Department of Transport and Main Roads

Bulimba to Teneriffe Active Transport Bridge

Summary Planning Report

SPR01

Issue 2 | 22 July 2016

Job number N/R

Arup
Arup Pty Ltd ABN 18 000 966 165

Arup
Level 4, 108 Wickham Street
Fortitude Valley
QLD 4006
GPO Box 685 Brisbane QLD 4001
Australia
www.arup.com

ARUP

Document Verification

ARUP

Job title	Bulimba to Teneriffe Active Transport Bridge			**Job number** N/R
Document title	Summary Planning Report			**File reference**
Document ref	SPR01			

Revision	**Date**	**Filename**	N/R		
Draft 1	30 May 2016	**Description**	First draft		
			Prepared by	Checked by	Approved by
		Name	N/R		
		Signature			
Draft 2	2 Jun 2016	**Filename**	N/R		
		Description	Second draft incorporating internal review		
			Prepared by	Checked by	Approved by
		Name	N/R		
		Signature			
Issue	15 Jul 2016	**Filename**	N/R		
		Description	Issue incorporating TMR comments		
			Prepared by	Checked by	Approved by
		Name	N/R		
		Signature			
Issue 2	22 Jul 2016	**Filename**	N/R		
		Description	Updated issue incorporating final TMR comments		
			Prepared by	Checked by	Approved by
		Name	N/R		
		Signature			
			Issue Document Verification with Document		✓

Contents

			Page
Executive Summary			**2**
1	**Introduction**		**5**
	1.1	Background	5
	1.2	Scope	6
	1.3	Study Area	6
2	**Route goal and objectives**		**8**
3	**Methodology**		**9**
	3.1	Stage 1 – Project Understanding	9
	3.2	Stage 2 – Options Development and Feasibility Review	9
	3.3	Stage 3 – Project Reporting	9
4	**Existing Situation**		**10**
	4.1	Connectivity	10
	4.2	CityCat and Cross River Ferry	11
	4.3	Bus Connections	14
	4.4	Current cross-river demand	17
	4.5	Existing Road and Path Network	29
	4.6	Crash and safety analysis	32
5	**Policy and planning framework**		**43**
	5.1	Local	43
	5.2	State	45
	5.3	Demographics	46
	5.4	Other studies	47
6	**Constraints and Opportunities**		**49**
	6.1	Desktop Study area review	49
	6.2	Environmental and heritage	49
	6.3	Land Use Planning	56
	6.4	Maritime	61
	6.5	Structures	62
	6.6	Route environment review	77
7	**Potential Future Users**		**94**
	7.1	Commuters	94
	7.2	Recreational users	95
	7.3	Local community	95

N/R

	7.4	Potential Patronage	95
8	**Options Development**		**104**
	8.1	Options definition	104
	8.2	Options refinement	104
	8.3	Other opportunities	105
9	**Options Analysis**		**107**
	9.1	SWOT Analysis	107
	9.2	Options Refinement	107
	9.3	Multi Criteria Assessment	107
	9.4	Cost Estimate	112
	9.5	Cost/Benefit comparison with other bridges	116
10	**Safety in design**		**117**
11	**Conclusion and Recommendations**		**118**
12	**References**		**120**

Appendices

Appendix A
SWOT Analysis

Appendix B
MCA Workshop Results

Appendix C
Environmental Site Management Plans

Appendix D
Bridge Images Gallery

Appendix E
Risk registers

Appendix F
Bridge Alignment Options Plan

N/R

Glossary

Acronym	Full name
AHD	Australian Height Datum
BCC	Brisbane City Council
BRT	Bus Rapid Transit
CBD	Central Business District
DIP	Department of Infrastructure and Planning (now the Department of Infrastructure, Local Government and Planning – DILGP)
GPS	Global Positioning System
HAT	Highest Astronomical Tide
ITALICS	Integrated Transport and Land Use: Inner City Strategy
MCA	Multi Criteria Assessment
RBWH	Royal Brisbane and Womens Hospital
RL	Reduced Level, a measure of level
SWOT	Strengths, Weaknesses, Opportunities and Threats (refers to SWOT assessment)
TMR	Department of Transport and Main Roads
URP	Griffith University Urban Research Program

Executive Summary

Project Background

The purpose of the Bulimba to Teneriffe Active Transport Bridge Feasibility Study is to investigate the potential development of a new active transport bridge across the Brisbane River between the Bulimba and Teneriffe districts. The study area defined for this project ranged from New Farm Park at the upstream end, to the Teneriffe Ferry Terminal at the downstream end.

There have been many previous proposals and studies for bridges at this reach of the Brisbane River, with one of the most recent being the ITALICS (*Integrated Transport and Land Use: Inner City Strategy*), which considered a green bridge carrying buses in addition to pedestrians and cyclists. To date, none of these bridge proposals has been constructed due to cost and/or community objection.

Connections across the river are currently provided by the CityCat and Cross River Ferry services, with relatively limited attractiveness due to relatively slow travel speeds (the ferry speed is approximately walking pace) and the delays at either end due to ferry mooring procedures the need to wait for ferries to arrive, and boarding/disembarking delays.

Based on this, the key aim of introducing a direct active transport link between Bulimba and Teneriffe is to enhance the accessibility of the Brisbane CBD, Fortitude Valley and Teneriffe from the eastern suburbs.

This study aimed to identify a preferred active transport bridge alignment with the greatest likelihood of feasibility, through a four stage process:

- Data collection and review;
- Identification of study area constraints and opportunities;
- Options development; and
- Preferred option selection.

Following this process, a review of the indicative costs and benefits associated with the bridge was completed.

Data Collection and Review

A variety of data sources were reviewed for this study, including (but not limited to):

- Site observations collected through a saddle survey;
- Go card usage data;
- Active transport patronage of existing bridges;
- Crash history on the surrounding road network;
- Demographics of the local area; and
- Local topography.

Further details of the data analysis are presented in Sections 4 and 5 of this report.

N/R

Key Constraints and Opportunities

Based on a review of the data collected for this study, a number of constraints and opportunities were identified. The most important of these were:

- **Vertical clearance**: The Maritime Services Queensland Harbour Master reiterated a requirement for the bridge to accommodate tall vessels requiring up to 30m of clearance above Highest Astronomical Tide (HAT). This could be achieved through a fixed bridge with 30m clearance above HAT, or an opening bridge with 12m clearance above HAT in its closed position. It was considered that a 30m high bridge would not be achievable in this region due to significant visual impact and ramp structure length, and this study has been progressed assuming that the bridge form will be an opening bridge;
- **Maximum grades**: The longitudinal grades for the bridge need to be suitable for pedestrian and cyclist use. A maximum 5% (1:20) grade with landings was assumed for this study based on comparison with the Kurilpa Bridge;
- **Local land use**: Ensuring that the bridge alignment provides convenient access to higher density residential and commercial development was considered to be a significant opportunity with respect to increasing the feasibility of an active transport bridge in the area; and
- **Connection to existing active and public transport networks**: There is an opportunity to increase the potential catchment of bridge users by providing direct and convenient connections to public transport (e.g. bus stops) and active transport routes (e.g. existing off-road shared paths) on either side of the river.

Further details of the constraints and opportunities identified in this study are presented in Section 6 of this report.

Deliberation

N/R

Deliberation

Conclusions

A review indicated that an active transport bridge at this location would be feasible from a technical perspective, as:

- The competing constraints of river clearance (vertical and horizontal) are able to be balanced with the need for a ramp of limited grade and length;
- Sufficient potential locations exist for a bridge to land on either shore; and
- The technology to provide an opening span exists and has been tested at many existing bridges.

From an economic feasibility perspective, this study found that there is a significant existing demand for travel from Bulimba to the Brisbane CBD via the cross river link to Teneriffe, and also via existing bus services along Wynnum Road. A high level review of the potential usage of a bridge between Bulimba and Teneriffe was also completed based on various methods, and a rough estimate of the possible usage of the bridge was in the order of 3,000 people per day.

Due to the uncertainty regarding the potential opening mechanism of the bridge, a review of the potential cost of a Bulimba-Teneriffe active transport bridge was completed using benchmarks from other bridge structures. This concluded that the overall capital cost of the bridge would be in the order of Deliberation although this could vary significantly depending on decisions regarding bridge architectural form and the type of opening span used.

N/R

1 Introduction

1.1 Background

The settlement of Brisbane was founded on the shores of the Brisbane River near North Quay in 1825, and over the last 189 years, development in what is now known as the City of Brisbane has expanded to encompass a significant part of South East Queensland. The Brisbane River, however, remains a significant component of the city, both uniting and separating residents. Today, there are fifteen permanent structures that cross the Brisbane River within or on the boundary of Brisbane City:

- Ten permanent crossings for general traffic (eight bridges, the Clem Jones Tunnel and the Mt Crosby Weir);
- One "green bridge" for buses and active transport between St Lucia and Dutton Park;
- Two dedicated active transport (walk and cycle) bridges (the Kurilpa Bridge and the Goodwill Bridge); and
- Two rail bridges.

The majority of these crossings (nine of the fifteen) are located in the vicinity of the Brisbane CBD, meaning that suburban areas on either side of the river are often isolated from each other, with ferry services being the only connection. To the east of the Brisbane CBD, there is a separation of over 10km between two consecutive permanent river crossings, the Story Bridge at Kangaroo Point and the Sir Leo Hielscher bridges (formerly known as the Gateway Bridge) at Murrarie.

The suburbs of Bulimba and Teneriffe are located on opposite sides of Brisbane River approximately half way between the Story Bridge and the Sir Leo Hielscher bridges. Both suburbs have a long history, having been settled from the late 19th century, and as a result have significant heritage value today. In recent years, the Teneriffe area and Newstead immediately to the north has seen significant growth (urban regeneration), with residential and commercial development still occurring today, particularly in the 'Gasworks' precinct near Commercial Road.

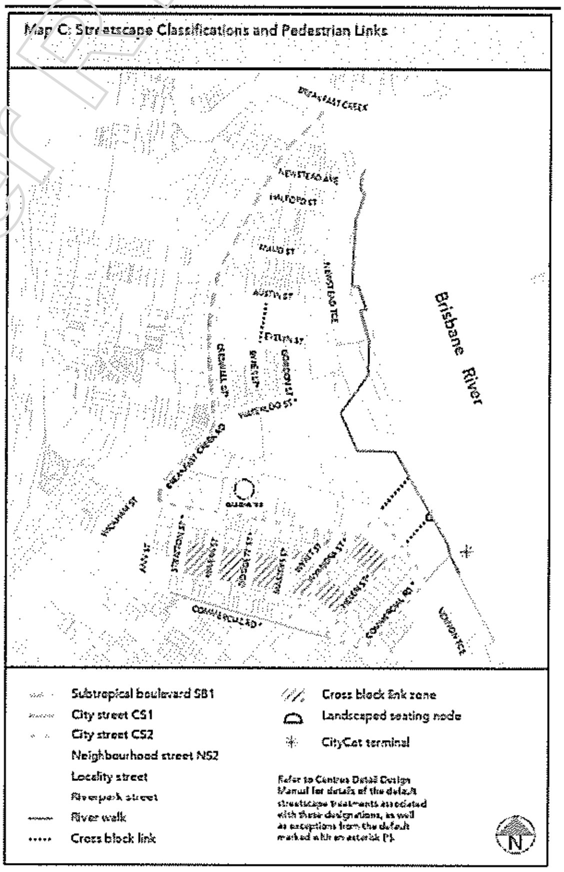


Figure 1 Newstead and Teneriffe waterfront Neighbourhood Plan – Pedestrian Links in support of increased development (Source: BCC City Plan)

Connections on either side of the river are currently provided by ferry, with Citycats connecting terminals at Teneriffe and New Farm Park on the left bank and at Bulimba and Hawthorne on the right bank. A cross-river ferry service also supplements the Citycat between Teneriffe and Bulimba terminals. These services combined provide approximately 130-140 crossings daily in each direction between Bulimba and Hawthorne ferry terminals, with approximately half of that number servicing Hawthorne and New Farm Park.

While these services do provide connectivity for pedestrians and cyclists, the attraction is restricted due to relatively slow travel speeds (the ferry speed is approximately walking pace) and the delays at either end due to ferry mooring procedures the need to wait for ferries to arrive, and boarding/disembarking delays.

Bridge connections between the Bulimba and Teneriffe have been proposed at various times in the past, with more recent options investigated ranging from general traffic bridges to green bridges for public and active transport only.

Arup was commissioned by the Department of Transport and Main Roads (TMR) in 2015 to undertake a study into the feasibility of constructing an active transport only bridge across the Brisbane River between Bulimba and Teneriffe. This report documents the methodology and outcomes of that study.

1.2 Scope

The objectives of this study are to determine the feasibility of an active transport bridge between Bulimba and Teneriffe. This includes the following:

- Determination of key attractors and potential connections to the wider pedestrian and cycle network on either side of the river;
- Investigation of the potential users of the facility, and the future function of the link (recreational, commuter etc.);
- Identification of opportunities and constraints on either side of the river; and
- Ensure that the design of the bridge does not exacerbate any existing safety issues on either side of the river.

1.3 Study Area

The study area covers a length of approximately 3km along the Brisbane River between Teneriffe / New Farm and Bulimba as shown on **Figure 2**. The indicative study area extents are:

- Upstream: The New Farm Park ferry terminal on the left bank and Wendell Street on the right bank; and
- Downstream: The Energex power lines crossing the river just downstream of the Teneriffe and Bulimba ferry terminals.

N/R

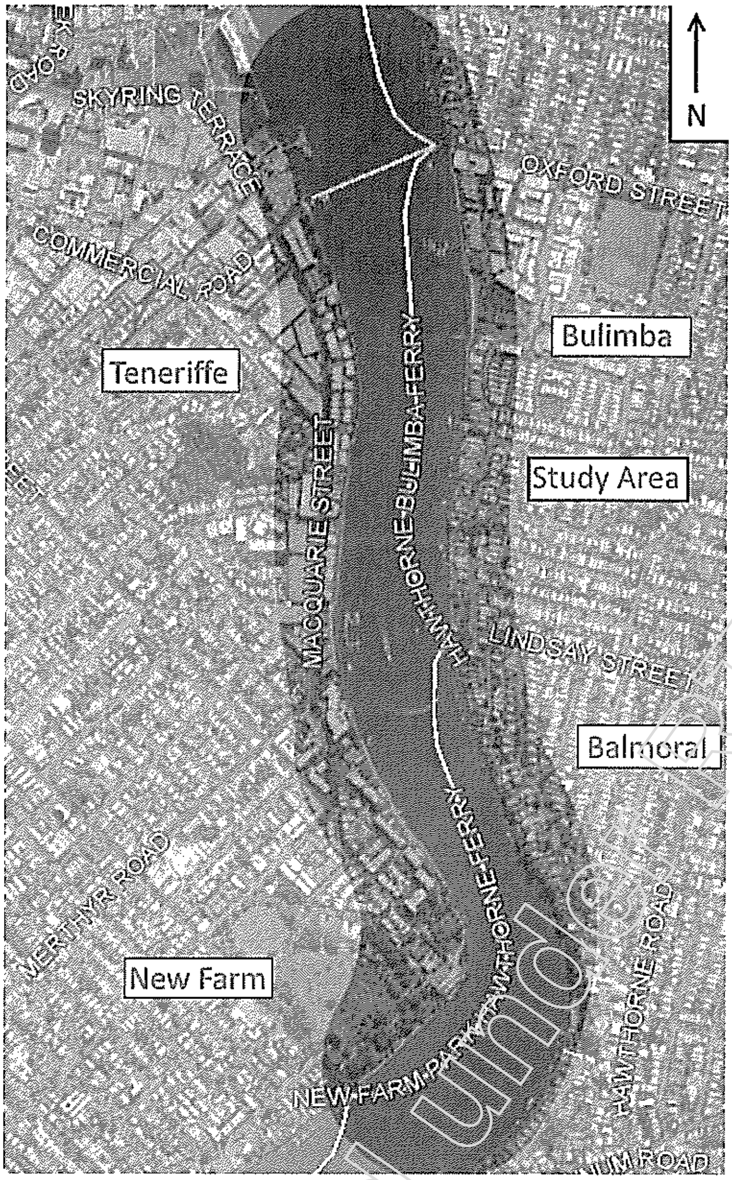


Figure 2 Extents of study area

N/R

2 Route goal and objectives

In planning for a new permanent crossing of the Brisbane River, it is important to understand the drivers and objectives behind the link. It is acknowledged that a new river crossing should not be constructed simply because one does not currently exist. Understanding where an active transport bridge crossing fulfils a "missing link" and has the potential to provide network connectivity currently only possible by other modes is essential towards demonstrating if it meets key objectives. This includes an understanding of cost implications as well as overarching planning context and potential demand.

The aim of introducing a direct active transport link between these two areas is to enhance the accessibility of the Brisbane CBD, Fortitude Valley and Teneriffe from the eastern suburbs. In addition, a direct active transport link also aims to reduce the travel time significantly for those who wish to walk and cycle between the two areas. An active transport connection would not only assist in increasing active travel but may also increase public transport mode share (primarily bus) and reduce the reliance on private motor transport in this part of Brisbane City to support the achievement of non-vehicular mode share targets for the region.

In order for this proposed link to fulfil the overall goal, the route should meet a number of key objectives:

- Maximise the potential active transport catchment by integrating with existing networks on both sides of the Brisbane River;
- Align as closely as possible with local (and wider) desire lines, and provide access to major attractors on both sides of the river;
- Facilitate access by users of all abilities and needs (including people with disabilities, less confident/strong cyclists, parents with prams, children etc.);
- Maintain access along the river for vessels that can currently traverse this section of the river; and
- Avoid designs that are likely to contribute to afflux[1] upstream.

[1] Afflux – an increase in water level that can occur upstream of a structure, that creates an obstruction in the flow.

3 Methodology

The methodology employed on this project is outlined below:

- Stage 1: Project Understanding;
- Stage 2: Options Development and Feasibility Review; and
- Stage 3: Project Reporting.

3.1 Stage 1 – Project Understanding

This phase involved a review of the project objectives and data, and included:

- An inception meeting with TMR representatives;
- Information gathering to understand the existing situation: including AT and PT networks / services, land use, environmental parameters, topography etc.;
- A review of previous studies undertaken on/along the corridor (based on information supplied by TMR);
- A review of the constraints and opportunities in the study area;
- A site visit / saddle survey undertaken with BCC and TMR to review the key features and constraints of the study area and to confirm the key desktop based assumptions; and
- A review of the potential usage of an active transport link based on assessment of existing public transport usage data.

The results of the above are summarised in Sections 4 to 9 of this report.

3.2 Stage 2 – Options Development and Feasibility Review

Following the review of project data in Stage 1, a number of potential route options were developed. These options accounted for local conditions based on data collected in Stage 1.

The options developed were then reviewed through a SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis and an MCA (Multi Criteria Analysis) to identify the routes most likely to be feasible for further analysis.

The standards and assumptions used in developing the route alignment options are presented in the Design Basis Report.

3.3 Stage 3 – Project Reporting

This report summarises the outcomes of the study and includes recommendations for additional work to be undertaken following the finalisation of this study.

N/R

4 Existing Situation

4.1 Connectivity

Bulimba and Teneriffe are located to the north-east of the Brisbane CBD, along a section of the Brisbane River that currently lacks any permanent crossing facilities. The nearest permanent crossing infrastructure includes the Story Bridge (approximately 4km upstream of the study area) and the Sir Leo Hielscher bridges (over 5km downstream of the study area) for all modes of transport including pedestrians and cyclists. For active travel purposes only, the nearest dedicated walk and cycle crossing is the Goodwill Bridge approximately 7km from this location. This is shown in **Figure 3**.

The ability to cross the River in the study area, is facilitated by public transport ferry services situated at stops including New Farm, Teneriffe, Hawthorne, and Bulimba. The existing public transport options for residents wishing to cross the river between Bulimba and Teneriffe include:

- CityCat ferry services;
- Cross river ferry services; and
- Bus (via the Story Bridge, or via the City).

In addition to the above, the Cleveland railway line passes to the east and south of the study area. However, Morningside (the closest railway station to the suburb of Bulimba) is located over 1km from the river and the train follows a circuitous route to the city and the Fortitude Valley. As such, it is not considered to be a convenient option for the current community living in Bulimba on the right bank.

It is noted that a future bridge crossing connection between Bulimba and Teneriffe will not only benefit those people with trips immediately starting and ending on either bank of the river, but also those undertaking longer journeys with a destination beyond these suburbs. In particular, it is considered that residents of adjacent suburbs travelling towards Fortitude Valley and the Brisbane CBD could also benefit from a bridge crossing in this area such as those who already currently regularly commute via Lytton –Wynnum Road.

In order to explore the potential attractiveness / demand for a crossing, we have considered the existing situation for people travelling from Bulimba to Teneriffe and onwards to Fortitude Valley and the CBD – via ferry and bus. This considers that:

- Public transport currently provides the fastest method for crossing the Brisbane River at this location; and
- The proposed active transport bridge will exclude general vehicular traffic access (in response to the brief). Hence the review has excluded an analysis of existing private vehicle trips as these are less likely to be shifted following the construction of the active transport bridge. However this does not refute the likelihood that a mode-change may occur as a result of the attractiveness, and convenience of the connection, particularly non-commuting trips.

The existing transport options and their utilisation are explored in the following subsections:

- Section 4.2: CityCat and Cross River Ferry services;

N/R

- Section 4.3: Bus services;
- Section 4.4: GoCard data analysis;
- Section 4.5: Existing road and path network; and
- Section 4.6: Crash and safety analysis.

Deliberation

4.2 CityCat and Cross River Ferry

The CityCat is a catamaran service operated by Transdev Brisbane Ferries on behalf of Brisbane City Council, and is a Translink service. Services typically operate between the University of Queensland St Lucia campus to Northshore Hamilton, with some peak hour short running and/or express services.

Services operate with a 15-minute frequency during the majority of the day (weekdays and weekends), with higher frequency during peak hours, and lower 30-minute frequency in the early morning and in the evenings.

Within the study area, the Citycat makes four stops, (in order from upstream to downstream) New Farm Park, Hawthorne, Bulimba and Teneriffe. All four ferry terminals are within Translink's Zone 2. These terminals are shown in **Figure 5** to **Figure 8**.

N/R

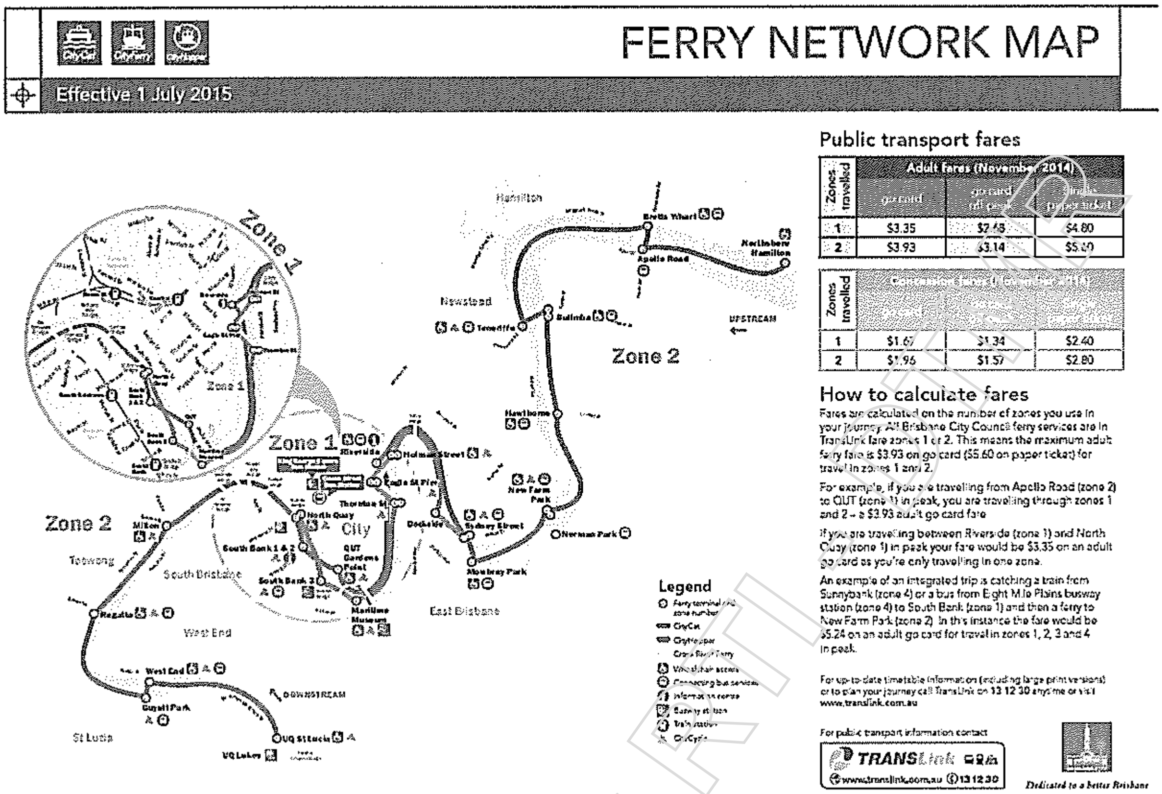


Figure 4 Brisbane City ferry network map (Source: TransLink.com.au)

The Cross River Ferry is a standard ferry service also operated by Transdev Brisbane Ferries for Brisbane City Council, and is also a Translink service. Within the study area, the main Cross River Ferry route is between the Teneriffe and Bulimba ferry terminals.

The Cross River Ferry supplements the CityCat service between these two terminals, effectively doubling the frequency to at least eight (8) crossings per hour in each direction through most of the day. Travel time between Bulimba and Teneriffe is approximately four to five minutes one-way depending on whether a CityCat or a Cross City Ferry operates the service.

A second Cross River Ferry service also operates at the southern end of the study area between New Farm Park and Norman Park, with a 15 minute frequency. However, this service has not been investigated further in this report as Norman Park ferry terminal is outside the scope of this study.

N/R

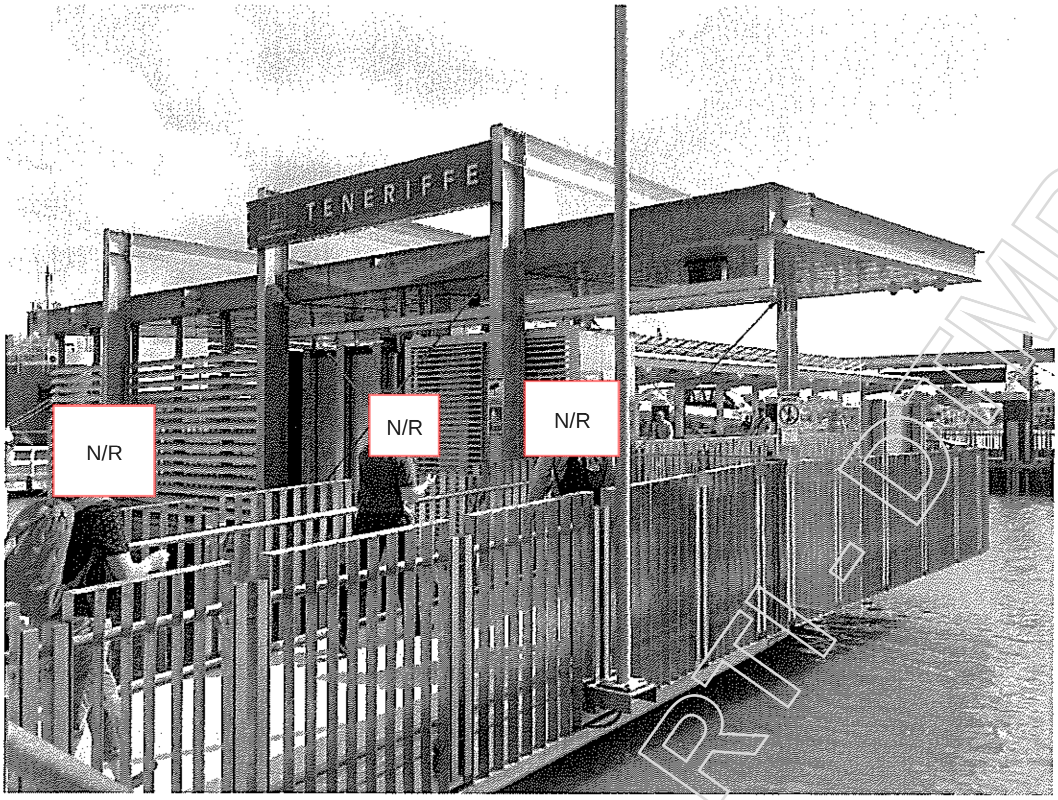


Figure 5 Teneriffe Ferry Terminal (source: Arup)

Figure 6 Bulimba Ferry Terminal (source: Arup)

N/R

Figure 7 Hawthorne Ferry Terminal (source: Arup)

Figure 8 New Farm Ferry Terminal (source: Arup)

4.3 Bus Connections

There are currently no direct bus services between Bulimba and Teneriffe, with passengers travelling between these suburbs being required to transfer in the CBD. The key routes on the Bulimba side are route 230 and 235, supplemented during peak hour by P231 and P236. All services operate between Bulimba and the City and Fortitude Valley.

N/R

Both routes 230 and 235 operate every 30 minutes throughout the day, with higher frequencies during peak hour.

The Bulimba bus routes are shown in **Figure 9**.

