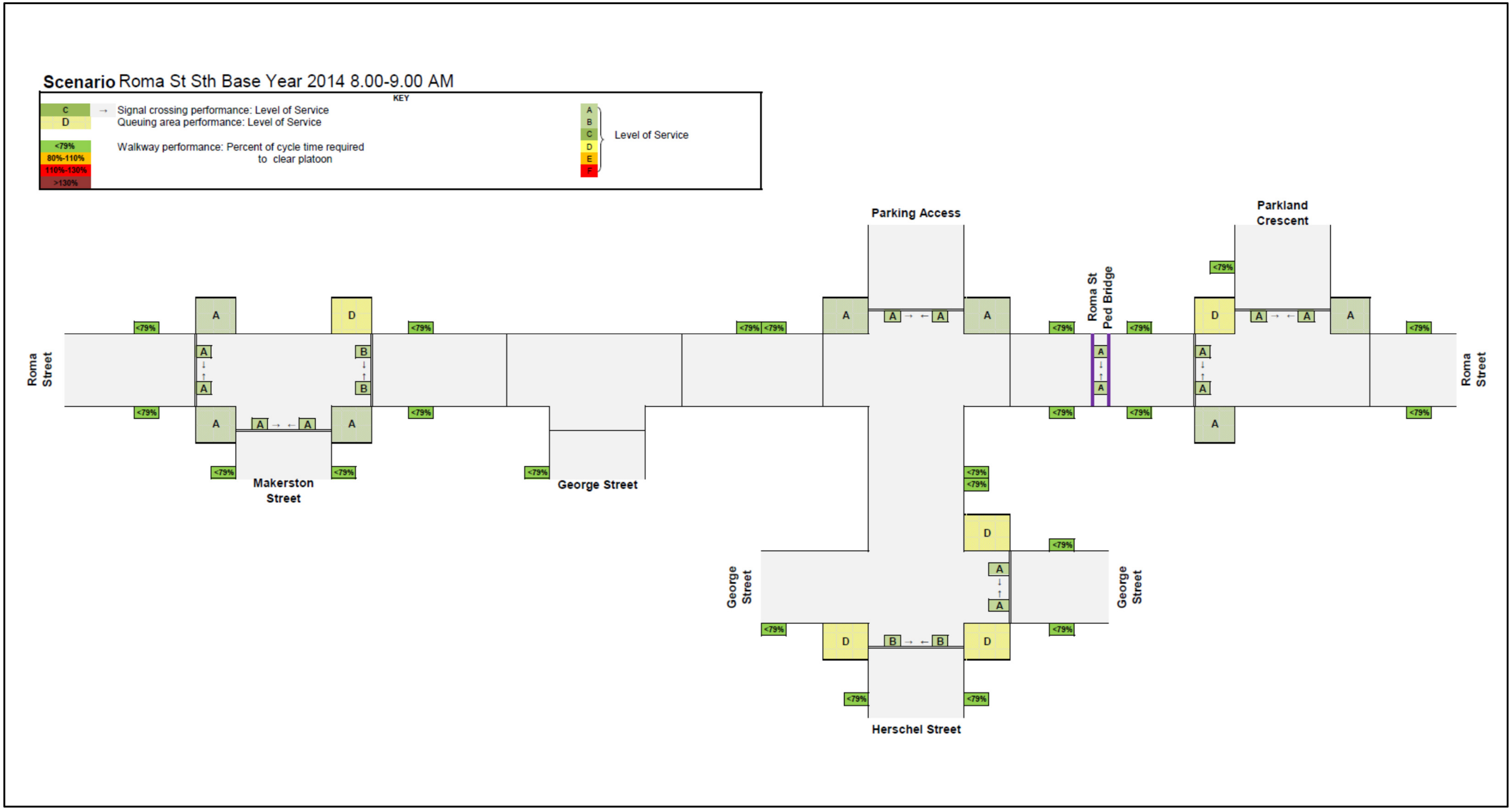


FIGURE 3-23

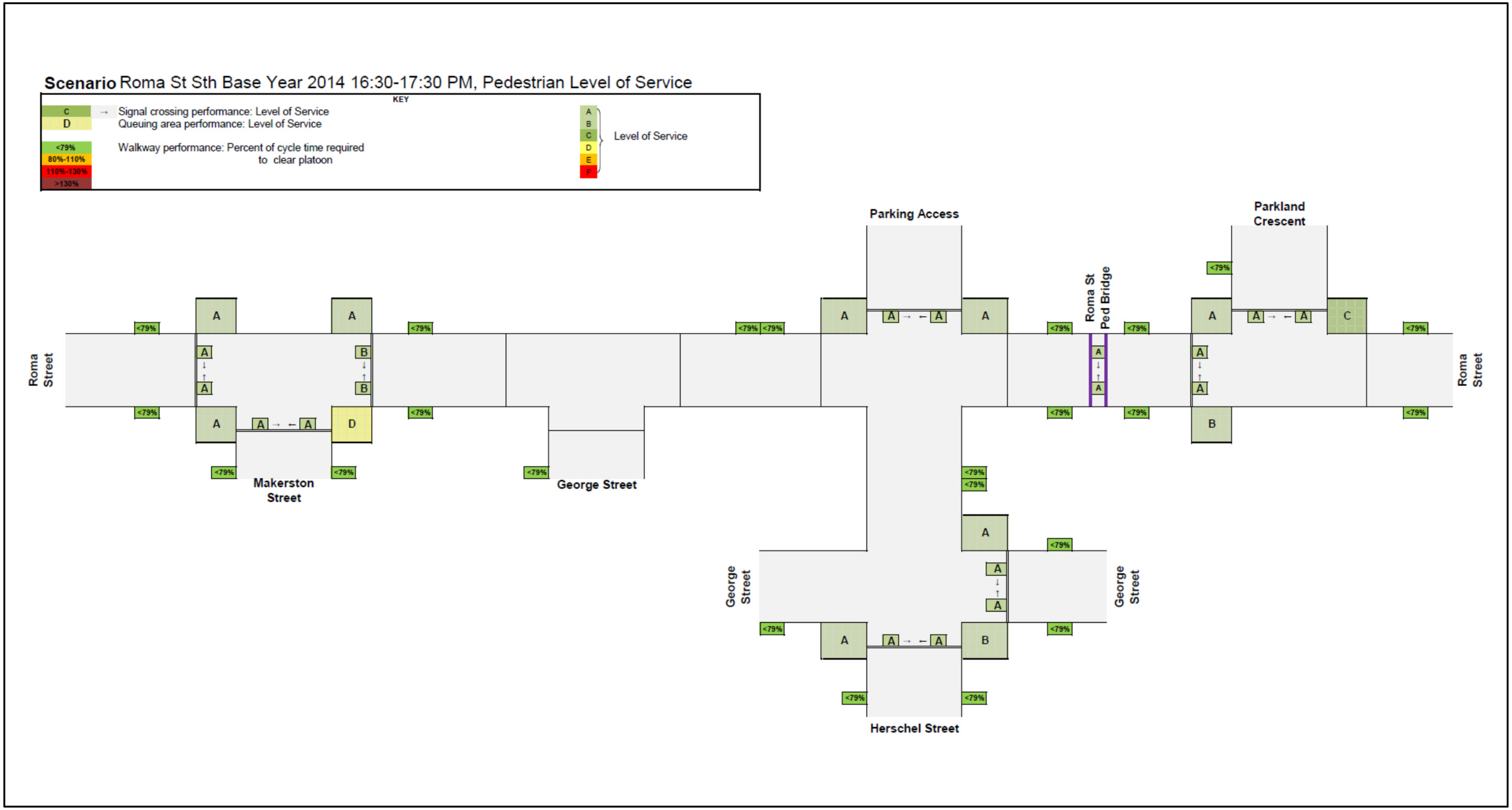
Roma Street current (2014) 15 minute maximum pedestrian volumes (Roma Street entrance) – PM peak hour



BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 3-24

Roma Street current (2014) pedestrian level of service (Roma Street entrance) – AM peak hour



BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 3-25

Roma Street current (2014) pedestrian level of service (Roma Street entrance) – PM peak hour

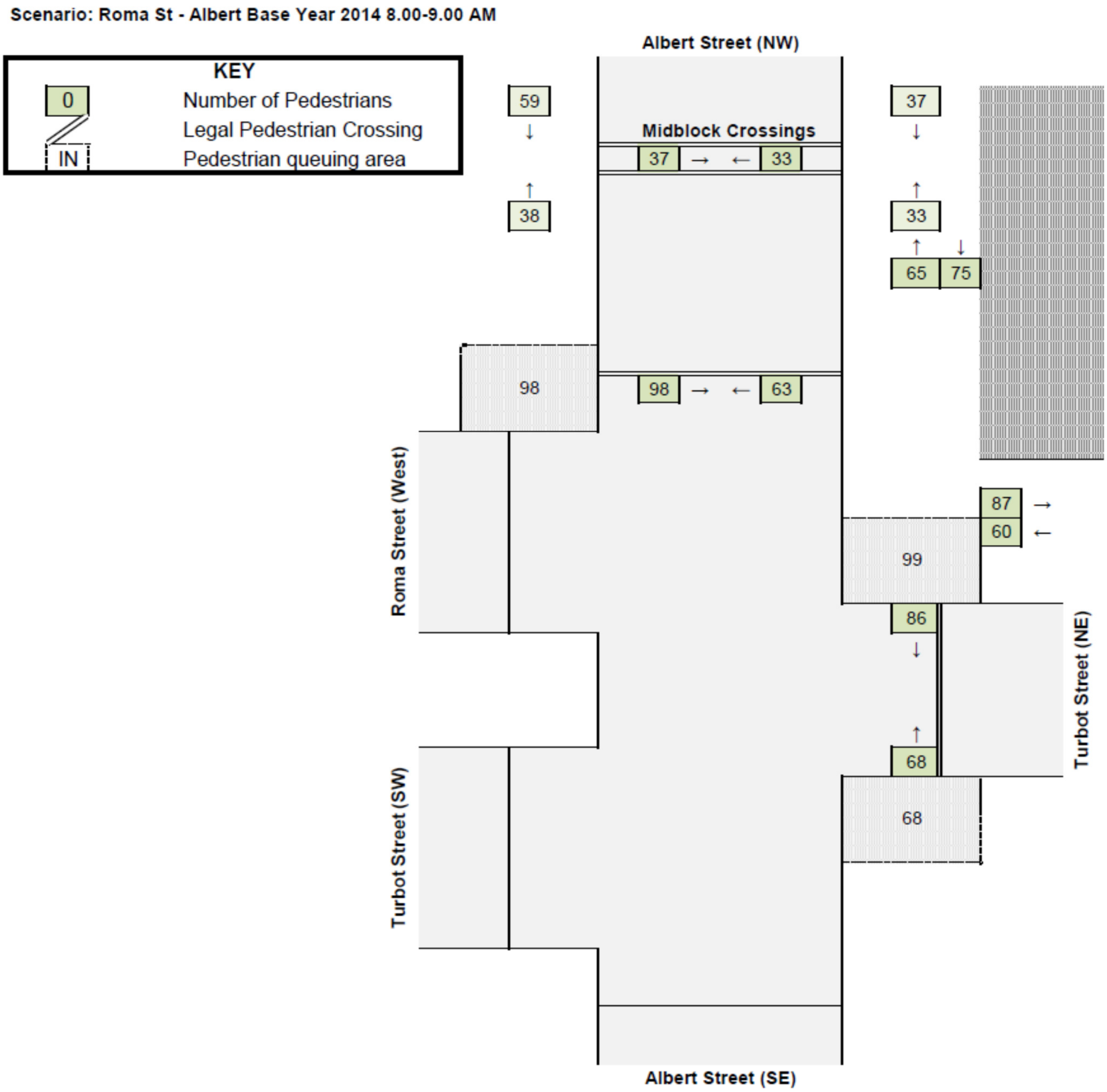
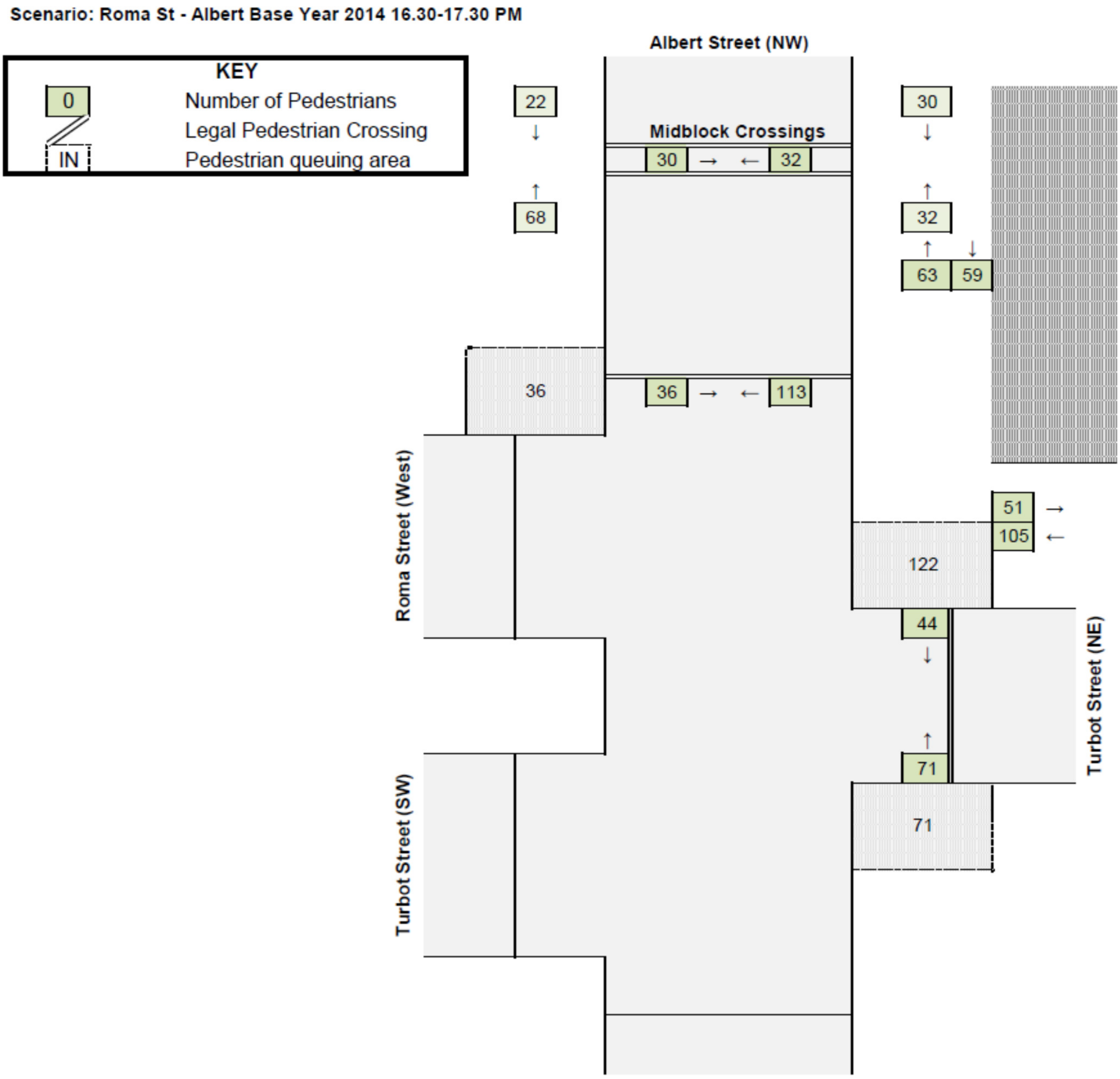


