CHAPTER FIVE

REFERENCE PROJECT

CHAPTER 5
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CHAPTER SUMMARY AND CONCLUSIONS:

- The key components of the CRR Reference Project include:
  - 10.2km link including 5.9km of twin running tunnels from Dutton Park in the south to Bowen Hills in the north
  - northern surface works consisting of a new track from the portal around the Exhibition Loop and through Mayne Yard
  - underground stations at Boggo Road, Woolloongabba, Albert Street and Roma Street
  - upgraded Dutton Park and Exhibition stations
  - provision for additional stabling at Mayne Yard (North)
  - provision of European Train Control System - Level 2 (ETCS L2) through the tunnel and northern surface connection
  - enabling works including ETCS L2 signalling from Dutton Park to Salisbury and southern platform faces for stations from Salisbury to Fairfield.
- The CRR Project alignment reduces the length of the corridor proposed by the CRR Project 2011 and significantly reduces private property impacts.

5.1 Purpose and Overview of this Chapter

The purpose of this chapter is to provide a detailed technical description of what the project will and will not include (scope of the Reference Project). The Reference Project is used as the base for the project analysis and is subject to minor changes as the project is further developed and procured.

5.2 Scope of the Reference Project

The key components of the Reference Project are as follows:

- 10.2km link including 5.9km of twin running tunnels from Dutton Park in the south to Bowen Hills in the north
- underground stations at Boggo Road, Woolloongabba, Albert Street and Roma Street
- northern surface works consisting of a new track from the portal around the Exhibition Loop and through Mayne Yard to the Breakfast Creek bridges
- upgrade of Dutton Park and Exhibition stations
- provision for additional stabling at Mayne Yard (North) and ETCS L2 through the tunnel and northern surface connection.

In addition to the scope of works listed above, the CRR Project will also require some future associated investment to realise the full project benefits by 2036. This includes some station and signalling works at Northgate and Wooloowin.

While not required for day one of operations the future acquisition of additional rollingstock will also be required to support the enhanced level of service facilitated by the CRR Project.

The CRR Project study corridor is located in the Brisbane LGA within SEQ. It is approximately 19km long, extending from Salisbury in the south, via Woolloongabba and Brisbane's CBD to Wooloowin in the north.

The study corridor in the south generally follows the existing rail corridor from Salisbury and includes the existing train stations of Salisbury, Rocklea, Moorooka, Yeerongpilly, Yeronga, Fairfield and Dutton Park. Between Rocklea and Dutton Park, the study corridor widens towards the west to include Fairfield Road. The northern part of the study corridor generally follows the existing rail corridor from Boggo Road Urban Village, through the Woolloongabba priority development area (PDA), widening to include Brisbane's CBD and Spring Hill. The corridor then narrows to the existing Exhibition station at Bowen Hills continuing along the existing rail corridor past Mayne Yard and Bowen Hills, Albion and Wooloowin stations.

The Reference Project alignment includes a southern portal at Dutton Park, the southern CBD station located at Albert Street, the inclusion of Exhibition station and a connection to the North Coast line, south of Albion station.

The key enabling works for the proposed Reference Project include the following:

- Station upgrades will be undertaken between Salisbury and Fairfield (inclusive), with a third platform added to all stations. Where required, new or upgraded *Disability Discrimination Act 1992* (DDA) compliant pedestrian bridges will be provided for each station.
- ETCS L2 signalling will be installed on the down suburban line from Dutton Park to Salisbury. This will accommodate the portal arrangements of the tunnel and maintain the operational integrity of the network.

The key elements of the CRR Reference Project are discussed in the following sections.

5.2.1 Alignment

The Reference Project alignment ties into the existing above-ground Queensland Rail network near Dutton Park station in the south and Breakfast Creek Bridge in the north. The route is approximately 10.2km long and features new underground stations at Boggo Road, Woolloongabba, Albert Street and Roma Street, as shown in Figure 5.1. The existing Exhibition station will be upgraded and included on the CRR main line. Figure 5.2 depicts the alignment as a line diagram. The existing Dutton Park station will also be upgraded, with the addition of a third platform on the dual-gauge line.

Approximately 5.9km of the route is tunnelled, starting at the Boggo Road precinct in the south and surfacing between Roma Street station and Exhibition station. Where possible, the alignment tunnel sections are wholly located in rock.

The remaining above-ground sections utilise the existing corridor where possible[41]. To avoid conflicts of mainline train movements, the Reference Project up lines and down lines diverge at Mayne Yard with the up line bypassing to the east and the down line proceeding through Mayne Yard.

[41] The corridor is owned by the Department of Transport and Main Roads and is being leased to Queensland Rail.

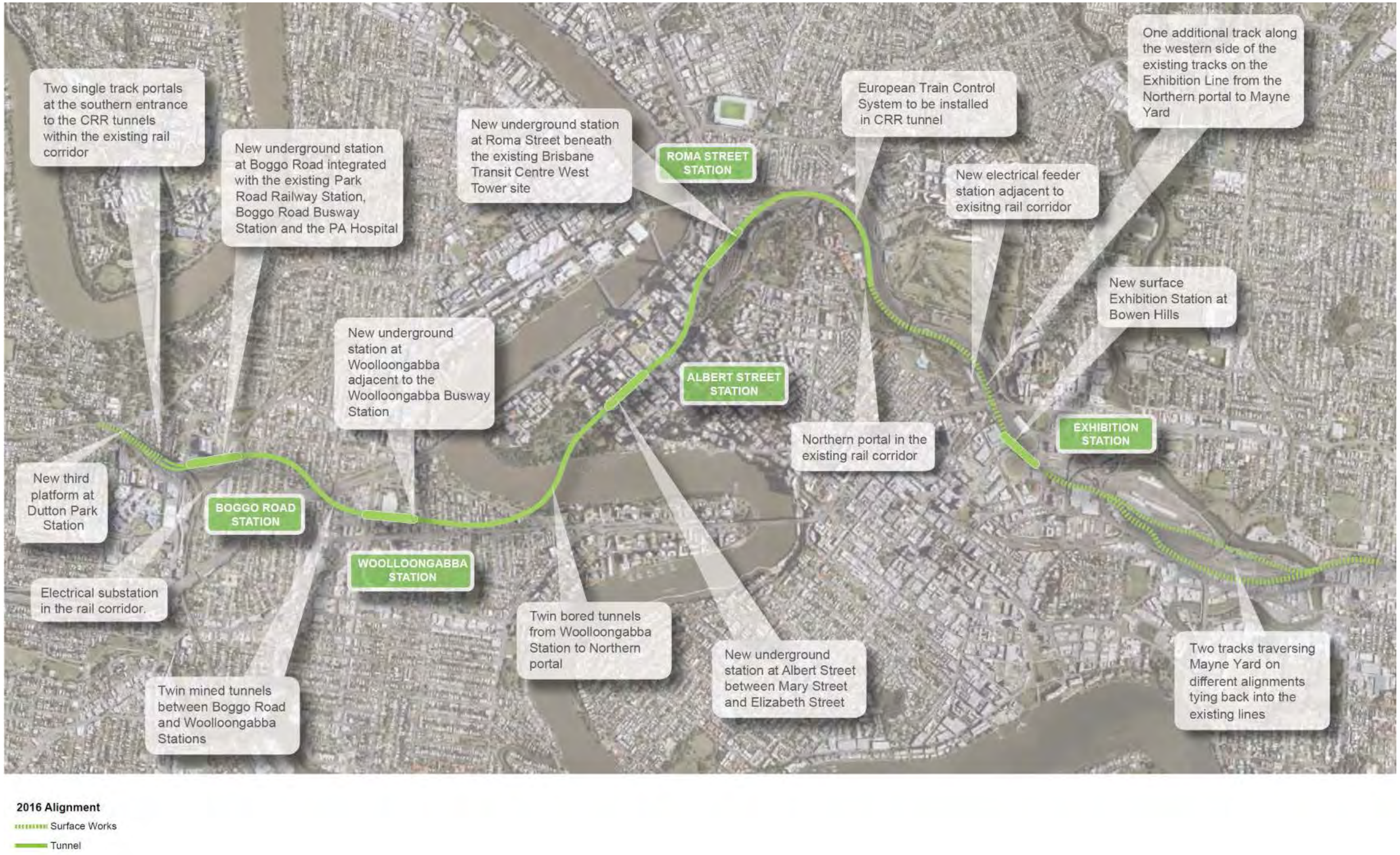

Figure 5.1: Reference Project Alignment

5.2.2 Track Configuration

The Reference Project includes two tracks passing under the city for the movement of trains from the north and south. Trains heading south from locations like Nambour and Caboolture will access the CRR lines just south of Albion station and pass through Mayne Yard and join the Exhibition line.

Realignment of the down main line and construction of a new stabling facility at Mayne Yard removes a key crossing conflict from the network, allowing effective connection of the project to the north.