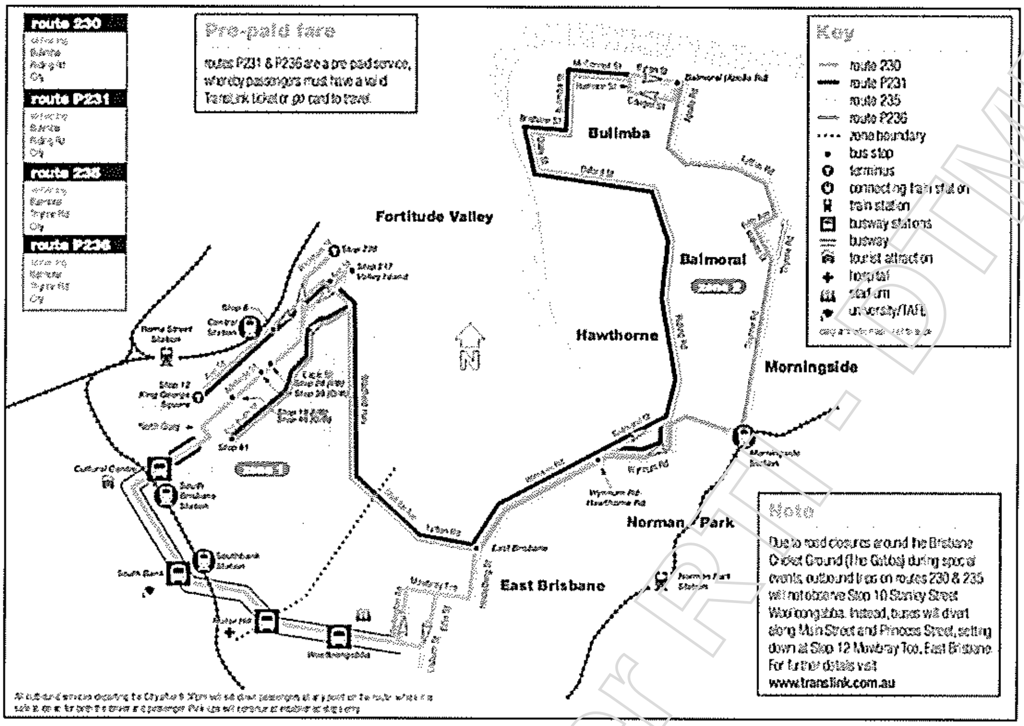


Figure 9 Key bus routes through Bulimba and Hawthorne (Source: Translink.com.au)

The key bus routes on the Teneriffe side of the river are the Blue Cityglider (also known as route 60) and route 199. Both of these are high frequency routes (every 10-15 minutes or better throughout the day) and operate between Teneriffe ferry terminal and West End ferry terminal. Both services also operate throughout the night on Friday and Saturday.

Other less frequent routes (operating hourly) to and from Teneriffe include the 470 to Toowong and the 393 to RBWH.

The 199 and Cityglider routes are illustrated below in **Figure 10** and **Figure 11**.

N/R

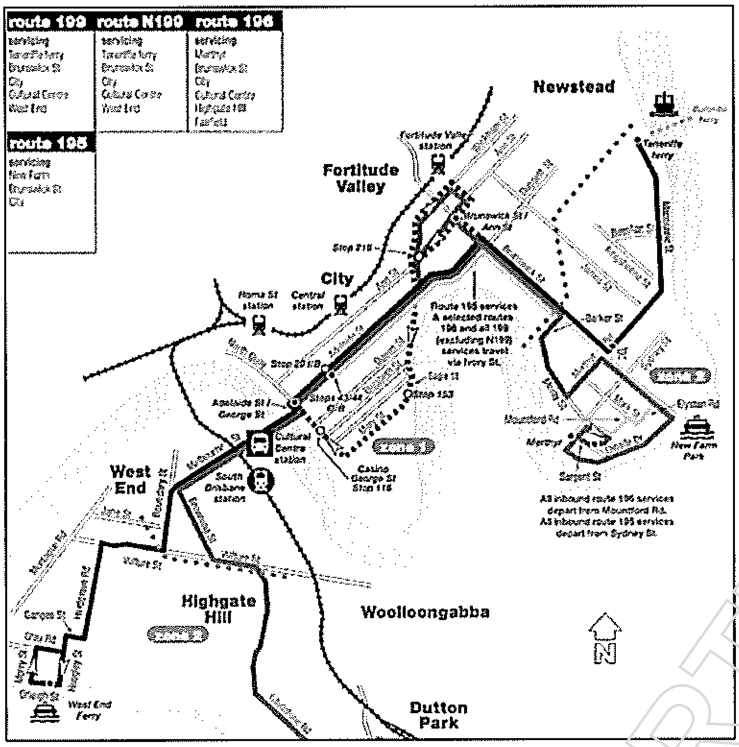


Figure 10 Bus 199 route map (Source: TransLink.com.au)

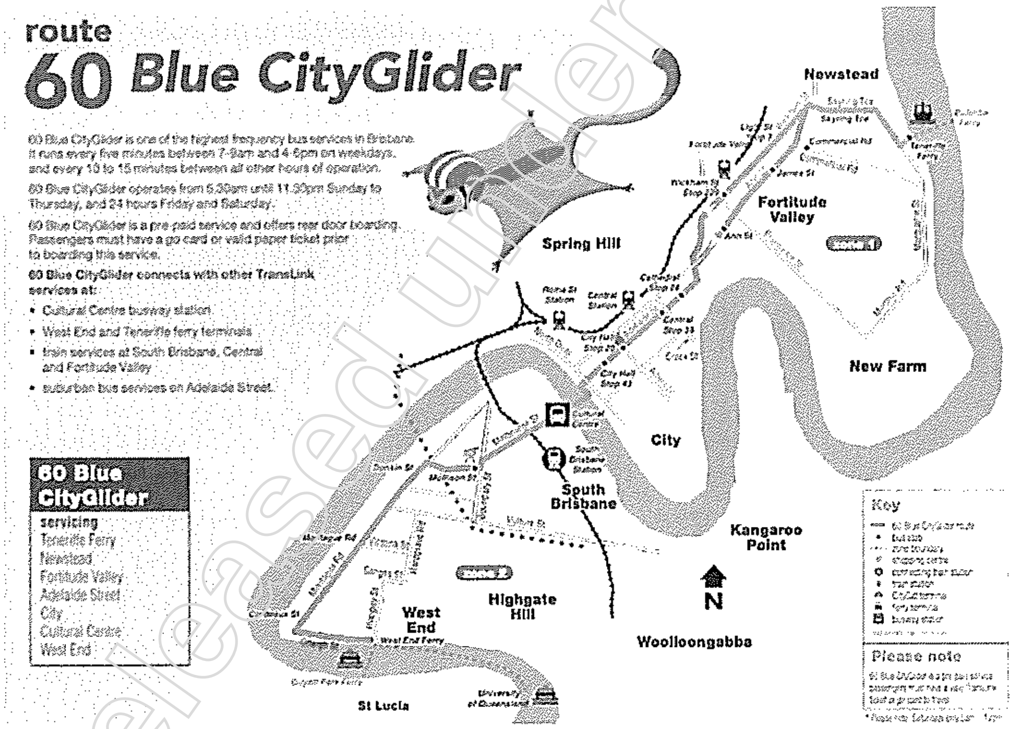


Figure 11 Blue Cityglider route map (Source: TransLink.com.au)

N/R

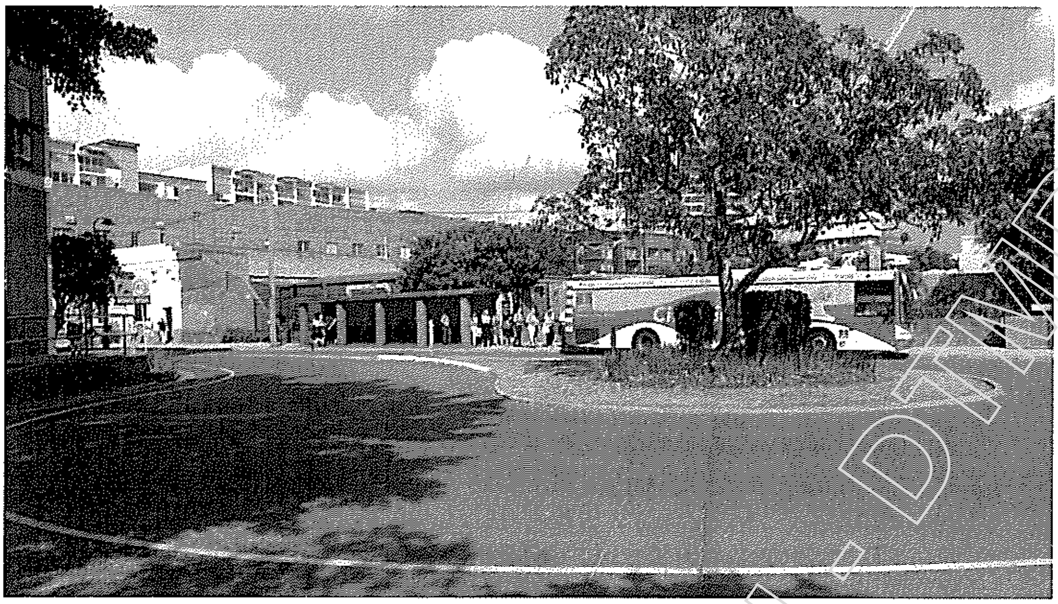


Figure 12 Teneriffe bus stop (source: Arup, 2015)

4.4 Current cross-river demand

As there are no current permanent river crossings between Bulimba and Teneriffe, latent demand for an active transport link at this location has been estimated using data for other transport modes and routes. Three different sets of data were reviewed to understand the current crossing patronage, and to assist with understanding potential future users and demand:

- existing public transport patronage on the cross river ferry services (refer to Section 4.4.1);
- Overall PT patronage between Bulimba and the City / Fortitude Valley (refer to Section 4.4.2); and
- Existing cycle mode share on ferries services (refer to Section 4.4.3).

4.4.1 Current Cross River Ferry Demand

An analysis of the existing demand for river crossings between Bulimba/Hawthorne and New Farm/Teneriffe has been conducted using *go* card data supplied from TransLink. The data includes passenger trips on CityCat, Bulimba to Teneriffe Cross River Ferry and Norman Park to New Farm Park Cross River Ferry services.

Daily trips were averaged over four weeks, between the 9th and 22nd of March 2015 and between the 12th and 25th October 2015.

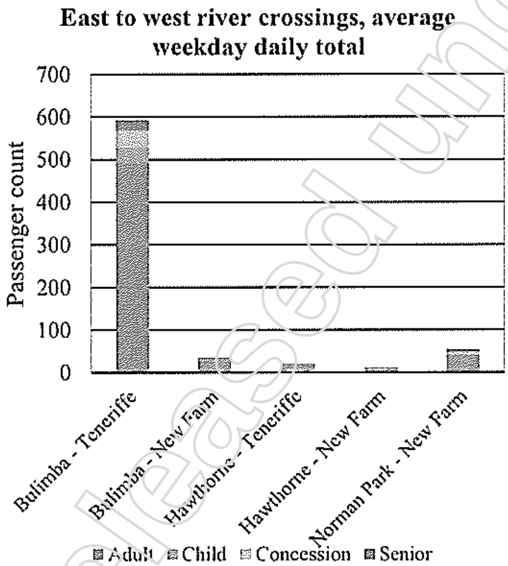
Passenger counts are shown in **Table 1** for weekdays and **Table 2** for weekends. A breakdown of the passenger types using each link is shown in **Figure 13**.

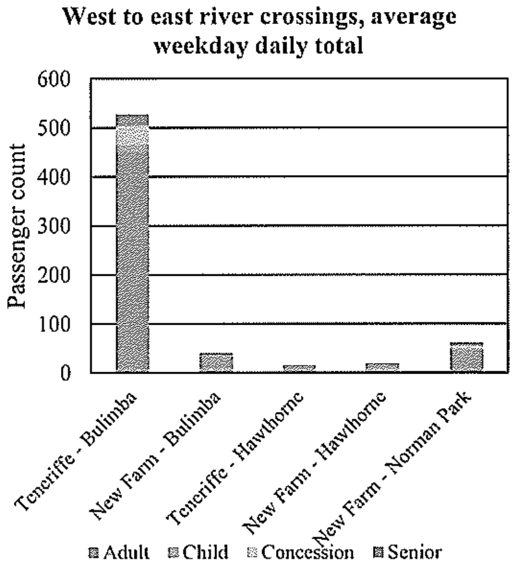
Table 1 **Average weekday ferry river crossings**

East terminal	West terminal	East - west passenger count Daily total	West – east passenger count Daily total
Bulimba	Teneriffe	592	527
Bulimba	New Farm	35	40
Hawthorne	Teneriffe	22	16
Hawthorne	New Farm	12	19
Norman Park	New Farm	54	62
Total per direction		**715**	**664**
Total river crossings		**1380**	

Table 2 **Average weekend ferry river crossings**

East terminal	West terminal	East - west passenger count Daily total	West – east passenger count Daily total
Bulimba	Teneriffe	246	226
Bulimba	New Farm	80	8
Hawthorne	Teneriffe	10	78
Hawthorne	New Farm	32	36
Norman Park	New Farm	67	57
Total per direction		**435**	**404**
Total river crossings		**839**	





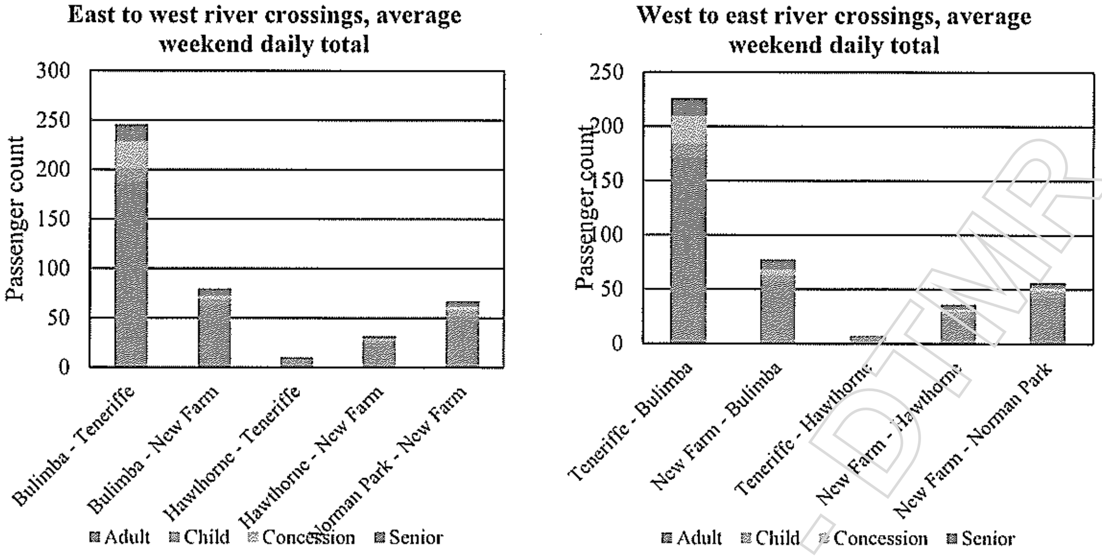


Figure 13 Passenger type breakdown of ferry river crossings

The profile of river crossings throughout the day is shown in **Figure 14**. The profiles show that there is a defined morning peak (7:00am – 8:00am) for the east – west direction, and evening peak (5:00pm – 6:00pm) for the west – east direction on weekdays. The data also indicates that most of the cross-river traffic is by adults, with children, students and seniors forming a much smaller proportion of traffic.

There is a small school peak at 6:30am-7:30am and 3:30pm-4:30pm, but even during those periods, most of the passengers are adults.

On weekends, there are no significant peaks, and the portion of children, concession and senior passengers is higher than during the week.

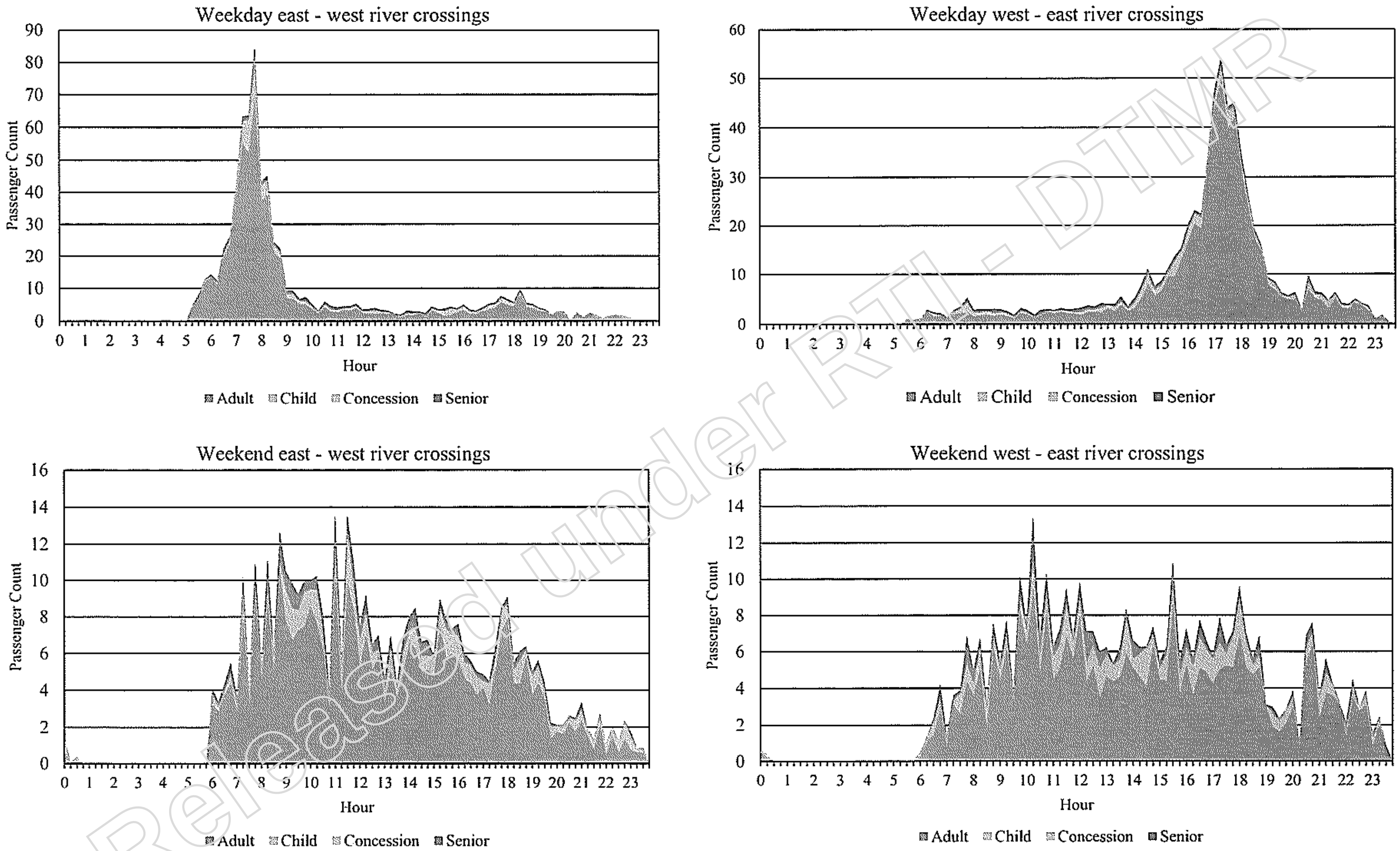


Figure 14 Daily profile of ferry river crossings

4.4.2 Overall public transport demand from Bulimba to the City and Fortitude Valley

Go card data from one week (9th – 15th March 2015) was analysed to assess the attractiveness between Bulimba/Hawthorne and the Brisbane CBD/Fortitude Valley.

All passenger journeys starting and ending in the areas of interest were included, regardless of whether they transferred between services or modes during their journey.

Average daily results are shown in Table 3 for weekdays, and Table 4 for weekends. The breakdown of passengers is shown in Figure 15. Figure 16 shows the profile of journeys throughout the day.

Table 3 Average daily weekday journeys between Bulimba/Hawthorne and the CBD/Fortitude Valley

Outbound Location	Inbound Location	Inbound Trips	Outbound Trips
Bulimba	Brisbane City	1432	1299
Bulimba	Fortitude Valley	12	39
Hawthorne	Brisbane City	184	430
Hawthorne	Fortitude Valley	1	51
Total		**1628**	**1820**

Table 4 Average daily weekend journeys between Bulimba/Hawthorne and the CBD/Fortitude Valley

Outbound Location	Inbound Location	Inbound Trips	Outbound Trips
Bulimba	Brisbane City	314	254
Bulimba	Fortitude Valley	5	6
Hawthorne	Brisbane City	21	51
Hawthorne	Fortitude Valley	0	10
Total		**340**	**320**

The data shows a strong connection between Bulimba and Brisbane City. This is likely to to be due to the high frequency of services between Bulimba and Teneriffe, with residents able to connect onwards to Blue Cityglider and 199 services to the City.

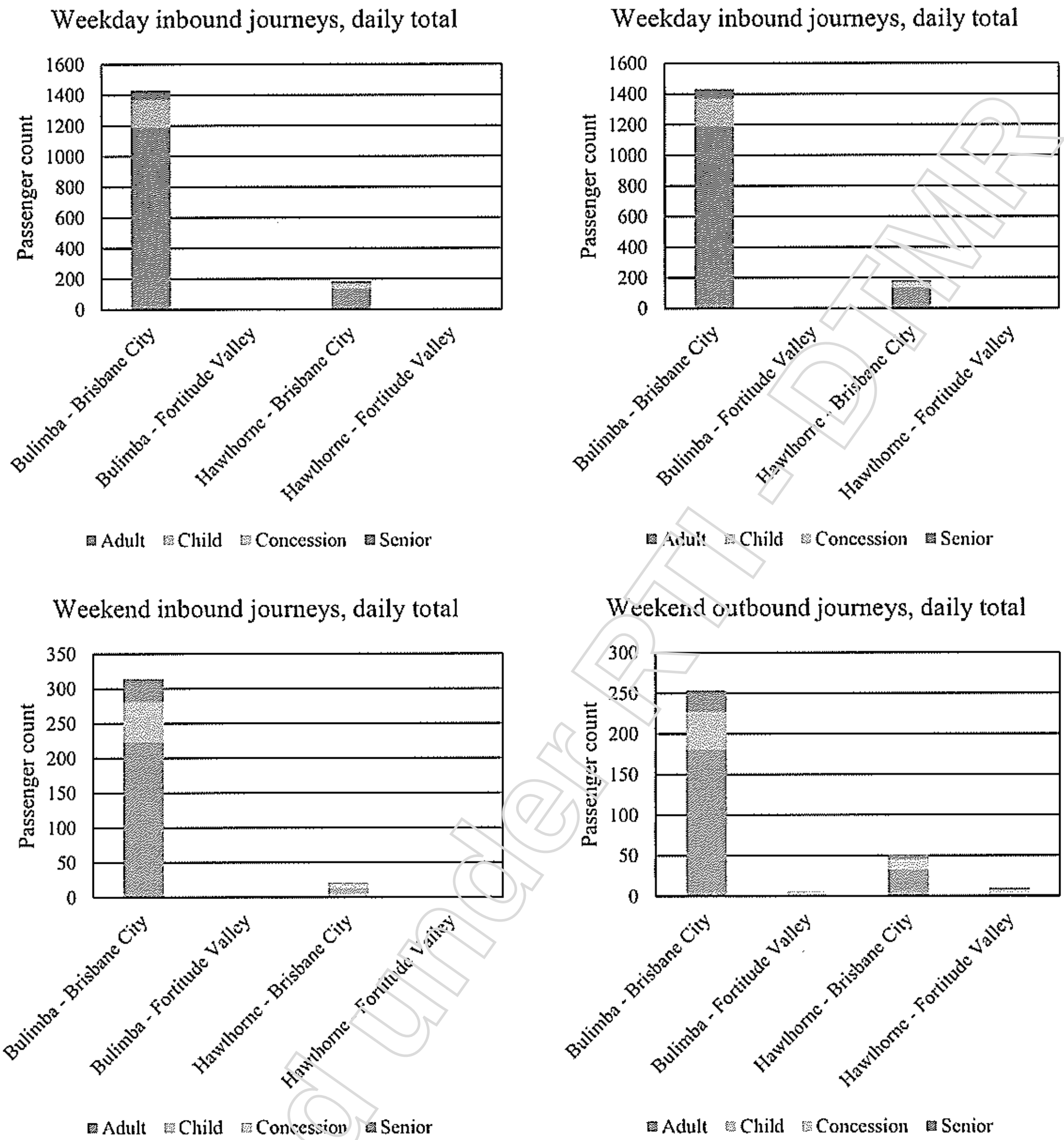


Figure 15 Passenger type breakdown of journeys between Bulimba/Hawthorne and the CBD /Fortitude Valley

N/R

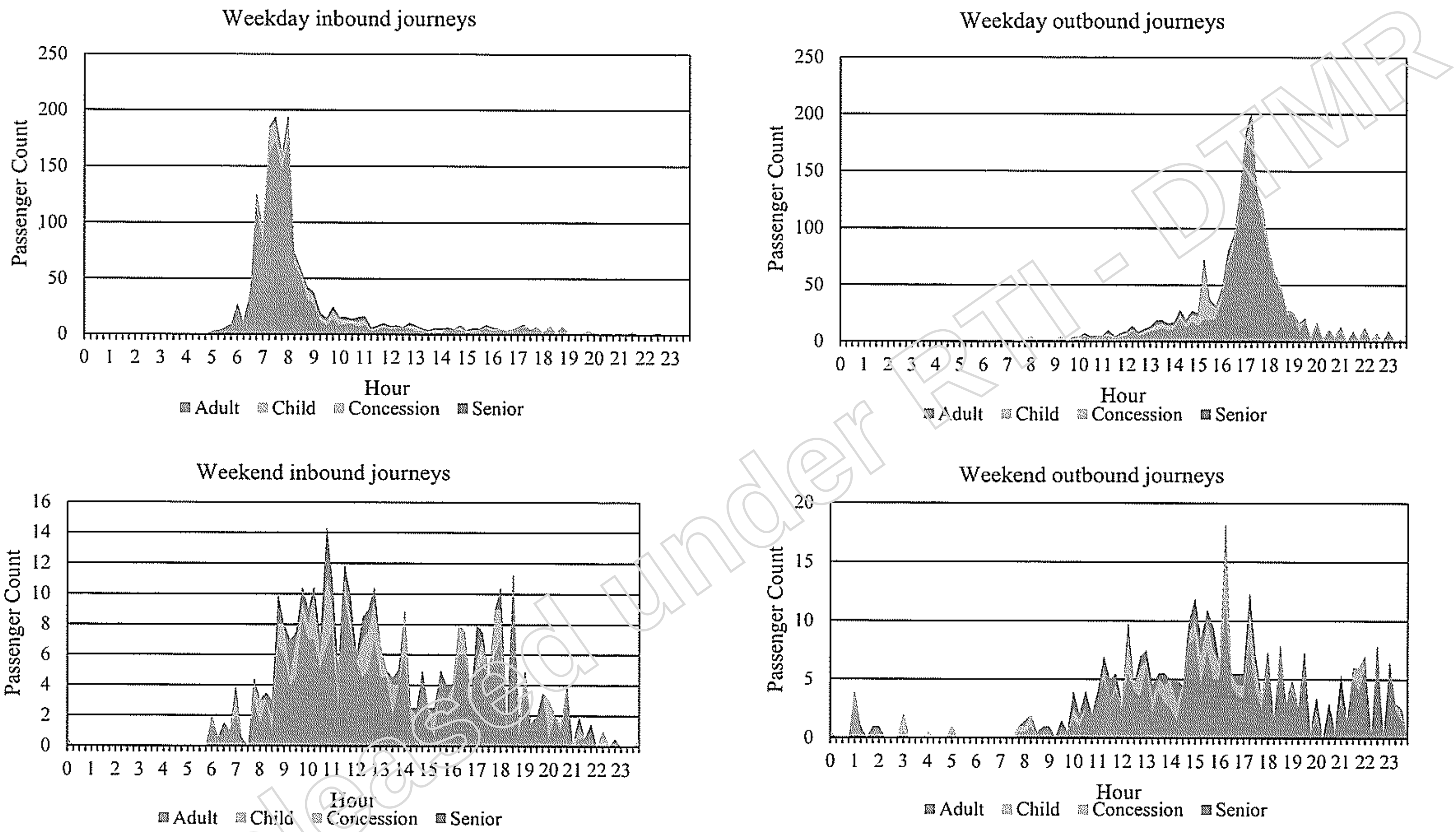


Figure 16 Daily profile of journeys between Bulimba/Hawthorne and the CBD/Fortitude Valley

N/R

4.4.3 Existing cycle demand

As current go card ticketing does not provide any statistics for whether a customer is travelling with their bicycle across the Brisbane River by ferry, we have sought existing network count data from other available sources, which is described in further detail below.