FIGURE 3-26

Roma Street current (2014) 15 minute maximum pedestrian volumes (Albert Street entrance) – AM peak hour



BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 3-27

Roma Street current (2014) 15 minute maximum pedestrian volumes (Albert Street entrance) – PM peak hour

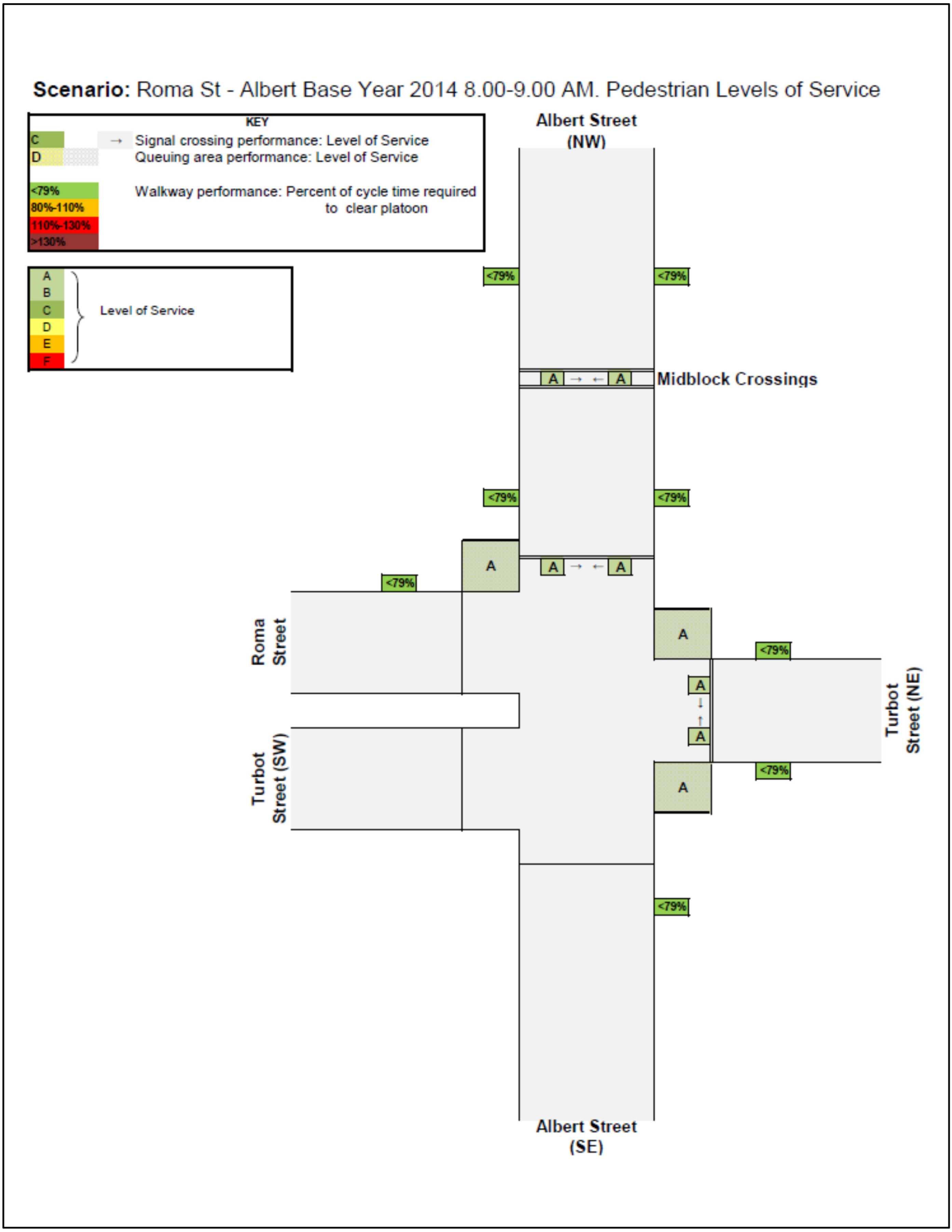


FIGURE 3-28

Roma Street current (2014) pedestrian level of service (Albert Street entrance) – AM peak hour