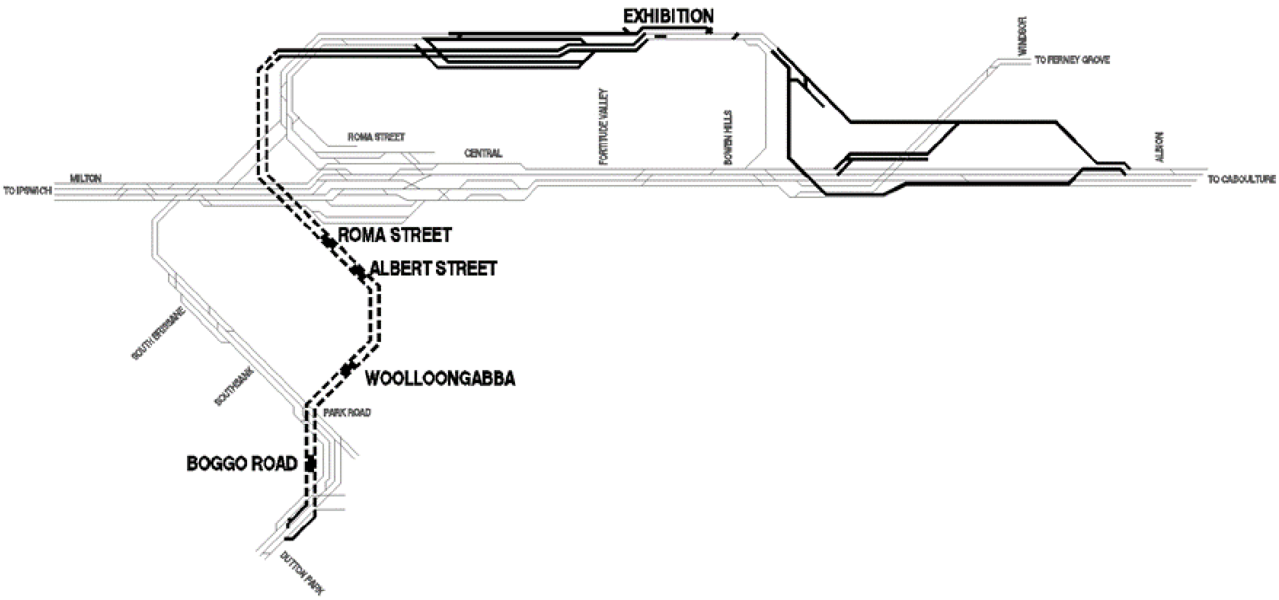

Figure 5.2: Reference Project Line Diagram

On the Exhibition line, three tracks are required between the CRR portal and Mayne Yard to facilitate the required operations. Two are CRR tracks, with the third required for non-passenger services moving between Mayne Yard and Roma Street, freight services and track maintenance vehicles.

CRR trains will enter the portal and resurface just north of Dutton Park. They will then either continue down as a service to Beenleigh–Gold Coast or end service at Clapham Yard.

Services from the south will come from Gold Coast and Beenleigh and enter the CRR portal at Dutton Park. Services in the afternoon contra peak will utilise the dual-gauge track. Stations from Salisbury to Dutton Park will require new platforms to allow passenger services to stop.

5.2.2.1 Technical Parameters

The Reference Project alignment has been developed to comply, where possible, with the Queensland Rail Civil Engineering Track Standard (CETS).

The vertical alignment of the Reference Project is depicted in Figure 5.3.

Figure 5.3: Vertical Alignment of the Reference Project

The following parameters have been adopted for the Reference Project:

- CRR tracks will be narrow gauge (1,067mm).
- Track will be electrified using 25KV alternating current overhead line equipment.
- The desired design speed is 80km/h, with an absolute minimum of 50km/h.
- The maximum compensated vertical grade is three per cent.
- The desired minimum horizontal radius is 400m. The absolute minimum horizontal radius is 212m to achieve a 50km/h design speed. The desired minimum horizontal radius of 400m has not been achieved at the following locations:
  - Between Dutton Park and Park Road station the alignment adopts a 212m radius to pass under existing tracks. The combination of curves and transitions achieves a 50km/h design speed. This radius is tighter than those adopted in the Bus and Train (BaT) Project alignment. However, it is necessary to ensure Boggo Road platforms are on tangent track and that the station can be constructed with minimal impact on above-ground infrastructure and residential properties.
  - Between Albert Street station and Roma Street station the tunnels have reverse curves with 300m minimum radius to minimise volumetric impacts. This provides a 60km/h design speed.
  - In the proximity of Exhibition station, the alignments adopt radii as low as 300m to match and tie in to the existing tracks, while remaining within the boundary of the CRR Project 2011.
  - Near and within Mayne Yard, the alignment adopts radii as low as 215m radius, which is similar to the existing tracks and can achieve 50km/h.
- Platforms are 220m long to accommodate future nine-car rollingstock.
- Tangent track through platforms and for 21m beyond the platform ends (where possible) to avoid throw issues relating to platform gauging and clearance.
- Platforms are designed on a constant gradient between platform ends. The preferred track gradient on underground sections is zero per cent (level track). This has been achieved on all stations except Boggo Road station and Exhibition station, which both have a gradient of 0.5 per cent. This gradient, of 0.5 per cent is permitted in accordance with the CETS.

5.2.2.2 Alignment at Stations

Where possible, all stations have been positioned on zero per cent grades (flat). These stations include Woolloongabba, Albert Street and Roma Street.

Boggo Road station is on a vertical grade of 0.5 per cent to achieve sufficient depth below Park Road station and to connect to the surface north of Dutton Park.

5.2.3 Tunnelling and Portals

5.2.3.1 Portals and Transitions

Southern Portal and Dive Structure

The tunnel portal is located between the existing Dutton Park station and the proposed Boggo Road station. It is constrained by the:

- connection to the existing lines before Dutton Park station
- clearance under the existing lines between the Dutton Park and Boggo Road stations
- need to avoid the existing Eastern Busway.

The preferred scheme for the southern portal and connecting structure with Boggo Road station is a cut-and-cover tunnel solution, as shown in Figure 5.4. The proposed solution consists of:

- two trough structures as the CRR tracks come to grade
- two single-track, cut-and-cover tunnels, where the dual-gauge and suburban tracks pass over the CRR tracks (these cut-and-cover structures connect to the station box).

The southern portal and dive structure are located approximately 300m north of the existing Dutton Park station. Between Dutton Park station and Boggo Road station the CRR tracks have a horizontal radius of 212m, which provides a design speed of 50km/h.

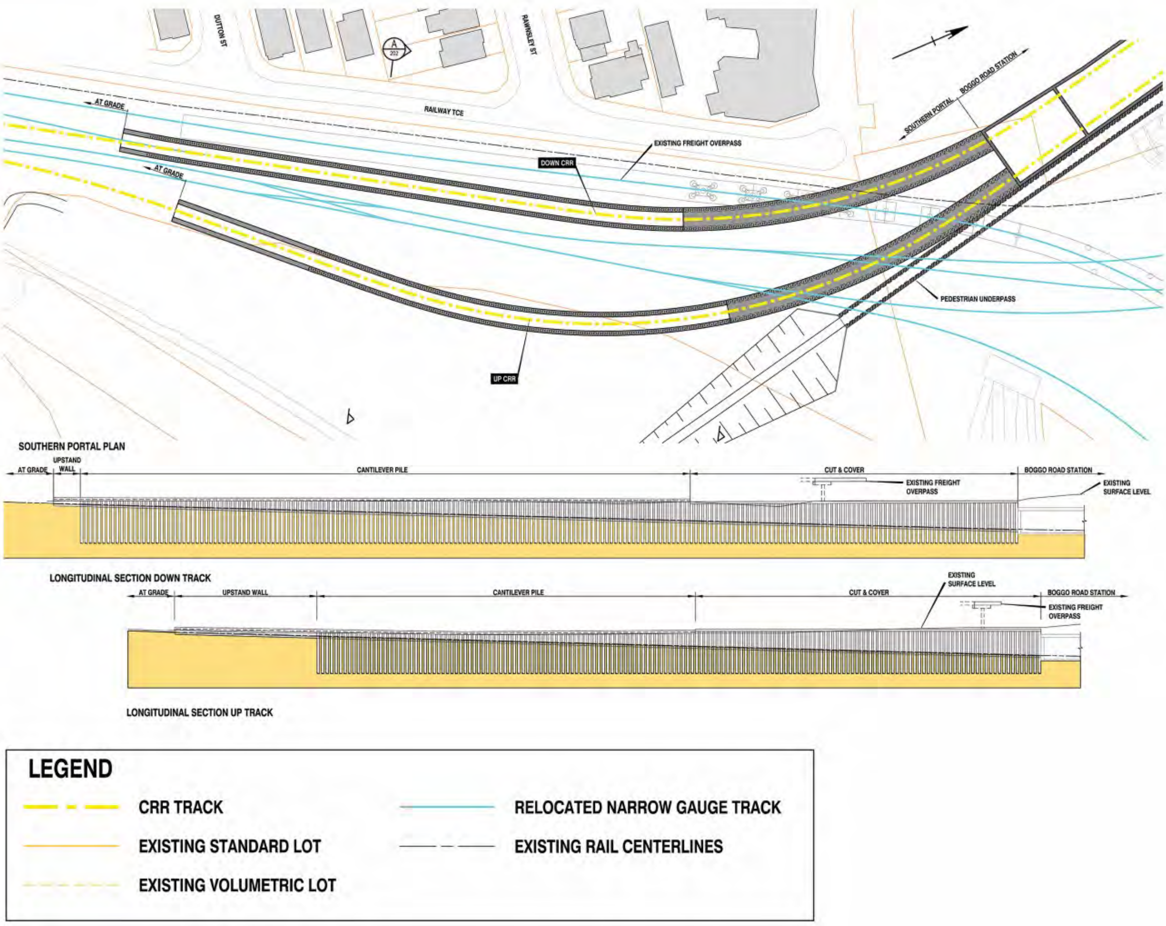

Figure 5.4: Southern Portal and Dive Structures

Northern Portal and Dive Structure

The 330m long northern portal and dive structure for CRR is located in the rail corridor adjacent to the Inner City Bypass, as shown in Figure 5.5. Both the CRR up lines and down lines will use the same portal structure. The vertical alignment returns to grade prior to (south of) the existing land bridge. The total length of the dive structure is approximately 180m.

The cut-and-cover section extends 150m, linking the daylight portal and the bored tunnel section. It is envisaged that the required lateral restraint for the piled walls will initially be provided by temporary anchors to allow full access from surface down into the trough for extraction, disassembly and removal of the tunnel boring machines (TBMs).

