

5. Engineering

5.1 Introduction

This chapter summarises the process involved in developing the alignment and busway station for the South East Busway extension from Rochedale to Springwood. Design criteria, assumptions, adjoining planning projects, construction issues and other related information were considered in the planning stages as part of the design process to determine the best solution for providing the necessary infrastructure for the busway extension. In addition, feedback from the consultation process was incorporated into the final concept design.

The engineering design process also identified the footprint of the extension. This provides the necessary information on the land required for the extension — in other words, the actual corridor that needs to be preserved.

Lastly, the quantities determined from the engineering design provided the necessary information to determine the cost estimate for the infrastructure for the extension.

5.2 Methodology

Alignment and busway station designs have been developed for the Concept Design Study to a level appropriate for corridor preservation and determining quantities to carry out a P50 cost estimate. The following concept design drawings were developed for the busway extension:

- layout plans showing 1:500 plan layout on aerial photo background, together with a longitudinal section
- typical cross-sections
- drainage plans (the relevant reporting is contained within Chapters 9 and 10 of this report)
- structures drawings showing the general arrangement of each structure.

The concept design drawings are contained within Volume 2 of 2: Plans.

5.2.1 Design standards

The Busway Planning and Design Manual (Queensland Transport 1998) was used as a point of reference during the development of the alignment of the busway extension. This document was originally developed during the design phase of the current South East Busway between the Brisbane central business district and Eight Mile Plains. The footprint for the extension alignment depends on the height of the fill/cut and whether structure or retaining wall is used. It is also based on the following:

- two lanes of 3.5 metres width each with a 1.6 metre hard shoulder either side
- a jersey barrier to separate the busway from other infrastructure.

At Springwood busway station, the following criteria were adopted:

- each station platform is 70 metres in length
- the 'docking bays' are 3.0 metres wide and the 3.5 metre lanes run through adjacent to the bays to allow overtaking.

Where roads were affected, the following two standards were used:

- Guide to Traffic Engineering Practice (Austroads)
- Road Planning and Design Manual (Department of Main Roads).

Future proofing

As with previous sections of the South East Busway, the extension from Rochedale to Springwood has been designed to accommodate a different mode should capacity upgrades be required in future. The horizontal and vertical grades and radii used, as per the Busway Planning and Design Manual, are suitable for light rail mode.

5.2.2 Previous investigations

Pacific Motorway Transit Project

The Pacific Motorway Transit Project included an extension of the existing South East Busway to Underwood Road and a new station at Rochedale with park 'n' ride facilities. The Pacific Motorway Transit Project also included bus lane facilities on the motorway continuing south from the Rochedale busway station. The busway extension to Springwood continues southward from the end of the South East Busway extension to Rochedale.

Further planning for this project — now known as the Pacific Motorway Upgrade — is currently being undertaken by the Department of Transport and Main Roads. It is noted that there would be savings and reduced construction impacts if the Pacific Motorway Upgrade project and the busway extension were constructed concurrently.

South East Busway Stage 2 Pre-Feasibility Study

The alignment determined during the pre-feasibility study presented two options along Rochedale Road — that is, alongside the motorway on retaining wall or centre-running on viaduct. The study presented two options for the Springwood busway station. This study also proposed an additional station approximately halfway between Rochedale and Springwood.

The preferred options from this study were used to inform the design development process of the Concept Design Study.

5.2.3 Additional investigations

The designs from previous stages have been developed further to determine a preferred alignment for the South East Busway extension from Rochedale to Springwood, including removal of the cut-and-cover tunnel under Rochedale Road. Additional technical investigations were carried out to inform the design process. Workshops were held with key stakeholders including Logan City Council to coordinate projects within the study area to ensure the best outcomes for both the busway extension and projects such as Pacific Motorway Upgrade and the Greater Springwood Master Plan.

5.3 Preliminary analysis

5.3.1 Design criteria

The following design criteria were used in the development of the concept design of the busway extension. These criteria were based on those of light rail, giving the alignment the flexibility to accommodate a different mode should capacity upgrades be required in the future.

