CHAPTER SUMMARY AND RECOMMENDATIONS:

- Understanding the design elements and their impacts is critical to inform the ultimate solution and to ensure key issues are identified and mitigated against. Ongoing consultation and engagement with key stakeholders will inform and shape the development of the detailed design.

- Brisbane Metro is a proposed high-frequency transport system, running across 21 kilometres of segregated busway, linking the Eight Mile Plains, the Royal Brisbane and Women’s Hospital (RBWH) and the University of Queensland (UQ) Lakes busway stations. It will include:
  - 18 stations, including a new underground metro station at the Cultural Centre and upgrades at the remaining stations.
  - A tunnel under Adelaide Street from North Quay, to connect to the existing busway tunnel at King George Square.
  - Metro vehicles with capacity of up to 150 customers (seated and standing).
  - A passenger and vehicle management system to monitor and proactively manage metro bus operations on the busway, and provide the required capacity, journey times, reliability, headway management and customer experience.

- There are a range of constructability considerations associated with Brisbane Metro, including:
  - Traffic and pedestrian management
  - Site facilities
  - Staging of service diversions to ensure utility services remain operational during construction
  - Busway operations during construction including temporary bus facilities, changes to routes and stops
  - Queensland Rail requirements associated with working within and adjacent to the rail corridor
  - Dewatering and environmental considerations such as noise and vibration
  - Night works requirements
  - Stakeholder management.

- Based on a preliminary delivery program, the main construction works for the Brisbane Metro are expected to take approximately 30 months, with commissioning and completion works in December 2022.

- A peer review was undertaken on the Brisbane Metro design constructability and delivery program. The review found that, based on the current level of design, the construction methodology for key elements of Brisbane Metro was sound, and that the delivery program is achievable.
9.1 Purpose and Overview of this Chapter

The purpose of this chapter is to present the concept design as it has been defined and developed during the Business Case phase. It also provides an appreciation of key issues that the design addresses, as well as issues and opportunities that require further resolution in future stages of project development.

This chapter outlines:

- The methodology used to develop the concept design for the Brisbane Metro, including key assumptions, constraints and design criteria.

- The key elements of the concept design, namely:
  - Station works, in particular the new Cultural Centre underground station, and other station upgrades
  - The new Adelaide Street tunnel
  - Other corridor works, including works on Victoria Bridge, North Quay, and layovers and turnarounds along the metro corridors

- Key constructability considerations associated with the project works.

- Fire and life safety provisions incorporated into the concept design at key locations such as the new Cultural Centre underground metro station, the Adelaide Street tunnel and other major metro stations.

- The metro vehicle used to inform the design development and operations planning for Brisbane Metro.

- The services and systems required to support the infrastructure and operations.

- The Brisbane Metro delivery program, including key construction timeframes and milestones.

- The outcomes of the peer review completed on the concept design, constructability analysis and delivery program.

Understanding the design elements and the impacts of a proposed project is critical to inform the ultimate solution and to ensure key issues relating to the project are identified and mitigated against.

This chapter draws from the product description presented in Chapter 6 to expand upon the key project elements. The concept design has also been informed by platform requirements derived from the network and transport modelling, as presented in Chapter 7.

Concept designs were developed to a level compatible with the development of risk adjusted capital cost estimates, with greater attention given to the larger, more complex and costly project elements. The constructability issues were given careful consideration during the development of the cost estimates and assessment of risks, with contingency allocations commensurate with the level of risk and constructability issues discussed in this chapter. The cost estimates, including P50 and P90 risk adjustments are presented in Chapter 11.

9.2 Methodology

Major aspects of the concept design of Brisbane Metro are located in highly developed city environment settings resulting in numerous, and sometimes conflicting, constraints to the achievement of optimised project outcomes.
For the concept design to progress, it was important to gather base information on infrastructure assets impacted by Brisbane Metro. Data was gathered from existing records and relevant previous Council and Department of Transport and Main Roads (TMR) projects and made available to the design team. The base project information collected included:

- Aerial photo imagery of the complete project area
- Light Detection and Ranging (LIDAR) survey of Buranda to University of Queensland (UQ) Lakes and from Eight Mile Plains to Herston with a gap from Greenslopes to Woolloongabba, and Herston and to RBWH
- Pockets of field survey of busway stations and roads around the central business district (CBD) and South Brisbane areas
- Utility services information as provided by Council’s information system
- Drawings of the South East Busway, Inner Northern Busway and Eastern Busway
- Various design reports.

The concept design effort focused on the existing constraints and key project infrastructure elements to enable the assessment of the impacts, and risks and opportunities of these features.

The existing constraints and key infrastructure elements considered as part of the Brisbane Metro concept design are:

- The tight horizontal gradients and steep vertical gradients (existing and new), and the associated impacts resulting from the adopted geometry.
- Busway configurations and requirements, including issues relating to grade, platforms and layover.
- The need to provide a metro that can increase the capacity of the busway to approximately 22,000 passengers per hour per direction (pphpd) (peak direction) on day one of operations, without precluding future upgrades to provide the ability to enable an increased future capacity.
- The need to provide peak services at high frequencies.
- The ability to comfortably and effectively interchange significant volumes of customers from metro vehicles to other forms of public transport (and vice versa) in busy peak periods.
- The risk during construction of significant disruption to the city’s bus network and broader traffic network operations.
- The ability of the proposed reference vehicle to respond to the patronage requirements and the geometric constraints of the corridor.
- Site specific constraints and associated impacts on constructability and risk, including geotechnical, hydraulics, hydrology, and public utilities issues as well as property impacts.
- Stations and other significant structures (including bridges and tunnels).

_consideration was given to the key architectural elements, geotechnical, hydrologic and drainage, structural, pavement, mechanical and electrical, fire and life safety, utility services design and construction staging._

The Brisbane Metro alignment has been modelled using 12D software and preliminary structural assessments and member sizing made for all major project elements. Minor
project elements were defined through reference to existing infrastructure design documentation (e.g. busway shelters), or through previous project experience of the design team members.

Ongoing consultation and engagement with key stakeholders is critical in informing and shaping the further development of the detailed design.

### 9.2.1 Key concept design assumptions

As the Brisbane Metro will utilise the majority of the existing South East, Inner Northern and Eastern (from Buranda to UQ Lakes) busways, the adopted alignment design criteria and standards have been based on the existing TMR busway design standards and criteria. These criteria have been reviewed, amended and supplemented to ensure compatibility and suitability for the metro requirements.

Table 9.1 provides a summary of key assumptions adopted in the Brisbane Metro concept design, as well as elements that have been specifically excluded from the design.

<table>
<thead>
<tr>
<th>PROJECT ELEMENT</th>
<th>KEY ASSUMPTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metro alignment and geometrics</td>
<td>The proposed cross section is consistent with the existing busway at 10.2 metre width (1.6 metre shoulders and 3.5 metre lanes), except at the Adelaide Street transition structure where a revised cross section has been adopted to accommodate existing structural elements associated with existing basement walls. This reduced width is considered acceptable given the low speed at the North Quay and Adelaide Street corner and the wider shoulder that is available within the Adelaide Street tunnel itself. Design speeds are generally consistent with the existing busway except at Cultural Centre for which the approach design speed is 30km/hr.</td>
</tr>
<tr>
<td>Underground Cultural Centre metro station flood immunity</td>
<td>Similar to other parts of the busway, the underground Cultural Centre station will not be able to function when Brisbane River flooding is greater than a 75 year average recurrence interval (ARI) event and surface flooding is greater than 2000 year ARI. It can continue to be open to metro vehicles and buses through traffic with the placement of pre-configured flood protection barriers around the station surface entries. The underground Cultural Centre station will have an overall flood immunity up to a 150 year ARI river flood event with the structure designed to withstand a 500 year ARI flood event.</td>
</tr>
<tr>
<td>Metro vehicle</td>
<td>The metro vehicle is approximately 24 metres long, 2.55 metres wide and 3.5 metres high.</td>
</tr>
<tr>
<td>Victoria Bridge active transport provisions</td>
<td>The upstream pathway on Victoria Bridge will be maintained at 2.73 metre wide as a 2-way shared path for pedestrians and cyclists. The downstream pathway will be widened by 1.2 metres to a total width of 3.93 metres to facilitate increased pedestrian movements accessing the Cultural Centre and North Quay.</td>
</tr>
<tr>
<td>Public utilities services</td>
<td>The design makes provision for existing utility services identified on service plans obtained from Council’s GIS Gecko system and Dial Before You Dig information. The existing sewer pump station on the corner of Melbourne and Grey streets is to remain with the grit chamber and associated connections relocated to the upstream sewer side of the new underground Cultural Centre metro station.</td>
</tr>
</tbody>
</table>
CHAPTER 9 – CONCEPT DESIGN

Table 9.1 – Key Brisbane Metro design assumptions and exclusions

<table>
<thead>
<tr>
<th>PROJECT ELEMENT</th>
<th>KEY ASSUMPTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Future proofing</td>
<td>Underground stations are to be designed to not preclude potential future upgrading for use by a rail guided rubber tyred metro system including:</td>
</tr>
<tr>
<td></td>
<td>• platform lengths plus vertical and horizontal travel path geometry to suit a 77 metre long 6-car set</td>
</tr>
<tr>
<td></td>
<td>• Maximum vertical gradient of 10 per cent</td>
</tr>
<tr>
<td></td>
<td>• 500 year ARI flood protection</td>
</tr>
<tr>
<td></td>
<td>• stray current protection provisions</td>
</tr>
<tr>
<td></td>
<td>• 1.1 metre height separation between platform and running surface.</td>
</tr>
<tr>
<td></td>
<td>Transition structures may need to be rebuilt on a new alignment dependent on the horizontal alignment on Victoria Bridge.</td>
</tr>
</tbody>
</table>

9.2.2 Key design criteria

New tunnels and associated transition/diver structures have typically adopted a cross section dimension not less than the typical tunnel cross section dimensions of the existing busway, as shown in Figure 9.1, and in accordance with Austroads and Fire and Life Safety requirements. The exception is the shoulder widths in the transition structure at Adelaide Street, which have been reduced to 750 millimetres. The basement wall of 300 George Street does not permit a wider shoulder but this reduced width is considered acceptable given the low speed at the North Quay and Adelaide Street corner, and the wider shoulder that is available within the Adelaide Street tunnel itself.

Figure 9.1 – Typical tunnel cross section

9.2.3 Safety in Design

Consideration has been given to Safety in Design relating to the construction, operations, maintenance and decommissioning of metro infrastructure as envisioned at this stage of development.

The Safety in Design register has been established and was updated during the business case with identified risks and opportunities including mitigation strategies.
9.3 Project Infrastructure

The Brisbane Metro follows the existing alignment of the South East Busway, between Eight Mile Plains busway station and North Quay; the Inner Northern Busway between King George Square and RBWH busway stations; and the Eastern Busway between Buranda and UQ Lakes busway stations, as described in Chapter 6.