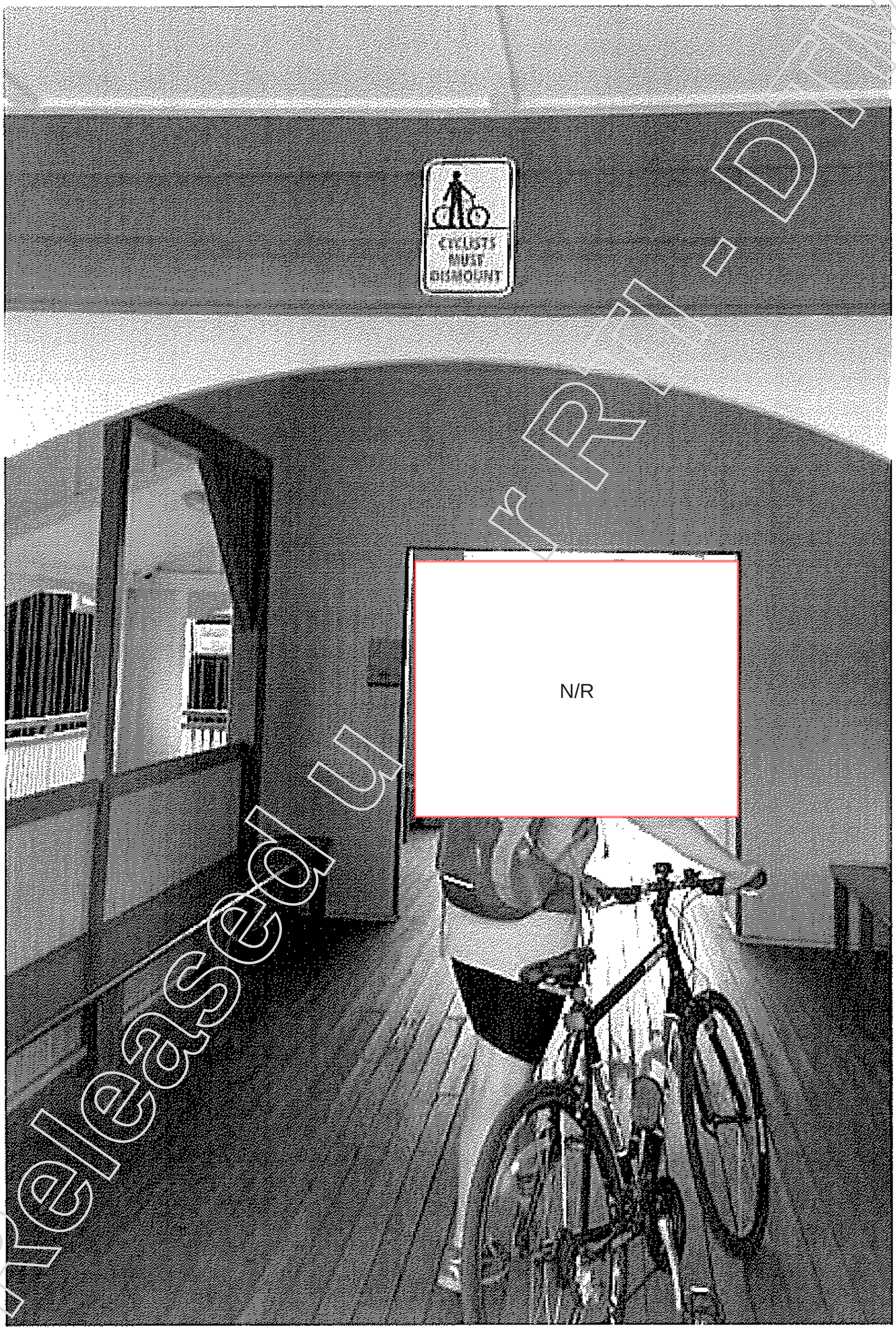


Figure 17 Observed rider at Bulimba Ferry Terminal (source: Arup, 2015)

N/R

4.4.3.1 Cyclists Surveys 2009

Griffith University's Urban Research Program (URP) in partnership with Brisbane City Council and the Department of Transport and Main Roads undertook a series of data collection surveys at several locations on Brisbane's bikeway network. One of these locations was at the entrance to the Bulimba Ferry terminal. The data was collected on Thursday 20 August 2009, over a three hour period between 06:00am and 09:00am. The data collected included the cyclist gender, age, attire, and whether they were wearing a helmet. In addition, intercept surveys were also undertaken to understand cyclists' trip origin, trip destination and purpose. Additional data was also captured from participants willing to complete a more detailed questionnaire.

The field tally sheet for cyclists travelling by ferry from the Bulimba Ferry terminal is shown in **Table 5**. The results illustrate that between 6am and 9am, 61 riders crossed with their bicycles, of which 74% were male, 80% adults, and the majority travelling towards the City.

Cyclists captured at this location, also indicated the self-reported routes used, as illustrated in **Figure 18**. This illustrates a strong desire-line between Bulimba and Teneriffe, Oxford Street, Commercial Road, and the river path network towards the CBD/Fortitude Valley. It also illustrates a desire line along the River linking with Hawthorne ferry terminal and New Farm Ferry terminal. The majority of these respondents had indicated that their trip purpose was for work.

N/R

Table 5 Field tally sheet data showing cyclist use of the bikeway at Bulimba Ferry Terminal (Source: GU URP, 2009)

BULIMBA FERRY TERMINAL													
Time Period	Cyclists	Gender		Demographic			Helmet	No Helmet	Attire			Direction	
		Male	Female	Child	Teen	Adult			Sport	Work	Other	City	Outbound
0600-0614	4	3	1	0	0	4	4	0	1	0	3	4	0
0615-0629	1	1	0	0	0	1	1	0	0	0	1	1	0
0630-0644	7	6	1	0	1	5	7	0	0	0	7	7	0
0645-0659	8	8	0	4	1	0	8	0	3	0	5	4	4
0700-0714	4	3	1	0	0	4	3	1	2	0	2	2	2
0715-0729	8	4	4	1	1	6	8	0	2	1	5	7	1
0730-0744	7	6	1	0	0	7	6	1	2	2	3	6	1
0745-0759	5	3	2	0	0	5	4	1	2	0	3	5	0
0800-0814	7	4	3	0	0	7	6	1	2	1	4	7	0
0815-0829	5	3	2	0	0	5	5	0	2	0	3	5	0
0830-0844	3	3	0	0	0	3	3	0	0	1	2	3	0
0845-0859	2	1	1	0	0	2	1	1	0	0	2	1	1
Total	61	45	16	5	3	49	56	5	16	5	40	52	9
	100%	74%	26%	8%	5%	80%	92%	8%	26%	8%	66%	85%	15%

N/R

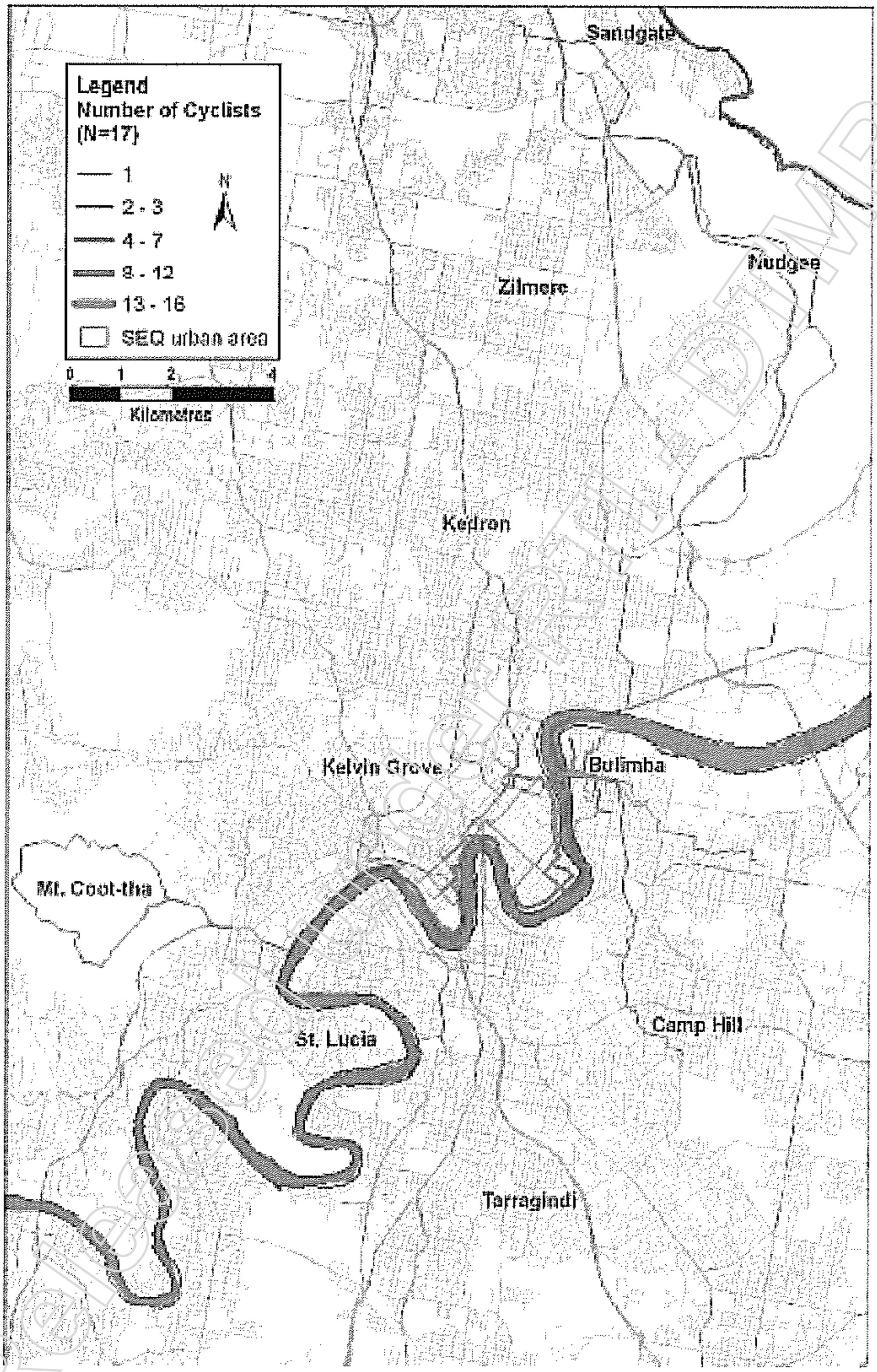


Figure 18 Self reported routes of questionnaire repsondants intercepted at Bulimba Ferry Terminal (Source: GU URP, 2009, Map 5)

N/R

4.4.3.2 Strava HeatMap

With reference to available Strava shared cycling data, captured through GPS enabled devices, an indication of the current cycle route preferences, and behaviours can be presented for the study area. **Figure 19** illustrates the immediate study area, and the broader catchment including Bulimba, Hawthorne, Balmoral, Murrarie to the east, and Brisbane CBD, Fortitude Valley, New Farm, Teneriffe, and West End to the west.

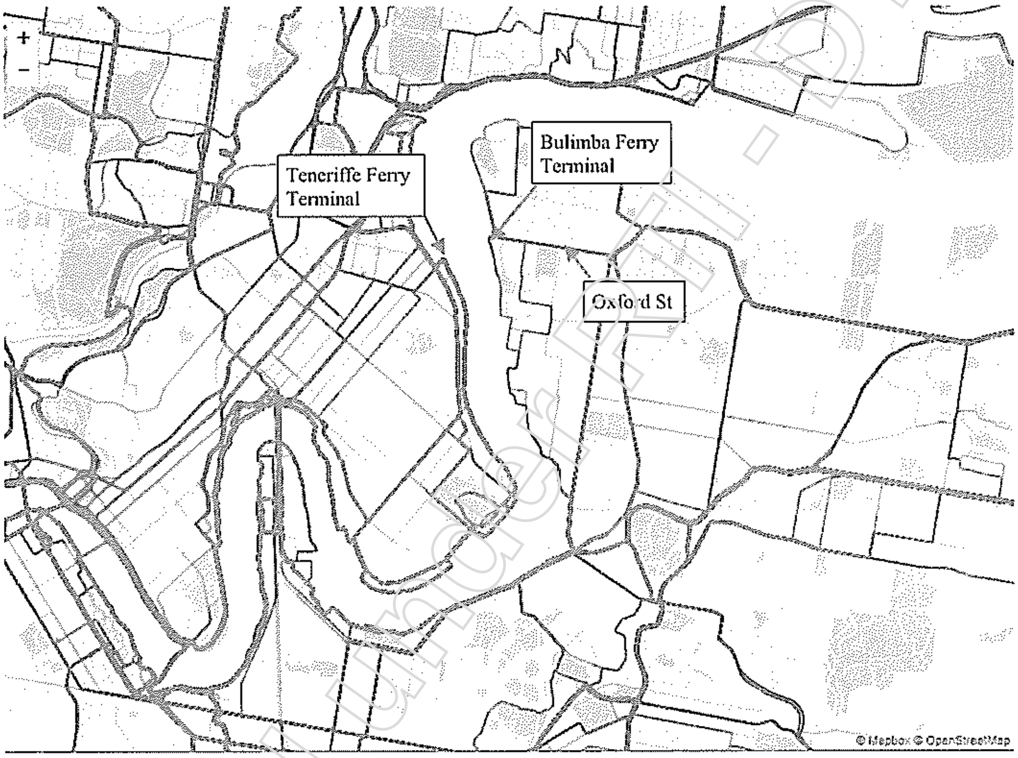


Figure 19 Usage of routes by Strava users (Source: Strava Global HeatMap)

The following observations can be made from the Strava heatmap:

- A cross river desireline at Bulimba-Teneriffe reflecting the use of the current ferry services linking Oxford Street, with the river paths, and Commercial Road to Ann Streets;
- Strong parallel desire lines along Wynnum Road, and Lytton Roads coupled with linkages via Hawthorne Road, Riding Road and Thyme Road as routes through the study area;
- Through Newfarm/Teneriffe a strong preference towards the river path network, Skyring Terrace to Ann/Wickham Streets, Merthyr Road, as well as the local cycle route via Arthur Street (rather than Kent Street); and
- An opportunity to strengthen the principal cycle route function of Oxford Street, with a permanent crossing.

4.5 Existing Road and Path Network

Most of the existing streets in the vicinity of the river are classified as "Neighbourhood Roads" within the Brisbane City Council planning scheme road hierarchy. These streets feed into the designated "District roads" in each suburb, which are:

- On the left bank:
  - Vernon Terrace / Macquarie Street
  - Commercial Road
  - Merthyr Road
- On the right bank:
  - Hawthorne Road
  - Oxford Street

This indicates that most of the roads and streets in both suburbs are lower order roads, which do not serve a significant through traffic carrying function. The District Roads will, however, connect major land uses in the area.

Due to the potential for a significant number of cyclists and pedestrians to be using an active transport bridge at this location, sufficient supporting infrastructure is required to provide access and accommodate users on paths surrounding the bridge landing.

The existing infrastructure on the neighbourhood road network on the right bank (Hawthorne and Bulimba) is generally limited to footpaths typically on one side of the road, with limited on road bicycle facilities. This poses a constraint to the potential success of an active transport bridge in the area, with less confident and recreational cyclists (and to a lesser extent pedestrians) less attracted to the lower-order infrastructure available to access the bridge.

An active transport bridge, however, presents a key strategic opportunity to provide connections with the existing primary cycle routes in the area. These routes include popular off-road shared paths along both sides of the river, and a connection to these routes could allow the new active transport bridge activate a wider catchment of potential users.

The existing and proposed cycle network in the region is shown in **Figure 20** to **Figure 22**.

N/R

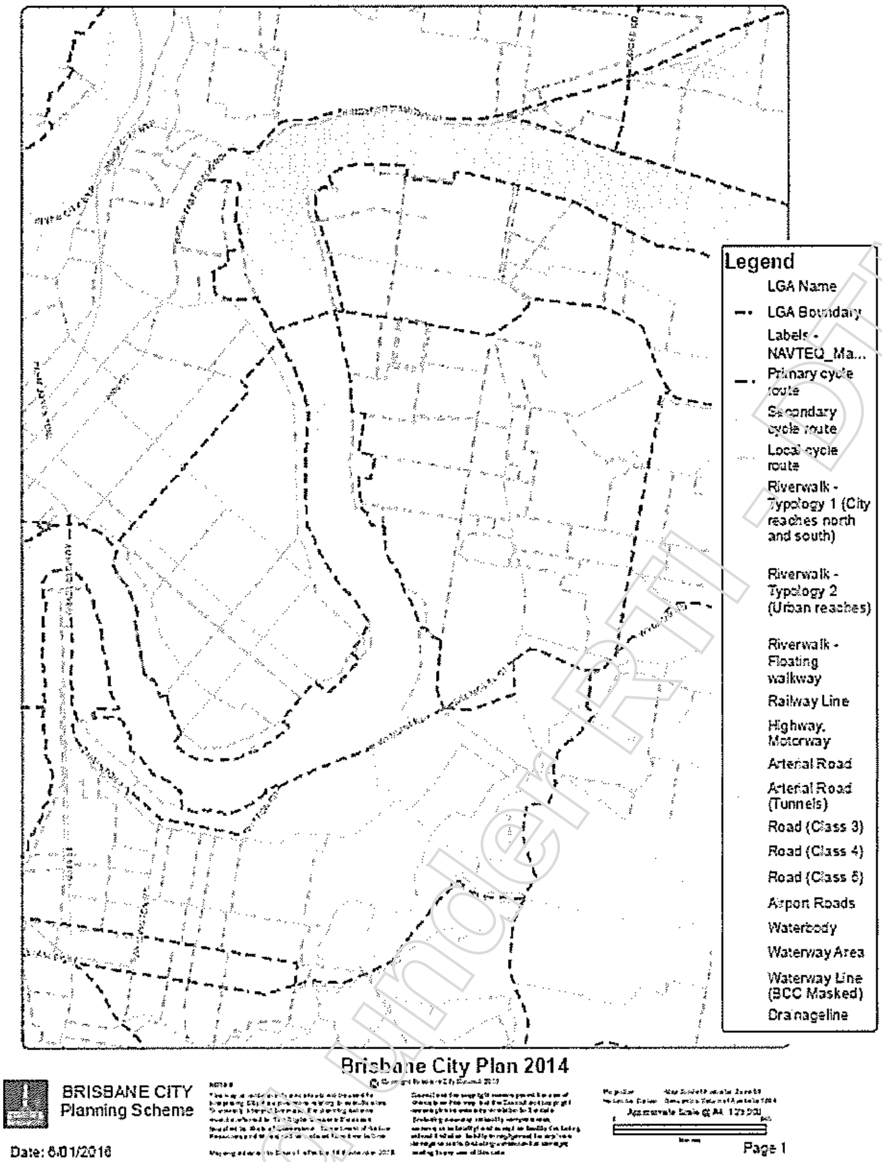


Figure 20 Brisbane City Plan 2014 - Bicycle route overlay

N/R

Brisbane City Council

Figure 21 Draft 2015 updated Principal Cycle Network

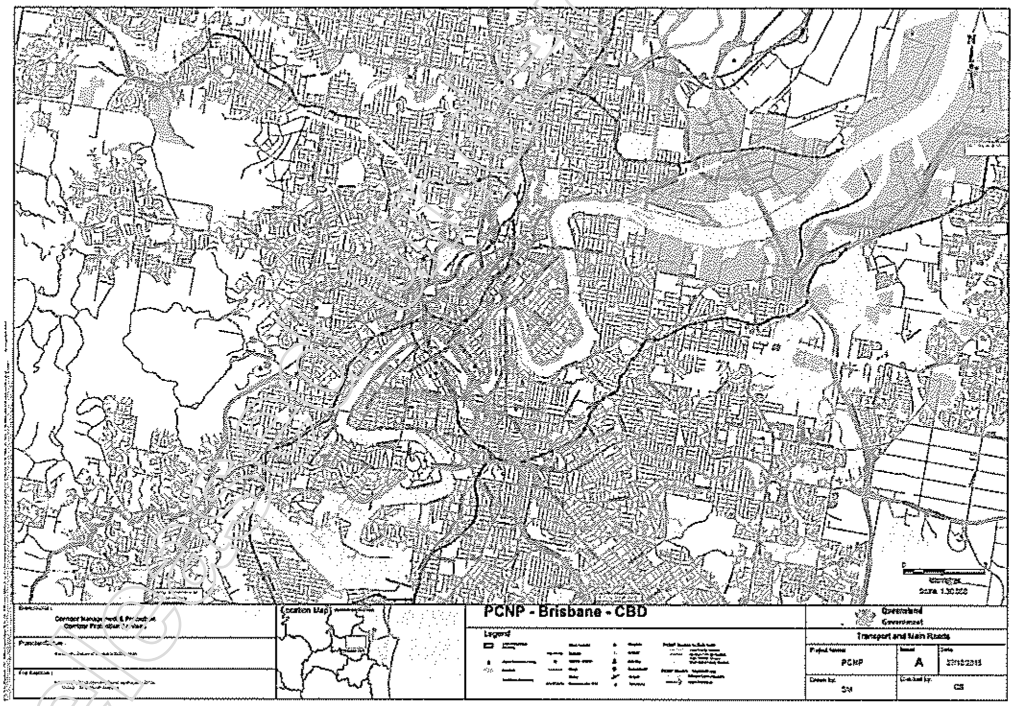


Figure 22 Draft PCNP – corridor protection plan (20xx)

N/R

4.6 Crash and safety analysis

4.6.1 Data source and methodology

A review of the crash history in the Bulimba-Teneriffe area was completed using data obtained from the Queensland Government open data website (http://data.qld.gov.au).

In order to identify crashes that would be relevant to the assessment of a proposed bridge, the data was refined to produce results based on locality, and then further refined to separate bicycle and non-bicycle related crashes. Consideration was also given to pedestrian crashes where recorded.

4.6.2 Crash review summary

Between 2006 and 2013, a total of 486 crashes were recorded in the Bulimba-Balmoral-Hawthorne area, and a further 302 crashes recorded within the New Farm-Teneriffe area. Further refinement revealed that there were 55 recorded bicycle crashes in the Bulimba-Balmoral-Hawthorne area, and 34 recorded bicycle crashes within the New Farm-Teneriffe area.

It was noted that the crashes on the right bank (the Bulimba-Balmoral-Hawthorne area) are generally located further away from each of the identified potential bridge landing sites, with the majority along Hawthorne Road and Riding Road. It was also noted that Oxford Street, the key primary cycle route towards the shore from the east, had relatively few crashes recorded.

This suggests that an active transport bridge between Bulimba and Hawthorne could provide a safer alternative for cyclists currently riding to the City via Hawthorne Road and Riding Road (and onwards to Wynnum Road). Instead of cycling along Hawthorne Road or Riding Road, which have an established crash history, cyclists could access the bridge crossing via various routes (including Oxford Street) and connect to an off-road cycle path that leads directly to the CBD (with some minor gaps in New Farm), which is a more direct and a significantly safer route as it is separated from motor vehicle traffic.

These crashes recorded on the right bank are discussed in general terms in Section 4.6.3, as they apply to all of the bridge options.

In contrast, the crashes recorded on the left bank (the New Farm-Teneriffe area) were recorded as being closer to each of the proposed potential bridge landing points. The crashes recorded on the left bank are discussed in more detail in relation to each bridge alignment option from Section 4.6.4 onwards.

4.6.3 Crashes on the right bank

On the right bank (the Bulimba-Balmoral-Hawthorne area), the crash history data showed that:

- Six bicycle related crashes occurred along Hawthorne Road;

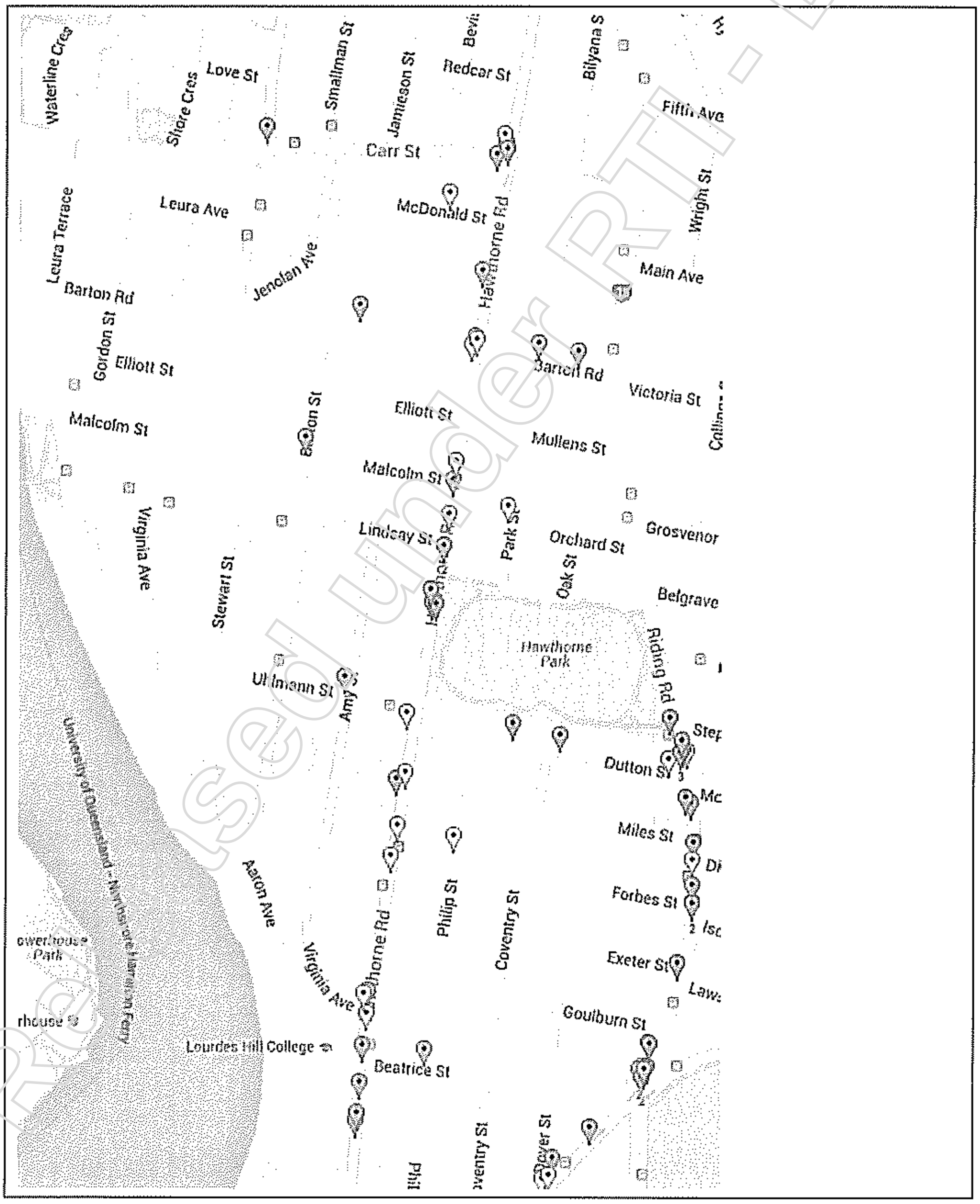
N/R

- Six bicycle related crashes occurred along Oxford Street; and
- The remainder of the bicycle related crashes occurred on side and feeder streets. However, no crashes were recorded in the immediate vicinity of any proposed bridge landings.

There were also a number of bicycle related crashes recorded along Riding Road, however, that was considered outside of the geographical scope for detailed analysis.

Hawthorne Road

The crashes recorded on the right bank of the river, including along Hawthorne Road, are shown in **Figure 23**.



N/R

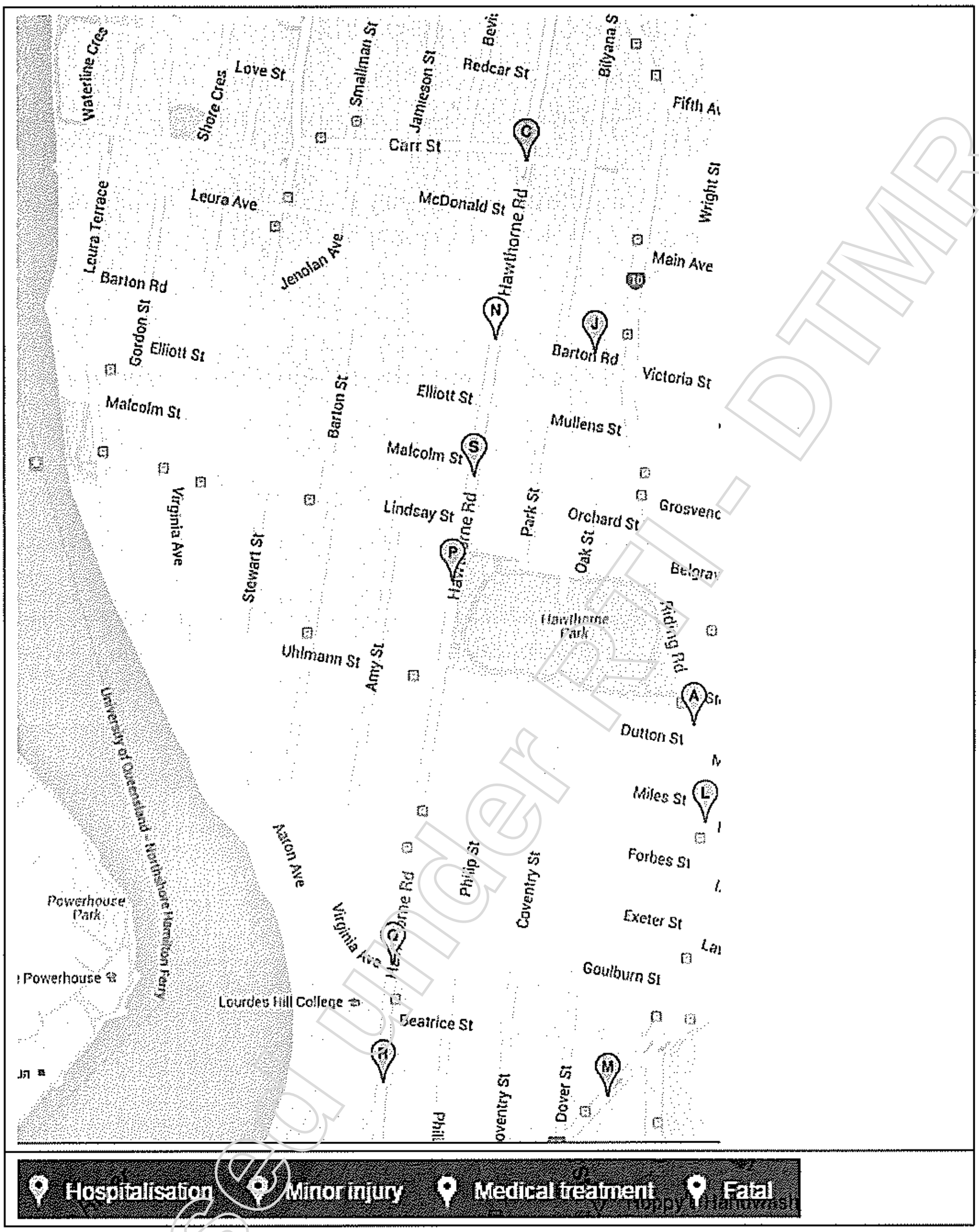


Figure 23 Recorded crashes in Bulimba and Hawthorne based on severity (all crashes on previous page, bicycle-involved crashes on this page) [2]

[2] Source: Queensland Government open data website (http://data.qld.gov.au)

N/R

Four out of the six bicycle related crashes recorded along Hawthorne Road required hospitalisation. Further investigation of the crashes along Hawthorne Road indicated that they were due to manoeuvring issues such as through-right collisions, or collisions for vehicles leaving driveways. Bicycle Awareness Zones are predominately used along Hawthorne Road, which has a 60kph road environment, and from experience a route more likely used by confident cyclists.