Table 5-1: Design criteria

Item	Design criteria
Design vehicle	14.5 rigid chassis bus
Design speed — busway mainline	90 km/h (posted at 80 km/h)
Design speed — busway station area	60 km/h (posted at 50 km/h)
Design speed — busway ramps and access roads	40 km/h (posted at 40 km/h)
Busway lane widths	3.5 m
Busway shoulder widths	1.6 m
Concrete barrier widths	0.6 m
Total busway width	11.4 m
Stations — length of platforms	55 m (nominal) / 70m (preferred)
Stations — width of standing lanes	3.0 m
Stations — median	1.5 m
Stopping Sight Distance (SSD) (Based on reaction time (RT) = 2.0s and level grade)	160 m (90 km/h) 82 m (60 km/h)
Minimum Horizontal Curve Radius on mainline (3.0% superelevation)	R = 690 m (80 km/h) R = 385 m (60 km/h)
Minimum horizontal curve radius at intersections, ramps, etc	To suit swept path of applicable vehicle
Intersection angle on busway	70° min, 90° max.
Busway station tapers	Arrival side: 1:7, departure side: 1:5
Maximum grade — busway mainline	5.0 % (desirable) 8.0 % (absolute)
Maximum grade — for access ramps	10 %
Maximum grade — at stations	0.0 % (desirable) 2.5 % (absolute)
Minimum Crest Curves — K values based on stopping sight distance with eye height = 1.8 m, object height = 0.2 m, RT = 2.0 s.	K = 40 (90 km/h) K = 11 (60 km/h)
Minimum Sag Curves – K Values based on passenger comfort (minimum = 0.05g, desirable = 0.03g)	K = 13, 21 (90 km/h) K = 6, 10 (60 km/h)
Vertical Clearance	5.2 m above busway 6.1 m above motorway and other roads
Minimum grade of busway (Except at busway stations)	0.4 % (kerbed)
Normal crossfall on busway	-3 %
Maximum superelevation (above 60 km/h)	3 %
Rate of Rotation	Max 2.5 % / sec
Horizontal Sight Distance	As per the Road Planning and Design Manual, Chapter 9 (Department of Main Roads)
Minimum horizontal curve radius, busway stations	To suit turning requirements of design vehicles
Minimum turning radii at intersections	As per Aust roads “Intersections at Grade”. Design vehicle swept path to be analysed. Design bus standard to be used.

5.3.2 Description of alignment

The South East Busway extension from Rochedale to Springwood starts approximately 200 metres south of Underwood Road at chainage 2100 m, where it joins to the proposed South East Busway extension from Eight Mile Plains to Rochedale.

From here, the alignment runs straight in a southerly direction adjacent to the Pacific Motorway for approximately 700 metres before turning to the east to develop a grade-separated crossing with the Rochedale Road off-ramp. The busway extension then approaches the existing Rochedale Road off-ramp alignment and meets Rochedale Road at grade at the site of the existing off-ramp intersection.

The busway extension continues from this point in a southerly direction adjacent to the motorway, although the busway is climbing above Rochedale Road to cross Springwood Road. The busway then continues to run on viaduct through to the elevated platforms at the Springwood busway station. A two-way ramp leads buses to the new at-grade turnaround facilities which also provide access on and off the busway. The existing bus station will be reconfigured to accommodate these new facilities.

General arrangement plans showing the alignment and busway station are contained within Volume 2 of 2: Plans.

5.3.3 Alignment selection

A number of general considerations were taken into account in developing the design for the busway extension. The future busway extension needs to:

- be a practical, workable solution (e.g. connect existing infrastructure)
- minimise impacts on the community and environment
- be cost effective (e.g. minimise 'throw-away' infrastructure, reduce the need for tunnelling, etc.)
- consider other projects (e.g. Pacific Motorway Upgrade)
- constructible — e.g. easy to construct with minimal disruption to traffic.