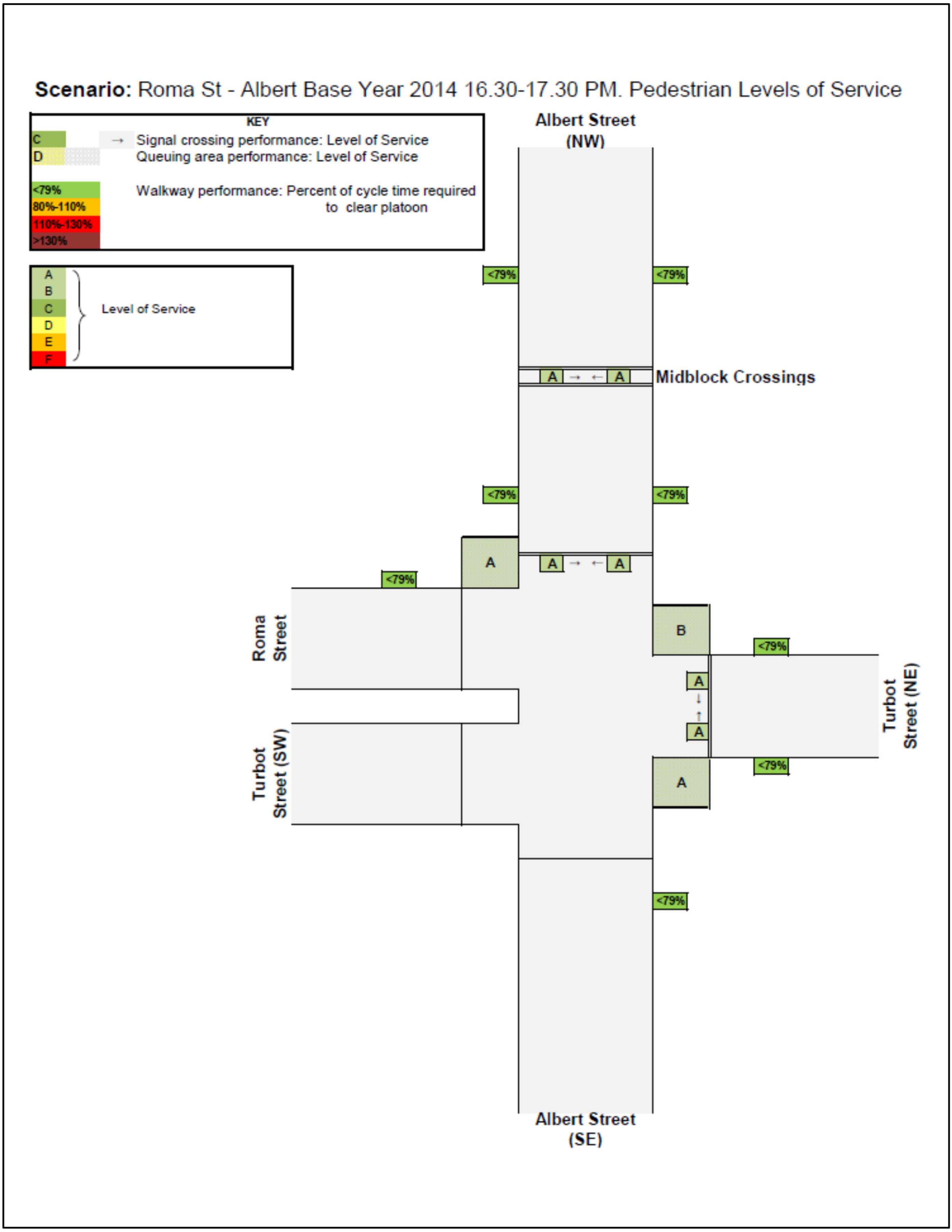


FIGURE 3-29

Roma Street current (2014) pedestrian level of service (Albert Street entrance) – PM peak hour

3.5.7 Central Station pedestrian and cycle facilities

Walking is the primary mode of access and egress to Central Station accounting for over 90 per cent of trips to and from the station during the morning peak.

Central Station is surrounded on all four sides by multi-lane roads, namely Ann Street, Edward Street, Creek Street and Turbot Street that passengers must traverse to access the station. However, a dense network of footpaths and subways connects the station with its surrounding catchment. These connections include:

- a pedestrian subway under Ann Street to the ANZAC Arcade and the ANZAC Square and Post-Office Square developments
- a pedestrian subways under Turbot Street to Wickham Terrace with three separate connections.

Each of these connections has issues with equitable access and capacity, with access to the platforms from the main subway linking ANZAC Square and Spring Hill (at the corner of Edward Street and Wickham Terrace) closing at 6.00pm.

The observations undertaken at Central Station together with Brisbane City Council pedestrian data highlighted some localised issues with current pedestrian network around the station:

- nearly half of the pedestrian incidents occurred within close proximity to Central Station, along Adelaide Street, Ann Street and Edward Street
- top five intersections for pedestrian movements in the city centre are clustered around Central Station
- there are sub-standard pedestrian facilities and poor sight lines on Creek Street between Turbot and Ann Streets east of Central Station. There are perceived dangers with pedestrian and vehicle conflict and pedestrians were observed undertaking risky crossings or walking on the road pavement due to lack of formal footpaths or back of kerbside waiting and movement space
- the effective footpath widths around Central Station were found to be among the narrowest in the CBD (less than 3m). This is a cause for concern as these correspond to the routes with the highest level of pedestrian activity
- although the CBD has high pedestrian crossing demands at most signalised intersections, there is only one scramble crossing (all pedestrian phase) observed in the area, at the Adelaide Street/ Edward Street intersection
- the Central Station footbridge that provides a link from the entrance at the corner of Ann Street and Creek Street to Wickham Terrace is under utilised. The footbridge is narrow, unattractive and the access points are not easily visible. Pedestrians instead choose to walk along Creek Street even though this link has no formalised pedestrian facilities.
- there are poor pedestrian crossing facilities at the Wickham Terrace entrance to the station – the area is dominated by roads and carpark access ramps while the uncontrolled crossing of Wickham Terrace provides poor sightlines to oncoming northbound traffic
- there is insufficient storage space on the traffic island at the intersection of Creek Street and Ann Street to service current morning peak demands, which results in pedestrian overspill.

Currently, there are minimal provisions for cyclists at Central Station. The major arterial roads surrounding Central Station provide a poor LoS for cyclists, due to high vehicle volumes and conflicting movements and no streets surrounding the Station being designated as cycle routes.

3.5.8 Queen Street Bus Station pedestrian and cycle facilities

The QSBS is a prominent public transport hub within the Brisbane CBD and a generator of significant walk trips. Pedestrian access to the station is via access stairs located at intervals along Queen Street Mall between George and Albert streets and through the Myer Centre.

There is currently no provision for cyclists within the QSBS and cycling is not permitted through the Queen Street Mall. However, bike racks and a CityCycle station bike racks are available at locations near to the entrances to the bus station, including within Reddacliff Place. The King George Square Cycle Centre is located approximately 200m from the QSBS with access of Ann Street.

3.6 Regional road network and performance

The Brisbane regional road network is characterised by a range of radial and orbital arterial and motorway routes including:

- the M1 (Gateway Motorway) – a north-south bypass on the eastern edge of the Brisbane Metropolitan area
- the M3/ M7/ A3 (Pacific Motorway/ Clem Jones Tunnel (CLEM7)/ Gympie Road/ Airport Link Tunnel) - a key north-south route through inner Brisbane
- the M5/ICB/ Kingsford Smith Drive – an east-west route linking the western suburbs to the north-eastern suburbs and airport via inner north Brisbane
- the M2/ M6 route (Logan Motorway) forming an east-west bypass of Brisbane on the southern edge of the metropolitan area.

The major arterial roads are shown in **Figure 3-30**. In 2012, almost 4.7 million car and commercial vehicle trips occurred within the Brisbane Statistical Division on an average weekday.

The volume/ capacity ratio (v/c) is a key measure of the performance of the regional and urban road network. It can be measured at a mid-block point or at an intersection, and provides an assessment of the operation as performance of the road network in terms of conditions experienced by drivers.