Brisbane Metro features two new high-capacity metro lines:

- Metro 1 – Eight Mile Plains busway station to Roma Street busway station
- Metro 2 – RBWH busway station to UQ Lakes busway station.

The metro reuses, repurposes and augments the existing busway wherever possible, and provides new infrastructure to raise the existing bus route to a complete grade separated standard at Cultural Centre and North Quay. Some busway station platforms and shelters will be lengthened, and all will have enhanced passenger information and dynamic stop systems added.

Table 9.2 provides a summary of the infrastructure elements of Brisbane Metro. The subsequent sections in this chapter provide further detail on each key element of the Brisbane Metro concept design.

<table>
<thead>
<tr>
<th>ALIGNMENT COMPONENT</th>
<th>DESCRIPTION</th>
</tr>
</thead>
</table>
| Pavements           | The metro option will reuse much of the existing busway infrastructure, including pavements. The current traffic volumes using the busways to date are less than the original design intent. While a large part of the busway alignment has existing reinforced rigid concrete pavements (typically greater than 225 millimetres thick) with an asphalt overlay, there are sections of flexible and flexible composite pavements (generally 40 millimetre SMA/200 millimetre DG20/200 millimetre cement stabilised base/150 millimetre working platform). Zones which do not have existing rigid concrete pavement are either those that are new works or those that are currently flexible pavement, including:  
  - new underground Cultural Centre metro station
  - North Quay
  - Adelaide Street tunnel
  - Countess Street busway section
  - Victoria Park busway sections that are not in tunnels or at stations
  - South East Busway between Eight Mile Plains and Buranda.
  The reinforced rigid concrete pavements have lower maintenance requirements, and are not sensitive to increases in total axle loading cycles. |
<p>| New metro depot      | A dedicated stabling and maintenance depot facility for the metro vehicle fleet is to be constructed. The location of the depot and maintenance facility will be subject to further investigations by Council. |
| Eight Mile Plains station | The existing Eight Mile Plains station will be the southern terminus station for the Metro 1 route. The platform lengths will be extended from 55.25 metres to 64.5 metres long. A bus access road and a bus turnaround facility exist to the south of the existing station. The existing station and associated platforms are essentially in the open air at-grade. There is a central busway corridor with side platforms. There is an over-bridge providing access between platforms. Minor modification is required to reinstate the Disability Discrimination Act (DDA) compliant access ramp to accommodate the platform extension. Typical minor platform modifications are required, such as new canopies to extended platforms, signage, services and new off board ticket validation. Layover for the metro vehicle is to be provided south of the station (inbound) and north of the station (outbound), in addition to the proposed bus layover to the north of the station (inbound). |</p>
<table>
<thead>
<tr>
<th>ALIGNMENT COMPONENT</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Mount Gravatt station</td>
<td>The existing station and associated platforms are essentially in the open air, in a deep cutting and constrained by existing perimeter retaining structure and surrounding elevated plaza and roads. There is a central busway corridor with side platforms. The platform lengths will be extended to the south from 55.25 metres to 64.5 metres long. There is an existing over-bridge providing access between platforms at the northern end of the platforms. Modification is required to the retaining walls and reinstatement of the upper plaza to accommodate the platform extension, including stairs, TransLink signage, road lighting and plaza features. Typical minor platform modifications are required, such as new canopies to extended platforms, signage, services and new off board ticket validation.</td>
</tr>
<tr>
<td>Griffith University station</td>
<td>The existing station and associated platforms are essentially in the open air at-grade. There is a central busway corridor with side platforms. The platform lengths will be extended to the north from 55.25 metres to 84.5 metres long. Major modification is required to accommodate the platform extension. Works required include new retaining wall to support the inbound platform, relocation of existing bike shelter and services, demolition of existing affected canopies, and plaza reconstruction to achieve DDA compliance. There is an existing over-bridge providing access between platforms. Typical minor platform modifications are required, such as new canopies to extended platforms, signage, services, and new off board ticket validation.</td>
</tr>
<tr>
<td>Griffith University turnaround and layover</td>
<td>A new turnaround and layover facility is proposed immediately north of Griffith University station to facilitate the turnaround of the Mains Road bus services. The turnaround and layover is designed to accommodate the swept path of a 14.5 metre long design vehicle, such as those in the existing bus fleet (which has a larger turning radius than the metro vehicle) and accommodate four articulated vehicles in the layover at any one time. The turnaround facility does not make provision for any driver facilities. The turnaround facility incorporates the existing busway access at Sports Drive into a single intersection, with a new separated right turn provided for northbound vehicles entering the layover and turnaround. The existing busway horizontal alignment is modified to accommodate the separated right turn lane. Associated works include earthworks, pavements, drainage, lighting, signage, new retaining wall adjacent to the M1 Motorway, barriers and landscaping.</td>
</tr>
<tr>
<td>Holland Park station</td>
<td>The existing station and associated platforms are essentially open air, elevated structures. There is a central busway corridor with side platforms and over-bridge providing access between platforms. The existing station length of 55 metres is suitable for the metro. There is an existing over-bridge providing access between platforms. Minor platform modifications are required, such as signage, services and new off board ticket validation.</td>
</tr>
<tr>
<td>Greenslopes station</td>
<td>The station and associated platforms are essentially in the open air, at-grade. There is a central busway corridor with side platforms. The station length remains 55 metres long. There is an over-bridge providing access between platforms. Minor platform modifications are required, such as signage, services and new off board ticket validation.</td>
</tr>
<tr>
<td>Buranda station</td>
<td>The existing station and associated platforms are essentially in the open air, in a deep cutting and constrained by existing perimeter retaining structure and surrounding elevated plaza, railway and roads. There is a central busway corridor with side platforms. The platform lengths will be extended from 55 metres to 84.5 metres long. There is an existing over-bridge providing access between platforms. Modifications are required at the Buranda station including extensive demolition of the existing public plaza bridge/structure, adjacent to O’Keefe Street and reconstruction of a new public plaza structure to suit the platform extension (lengthening). Typical minor platform modifications are required, such as new canopies to extended platforms, signage, services, and new off board ticket validation. Subject to further bus operational modelling and investigation, an additional bypass lane may be required on the inbound approach to the station.</td>
</tr>
<tr>
<td>ALIGNMENT COMPONENT</td>
<td>DESCRIPTION</td>
</tr>
<tr>
<td>---------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Woolloongabba station</td>
<td>No changes are proposed to the existing Woolloongabba bus station. The Woolloongabba station does not form part of the Brisbane Metro network, but a modification to the existing turnaround is required at the western station extent within the existing bus layover area to provide a new separate turnaround facility, which can operate independently from the metro through alignment, for interconnecting local bus services that terminate at the station.</td>
</tr>
<tr>
<td>Mater Hill station</td>
<td>The existing station and side platforms are essentially open to the air in a shallow cutting, which is extremely constrained by development over (on the outbound side), adjacent development along Stanley Street and the start of the dive structure to the Vulture Street tunnel (on the inbound side). The inbound platform length will be extended from 44 metres to 50 metres long. The outbound platform length will be extended from 47 metres to 50 metres long. Typical minor platform modifications are required, such as new canopies to extended platforms, modifications to access ramps, signage, services, and new off board ticket validation. Modifications are required to the ramps and stairs at the entrance to the Mater Medical Centre, while the stairs, ramp and adjacent station entrance on Stanley Street also require modification. All ramps are to be DDA compliant.</td>
</tr>
<tr>
<td>South Bank station and Tribune Street bridge</td>
<td>South Bank station is an existing open air, elevated structure. The eastern platform and the northern part of the busway is supported on a reinforced earth structure, whilst the western platform is suspended reinforced concrete and supported by reinforced concrete columns and reinforced earth wall. There is a central busway corridor with side platforms. The station platform lengths are to remain at 55 metres long. Access to each platform is via separate stairs and lifts from Tribune Street concourse area below. Minor platform modifications are required, such as signage, services and new off board ticket validation.</td>
</tr>
<tr>
<td>Brisbane Convention and Exhibition Centre (BCEC) busway tunnel and under-passing of the Queensland Rail corridor</td>
<td>From South Bank station, the alignment follows the existing busway to the BCEC corridor tunnel. From here, the metro alignment passes under the existing South Brisbane rail line near South Brisbane railway station, which means penetrating through the existing bored pile wall that is part of the BCEC tunnel and which supports the BCEC loading dock above. There is a need to lower the final pavement level, by approximately five metres, in the BCEC tunnel to enable the metro to pass under the rail line. Existing busway tunnel foundations on the west side and piled embankment on the east side will need additional ground retaining applied. The metro alignment continues underground beneath the development site on the corner of Melbourne Street and Grey Street.</td>
</tr>
<tr>
<td>New underground Cultural Centre station</td>
<td>The new Cultural Centre station is an underground station located under the Melbourne Street and Grey Street intersection and Queensland Performing Arts Complex (QPAC) forecourt area. The station is approximately 120 metres long by nominally 35 metres wide with a maximum width of approximately 55 metres to accommodate passenger vertical transportation zones. The metro running surface is approximately seven metres below Grey Street. The side platforms are limited to 100 metres long. The construction in this location includes a cut and cover structure with side platforms, vertical transportation, Fire and Life Safety systems and reinstating the roadway and public realm above. The underground station will include full height Platform Screen Doors (PSDs), be an enclosed air conditioned building and include ticket gates at the surface entries.</td>
</tr>
<tr>
<td>Surface Cultural Centre stops</td>
<td>While the surface stops do not form part of the metro network, the current surface Cultural Centre bus station will need to be demolished and reconstructed on a new alignment to accommodate the transition structure to the new underground station which exits to Victoria Bridge at this location. The metro alignment runs through the centre of the new surface Cultural Centre stops. The metro transition/portal structure will be in between the inbound and outbound surface bus stops with new 10 metre long canopies provided on each platform and new vertical transport for the outbound platform, as the existing vertical transport to the overpass will need to be demolished. Significant new public realm and pedestrian crossings will be included at the Melbourne and Grey streets corner.</td>
</tr>
</tbody>
</table>
## Chapter 9 – Concept Design