Busway corridor along eastern side of Pacific Motorway

A future busway extension needs to connect the existing Eight Mile Plains busway station to the existing Springwood bus station, both of which are located on the eastern side of the Pacific Motorway.

Planning has been completed for the first stage of the busway extension between Eight Mile Plains and Underwood Road, Rochedale with a new busway station proposed at Rochedale. This project is located on the eastern side of the motorway.

The shortest, most direct route between the proposed Rochedale busway station and Springwood is therefore along the eastern side of the motorway. This simplifies construction (no motorway crossing points) and significantly reduces construction costs. In addition, an eastern alignment also produces staged delivery opportunities along Rochedale Road.

In determining the draft alignment, options were considered along the entire corridor. All options ran adjacent to the motorway with variations around the bus entry point at Rothern Drive and around the existing Rochedale Road motorway off-ramp.

Due to the proximity of the busway extension to the Pacific Motorway and the potential impacts, the Pacific Motorway Upgrade project team was consulted in the development of the busway alignment between Underwood Road and Rochedale Road. As a result some changes have

been proposed around the Rochedale Road off-ramp. To accommodate the busway alignment through this section, the off-ramp was relocated slightly to the east. This resulted in a safer intersection with Rochedale Road and significant cost savings due to improved constructability. Also, the cut-and-cover tunnel from the prefeasibility design is no longer required.

Springwood busway station

Several layouts have been developed for the new busway station at Springwood. The Department of Transport and Main Roads have consulted with Logan City Council during the development of the station design due to the planning work currently being undertaken around the Springwood town centre. The new busway station needed to interact with local buses while minimising impacts on the local roads and surrounding properties. In addition, the following factors were considered during the design development:

- ramp connection for buses to enter/exit the busway
- flexibility for a future extension
- pedestrian linkages to the east and west
- location of local bus stops
- interaction between local traffic and buses
- increase kiss 'n' ride spaces
- maintain existing volume of the detention basin (see Chapters 9 and 10 — Hydrology and hydraulics, and Water quality respectively — for details)
- cost and constructability.

In total, seven discrete layouts were developed and these are presented in Appendix C. Table 5-2 below lists issues and advantages associated with each of the options.

Table 5-2: Springwood busway station options — issues and advantages

Option	Issues/advantages
Option 1	<ul style="list-style-type: none"> ▪ Conflict between buses and local traffic along Vanessa Boulevard ▪ Constructability issues ▪ Change in access arrangements at Centro Shopping Centre ▪ Significant visual impacts
Option 2	<ul style="list-style-type: none"> ▪ Constructability issues with structure crossing over Rochedale Road to the north of the station ▪ Conflict between buses and local traffic along Vanessa Boulevard ▪ Large property impacts ▪ Busway station is closer to the proposed Springwood Town Centre ▪ Segregation between local interchange (existing station) and busway station ▪ Future southern connection would cause large property impacts
Option 3	<ul style="list-style-type: none"> ▪ Conflict between buses and local traffic along Vanessa Boulevard ▪ Constructability issues ▪ Change in access arrangements at Centro Shopping Centre ▪ Large property impacts ▪ Significant visual impacts ▪ Provides a ramp for local connection to/from the busway at Springwood ▪ Rearrangement of Rochedale Road intersection with Vanessa Boulevard and motorway off-ramp

Option	Issues/advantages
Option 4	<ul style="list-style-type: none"> ▪ Conflict between buses and local traffic along Vanessa Boulevard ▪ Constructability issues ▪ Change in access arrangements at Centro Shopping Centre ▪ Large property impacts ▪ Significant visual impacts ▪ Provides a ramp for local connection to/from the busway at Springwood ▪ Future southern connection would cause large property impacts
Option 5	<ul style="list-style-type: none"> ▪ Constructability issues ▪ Change in access arrangements at Centro Shopping Centre ▪ Large property impacts ▪ Significant visual impacts ▪ Provides a ramp for local connection to/from the busway at Springwood
Option 6	<ul style="list-style-type: none"> ▪ Large property impacts ▪ Change in access arrangements at Centro Shopping Centre ▪ Provides a ramp for local connection to/from the busway at Springwood ▪ Realignment of Vanessa Boulevard ▪ Rearrangement of Rochedale Road intersection with Vanessa Boulevard and motorway off-ramp
Option 7 (Preferred)	<ul style="list-style-type: none"> ▪ Reduced property impacts, e.g. footprint of station is similar to existing situation ▪ Change in access arrangements at Centro Shopping Centre ▪ Minimal realignment of Rochedale Road ▪ Allows for maximum additional kiss 'n' ride spaces to be incorporated ▪ Best in terms of bus operations (i.e. getting on/off busway and interchanging between local and spine services)