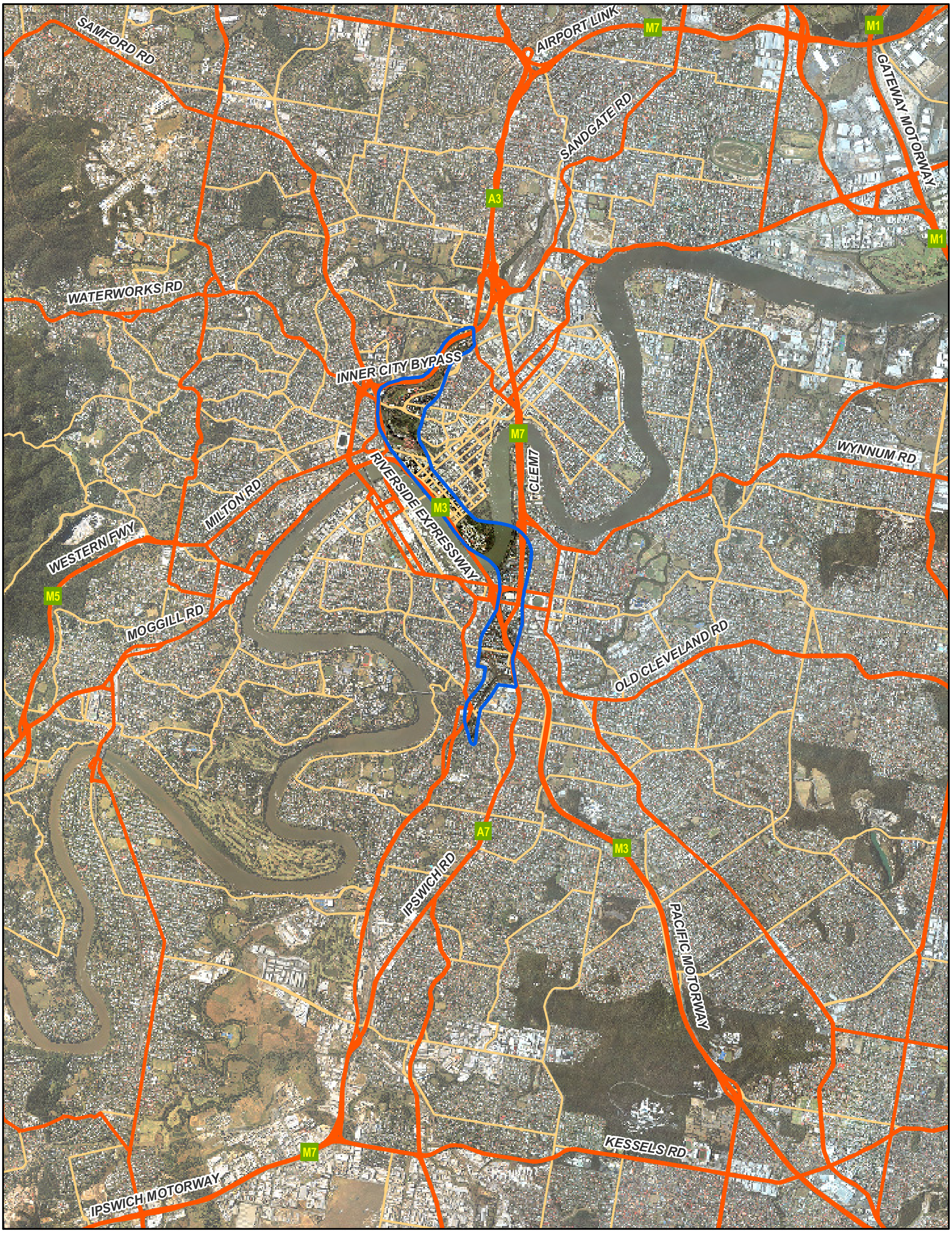
The v/c ratio for roads within, or close to the study corridor has been determined for existing conditions for the base year 2012 (as estimated from the Project model) as the defining measure for urban and suburban arterial roads with interrupted flow. As travel speeds decrease from the optimum free-flow condition, the LoS to road users deteriorates. A v/c ratio of over 90 per cent is considered to illustrate congested conditions. The performance of the road network in the morning peak in 2012 is shown in **Figure 3-31** and the evening peak in **Figure 3-32**.

This assessment shows that in the morning peak, the radial road network centred on the CBD is heavily constrained with several key road corridors experiencing congested conditions (v/c ratio of over 90 per cent) with significant delays and low average travel speeds including sections of:

- Riverside Expressway (both directions)
- Pacific Motorway (Captain Cook Bridge) inbound
- Sandgate Road/ Abbotsford Road (north of the ICB)
- Lutwyche Road/ Bowen Bridge Road
- Story Bridge (northbound)
- Coronation Drive and Milton Road (inbound)
- Kelvin Grove Road

- Waterworks Road and Musgrave Road
- Ipswich Road and the Ipswich Motorway.

Recent investment in road projects such as the CLEM71, Airport Link, Legacy Way and Go Between Bridge provide alternative routes for cross-city movements that avoid many of the above congested roads. However there are no proposals for major road capacity upgrades into the Brisbane CBD itself. As such the capacity of the these roads is considered fixed and the ability of the regional and arterial network to satisfactorily cater for further growth in travel demand by private vehicles to Brisbane's CBD during the peak periods is therefore constrained.



LEGEND

Road Network

Motorway/highway/arterial road

Connector road

Study corridor

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 3-30

Existing Brisbane regional road network

N

0 1 2

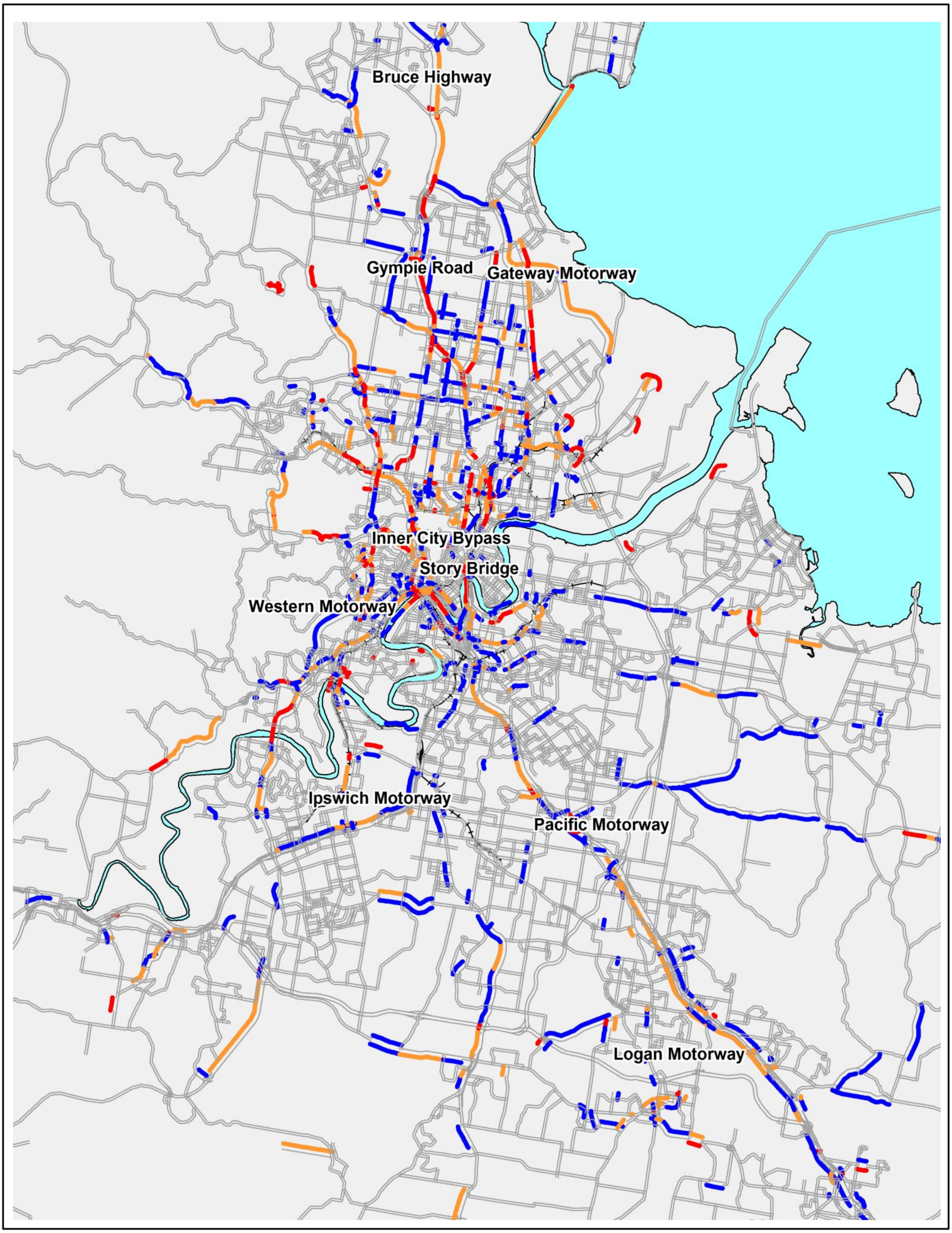
Kilometres

1:75,000 (at A4)