<table>
<thead>
<tr>
<th>ALIGNMENT COMPONENT</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Victoria Bridge</strong></td>
<td>The metro alignment transitions from the new underground Cultural Centre station up on to the Victoria Bridge, and may require the reconstruction of the back-span of the bridge over Little Stanley Street. It is envisioned the new back-span structure will be of similar construction to the existing structure. The lane configuration on the bridge is to be adjusted to suit the metro with the two metro lanes centred on the bridge with non-metro bus lanes either side. The bridge is to be closed to general traffic with the existing on-road bike lane width reallocated to widen the existing downstream path by 1.2 metres to further facilitate pedestrian movement across the bridge, with cyclists required to dismount at each end of the bridge on this side. The existing shared path on the upstream edge of the bridge remains as is, to facilitate cycle movements, with the upstream crossing between Victoria Bridge and Reddacliff Place being diverted to an at grade crossing at Adelaide Street and George Street. The weight of the metro vehicles (per metre) is similar to the weight of existing bus fleet (per metre), and therefore does not significantly add to the existing bridge loading conditions. The bridge loading condition is presently actively managed under event conditions (e.g. Riverfire). Strengthening works to increase the capacity of the bridge girders are included in the scope of the Brisbane Metro. The eastern (city side) abutment of Victoria Bridge will be extended by approximately 10 metres past the current kerb line in the upstream direction, to provide an acceptable turning path for the metro and bus lanes. It is proposed that an extended reinforced concrete slab be constructed for the lane extension and shared path.</td>
</tr>
<tr>
<td><strong>North Quay to Adelaide Street portal</strong></td>
<td>The alignment transitions off the Victoria Bridge at grade onto North Quay. On North Quay, a transition structure turns into Adelaide Street between North Quay and George Street, with the tunnel portal on the river side of George Street.</td>
</tr>
<tr>
<td><strong>Adelaide Street tunnel</strong></td>
<td>The alignment continues under Adelaide Street between George Street towards the King George Square station below Albert Street in a new cut-and-cover tunnel structure that is 13 metres wide (clear distance between outside walls), which provides for a 1.5 metres wide emergency egress passage. Construction techniques will be employed to allow for two bus lanes along Adelaide Street surface level (one in each direction) to remain operational during weekdays. The existing bus stops along Adelaide Street in this section are to be temporarily relocated during these works.</td>
</tr>
<tr>
<td><strong>Adelaide Street tunnel and Albert Street tunnel intersection</strong></td>
<td>The metro proceeds from the new Adelaide Street tunnel into the Albert Street tunnel. This will require the removal and modification of existing structures within the Albert Street bus tunnel and the King George Square station, to accommodate the new tunnel intersection. Structural modifications to the existing Albert Street tunnel turnaround, including new transfer beams, and modification to several existing major public utilities will be required.</td>
</tr>
<tr>
<td><strong>King George Square station</strong></td>
<td>King George Square station is an existing underground busway station. The Albert Street busway tunnel joins to the eastern side of the station. The platform lengths remain at 120 metres long. The busway has a central busway corridor with side platforms. Underground platforms are separated from the corridor by concrete barrier/glass panels with access by PSDs. The station is accessed from the south by an underground concourse and from the north by a concourse at grade. Platform modifications are required, such as new full height PSDs to align with new vehicle boarding points, which may require removal of some of the existing concrete columns, and changes to signage and services.</td>
</tr>
</tbody>
</table>
### Alignment Component

<table>
<thead>
<tr>
<th>Alignment Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roma Street station</td>
<td>Roma Street busway station is an existing elevated busway station, which is integrated with the Roma Street Transit Centre and the associated subway pedestrian tunnel supports part of the busway and platforms. The outbound platform (Platform 1) currently is approximately 71 metres long and modification to the Roma Street Transit Centre building will be required to extend the platform approximately 13.5 metres on the outbound side with significant impacts on the current layout, services and emergency egress of the existing building. These impacts will be further investigated in subsequent design phases. The section of the inbound platform (platform 2) which currently services buses is presently approximately 98 metres long with sufficient capacity and does not need to be extended. Other minor platform modifications are also required, such as signage and services. Under the Cross River Rail (CRR) Project this station will become a major interchange between CRR and Brisbane Metro. The impact of integrating the design of Brisbane Metro, including new vertical transport at the southern end of the existing platforms will be investigated further in future design stages.</td>
</tr>
<tr>
<td>Countess Street layover</td>
<td>The existing Countess Street bus layover area is to be modified in terms of line marking to provide both layover and turnaround provisions for both the metro vehicle and standard buses. No modifications to the existing retaining walls are proposed. The existing Countess Street bus layover and turnaround will be the northern terminus for the Metro 1 line.</td>
</tr>
<tr>
<td>Normanby station</td>
<td>The existing station is an at-grade, essentially open air station in a shallow cutting. There is partial coverage at one end from a building associated with the adjacent Brisbane Grammar School sports complex (BGSSC) above. There is a central busway corridor with side platforms, and there are over-bridges providing access between platforms at both ends. Lengthening the existing 55 metre long platforms is not required. Minor platform modifications are required, such as signage, services and new off board ticket validation.</td>
</tr>
<tr>
<td>QUT Kelvin Grove station</td>
<td>The existing station and associated platforms are essentially in the open air at-grade. For protection from golf balls, the entire station and extensions from the ends are covered by a steel frame with a wire mesh covering. There is a central busway corridor with side platforms, and there is an over-bridge providing access between platforms. Lengthening the existing 80 metre long platforms is not required. Minor platform modifications are required, such as signage, services and new off board ticket validation.</td>
</tr>
<tr>
<td>Herston station</td>
<td>The existing station and associated platforms are essentially in the open air at-grade. For protection from golf balls, the entire station and extensions from the ends are covered by a steel frame with a wire mesh covering. There is a central busway corridor with side platforms. There is an over-bridge providing access between platforms and an existing shared cycle-pedestrian bridge/link between Herston Road and Gilchrist Avenue. Lengthening the existing 80 metre long platforms is not required. Minor platform modifications are required, such as signage, services and new off board ticket validation.</td>
</tr>
<tr>
<td>RBWH station</td>
<td>The existing station will be the northern terminus station for the Metro 2 line. The station and associated platforms are essentially in the open air on an elevated structure adjacent to RBWH and above the Emergency Access to the hospital. There is a central busway corridor with side platforms, and there is an under-bridge/concourse providing access between platforms. Lengthening the existing 55 metre long platforms is not required. Minor platform modifications are required, such as signage, services and new off board ticket validation.</td>
</tr>
</tbody>
</table>
Ernie’s Roundabout

Ernie’s roundabout is an existing turnaround facility immediately to the north of Butterfield Street, which, in addition to providing a turnaround facility, also provides access between the busway and Butterfield Street. This turnaround will become the final terminus of the Metro 2. TransLink are currently in the process of procuring the construction of a bus layover facility in this location. The proposed layover facility is located immediately adjacent to the roundabout, allowing buses to pull directly onto the roundabout. Minor works (i.e. line marking and minor widening) will be required to enable the metro vehicles to utilise this layover area, albeit with reduced capacity.

Princess Alexandra (PA) Hospital station

The existing station and associated platforms are essentially in the open air, on an elevated structure. There is a central busway corridor with side platforms, and there is an over-bridge providing access between platforms. Lengthening the existing 75 metre long platforms is not required. Minor platform modifications are required, such as signage, services and new off board ticket validation.

Boggo Road station

The existing station and associated platforms are essentially in the open air at-grade. There is a central busway corridor with side platforms, and there is an over-bridge providing access between platforms. Lengthening the existing 58 metre long outbound and 66 metre long inbound platforms is not required. Minor platform modifications are required, such as signage, services and new off board ticket validation. Under the CRR Project this station will become a major interchange between CRR and Brisbane Metro. The impact of integrating the design of Brisbane Metro will be investigated further in subsequent phases of work.

UQ Lakes station

The existing UQ Lakes station and turnaround will be the western terminus station for the Metro 2 line. The existing station and associated platforms are essentially in the open air at grade, and there is a central busway corridor with side platforms. Lengthening the existing platforms is not required. Minor platform modifications are required, such as signage, services and new off board ticket validation.

<table>
<thead>
<tr>
<th>ALIGNMENT COMPONENT</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ernie’s Roundabout</td>
<td>Ernie’s roundabout is an existing turnaround facility immediately to the north of Butterfield Street, which, in addition to providing a turnaround facility, also provides access between the busway and Butterfield Street. This turnaround will become the final terminus of the Metro 2. TransLink are currently in the process of procuring the construction of a bus layover facility in this location. The proposed layover facility is located immediately adjacent to the roundabout, allowing buses to pull directly onto the roundabout. Minor works (i.e. line marking and minor widening) will be required to enable the metro vehicles to utilise this layover area, albeit with reduced capacity.</td>
</tr>
<tr>
<td>Princess Alexandra (PA) Hospital station</td>
<td>The existing station and associated platforms are essentially in the open air, on an elevated structure. There is a central busway corridor with side platforms, and there is an over-bridge providing access between platforms. Lengthening the existing 75 metre long platforms is not required. Minor platform modifications are required, such as signage, services and new off board ticket validation.</td>
</tr>
<tr>
<td>Boggo Road station</td>
<td>The existing station and associated platforms are essentially in the open air at-grade. There is a central busway corridor with side platforms, and there is an over-bridge providing access between platforms. Lengthening the existing 58 metre long outbound and 66 metre long inbound platforms is not required. Minor platform modifications are required, such as signage, services and new off board ticket validation. Under the CRR Project this station will become a major interchange between CRR and Brisbane Metro. The impact of integrating the design of Brisbane Metro will be investigated further in subsequent phases of work.</td>
</tr>
<tr>
<td>UQ Lakes station</td>
<td>The existing UQ Lakes station and turnaround will be the western terminus station for the Metro 2 line. The existing station and associated platforms are essentially in the open air at grade, and there is a central busway corridor with side platforms. Lengthening the existing platforms is not required. Minor platform modifications are required, such as signage, services and new off board ticket validation.</td>
</tr>
</tbody>
</table>

Table 9.2 – Brisbane Metro infrastructure elements

9.4 Stations

The Brisbane Metro will upgrade the capacity of 7 stations, build one new underground station and utilise 10 existing busway stations, to deliver a total of 18 metro stations to allow customers to access the metro system.

Each station will be designed to include the following features:

- DDA compliant access and ramps as required, whilst maintaining existing entrances.
- Off-board ticket validation in order to create free flowing boarding and alighting without any requirement for on-board ticketing transactions.
- Re-use of existing entrances and exits to current stations
- Highly visible and integrated station information and way-finding signage.

The new Cultural Centre underground metro station will include the following features:

- Full height PSDs on platform edges for underground stations at the new underground Cultural Centre station. The existing PSDs at King George Square station will be redesigned to suit the new fleet mix.
• Fire and Life Safety integrated into design to include smoke zones, emergency egress/evacuation facilities to meet Queensland Fire and Emergency Services (QFES) requirements, including necessary fire prevention and fire control systems.

• Platform design standards based on the Fruin Level of Service (LOS) C (with LOS D for periods of less than 5 minutes)\(^1\).

• A level of finish similar to existing bus stations (e.g. quality of tiling and glazing finishes).

• A level of public realm that integrates the infrastructure to the local precincts.

• Vertical transport to be provided with an escalator capacity of 100 people per minute (6000 people per hour), per escalator.

**9.4.1 Cultural Centre underground metro station**

A new underground metro station is to be constructed under the intersection of Grey Street and Melbourne Street in the Cultural Centre precinct. The station and tunnels will link to the existing busway tunnel beside the BCEC and to Victoria Bridge. This will provide a dedicated metro route eliminating key delay points in the existing busway system at the signalised Grey and Melbourne streets intersection, the Melbourne Street portal to the BCEC busway tunnel, and the constrained Cultural Centre station.