Option 7 provides the best overall solution in terms of the design considerations mentioned above.

Design changes to the draft alignment

Feedback from the local community during the consultation process (see Chapter 2) has resulted in design changes in two locations. At Rothern Drive the following changes were incorporated in the final alignment:

- Rothern Drive is to be closed off at its intersection with Beverley Avenue and access to Underwood Road will be provided via Beverley Avenue and Centre Place to the east
- the Rothern Drive intersection with Underwood Road is to be converted to a bus only entry point which will connect directly to the busway extension and provide access to the motorway entry
- the layout of the bus turnaround loop has also been amended — the turnaround function will be incorporated as part of the bus only entry conversion of Rothern Drive. See plan no's. 2112646A-TRA-0021 and 2112646A-TRA-0031 (contained within in Volume 2 of 2: Plans) for details.

A minor design change was also made to the intersection of Rochedale Rd/Kumbari St to address local resident concern. This design change involved reducing the number of property requirements on the southern side of Rochedale Road.

5.3.4 Land requirements

The draft alignment potentially affects 124 properties along the eastern side of the motorway. These are a combination of 'full' and 'partial' takes and include a mix of residential, commercial and state government owned properties. The Department of Transport and Main Roads has consulted with property owners with potential land requirements during the planning for the draft alignment — see Chapter 2 for more information regarding property owner consultation.

5.3.5 Operational management

The entire Brisbane busway network is managed from the Busway Operations Centre, currently located in the joint Brisbane Metropolitan Transport Management Centre (in Brisbane Square). This centre coordinates the Department of Transport and Main Roads and Brisbane City Council road traffic and transport, including busways. Each section of the busway extension would be integrated with the Busway Operations Centre once construction is completed.

The Busway Operations Centre is an around the clock facility that manages the busway, busway stations, busway tunnels and public transport operations and responds to any incidents that occur. The staffing of the Busway Operations Centre includes Busway Safety Officers. Busway Safety Officers are required to be on duty at all times at the operations centre and they also undertake road patrols. All safety officers have undertaken extensive busway safety training, including incident management.

The operations centre is supported in the management of the busway by an extensive Intelligent Transport System with closed-circuit television coverage, vehicle detection systems, tunnel operations systems, tunnel alarm systems, and bus station facilities such as public address systems and emergency call points. The Intelligent Transport System platform is housed at the Busway Operations Centre.

TransLink has developed an extensive incident management plan for managing the range of incidents that may occur within the existing busway network (e.g. bus breakdown), the busway stations (e.g. passenger incidents), and within tunnels (e.g. scheduled maintenance access).

The busway incident management plan is regularly reviewed and maintained by the Busway Operations Centre. This plan would be updated to include the proposed busway extension.

5.3.6 Safety

Busway stations are open to the atmosphere and are of a simple non-combustible construction. The following safety systems are proposed for the Springwood busway station:

- monitored 24-hour closed-circuit television coverage, with surveillance from the Busway Operations Centre
- passenger information systems including public address and emergency call points
- high-quality lighting of roadways and pedestrian paths of travel
- hydrants and hose reels in the vicinity of the busway station in accordance with the Building Code of Australia
- free venting of smoke to the atmosphere.

A review of escape paths of travel from the busway station will also be undertaken during further project stages.