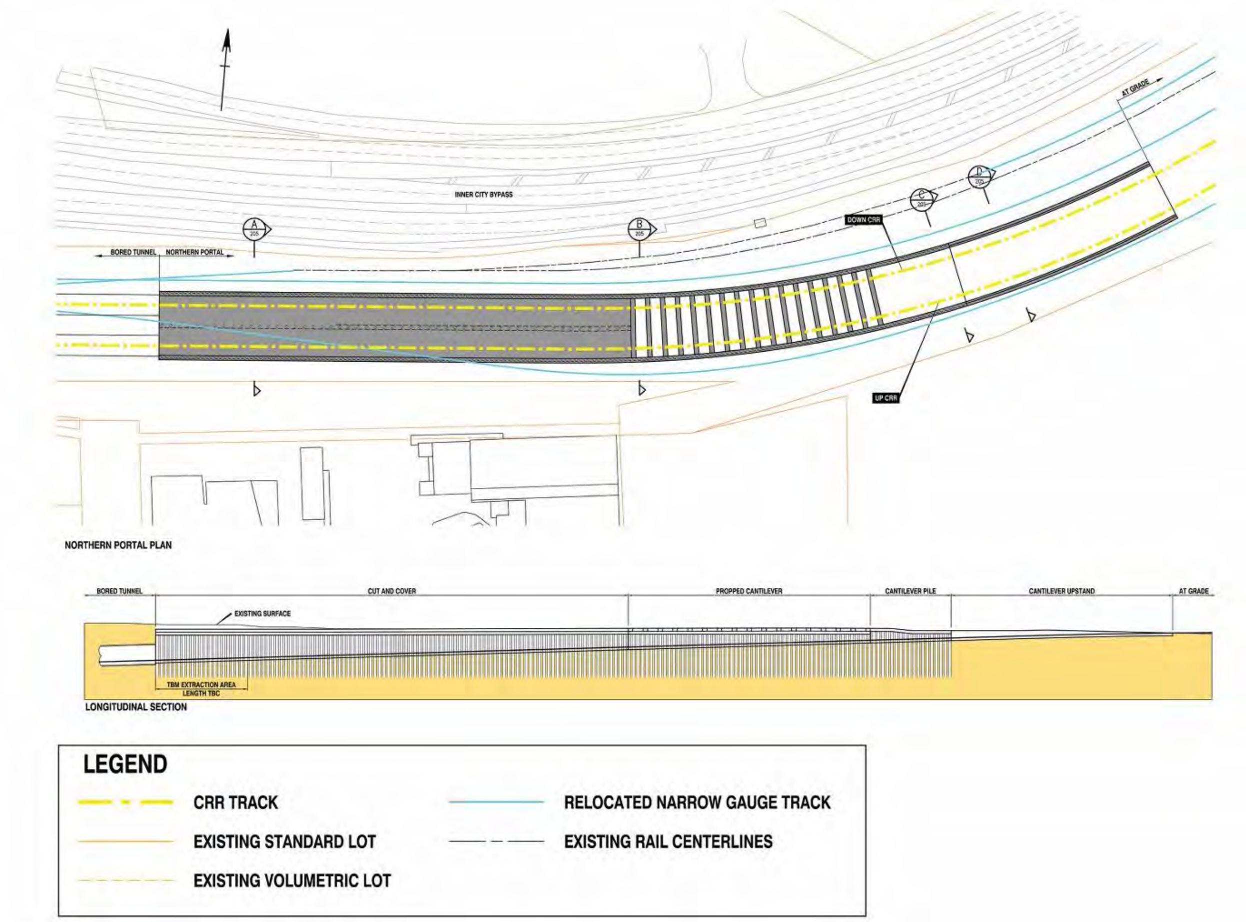

Figure 5.5: Northern Portal and Dive Structure

5.2.3.2 Tunnels

Mined Tunnel (Boggo Road to Woolloongabba)

The mainline tunnels are proposed to be constructed as twin single-track mined tunnels between Boggo Road station and Woolloongabba station, with an excavated width and height of approximately 5.7m and 6.2m respectively. The track separation for the two mined tunnels is 13.7m centre to centre.

Bored Tunnel (Woolloongabba to Northern Portal)

The mainline tunnels comprise twin bored tunnels with an internal diameter of 6.2m and a centre-to-centre separation of 13.7m, as shown in Figure 5.6. The permanent tunnel support is provided by a precast concrete segmental lining, with a typical thickness of 275mm.

The running tunnel for the train allows for a headroom clearance of 4.2m minimum from top of rail to contact rod. Also in the tunnel is a 700mm-high walkway level provided for emergency egress on one side and a maintenance walkway on the other. Tunnel services will be attached to the tunnel lining.

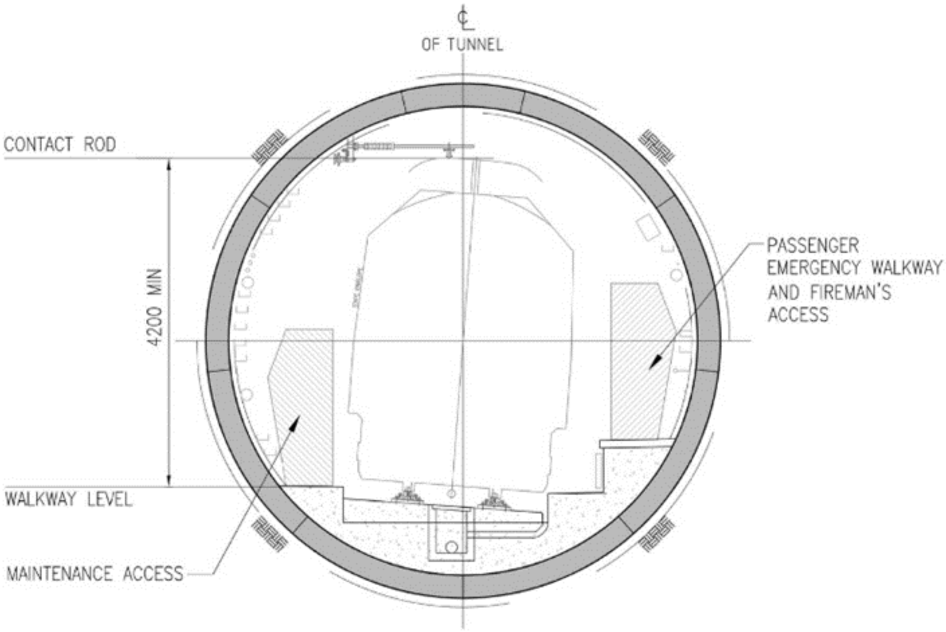

Figure 5.6: Bored Tunnel Cross-section

Caverns

The mined station caverns accommodate the platforms where they are longer than the cut-and-cover station box. Beyond each station cavern there is typically an oversized cavern to provide adequate space to receive or launch the TBMs. After tunnel construction, this space will be used to house emergency egress walkways, and mechanical and electrical equipment.

Cross Passages

From a fire safety perspective, cross passages have been provided at maximum 240m centres.

5.2.4 Stations

The underground stations for the Reference Project include Boggo Road, Woolloongabba, Albert Street and Roma Street stations. The Reference Project also includes the Exhibition station, which is at surface level and located in the vicinity of the existing Exhibition station. All stations have 220m platforms to accommodate nine-car trains to provide for additional future capacity. Refer to Chapter 6: Project Benefits for further detail on the new CRR stations and the outcomes that they provide.

Between the southern portal and Salisbury, the Reference Project includes upgrades to suburban stations to accommodate passenger services for both CRR and non-CRR services. This requires a third platform to be added on the dual-gauge tracks at Dutton Park, Fairfield, Yeronga, Yeerongpilly, Moorooka, Rocklea and Salisbury. At Yeerongpilly, additional track work is required due to the interaction with the Tennyson Loop. At Moorooka, the dual-gauge track is repositioned to allow stabling of CRR trains between the suburban tracks and dual-gauge tracks.

5.2.4.1 Station Design

A consistent approach to station layout has been adopted to improve cohesion and identity across the CRR Project while enhancing user experience, wayfinding and providing equitable access within stations. This has been achieved through reviewing the urban realm, land availability, passenger demand on vertical transport, constructability and relative cost.

The station entrances have been rationalised while ensuring entrances are in keeping with the subtropical environment and precinct planning.

5.2.4.2 Underground Station Layout

The context of each station entry point varies. Therefore, the functional layout varies, especially the location and level of the transition between paid and unpaid areas. As a result, methods of providing cohesion and identity across the underground station layouts have been considered.

This has influenced the development of a consistent underground station layout with a central station box that extends down to platform level and houses the vertical transport (or most thereof), emergency egress, maintenance access and ventilation risers. A minimum of 1,500m^2 floor area is provided for each station. Generic station configurations are described in Figure 5.7 and in Figure 5.8. Beyond each end of the station box, the platform continues in a mined cavern.

The use of platform screen doors (PSDs) is assumed in all underground stations. In keeping with modern standards for an underground urban railway, this offers the following benefits of:

- providing improved safety by separating passengers from trains
- enabling more effective air management in stations, giving an improved environment for passengers
- providing for separation of station and tunnel ventilations systems, simplifying fire and life safety (FLS) provisions.