Although one of the crashes that occurred along Hawthorne Road was noted to involve a pedestrian, this was not considered to be sufficient to reflect a pattern of pedestrian safety issues in the area.

Due to the distance of Hawthorne Road to all of the bridge options, it is considered that the impacts are common across all options. As such, these crashes have not been considered further in this report.

Oxford Street

A total of five bicycle-related crashes were recorded along Oxford Street and on side streets near Oxford Street. Of these crashes, only three occurred on Oxford Street itself, with two crashes leading to hospitalisation.

Upon further review, it was noted that Oxford Street lacks any dedicated bicycle facilities, with cyclists sharing the road with only a reduced speed environment in support of mixed users. This has been noted as a potential concern, as this route is identified as a priority route on the Principal Cycle Network Plan.

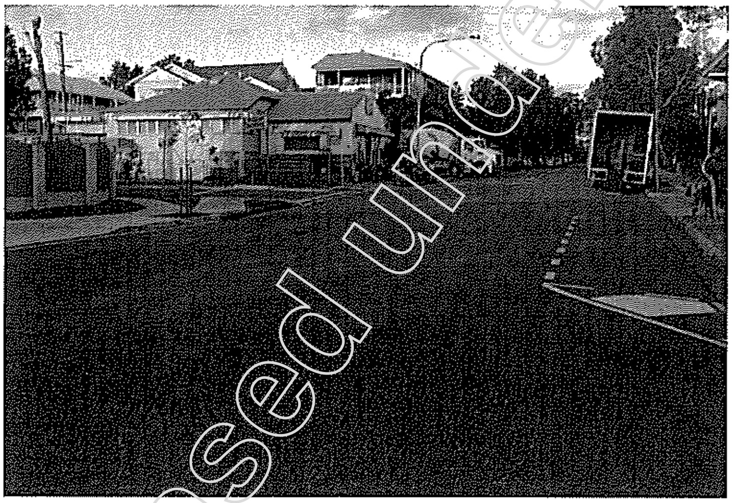


Figure 24 View of Oxford Street near Bulimba Ferry Terminal

Two of the crashes recorded along Oxford Street were noted to involve pedestrians. However, this was not considered to be sufficient to reflect a pattern of pedestrian safety issues in the area.

There were a large number of general vehicle crashes recorded along Oxford Street leading up to the Oxford Street / Lytton Road / Hawthorne Road roundabout. The presence of recorded crashes on the side streets in the area surrounding Oxford Street indicate a high turnover of parking and associated parking manoeuvres due to shopping and residential use.

N/R

Comparing the number of crashes (both bicycle related and non-bicycle related) recorded along Oxford Street against those recorded along Hawthorne Road, however, it can be seen that there are fewer crashes along Oxford Street. This is potentially due to lower travel speeds along the built-up section of Oxford Street, where a 40km/h posted speed limit applies.

The crashes recorded along Oxford Street are presented in **Figure 25**.

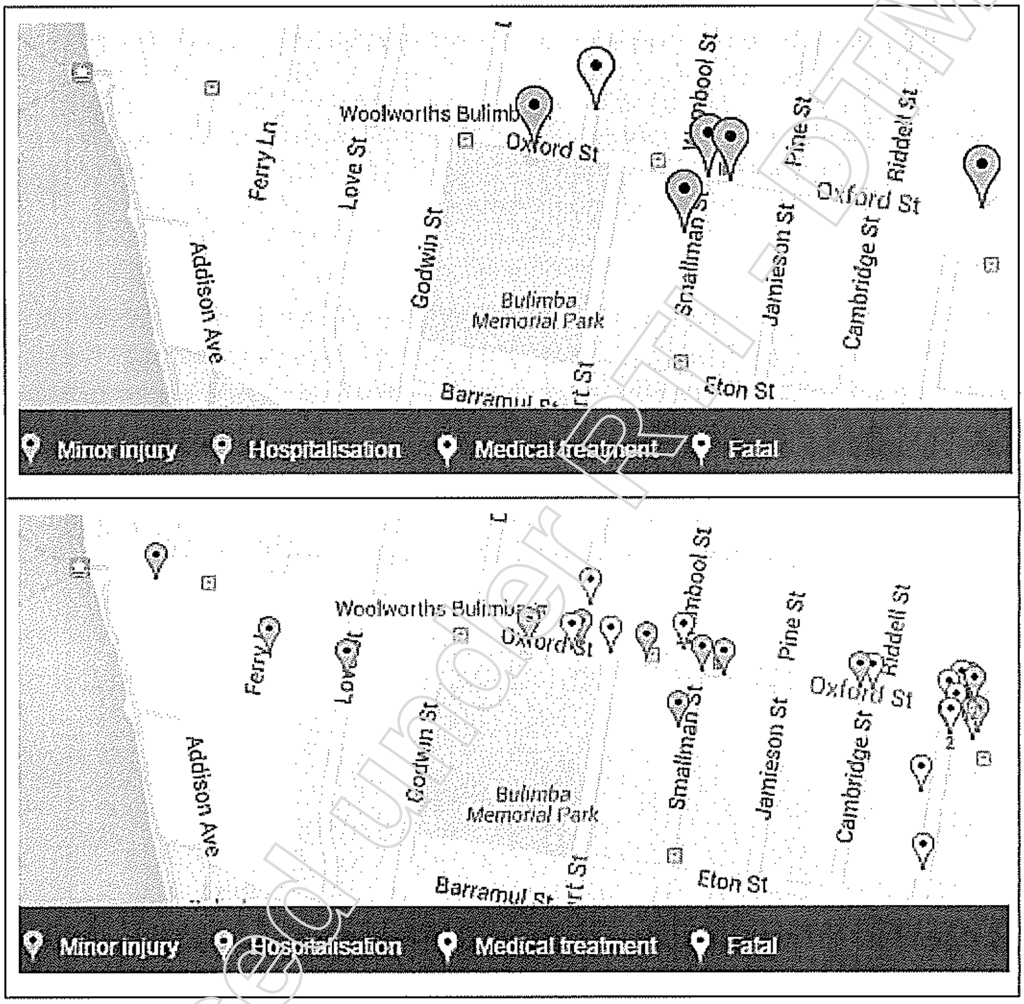


Figure 25 Crash map of recorded crashes along Oxford Street (top: crashes involving cyclists only, bottom: all crashes)

4.6.4 Crashes on the left bank

In comparison with the right bank, a higher number of crashes was recorded near the Brisbane River on the left bank, due to the layout of the local road network. As such, the crash analysis for this bank was separated in a number of sections to provide additional detail:

- In the vicinity of New Farm Park;
- Near Merthyr Road;

N/R

- Along Vernon Terrace; and
- Near Commercial Road.

Near New Farm Park

As seen in **Figure 26**, there were a number crashes recorded along Lamington Street and portions of Brunswick Street in the vicinity of the bridge landing. Of these recorded crashes, the most applicable bicycle related crashes are located in a cluster of three at the intersection of Sydney Street and Brunswick Street near the South-West corner of New Farm Park.

The severity of this crash cluster varied, with one only requiring medical treatment, another leading to minor injury and the most severe case requiring hospitalisation. In addition, there were also crashes recorded on Sargent Street, Moray Street and at the intersection of Moray Street and Merthyr Road. The majority of these crashes required hospitalisation. There were no recorded fatalities related to bicycles near the river in this area.

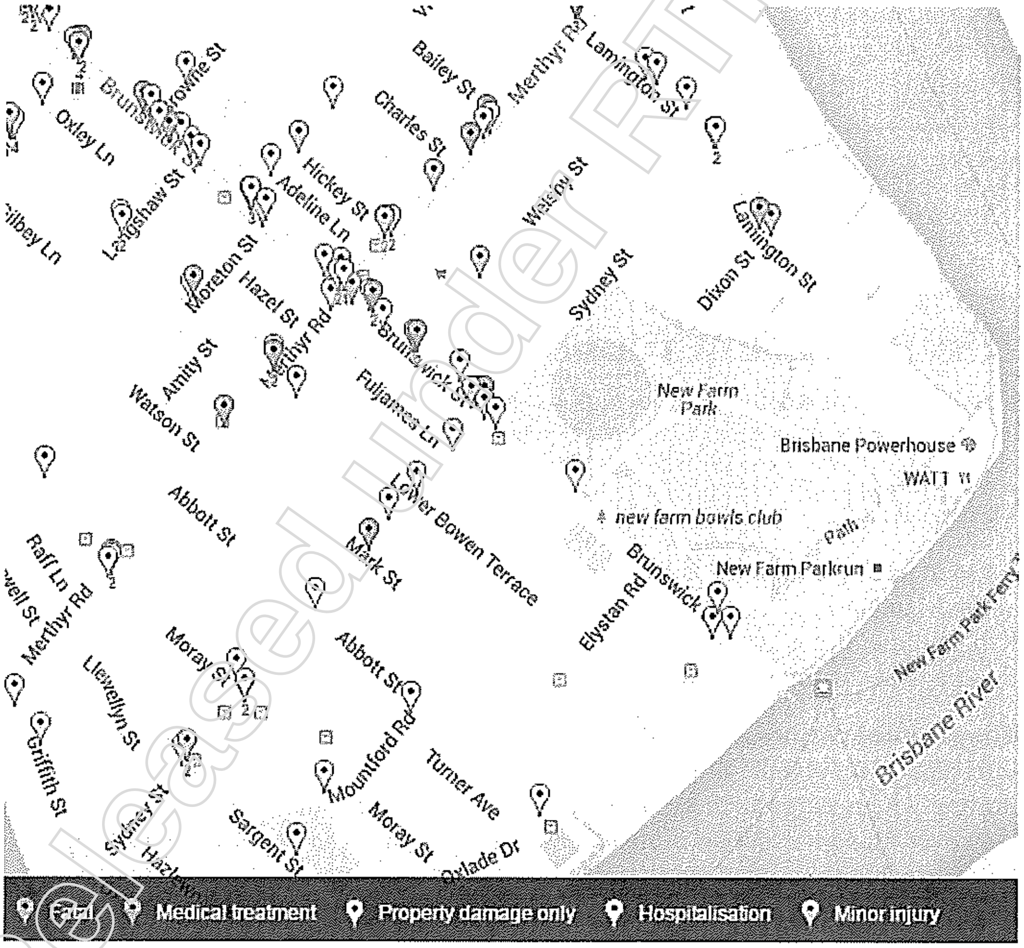


Figure 26 Crash map of recorded crashes in the vicinity of New Farm Park based on severity

N/R

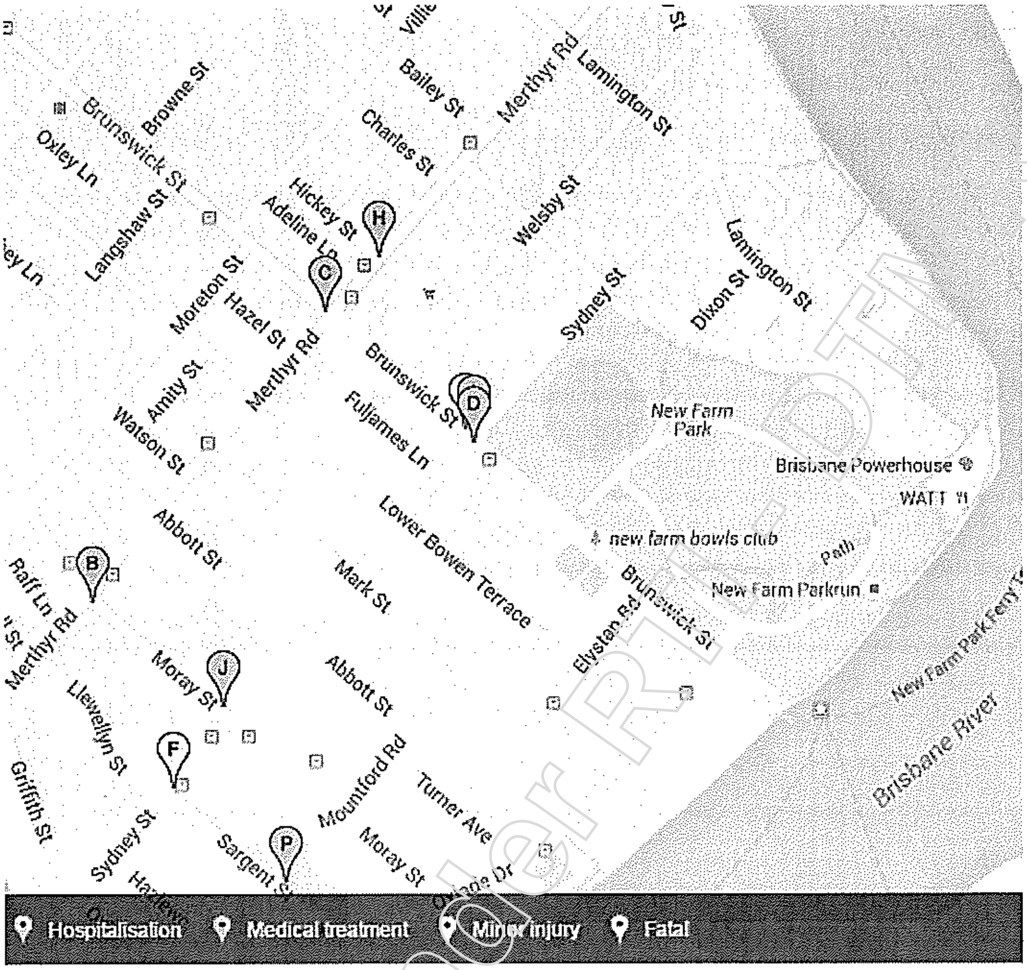


Figure 27 Map of recorded crashes with bicycle involvement based on severity

<u>Merthyr Road</u>

As seen in **Figure 28**, there are a set of three recorded crashes involving bicycles at the Macquarie Street / Gray Street / Merthyr Road and Macquarie Street / Kingsholme Street intersections. All three crashes led to hospitalisation, however these crashes were the only bicycle related crashes in this area.

The recorded crashes at the Macquarie Street / Gray Street / Merthyr Road intersection involved collisions from adjacent approaches and parallel lanes turning which suggests there could be visibility issues at the intersection. However, this intersection is also located over 200m from the proposed bridge landing, which should mean that there are few direct impacts due to the bridge.

N/R

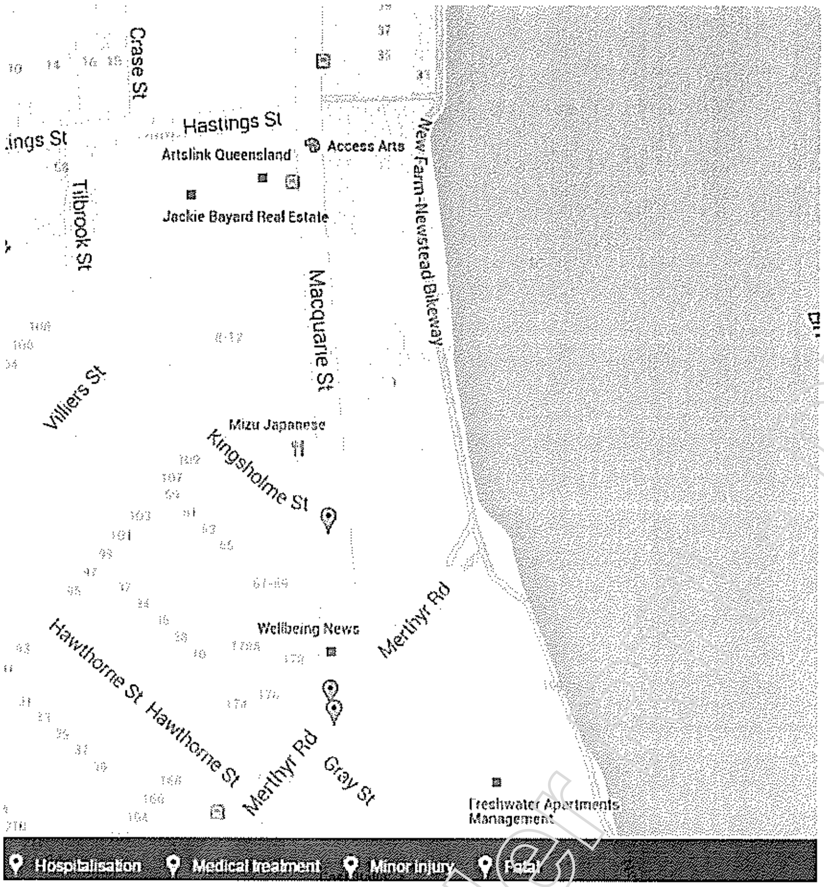


Figure 28 Crash map of bicycle-involved crashes near the Macquarie St / Merthyr Rd intersection

<u>Vernon Terrace</u>

The crashes recorded along Vernon Terrace that involved bicycles include:

- Collisions between a left turning vehicle and a through travelling vehicle; and
- A bicycle collision with a parked vehicle (potentially with a car door).

The most severe of these crashes resulted in minor injury whilst the other two only required medical treatment.

General vehicle crashes in the area were recorded at the intersection of Beeston Street and Macquarie Street, where there were two recorded collisions from adjacent approaches involving a right turning vehicle and a through-travelling vehicle.

Upon further review of the intersection, walls and hedges at the boundary lines of the properties adjacent to the intersection were observed, which can restrict sight lines and visibility for drivers. However, there are facilities to maintain safety for pedestrians and cyclists, including bicycle lanes and mid-block refuges for pedestrian crossings.

N/R

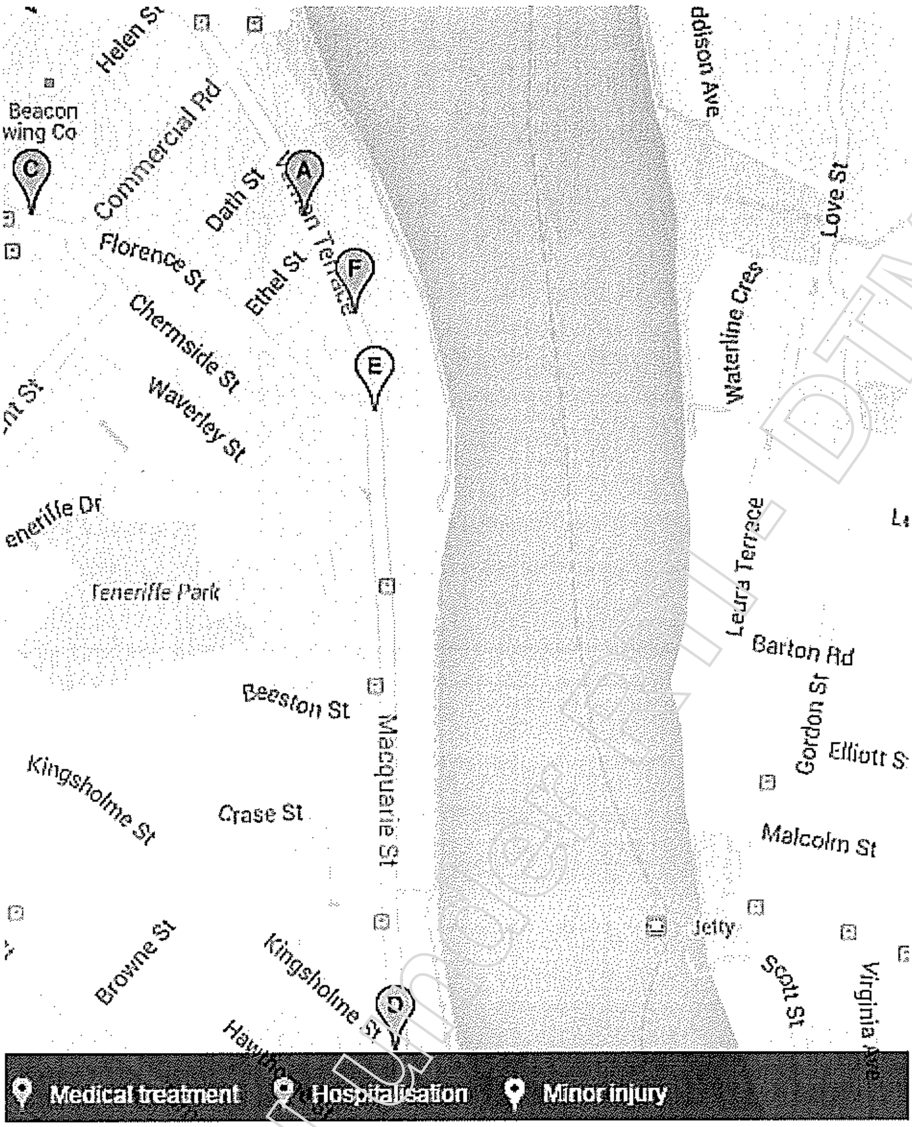


Figure 29 Crash map of bicycle-involved crashes along Vernon Terrace

N/R

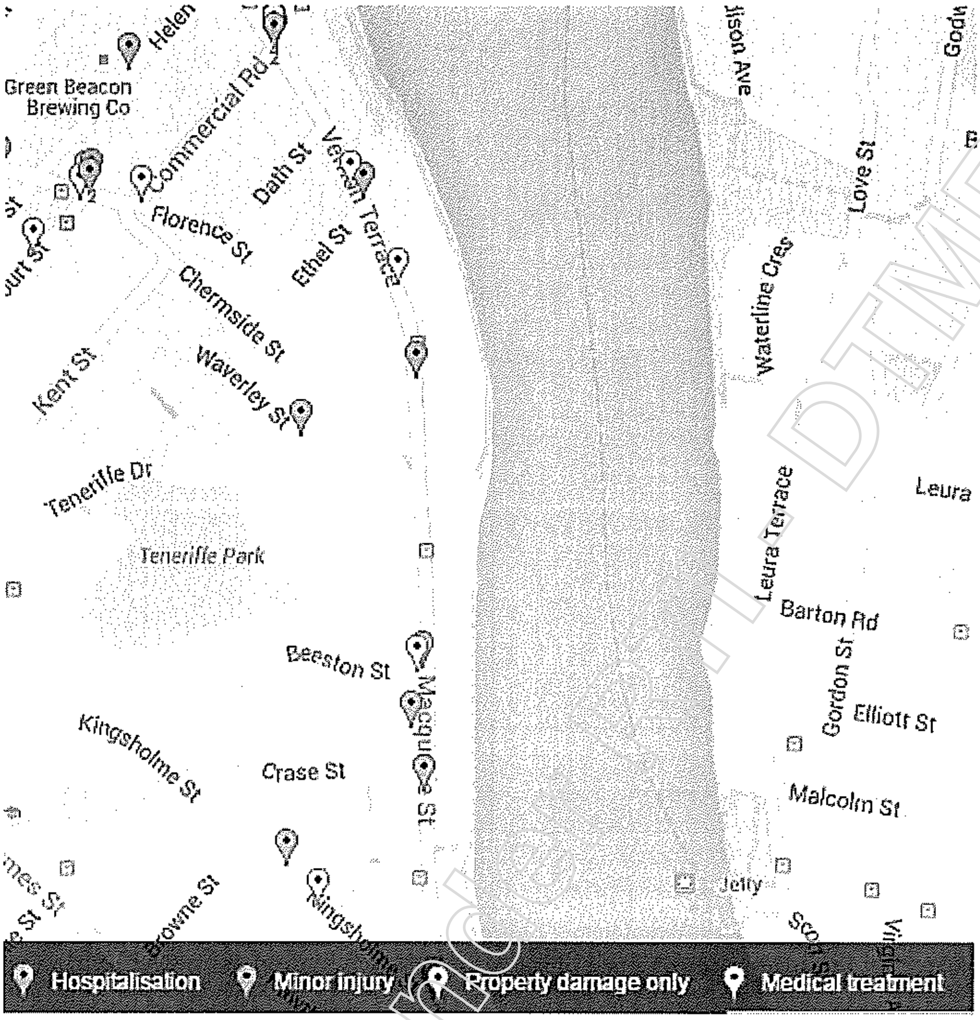


Figure 30 Map of all crashes in Teneriffe (focussing on Macquarie Street / Vernon Terrace)

<u>Commercial Road</u>

A review of the crash history indicated a cluster of six recorded crashes (none involving cyclists) at the intersection of Vernon Terrace and Commercial Road, all of which were collisions from adjacent approaches. This is presented in **Figure 31**.

However, this intersection has recently been signalised (refer to **Figure 32**), with signalised pedestrian crossings and cycle lanes on each approach in turn improving the safety in the intersection.

Several bicycle related crashes in the immediate area have been recorded as shown previously in **Figure 29**. The crashes were mild in severity (medical treatment or minor injury only) and involved:

- A cyclist striking a parked car (potentially an open car door);
- A through-left collision on adjacent approaches at an intersection; and
- A manoeuvring vehicle colliding with a cyclist.

N/R

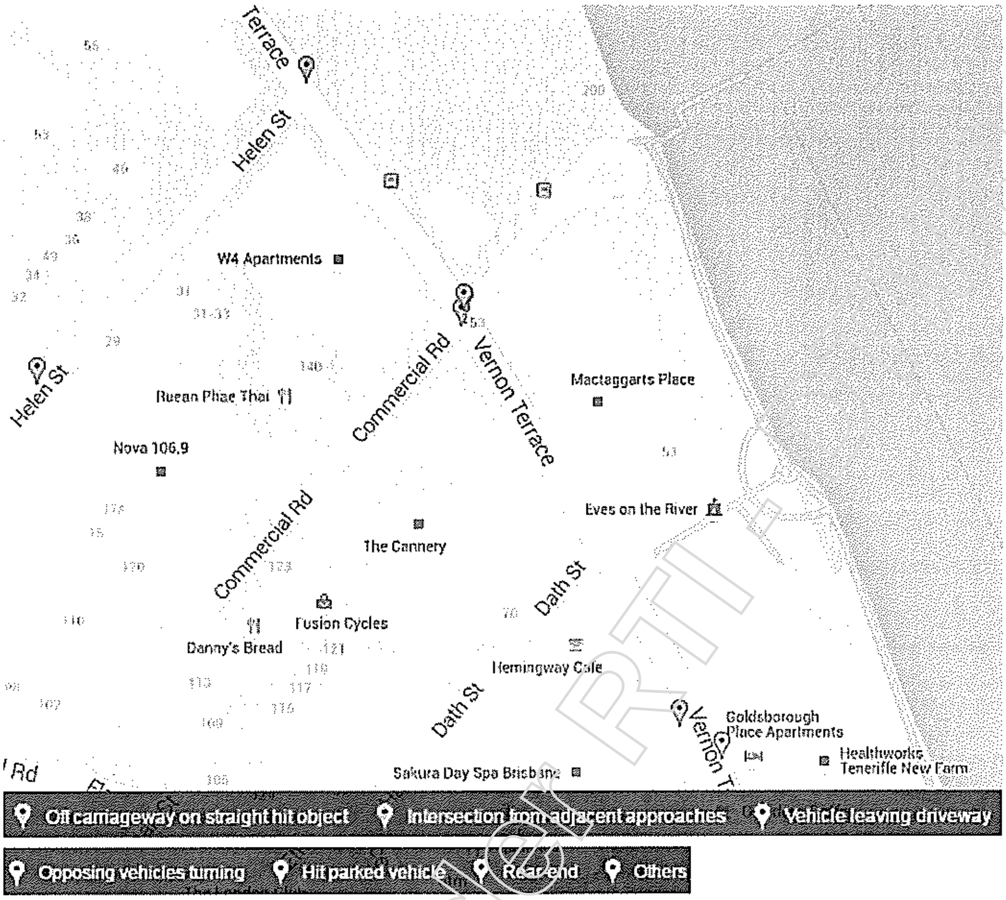


Figure 31 Map of crashes recorded near Commercial Road / Vernon Terrace intersection

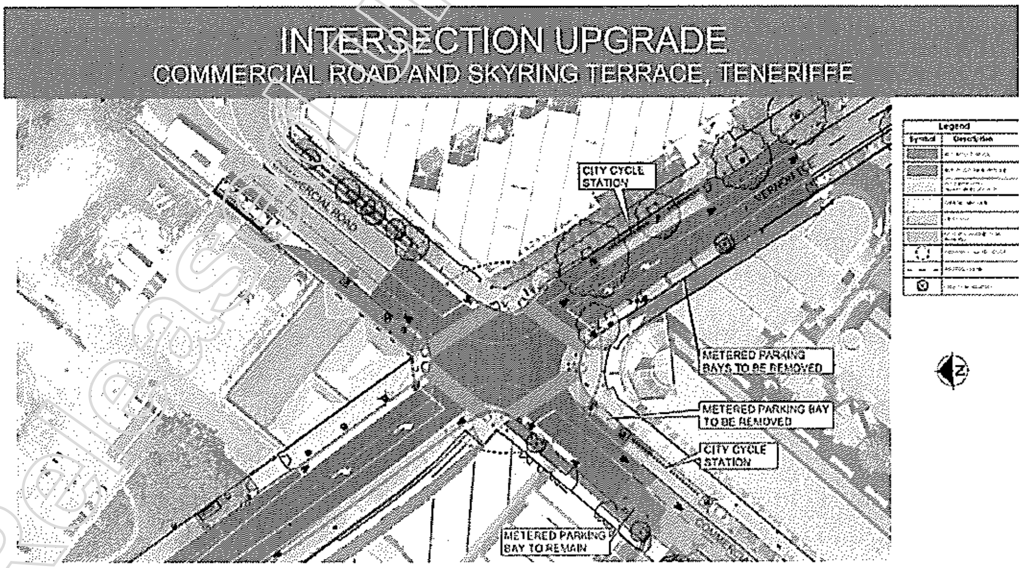


Figure 32 Vernon Terrace / Commercial Road signalised intersection layout

N/R

5 Policy and planning framework

5.1 Local

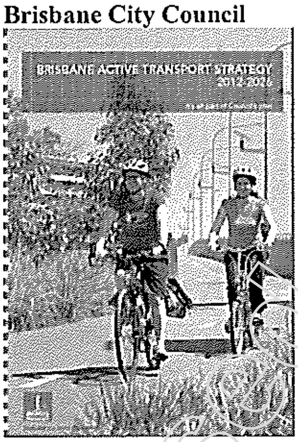
Local policy context of relevance to the feasibility assessment of an active transport bridge crossing of the Brisbane River at Bulimba/Teneriffe has been summarised in Table 6 below.