Safety is paramount on the busway and there are procedures and policies in place for the safe operation of the busway, for example:

- all bus drivers are required to undertake extensive driver training and are formally issued with a Busway Authorised Driver Training Manual by the Department of Transport and Main Roads. The training and manual include procedures and policy for normal busway and public transport operations and incident management procedures
- all vehicles authorised to use the busway have direct UHF radio communications with the Busway Operations Centre. In addition all Busway Safety Officers have mobile phone communication with the Busway Operations Centre
- all buses and maintenance vehicles using the busway carry portable fire extinguishers
- all buses using the busway are equipped with emergency escape windows/doors in accordance with Australian Design Rules
- an operational policy that requires a minimum spacing of 50 metres between buses operating within busway tunnels
- an operational policy that requires bus drivers to not enter a busway tunnel if they are aware that their vehicle may breakdown
- an operational policy that bans vehicles from overtaking another vehicle along the busway and in particular within a tunnel environment. Overtaking provision is provided at busway stations through the use of a passing lane and a bus standing lane. A bus is not allowed to overtake another bus, including a broken down vehicle, within a tunnel except under the direction of a Busway Safety Officer, a police officer or an officer from Emergency Services.

The planning, design and operational procedures of all fire and life safety features, including the incident management plan will be agreed with the Department of Emergency Services.

5.3.7 Infrastructure cost estimate

A cost estimate was prepared for the busway extension using the concept design drawings — the drawings are contained in Volume 2 of the Concept Design Study. Where the concept design drawings do not provide sufficient information to price the project, informed engineering assumptions were made to ensure that the estimate can be priced accordingly.

Given that the design is currently at concept stage and therefore subject to change/refinement a risk and range analysis was undertaken to produce a P50 Total Project Capital Cost Estimate, that is, a 50% probability that the total cost estimate will not be exceeded. In summary the project estimate was developed as follows:

Base estimate + Range analysis + Risk Analysis = Total Project Capital Cost Estimate

The cost estimate was calculated in 2008 dollar values and does not include provision of ongoing services to support maintenance and up-keep.

Assumptions

In preparing the estimate the following assumptions were made:

- construction will be concurrent with the Pacific Motorway Upgrade Section A construction works
- the works will be let to either a tier 1 or 2 contractor to construct
- minor temporary construction works will be required to load and unload trucks etc. Construction machinery will be able to traffic the area with little problem
- the select material will be supplied by way of imported from local suppliers

- the spoiled material will be stockpiled off site within one kilometre
- the bulk fill material (Type 2.5 material) quantity is based on the calculation between the existing and design level
- a capping layer (Type 2.1 material) has been allowed for subgrade replacement
- a layer of 150 millimetres has been allowed for the CBR8 material
- a layer of 150 millimetres has been allowed for the Type 1.2 material
- a layer of 220 millimetres has been allowed for the DG20 overlay on the busway
- a spread rate of 65 square metres per cubic metre has been allowed for 14 millimetre seal
- road lighting is based on 30 metre intervals
- the precast Type F barrier is 820 millimetres height
- the standard height for the noise barrier is 2.5 metres
- the same price for the installation of the decking units as per the viaducts
- prices for bus station taken from Boggo Road Bus Station 2008 for comparison
- assumed that the parapet is precast and not cast insitu
- a period of approximately 90 weeks has been allowed for traffic control.

Exclusions

In preparing the estimate the following exclusions applied:

- costs of property acquisitions
- the production rate of construction is based on normal working environment
- working time is within normal working hours
- the whole site is clear of property. No allowance has been made for demolition
- owners' delivery costs include project management, design management, site supervision and contingency.

Cost estimate

The P50 estimate for the busway extension is \$155 million — this excludes any allowances for property acquisitions.

The cost estimate summary, including the risk and range analysis is presented in Appendix D.

5.4 Managing issues and opportunities

5.4.1 Improved safety

The Pacific Motorway Transit Project proposed a busway access point at Rothern Drive, however safety issues were identified with the layout and as a result some changes were proposed in the draft Concept Design Study. The final alignment incorporated further changes at this location as described in Section 5.3.3.