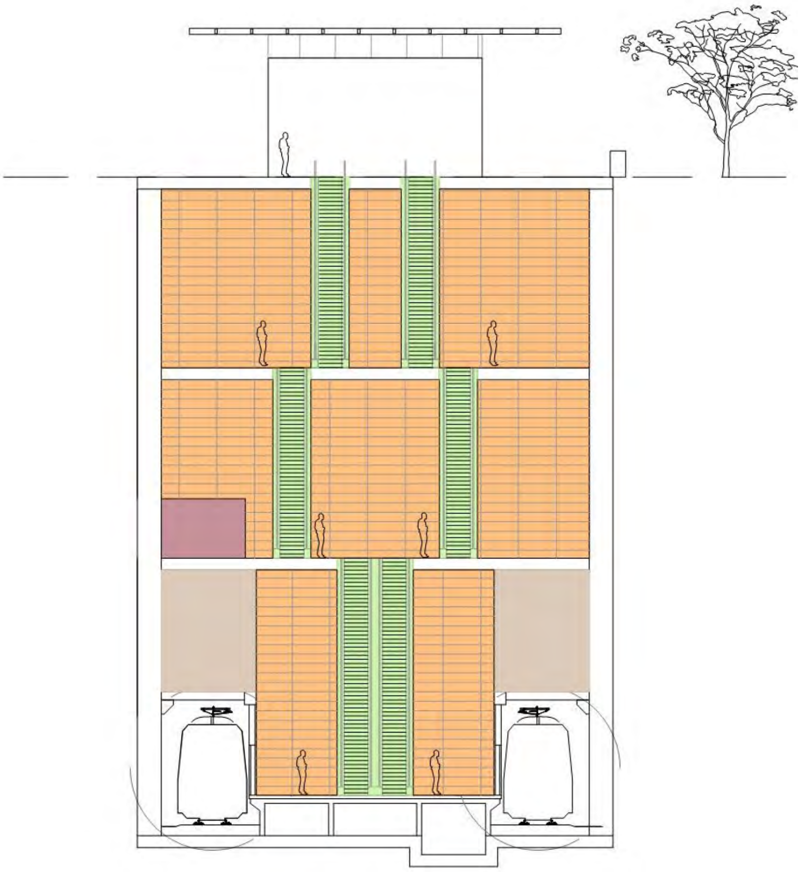

Figure 5.7: Cross-section of Generic Station Configuration

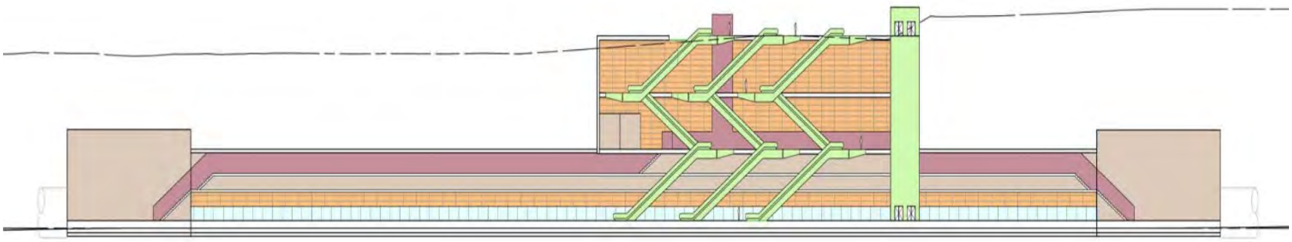

Figure 5.8: Long-section of Generic Station Configuration

Dutton Park Station

A new Dutton Park station dual-gauge platform has been positioned on the eastern side of the dual-gauge line to form a staggered island platform (with the existing platform). The existing inbound platform will need to be widened and a new 150m-long platform face added to cater for six-car trains. A new stair and DDA-compliant lift from the western side of the Annerley Road footpath will also be provided.

Boggo Road Station

The Boggo Road station will provide a new station in the Boggo Road–Princess Alexandra (PA) Hospital precinct, as shown in Figure 5.9. The station will be located adjacent to, and integrated with, the existing Park Road rail and Boggo Road busway stations. The station will perform a critical role in facilitating interchange between rail services and the rail network and busway system. This network junction is forecast to become the second busiest location for passenger interchange on the SEQ public transport network, after Roma Street station. The new Boggo Road station will support the further development of the Boggo Road Urban Village and surrounding precincts.

The Boggo Road station will be an underground station, with the station box primarily located on Lot 2 on Joe Baker Street, adjacent to the Ecosciences Precinct. This is currently a vacant, Queensland Government-owned site. The platform extends to the north of Lot 2, within a cut-and-cover section, under the Eastern Busway.

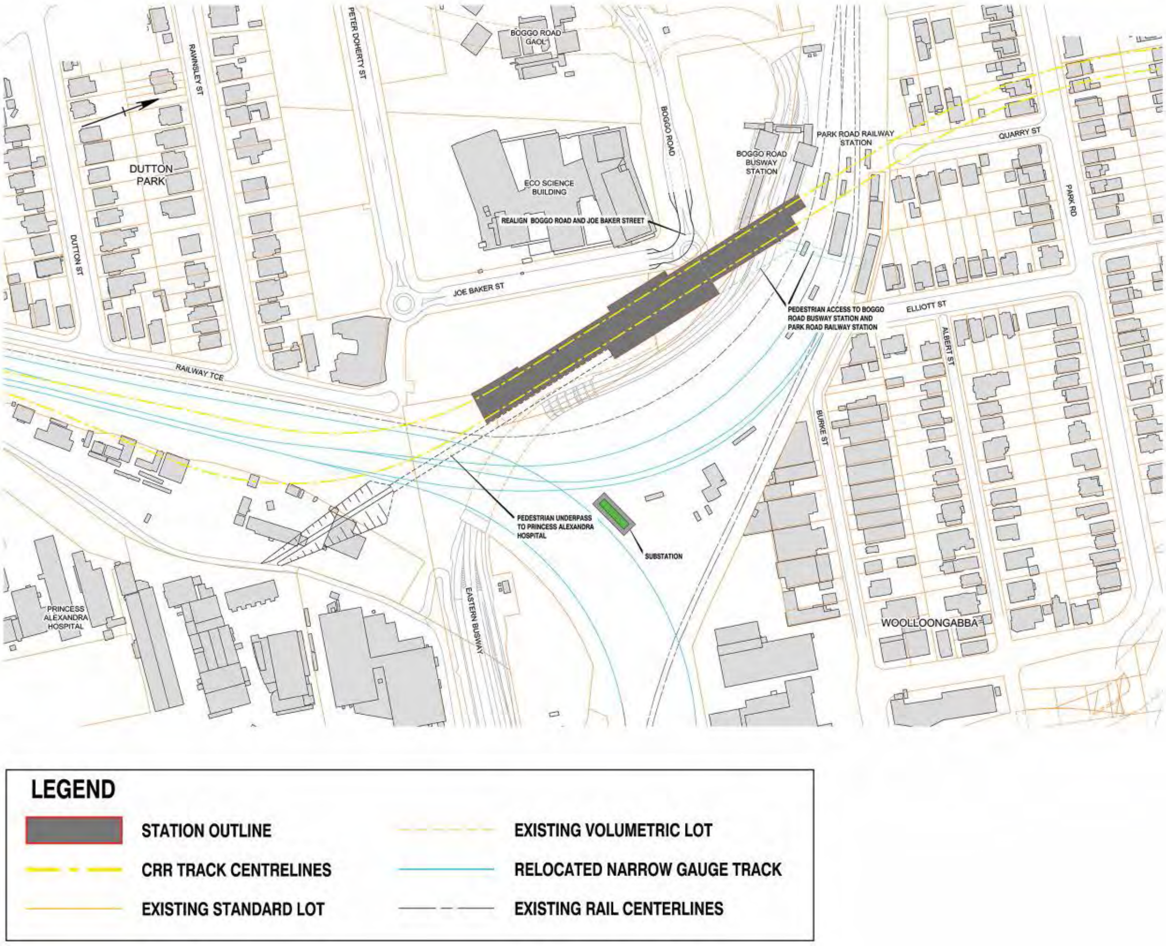

Figure 5.9: Boggo Road Station

The platform is approximately 19m below ground level. This is required to ensure there is adequate cover to the existing tracks that the tunnels to the south pass beneath.

Access for pedestrians to the site is quite constrained due to the existing busway and surface rail and variation in ground levels. In order to provide the required connectivity to the surrounding origin and destination points, the following is proposed:

- The station entrance will be located at the eastern end of the Boggo Road precinct.
- A pedestrian bridge will link the main entrance with the Boggo Road busway station and Park Road station.
- A DDA-compliant pedestrian underpass will link the station concourse level with the PA Hospital.

The island platform is slightly staggered to minimise construction impacts to Park Road station and the adjacent dual-gauge track.

Woolloongabba Station

The Woolloongabba station is located within the designated Woolloongabba PDA to support planned urban growth in that location, as shown in Figure 5.10. The station will provide passenger rail access to the Woolloongabba PDA, the Brisbane Cricket Ground (The Gabba) and offer interchange opportunities with the busway system.