The station is oriented at approximately 45 degrees to the local road network to maximise the available station platform length and achieve grade separation of the metro and local roads. The station has side platforms and stopping bays, and central through running lanes. Figure 9.2 provides a schematic of the station layout.

Metro customers gain access to the underground station platforms via lifts, stairs and escalators located on 125 Grey Street beside the South Brisbane railway station on the corner of Grey and Melbourne streets. The station ground level concourse is to have a roof canopy that covers the majority of this site and makes provision for small retail tenancy spaces.

Space for essential platform equipment, such as transformers and smoke extraction is provided above the underground station roof under the rail underpass.

---

\(^1\) Fruin Levels of Service measure pedestrian flows in queuing areas, walkways and stairways. LOS C indicates that the areas have slightly restricted circulation due to difficulty in passing others and there is difficulty with reverse and cross-flows. LOS D indicates that the areas have restricted circulation for most pedestrians and there is significant difficulty for reverse and cross-flows.
Figure 9.2 – Cultural Centre underground metro station

The vertical constraints at the Cultural Centre (including the existing busway, Grey Street, Melbourne Street and Victoria Bridge) result in the platforms for the new station being approximately seven metres below surface level with a central vertical portal connection to surface and services and emergency egress at either end.

The southern end of the metro station connects into the existing busway tunnel which sits underneath and supports the BCEC loading dock above. The BCEC end of the metro station also passes under the existing rail corridor and parts of the South Brisbane railway station where it joins into the BCEC tunnel. A rail underpass structure is to be constructed to support the existing rail lines and station platforms whilst permitting the metro alignment and part of the metro station to be located underneath.

Due to geometrical constraints of the metro alignment, and requirements for provision of stopping sight distance for buses approaching the station, the junction with the BCEC tunnel extends over approximately a 40 metre length of the tunnel wall on the rail corridor side. The existing tunnel piled wall over this length is to be removed and BCEC loading dock above supported by the installation of a grid of support beams and columns/piles located within the western half of the rail underpass. The deck structure that supports the rail tracks and station platform on the western half of the rail underpass is proposed to be formed by installation of a series of transverse precast pre-stressed slab spans with an in-situ reinforced concrete deck slab. This is an economical and efficient construction method that minimises the requirements for rail track closures.

On the Grey Street side of the rail underpass structure, a more traditional skewed precast pre-stressed girder with in-situ reinforced concrete deck slab supports the rail tracks and station platforms. Both halves of the rail underpass deck are supported on a series of support beams borne by internal columns/piles and secant pile walls that retain the existing rail embankment. The rail underpass columns have been positioned to best suit the metro station arrangement whilst providing an economical support arrangement to resist the significant horizontal and vertical loads. The section of the existing large concrete gravity
wall that separates the rail formation along 125 Grey Street is to be removed, where it is adjacent to the rail underpass structure. This provides access to the plantroom equipment located under the rail underpass.

The section of the BCEC tunnel, including the Melbourne Street portal to the north-west of the metro station junction is to be closed to bus traffic. This section will provide access to the station equipment rooms and ducting from smoke exhaust system in case of a fire in the station. The section of the BCEC tunnel and transition structure to the south east of the tunnel portal require the construction of a new water tight u-trough retaining structure to provide a level of flood immunity to the metro station.

The concept design of the metro station has made some allowances for a potential future low rise development over the station. Consideration has been given to the arrangement of the ground level concourse and station entries plus sizing of station structural supports to suit a potential future low-rise development. The documented concept design provides for a canopy cover over the top of the ground level station concourse with provision for lifts, stair and escalator access to the underground station platforms only.

On the river side of the metro station, the horizontal constraints result in a requirement for the partial demolition and reconstruction of the existing QPAC performance courtyard (‘the Green’) adjacent to Grey Street, including the loss of large established trees along the boundary.

The transition structure from the Victoria Bridge to the Cultural Centre station requires demolition and removal of the existing subterranean pedestrian link between QPAC and the Queensland Museum carpark. The removed underground link is not proposed to be reinstated with connection across the metro and West End bus services available by the existing overpass pedestrian link, which remains, and via improved street level connection at the Melbourne/Grey streets intersection.

Removal of private vehicle traffic from Victoria Bridge removes one access point to QPAC underground carparks. This access is not proposed to be reinstated and future access will be via the existing Peel Street/Little Stanley Street access.

A significant number of utility services, including some major services are impacted by the proposed metro station. Section 9.8.10 provides further detail on the impacts to current utility services.

Consultation and engagement with key stakeholders, including BCEC, QPAC and Queensland Rail, will be critical in shaping the development of the station and understanding impacts on affected parties.

9.4.2 Cultural Centre surface stops

The existing Cultural Centre bus station functionality will remain for bus customers using West End services. The area is to be completely rebuilt to make space for the transition structure that joins the underground station to Victoria Bridge. The transition structure sits centrally on Melbourne Street with the new surface stops and through lanes either side of the central metro transition structure. The new surface stops and shelters have reduced lengths that are suitable for the forecast West End services patronage.

9.4.3 Upgrades to existing busway stations

Platform extensions are proposed at the existing busway stations at Eight Mile Plains, Upper Mount Gravatt, Griffith University, Buranda, Mater Hill and Roma Street to accommodate the
proposed metro vehicles and operations. In addition to the platform extensions, other minor modifications are required to suit metro operations. Modifications at the existing Eight Mile Plains, Upper Mount Gravatt, Griffith University, Holland Park West, Greenslopes, Buranda, Mater Hill, South Bank, Normanby, QUT Kelvin Grove, Herston, RBWH, PA Hospital, Boggo Road and UQ Lakes stations, comprise:

- New ticket gates at platform entry and exists to facilitate off-board ticketing and ‘tagging on and off’
- New Passenger Information Displays (PID) system to be installed to support real-time metro/bus management, and to inform customers which stops approaching buses and metro’s will arrive and depart from
- Updated station customer information (service arrival time, route service areas) wayfinding signage and branding.

The future of the Transit Centre at Roma Street is dependent on the Queensland Government’s CRR Project, which proposes to utilise the site for construction of a new underground station connecting to the existing Roma Street railway station. In the event that CRR construction occurs prior to or during the Brisbane Metro’s delivery phase, an integrated design approach between Brisbane Metro and CRR will be required to ensure minimal construction disruptions, as well as an optimum design and interchange between the services.

The design of Boggo Road station also requires coordination with CRR, including the addition of vertical transport at the southern end of the platforms to connect the surface station to the underground CRR passenger concourse, which will facilitate customer interchange.

## 9.5 Tunnels

A number of existing tunnels are present on the South East, Inner Northern and Eastern busways that are to be utilised for Brisbane Metro. The metro vehicle fits within the static vehicle and kinematic envelopes, adopted at the time of the original design of the busway tunnels, and hence it has been assumed the existing busway tunnel structures (i.e. the final linings) will not be adversely impacted by the metro, i.e. the final linings will not require enlarging or modifying.

The existing tunnels also include varying provisions for Fire and Life Safety, which were previously agreed with QFES. At this stage of the design, it is assumed no further modifications are required to the existing tunnels. This will be confirmed through engagement with the relevant stakeholders during subsequent project development phases. Section 9.9 further discusses Fire and Life Safety.

To finalise the missing busway link, a new tunnel is to be constructed along Adelaide Street between North Quay and King George Square station as described in the following section.

### 9.5.1 Adelaide Street tunnel

In combination with the partial closure of North Quay to through traffic, the Adelaide Street tunnel will complete the segregation of the busway corridor from general traffic and create a dedicated metro connection from North Quay to King George Square busway station. Other bus services will continue to utilise the surface level of Adelaide Street.
The transition structure into the tunnel commences at the corner of North Quay and Adelaide Street, and then dives down to a tunnel portal located on the river side of the George Street and Adelaide Street intersection.

Single traffic lanes located either side of the centrally located dive structure provide surface access to adjacent high rise buildings (Brisbane Square and 300 George Street) and for West End and Glider services from Victoria Bridge to Adelaide Street via North Quay. The transition structure is immediately adjacent to the newly constructed basement of 300 George Street with the inbound bus lane running over the surface of the basement, at ground level with the development frontage set back under a development approval volumetric provision.

The main Adelaide Street tunnel section is a cut and cover tunnel structure, 13 metres wide (from the insides of each the concrete lining panels) with bored pile walls and reinforced concrete roof slab. It is located directly under Adelaide Street and provides a direct connection for metro services into the existing Albert Street bus tunnel at the southern end of the existing underground King George Square station. A signalised right hand turn lane is provided for south east BUZ services that turn into the Albert Street tunnel to terminate at the Queen Street bus station.

An emergency egress tunnel is provided along the length of the tunnel for safe passage of metro and bus customers in the case of a fire.

The right hand turn lane and the curve radius of the metro lanes at the junction of the Albert Street tunnel result in the Adelaide Street tunnel widening out from the typical 13 metre wide section to approximately 30 metres wide at the junction. At the junction point, the Adelaide Street tunnel is also a lower depth to match the levels of the Albert Street tunnel.

To provide for the turning movement of metro services at this underground tunnel junction, it is necessary to remove a number of structural support columns and service access shafts. The shafts are currently located along the junction interface, in the median of the existing Albert Street tunnel and in the median of the turnaround prior to the southern end of the King George Square station.

The means of support to replace the eliminated structural columns is provided via the construction of an extended intermediate level support slab that matches the level of the smoke extraction and services duct that connects between King George Square station and Queen Street bus station under the Albert Street tunnel roof. The extended intermediate slab transfers vertical loads and horizontal earth pressure loads to the Adelaide Street tunnel walls and to new columns located in the tunnel junction median adjacent to the right-hand turn lane.

Council will continue to consult with key stakeholders, including property owners and adjacent businesses, during further development of Brisbane Metro to understand the impact of Adelaide Street tunnel works on affected parties.

9.6 Pavements

A preliminary assessment has been made of the pavement loading impacts for the business case and forecast metro/bus fleet mixes and vehicle movements up to 2041.

This assessment has been based on details from examples of the original pavement design reports and drawings which have been obtained, for example typical sections of the busway
network. The busway network has a range of pavement details but the pavement types can be loosely classified into two generic pavement types.

Concrete pavements were installed to approximately 32 per cent of the busway total length with typical pavement composition as 225 millimetre Jointed Reinforced Concrete Pavement on sub-base and working platform, with subgrade California Bearing Ratio (CBR) >10 per cent.

The second generic type of pavement adopted is a flexible composite pavement which is installed to approximately 46 per cent of the total busway length. The typical flexible pavement composition is a 40 millimetre Stone Mastic Asphalt on 200 millimetre thick 20 millimetre Dense Graded Asphalt mix with 200 millimetre thick cement stabilised base, 150 millimetre thick working platform with a subgrade CBR >3 per cent.