In addition, the Pacific Motorway Transit Project proposed a southbound off-ramp from the Pacific Motorway to Rochedale Road. This was redesigned to accommodate a grade-separated crossing of the busway extension. The revised off-ramp departs the Pacific Motorway approximately 200 metres earlier than the off-ramp proposed in the Pacific Motorway Transit Project. Also, the horizontal and vertical geometry has been revised to decrease the skew of the crossing of the busway extension as much as possible and to intersect with Rochedale Road adjacent to the Moffit Court intersection. This removes the existing intersection at the crest of Rochedale Road and therefore has improved safety for road users. These changes have been

incorporated into the current planning for the motorway (i.e. the Pacific Motorway Upgrade project).

Rochedale Road has been widened to four lanes to the west of the proposed off-ramp intersection to provide a continuation of the existing four-lane corridor to the south. In addition, Moffit Court and Pindari Street will be closed off at their respective intersections with Rochedale Road. Kumbari Street will be realigned to minimise property impacts and connected to Rochedale Road in the form of a new signalised intersection. This avoids potential safety issues due to the proximity of the new off-ramp and its intersection with Rochedale Road.

5.4.2 Joint delivery with Pacific Motorway Upgrade project

Due to the confined corridor of the busway extension there would be significant benefits in undertaking joint delivery with the Pacific Motorway Upgrade project, including:

- improved constructability
- reduced traffic management requirements
- shortened construction period.

The overall benefit from the above would be reduced costs and less disruption to the community.

5.4.3 Cost effective design

By creating a grade-separated crossing of the busway extension with the southbound off-ramp from the Pacific Motorway to Rochedale Road, the cut-and-cover tunnel that was proposed in the prefeasibility study is no longer required. This improves constructability and significantly reduces infrastructure costs.

5.4.4 Property impacts

As a result of the realignment of the Rochedale Road off-ramp, some property acquisitions will be required. However, the final alignments of the busway and the off-ramp retain the commercial property and church to the east of the existing Rochedale Road off-ramp.

Rochedale Road will need to be relocated eastwards from the intersection with the existing off-ramp up to Fitzgerald Avenue, to accommodate the busway corridor and to ensure Rochedale Road to maintain its current four-lane capacity. Where practical, the busway extension was designed to run on viaduct through this area to allow one northbound traffic lane (on Rochedale Road) to travel beneath the structure, thereby minimising the property impacts along the eastern side of Rochedale Road.

At Springwood bus station, provision for a local interchange — i.e. a kerbside stop — was made along the western edge of Rochedale Road. This allowed the site of the existing interchange to be used for a ramp and turnaround area, thereby minimising the footprint of the bus station and subsequently minimising impacts on Rochedale Road and the surrounding commercial properties.

5.4.5 Sustainable design

Opportunities for resource efficiencies through the incorporation of sustainable design principles will be considered during the detailed design and construction phases of the busway extension and may include the following:

- features such as rainwater and solar energy collection and use
- Water Sensitive Urban Design
- climate sensitive design
- energy and waste minimisation and recycling facilities
- whole-of-life considerations, including optimal material choices for maintenance minimisation
- strategies for minimising vandalism.

5.5 Future investigations

The following tasks are to be undertaken during a future (detailed) design phase for the busway extension:

- detailed ground survey of the project site, including public utility plant
- detailed design of the preferred alignment, incorporating the inputs from the detailed technical investigations and the refinements required following the community consultation process
- P90 cost estimate from the detailed design.

5.6 References

Austrroads, *Guide to Traffic Engineering Practice*, Austrroads, Sydney.

McCormick Rankin 1998, *Busway Planning and Design Manual*, Queensland Transport, Brisbane.

Connell Wagner 2008, 'Pre-Feasibility Study, South East Busway Extension Stage 2 – Rochedale to Springwood', report for Queensland Department of Main Roads/TransLink, Brisbane.

Queensland Department of Main Roads, *Road Planning and Design Manual*, Queensland Department of Main Roads, Brisbane.