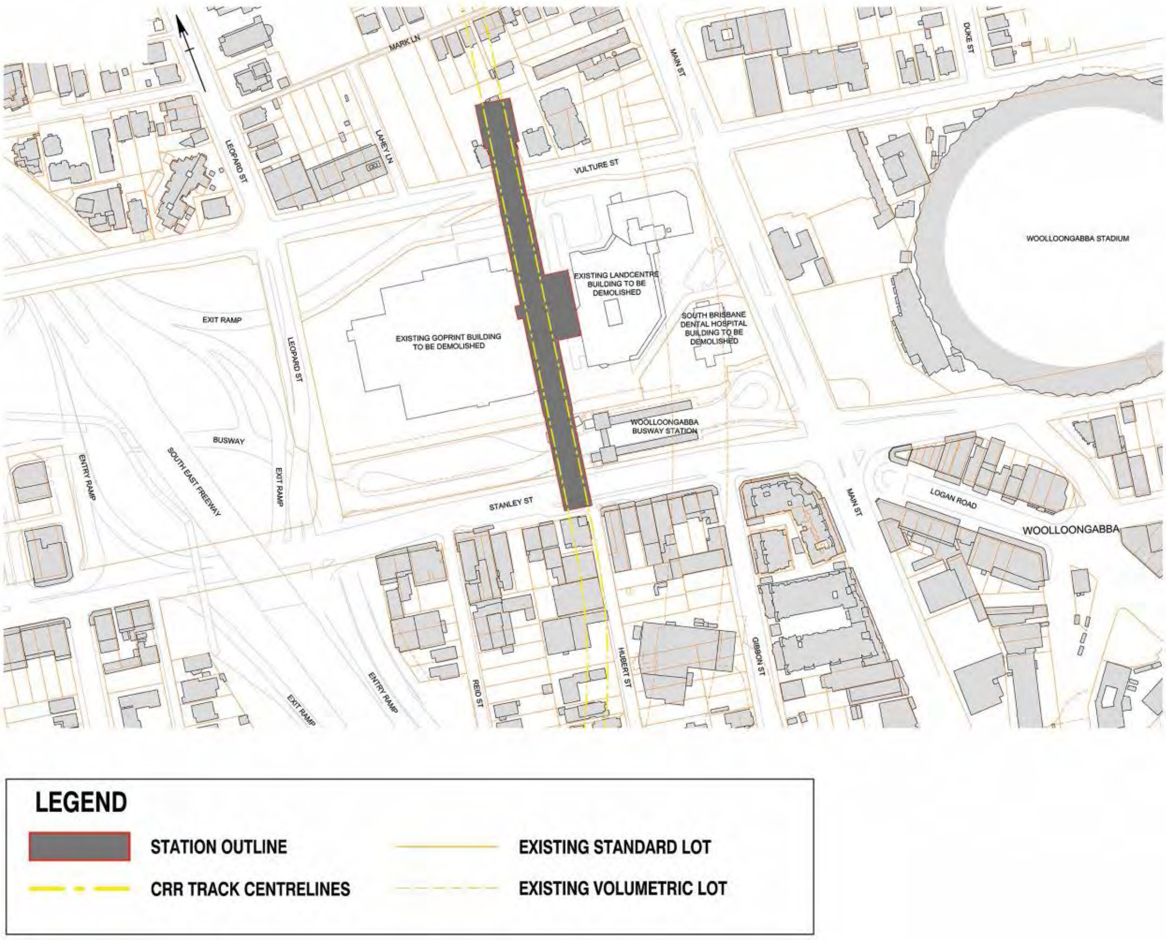

Figure 5.10: Woolloongabba Station

The proposed station is positioned at the eastern side of the Queensland Government-owned Goprint site, which is similar to the BaT Project. This will require the resumption and demolition of the Goprint building and resumption and demolition of the Landcentre building and dental clinic.

The position of Woolloongabba station is heavily influenced by the rail alignment from Boggo Road. The location also allows for better rock cover further along the alignment at the river. Also, the proposed station location provides better connectivity with the busway station, as well as being closer to The Gabba. Northern and southern entrances will be provided.

This site accommodates the central station box. Since there is ground-level entrance and connectivity, there is no perceived benefit in a below-ground level concourse. The platform will be approximately 27m below ground level. The escalator layout has achieved a single landing level between ground and platform level.

Albert Street Station

Albert Street station will be the most centrally located rail station in the Brisbane CBD. It will be critical in enabling passengers to access the city centre, particularly areas currently not well served by rail. The station will significantly improve access to existing areas of employment, recreation, parklands and the Queensland University of Technology campus at Gardens Point. It will be integrated with ongoing development to revitalise the southern sections of the CBD. It will also support BCC's vision for Albert Street as a green spine connecting Roma Street Parklands to the City Botanic Gardens. BCC plans to reduce the street's road traffic function in favour of pedestrian uses over time.

Figure 5.11: Albert Street Station

The proposed station is located under Albert Street, extending from Margaret to Elizabeth Streets, as shown in Figure 5.11. The new station will require the resumption and demolition of properties located north of the intersection with Mary Street, on either side of Albert Street. The sites accommodate a section of the central station box, with one offline ground-level entrance. Three additional in-line ground-level entrances (along Albert Street) connect through a high-level concourse.

The platform will be approximately 31m below ground level, requiring four levels of escalators. This results in three below-ground levels before platform level that have the escalator landings.

With the proposed station layout, either the existing Myer Centre car park exit ramp to Albert Street is permanently closed or a relocation and right turnout extension of the existing Myer Centre car park exit ramp to Charlotte Street is potentially required.

Flooding at Albert Street

Flood protection at Albert Street station requires particular consideration. The Brisbane floods of January 2011 saw Albert Street inundated to a depth of around half a metre. In the context of the CRR Project, this would be considered a Type B intermediate flood event with mitigations articulated below.

The northern station entrance is separated from the Myer Centre car park exit ramp, which provides fire isolation and improved flood resilience. Ventilation outlets and the like will need to extend above the Q10,000 design flood level, consistent with flood mitigation standards for other major infrastructure projects.

Flood immunity is a critical design requirement for Albert Street station and the design solutions are integrated with BCC'S green spine vision. Having smaller entrance structures enables discrete flood protection measures that can be easily and quickly deployed. There are three levels of flood protection, depending on the flood event, which are discussed below.

Type A: Minor Flood Events

As part of the urban design, the entrances will be locally raised, while still being DDA compliant. This will reduce surface water runoff from entering the station and provide flood immunity from small flood events.

Type B: Intermediate Flood Events

During intermediate flood events, Albert Street station will be closed but other CRR stations could remain operational.

Each entrance location will have low-height flood mitigation measures, such as an upstand wall, approximately one metre high, on three sides.

For intermediate flood events, a vertical flood barrier, approximately one metre high, will be activated at each entrance location, immediately in front of the escalators or lifts. This flood barrier adjoins the low height upstand walls to provide a barrier around the full perimeter of each entrance.

Type C: Extreme Flood Events

For more significant events there will be sufficient time to activate the next level of flood protection measures.

Placing a small structure horizontally above the low height wall upstands offers a suitable solution to an extreme flood event. These would have gaskets and other seals to provide water cut-off. This will be designed for the required hydrostatic water pressure from a Q10,000 flood event. As such, the only elements that will not be protected are the small entrance structures.

Roma Street Station

Roma Street station will extend the region's primary transport interchange hub and support the continued development of commercial and mixed-use activities in this quarter of the CBD. Constructing the new station provides the opportunity to redevelop the Brisbane Transit Centre (BTC) in line with BCC's vision for a new western 'gateway' to the city at this location.

Roma Street station interchanges with the existing Roma Street train network and Roma Street busway station, as shown in Figure 5.12.

This site accommodates the central station box and the single entry. Furthermore, having the station box on this site provides connectivity with the existing pedestrian subway that services the railway and busway platforms. A below-ground level concourse therefore has no benefit, given this ground-level entrance and connectivity.

To accommodate the proposed northern portal arrangement, the rail alignment is skewed in plan relative to Roma Street and the existing rail and busway platforms. As such, part of the station is below the existing rail and busway corridor.

The platform will be approximately 27m below ground level, requiring three levels of escalators. This results in two below-ground levels that serve as landings between ground level and platform level.

With the proposed station layout, temporary support of the Inner Northern Busway will be required during excavation.

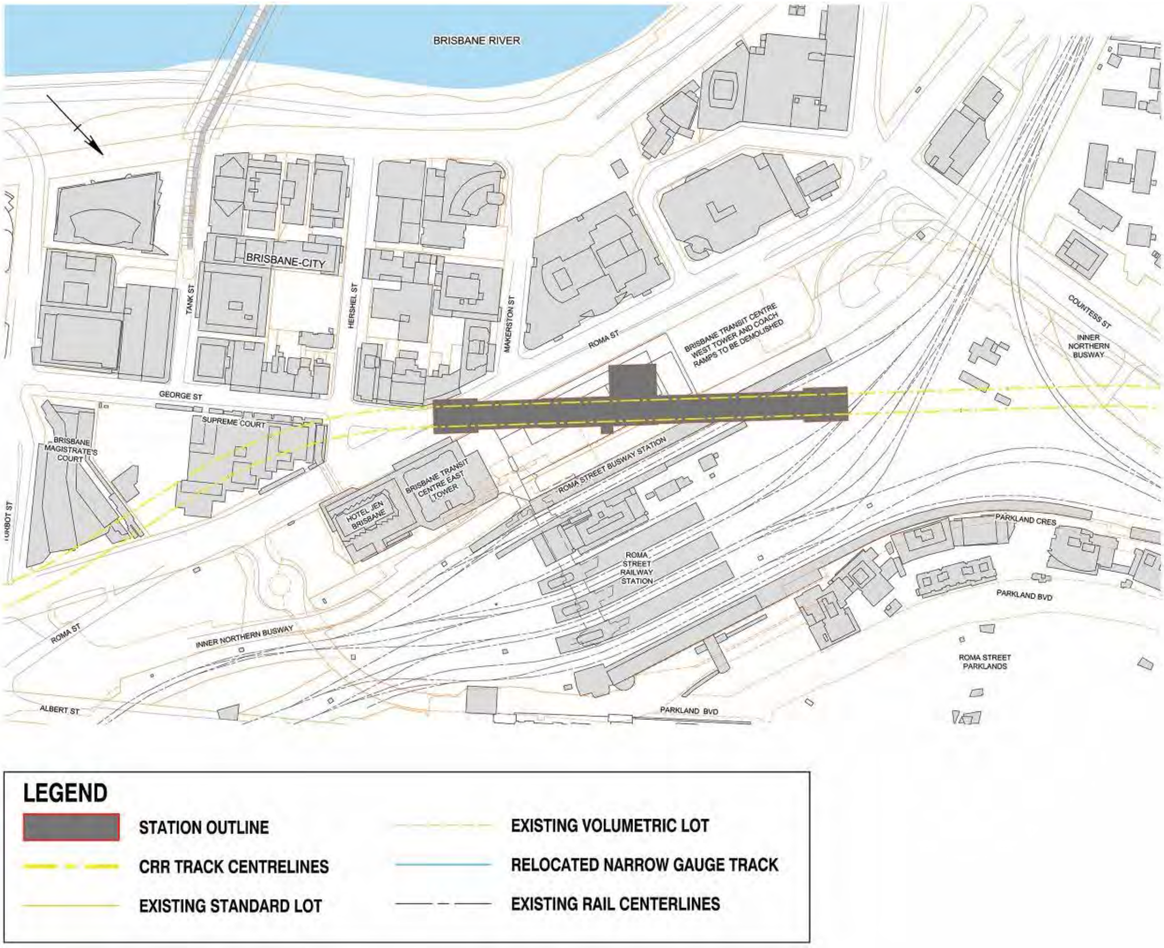

Figure 5.12: Roma Street Station

Exhibition Station

The existing Exhibition station is changing from an event-only station to a general commuter station. It is located between Bowen Bridge Road and O'Connell Terrace, as shown in Figure 5.13. A reference design has been proposed that upgrades the existing station, resulting in:

- reduced impacts to rail operations during construction by retaining the existing rail lines between Bowen Bridge Road and O'Connell Terrace
- avoiding re-grading of O'Connell Terrace by utilising the existing O'Connell Terrace Bridge (also eliminating construction impacts of a new bridge)
- a pedestrian connection between the station, O'Connell Terrace and Bowen Bridge Road.