An estimate has been made of the likely reduction in life of the existing pavements on the busways under the forecast usage of the busway network for the Metro 1 and Metro 2 lines.

The preliminary pavement loading assessment has indicated the following outcomes:

- The current traffic volumes using the busways to date are less than the original design intent.
- At a flexural concrete strength of 4.5 MPa, the concrete sections of pavement are expected to achieve roughly the original pavement design life (30 years).
- The estimated damage caused to the flexible and flexible composite pavements by the metro fleet mix is 4.5 Equivalent Standard Axle (ESA)/vehicle. While this will cause more damage than the current bus fleet mix, the original pavement designs adopted values greater than this, to take account of increased future axle loadings. Therefore, the original designs have adequately covered the increased traffic loadings currently forecast by the metro system.
- Due to the increased axle loads adopted in the original designs, and lower daily bus movements presently predicted (compared to the original designs), the strength of the flexible and flexible composite pavements are expected to be sufficient to carry the metro without requiring major maintenance before the end of the original design life (30 years).

9.7 Other corridor works

9.7.1 Re-purposing of Victoria Bridge

The metro alignment transitions from the new underground Cultural Centre station up on to the Victoria Bridge, and requires the reconstruction of the back-span of the bridge over Little Stanley Street. It is envisioned the new back-span structure will be of similar construction to the existing structure.

The lane configuration on the bridge is to be adjusted to suit the metro with the two metro lanes centred on the bridge with non-metro bus lanes either side. The bridge is to be closed to general traffic with the existing on-road bike lane width reallocated to widen the existing downstream footpath by 1.2 metres to further facilitate pedestrian movement across the bridge. Cyclists are required to dismount at each end of the bridge on the downstream footpath side. The existing shared path on the upstream edge of the bridge remains as-is to facilitate cycle movements, with the upstream crossing between Victoria Bridge and Reddacliff Place being diverted to an at-grade crossing at Adelaide Street/George Street intersection.

Figure 9.3 presents the typical cross section for the proposed Victoria Bridge configuration.
Figure 9.3 – Proposed Victoria Bridge deck re-configuration

Significant new public realm and pedestrian crossings will be developed at each end of the bridge connecting to the Cultural Centre and Reddacliff Place.

The weight of the metro vehicles (per metre) is similar to the weight of existing bus fleet (per metre), and therefore does not significantly add to the existing bridge loading conditions. The bridge loading condition is presently actively managed under event conditions (e.g. Riverfire). Strengthening works to increase the capacity of some bridge girders are included in the scope of Brisbane Metro.

Strengthening of the bridge would likely comprise the attachment of carbon fibre strips to the underside and sides of bridge girder sections. An alternative would be the installation of external post tensioning cables on the insides of some bridge girders, however an initial structural assessment of the bridge has indicated that post tensioning may not be necessary.

It is not expected that replacement of the existing bridge bearings will be required as a result of Brisbane Metro.

9.7.2 Re-purposing of North Quay

The section of North Quay between Queen Street and Adelaide Street is to be reconstructed to suit the alignment of the metro as it turns from the central lanes on Victoria Bridge into North Quay and again from North Quay into Adelaide Street.

Either side of the two central metro lanes are general bus lanes. This section of North Quay is to be closed to use from general traffic with the exception of the inside lane that travels from Adelaide Street around into North Quay, to provide for traffic entering Brisbane Square. Traffic exiting from Brisbane Square will cross the single lane of bus traffic that is entering/exiting from the Queen Street bus station tunnel at a signalised intersection gaining access to Elizabeth Street via William Street.
Figure 9.4 provides an overview of the works required at North Quay and Victoria Bridge through to the commencement of the portal at Adelaide Street.

Figure 9.4 – Victoria Bridge and North Quay re-purposing works

The corner from Victoria Bridge to North Quay will be widened towards the river, by approximately ten metres behind the existing kerb line, to facilitate the horizontal curve geometry of the metro at this location. This horizontal curve provides for cornering of metro at a maximum speed of 5 to 10km/hr. The alignment geometry along this section of North Quay is tightly constrained by the requirement to maintain access to Brisbane Square, provide for the regular bus movements either side of the metro lanes and maintain the Centennial Bikeway ramp and the Riverside Expressway at a location where the river bank is very steep.

9.7.3 Layovers and Turnarounds

A number of existing turnaround are utilised, with new layovers to be added and existing layover facilities modified to suit the operational requirements of the metro vehicles. In other locations, new turnaround and/or modification of layovers are required for termination of interconnecting local bus services.

Provisions for existing and new turnaround and layovers include:

- Eight Mile Plains – metro layover (four vehicles) and existing turnaround
- Griffith University – Existing bus fleet layover (four vehicles) and new turnaround
- Countess Street – metro layover (four vehicles) and turnaround and existing turnaround
- Ernie’s Roundabout – metro layover (four vehicles) and turnaround and existing turnaround
- Boggo Road – Existing bus fleet recovery layover (one vehicle)
- UQ Lakes – metro layover (one vehicles) and existing turnaround
- Woolloongabba – New bus fleet turnaround.

Further refinement of the layover and turnaround requirements will be undertaken in the further design stages, following further optimisation of non-metro services.

9.7.3.1 Metro 1 Services

The existing turnaround at the southern end of the Eight Mile Plains station will be utilised by metro vehicles for southern termination of the Metro 1 line. The existing layover to the north of the inbound platform and turnaround are suitable for metro vehicle use. A new layover space is to be provided prior to the northern end of the outbound station platform and one bay prior to the southern end of the inbound platform. Some modifications are required at either end of the station to provide for the recovery layover facilities for the Metro 1 line. Figure 9.5 and Figure 9.6 provide aerial views of the Eight Mile Plains turnarounds with notes on the planned modifications.

![Figure 9.5 – Eight Mile Plains turnaround modifications (southern)](image-url)
The existing turnaround at the existing Countess Street layover is to be used as the northern terminus of the Metro 1 line. Line marking in the existing Countess Street bus layover area is to be modified to provide both layover and turnaround provisions for both metro vehicles and standard buses. No modifications to the existing retaining walls are proposed. Figure 9.7 provides an aerial view of the Countess Street turnaround with notes on the planned modifications.

Ernie’s Roundabout is an existing turnaround facility immediately north of Butterfield Street near the RBWH busway station. In addition to providing a turnaround facility which is suitable for metro vehicles and other buses, the turnaround also provides access between...
the busway and Butterfield Street. This turnaround will become the northern terminus of the Metro 2 line. Figure 9.8 provides an aerial view of the Ernie’s Roundabout turnaround with notes on the planned modifications.

**Figure 9.8 – Ernie’s Roundabout turnaround modifications**

TransLink are currently in the process of procuring the construction of a bus layover facility at this location. The proposed layover facility will be located immediately adjacent to the roundabout, allowing the metro vehicle to pull directly onto the roundabout. It is proposed that minor works (i.e. line-marking and minor widening) will be required to enable the metro vehicle to utilise this layover area, albeit with reduced capacity.

The Metro 2 western terminus is at the UQ Lakes station. Metro vehicles will use the inside of the UQ Lakes turnaround as a recovery layover space. Line marking and changes to island kerbing, pedestrian paths and ramps are required to suit the turn swept paths of the metro vehicles at this location. Figure 9.9 provides an aerial view of the UQ Lakes turnaround with notes on the planned modifications.
9.7.3.3 Changes to bus service facilities

**Woolloongabba station**

A new turnaround is proposed to the western end of the station’s existing layover facility. Works include pavement widening, retaining walls, drainage, new kerbs and line marking to provide a new separated turnaround facility, which can operate independently from the metro through alignment. Figure 9.10 provides an overview of the new turnaround at Woolloongabba station.
The turnaround facility is to provide for local interconnecting bus services that terminate at the station and will require the removal of a large established tree at the western end of the existing bus layover facility.

**Griffith University station**

A new turnaround and layover facility is proposed immediately north of Griffith University station to facilitate the turnaround of the Mains Road bus services. The turnaround and layover is designed to accommodate the swept path of a 14.5 metre design vehicle, such as those in the existing bus fleet (which has a larger turning radius than the metro vehicle) and accommodate four articulated vehicles in the layover at any one time. Figure 9.11 provides an overview of the new turnaround at Griffith University station.

**Boggo Road station**

A layover bay for a single articulated vehicle is proposed immediately west of Boggo Road station. Figure 9.12 provides an overview of the layover modifications at Boggo Road station.
Council will continue to consult with key stakeholders, including Griffith University, University of Queensland and property owners, during further development of Brisbane Metro to understand the impact of these proposed works on affected parties.

9.8  Constructability

In order to re-purpose and re-use the existing busway to support both metro and bus operations, there are a number of constructability considerations, including:

- Traffic and pedestrian management
- Site facilities and laydown areas
- Spoil removal routes
- Busway operations during construction including temporary bus facilities, changes to routes and stops
- Construction worker transport
- Queensland Rail closures and safety considerations and requirements associated with working within and adjacent to the rail corridor
- Dewatering and environmental considerations, such as noise and vibration at the Cultural Centre and Adelaide Street
- Night works requirements
- Stakeholder management.

Critical constructability issues are discussed in the sections below.

9.8.1  BCEC busway tunnel

Construction of the missing busway link, which passes from the BCEC busway tunnel under the South Brisbane railway lines, will require breaking through a section of the existing bored pile wall that forms part of the existing busway tunnel supporting the BCEC loading dock above. This work cannot be undertaken until the rail underpass structure is completed to take the lateral and vertical loads currently resisted by the existing wall. The removal of the
section of piled wall requires the de-stressing of the affected pile wall anchors. Piles will be cut under the pile cap beam and the bases of the piles.

The metro finished pavement level at the tunnel wall junction is approximately 5 metres below existing tunnel pavement levels at its deepest point. Excavation to the new tunnel base levels will undermine the foundation of a number of wall piles and also an existing retaining wall and pile foundations on the BCEC side of the tunnel. This is to be addressed by installing additional tie-back anchors to the base of the piles that are to be retained and forming a waterproof stand-alone u-trough base and retaining walls within the existing tunnel profile and adjoining transition structure.

The break-through of the BCEC piled wall and ultimate demolition will be from within the BCEC tunnel. This will require partial closure of busway operations at this location with the outbound bus lane shut and the running of busway traffic, at a minimum, under a one lane tidal flow with predominate flow direction matching the morning/afternoon traffic peak. Traffic barriers will be installed to protect bus traffic from the construction works. Disposal of excavated material and demolished piled wall material will be via the partitioned off outbound lane with access from the Melbourne Street tunnel portal.

Other construction works required for the BCEC tunnel include, the removal of the existing retaining wall facing panels and the demolition of the edge concrete barriers on both sides of the existing BCEC transition structure outside of the tunnel portal. Similarly, the tunnel side cladding panels and concrete side barriers from the Melbourne Street side of the new metro entry portal (into the Cultural Centre station) back to the BCEC tunnel southern portal will be removed.