Projection: GDA 1994 MGA56

Aerial Photo: Brisbane City Council 2012

G:\QENV2\Projects\QE06863\Spatial\ArcGIS\Figures\Final_EIS_Figures\04_Transport\Tech_Report\TranspTechRpt_Figure3-30_Existing_Regional_Road_Network.mxd Date: 14/08/2014

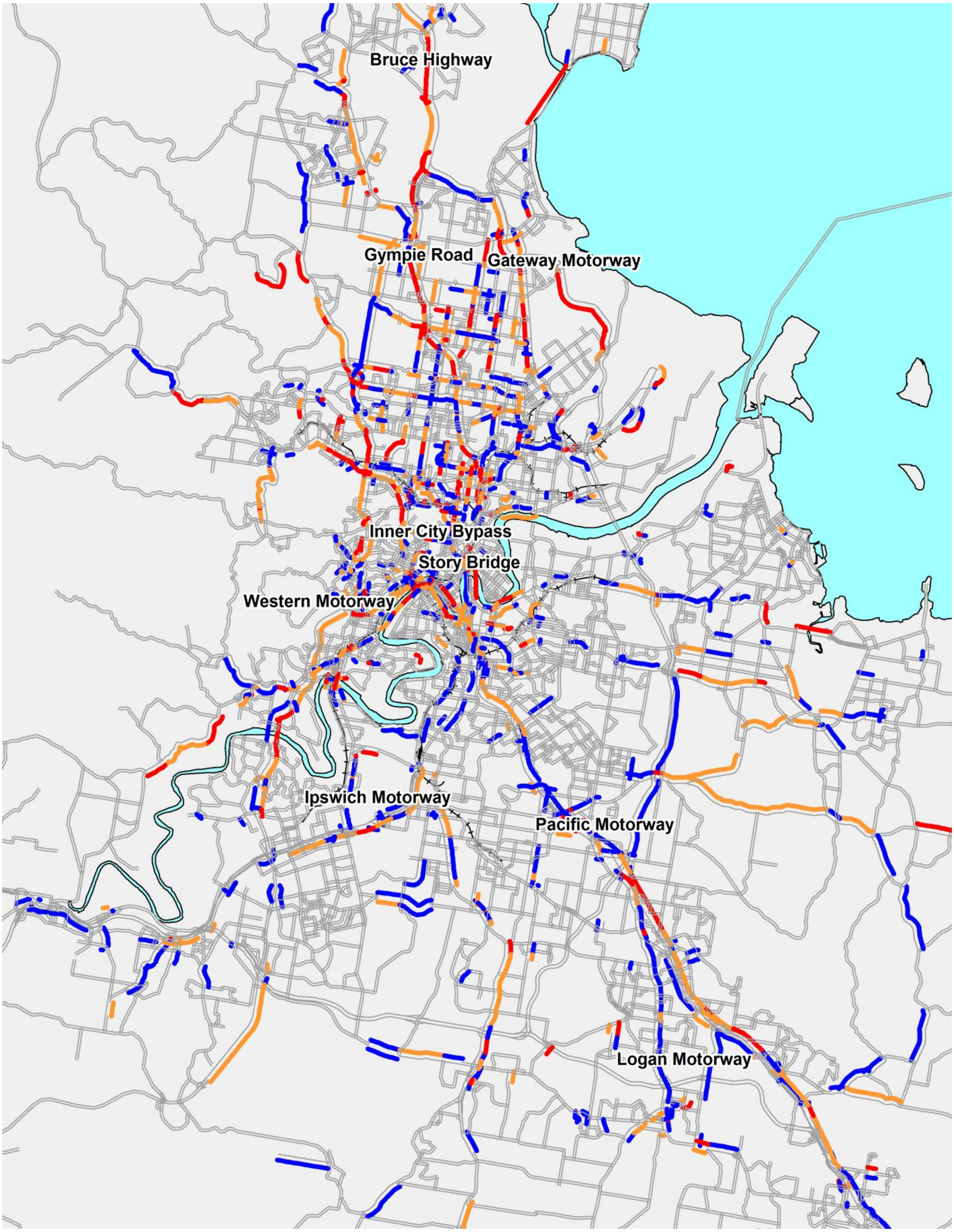


BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 3-31

Road traffic volume over capacity – 2012

Morning peak period



LEGEND
PM peak (2 hrs) v/c ratio

- > 1.00
- 0.90 to 1.00
- 0.75 to 0.89
- < 0.75

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 3-32

Road traffic volume over capacity – 2012

Evening peak period

3.7 Road access and parking at stations

Details of traffic and parking at each station within the study corridor is outlined in the following sections.

3.7.1 Dutton Park Station vehicle access and parking facilities

Dutton Park Station has good access to the surrounding road network including the adjacent Annerley Road, classified as an arterial road, and Cornwall Street, a suburban access route. The station is adjacent to the PA Hospital with high demands for on-street parking managed through timed parking controls.

A taxi bay (with space for two taxis) and taxi call box is located on Cornwall Street, approximately 50m from the station entrance. There is no formal park ‘n’ ride facility at Dutton Park Station and the station is located in the Dutton Park traffic area limiting parking on surrounding streets.

3.7.2 Park Road and Boggo Road Station vehicle access and parking facilities

Park Road Station and Boggo Road Busway Station are located around 200m from the nearest arterial road, Annerley Road and are surrounded by local access streets

No dedicated taxi facilities are provided with the current (mainly residential) development. No dedicated kiss ‘n’ ride (drop off and pick-up) facilities exist although this activity occurs informally in Quay Street. Some kiss ‘n’ ride activity occurs within the dedicated off-road facility at Dutton Park State School on the southern side of the station.

A small (28-bay) park and ride facility currently exists at Park Road Station which is free and typically well-utilised by commuters.

All streets to the north of the station are part of the Brisbane Central Traffic area, where parking is limited to two hours from 7.00am to 6.00pm Monday to Friday and 7.00am to 12.00pm on Saturdays, unless otherwise signed. Streets to the south of the station are included within the Dutton Park Traffic Area, where parking is limited to two hours (unless otherwise signed) between 7.00am and 7.00pm, Monday to Friday.

3.7.3 Woolloongabba area vehicle access and parking facilities

Woolloongabba is surrounded and dissected by major road links including the M3 (Pacific Motorway) to the west, Ipswich Road (A7) running north-south through the study area as well as Vulture Street and Stanley Street running east-west through the study area.

Stanley Street runs westbound through the study area and is the key access road to the M3 (Pacific Motorway) inbound. It suffers from heavy morning inbound traffic, queuing to get onto the motorway. Vulture Street runs eastbound through the study area and is a key motorway distributor route. It suffers from heavy outbound traffic in the evening peak.

There is a taxi zone located on Stanley Street (south side by the Chalk Hotel) and on Gibbon Street that is located just off the Stanley Street service road. Busway passengers must cross Stanley Street at the mid-block signalised pedestrian crossing to access the busway station. No formal park ‘n’ ride facility exists at Woolloongabba Busway Station.

3.7.4 George Street area vehicle access and parking

Within the southern precinct of the Brisbane CBD, taxis provide service to the wider CBD. Dedicated taxi pick-up and set-down facilities located within the CBD south precinct on George Street (outside the Office of Births, Death and Marriages), Albert Street, Felix Street, Edward Street, Alice Street, and Gardens Point Road at QUT. Public off-street car parking is in strong demand within the CBD with weekday parking fees observed to be up to approximately $40.00 per day.