The existing station is being retained and modified to cater for CRR trains. The two existing platforms are being lengthened to 220m to cater for nine-car trains. The northbound platform will be widened to provide a 6.5m-wide platform.

Over the length of the station, the natural ground level rises from the south to the north. This means that the northbound platform will be widened and lengthened using retaining walls, or suspended structure, as there is up to a five-metre difference between the platform level and the adjacent existing ground. The northern end of the platform will be extended using a suspended structure to maintain the existing pedestrian underpass (below rail level).

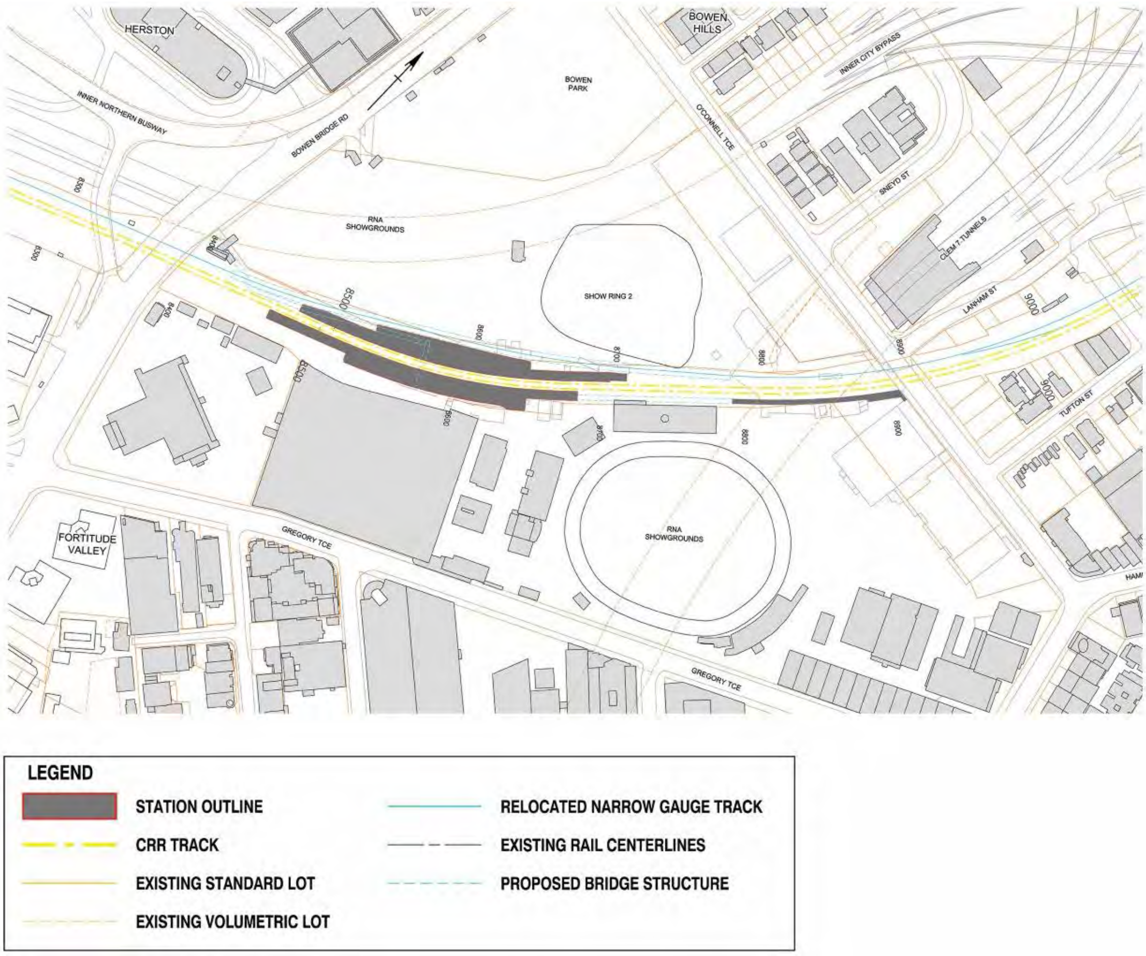

Figure 5.13: Exhibition Station

Pedestrian access is provided between the station and both Bowen Bridge Road and O'Connell Terrace. Pedestrian access to Bowen Bridge Road and O'Connell Terrace is as follows:

- pedestrian bridge from the northbound platform to the footpath on Bowen Bridge Road
- pedestrian bridge between platforms, which directly connects to the Bowen Bridge Road pedestrian bridge
- pedestrian path from the southbound platform to the footpath on O'Connell Terrace
- pedestrian bridge over the rail corridor, adjacent to the existing O'Connell Terrace Bridge, to provide footpath connectivity either side of rail corridor (for the southern O'Connell Terrace footpath).

Pedestrian access to the Brisbane Showgrounds is as follows:

- ramp access from the northbound platform to the Brisbane Showgrounds (with stairs at the northern end of the platform for use during showground events only)
- existing at-grade access from southbound platform to the Brisbane Showgrounds.

5.2.5 Track

5.2.5.1 Track Structure

For surface sections, ballasted track with concrete sleeper will be adopted in accordance with Queensland Rail guidelines.

For tunnels and their approaches, non-ballasted track (i.e. slab track) is proposed. Details of the slab track shall be proposed at later stages in design development and will be subject to recommendations from noise and vibration modelling. Floating slab track technology may be required.

5.2.5.2 Junction Work

All switches and crossings are to Queensland Rail standard layouts. Location of switches and crossings include:

- southern portal and connection to existing mainline
- northern portal and connection to mainline
- Mayne Yard access
- northern tie-in.

5.2.6 Rail Signalling and Systems

The Reference Project includes the following works in relation to rail signalling, communications and train control systems:

- ETCS L2 through the CRR tunnel and northern surface connection, including the supporting telecommunications and radio systems and interfaces with conventional signalling at either end
- automatic train operation (ATO) through the CRR tunnel, overlaid on ETCS L2
- wider signalling works to support CRR operations.

An overview of each component of works is provided below.

5.2.6.1 ETCS L2

The CRR Project will incorporate ETCS L2 throughout the tunnel sections with connections into the surface network. An ETCS L2 system with associated ancillary systems is illustrated in Figure 5.14.

Under ETCS L2, the network controller requests routes to be set or cancelled via the traffic management system (TMS). Once a route request is issued, it is passed to the interlocking to prove it is safe. Train detection continues to be performed trackside by devices such as track circuits and axle counters. Once a route has been set and proved by the signal interlocking, the radio block centre (RBC) issues a movement authority to the train via the radio system. The movement authority is displayed to the driver on the driver-machine interface (DMI).

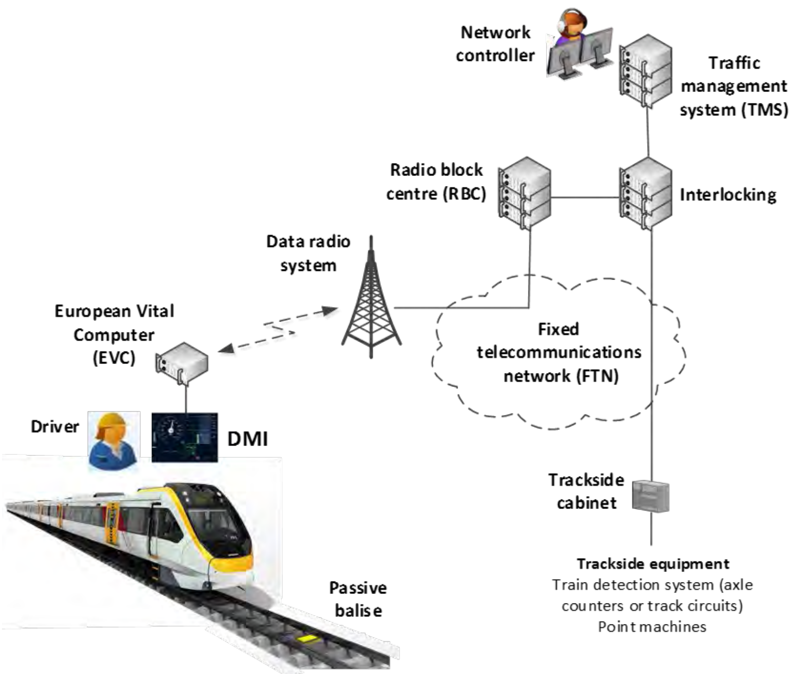

Figure 5.14: ETCS L2 Components

Using ETCS L2 in the CRR tunnel will:

- enable capacity to be maximised as the restrictions that apply to signal placement are eliminated (modelling indicates that the capacity targets for CRR would not be achieved using conventional signalling)
- minimise the tunnel profile and overall CRR cost as there is no need to accommodate lineside signals
- minimise the amount of equipment in the tunnels, providing greater maintainability
- provide a technology basis for enhanced technology and higher performance, including ATO (see section 5.2.6.2).

ETCS L2 is consistent with the technology strategy developed for the SEQ network through the 2011 Rail Safety Systems Assessment and is currently being implemented through the inner-city rail network via the ETCS – Inner City Project being delivered by Queensland Rail.