The existing cantilever retaining barrier on the BCEC side of the tunnel section is to be demolished down to the existing top of busway pavement and anchored micro piles installed on this side of the tunnel over this length. An additional row of pile anchors is required to the lower section of the eastern pile wall where the existing piles are retained to ensure there is appropriate support of the pile bases when excavating below the pile toe level.

The busway pavement will then be removed and the surface excavated to the required level of the new concrete base slab. Following casting of the base slab, waterproofing reinforced concrete walls are then formed and cast on both the western and eastern sides of the tunnel and the new metro pavement installed before reopening to bus traffic.

Council will continue to work with BCEC, South Bank Corporation and other key stakeholders during further development of Brisbane Metro to understand the impact of these proposed works on affected parties.

9.8.2 South Brisbane Queensland Rail underpass

The Queensland Rail underpass in South Brisbane is a geometrically constrained site with large amount of construction activity required to be carried out under a managed track possession regime. Preliminary staging plans have been prepared which assume works can be carried out over a significant number of rail track closures. Works will be subject to Queensland Rail approvals, with detailed consultation on the proposed staging methodology ongoing. Council will continue to work with Queensland Rail to investigate design and construction methodologies to minimise impacts of the proposed works.

The rail underpass is to be constructed through existing railway embankment fill that is highly likely to have some level of contamination. Access to the rail corridor is proposed to be from the active BCEC loading dock on the western side of the rail corridor. Access from
the east is via the proposed development site on the corner of Grey Street and Melbourne Street (adjacent to South Brisbane railway station).

In each of four stages, one of the existing rail tracks is closed to rail traffic, in turn for a period of time (noting that detailed scheduling of works has yet to be completed), while a section of the rail underpass is constructed in sections working from the western BCEC loading dock edge to the eastern development site boundary of the railway corridor.

Due to the work being very close to adjacent operational rail tracks, a significant amount of work will be carried out under weekend possessions of adjacent track(s) including installation of support piles/columns plus secant pile walls and the deck girders erection. Other construction activities can be carried out between trains by keeping greater than 3 metres away from the nearest operating rail line or overnight during short term track closures.

Due to their lighter weight, the shorter pre-stressed concrete deck slabs used on the western half of the underpass deck can be lifted into place with smaller cranes from the rail corridor surface. The longer and heavier bridge girders on the eastern half of the rail underpass will require a large capacity mobile crane (or possibly two cranes) positioned adjacent to the gravity retaining wall on the development site to lift the girders up and into place on the railway corridor under weekend track closures of the adjacent eastern tracks.

Excavation of the tunnel below the roof deck units is to be from the east (Grey Street) to the west (BCEC tunnel) to permit continued bus operations within the BCEC busway tunnel during construction of the rail underpass.

The excavation for the station under the rail underpass is to be carried out in two vertical stages to limit un-propped height of the underpass end retaining walls. This also permits the station roof slab to be cast on ground during the first of the excavation stages. Access for removal of the rail formation material in the first excavation stage, will be under the underpass structure at street level from a cut through section of the gravity retaining wall along the development site.

Excavation of the remaining material within the metro station below the plant room floor is to be carried out from within the station box structure. It would stop short of the BCEC eastern piled wall so as not to undermine their base. The toe of existing piled retaining wall is likely to be socketed in rock above the final excavation level of new station base slab. The piles are to be cut out from the BCEC busway tunnel side during a busway closure.

**9.8.3 Cultural Centre underground metro station**

The new underground Cultural Centre station is located beneath the Melbourne Street and Grey Street intersection and QPAC forecourt area. Construction at this location includes a cut and cover structure with side platforms; through alignment; vertical transportation; mechanical, electrical and plumbing systems; and reinstating the roadway and pedestrian precinct above.

The station structure will be constructed top-down and carried out in sections to minimise surface disruption. Surface traffic management will be required with reduced traffic lane widths, closures and switches to suit the construction sequencing of the perimeter walls and roof elements.

The station design has adopted an undrained structure due to an indication of high groundwater table and relatively high permeability alluvial soils in the area. Diaphragm
perimeter walls construction has been selected for water-tightness of the structure but a secant pile wall could be used as a practical alternative. This approach prevents flooding of station excavation; as well as reducing groundwater drawdown and its subsequent impact on surrounding heritage listed structures. Recharge wells are still likely to be required around sensitive neighbouring structures and utilities to limit groundwater drawdown and minimises consolidation settlement, particularly for the heritage railway station building and adjacent QPAC buildings.

An existing major sewer pump station with rising main is located adjacent to the Melbourne and Grey streets intersection on the south eastern corner. The developed concept design makes provisions to keep the main pump well and valve box but assumes the inlet grit chamber and associated connections will be relocated as part of early works to the southern side of the station shell. The proposed station retaining wall layout has been located adjacent to the main pump station in order to maintain it in its current location.

Construction openings are to be left in the roof slab to enable the station shell to be excavated down to the proposed base slab level and remove material from the station shell. Temporary strutting or installation of temporary ground anchors may be required to support the retaining walls during excavation to base slab level. Temporary supports can be removed after the station base slab has been cast.

Due to the size and complexity of the new Cultural Centre station and the Queensland Rail underpass construction, the area required by the contractor for site facilities may be substantial. It is proposed that the top of the completed roof slab be used for site facilities space. Section 9.8.10 discusses other key utility services conflicts.

Continuing consultation and engagement with key stakeholders, including QPAC and Arts Queensland, will be critical in shaping the development of the station and understanding the impacts on affected parties.

### 9.8.4 Transition structure from new Cultural Centre station to Victoria Bridge

A small segment of transition structure from the underground station to Victoria Bridge will be cut and cover construction with the remainder being a U-trough section with diaphragm wall construction. This will minimise groundwater ingress and maintain a tanked structure. The retaining walls are proposed to be installed in stages with staged diversion of existing busway lanes and construction of the new Cultural Centre surface station busway platforms and shelters.

Due to the proximity of the southern retaining wall to existing barriers behind the outbound busway platform, temporary closure of one of the passing lanes and construction of a new outbound platform in the passing lane will be required. Proposed methodology to address this includes the temporary closure of passing lanes at the station with an over-width common area between platform stopping lanes to be utilised, under traffic control, in an emergency should a bus break down at the station platforms.

The excavation and removal of spoil from the transition will be only be undertaken following the completion of the surface stops and will be taken/transported across Victoria Bridge by accessing the area between the two retaining walls of the transition structure.

### 9.8.5 Victoria Bridge South Bank abutment back span

Where the metro alignment transitions from the new underground Cultural Centre metro station to the Victoria Bridge, the vertical geometry of the transition requires the
reconstruction of the top section of Victoria Bridge South Brisbane back-span, which spans over Little Stanley Street.

The replacement back-span deck structure is to be of similar form to the reinforced concrete construction of the existing bridge back-span deck but lowered at one end by approximately 0.5 metres. The back span is to be re-constructed in sections working from one side of the bridge across to the other to minimise distress to the support/retaining wall from non-uniform earth pressure on the Queensland Museum side of Little Stanley Street during construction. This avoids a requirement for installation of temporary ground anchors or horizontal propping that would block Little Stanley Street. Partial busway closures are expected during these works.

9.8.6 Victoria Bridge North Quay widening

The widened corner of the Victoria Bridge is to be constructed as a reinforced concrete flat slab supported on an extended low height retaining wall along North Quay, the existing bridge abutment on the other side and with discrete columns/piles underneath.

It is expected that the new concrete slab would likely be formed with falsework supported on collars clamped to the completed support columns, as the ground surface steeply dips towards the Brisbane River at this location. The permanent removal of a localised portion of masonry facing blocks from the bridge abutment is required.

A portion of the existing upstream shared path on the bridge deck is to be demolished and a tapering widened section of pathway/roadway constructed. The extended deck section is to cantilever off of the existing bridge edge girder. Pedestrian traffic on the upstream existing shared path will need to be diverted to the downstream footpath for periods during construction.

The extent of path widening on the bridge deck extends approximately ten metres out from the bridge abutment joint towards the river and is located over the outermost Ann Street onramp merge lane onto the Riverside Expressway. The erection of a working platform to complete works under the bridge will require further consideration, particularly in relation to access and traffic management.

Works would be constructed in conjunction with the North Quay busway road works and will have traffic safety barriers on the bridge deck and North Quay to form a work zone separated from the busway traffic still utilising the bridge.

9.8.7 North Quay to Adelaide Street portal

The transition structure is proposed to be constructed in multiple stages, with access to 300 George Street and 275 George Street (Brisbane Square) maintained and dependent on the staging allowing for buses to travel along Adelaide Street between North Quay and George Street. Alternative bus routes are proposed inbound from Victoria Bridge, turning right onto North Quay, left onto Elizabeth Street, left onto George Street turning right into Adelaide Street; and outbound from Adelaide Street turning right onto George Street, left onto Ann Street, left onto North Quay and right onto Victoria Bridge.

Existing ground anchors are likely to be encountered from the basement construction of high buildings in Adelaide Street. There is a risk of anchors and other obstructions affecting piling works and that the existing anchors have not been de-stressed. This will need to be carefully managed through construction, and will be considered further during future design stages.
Surface drainage will need to be carefully managed during construction, so as not to flood the transition structure.

**9.8.8 Adelaide Street tunnel**

The Adelaide Street tunnel structure is to be cut and cover and will be constructed top-down, installing one wall of piles down one side of the road at a time and construction of half of the tunnel roof slab. During these periods, one side of the road will be closed and two lanes will remain open for bus traffic (with no bus stops) and for deliveries only. The overall width of the tunnel cross section will require a temporary reduction in the footpaths along Adelaide Street and will require relocation of the services within them.

The tunnel roof slab is to be constructed in two equal halves generally, with a construction joint in the centre of the slab. Waterproofing is applied to the top of the tunnel roof slab and the new Adelaide Street road pavement constructed over the top of the tunnel roof slab. Excavation of the tunnel is done from the tunnel portal underneath the completed roof slab with construction of the base slab and pavement following. Barriers, escape tunnels and the remaining tunnel fit out will then be completed.

Similar to the transition structure, ground anchors and retaining walls of existing building basements may cause obstruction or difficulties with tunnel wall construction.

There is a risk that the existing anchors have not been de-stressed and this will need to be carefully managed through construction.

**9.8.9 Adelaide Street tunnel and Inner Northern Busway intersection**

Brisbane Metro breaks into the existing Albert Street tunnel at the southern end of King George Square busway station, from the new Adelaide Street tunnel. The proposed structural solution retains most of the existing Albert Street tunnel structure, minimising effects on the existing busway, other existing infrastructure and surface disruption at the Adelaide Street/Albert Street intersection during construction.