Table 6 Policy Context - Local

Name	Summary	Relevance
Brisbane City Plan 2014 **Brisbane City Council (2014)** 	Council's statutory planning document outlining its plans for the future development of Brisbane, including guidance on how to plan its infrastructure to support growth, economic activity, and develop active and healthy communities.	The following local planning documents are applicable in the project site. • The Bulimba District Neighbourhood Plan • Newstead and Teneriffe Hill Neighbourhood Plan • Commercial Road Precinct • Riverside sub-precinct • Newstead North neighbourhood plan – currently in drafting phase
	South of the River – Bulimba - Hawthorne The Bulimba District Neighbourhood Plan's key intent is to reflect community values that include green neighbourhood, suburban character, improved public realm, connectivity and accessibility, village identity and quality low-medium density built form (Brisbane City Council , 2014). Development principles outline that the area will preserve the low-medium density housing, to represent the strong traditional built character from existing Queenslanders. The Plan focuses on the development of mixed use development, largely focussed around servicing the needs of business of the residents in the Bulimba District. Pedestrian and cyclist movement along Oxford Street are given priority and in sub-precinct B1 (refer to image).	
	North of River – Tenerife / New Farm The intent for this area is outlined in the Brisbane City Plan 2014. Within this, are zones and neighbourhood plans that guide development to ensure it is in accordance with the Councils development objectives for the area. New Farm and Teneriffe have a variety of precinct and neighbourhood plans that govern the development in the suburb.	

N/R

	All of the plans listed above show support to the integration and development of a bicycle route, however does not provide any specific legislation that will significantly impact the development of the bicycle route. According to the Brisbane City Plan 2014, the development intent of the New Farm / Teneriffe area will remain similar. This will be done by ensuring the character housing in the area is maintained or enhanced. Along the front of the river MDR medium density residential will be further developed, with low-medium density encouraged. Currently, this area varies from low-set to medium density therefore in due time the population will slowly experience an influx of people as higher density developments are constructed. The Bicycle Network Overlay Code is particularly relevant to the development of the bikeway. It will play a large role in the implementation of the proposed bikeway, along with incorporating the Strategic Framework outlined in the Brisbane's transport infrastructure networks. It also provides standards that the cycle route needs to comply with.

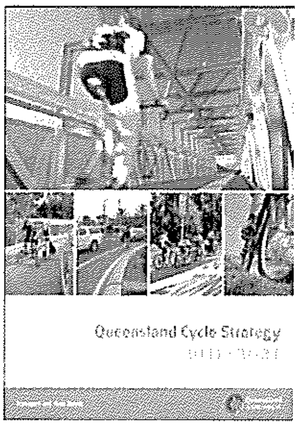
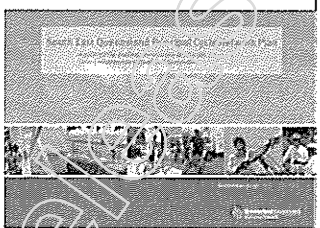
Name	Summary	Relevance
Brisbane Active Transport Strategy 2012-2026 **Brisbane City Council**  http://www.brisbane.qld.gov.au/sites/default/files/active_transport_strategy_2012-2026.pdf	Council's Active Transport Strategy outlines its vision for active transport in the city, which is to "create a high quality, connected, accessible pathway network which will attract people of all ages to walk and cycle." The strategy outlines an aim to see 1 in 5 transport trips by walking or cycling by 2026. Five priorities are outlined in the strategy: • Priority one: encouraging walking and cycling • Priority two: Walking and cycling friendly suburbs • Priority three: a connected commuter network • Priority four: a safe and accessible network • Priority five: information at your fingertips	A dedicated active transport connection across the Brisbane River would contribute towards actions associated with Priority two – in improving access to public transport, and reducing short car trips. It would contribute to Council's priority three through bridging the gap between key commuter routes to Brisbane's CBD, and inner city employment nodes. It may offer the potential of extending Council's CityCycle beyond the inner city to the immediate communities.

N/R

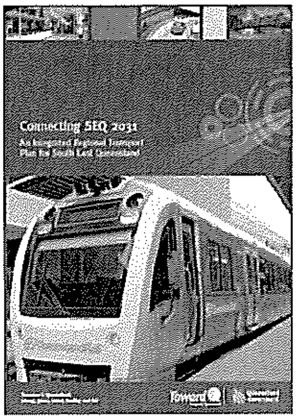
5.2 State

State policy context of relevance to the feasibility assessment of an active transport bridge crossing of the Brisbane River at Bulimba/Teneriffe has been summarised in Table 7 below.

Table 7 Policy Context - State

Name	Summary	Relevance
State		
Queensland Cycle Strategy 2011-2021 **Queensland Department of Transport and Main Roads (2011)** 	This strategy outlines the state government's vision for "**more cycling more often**" on safe, direct and connected routes. It identifies four priority areas of actions to achieve this vision, including: • Building safe, direct and connected cycle networks; • Growing a cycling culture • Creating cycle-friendly communities; and • Developing a cycling economy *Note this strategy is currently being reviewed by State Government.*	Provides guidance for the design and delivery of Council's active transport network. Identifies the barriers for people that cycle, particularly safety, lack of facilities, distances to travel being too far, and comfort. Indicates the state signature projects to address the priority areas, and where these will be developed in partnership with local government (e.g. Complete 5, Educated Ways and Connect To, Bicycle education programs).
South East Queensland Principal Cycle Network Plan **Queensland Government Department of Transport and Main Roads (2007)** 	The SEQ PCNP (which has currently been under review by the State), identifies the demand for, location and function of important cycle routes and missing links to inform planning, design and construction of cycle infrastructure.	The SEQ PCNP sees priority given to: • Providing links which connect centres and key attractors (i.e. via protected cycletracks/ veloways); Completing the active transport network within 5km of key centres to deliver a connected network to an immediate catchment; • Ensuring safe and connected routes are provided to schools, universities and TAFEs, focusing on a 3km catchment around schools; and • Putting active transport links in place to key public transport stations and stops.

N/R

Connecting SEQ 2031: An Integrated Regional Transport Plan for South East Queensland Queensland Government Department of Transport and Main Roads(2011) 	**Identifies regional priority actions and initiatives for active transport modes in the region.** **Provides guidance on the types of user groups and trips to target.** **Specifically for Brisbane it identifies the issues and challenges, in particular the need to provide safe cycle routes on the north side of Brisbane and to the CBD.**	**Provides guidance for the design and delivery of Ipswich's active transport network.** **Predicts that the number of daily transport trips made by Brisbane residents will increase from about 3.4million in 2006 to 4.2 million by 2031.** **Identifies the future mode share targets for walking and cycling from 10.6% to 13% and 1% to 11% respectively.**

5.3 Demographics

The demographics of the suburbs in the vicinity of the proposed active transport bridge were reviewed based on 2011 Census data. A summary of the data is presented below in Table 8.

Table 8 Demographic data for nearby suburbs

Suburb	Population (Density)	Car ownership by household	2006 Cycle mode share (based on Journey to Work data)
Bulimba	6,000 persons (29 persons/ha)	40% own 1 car 45% own 2+ cars	1.4%
Balmoral	3,823 persons (30.07 persons/ha)	37% own 1 car 46% own 2+ cars	1.9%
Hawthorne	4,704 persons (34.65 persons/ha)	39% own 1 car 46% own 2+ cars	1.3%
Newstead (inc. Teneriffe)	5,546 persons (43.44 persons/ha)	46% own 1 car 34% own 2+ cars	2.5%
New Farm	11,201 persons (55.22 persons/ha)	40% own 1 car 24% own 2+ cars	3.0%
Brisbane City LGA	**1,041,821 persons (7.86 persons/ha)**	**37% own 1 car 45% own 2+ cars**	**1.3%**

N/R

The demographic data shows that as expected, the suburbs in the vicinity of the bridge have a significantly higher population density compared to the city-wide average. It also shows that the suburbs on the right bank have significantly lower cycle mode shares (levels comparable to the city-wide average) compared to those on the left bank. This indicates that there is there is an opportunity to increase cycle and walk mode share in Bulimba and Hawthorne to levels closer to those currently observed in Newstead and New Farm.

5.4 Other studies

5.4.1 Integrated Transport and Land Use: Inner City Strategy (ITALICS)

The Integrated Transport and Land Use: Inner City Strategy (ITALICS) investigated the need and options for various transport modes around inner city Brisbane, from St Lucia to the south-west to Bulimba in the north-east.

The ITALICS recognises that the Brisbane CBD is likely to grow in the future, particularly northwards towards Fortitude Valley and Bowen Hills. In order to facilitate this growth, the study suggested the construction of a "green bridge" linking Bulimba to Newstead, as part of a Bulimba to University of Queensland (St Lucia) Boulevard. It was suggested that this link could:

- Support potential future Bus Rapid Transit (BRT) and/or metro services;
- Provide better public transport connectivity linking the major transport hub location at Bowen Hills with Bulimba, the eastern suburbs of Brisbane and the Australia Trade Coast (South);
- Connect residents on both sides of the river to major public open spaces at Newstead, some of which has been constructed in the years after ITALICS was published;
- Catalyse development in the vicinity of the bridge, as well as in suburbs further to the east;
- Contribute to a "ring road" for active transport around the city;
- Promote the appeal of public transport in the region; and
- Enhance the liveability of Brisbane.

The ITALICS recognises that a bridge linking both sides of the river at this location is made particularly difficult due to the combination of low lying land on both banks (with levels around RL2) and the requirement for significant height clearance for vessels at this reach of the Brisbane River. The ITALICS obtained advice from Maritime Safety Queensland (MSQ), which indicated that a bridge at this reach of the river required a minimum of:

- 30m clearance from Highest Astronomical Tide (HAT) for a fixed bridge; or
- 12m clearance from HAT for an opening bridge.

N/R

The ITALICS suggested that the minimum desirable horizontal clearance was 100m, with a 70m absolute minimum subject to agreement with MSQ.

Two main bridge alignment options were considered in the ITALICS, both located north of the Teneriffe ferry terminal and both primarily based on an opening bridge design:

- BN1: From Coutts Street, Bulimba to Park Street, Albion
- BN2/3: From Brisbane Street, Bulimba to Maude Street, Newstead

Both of the bridge alignment options were primarily designed to optimise bus access, with pedestrian and cyclist access improvements limited due to the detours required.

Option BN1 was found to reduce impact on expensive residential properties, but is more indirect and introduces navigational risk due to being on a river curve.

Option BN2/3 would have more impact on expensive residential properties, but is on a straighter reach of the river and is more direct compared to Option BN1.

Three potential different opening bridge structures were reviewed, including:

- Swing bridge;
- Bascule bridge; and
- Split opening bridge.

5.4.2 A people oriented vision for Brisbane, Gehl Architects 2009

This study undertaken by Gehl Architects for the Queensland Department of Infrastructure and Planning (DIP), aimed to provide a 'people first vision for Brisbane' in particular to inform and support Council's 'River City Blueprint' project.

It focussed on looking at two specific corridors, as case studies, namely: a corridor connecting Bulimba with the University of Queensland via the CBD; and a connection between Woolloongabba and South Bank.

The former case study is of relevance to this feasibility planning study. The outcomes of the study provide a range of 'persuasive and innovative ideas and strategies to inspire the way we think, and in turn respond to tackling the challenges that Brisbane faces'.

N/R

6 Constraints and Opportunities

6.1 Desktop Study area review

The following desktop review has been undertaken for the study area, to assist with informing the development and selection of suitable options for an active transport bridge crossing.

6.2 Environmental and heritage

6.2.1 Waterways and wetlands

6.2.1.1 Waterway Barrier Works

The Department of Agriculture and Fisheries (DAF) have mapped all waterways in Queensland according to their level of risk of impacts on fish movement. This mapping defines whether the site of proposed waterway barrier works (such as culverts, bridges or temporary erosion and sediment control devices) requires assessment and approval under the *Fisheries Act 1994*. These coloured zones indicate whether the waterway barrier works can potentially proceed under the relevant DAF self-assessable code, or whether the works will require a permit.

The Study Area includes a stretch of Brisbane River, mapped as Grey (Major risk of impact). Works within the high bank of the Brisbane River will require a waterway barrier permit, unless the works are temporary, where they may be self-assessed.

6.2.1.2 Wetlands

There are no mapped wetlands within either Study Area.

6.2.1.3 Potential Impacts and Approvals

Works within or adjacent to waterways may cause impacts on riparian vegetation, earthworks within creek banks and channels, and permanent or temporary waterway barriers formed by bridge or culvert crossings, or construction works. It is dependent on what works will be undertaken within the waterways as to whether a Waterway Barrier Works Permit will be required, or the works can proceed under the self-assessable code.

Works that involve the destruction of vegetation, excavation or placing of fill within the bed and banks of a watercourse, lake or spring or any other water-related development may require a Riverine Protection Permit under the *Water Act 2000* (Water Act), unless the works can be carried out in accordance with exemption requirements.

N/R

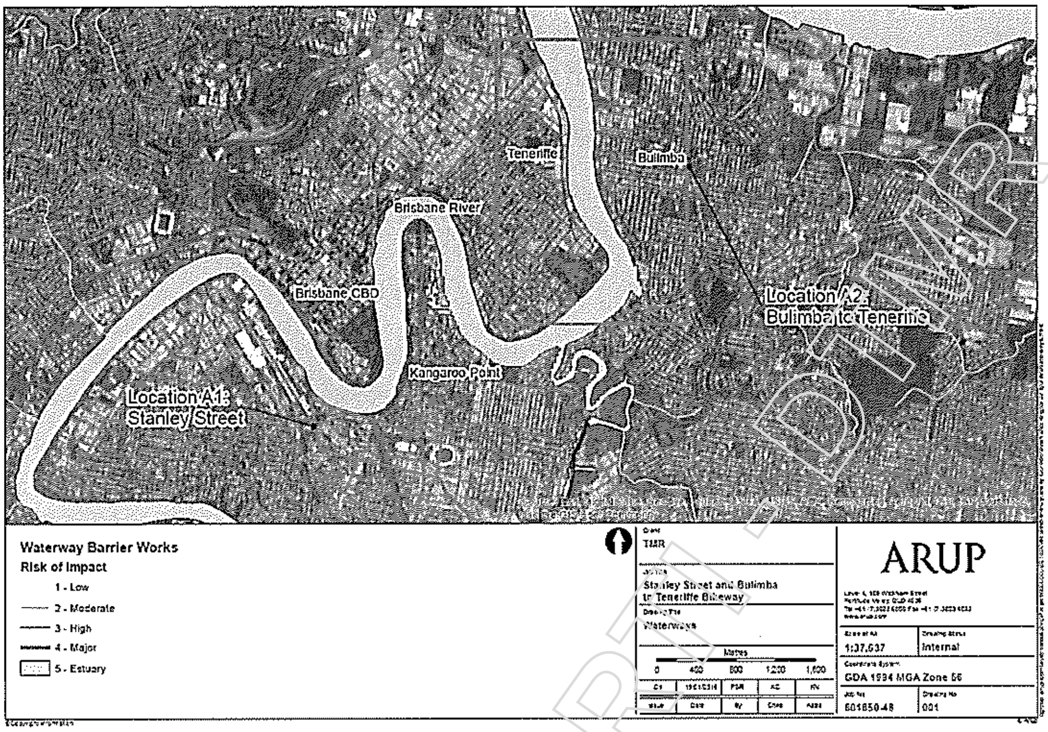


Figure 33 Waterway Barrier Works Risk of Impact

6.2.2 Flora and Fauna

6.2.2.1 Remnant and regrowth vegetation

There is no mapped remnant or regrowth regional ecosystems within the Study Area.

6.2.2.2 Threatened ecological communities

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) lists threatened ecological communities (TEC) as matters of national environmental significance MNES. The EPBC Act Protected Matters Search Tool (PMST) identifies the critically endangered Lowland Rainforest of Subtropical Australia as potentially occurring within the Study Area. Due to the developed urban nature of the study area it is highly unlikely that any rainforest communities are present.

6.2.2.3 Significant flora species

Significant flora species are those listed in the NC Act as endangered, vulnerable or near threatened and/or listed in the EPBC Act as vulnerable, endangered or critically endangered. These species are defined as species that have conservation significance, due to their rarity or high levels of endemism.

A search of the EPBC Act PMST database (accessed 19 January 2016), identified a total of nine significant flora species with the potential to occur within a 500m

N/R

radius of each of the Study Area. The EPBC Act PMST carries out a predictive modelling exercise, based on the species' known range and does not take into account known records or the habitat features present within the search area.

The Queensland Wildnet database (accessed 19 January 2015) has a record of Angle-stemmed Myrtle *Gossia Gonoclada* occurring within 2km of the study area. There are no other records of any significant flora species within the Study Area.

The NC Act Protected Plants flora survey trigger map shows records of listed endangered, vulnerable or near-threatened plants maintained by the Queensland Government. The Study Area is not within these trigger areas.

Additional ecological fieldwork would be required to ground-truth the habitat suitability for threatened flora species.

6.2.2.4 Potential impacts and approvals

Given the highly developed nature of the Study Areas it is unlikely that the project will result in significant impacts on native vegetation or significant flora species. It is recommended that site investigations are undertaken at a future stage of the project to ground-truth the conditions.

6.2.3 Fauna and habitats

6.2.3.1 Significant fauna species

Significant fauna species are those listed in the NC Act as endangered, vulnerable or near threatened and/or listed in the EPBC Act as vulnerable, endangered or critically endangered. These species are defined as species that have conservation significance, due to their rarity, declining populations, small range or distribution or reduction in supporting habitats.

A review of the EPBC Act PMST database identified 17 protected terrestrial fauna species under the EPBC Act that have the potential to occur within the Study Areas. These species include seven mammals, nine reptiles, one fish and 23 birds.

The EPBC Act PMST uses predictive modelling, based on the species' known or potential ranges and does not rely on habitat features present within a specific study area or recorded observations of species. Given the highly developed nature of the Study Areas it is unlikely that the project will result in significant impacts on significant fauna species. It is recommended that site investigations are undertaken at a future stage of the project to ground-truth the conditions.

There is no mapped Koala habitat within the Study Areas under the Koala Conservation SPRP.

N/R

6.2.3.2 Potential impacts and approvals

Given the highly developed nature of the Study Areas it is unlikely that the project will result in significant impacts on fauna and habitat. It is recommended that site investigations are undertaken at a future stage of the project to assess the habitat potential for significant species.

6.2.4 Contaminated land

It was understood that the Bulimba Riverside Park was historically used for industrial purposes. As such, a search of the Environment Management Register and Contaminated Land Register was completed for that site. This indicated that the sites/lots that comprise Bulimba Riverside Park are registered on the Environmental Management Register, and have Site Specific Management Plans attached.

The Site Management Plans indicate that:

- Contamination within the site is both organic (hydrocarbon) and inorganic (including lead, cadmium, chromium, copper and zinc) in nature;
- The historical uses on site include tank and drum manufacturing, plastic moulding, cadmium/chromium plating, steel fabrication, fibreglassing and spray painting; and
- Any works that occur within the site must be in accordance with the requirements listed in the Site Management Plan. Excavation in some parts of the site is at high risk of exposing contaminated material and should be avoided.

The relevant site management plans are attached in Appendix C.

6.2.5 Cultural Heritage

6.2.5.1 Non-Indigenous Cultural Heritage

There are a range of State and Local Government heritage places within the Study Area, as shown in Table 9, Table 10, Figure 34 and Figure 35.

Table 9 Queensland Heritage Register

Location / Place Name	Address
Glenugie	186 Moray St, New Farm
Santa Barbara	209 Moray St, New Farm
Residence, Abbot St	41 Abbott St, New Farm
New Farm Park	137 Sydney St, New Farm
CSR Refinery (former)	Lamington St, New Farm
Amity	101 Welsby St, New Farm
Australian Estates No. 1 Store	50 Macquarie St, Teneriffe
Australian Estates No. 2 Store	24 Macquarie St, Teneriffe
Elder Smith Woolstore	64 Macquarie St, Teneriffe
Hawthorne Ferry Terminal & Hardcastle Park	28 Gordon St, Hawthorne
Goldsborough Mort Woolstore	88 Macquarie St, Teneriffe

N/R

Roseville	56 Chester St, Teneriffe
Teneriffe House	37 Teneriffe Dr, Teneriffe
Teneriffe Village (Former Paddys Market)	110 Macquarie St, Teneriffe
Australian Mercantile Land & Finance Woolstores	34 Vernon Terrace, Teneriffe
Winchcombe Carson Woolstores	54 Vernon Terrace, Teneriffe
Mactaggarts Woolstore (former)	53 Vernon Terrace, Teneriffe
Queensland Primary Producers No 4 Woolstore (Commercial House)	16 Skyring Terrace, Teneriffe
Newstead Air Raid Shelter	Commercial Rd, Teneriffe
Bulimba Memorial Park	129 Oxford St, Bulimba
St John the Baptist Anglican Church	171 Oxford St, Bulimba
Bulimba State School	261 Oxford St, Bulimba
Newstead Gasworks No.2 gasholder (remnants) and guide framing	70 Longland St, Teneriffe
Bulimba Ferry Terminal	Oxford St, Bulimba

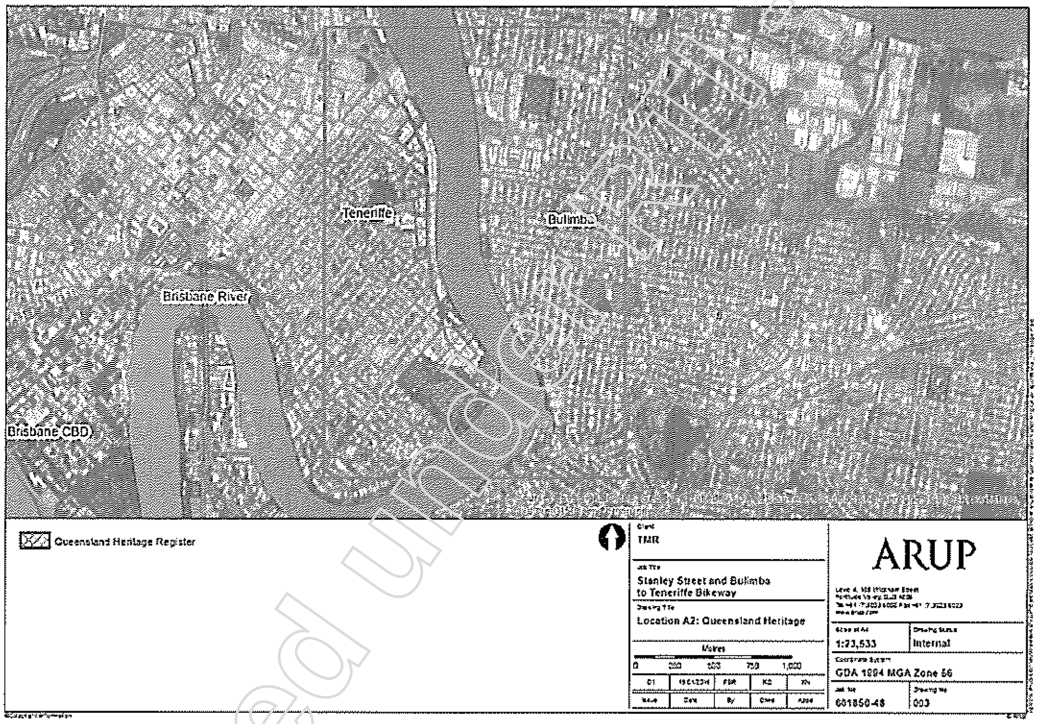


Figure 34 Queensland Heritage Register Results

N/R

Table 10 Location A2 Brisbane City Council Heritage Register:

Location / Place Name	Address
Residence	49 Bulimba Rd, Bulimba
19th Century Residence	90 Bulimba Rd, Bulimba
Naval Cannon	Quay St, Vic Lucas Park, Bulimba
Anzac Cottage	29 Jamieson St, Bulimba
Bulimba House	34 Kenbury St, Bulimba
Bulimba Ferry Terminal	Oxford St, Bulimba
19th Century Residence	40 Oxford St, Bulimba
Bulimba Memorial Park – Jamieson Park	129 Oxford St, Bulimba
St John's Anglican Church	171 Oxford St, Bulimba
Bulimba Uniting Church	216 Oxford St, Bulimba
Anzac Cottage	30 Stuart St, Bulimba 32 Stuart St, Bulimba
Health Clinic	171 Riding Road, Hawthorne
19th Century Residence	35 Amy St, Hawthorne
Brethren's Meeting Room	62 Balmoral St, Hawthorne
19th Century Residence	142 Barton Road, Hawthorne
Residence	156 Barton Road, Hawthorne
Hawthorne Ferry Terminal & Hardcastle Park	28 Gordon St, Hawthorne
Residence "Halcyon"	46 Hawthorne Rd, Hawthorne
Lourdes Hill College	86 Hawthorne Rd, Hawthorne
Hawthorne Presbyterian Church (former)	159 Hawthorne Rd, Hawthorne
19th Century Residence	25 Virginia Ave, Hawthorne
Early Brick Cottage	201 Arthur St, Teneriffe
Corner Shop	206 Arthur St, Teneriffe
Queensland Primary Producers Woolstore (former)	241 Arthur St, Teneriffe
Residence	1 Beeston St, Teneriffe
Corner Shops	1 & 1A Chermside St, Teneriffe
Residence	42 Chester St, Teneriffe
Roseville – Uradah	56 Chester St, Teneriffe
Residence	64 Chester St, Teneriffe
Residence	81 Chester St, Teneriffe
Stone Retaining Wall	72, 78 and 78A Chester St, Teneriffe
Halls Building (former)	102 Commercial Rd, Teneriffe
Woolstore Willoughby & Co (former)	128 Commercial Rd, Teneriffe
Whatmore McIntosh Motors (former)	132 Commercial Rd, Teneriffe
Newstead Air Raid Shelter	End of Commercial Rd, Teneriffe
Residence	25 Crase St, Teneriffe
Hide Store (former)	17A, 21 & 25 Helen St, Teneriffe
Residence	22 Kyabara St, Teneriffe
Wilcox Moffin Ltd (former)	33 Longland St, Teneriffe
Gasworks No 2 Gasholder	70 Longland St, Teneriffe
Australian Estates No 2 Woolstore (former)	24 Macquarie St, Teneriffe
Australian Estates No. 1 & Mortgage Co Woolstore	50 Macquarie St, Teneriffe
Elder Smith & Co Woolstore (former)	64 Macquarie St, Teneriffe
Engine Room (former) Capricorn New Farm Wharf	71 Macquarie St, Teneriffe
Goldsborough Mort & Co Woolstore (former)	88 Macquarie St, Teneriffe
Teneriffe Village (former Paddy's Market) - Dalgety & Co Ltd No. 3 Woolstore, Queensland Primary Producers No. 8 Woolstore	110 Macquarie St, Teneriffe

N/R

Queensland Primary Producers No. 4 (Commercial House)	16 Skyring Tce, Teneriffe
Teneriffe Park	33 Teneriffe Dr, Teneriffe
Residence	36 Teneriffe Dr, Teneriffe
Teneriffe House	37 Teneriffe Dr, Teneriffe
Australian Mercantile Land & Finance Co Woolstore (former)	34 Vernon Tce, Teneriffe
Mactaggarts Woolstore (former)	53 Vernon Tce, Teneriffe
Winchcombe Carson Woolstore (former)	54 Vernon Tce, Teneriffe

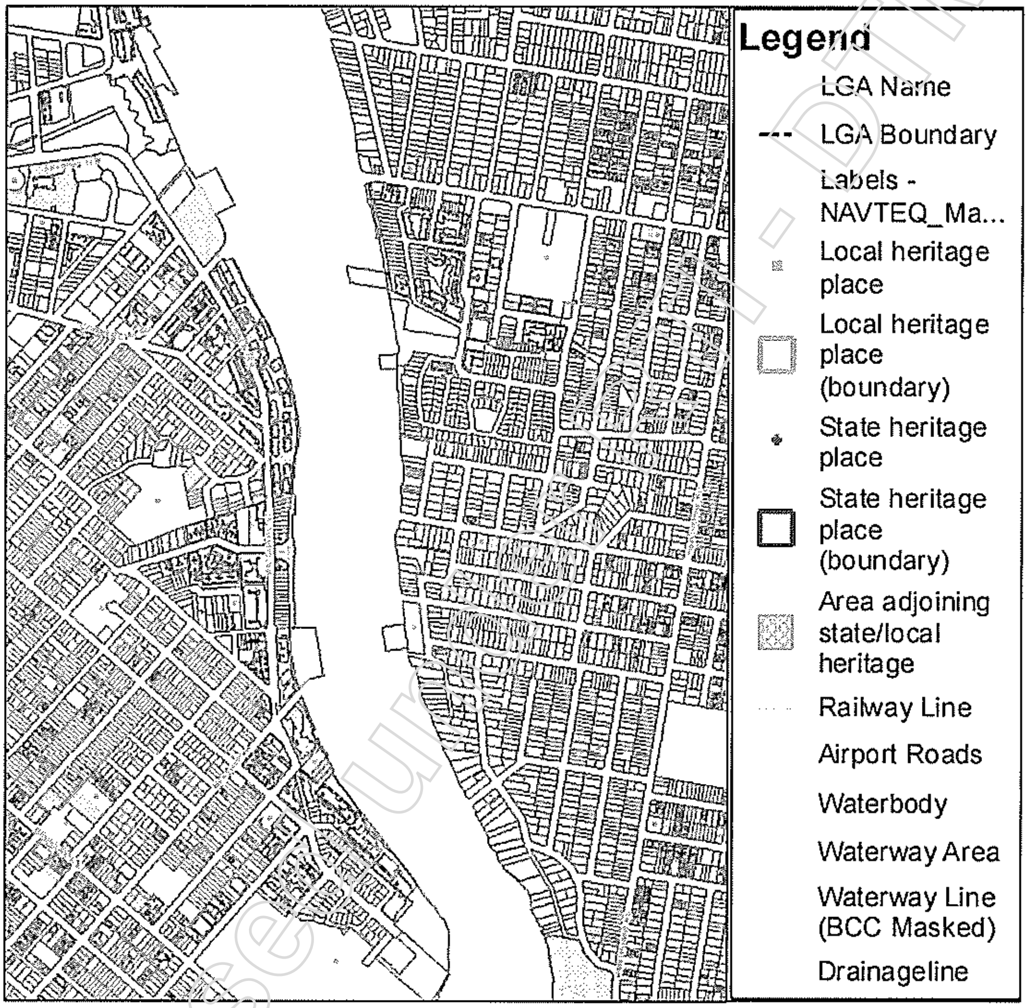


Figure 35 Brisbane City Council Heritage Register Results

6.2.5.2 Indigenous Cultural Heritage

A search of the Department of Aboriginal and Torres Strait Islander Partnership (DATSIP) Cultural Heritage Database and Register has established no sites have been recorded within the Study Area.