There is a large number of off-road commercial and multi-storey private parking facilities within the precinct, there are no formal park 'n' ride facilities in CBD south.

Public on-street car parking in the Brisbane CBD is limited and restricted due to the Brisbane Central Traffic Area that limits on street parking to two hours 7.00am to 6.00pm Monday to Friday and 7.00am to 12.00pm on Saturday unless signed. There is strong demand for on-street car parking in the CBD that is managed through metered car parks with typically two to three hour fine restrictions applied.

Kerb space is also provided for other activities throughout the CBD such as commercial and passenger loading and taxi ranks. George Street between Elizabeth Street and Alice Street has a number of loading bays.

3.7.5 Roma Street Station vehicle access and parking facilities

Positioned at the north-western edge of the Brisbane CBD, Roma Street Station is served by good road access. As a major interchange station there is a range of access modes provided including taxi and private car. There are several taxi facilities provided at/around Roma Street Station, including:

- ground level taxi rank with space for at least two taxis adjacent to the Roma Street entrance to the transit centre. However this facility provides a poor passenger waiting environment, being within the ground level of the Transit centre carpark. No taxis or passengers were observed using this facility in the morning peak
- taxi rank at the rear (north side) of the long distance inter-city platform 10 to the north of the station. This is a more attractive, open taxi facility with dedicated space for approximately eight taxis with a waiting area provided under cover. This facility is expected to be used predominantly when a long distance train is in service from the adjacent platform 10
- the coach terminal on level 3 of the transit centre has dedicated taxi facilities with space for at least four taxis, which appear to be well used as this facility provides convenient interchange for people accessing coach services, is well lit with weather protection. At least two taxis were observed during the morning peak hour
- short term waiting and loading bays exist on Roma Street itself, in front of both the Telstra Tower and the Holiday Inn hotel.

There is no dedicated park 'n' ride facility at Roma Street Station however there is a large multi-storey public carpark immediately adjacent to and integrated with the station. This is principally parking for tenants of the transit centre office buildings as well as offering paid parking for CBD commuters. Such parking is intended to cater for commuter driving trips rather than driving as part of a public transport journey and therefore is not considered a commuter park 'n' ride facility.

Kiss 'n' ride facilities are provided at the northern and southern ends of the station complex. A short term drop-off facility is located within the ground floor of the multi-level carpark fronting Roma Street, adjacent to the first of the above-mentioned taxi facilities. This principally serves passengers using the suburban and Sydney trains as well as the intercity coaches and has capacity for at least four cars. Another drop-of and pick-up facility is provided adjacent to Platform 10 on the north side of the station. This principally serves long distance Queensland trains (such as the Tilt Trains to Rockhampton and

Cairns, Sprit of the Outback to Longreach and Westlander to Roma). Capacity is provided for approximately 30 cars in this carpark with parking limited to three hours.

While there were two kiss ‘n’ ride (short term pick up and drop off) facilities within the station complex, they were not well used at the time of site observations (AM peak). This is partly due to the fact that Roma Street Station has substantially more alighting passenger movements than boarding movements in the morning peak and that passenger drop offs are associated primarily with long distance trips rather than weekday commuting trips. Given the relative infrequency of long distance trains, using platform 10, the kiss ‘n’ ride facility to the north of the station is only used sporadically. Also, given the spread of long distance bus services throughout the day, the kiss ‘n’ ride facility to the south would not be likely to coincide with the morning peak.

3.7.6 Central Station vehicle access and parking facilities

Central station is located between the busy CBD through-routes of Ann Street and Turbot Street.

There are currently no taxi ranks dedicated for railway station use. Consequently, rail passengers wishing to transfer must exit the station precinct and utilise on-street taxi facilities. On-street taxi ranks that rail passengers could choose to use if they are prepared to walk are located on:

- Ann Street, directly outside the Grand Central Hotel in the Central Station sub-precinct
- off Turbot Street at the Sofitel Hotel (four bays), although passenger access from Central Station to these ranks is indirect and is not signed
- Creek Street, servicing the CBD east and the financial precinct around Eagle Street (16 bays north and south of Queen Street and five bays south of Elizabeth Street). All except the taxi rank south of Elizabeth Street are well used during the day. These taxi ranks are over 200m from the railway station and do not provide good interchange with Central Station.
- Albert Street, between Elizabeth Street and Charlotte Street, servicing the CBD centre and CBD south. These ranks were observed to be well used during the day and in the evenings. These taxi ranks are over 200m from the railway station and do not provide good interchange facilities.

There is a general lack of way-finding information signage directing Central Station passengers to the nearby taxi ranks within the station precinct. When the demand is present, the majority of interchanging rail-taxi passengers were observed to ‘hail-down’ taxis on the street network within close proximity to the station.

Kiss ‘n’ ride bays or passenger loading bays are not provided at Central Station. There are two short term passenger loading bays on Ann Street on the opposite side of Central Station primarily servicing the Rendezvous Hotel that rail passengers could potentially use. Rail passengers are also likely to use kerbside locations on the surrounding streets for any kiss ‘n’ ride activities.

Given the lack of dedicated kiss ‘n’ ride facilities, no observations were made of kiss ‘n’ ride operational issues. The mode of access data presented above confirms that kiss ‘n’ ride is a minor mode of access to Central Station.

There is no formal park ‘n’ ride facility at Central station. However, off street public car parking is provided adjacent the station at:

- corner of Edward Street and Turbot Street (access from Wickham Terrace, Turbot Street or Creek Street)
- Secure Parking on Adelaide Street
- Kings Parking on Adelaide Street.

On street parking within the Brisbane CBD falls under the Brisbane Central Traffic Area parking restriction. This is an on-street parking control to limit the availability of all day commuter on-street parking. As such, there is currently severely limited catchment for private vehicle trips.

The mode of access data presented above confirms that park ‘n’ ride is a minor mode of access to Central Station. Central Station is predominantly a destination station (with negligible demand for park ‘n’ ride trips).

3.8 Car parking in the CBD

3.8.1 Access, parking and servicing for new development

Parking for new development within the study corridor has been set by Brisbane City Council Code A012 – Transport, Access, Parking and Servicing of the Brisbane City Plan 2014. In the City core and City frame, maximum car parking rates for new development by type are specified. Parking is capped to a maximum of one space per 200m² for any development other than dwellings. In the City Centre a balance between controlling congestion and providing sufficient short term shopping and business parking to keep the City Centre viable is sought. Long term parking within the City Centre is strongly discouraged, particularly in the case of purpose built car parks. Outside of the City Centre and City Frame, minimum parking rates apply which are generally intended to cater for user car parking needs within the development.

3.8.2 Off-street parking

A survey (2011 Colliers International) of global city centre parking charges found that Brisbane was ranked 14th in the world in terms of most expensive unreserved monthly parking rates and equal 14th for daily parking rates. Compared to other Australian cities, Brisbane is on par with Melbourne as the second most expensive city for daily parking charges (after Sydney) at around $41.00 per day (Colliers International, 2011). Within the Brisbane CBD there are over 10,000 publicly accessible commercial car parks available (Brisbane City Council, 2009).

Despite the apparent high cost of commercial car parking in the Brisbane CBD there is strong use of these facilities with the majority of car parks operating close to capacity on weekdays. Consequently, there is a lack of car parking spaces that could accommodate additional commuter trips by car to the CBD.