The Adelaide Street tunnel walls, columns, roof slab, intermediate level slab and base slab will be constructed in a top down sequence and will be connected into the Albert Street tunnel structure at each level as required. Once the respective elements of the new Adelaide Street tunnel structure are complete, the relevant portions of the Albert Street tunnel and King George Square station structures can be demolished with vertical and lateral loads transferred to the Adelaide Street tunnel structure.

Access to construct the works via the Adelaide Street tunnel is limited by tunnel staging and Albert Street tunnel is limited by busway operational impacts. Access to the Adelaide Street tunnel works will be via the Adelaide Street tunnel portal and a temporary opening in the roof slab (if required). Delivery and installation of the permanent structural steel underpinning trusses, to be installed within the existing smoke duct (located above the ceiling of Albert Street busway tunnel), will be undertaken by removing the light weight ceiling to the south-east end of the smoke duct; with the ceiling to be reinstated once access is no longer required.

Temporary horizontal props will be required within the smoke duct and temporary vertical props will be required between the roof, smoke duct and tunnel base slabs, along the length of the existing piled wall that is to be removed along the tunnel connection interface. Temporary protection hoarding will be installed around construction zones with speeds and lane widths reduced within the Albert Street busway tunnel to improve safety.
Night works and short term busway closures will be required to allow for delivery of construction materials, removal of the existing south-west piled wall, removal of columns within metro alignment and construction of new columns. The final construction methods will need to incorporate additional measures to ensure noise, dust and vibration limits are appropriately addressed.

9.8.10 Utility Services

The need to maintain uninterrupted services supplies requires all existing services to remain live until alternative supplies are established. The implementation of this process will be made more complex when existing live services are present in areas where the diverted services are to be installed, requiring planning and design to be undertaken with stakeholders and asset owners/operators. Wherever reasonable and cost-effective, utilities will be relocated/protected during early works, in advance of construction works.

Council will continue to engage and consult with service providers in developing the Brisbane Metro design and construction methodologies.

9.8.10.1 Cultural Centre Precinct

Existing utility services in the vicinity of the proposed works in Melbourne and Grey streets will be affected by the station and transition structure construction and will need to be diverted. Due to their susceptibility to damage during construction and the need to maintain uninterrupted supply, services should be diverted away from, and around the construction works during the early stages of Brisbane Metro wherever possible.

The approach to services relocations at this location is the diversion and relocation of numerous services that cross the station structure/tunnel between the two sides of road. Non-gravity dependent services will cross the tunnel in the roof space by embedding the services in the roof structure, whilst gravity dependent services will cross the tunnel at locations where the base slab of the station/transition structure is at a suitable elevation. The potential construction challenges are:

- Services works will be undertaken during the early stages of Brisbane Metro. It is important that non-gravity dependent services are installed at the correct elevation and levels, complete with conduits or envelopers and protective membranes, so that subsequent structural roof construction can encase the services. This will minimise future disturbance to the live services caused by the subsequent structural construction activities.
- Propping of unsupported crossing services will be required during structural construction, when the ground is excavated.
- The embedment of electrical services in the station roof structure (particularly high voltage cables) may require measures to mitigate adverse effects of induction. This may include bonding or cathodic protection.
- Future waterproofing of the station structure at services penetration locations.

The following summarises the key service conflict works around the Cultural Centre precinct in the central section of the metro alignment, and proposed mitigation strategies:

- 110kV – The deep excavation associated with the station will sever the existing 110kV cable in Melbourne Street. Diversion of the 110kV around the northern side of the station/tunnel structure is required.
- 675 millimetre gravity sewer and 450 millimetre sewer leading to the existing pump station in Grey Street. Deep excavation associated with the station will sever both the
gravity and pumped sewers. The 675 millimetre and 450 millimetre sewer connection to the existing pump station will require a new grit chamber located to the south of the station and a connection to the existing pump station to the north. Additionally, in Melbourne Street the 225 millimetre and 100 millimetre diameter rising mains downstream of the pump sewer line, will also be severed and must be diverted.

- Sewer 525 millimetre diameter gravity line in Grey Street crossing Melbourne Street. The 525 millimetre gravity main will be intercepted by the station box, and will have to be diverted to a new pump station located adjacent to the Queensland Museum. The 525 millimetre pump bypass sewer line is proposed to be diverted to east of the station and through the transition structure base slab to maintain a gravity flow regime along Grey Street to a new pump station to the north of the station. The pump station will need to provide for an emergency overflow in the event of a pump failure.

- Stormwater – The station structure and associated deep excavation will sever the existing 1350 millimetre and 1650 millimetre diameter stormwater drains in Melbourne Street. Diversion of the drains around the northern side of the station/tunnel structure is required. At the constrained section approximately located at Ch15540 the drain will be combined, however the convergence and divergence of the two main drain pipes may be difficult and will require substantial stormwater chambers.

The wide station/tunnel footprint will result in narrow residual widths in the remaining road reserve and will require diverted services to be installed in a shared trench arrangement. The potential construction challenges for the shared trench design are:

- the clearance between the diverted services and existing 110kV alignments
- the constrained trench width to the north side of Melbourne Street at Ch15540
- the constrained trench width adjacent to the retaining structures and within the QPAC forecourt.

9.8.10.2 Victoria Bridge

No service relocations are proposed in Victoria Bridge; however given the reconstruction of the back-span at Little Stanley Street and the widening at North Quay, awareness of the major services will be important. Key services include:

- 110kV electrical
- 11kV electrical
- 225 millimetre pumped sewer main
- significant communications conduits.

9.8.10.3 North Quay

A number of key services conflict with the works around the North Quay and Adelaide Street intersection:

- Crossing the alignment at the North Quay and Adelaide Street intersection are a group of four significant underground electrical cable groups, three optical fibre cables, 225 millimetre and 150 millimetre diameter sewers, 300 millimetre diameter water main and three groups of underground communication conduits.
- In the new north-western footpath of Adelaide Street between North Quay and George Street are ten underground electrical conduits, seven underground communication conduits and one underground communication conduit.
9.8.10.4 Adelaide Street tunnel and junction with Albert Street tunnel

A number of key services conflict with the works around the North Quay and Adelaide Street intersection:

- All existing Adelaide Street longitudinal services currently cross the existing busway at Albert Street through the roof structures of either the busway or the smoke vent voids. These services are currently embedded in the existing structure.

- Across the Adelaide Street portal at George Street, two significant underground electrical cable groups and 30 optical fibre cables are present. An optical fibre cable crosses the proposed Adelaide Street tunnel between George Street and Albert Street. Eleven optical fibre cables cross Adelaide Street at the proposed King George Square portal, as well as a 225 millimetre diameter water main, 90 millimetre diameter gas main, and 110 millimetre diameter gas main.

- Along the north-western footpath are diverted 225 millimetre diameter sewers, diverted 300 millimetre diameter water main, stormwater drain, and 14 electrical conduits.

- Along the south-eastern footpath are diverted 225 millimetre diameter sewers, diverted 150 millimetre diameter water main, stormwater drain, 6 electrical conduits, and 110 millimetre diameter gas main.

- Along the western side of Adelaide Street at the proposed junction with the Albert Street tunnel is a group of five underground electrical lines, and one optical fibre cable. These services are currently encased in a slab which intersects with the Albert Street tunnel.

9.8.11 Traffic Management

For stations and locations where minor platform extensions and modifications are required, no significant construction issues are anticipated, however public exclusion provisions and busway traffic management will be required for the station platform extension works. These stations include Eight Mile Plains, Griffith University, Griffith University layover, Upper Mount Gravatt, Woolloongabba turnaround, Upper Mount Gravatt, Mater Hill, Normanby, Ernie’s roundabout, Boggo Road and UQ Lakes.

At Upper Mount Gravatt, modifications to the retaining walls will require traffic management of the local roads into and around Garden City Shopping Centre and pedestrians to be redirected around the site.

At Buranda, public exclusion provisions and busway traffic management will be required for the station platform extension works. Traffic management will also be required on O’Keefe Street due to the proximity to the site. Removal and reinstatement of the existing public plaza bridge/structure will require traffic management of O'Keefe Street and pedestrians to be redirected around the site.

At Mater Hill, modifications to the ramps and stairs will require pedestrians to be redirected around the site or managed through the site.

The Normanby, South Brisbane, and Cultural Centre stations are adjacent to the railway corridor, therefore appropriate safety considerations and methods will have to be incorporated within the constructor’s safe work method statements.
9.9 Fire and Life Safety

Consideration has been given to the identification and preliminary sizing of fire and life safety elements to the new metro infrastructure. A summary of provisions made is detailed in the sections below.

9.9.1 Cultural Centre underground metro station

Provisions made in the concept design include:

- Fire separation of metro carriageway and platforms
- Separated smoke extraction ducting to the metro carriageway in the station and the platform areas
- Smoke extraction fans and exhaust ducting to Melbourne Street portal
- Jet fans in the BCEC tunnel section
- Fire isolated corridors to each side of the transition structure from the underground station towards Victoria Bridge.

9.9.2 Adelaide Street tunnel

Provisions made in the concept design include:

- Jet fans in the Adelaide Street tunnel section near the Albert Street tunnel junction.
- Fire isolated corridor along the tunnel with egress to North Quay near the George Street portal. Egress to King George Square for two-thirds of the tunnel length near the Albert Street tunnel junction and egress to the Adelaide Street portal for the remaining third of the tunnel length.

9.9.3 Existing Busway infrastructure

A review of the Fire and Life Safety aspects of the existing infrastructure elements that form part of Brisbane Metro has also been undertaken and a risk rating completed to indicate which elements of Brisbane Metro may be subject to review and challenge during the fire and life safety approvals processes.

The main risk associated with the use of the existing infrastructure elements relates to the increase in busway vehicle occupancy numbers under the metro system and hence emergency egress requirements are greater than those considered when the busway infrastructure was first constructed. For sections with reasonably long tunnels there is a risk that egress and ventilation provisions may not be considered adequate with increased vehicle occupant numbers and details of the new metro vehicle.

Details of the vehicle selected for the use on the metro system could also impact on the assessment of fire and life safety provisions for both new infrastructure elements and existing infrastructure elements. As the metro vehicles are larger vehicles than any bus currently operating on the busway system the fire loading is potentially greater. Selection of fit out materials could exacerbate this as well as the fuel type to be used for the metro vehicles.

It is noted that provisions for older busway infrastructure do not align with more recent busway projects (e.g. egress passages and exit spacing). Some of the more recent busway projects have included deluge systems and fire isolated escape corridors.

A medium level risk level has been assigned to other existing project elements as follows:
- Mount Gravatt station with potential for addition of a fire isolated emergency egress to the longer northern tunnel section.
- Buranda station with potential for addition of a fire isolated emergency egress and deluge system to adjoining northern tunnel section.
- Existing busway section between South Bank station and Cultural Centre station with potential for addition of deluge system and jet fans to the short section under the BCEC connection link and potential egress concerns on narrow corridor sections.
- King George Square station and Queen Street bus station which have linked fire response systems which may be affected by the new Adelaide Street tunnel.
- Roma Street station with potential for addition of extra egress requirements.
- Existing busway tunnels at Victoria Park with potential egress tunnel augmentation.
- RBWH station with potential extra egress requirements.
- Boggo Road to Dutton Park station tunnel with potential concerns around current egress and ventilation provisions.