6.2.5.3 Native Title

There is an area along the shoreline of the Brisbane River, parallel with Macquarie Street, Teneriffe for which the Turrbal People have a Native Title Claim.

The Yugara Yugarapul People submitted an application for Native Title in 2011, for an area which covers both Study Areas. In 2013 their application was declined. The Turrbal People also had a Native Title claim over the Study Area, and the claims of the Turrbal People and the Yugara Yugarapul People were combined in 2013. In January 2015, the combined claim was rejected by the Federal Court.

It should be noted that Indigenous heritage values may continue to exist on a site, whether or not Native Title has been granted.

6.2.6 Summary

This is a high-level desktop study of the potential environmental impacts, hence given that the works are likely to be confined to areas that have already been developed, and predominantly within the existing road reserve, it is unlikely that the works will have a significant impact on environmental or heritage features, however site investigations are recommended to further refine these assumptions.

It is recommended that where possible, design is refined to avoid any significant environmental or heritage features.

6.3 Land Use Planning

6.3.1 Right bank

6.3.1.1 Key attractors

Bulimba is located 4 kilometres north east of Brisbane's CBD. It is surrounded by Balmoral, Hawthorne, Morningside and East Brisbane. The suburb is home to various alfresco eateries, boutiques, art galleries, character listed Queenslanders and cinemas. It is characterised by Oxford Street that travels north towards the Brisbane River. Oxford Street is an iconic hub in Brisbane that well known by tourists and locals. It attracts a variety of people for work or recreational uses. It is a popular spot due to its inner-city location, green open spaces with playgrounds and its locality in relation to the river. Key local features in the Bulimba area include the Ferry Terminal, Brisbane River, Bulimba Riverside Park, Oxford Street and Bulimba Memorial Park (Brisbane City Council , 2014).

6.3.1.2 Future development

A large development that is planned for the area is the regeneration of the existing site formerly referred to as the Bulimba Barracks, located on the eastern side of Bulimba. Brisbane City Council has worked with the Queensland Government to

N/R

create a master-plan for the area. The intent of the master plan is to guide the future development along the riverfront site, whilst incorporating the existing objectives in the Bulimba District Neighbourhood Plan. In particular the site is planned to be characterised as a mixed use area that includes a neighbourhood centre and low-medium density residential buildings. (Brisbane City Council , 2015). This is expected to activate the existing area and increase the economic and social demographics of the area. It will improve the existing interface between the land, the river and Hamilton. This is the only identified large form of development planned for the area that will potentially impact the bicycle route.

6.3.1.3 Existing active transport infrastructure

Currently the existing active transport is minimal, consisting mostly of footpaths along the side of streets. The only identified form of active transport is the boardwalk that is located at the end of Oxford Street.

However, a future principle route is planned travelling north from Oxford Street (Queensland Government , 2015) around to the Bulimba Barracks re-development via Quay Street and a potential continuation of the off-road cycle network. This future route could extend the catchment for the future Bulimba-Teneriffe bridge.

Deliberation

6.3.2 Left bank

6.3.2.1 Key Attractors

Teneriffe and New Farm are well known for their outdoor spaces including New Farm Park. New Farm Park is situated along the Brisbane River and attracts visitors and locals from Brisbane and the broader SEQ region. It is a popular place for families due to the tree-house style adventure playground. New Farm and Teneriffe are largely characterised by mixed-use developments, character housing and various cafés, bars and restaurants.

N/R

The Power House is a key entertainment facility that hosts events for all age groups, with bar and restaurant facilities inside. A separate bar called Watt bar adjoins the Power House and faces out onto an existing bicycle route and the Brisbane River. Every Saturday, the Powerhouse Farmers Markets are on and this also attracts locals and others to buy food from local farmers. This is shown in **Figure 36**.

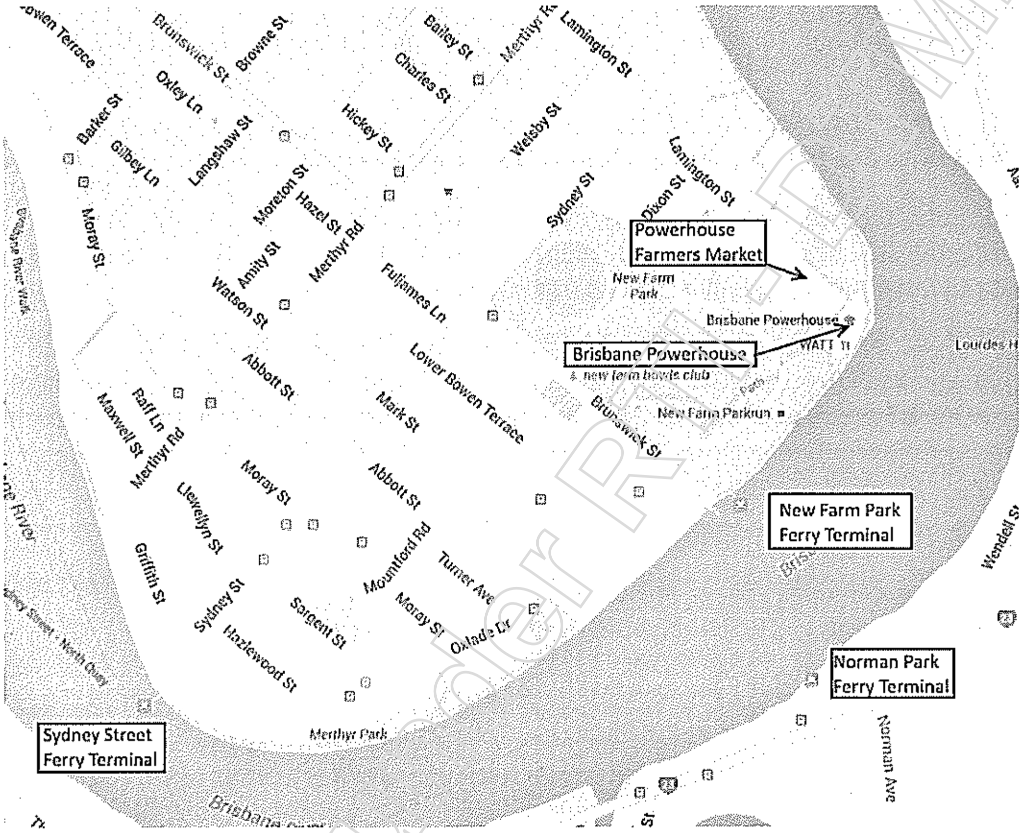


Figure 36 Context plan of New Farm

James Street is a popular place that has a variety of bars, boutiques and restaurants. New Farm and Teneriffe are closely located to the Emporium Precinct, as shown in **Figure 37**.

N/R

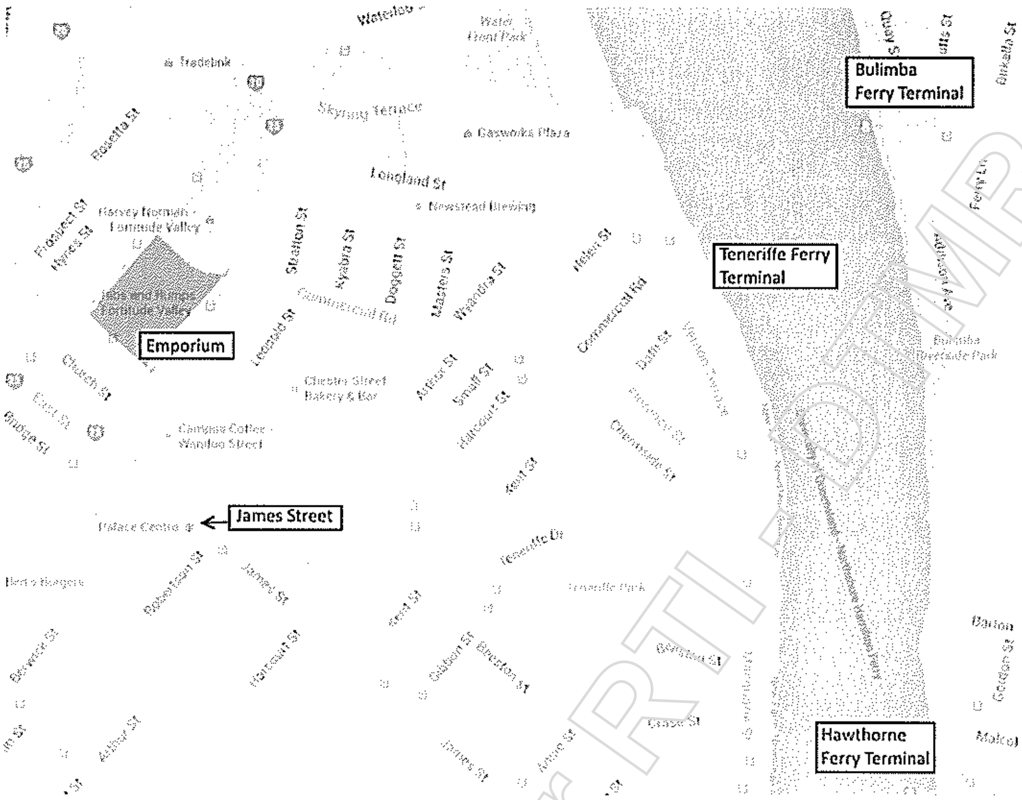


Figure 37 Context plan of Teneriffe

6.3.2.2 Existing active transport infrastructure and network

There is a riverside walk and cycle route approximately 6 kilometres long, which travels along the waterfront towards New Farm Park and the Power House. From this point, the Brisbane Riverwalk traverses between New Farm and the Howard St Wharves into Brisbane's CBD. The route is 870 meters long and provides separation between cyclists and pedestrians. A principle cycle network is planned to be implemented along Doggett Street that travels up to the Howard Smith Wharves.

An alternative on-road cycle route from Teneriffe to New Farm also exists with cyclists sharing the road with vehicles on Kent Street.

Public transport includes the New Farm Park Ferry Terminal, which is located just off New Farm Park with the Teneriffe Ferry Terminal just across from Bulimba. It is important to consider the existing linkages and future planned linkages in the area before proceeding with the confirmed bicycle alignment.

6.3.2.3 Future development

Major developments located adjacent to the study area are outlined in Table 11.

N/R

Table 11 Major developments adjacent to the study area

Development Application Type	Location	Status	Implication for potential bridge
Material Change of Use for an Indoor Sport and Recreation Facility	170 Merthyr Rd New Farm, QLD 4005.	Approved	Potentially increased demand
Material Change of Use for a Multi-unit dwelling.	218 Moray Street New Farm, QLD, 4005.	Approved	High density living is increasing in the area, and therefore pressures and demand will be placed on existing transport infrastructure. The provision of localised improved active transport infrastructure and connections provides alternative travel options to reduce the impacts of localised congestion.
Subdivision of Land to build two 21 storey residential towers, including 279 apartments in total.	60 Skyring Terrace, Newstead, QLD 4006 58 Wyandra St, Newstead, QLD, 4006.	No decision	As above
Mirvac Development (Gasworks Plaza and surrounds), delivering approximately 750 apartments upon completion	76 Skyring Terrace, Newstead. 16,860sqm of retail space + 103,400sqm of office space results in an influx of approximately 8,000 employees.	Under construction	As above

6.3.3 Fortitude Valley – CBD

6.3.3.1 Key attractors

Gasworks Plaza- is a residential, commercial and retail development at Newstead that services the local community and also attracts a greater catchment.

Emporium Precinct- a mixed use development that has a hotel, cafes, restaurants and bars. It is mostly popular at night time.

Deliberation

N/R

Deliberation

6.3.3.3 Constraints

Barriers within the study area include natural topography and manmade features. These include the Brisbane River and Wickham Street. Considerable on street parking throughout the area presents risks associated with car doors opening and collision with cyclists.

6.4 Maritime

A number of maritime constraints posed to a potential bridge crossing between Bulimba and Teneriffe were identified, including:

- Requirement for vertical and horizontal clearance for vessels;
- Potential impacts of the structure on ferry and private vessel manoeuvres near terminals and private moorings; and
- Potential afflux effects.

With respect to the vertical and horizontal clearance requirements, these were initially adopted from the requirements presented in the ITALICS study:

- Horizontal clearance of 100m for the navigational channel (with refinement in the structural assessment); and
- Minimum vertical clearance of 12m above Highest Astronomical Tide (HAT) for an opening bridge, or 30m above HAT for a non-opening bridge.

These requirements were later confirmed during a meeting with the Harbour Master as part of this study. Further consideration and rationale of these parameters are discussed in the following section of this report, Structures.

In relation to impacts on vessel manoeuvres near ferry terminals and private moorings, it was understood that the actual requirements will depend on the location of each mooring point and the type of vessel that requires access. As such, indicative "clear" areas adjacent to existing bridges further upstream were identified to give an understanding of the magnitude of clearance required. Two locations were reviewed for this study:

- The North Quay ferry terminal is located approximately 80m from Victoria Bridge; and
- The QUT Gardens Point ferry terminal is located approximately 180m from the Goodwill Bridge.

These clearances were used as benchmarks for reviewing potential bridge alignment options.

N/R

For most options considered, the bridge deck is likely to be well above water level in areas near pontoons, in these cases it is anticipated that most small craft will not be impacted by the bridge.

6.5 Structures

This section analyses the constraints and opportunities relating to or resulting from the bridge structure and the approach ramps. For most part, it is assumed that the structure itself has lesser impact on the options multi criteria assessment based on understanding that the key differentiators lie within the transport network and the connectivity at each end. However there are a range of factors that will need to be further considered and resolved in the next stage of the project before the bridge structure can be confirmed. These factors include:

- The proposed architectural form of the bridge;
- The desired opening mechanism; and
- The desired layout of the bridge, including separation by direction of travel and/or mode, and the number and location of viewing points.

Therefore, this section focuses on constraints and opportunities that may be considered as differentiators between the options, but also provides a basis for considerations for the preferred option as it is developed further in next stage of the project. Generally speaking, the study demonstrates that such a bridge is physically feasible, taking into account technical aspects, engineering issues, and structural solutions discussed in the following sections of the report.

By comparison to other pedestrian bridges on Brisbane River, including Kurilpa and Goodwill Bridges, this bridge will need to address similar constraints and requirements. However, this bridge will need to resolve much higher maritime navigation clearance requirements, which is exacerbated by low ground levels at the two banks. The bridge will also require much longer ramps, as well as an opening span structure. All these requirements and constraints are soluble, the cost of which will depend on the overall balance between the requirements and desirables, provided adequate funding is available.

6.5.1 General functional requirements

The bridge and associated structures will need to provide a safe and convenient connection for pedestrians and cyclists, both recreational and commuter. Safety in Design will be paramount for the design, including appropriate considerations to Crime Prevention Through Environmental Design (CPTED).

It is anticipated that equitable access needs to be provided on all key connections/routes, and the structure will need to be guided by requirements in the Disability Discrimination Act (DDA).

The main functional requirements considered in this report are as follows:

- Max 5% gradient for cyclists and disabled access with landings rest areas is recommended, based on AustRoads requirements and Australian Standard

N/R

AS1428. Each proposed bridge option has been developed to meet this requirement, and therefore has an average slope of 1 in 20 or gentler (including the allowances for landings). This is also consistent with those on the Kurilpa and Goodwill Bridges.

However, based on the existing ground levels at the embankments, and the assumed maritime constraints in regards to vertical and horizontal navigational clearances, all options will require the bridge lengths to be significantly extended in order to meet the minimum requirements (compared to the width of the river in its relevant reach).

This means that the cyclists and pedestrians will be required to negotiate approximately 200-300m long ramp on 5% slope both up hill and downhill going in one direction.

Whilst the vertical climb will be a challenge, going down the alignment will allow cyclists to develop higher speeds. Carefully assessed Safety in Design will therefore need to take into account radii of horizontal curves, lengths of each ramp, and/or angle of approach for both cyclists and wheelchair users. Sight distances and conflict areas will also need to be taken into account.

Conversely, straight alignments with no natural speed controls/dampers will need to be assessed for potential conflict areas to minimise the safety and collision risks.

Likely pedestrian preferences for the viewing will need to be considered in each case.

- An average bridge length for all options considered is approximately 600m. Rest areas (say 8m long by 2m wide) and viewing platforms at approximately 100m centres should be considered along the river spans, with location dependent on vertical grades and potential vistas. The location of the rest stops within the bridge spans can be varied to suit the overall design of the structure.

  These will be determined at a later stage of the design, however it is anticipated that each option would have a similar number of platforms. Based on the assumed lengths for each option, there could possibly be four platforms.

- At this point, it is not known if the bridge will be designed as a shared or separated path facility. However, a 6m wide footpath is assumed to offer adequate allowance in each case, similar to nearby bridges and walkways constructed in recent years along the Brisbane River (e.g. Kurilpa and Goodwill Bridges (both shared), and Bicentennial Bikeway and New Farm Riverwalk (separated)).

  Line marking and coloured surfaces to designate areas for pedestrians and cyclists, as well as direction of travel, should be considered.

- Balustrades and handrails will need to cater for both cyclists and pedestrians, to prevent overturning and pedal/wheels snagging, and handrails being at suitable levels – which is very different for cyclists and wheel chair users.

N/R

Early consideration of connections and detailing will be essential as it may impact on the overall bridge width.

Whilst the zig-zag horizontal alignments may introduce interesting changes in vistas during the journey, these will create potential sight line issues and limitations which would need to be resolved. Limitations and impact of a 1.4m high cyclist balustrade on pedestrians, particularly on people in wheelchairs, will also need to be considered (e.g. line of sight).

On the straight horizontal alignments it will be possible to consider having the high balustrade on one side, and lower (pedestrian balustrade) on the other. However for the exaggerated zig-zag horizontal alignments on 5% vertical fall, cyclist balustrades may be required on both sides depending on the risk assessment.

- For clearances of 30m above HAT it is likely that anti jump screens would need to be considered at the bridge. For clearances of 13-14m above HAT it is assumed that standard balustrades are acceptable.
- Should stairs be provided at the end of the structure, an alternative bikeway/disabled ramp of width of at least 3m width would be required to match the through capacity of the viaduct with its entry points.

For all options, live loads and load patterns for crowds during special events may need to be considered.

To allow for maintenance and emergency vehicle access, at least 3.5m vertical clearance above the bridge deck should be provided, this should be considered for any shade structures for all options.

For a bridge of this length and grade, it is anticipated that shade structure will be required to provide relief from the sun and other elements.

Deck drainage may be in a scuppers to the river below given the bridge is a pedestrian cycleway bridge and not contaminated, this is typical for pedestrian cycleway bridges.

6.5.2 Deck levels and span arrangement

In the marine and tidal river environment, deck levels are driven by a range of (often conflicting) factors. For this project, the key parameter considered at this point is the maritime vertical navigational clearance that has been recommended to be 30m above HAT for a standard footbridge (set by Gateway Motorway first bridge downstream) or 12m above HAT for a bridge with an opening span that would provide either 30m (e.g. lift bridge) or indefinite vertical clearance.

The HAT is estimated at 1.75m AHD. Existing levels at the east and west banks vary between 3m and 4m AHD. Taking into consideration an approximate superstructure depth, a ramp of 11 to 12m vertical height is needed for each option.

N/R

The navigable channel width of 100m is approximately 1/3 to 1/4 of the width of the river. Assuming that the channel is placed centrally within the river, the remaining length to either side is not adequate to develop the ramps within the maximum recommended gradient. Therefore the bridge length will exceed the overall river width, and in some cases may be twice as long as the river is wide.

Various landing sites have been considered, however in most cases such constraint will need to be resolved by creating complex horizontal alignments (e.g. the zig-zag alignment), skewing the alignment in relation to the river, or curving the alignment and running the length of the bridge parallel with the banks. There is little opportunity to develop the alignments on land without land resumption, however where feasible curved ramps can be introduced on land.

Horizontal alignment at skew increases the length of the navigational spans. Ship impact considerations too will impact on location / offset of the bridge piers (and pile caps) relative to the navigational channel, which further increases the navigational span length.

By far most prominent and long lasting effect of the bridge height and geometry is the visual amenity and its impacts on the landscape and community at large. The structure will require an elegant solution so not to be imposing in this location, and likely to require an architectural solution, which could have a significant impact on capital cost.

Therefore each of the options considered has large cost penalties associated with the complex geometry and excessive bridge length.

Further considerations and rationale to the maritime requirements will need to be carried out in order to optimise the bridge alignment, and an overall solution.

By examining the existing bridge clearances upstream from the location, the Story Bridge currently governs the clearance between Gateway Bridge and Goodwill Bridge with 30m above HAT. The Goodwill Bridge has a vertical clearance of 13.25m, which is just above the Captain Cook Bridge of 12.7m, and the Kurilpa Bridge further upstream has 9m vertical clearance. None of these bridges has an opening span.

By introducing an opening span along the structure, there is an opportunity to balance the frequency of its use (direct impact on long term cost) with the maximum vertical clearance at the fixed navigational section.

All bridge options must make adequate provisions for the inspection and maintenance of the bridge for the entire design life.

6.5.3 Connectivity

The connections to local streets and cycling network on either side should provide safe interaction of pedestrians, cyclists and vehicular traffic. This will be of particular importance where transitioning straight off and on the bridge to cycling/road network.

N/R

Existing connections between the existing properties and private dwelling to the river will need to be maintained. Impact on access for the private pontoons along the east bank will need to be considered, during the construction and in permanent case.

Consideration of the marina immediately north from the bridge location and other private vessel moorings will need to be undertaken during the next stage of the project.

6.5.4 Visual amenity

Visual impact on the river users, residents, and business owners and their patrons, will all need to be considered in developing the form of the bridge structure.

The higher the vertical alignment, the greater the impact, and therefore the elegance of the solution will play a crucial role on perceptions of those away from the structure.

Considerations such as:

- **Superstructure depth** - often preferred to be minimised, however this depends on the length of the span and the form of the structure (e.g. a cable stay bridge will have a shallower superstructure compared to some other forms). However the tower will extend approximately half the open length above deck level. Longer spans will increase the deck cost.
- **Superstructure shape** - clever shapes can be utilised to minimise the perception of depth (e.g. introducing shade areas by extending cantilevers along the edge of the deck)
- **Deck level** - in the marine and tidal river environment, deck levels are driven by a range of (often conflicting) factors determined by navigational requirements, material durability and inspection access.
- **Bridge furniture** – these elements increase perception of structural depth, and add weight to the structure, require maintenance
- **Bridge lighting** - location, spacing, height, visibility, strength of luminaires, and other, should all be considered in order to create an overall pleasing effect at night. However, consideration should be given to long term maintenance cost and sustainability
- **Bridge piers** - size and number will depend on design sensitivity to an afflux, flood velocities, constructability, cost, and visual perspective. Requires balance with the superstructure form, depth and height of the deck, as well as location in the river. At this location it is expected that:
    - Afflux will be relatively low;
    - Flow velocity is low;
    - Water depth is approximately 10m;

N/R

- Ship impact criteria may dictate the optimum span length for the site;
- Span length to height above water will be of important visual consideration.

- **Bridge landing site** - treatment to create a landmark notes shaping the city. Limited site/space, constricted areas, proximity to residential areas, difficult to match the sites on both banks with shortest bridge alignment.

A design clearance of 12 metres above Highest Astronomical Tide (HAT) has been adopted for the main navigable channel. This is consistent with the upstream bridges including Captain Cook and Goodwill Bridges, and should provide adequate clearance for the majority of the vessels using the River.

However, it is noted that some vessels currently moored adjacent to the Botanic Gardens have masts higher than this clearance. In addition to this, a new mooring precinct has been identified for consideration to the north of the bridge. Whilst some of these vessels could pass below the bridge clearance at the proposed main navigational channel at low tides, some vessels with taller masts will require a safe passage through an opening span which is proposed for this bridge, but add considerable capital operating cat to the project.

6.5.5 Bridge hydraulics

One of the major influences on potential afflux will be the placement and general arrangement of bridge piers – both in respect to the number of piers, as well as their shape and orientation. The pier design will be resolved further in later design phases of this project as a function of an overall structural solution, and as such is subject to a range of variable factors. Therefore, for the purposes of option assessment, a comparison between afflux potential of different route options was limited to consideration of the fact that ramp structures with complex horizontal alignment over water would tend to require more piers compared to a straighter alignment (all else being equal).

At this stretch of Brisbane River, it is unlikely that flooding will have significant impact compared to sections further upstream. Storm water surge from Breakfast Creek is likely to have biggest impact. Afflux is proportional to the flood velocity squared and flood velocities are generally low in this reach of the river. Approach embankments and ramps are unlikely to impeded overland flow paths in events below the Q100 event.

6.5.6 Constructability

Key issues relating to constructability of a potential active transport bridge include:

- **Construction access:** construction in Brisbane River and impact on navigational channel, limited access along the river due to residential properties (particularly on the east bank) and local business (along Teneriffe and Newstead along the west bank), impact on existing cycleway and pedestrian links and disturbance of existing parks;

N/R

- **Procurement methods:** construction market conditions and number of tenderers should all be considered to identify the impact on cost and programme. These should be identified and included in the project risk and opportunities, and linked to structural form, skill requirements, and size of the project;
- **Site geology:** bridge foundation, constructability, geotechnical investigations. The bridge is likely to be funded on soft mud. Timing of the investigations will need to be considered as an impact on the project timeline;
- **Environmental impacts:** contamination, spoil removal, noise pollution and associated timing limitations for the piling work (impact on local residents and businesses), afflux;
- **Construction safety:** work above water and navigable river (safety to workers and river users), construction near residential area and local business (safety to residents and patrons), consideration of extreme events including flooding and storm season, vessel impacts during the construction;
- **Design innovation:** including unusual construction methods impacting on programming delays (requiring adequate lead times and allowances for testing)

6.5.7 Opening Span

The selection and design of an opening bridge is a specialised area and will require mindful considerations of a range of issues that will drive the design solution.

Selection of the bridge type, structural form, opening mechanism, and operational preferences will need take into account all aspects of the overall bridge criteria and objectives, as well as additional considerations specific to the moving bridge structures.

A selection of opening span examples that could inspire the selection for this bridge is included in Appendix D.

The following paragraphs summarise the key issues that will require further consideration before the selection of the opening section is made.

6.5.7.1 Cost

The opening bridges are typically costly to construct, but also require much higher and ongoing maintenance, including the cost of operation – to open and close the bridge when required.

The capital cost will vary significantly depending on the type, scale, and size of the bridge, as well as the required speed of operation – time to open and close the bridge when required.

N/R

6.5.7.2 Reliability

A number of key issues relating to bridge reliability were identified, including:

- Resistance to flooding and performance after a flood event – directly impacts on long term maintenance cost as well as disruption to the operation of the bridge during the maintenance. Highly dependent on the deck level, and location of the opening mechanism relative to the flood levels and/or water levels;
- Requirement for additional specialised equipment such as locking pins – impact on capital cost and long term maintenance. Dependant on the form and type of opening bridge;
- Size of foundation – directly impacts on the cost, often quite large to house the mechanical parts and to allow the inspection and maintenance. The size is also dependant on the size/length of the bridge, including the type;
- Speed of operation, time to open/close – this needs to be well understood from the user perspective, as it directly impacts on operation of the pedestrian / cycle link;
- Area of the bridge that has to be cleared of pedestrians and cyclists before the opening – directly impacts on operation of the pedestrian / cycle link;
- Ability for bridge to be controlled by a non-specialist / untrained operator – which in this case is unlikely as it directly impacts on safety of both the pedestrian/cyclist link users as well as boat operators; and
- General maintenance liability.

6.5.7.3 Aesthetics and visual amenity

The opening span will need to complement the general requirements of the bridge as a whole, including the following additional criteria:

- The structure and the piers are fundamentally more bulky and must house hydraulic and mechanical plant;
- Functional requirement of opening to allow boats of indeterminate height to pass;
- Potential to create a visual statement. The scale of the walkway and the location may warrant an exaggerated form for which an opening structure may create a suitable opportunity;
- Be an integrated part of the crossing as a whole and adopt a form that emerges from engineering design and meeting other key criteria; and
- Safety gates, warning systems and lights need to be integrated into the opening solution.