The scope of works for ETCS L2 that has been included in the Reference Project includes the following:

- ETCS L2 and trackside equipment: All trackside and technical equipment to be installed on CRR, including interlocking and RBC, forms part of the scope. The design has allowed for the use of axle counters for train detection. A single interlocking and RBC have been assumed and will have adequate capacity to cover the entire corridor.
- Fixed telecommunications network (FTN): A FTN has been allowed for throughout the CRR tunnel, integrating with Queensland Rail's existing infrastructure at the north and south interface locations.
- Data radio: A new data radio will be provided by the ETCS contractor. This will be compatible with the supplier's ETCS L2 system and will work on the frequency band that has been allocated by Queensland Rail for this purpose (1,800MHz). The reference design assumes that coverage through CRR will be achieved by a leaky coaxial feeder installed through the tunnels. Coverage will also be required in the area on approach to CRR, for approximately two kilometres, and the reference design has allowed one base station transceiver site north and south of the tunnel for this purpose.
- Interfaces: CRR's ETCS L2 system will interface with existing Queensland Rail signalling at the north and south. The Reference Project allows for the transition between conventional and ETCS L2 as trains divert from the existing corridor. The junction itself will be controlled using conventional signalling, however the train will establish contact with the CRR ETCS system on approach. This means the authority to proceed across the junction and into CRR will be under ETCS L2. In the event that a train does not establish contact with the CRR ETCS system (for any reason, including equipment failure), it may come to a stand at the junction until a movement authority is received or may continue along the existing corridor under conventional signalling.

5.2.6.2 Train Operations

ETCS provides a safety envelope (permissible speed and limit of authority) within which each train can operate. As noted above, the use of ETCS L2 in CRR will provide the required capacity at a lower cost and better outcomes for reliability and maintainability than conventional signalling.

The use of ATO in conjunction with ETCS will further enhance network capacity and the performance of trains. For the CRR Project, ATO is also required due to the use of PSDs, ensuring the train stops in the required position.

For the CRR Project, ATO will involve a driver being present. Four different levels of ATO are defined, known as Grade of Automation (GoA). These are:

- GoA 1: ATP fitted but no ATO
- GoA 2: ATO used for all normal operations, with a driver present to supervise the corridor, manage station departures and to manage degraded operations
- GoA 3: ATO used for all normal operations, with a driver or train attendant present for irregular operations
- GoA 4: Driverless operation; ATO manages all functions.

For the CRR Project, GoA 2 has been assumed. This is consistent with ATO-over-ETCS developments worldwide but also reflects the need for a driver on the train to travel in non-ATO fitted areas on the approach to CRR.

These grades of automation are illustrated in Table 5.1.

GRADE OF AUTOMATION	TYPE OF TRAIN OPERATION	SETS TRAIN IN MOTION	STOPS TRAIN	CLOSES DOOR	OPERATES IN EVENT OF DISRUPTION
GoA 1	ETCS L2 with driver	Driver	Driver	Driver	Driver
GoA 2	ETCS L2 and ATO with driver	Automatic	Automatic	Driver	Driver
GoA 3	Driverless	Automatic	Automatic	Train attendant	Train attendant
GoA 4	Unattended train operation	Automatic	Automatic	Automatic	Automatic

Table 5.1: Grades of Automation Defined for ATO

In addition to the ETCS L2 scope described above, ATO will require:

- an ATO server, which will communicate to the TMS to obtain timetable information and transmit messages to trains via the RBC
- additional onboard equipment to manage ATO messages and functions, fitted to new generation rollingstock (NGR)
- additional enabling works, in rules development, training, testing and proving and operational trialling.

ATO makes use of the same DMI as provided for ETCS, giving a consistent interface to the driver.

The normal sequence of operation under ATO is as follows:

- On approach to CRR, the train will establish communication with the CRR ETCS system (as above) and receive a movement authority to proceed into the tunnel.
- When fully transitioned to ETCS, the driver will select 'ATO start'. ATO will drive the train to the next station, in accordance with the movement authority and the timetable (i.e. the required arrival time).
- ATO will stop the train at the station, aligning the train doors with the PSDs, and will initiate the door opening process.
- The driver or guard will monitor passenger movements at the station. When complete, the driver will initiate the door closing process.
- Once the doors have closed, the driver will authorise the starting of the train by pressing the ATO start button. ATO will then drive the train to the next station.
- At the exit to CRR, the train will transition back to conventional signalling and driver control.

5.2.6.3 Wider Signalling Works

Signalling works will also be required at several locations as enabling works. These include:

- ETCS L2 signalling from Dutton Park to Salisbury
- upgrades to signalling at Mayne Yard.

5.2.6.4 Relationship to ETCS – Inner City Project

Deployment of ETCS L2 in the inner-city network in advance of the CRR Project (via the ETCS – Inner City Project) reduces the risk of bringing CRR into service by ensuring that key enabling activities are completed and stakeholders are familiar with the systems to be used within the CRR tunnel. In particular, the ETCS – Inner City Project will:

- develop rules and procedures for operators working under ETCS L2, which will be equally applicable within CRR
- undertake training of drivers and other staff in processes related to ETCS L2, ensuring a baseline of familiarity in advance of the introduction of the CRR Project
- introduce the new TMS into the SEQ network and resolve all interfaces between the TMS and other systems
- fit all Queensland Rail rollingstock with ETCS L2, as well as undertake integration testing with NGR trains
- undertake all testing, proving and operational trialling activities, including gaining regulatory approval for the new system of working.

The prior completion of the ETCS – Inner City Project will also result in a simpler and lower risk signalling interface between CRR and the existing network at the northern end of the tunnel (as this will involve no ETCS transition) and will provide additional options for the southern interface.

The ETCS – Inner City Project does not include the development, testing and operational introduction of ATO, which will remain as part of the CRR Project. However, the step to ATO has been identified as a potential 'next step' in the ETCS – Inner City Project to ensure that the selected technology supplier has a roadmap to delivering this capability.

5.2.7 Power

Each station will be provided with power from two transformers.

The electrical distribution systems will provide power to all systems including general and emergency lighting, general power, intelligent transport systems, FLS systems, mechanical plant and general power distribution.

All essential supplies in the station will be fed from both main switchboards via an automatic transfer switch to ensure sufficient redundancy. Low-voltage power supplies will be provided at each underground station via transformers located within the station. The transformers will be supplied via high-voltage feeder cabling run in diverse paths along the tunnel length. The transformer and high-voltage supply arrangement should cater for a double failure of two primary power feeds into the station.

Electrical supplies for non-CRR equipment can be provided via Energex local supplies. Non-essential CRR equipment can be provided via Energex local supplies.

5.2.7.1 Backup Power Supplies

In addition to the dual feed to essential services in the station and tunnels, additional backup power supplies will be provided to allow for further redundancy, including:

- generator backup power provided for essential systems
- an uninterruptible power supply provided for FLS systems, such as tunnel lighting (currently indicated to be located at platform level).

5.2.7.2 Rail Traction Supplies

Traction power has been designed to integrate with the SEQ rail network. Queensland Rail's electrical network is being upgraded with new technologies. This has resulted in the scale of the electrical system upgrade requirements being reduced for the CRR network. Introducing a static frequency converter has allowed the system to be connected in a mesh fashion. This allows loads to be shared across the meshed network, increasing system robustness and redundancy, while lowering the amount of injection points or bulk supply points. Because of these changes, the CRR traction network will only require:

- one new sectioning substation at Park Road, with supply from the feeder station at Moolabin (Yeerongpilly)
- one new traction feeder substation at Exhibition
- new supply to the existing Mayne feeder station from Exhibition substation.

The Exhibition feeder station is servicing the CRR lines to Mayne and providing the additional supply to the existing Mayne feeder station.

At Woolloongabba, temporary construction supply for the TBMs will be provided, with the possibility of converting it into the final supply for the stations.

5.2.8 Tunnel Ventilation

Major equipment components required for the tunnel ventilation system include:

- reversible axial fans
- acoustic attenuators (to limit noise levels both at the surface and within the station)
- fire dampers (to configure the system to provide the required flow directionality)
- screening (to prevent objects from entering the tunnel ventilation system).

5.2.9 Fire and Life Safety

Protection measures will be provided for fire events in the stations and the running tunnels. This includes:

- tunnel ventilation systems
- the provision of an emergency walkway along each tunnel with cross passages between the tunnels
- emergency egress stairs at each end of all underground stations
- back-of-house spaces being designed to the Building Code of Australia
- FLS capability of NGR.

Other assumptions include the following:

- The egress strategy is four minutes maximum to a point of relative safety and six minutes maximum to exit the station.
- Escalators will be used at a reduced capacity during emergency egress.
- Only one train will be in each section of tunnel at any one time.

As noted in Section 5.2.4, it is assumed that PSDs will be adopted at all underground stations. This will improve safety by separating passengers from trains and simplify FLS provisions through the separation of station and tunnel ventilations systems.

In the underground stations, the emergency egresses have been designed to be DDA compliant. At platform level, ramps lead down to an emergency egress passageway under the platform. This, in turn, leads to a fire-isolated lift core, typically containing two fire-isolated emergency lifts with fire-isolated stairs wrapping around them. An emergency egress review has been carried out, resulting in three-metre-wide ramps and stairs being adopted.

The use of fire isolation and pressurisation of the egress route and stairwell within the station is consistent with Australian and international practice.

5.2.10 Station Pedestrian and Vertical Transport

Stations have been architecturally designed to achieve a functional layout and an enjoyable user experience. Various elements are discussed below.

5.2.10.1 Fare Gates

Automated fare gates for underground stations are proposed. The location of the fare gates needs to consider where the various pedestrian flows meet, the escalator layouts and the physical space available.

5.2.10.2 Escalators

Generally, linear station arrangements are preferred as this provides clear wayfinding with improved sightlines and a minimal number of turns. Given the station depths, and the corresponding escalator lengths, this is generally not possible to achieve. However, if the escalators use switchbacks, wayfinding can be improved through the use of larger voids near the escalators to increase sightlines. This also provides architectural enhancements to the underground space.

No public stairs have been provided in the underground stations as the platform depths make the use of stairs impractical.

5.2.10.3 Lifts

Lifts will provide DDA-compliant access from the ground level or concourse level down to the platform level. They will be provided at each station entrance to ensure stations have equitable access at each entry point. Table 5.2 summarises these features for each station.