3.8.3 On-street parking controls

Within large parts of the study corridor, on-street parking and loading is controlled under designated traffic areas such as the Brisbane Central Traffic Area, Gabba Traffic Area, Dutton Park Traffic Area and Lang Park Traffic Area. Details of restrictions applied are provided in **Section 3.1.5**.

Within the Brisbane Central Traffic Area a two hour parking limit applies, except as signed or where meters operate, and as permitted by the road rules.

Short term (up to and including 3 hours) on-street parking bays in the CBD are charged at up to $4.40 per hour during weekdays (7.00am to 7.00pm). Where four hour or longer parking is available (such as in the city frame area) a fee of $2.70 per hour applies, up to a maximum daily charge of $10 on weekdays ($6 on weekends).

Parking restrictions apply Monday to Friday 7.00am to 10.00pm and Saturday and Sunday 7.00am to 7.00pm.

3.9 Regional freight rail – operations and constraints

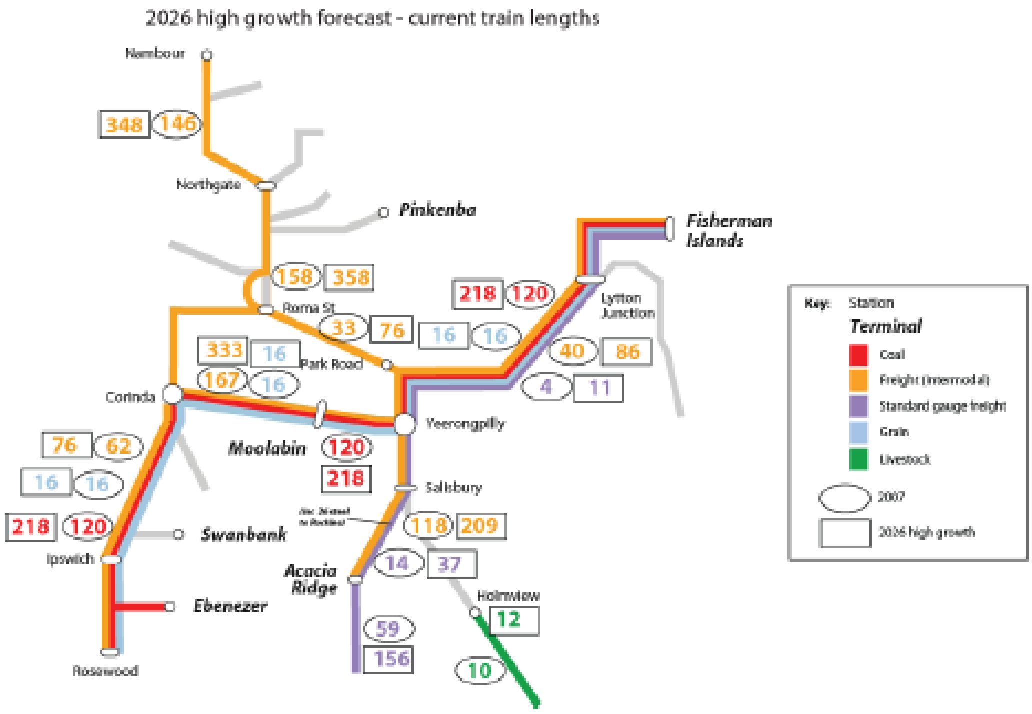
Freight services currently pass through the Brisbane rail network to destinations including Fisherman's Island (Port of Brisbane), Acacia Ridge Freight Terminal, and to regions serviced by the North Coast line. Currently, there is no dedicated rail freight network in South East Queensland. As a result, passenger and freight rail services share network capacity with passenger services prioritised over freight.

Freight services through the inner city bypass the CBD by taking an alternative route via the Exhibition loop. This is partially because the inner city stations were not designed to accommodate freight services, and largely because the freight services would cause operational difficulties in the heavily used inner city corridor and would present a safety issue with potentially dangerous goods passing through the tunnel network between Roma Street Station and Fortitude Valley Station.

Figure 3-33 shows estimates of weekly freight train for 2007. This illustrates that in 2007:

- 120 two-way coal trains per week between the west and the Port of Brisbane via Yeerongpilly and Park Road
- 78 two-way weekly freight trains accessing the Brisbane inner city rail network from the west
- 33 two-way freight (intermodal) trains per week between Roma Street and Park Road and so passing over the Merivale Bridge
- a total of 158 two-way weekly freight trains accessing the Brisbane inner city rail network from the north
- 132 two-way weekly freight trains accessing the Brisbane inner city rail network from the west.

Figure 3-33 Existing estimates of weekly train movements within SEQ rail network[12] (two-way flows)



[12] Queensland Transport (2008) Inner City Rail Capacity Study. Note that figure contains estimates for 2026 – see Section 3 for further information relating to future freight demand.

Due to the reasons mentioned above there is limited spare capacity for freight rail within the Brisbane metropolitan rail network.

3.9.1 Constraints to rail freight operations[13]

Passenger and freight rail services share network capacity, with passenger services prioritised over freight. Currently freight trains do not operate during peak periods within the Brisbane metropolitan rail network. Efficiency and performance of non-peak passenger rail operations are often affected by the need to schedule freight trains in the times available between higher priority passenger train services.

Key generators of freight rail services are the Port of Brisbane, Acacia Ridge Freight Terminal, and regions serviced by the North Coast line. The current freight peak periods are between 4.00am and 7.00am for arriving at the terminals, and between 6.00pm and 9.00pm for departures to match current logistics trends. There is more flexibility for afternoon and evening departures depending on the length of journey but freight arrivals typically must arrive at the beginning of the day to meet distribution needs.

A series of specific conflicts exist that affect the operation of freight trains. These include network conflicts and conflicts with the operation of passenger trains around the inner city. The capacity for freight movements from one side of the city to the other is determined by these key freight capacity constraints within the inner city area. Specific performance issues are:

- peak freight curfew – freight operational hours are currently restricted by a passenger-peak freight curfew, not allowing freight services access to the passenger network during the morning or evening peak hours, with restricted access during the shoulder period. This prevents freight operations for approximately four hours of the day on large parts of the network.
- operations on the Merivale Bridge – passenger train operations have priority on the Merivale Bridge. This route is only used opportunistically when train paths are available for freight traffic. The primary route for all freight to and from Acacia Ridge from the North Coast is via Corinda and the Tennyson loop.
- network constraints such as
  - freight services arriving from the North Coast must cross the path of passenger services heading to the north at Bowen Hills junction
  - non-freight services entering and exiting Mayne Rail Yard cause flat junction conflicts with the freight services on the Exhibition loop tracks
  - the area around Normanby Yard has many potential crossing and merging conflicts, especially with passenger services finishing at Roma Street and heading to Mayne Rail Yard
  - junction conflicts between freight and passenger services at the Milton and Roma Street Junction
  - passenger and freight trains sharing the single bi-directional dual gauge track between Salisbury and Park Road, preventing freight trains from operating on this part of the network in peak commuting hours, and limiting the number of both freight and express passenger (ie Gold Coast) services in the off peak to approximately current levels.

One of the most complicated sections of the inner city rail network (in terms of freight operation) is the area between College Road, Roma Street Station, and the junction west of Roma Street. Flat junction conflicts exist between freight services and passenger services moving between Roma Street and Mayne Rail Yard, and all passenger movements south of Roma Street. Freight services travelling via the Merivale Bridge must travel across all four tracks at grade and so interact with commuter rail services from the west and south.

[13] Source: Inner City Rail Capacity Study (Queensland Transport, 2008)