N/R

6.5.7.4 Constructability and any restrictions that may apply

The reliability of the bridge is understandably paramount. In order to maximise reliability, the operating mechanism must be simple and be as un-reliant on high precision set-up or excessive sensors. This is particularly important when any flooding condition is considered, noting that the simpler the system, the less there is to get damaged. However, unlike Riverwalk, flooding in the study area is low. As such, accidental vessel impact may be a greater consideration. To aid the longevity and minimise the long term maintenance, the mechanism should be as robust as possible.

Electrical systems are less tolerant of water when compared to hydraulics which can operate in harsh environments, however both are readily available. The potential down side to hydraulics is the added unlikely environmental risk posed by the oil, however biodegradable oil can be considered.

The frequency of the opening will impact on speed of operation and how critical it is for the design. The faster the bridge opening needs to be, the more power is required and hence the larger the equipment that has to be installed. Keeping the speed of operation relatively low will mean that the installed power and equipment size will also be relatively low.

N/R

6.5.7.5 Opening bridge types

Table 12 Type of opening bridges

Bridge Type	Brief description	Advantages	Disadvantages
Single swing	The bridge deck rotates about a vertical axis. The bridge can be rotated using hydraulic cylinders, electric motors & gearbox or hydraulic motors. Counter weights are nearly always provided to reduce the over turning moment at the pivot.	Provides a navigation clearance of unrestricted height. Proven design basis. One of the simplest forms of moving bridge. The deck can be swung relatively quickly and is less affected by wind speed than a bascule bridge. Relatively low maintenance requirements.	The bridge has to be longer than the required navigation opening by half the width of the bridge due to the fact that when it is rotated to allow the passage of marine craft half of the bridge width still hangs over the centre line of the pivot. A mechanisms at the nose (and potentially also the tail) may be needed to provide vertical alignment between the fixed ends either side of the moving section and the moving deck. Marine vessels will be passing close by the swing bridge and hence protection fenders may be needed around the shadow of the swung deck. This can look visually unattractive and also may cause a hazard to vessels when the bridge is in the bridging position.
Double swing	Each deck rotates about a vertical axis. Counter weights are nearly always provided to reduce the over turning moment at the pivots. The bridge can be rotated using hydraulic cylinders, electric motors or hydraulic motors.	Provides a navigation clearance of unrestricted height. Proven design basis. The decks can be swung relatively quickly and they are less affected by wind speed than a lifting draw bridge. One span can be worked on for maintenance or inspection whist the other continues to operate and let vessels pass the bridge. Relatively low maintenance requirements however twice more than for a single span.	Locking and locating pins required at joint between the two decks and at both tails to provide horizontal and vertical alignment with approach spans. Two driving mechanisms required and hence twice the risk of failure. Issue of how to get power and control to other side of opening span without having to run power along the entire length of the bridge.

N/R

Bridge Type	Brief description	Advantages	Disadvantages
Bascule, or Single lift (draw bridge)	Rotates vertically about an axis in the horizontal plane. Probably the most common type of moving bridge.	One of the simplest forms of moving bridge. A counter weight can be utilised to reduce the forces on the lifting mechanism. If rotated enough can provide unlimited navigation height. Pedestrians can be stopped close to the opening section minimising the length of deck that needs to be cleared and hence minimising the period of disruption to those wanting to cross the bridge. Probably the lowest maintenance requirements. Could potentially have the mechanism above deck level	Wind loads will have an effect on the foundation. Realistically, limited to hydraulic drive options only. In the event that the bridge requires maintenance the bridge cannot be passed.
Double Bascule, or Double lift (draw bridge)	Each deck rotates vertically about an axis in the horizontal plane. Where the two decks meet a locking devise ensures alignment of the decks.	Mechanical equipment will be readily available for this size of span. Counter weights can be used to minimise pier size and to reduce loads on mechanisms. If rotated enough can provide unlimited navigation height. Pedestrians can be stopped close to the opening section minimising the length of deck that needs to be cleared and hence minimising the period of disruption to those wanting to cross the bridge. One span can be worked on for maintenance or inspection whist the other continues to operate and let some vessels pass the bridge. Relatively low maintenance requirements (but more than for a single span).	Requires locking pins at the joint between the two decks to ensure vertical alignment. Twice the mechanical equipment of the single swing and lift options. Two driving mechanisms required.

N/R

Bridge Type	Brief description	Advantages	Disadvantages
Vertical lift	The rectangular deck is lifted vertically. Two methods of lifting the deck: 1. Cables attached to a counter weight at each end of the deck. The cables are usually wound round a drum that is either electrically or hydraulically driven. 2. Alternatively the deck could be raised using hydraulic cylinders. The stroke of the cylinders would have to be the navigation height required.	Counter weights would be used to reduce the forces on the lifting mechanism if winch drums were used. Pedestrians can be stopped close to the opening section minimising the length of deck that needs to be cleared and hence minimising the period of disruption to those wanting to cross the bridge.	Large towers are required at each corner of the lifting span to provide vertical guidance and horizontal restraint. These towers will restrict the architectural elements and could be unattractive and cause visual clutter. The vertical clearance required will dictate the height of the towers. Cables will require replacing in 10 - 15 years - replacement is a time and labour intensive activity and would result in the bridge being closed to either pedestrian or river users for days or even weeks. Lots of mechanical equipment to maintain and inspect.
Retracting (sliding)	The moving bridge span slides backwards along the adjacent span. The deck is usually mounted on wheels which roll along tracks. The bridge would be moved usually by pulling via cables.	Provides a navigation clearance of unrestricted height.	To slide the moving span back would require a clearance behind the deck of in excess of the navigation width required. This would also cause problems with handrails and potentially lighting as one span has to slide backwards onto the adjacent span. Mechanising the bridge would be expensive and would require winches or similar to pull back the deck sufficiently. The moving deck often has to lifted slightly as well as slide back. Maintenance requirements likely to be fairly high. Drive cables will require replacement within 10 – 15 years.

N/R

Bridge Type	Brief description	Advantages	Disadvantages
Lifting (rolling Schertzer)	Similar to the draw bridge type but instead of rotating about a fixed axis the bridge deck rolls back along a large radius track. This allows the vertical clearance to be achieved faster.	The required navigation height clearance is achieved quickly. Maintenance requirements are not too extensive. Can be designed to provide a navigation clearance of unrestricted height.	A significant portion of deck has to be cleared to allow space for the deck and mast to roll back. A counter weight would almost certainly be required to keep the loads within reasonable limits. The rolling track is visible on the adjacent span.

Once the preferred form of the opening span is selected, an appropriate mechanism will need to be selected. This will depends on;

- Bridge geometry;
- Available space to accommodate the mechanism;
- Design forces, depending on the bridge self-weight and flood/water forces, although at the proposed location for this bridge it is expected that the structure will be well above the flood level and therefore will not be significantly impacted by floods;
- Access / plan for maintenance; and
- Available budget / capital cost.

6.5.7.6 Opening span operator and operating position

Several options are available as to who the bridge operator could be, the decision over who is suitable to operate the bridge is dependent upon several key factors:

- Frequency of bridge operation;
- Notice period to operate the bridge;
- Safety of the operator and public; and
- Skill of the operator and the complexity of operation.

There are three main options to consider:

- Operated by an unskilled (and potentially untrained) member of the public;
- Operated by a trained member from the bridge owner; and
- Fully automatic – the bridge opens when it senses a marine vessel.

6.5.7.7 Operated by an unskilled member of the public

The option of an unskilled member of the public operating the bridge relies on a very simple method of operation which could potentially be achieved in this instance. However, if the member of public is also required to control those wanting to cross the bridge and the level of pedestrian and cycle traffic is high

N/R

then this added responsibility can make the operation unsafe as they do not have any obvious authority over anyone else wanting to use the bridge.

The control system for this type of operation would be a series of three buttons; open, close and emergency stop. The operator would be required to insert a key issued to the relevant people following a brief training session. The main issues with this option are;

- Cannot guarantee that only those that have been trained have access to the operator's key.
- Controlling the public when you have no noticeable authority over them may be difficult.
- Ensuring that any issues that crop up are dealt with correctly and efficiently is harder to achieve.

All of the key issues directly relate to safety of the public, which includes both boat operators as well as users of the walkway. Potential liability issues would need to be considered if this option is adopted.

This form of operation is not considered to be appropriate for this bridge.

6.5.7.8 Operated by a trained member of the bridge owner

The operator plays an important role in spotting any gradual problems that may be developing, if the person operating the bridge is different each time then this working knowledge of the bridge is lost.

The benefit of a trained operator (or small team of operators on rotation) is that they can be trained in all aspects of the bridge operation, plus any recovery systems that may need to be employed.

This form of operation is considered most appropriate for this bridge.

The down sides of this option are:

- The role of bridge operator may require additional staff to be employed (with associated cost issues), or if the bridge operation is infrequent, finding the correct existing members of staff who would be free at the right time and location to operate the bridge. However this role can be combined with the New Farm Riverwalk operations, which should provide valuable lessons learned and set positive precedence for this bridge.
- The notice period given before the bridge is required to open. If this is on a timetable basis then staffing requirements can be planned and provision made. If the bridge operation is on demand this could require full time attendance at the bridge or between certain time windows.

To overcome the issue with having to attend the bridge, a remote operating system could be installed. This would require a dedicated link between the bridge and the remote operating position to ensure that safety systems such as the emergency stop were functioning correctly.

N/R

Additionally, CCTV coverage of the bridge approach spans, along with views up and down stream in the vicinity of the bridge and in the distance would be required. A public address system to allow the operator to communicate not only with the marine craft but also the pedestrians and cyclists would also need to be installed. A position for the remote control station would also need to be found in a suitable building (town security centre etc.).

Whilst this option seems simple, there can be significant costs involved in ensuring that the system is safe. It is also worth noting that no remote system can be as safe as an operator next to the bridge. Someone who is at the bridge in person can react much quicker and assess the situation much more effectively when they are at the scene of any problem or potential incident. If a remote system was installed a local control point would still be needed for use in the event that the link between the bridge and the remote control point was lost.

6.5.7.9 Fully Automatic Operation

The fully automatic option may not be suitable for this location due to the highly navigable river and variable direction of marine craft. This option is most suitable for very remote bridges which have to be raised infrequently, with little traffic passing over them, and on calm canals and rivers where the flow speed of the water is low. The requirement to manage the public in the bridge and ensure people follow the directions can be difficult in the operation mode, noting those on the bridge may not be regular bridge users who understand the process, and may not speak English.

N/R

6.6 Route environment review

A saddle survey of the subject site was undertaken on 7 January 2016 to understand the existing opportunities and constraints on both sides of the river. By cycling the route, an understanding of how cyclists would perceive the existing and potential future facilities was gained. A follow-up site visit was conducted with TMR and BCC representatives on 20 January 2016. This visit was primarily conducted on foot to understand the needs, opportunities and constraints of pedestrians that may use the active transport bridge.

During the saddle survey and the follow up site visit, a number of potentially suitable landing locations were identified, based on criteria such as:

- Proximity to key attractors;
- Available land for bridge ramps; and
- Avoidance of constraints such as heritage buildings, boat moorings and utilities.

The locations identified during the saddle survey are shown in **Figure 38**, with a further description of the opportunities and constraints associated with each option presented in the following sub-sections.

Deliberation

N/R

Pages 82 through 97 redacted for the following reasons:
- -
Deliberation

7 Potential Future Users

In addition to a review of the potential bridge structure and landing locations, consideration was also given to the potential future users of the bridge.

Based on the general location of the bridge, three main groups of users were identified:

- Commuters – from Bulimba and other Eastern suburbs to Fortitude Valley and the CBD;
- Recreational users – the bridge would provide an extension to the off road network for pedestrians and cyclists who currently walk and cycle along the river on either bank. This group would also include pedestrians and cyclists travelling to the area to visit the bridge specifically; and
- Local community – the bridge would connect residents on both sides of the river to attractors on the other bank.

These groups are discussed further in Sections 7.1 to 7.3 below. A review of the potential future patronage was also completed, and discussed in Section 7.4.

7.1 Commuters

7.1.1 Commuter cyclists

Commuter cyclists using the bridge are anticipated to consist primarily of people living in Bulimba or other suburbs to the east cycling to and from businesses located in the CBD and surrounding suburbs such as Fortitude Valley and Spring Hill. These cyclists prefer routes that are direct, fast and safe.

This category of future bridge users are likely to be currently:

- Cycling along Wynnum Road to the CBD. These users may divert their route to cycle via the new bridge;
- Catching a Cross River Ferry or CityCat with their bicycle to continue their journey by bike. These users may travel the entire route by bicycle in the future; or
- Driving, or taking the bus or ferry to work. These users may change their mode choice in the future if a convenient bridge is available.

7.1.2 Commuter pedestrians

Commuter pedestrians using the bridge are anticipated to consist primarily of:

- People living in Bulimba walking to bus services in Teneriffe to connect to their place of work;
- People living in Bulimba walking to workplaces in Teneriffe, New Farm or Fortitude Valley;

N/R

- People living in nearby suburbs parking near the bridge to connect to buses in Teneriffe.

These future users would prefer a bridge that is:

- Located close to public transport (on the Teneriffe side);
- Located close to parking or connecting bus services (on the Bulimba side); and
- As straight and direct as possible.

7.2 Recreational users

Visitors (both pedestrians and cyclists) using the bridge for recreation may have a variety of reasons attracting them to the area:

- Enjoying a walk / cycle along the riverside paths;
- Visiting existing attractors in the area such as New Farm Park, the Gasworks precinct or Oxford Street; and/or
- Visiting the bridge for its intrinsic attraction value. The level of attraction could be higher if the bridge has a unique element of attraction, similar to the design of the Kurilpa Bridge. The fact that the bridge is an opening bridge may be enough to attract visitors, similar to the Palace Bridge in St Petersburg or the Tower Bridge in London.

7.3 Local community

A major potential group of future bridge users is the local community, which includes residents and employees based in Bulimba and Teneriffe. These users would use the bridge to undertake relatively short trips to local attractors, for example:

- A resident in Bulimba walking to the shops at the Gasworks precinct;
- A resident in Teneriffe walking to restaurants along Oxford Street; or
- Someone working in Teneriffe walking to Bulimba for lunch.

The potential usage by the local community will be most influenced by the directness of the bridge, and the proximity of the bridge landings to major trip attractors in the area.

7.4 Potential Patronage

7.4.1 Factors affecting future patronage

An important consideration in the feasibility of an active transport bridge between Bulimba and Teneriffe is the potential level of patronage. In order to estimate this, it is important to understand the reasons for people to use the bridge. With

N/R

consideration of the three main potential users of the bridge discussed in Sections 7.1 to 7.3, it is anticipated that the three main drivers of bridge usage will be:

- Reduced cost;
- Time saving; and
- Perceived safety benefits.

These are discussed further below.

<u>Reduced Cost</u>

One driver for future bridge usage is reduced cost. Currently, people wishing to cross from Bulimba to Teneriffe or vice versa must pay a one zone fare ($3.35 per trip for an adult using a go Card during peak hour). This would be negated if a bridge was present.

People continuing to the Brisbane CBD or Fortitude Valley would also see some level of savings. Walking across the bridge and catching the Blue Cityglider service costs a single zone fare. On the other hand, catching a bus from Bulimba to the City, or catching a ferry then connecting to a bus in Teneriffe currently costs a two zone fare. The resultant $0.58 saving (per trip, for an adult using a go Card during peak hour) may attract more people to use the bridge.

<u>Time Saving – Cross River Only</u>

The current Cross River Ferry and CityCat services provide a frequency of up to eight (8) services per hour between Bulimba and Teneriffe, with a travel time of approximately five (5) minutes. Based on an average 3.75 minute wait for a ferry, the current average travel time between Teneriffe and Bulimba is 8.75 minutes during peak hour. It should be noted that the average travel time outside of peak hour is longer due to lower ferry frequencies.

The potential bridge alignment options are generally 500m to 600m long. The *Austroads Guide to Traffic Management Part 6* suggests that an average able-bodied person's walking speed is 1.5m/s, and that the 15th percentile walking speed is 1.2m/s (i.e. 15% of people walk slower than 1.2m/s). The *Vicroads supplement to Austroads Guide to Road Design Part 6A* suggests that "Over the lengths encountered by normal pedestrian movements, grades of up to 5% generally do not affect speeds". Given that the bridge is not anticipated to exceed 5% in grade, these walking speeds have been adopted to estimate travel time across the bridge.

The equivalent walking times across the bridge are therefore approximately:

- 5.5 to 7 minutes for an able bodied person; or
- 7 to 8.5 minutes for a person walking at the 15th percentile speed.

It should be noted that time savings can be achieved by both types of users. It should be noted that the above represents a high level analysis that only considers the actual travel time, and that attractiveness may be affected by differences in perceived time between walking, sitting on a ferry and waiting at a ferry terminal.

N/R

Research collated for the California Department of Transportation (Iseki, Taylor, & Miller, 2006) indicated that the average relative weight for waiting time is between 1.47 to 4.36 times in-vehicle time, while the relative weight for walking time is between 1.66 to 2.72 times in-vehicle time.

Greater levels of travel time savings are able to be achieved by cyclists. Assuming a cycling speed of 10km/h (as per speed limits on the Goodwill Bridge), the cycle travel time across the bridge is approximately 3 to 4 minutes.

Time Saving – Bulimba to City

In addition to people only crossing the river, a future bridge crossing could also offer time savings to people continuing to the Brisbane CBD.

Current bus travel times from the Bulimba Ferry Terminal to City Hall are approximately 37 minutes during the morning peak hour (on route 230). However, walking across the bridge (up to 8.5 minutes) then waiting for a Blue Cityglider (up to 5 minutes) and continuing to City Hall (14 minutes travel time) leads to a total travel time of 27.5 minutes. This offers a travel time saving of over 9 minutes (24%) compared to an existing bus journey.

It should be noted, however, that this travel time reduction is based on a comparison between two defined stops. Residents that may live away from Oxford Street may find that the time required to walk to the bridge landing point at Bulimba cancels out the travel time benefits.

In order to estimate the catchment that would perceive travel time benefits, an indicative 9 minute (approximately 600m) radius from the Bulimba Ferry Terminal was drawn to determine the area within which it may be faster to walk across the bridge than catch a bus (refer to **Figure 55**). It should be noted that the 600m circle is indicative assuming that the bridge landing is located at the Bulimba Ferry Terminal. The exact location of the catchment circle will vary depend on the actual bridge landing location.

N/R

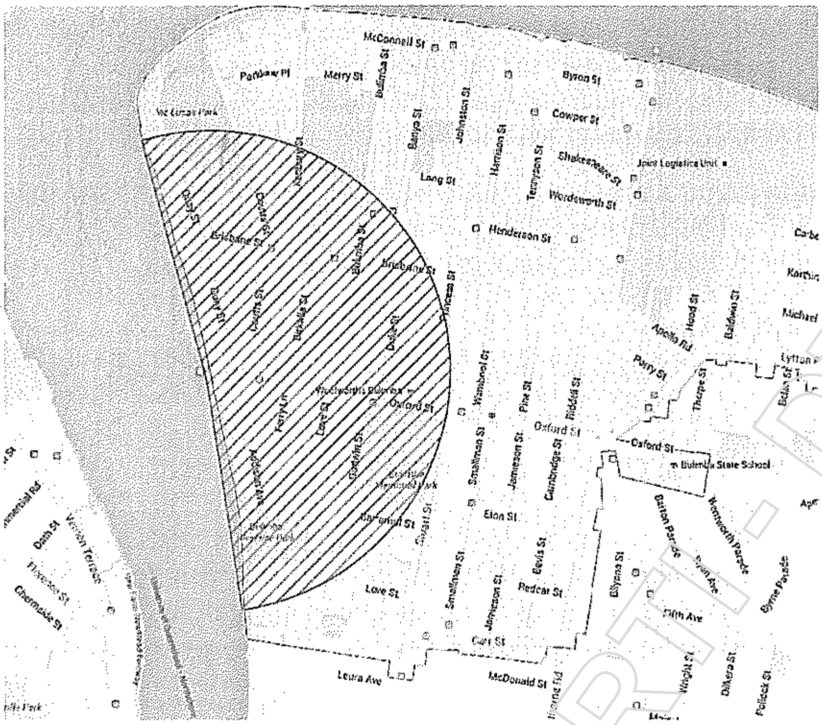


Figure 55 600m catchment around Bulimba Ferry Terminal in blue, Bulimba suburb extents shaded in red. Map source: Google

The figure above shows that despite the additional walking time, residents in approximately one quarter of Bulimba would have reduced travel times if they walked across the bridge to the Blue Cityglider compared to catching a bus directly from Bulimba to the city.

Perceived Safety Benefits

Another potential driver for future bridge users is the perceived safety benefit of an off-road route, particularly for cyclists. Many cyclists in Bulimba and Hawthorne currently cycle along Hawthorne Road or Riding Road and then along Wynnum Road towards the City. Parts of this route require cycling with traffic along busy roadways, which can be daunting for less experienced riders. An active transport bridge from Bulimba to Teneriffe could significantly reduce the on-road cycling required to travel between Bulimba and the Brisbane CBD, with riders only required to navigate traffic from their homes to the bridge, and along short sections of road in New Farm.

7.4.2 Potential level of patronage

It is noted that the potential level of patronage is an important consideration in the feasibility of a new active transport bridge between Bulimba and Teneriffe. At this stage of design, however, it is difficult to determine future patronage with certainty. Further detailed transport modelling using the preferred bridge alignment would be required to more accurately inform future patronage.

In order to obtain an estimate of the potential level of patronage across an active transport bridge between Bulimba and Teneriffe for this feasibility study, three

N/R

methods of determining the potential patronage (in terms of order of magnitude) were utilised:

- Based on comparison with usage of other bridges in Brisbane;
- Based on an estimate of potential mode switching, and data from previous new cycleway infrastructure; and
- Based on potential pedestrian and cycle mode share increase.

It should be noted that each of these three methods relies on many assumptions regarding future behaviour, and the results must be interpreted as an indication of the order of magnitude of patronage across the bridge.

The estimate of potential future usage of the bridge obtained through each of the three methods was approximately 3,000-3,600 people per day. Further details of the estimation processes are presented below.

Estimation through comparison

The first estimate of the potential patronage across a Bulimba-Teneriffe bridge was obtained by benchmarking against other crossings and cycle infrastructure in Brisbane, as shown below in **Figure 56**.

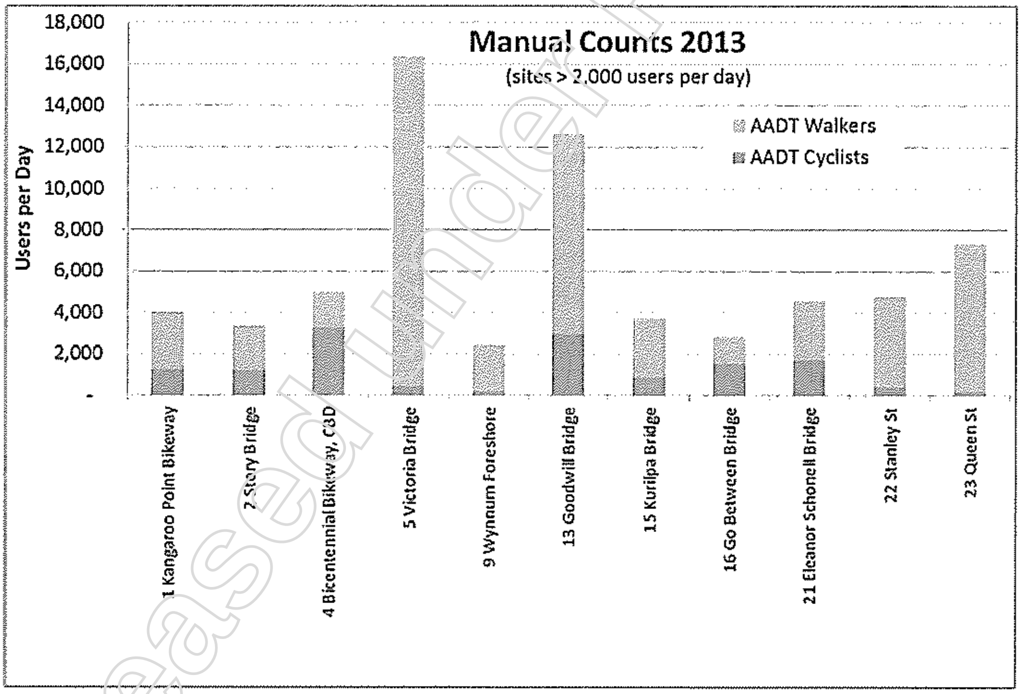


Figure 56 Usage of existing active transport infrastructure in Brisbane (*Approved by BCC for external use*)

Additional data was obtained from BCC (via TMR) with respect to the trends of pedestrian and cycle usage of a number of river crossings, including the Goodwill, Kurilpa and Victoria Bridges for the period between 2009 and 2015 (note that some data points were not available). These are shown in **Figure 57** and **Figure 58**.

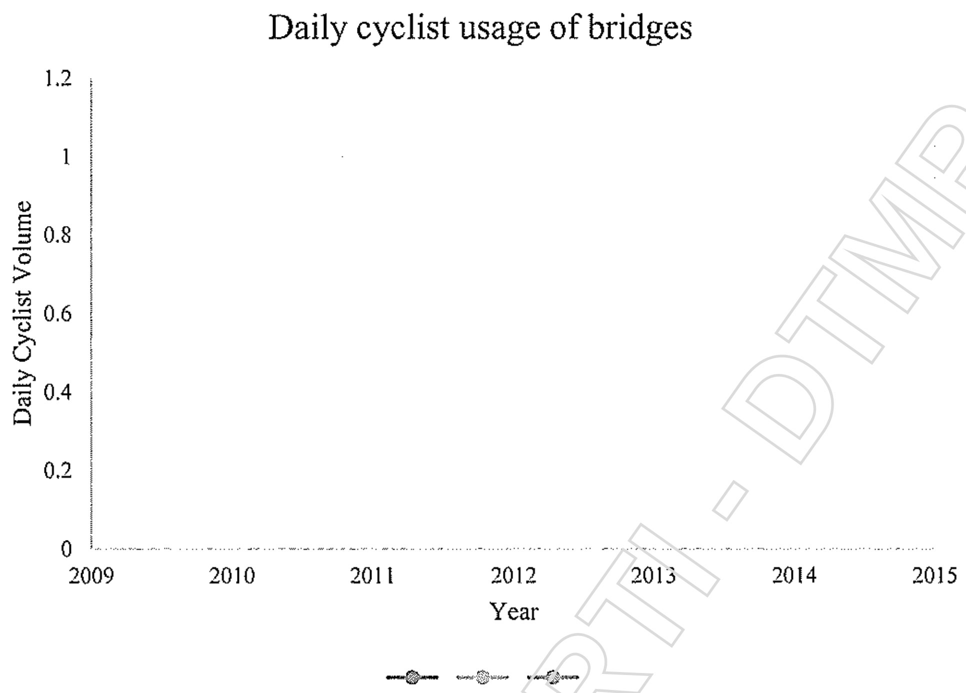


Figure 57 Trend cyclist usage of active transport infrastructure in Brisbane (source: Public Works and TMR permanent counters)

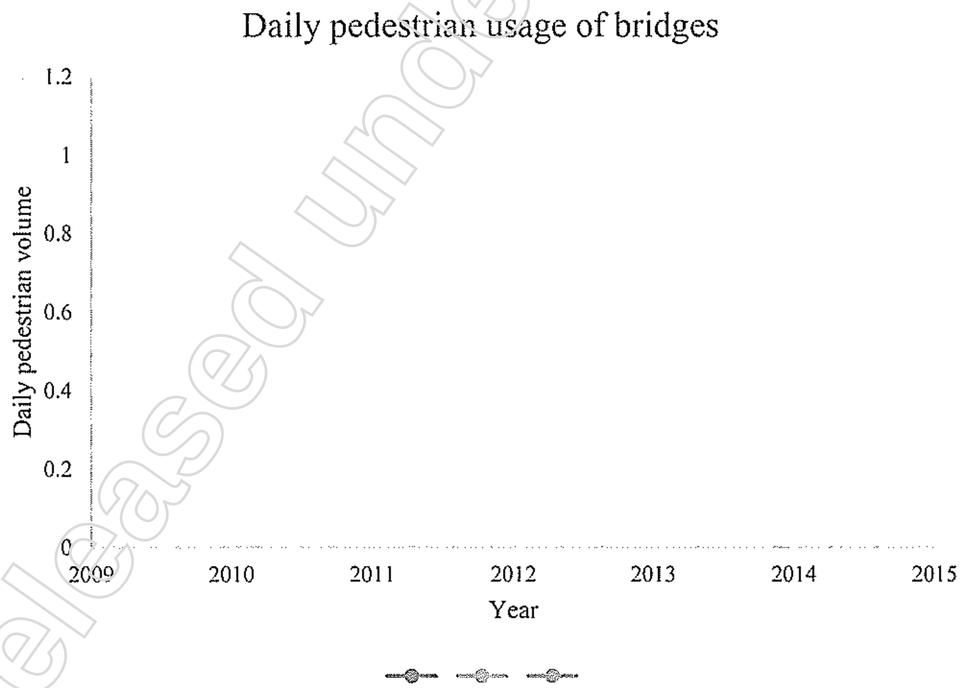


Figure 58 Trend pedestrian usage of active transport infrastructure in Brisbane (source: Public Works and TMR permanent counters)

N/R

While very high usage was recorded along the Victoria Bridge and the Goodwill Bridge (over 10,000 cyclists and pedestrians per day), it is considered that those are unique cases due to their location. The Victoria Bridge provides a connection between Queen Street Mall and the Cultural Centre precinct and South Bank, while the Goodwill Bridge lies along the most direct route from the CBD to the V1, and also provides connectivity from QUT to South Bank.