Appropriate design and/or operational provisions and mitigations to address these risks, will need to be developed during further design stages in consultation with stakeholders.

### 9.10 Metro Vehicles

Metro vehicles have the capacity to carry up to 150 customers (depending on passenger density) and are approximately 24 metres in length. They have two articulation points which facilitate smaller turning circles and reduced swept path vehicle movement. Metro vehicles involve an additional axle compared to an 18 metre articulated vehicle and will have four passenger doors along the left side of the vehicle.

Due to the extended length, metro vehicles tend to be used on high-frequency core routes rather than conventional bus routes.

At this stage of development of Brisbane Metro, the actual vehicle type has not been selected, to avoid precluding future suppliers and delivery methods. In order to develop the concept design, a reference vehicle has been used. The dimensions of the reference vehicles are shown in Table 9.3.

<table>
<thead>
<tr>
<th>ITEM</th>
<th>ASSUMED REFERENCE VEHICLE DIMENSIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum vehicle length</td>
<td>24 metres</td>
</tr>
<tr>
<td>Maximum vehicle width</td>
<td>2.55 metres</td>
</tr>
<tr>
<td>Maximum height of the vehicle</td>
<td>3.5 metres</td>
</tr>
<tr>
<td>Boarding height</td>
<td>0.33 metres</td>
</tr>
<tr>
<td>Platform kerb height</td>
<td>0.15 metres minimum (to match existing)</td>
</tr>
<tr>
<td></td>
<td>Note: This assumes that any DDA compliance issues are resolved.</td>
</tr>
<tr>
<td>Minimum clearance height</td>
<td>Not less than 4.5 metres</td>
</tr>
<tr>
<td>Vehicle will have multiple doors at front, centre and rear of the vehicles.</td>
<td>4 access doors with accessibility provision</td>
</tr>
<tr>
<td>Tyres</td>
<td>12 tyres, in single and dual tyre configuration.</td>
</tr>
<tr>
<td>Axles</td>
<td>4</td>
</tr>
</tbody>
</table>

*Table 9.3 – Brisbane Metro reference vehicle dimensions*
9.11 Services and Systems

9.11.1 Existing Systems

The existing systems on the busway were installed approximately 10 years ago and include:

- Real-time passenger information and passenger information displays at all busway stations. This provides customers with up to date bus route timetable information and 'next arrival' information
- 24 hour security:
  - Monitored CCTV security cameras are located throughout the busway stations and along the entire busway, and are monitored 24 hours a day, seven days a week, by the Busway Operations Centre (BOC)
  - Lighting systems with true white light colour system to allow for true colour rendition and improved facial recognition for the CCTV recording system
  - All busway station platforms have Emergency Help Telephone (EHT) at key locations to assist customers in the event of an incident.
  - This emergency phone is responded to by the BOC and is linked to the CCTV security system to observe and record the emergency help telephone location
  - Incident management response to incidents on the busway or the busway stations is by trained TransLink Busway Safety Officers who are available to respond 24 hours a day, seven days a week
- Station and vehicle communications:
  - All busway buses are in contact with the BOC by a dedicated and secure UHF radio system.
  - All busway stations have a public address system managed by the BOC.
  - Buses are currently equipped with on-board CCTV and recording systems for driver and passenger security.

For Brisbane Metro, it is envisaged that these systems are to remain functional and are supplemented by the proposed Passenger and Vehicle Management System, as discussed in Section 9.11.3 below.

9.11.2 Busway Operations Centre

The BOC is the traffic control and management centre for the operations of the Brisbane busway network. It is integrated with the Brisbane Metropolitan Transport Management Centre (BMTMC), and located at Brisbane Square in the CBD. It is manned by trained busway operations staff, 24 hours a day, seven days a week and its primary function is to manage and monitor busway operations, including stations, and to respond to any incidents that might occur on the busway network. It is envisaged that the BOC will manage the busway and be augmented to accommodate the proposed Passenger and Vehicle Management System.

9.11.3 Passenger and Vehicle Management System

Vehicle management systems include a variety of advanced technologies to collect, process and disseminate real-time data from vehicle and roadway sensors. The data is transmitted via a dedicated communications network and computing intelligence is used to transform this data into useful information for the bus operator, transport agency, driver and ultimately the customer. Various technologies combine to form distinct types of passenger and vehicle management systems. For example, automatic vehicle location in combination with
automated scheduling and dispatch and traffic signal priority can improve schedule adherence, resulting in better service reliability as well as faster speeds.

There are a range of considerations for a passenger and vehicle management system to support the operations of Brisbane Metro. This is further discussed in Chapter 6.

9.12 Brisbane Metro Delivery Program

A preliminary delivery schedule for the Brisbane Metro has been developed to understand the timeframes associated with each phase of delivery, and to inform the cost analysis (presented in Chapter 11).

Table 9.4 summarises the key delivery milestones for Brisbane Metro. It should be noted that these timeframes are subject to Queensland Government approvals.

<table>
<thead>
<tr>
<th>MILESTONE</th>
<th>INDICATIVE DURATION</th>
<th>INDICATIVE COMPLETION DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment Decision and Procurement</td>
<td>22 months</td>
<td>June 2019</td>
</tr>
<tr>
<td>Site Investigations</td>
<td>5 months</td>
<td>November 2018</td>
</tr>
<tr>
<td>Planning and Approvals</td>
<td>10 months</td>
<td>May 2019</td>
</tr>
<tr>
<td>Early Works</td>
<td>7 months</td>
<td>June 2020</td>
</tr>
<tr>
<td>Main Works</td>
<td>30 months</td>
<td>November 2022</td>
</tr>
<tr>
<td>Commissioning and Completion Works</td>
<td>4 months</td>
<td>December 2022</td>
</tr>
</tbody>
</table>

Table 9.4 – Indicative Brisbane Metro Delivery Schedule

The delivery schedule will undergo further development to inform packaging and delivery model analysis and implementation planning.

9.13 Environmental impact assessment process

A detailed environmental assessment will be undertaken in future phases of development of Brisbane Metro. This assessment would address the full range of environmental matters and include further detailed review of existing information, as well as field studies to gather additional information on existing values to determine any major impacts or legislative triggers.

This voluntary environmental assessment could take the form of a Concept Design and Impact Management Plan (CDIMP). The CDIMP provides a breakdown of the project’s anticipated benefits and impacts, including typical mitigations for potential impacts that will be addressed in future detailed design and construction phases.

CDIMPs have previously been conducted for major transport infrastructure including Gold Coast Light Rail.

9.14 Constructability and Delivery Program Peer Review Outcomes

A peer review of the constructability of the concept design and the delivery program for Brisbane Metro was also completed by a suitability experienced and independent advisory firm. A peer review of the Brisbane Metro cost estimate was also in scope, the findings of which are presented in Chapter 11.

---

2 Timings are subject to approvals.
9.14.1 Constructability Peer Review

The proposed construction methodology for the South Brisbane rail underpass, the Cultural Centre underground metro station and Adelaide Street Tunnel were considered adequate for the business case, as it demonstrated solutions for constructability, program and interface related challenges. It was noted that construction contractors would likely develop alternative solutions that could enhance the current business case design during procurement and detailed design for Brisbane Metro.

9.14.2 Delivery Program Peer Review

The proposed delivery program, covering activities from completion of the business case to Practical Completion of construction activities was reviewed. The overall duration proposed for completion in December 2022 was considered achievable, but is subject to Queensland Government approvals.

It was noted that the proposed concept design is presently based on a range of planned road and busway closures. These planned closures, including alternative arrangements where applicable, were considered appropriate for the business case. The planned closures as well as consideration of other options/alternative arrangements to better manage the road and busway user experience, whilst providing adequate access to efficiently deliver Brisbane Metro were noted as key issues to be fully explored with all key stakeholders during further design development.

9.15 Summary and Next Steps

There are a number of key elements of the concept design for Brisbane Metro, including:

- Utilising 21 kilometres of the existing busway for a high-frequency transport system, linking Eight Mile Plains busway station (on the South East Busway) to RBWH busway station (on the Inner Northern Busway) and UQ Lakes busway station (on the Eastern Busway) to the Buranda busway station.
- Constructing a new underground metro station at Cultural Centre with a new portal to Victoria Bridge.
- Removal and rebuilding the existing surface Cultural Centre station to make space for the transition structure that joins the underground station to Victoria Bridge.
- Augmenting existing busway stations at Eight Mile Plains, Upper Mount Gravatt, Griffith University, Holland Park West, Greenslopes, Buranda, Mater Hill, South Bank, King George Square, Roma Street, Normanby, QUT Kelvin Grove, Herston, RBWH, PA Hospital, Boggo Road and UQ Lakes to accommodate metro services.
- Converting Victoria Bridge to a ‘green bridge’ for metro, bus services, pedestrians and cyclists, including widening the existing downstream pedestrian path by 1.2 metres to further facilitate pedestrian movement across the bridge.
- Re-purposing North Quay to allow for a direct link for bus and metro services between Victoria Bridge and Adelaide Street/Adelaide Street tunnel.
- Building a new portal and tunnel at Adelaide Street to connect to the existing Albert Street busway tunnel.
- Augmenting existing turnarounds and layover facilities to support the operational requirements of the metro vehicles.
- Constructing a new metro depot, including a 15 bay maintenance garage, a fuelling, wash down and cleaning facility, and administration facilities.
- Provision of metro vehicles.
- Implementation of a new passenger and vehicle management system that will enable effective management of metro and other bus operations along the busway.

Constructability issues identified at this stage of the infrastructure design include the construction of the new tunnel next to the BCEC and under the South Brisbane rail underpass, the proximity of the new underground Cultural Centre station to existing utility services and the transition structure from the station to Victoria Bridge, and the construction of the portal and tunnel in Adelaide Street.

Based on a preliminary delivery program, the main construction works for Brisbane Metro are expected to take approximately 30 months, with commissioning and completion works in December 2022, subject to Queensland Government approvals.

Further design development is required in the subsequent project development phases following acquisition of coordinated survey, more detailed geotechnical information and engagement with key stakeholders.

A CDIMP will be undertaken in future phases of development of Brisbane Metro, which will address the full range of environmental matters and include further detailed review of existing information, as well as field studies to gather additional information on existing values to determine any major impacts or legislative triggers.

A peer review was undertaken on the Brisbane Metro design constructability and delivery program. The proposed construction methodology for the South Brisbane rail underpass, the Cultural Centre underground metro station and Adelaide Street Tunnel were considered adequate for the business case, as it demonstrated solutions for constructability, program and interface related challenges. The overall delivery program, proposed for completion in December 2022, was also considered achievable at this stage, but is subject to Queensland Government approvals.