It is considered that a Bulimba-Teneriffe bridge could achieve cycle/pedestrian patronage similar to the Story Bridge and the Go Between Bridge, with approximately 3,000 users per day. Both bridges provide connectivity on the outskirts of the CBD, and are located relatively far away from other river crossings (with the exception of the Kurilpa Bridge, which is located near the Go Between Bridge).

Estimation through mode switch assumptions

Another high level estimate of the potential usage of a new active transport bridge was derived using data from a paper published by TMR (Langdon, 2015). This paper presented indicative diversion rates obtained from surveys of new cycling infrastructure in South East Queensland, and found that of the users of new cycling infrastructure in the inner city:

- 10% previously travelled by car;
- 20% previously caught public transport;
- 5% previously walked; and
- 65% previously cycled, but via another route (i.e. route change rather than mode change).

A key message from the data is that new cycling infrastructure in the inner city area leads to a significant level of route change in addition to the expected mode change. In the context of a new bridge from Bulimba to Teneriffe, this route change is likely to consist mainly of cyclists from Bulimba / Hawthorne currently riding via Hawthorne Road or Riding Road, along with some cyclists currently commuting from suburbs further to the east.

It was noted that approximately 1,100 people per weekday currently use the Cross River Ferry service between Teneriffe and Bulimba, with a further 3,500 people per weekday catching a bus from Bulimba/Hawthorne to the City or Fortitude Valley. It is considered that not all of these people will use a Bulimba-Teneriffe bridge if it were built. However, based on previous analysis, it was understood that the bridge would provide improvements to travel time for users of the ferry, as well as for a significant proportion of people currently catching the bus.

As an initial assumption, approximately half of the people currently catching a Cross River Ferry, as well as approximately one tenth of the people currently catching a bus to the City or Fortitude Valley were assumed to use the bridge. This allows for some people to remain on their existing modes. This led to an estimate of approximately 900 people per day switching from ferry or bus to using the bridge (both cyclists and pedestrians). Based on the analysis of previous cycleway infrastructure presented above, 25% of users of new cycleway

N/R

infrastructure shifted from public transport or walking (as walking from Bulimba to Teneriffe is currently not possible, this demand is currently fulfilled by the cross river ferry). Assuming that this also holds for pedestrians, this leads to an estimate of approximately 3,600 people per day using a new active transport bridge between Bulimba and Teneriffe.

Estimate using increased cycle and walk mode share

A third method of estimating the future usage of an active transport bridge was using Journey to Work (JTW) data. The 2006 JTW data for the suburbs most likely to generate weekday trips (on the right bank) is presented in **Table 13**.

Table 13 Journey to Work data for suburbs adjacent to potential future bridge

Suburb	JTW trips	% Cycle Mode Share (2006)	% Walk Mode Share (2006)
Balmoral	1,981	1.9%	2.6%
Bulimba	2,760	1.4%	2.8%
Hawthorne	2,397	1.3%	2.0%
Total	7,138		

The existing cycle and walk mode shares in the suburbs of Balmoral, Bulimba and Hawthorne are low compared to the mode shares across the river. For example, the corresponding figures for Newstead are 2.5% mode share for cycling and 9.9% mode share for walking (12.4% total), compared to approximately 4% for Bulimba, Balmoral and Hawthorne currently.

It is anticipated that while a new active transport bridge will increase cycle and pedestrian mode share, a 12.4% combined walk/cycle mode share as per Newstead may not be achievable due to the slightly increased distance. As such, an estimate of the potential usage of the bridge was derived using a 6.2% potential combined walk/cycle mode share (i.e. half of the Newstead share).

This was benchmarked against the mode share data for Albion, which like Bulimba is also separated from Newstead by a waterway (Breakfast Creek). Albion, unlike Bulimba, has bridge crossings over Breakfast Creek suitable for use by pedestrians and cyclists located adjacent to Allison Street and Breakfast Creek Road. This provides some level of similarity with the potential future situation for Bulimba if an active transport bridge is constructed. The combined walk/cycle mode share for Albion based on JTW data is 6.1%, which is similar to the 6.2% assumption presented above.

Based on a 6.2% combined walk/cycle mode share for journeys to work and 7,138 total journeys to work, approximately 443 journeys to work would be undertaken by cycle or walking. However, not all of these trips would utilise the bridge, as there would still be some level of local employment within the Bulimba precinct, and some people may still prefer to cycle via Wynnum Road (for example, to Kangaroo Point, South Bank or West End).

An estimate of the potential daily usage of the bridge was then derived using the following assumptions:

- All "new" walk/cycle journeys to work (6.2% - 4% = 2.2%) caused by mode shift would use the bridge;
- Half of the existing walk/cycle journeys to work would use the bridge (4% / 2 = 2%);
- Each journey to work involves two trips – one to work, one from work; and
- The number of daily trips was calculated by multiplying the number of journeys to work by 10. This is based on typical ratios of peak hour traffic (primarily journeys to work) to daily traffic generated by residential properties.

Based on the above assumptions, the future usage of an active transport bridge between Bulimba and Teneriffe was estimated to be approximately 3,000 people per day.

N/R

Pages 108 through 120 redacted for the following reasons:
- -
Deliberation

10 Safety in design

Safety in Design assessment is required under occupational health and safety legislation. The intention of this legislation is to ensure that hazards and risks that may exist in the design of a workplace are eliminated or controlled at the design stage, so far as reasonably practicable. A number of project participants, including clients, have a role to fulfil with regard to safety in design and on the Project generally. Regardless of whether there is a legislated requirement for safety in design in place, there is a requirement to provide a workplace that is safe and without risk as far as reasonably practicable. Safety in design will assist in achieving this outcome.

This Safety in Design review has focused on unusual aspects of the design which may involve unusual hazards or may require unusual risk controls to eliminate or minimise the risk. It is assumed that hazards that can be adequately addressed by applying solutions/guidelines in existing standards, e.g. building code requirements, Standards, specific Industry Guidelines have been addressed via adoption of the relevant standards and guidelines.

A Safety in Design review was held on the 6th June 2016. All design disciplines contributed. The outcomes of the review are recorded in the Safety in Design Report and Risk Register in Appendix E.

Table 22 summarises three key items identified within the safety in design assessment and control measures adopted.

Table 22 Safety in Design assessment controls

Safety in Design Risk	Control Measure
Risk of cyclists travelling at speed colliding with pedestrians (particularly children) adjacent to park space	During future design stages investigate opportunities to offset the cycle path from the playground, as well as providing physical barriers such as fences. Ensure adequate sight lines through these areas also.
Steep downhill grades in wet may lead cyclists to lose control and injuries to occur.	Review of pavement design of cycleway in future design stages to include considerations of wet weather.
During excavation activities the construction crew may be exposed to contaminated soils.	Detailed design phase to include geotechnical reviews of soil condition to confirm the presence of any contaminated soils on site.

N/R

11 Conclusion and Recommendations

This Summary Planning Report for the Bulimba to Teneriffe Active Transport Bridge considered the feasibility to constructing a new active transport bridge across the Brisbane River between Bulimba and Teneriffe.

Key issues considered in assessing the feasibility of the bridge included:

- Existing active and public transport demand across the river;
- Local and state planning requirements;
- Constraints and Opportunities in the area, relating to:
  - Environmental issues;
  - Cultural heritage;
  - Land use planning;
  - Existing road and path networks;
  - Maritime requirements (as per Maritime Services Queensland); and
  - Structures.
- A review of the needs and wants of potential future users of the bridge.

The study found that the bridge would cater for existing demand for crossing the Brisbane River at this location, with potential for future demand evidenced by factors such as high public transport demand between Bulimba and the CBD. In addition, the construction of an active transport bridge at this location offers opportunities to link existing networks on either side of the river, including the off-road riverside paths between New Farm and Teneriffe and between Bulimba Ferry Terminal and Bulimba Riverside Park.

Key potential constraints to the project were also identified, including:

- The requirement for a bridge of reasonable height to be able to open. A non-opening bridge would be required to have over 30m of clearance above HAT, which would require significant ramping and be very unattractive to users;
- The width of the Brisbane River at this locality is quite significant. This would lead to higher structure costs; and
- The limited amount of land available on both banks of the river to accommodate a bridge landing and ramp structure. This limits the number of potential crossing options that can be achieved without costly property resumptions.

Taking into account the constraints and opportunities in the area, this study identified eight high level alignment options for a bridge across the Brisbane River, with one preferred alignment option selected for further review and assessment. A review indicated that an active transport bridge at this location would be feasible from both technical and planning perspectives including:

N/R

- **Bridge approaches**: there is sufficient room for landings on either side of the river;
- **Bridge geometry**: the required river navigational clearances can be achieved, however the solution is likely to require long approach ramps at high longitudinal grades, set on a curved horizontal alignment; and
- **Structural form**: range of structural forms can be explored, for both the fixed and the opening span sections. The solutions ranging from a simple multi-span structure, to more complex architecturally designed bridges will depend on available funds, visual amenity, and an overall value for money including the long term operation and maintenance (refer Appendix D for selected global examples). There is existing precedence of tried and tested opening span technologies available globally and in Australia.

With respect to the economic feasibility of the project, this study found that there is a significant existing demand for travel from Bulimba to the Brisbane CBD via the cross river link to Teneriffe, and also via existing bus services along Wynnum Road. A high level review of the potential usage of a bridge between Bulimba and Teneriffe was also completed based on various methods, and a rough estimate of the possible usage of the bridge was in the order of 3,000 people per day.

Due to the uncertainty regarding the potential opening mechanism of the bridge, a review of the potential cost of a Bulimba-Teneriffe active transport bridge was completed using benchmarks from other bridge structures. This concluded that the overall cost of the bridge would be in the order of Deliberation although this could vary significantly depending on bridge architectural form and the type of opening span used.

Key items that should be investigated in future design stages include:

- Obtain detailed terrain survey (including underwater) for the study area to more accurately inform the future design stages;
- Conduct further investigation on the appropriate opening mechanism for the bridge;
- Undertake geotechnical investigation. This will identify, among other things:
    - The presence and extent of contaminated land;
    - The presence and level of rock along the proposed bridge alignment, which will inform the number and scale of bridge piers;
    - The capacity of the existing banks to support a bridge ramp structure;
- Review existing utilities present in the study area;
- Further review of the economic feasibility of the active transport facility;
- Further review and confirmation of bridge structure including;
    - Basis for the design and any bespoke requirements such as ship impact, urban debris, maritime safety, and navigational clearances;
    - Overall bridge functional requirements;

N/R

    - Flood immunity requirements, flooding impacts including afflux and bridge design;
    - Deck levels;
    - Bridge alignment;
    - Urban design and visual amenity requirements;
    - Opening span functional requirements including the future operational requirements;
- Develop key objectives and desired outcomes for the bridge, define relevant benchmark criteria and carry out a Multi Criteria Option Assessment to identify the preferred option(s);
- Undertake concept structural design to further develop the preferred option and develop concept cost estimates.

12 References

Brisbane City Council . (2014). *Bulimba District Neighbourhood Plan* .
Brisbane City Council . (2015). *Bulimba Barracks Master Plan* .
Brisbane City Council. (2012). *Brisbane Active Transport Strategy 2012-2026.* Brisbane City Council.
Brisbane City Council. (2014). *Brisbane City Plan 2014.* Retrieved from Brisbane City Plan 2014: http://eplan.brisbane.qld.gov.au/CP/DistrictCentreZC
Brisbane City Council. (2015, August). *Brisbane City Centre Master Plan 2014.* Retrieved from http://www.brisbane.qld.gov.au/planning-building/planning-guidelines-tools/brisbane-city-centre-master-plan-2014
Iseki, H., Taylor, B. D., & Miller, M. (2006). *The Effects of Out-of-Vehicle Time on Travel Behavior: Implications for Transit Transfers.* Sacramento: California Department of Transportation.
Langdon, M. (2015). An evidence-based assessment of the impact of cycling infrastructure in South East Queensland. *AITPM 2015 National Conference.*
Queensland Government . (2009). *South East Queensland Regional Plan* .
Queensland Government . (2015). *Priority Development Areas.* Retrieved from Department of Infrastructure, Local Government and Planning .
Queensland Government . (2015). *South East Queensland Principal Cycle Network Plan.* Retrieved from Department of Transport and Main Roads: http://www.tmr.qld.gov.au/Projects/Name/S/South-East-Queensland-Principal-Cycle-Network-Plan.aspx
Queensland Government. (2015). *Cross River Rail Project* . Retrieved from Department of State Development: http://www.statedevelopment.qld.gov.au/assessments-and-approvals/cross-river-rail-project.html
Queensland Government. (2015). *Woolloongabba Brisbane* . Retrieved from Department of Infrastructure, Local Government and Planning .

N/R

Stadiums Queensland . (2010). *The Venue*. Retrieved from http://www.thegabba.com.au/The-Venue.aspx
Urban Land Development Authority . (2011). *Woolloongabba Urban Development Area, Development Scheme* . Brisabne .

N/R

Pages 126 through 159 redacted for the following reasons:
- -
Deliberation
Other Access Available

Appendix D

Bridge Images Gallery

N/R

Kurilpa Bridge, Brisbane, Australia; **Owner:** Department of Public Works, **Designer:** Arup, Cox Rayner Architects

This 470m long structure is a multi-mast, cable stay structure based on the principles of tensegrity. The main span is 120m long with a minimum river clearance of 11m. Along the length of the bridge are two large viewing and relaxation platforms, two rest areas and a continuous all weather canopy, and it features a curved ramp on the South bank.

Goodwill Bridge, Brisbane, Australia; **Owner:** Department of Public Works, **Designer:** Arup, Cox Rayner Architects

This 450m long bridge provides a pedestrian and cycle link between South Bank and the CBD. The 6.5m wide cable stay steel arch bridge features a 102m main span with 12.7m clear height over the river.

New Farm Riverwalk, Brisbane, Australia; **Owner:** BCC, **Designer:** Arup, Cox Rayner Architects, and Eadon Constulting

Completed in 2014, this non-symmetrical pedestrian and cyclist single leaf swing bridge rotates to provide a 15m clearance to allow access for local residents to Brisbane River. The bridge is rotated by a pair of horizontally orientated hydraulic cylinders, with the power pack for the main drive, jacking and locking pin cylinders located on the moving span.

Elizabeth Quay Bridge, Perth, Australia; **Owner:** Metropolitan redevelopment Authority, **Architect:** Arup Associates **Designer:** Arup

The artistic narrative for this pedestrian bridge is one in which the form of the bridge itself was the structure. The piers are an extension of the arches which span 45m. The bridge has a 3m clearance to the navigational channel below which was agreed with local authorities to allow ferry operations.

N/R

Millennium Footbridge, Rome, Italy; **Owner:** Comune di Roma, **Designer:** Massimo D'Alessandro Associate SRL and Arup

This 3.5m wide steel pedestrian and cyclist footbridge is curved on plan with maximum 46m span lengths. The deck floats above the supporting structure with the support system a combination of a vertical diaphragm and a combined horizontal truss.

Center Street Footbridge, Iowa, USA; **Owner:** Safdie Rabines Architects; **Designer:** Arup

The Principal Riverwalk in Des Moines, this steel arch pedestrian bridge features twin curved decks spanning over a 121m wide river channel, with 27.5m tall steel trapezoidal arch cross-sections tapering in both dimensions. The mid-span pathway links the decks for cyclists and pedestrians.

Viale Serra Footbridge, Milan, Italy; **Owner:** Iper Montebello SpA, **Designer:** Arup

This footbridge connects a business central plaza and residential area with Portello Park. The structure comprises a deck supported by a parabolic arc with the span between the supports of 90m. The deck and the arch are made of steel whilst the support structures are sculptures in concrete made with special formwork.

Nescio Bridge, Amsterdam, Netherlands; **Owner:** City of Amsterdam, **Architect:** Wilkinson Eyre Architects, **Engineer:** Arup, Grontmij

This 790m cycle and pedestrian bridge crosses the Amsterdam-Rhine canal. The suspension bridge features a monocable, self-anchored structure with 170m long main span. It is curved in plan, bifurcated at both ends, and suspended on one side only. Tuned mass dampers prevent Synchronous Lateral Excitation, with wind tunnel tests as part of design.

Designates an Opening Bridge

N/R

Infinity Bridge, Stockton-on-Tees, UK; **Owner**: Stockton-on-Tees Borough Council, **Designer:** Expedition Engineering

This dual tied arch bridge is constructed of tapering trapezoidal box section arches and has a total length of 240m with a main span of 120m. Clearance to the river below is 8m and allows for leisure craft.

Wynyard Crossing, Auckland, New Zealand; **Owner:** Waterfront Auckland,

This 100m long 5m wide pedestrian and cyclist bridge features two 22m long cantilever bascules, which allow for a 36m wide navigational channel. The foundations have been sized assuming a future structure carrying public transport vehicles.

Robert I Schroder Overcrossing, San Francisco, USA; **Owner:** Contra Costa County Public Works, **Architect:** MacDonald Architects, **Engineer:** Arup

The 184m long, 3m wide pedestrian bridge over Treat Blvd is a cable stay bridge with arch ribs and 73m main span. A 3m travel path is provided allowing passage from the high density residential development to the commuter railway station.

Swansea Bridge, UK; **Owner:** Welsh Development Agency, **Architect:** Wilkinson Eyre, **Engineer:** Flint Neill

Known as the Sail Bridge, this single mast cable stay structure has a span of 140m. The cables are only connected to one side of the deck. To reduce dynamic effects associated with large crowd loading, tuned mass dampers have been installed underneath the deck.

N/R

Bryggebroen, Copenhagen, Denmark, **Owner:** Municipality of Copenhagen, **Designer:** Carl Bro Group

This bridge is 190m long, with a maximum 35m long span. It is a 6m wide pedestrian and cyclist asymmetrical swing bridge in a harbour. The swing mechanism rotates the bridge to provide 21m navigational opening.

Gustave Flaubert Bridge, France, **Designer:** ARCADIS, IOA, Quille, Eiffel Construction Metallique, Eiffage Construction

This 670m long Road bridge features a 100m long lift bridge with 7m vertical navigational clearance in operation, and a 48m lift capacity which provides 55m vertical clearance for large ships and vessels.

Milton Rd Pedestrian Bridge, Brisbane, Australia **Owner:** Stadiums Queensland; **Architect:** HK Architects; **Designer:** Arup

This two span pedestrian bridge provides a link to Suncorp Stadium over Milton Road with a minimum vertical clearance of 5.9m. The super structure consists of a 3.35m deep steel truss supporting a maximum span length of 46.8m.

Eleanor Schonell Bridge, Brisbane, Australia **Owner:** Brisbane City Council; **Designer:** GHD

At 20m wide, this cable stayed bridge provides a pedestrian, cyclist and public transport link to The University of Queensland. With 18m vertical clearance to the Brisbane River, the main span is 195m long.

Designates an Opening Bridge

N/R

Gateshead Millenium Bridge, UK; **Architect**: Wilkinson Eyre, **Engineer**: Gifford

This is a 126m long 8m wide pedestrian and cyclist tilt bridge spanning the River Tyne. The bridge takes as little as 4.5 minutes to rotate through the full 40° from closed to open, depending on wind speed. Its appearance during this manoeuvre has led to it being nicknamed the "Blinking Eye Bridge".

Columbus State Community College Bridge, USA; **Architect**: McDonnald Cassell and Barret, **Engineer**: Arup

This unusual architecturally designed steel bridge has a 36.5m span which provides a pedestrian link between adjacent buildings within the college.

Puente de la Mujer, Buenos Aires, Argentina; **Designer**: Santiago Calatrava

This 170m long 6m wide bridge is a rotating footbridge in a commercial district of Buenos Aires. It is a cantilever spar cable-stayed bridge as well as a swing bridge, with a rotating 102.5m long middle section. The central section is supported by a 34m high steel needle with concrete core. The cables are suspending a portion of the bridge which rotates 90 degrees in order to allow water traffic to pass.

N/R

ANZAC Parade Albert Tibby Cotter Bridge Sydney, Australia; **Owner**: RMS, **Designer**: Arup

With a main road crossing of 150m and total length of 400m, the ANZAC Parade Bridge was built to handle the large crowds associated with sporting events at the Sydney Cricket Ground and Allianz Stadium.

Jubilee Bridge, Singapore **Owner**: Singapore Urban redevelopment Authority, **Designer**: Arup, COX, Architects 61

With a total length of 220m and forming part of an 8km commemorative walkway, the Jubilee Bridge provides a 6m wide access between Merlion Park and the promenade in front of the Esplanade.

Helix bridge, Singapore **Owner**: Singapore Urban redevelopment Authority, **Designer**: Arup, COX, Architects 61

At 280m long, the Helix bridge utilises complex DNA inspired geometry to span along Marina Bay. The structural steel lattice / net tube uses 5 times less steel than a conventional box girder

Designates an Opening Bridge

Pages 164 through 165 redacted for the following reasons:
- -
Deliberation

Appendix E1

Safety in Design Register

Project Number	N/R	Project Name	Brisbane Cycleway Corridor Study - Bulimba to Teneriffe
Project Participants	N/R		
Client	TMR	Date	26/05/2016

Hazard ID	Hazard Group	Hazard	Area/Location of Risk Exposure	Description of Hazard and Risk Exposure	Control Measure	Op's, Maint', Cons'	Comment / Further Actions / Evidence	Date Due	Risk Owner	Status
1	Demolition_Hazards	Existing buildings, pits or services to be demolished contain asbestos	Project wide	Works and public are exposed to asbestos during demolition works	Contractor to undertake complete review of asbestos prior to undertaking any demolition works.	Decommissioning / Demolition	Contractor to provide TMR with Safe Work Method Statement for works dealing with asbestos identification and management		TMR	Open
2	Soil_Hazards	Exposure to contaminated soils during excavation	Project wide	During excavation activities the construction crew may be exposed to contaminated soils	Detailed design phase to include geotechnical reviews of soil condition to confirm the presence of any contaminated soils on site.	Construction	TMR to include in scope of preliminary and detailed design phase.		TMR	Open
3	Public_Hazards	Risk of cyclist/pedestrian collision	Project wide	Risk that pedestrians may use cycle path, or require crossing the cycle path to access independent footpath or specific properties/vehicles - hence creating a potential conflict point		Operation	Line work and signage to be added during future design stages to separate cyclist and pedestrian movements. Consultation period and education campaign as necessary.		TMR	Open
4	Services_Hazards	Excavation works over live services	Project wide	Risk of construction workers and general public being exposed to underground services during construction. If a service is hit there is a risk of explosion, electrocution or loss of connection		Construction	Detailed survey including potholing of all services required during future design phase.		TMR/BCC	Open
5	Public_Hazards	Afflux caused by the bridge structure causing actionable nuisance to adjacent properties	Project wide	Risk of increased flooding caused by new bridge structure		Operation	Flood Impact Assessment to be conducted in next design phase. Bridge pier arrangement to be designed to minimise afflux caused.		TMR/BCC	Open
6	Public_Hazards	Hazards in close proximity to bikeway	Project wide	Risk of bicycle handlebar clip or collision with these hazards (post, rail, tree)		Operation	Minimum clear zone from designated cycle track to be determined in next design phase. Where possible objects should be located away from proposed path. In cases where crucial trees and power poles are directly impacted by the proposed cycleway, further considerations should be made as to whether reduced path widths or alignment deviations can being incorporated to prevent conflicts.		TMR/BCC	Open
7	Public_Hazards	Potential for gravel, dirt and debris to collect on cycleway within park region.	Project wide	Risk of cyclists falling due to debris on cycleway	It is anticipated that BCC will undertake cleaning operations and be required to undertake maintenance checks to keep road surfaces and cycleway clear.	Maintenance	Regular maintenance required of these areas to remove debris as needed.		TMR/BCC	Open

Safety in Design Register

ARUP

Project Number	N/R	Project Name	Brisbane Cycleway Corridor Study - Bulimba to Teneriffe	
Project Participant	N/R			
Client	TMR	Date	26/05/2016	

Hazard ID	Hazard Group	Hazard	Area/Location of Risk Exposure	Description of Hazard and Risk Exposure	Control Measure	Op's, Maint', Const'	Comment / Further Actions / Evidence	Date Due	Risk Owner	Status
8	Public_Hazards	Designated cycleway path on hilly terrain may force cyclists to reach high speeds. Particularly on approach to road crossings intersections. Variation in cyclist speeds, and steep grades may facilitate cyclist collisions	Project wide	Risk of cyclists thinking they still have priority on approach to intersection and potential for high speed conflicts. Also occurs on transitions from dedicated bushland cycleway to cycle paths adjacent to road (where property accesses exist). Cyclist fatigue is a prevalent issue for a long cycleway with steep grades, and may limit public use. Cycleway expected to be utilised for both transport and recreational purposes, hence difference in cyclist speeds may lead to conflicts. Reduce visibility on sub standard vertical curves.	Specific alignment configurations, intersection treatments and sight line improvements have been proposed thus far to instigate reduce cyclist and vehicle speeds and allow for safe movements through crossings. Future design phases to re-examine alignments with steep terrain to propose speed control features.	Operation	Further design to be undertaken to maximise safety at major road crossings, formalising sight distance and gap acceptance checks. Line marking and signage to be investigated to let cyclists know of approaching intersection. Resting and/or overtaking areas to be considered near very hilly areas, or in locations with unobstructed paths.		TMR/BCC	Open
9	Public Hazards	Magpie attacks	Project wide	Locations of cycle path may coincide with magpie nesting areas, leading to a risk of attacks. This could cause a user to make eratic changes in direction and collide with other users		Operation	Environmental consultation to be undertaken to limit the risk.		TMR/BCC	Open
10	Public Hazards	Risk of injury for cyclists travelling in wet conditions	Project wide	Steep downhill grades in wet may lead cyclists to lose control and injuries to occur	Review of pavement design of cycleway in future design stages to include considerations of wet weather	Operation	Signage and alignment changes to be considered to encourage cyclists to slow down in high risk areas.		TMR/BCC	Open
11	Public Hazards	Risk of injury to cyclists from damaged cycleway pavement.	Project wide	Construction faults or fatigue may lead to pavement damage (potholes, cracks etc.), which can add risks to cyclists (particularly those with road bikes)	Pavement maintenance plan to be introduced as part of later design stages	Maintenance	Investigate alternative pavement treatments that can prolong design life and prevent cracking - such as asphalt.		TMR/BCC	
12	Public_Hazards	Risk of cyclist-pedestrian collision at parks playgrounds adjacent to cycle path.	Project wide	Risk of cyclists travelling at speed colliding with pedestrians (particularly children) adjacent to park space	During future design stages investigate opportunities to offset the cycle path from the playground, as well as providing physical barriers such as fences. Ensure adequate sight lines through these areas also.	Operation			TMR/BCC	Open
13	Public_Hazards	Y-junction connection with existing shared path.	Project wide	Collision between cyclists travelling at speed down the ramp towards Teneriffe and pedestrian cyclists travelling North along the existing shared path due to limited visability.		Operation	Detailed sight line analysis required during future design stages. Signage and road furniture to be considered to improve awareness of cyclists at this location.		TMR/BCC	Open
14	Public_Hazards	Collision of water vehicles due to poorly managed river traffic	Project wide	River traffic not controlled while bridge is open resulting in collision between water vehicles.		Operation	Adequate operational plan required during implementation stage		TMR/BCC	Open
15	Public_Hazards	Water vehicles struck by objects thrown by users on the bridge	Project wide	Objects thrown from bridge at water vehicles causing damage injury death.		Operation	Detailed bridge design to include suitable edge protection to prevent objects being thrown over bridge		TMR/BCC	Open
16	Public_Hazards	Collision with bridge piers structure	Project wide	Collision between water vehicles and bridge piers/structure		Operation	Detailed design to consider adequate protection measures to reduce the risk of water vehicle collision with bridge piers/structure		TMR/BCC	Open
17	Public_Hazards	Long bridge structure could lead to sections in the middle that are difficult to casually observe	Project wide	Pedestrians / cyclists who require assistance in an emergency may not be able to be observed / heard, exacerbating the severity of the issue.	During future design stages investigate opportunities to provide security equipment, including emergency call buttons and CCTV.	Operation			TMR/BCC	Open

N/R

N/R

ARUP

Project Number	N/R	Project Name	Brisbane Cycleway Corridor Study - Bulimba to Teneriffe
Project Participants	N/R		
Client	TMR	Date	26/05/2016

Hazard ID	Hazard Group	Hazard	Area/Location of Risk Exposure	Description of Hazard and Risk Exposure	Control Measure	Op's, Maint', Const'	Comment / Further Actions / Evidence	Date Due	Risk Owner	Status
18	Falling_From_Height_Hazards	Fall from elevated structure	Project wide	Users may climb rails/parapets and fall into the Brisbane River from significant height causing injury or death		Operation	Detailed bridge design to include suitable edge protection to prevent falls		TMR/BCC	Open
19	Public_Hazards	Conflict between normal bridge users and maintenance / emergency vehicles	Project wide	The bridge could potentially be used by maintenance and/or emergency vehicles to cross the river. Depending on the width of the bridge, there may not be sufficient room for a wheelchair to pass a vehicle.		Operation	Detailed bridge design to provide adequate width to allow passing of potential bridge users.		TMR/BCC	Open
20	Temporary_Works_and_Sequencing_Hazards	Land slips due to heavy construction vehicles on poor ground conditions adjacent the river	Project wide	Construction vehicle and temporary works fall into river due to poor gound conditions.		Construction	Detailed design phase to include geotechnical reviews of soil condition and identify ground improvement measures required for construction activities		TMR/BCC	Open
21	Temporary_Works_and_Sequencing_Hazards	Flood event in Brisbane River	Project wide	Flood event in Brisbane River during construction causing destruction of temporary works and risk to life of construction workers		Operation	Detailed design drawings to indicate various flood levels to allow the contractor to plan for flood risk adequately		TMR/BCC	Open

Pages 170 through 180 redacted for the following reasons:
- -
Deliberation