STATION	FARE GATE LOCATION	TOTAL VERTICAL TRAVEL DISTANCE (METRES)	ESCALATORS	LIFTS	PUBLIC STAIRS AND RAMPS	EMERGENCY STAIRS
Boggo Road station	Concourse level	19	6	2	0	2
Woolloongabba station	Ground level	27	8	2	0	2
Albert Street station	Concourse level	31	10 ground to concourse 8 concourse to platform	2	0	2

STATION	FARE GATE LOCATION	TOTAL VERTICAL TRAVEL DISTANCE (METRES)	ESCALATORS	LIFTS	PUBLIC STAIRS AND RAMPS	EMERGENCY STAIRS
Roma Street station	Ground level	27	6	2	0	2
Exhibition station	Platform level	7	0	2	1 stair 1 ramp	N/A

Table 5.2: Vertical Transport Summary

5.2.10.4 Redundant Vertical Transport

The underground stations are deep and require redundancy to cater for an escalator being taken out of operation due to breakdown or maintenance. This can be achieved with additional escalators or stairs. Stairs are only effective for level differences up to five metres – the CRR escalator layouts for the underground stations generally have run heights well in excess of five metres.

5.2.11 Flood Protection

5.2.11.1 Flood Immunity

The desired flood immunity is for a 1 in 10,000-year flood for portals and entrances.

The estimated design entrance levels, interpolated Q10,000 design flood levels and flood protection requirements are summarised in Table 5.3.

LOCATION	DESIGN ENTRANCE LEVEL (METRES)	ESTIMATED Q10,000 DESIGN FLOOD LEVEL RANGE (METRES)	FLOOD PROTECTION REQUIREMENTS
Southern rail portal	20.5	13.5–16	Above Q10,000 level Local runoff protection required
Boggo Road station	17.5 at PA Hospital underpass 30.0 at station entrance	13.5–16	Above Q10,000 level Local runoff protection required
Woolloongabba station	12–14	7–8	Above Q10,000 level Local runoff protection required
Albert Street station	4.3	9–10.5	Susceptible to flooding Flood mitigation measures required
Roma Street station	16	10–12	Above Q10,000 level Local runoff protection required
Northern rail portal	23	5.5–6.5	Above Q10,000 level Local runoff protection required

Table 5.3: Q10,000 Design Flood Levels

It is expected that each station entrance will be locally raised from the surrounding surface level and have suitably sized entrance roofs to minimise ingress to the stations from surface runoff and heavy localised rainfall events. This can be achieved with short DDA-compliant ramps.

Section 5.2.4 outlines consideration of flooding issues at Albert Street station.

5.2.12 Enabling Works

Enabling works are those works which are outside the geographic scope of the project and are separate to the project approvals process. These works are typically time-critical in terms of their delivery for day one operations for the CRR Project.

5.2.12.1 Southern Platform Faces

New platform faces will be provided to allow all-stopping afternoon contra-peak trains to run on the dual-gauge line and stop at these inner-suburban stations (Salisbury to Fairfield–Dutton Park is included in the CRR works due to its proximity to the southern portal).

5.2.12.2 ETCS L2 Signalling Salisbury to Dutton Park

New signalling (extending ETCS L2) is required to provide bi-directional running capability on the suburban down line between Salisbury and Dutton Park. This will maintain the operational integrity of the network and accommodate the portal arrangements of the CRR tunnels.

5.3 Property Requirements

Project construction will require the acquisition of private property and the conversion of purpose and tenure of some Queensland Government freehold land and reserves.

The CRR alignment has endeavoured to minimise private property acquisitions by locating portals and most of the station structures within Queensland Government-owned land, including roads and rail corridors.

The CRR Project alignment reduces the length of the corridor proposed by the original CRR Project and significantly reduces the extent of private property impacts.

The majority of the private property impacts will entail acquiring a volumetric stratum from properties for the tunnels and underground stations and a surrounding perimeter of the supporting subterrain, as depicted in Figure 5.15.

The extent of the volumetric stratum will vary depending on factors including:

- tunnel and station proportions and structural design scope
- surrounding subterrain conditions
- proximity and nature of existing and approved structures
- contingency for design and final alignment flexibility during construction.

The volumetric stratum will be acquired from beneath residential areas of Woolloongabba and Kangaroo Point and part of commercial areas in Woolloongabba and in the CBD adjoining Albert and Roma Streets.

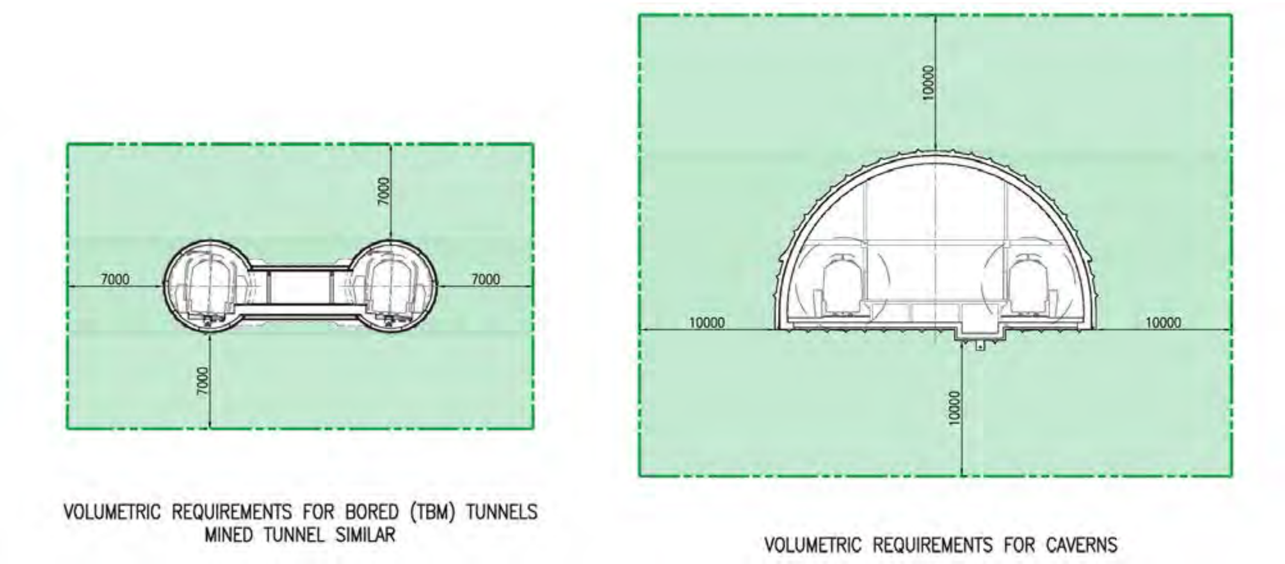

Figure 5.15: Volumetric Requirements for Bored Tunnels and Caverns

Stations at Woolloongabba and Boggo Road will require excision of land and volumetric stratum from Queensland Government properties, including freehold sites, stratum, reserves, roads and other transport land tenures. Albert Street, Roma Street and Exhibition stations will impact some private freehold sites and volumetric stratum in roads and other transport land tenures.

In addition to permanent land requirements, during the construction phase the project will need to temporarily use some property for establishing safe work perimeters, vehicle movement and management, machinery and materials set down, spoil handling, site amenities and management. The period of temporary use will vary dependent on location and purposes.

Table 5.4 summarises the number and types of property acquisitions that will be required for the construction and operation of the project reference design.

PROPERTY AND ACQUISITION TYPE	NO. OF PROPERTIES
SURFACE ACQUISITION	
Residential	0
Commercial or industrial	15
Other (park, showground etc.)	14
Subtotal	29
VOLUMETRIC ACQUISITION	
Residential	141
Commercial or Industrial	38
Other (park, showground etc.)	16
Subtotal	195
TOTAL	**224**

Table 5.4: Property Acquisitions

5.4 Construction of the Reference Project

Major infrastructure projects need to balance the competing tensions of the construction program, project cost, construction-related impacts and staging opportunities and maximise benefits for government. These competing interests generate the construction objectives for the CRR Project as identified below:

- a reference scheme that is robust enough to be able to be constructed while remaining cost effective
- definable staging options that maintain flexibility for project delivery
- optimisation of land requirements to provide the most cost and time-efficient construction while minimising the need to acquire additional land
- minimal disruptions to existing road, rail and pedestrian traffic or businesses
- minimal construction risks and impacts, particularly those associated with potential third-party impacts and sensitive receptors
- protection of future development along the corridor.

The timeframe for the procurement and delivery of the Reference Project is described in Chapter 14: Implementation Plan.

5.4.1 Tunnels

It is anticipated that the majority of tunnelling operations will be supported from the Woolloongabba station construction worksite. This construction worksite offers the benefit of:

- being centrally located within the project
- sufficient area to support the logistics required for operating TBMs and simultaneous mined tunnel construction
- good direct access to the motorways
- a station that is relatively straightforward to construct.

Concentrating most of the tunnel works at Woolloongabba also has the benefit of creating materials handling and logistical support efficiencies. It will, however, also concentrate the majority of the spoil handling movements and material deliveries in this location, increasing construction traffic impacts around Woolloongabba.

The CRR Project will utilise two TBMs travelling north until they are retrieved at the northern portal location within the Exhibition Loop. The twin running tunnels between Boggo Road and Woolloongabba stations will be mined from Boggo Road and from Woolloongabba.

The TBMs will interface with underground stations at Albert Street and Roma Street. At these locations, it is anticipated that the TBMs will break through into the station caverns in an enlarged cavern opening and be 'walked' through the station box and cavern excavations. The TBMs will then be relaunched from cavern widening at the opposite end of the station.

TBM retrieval is currently proposed to occur within the Exhibition line at the northern portal.

A locally mined sump and pump well will be required at the tunnel low point under the Brisbane River.

5.4.2 Stations

Station excavation of the four underground stations at Boggo Road, Woolloongabba, Albert Street and Roma Street follows a similar construction methodology. The central access to these deep stations is constructed using mainly traditional bottom-up cut-and-cover construction methods. The extent of these cut-and-cover works will be used to accommodate the required vertical transport and back-of-house facilities such as mechanical and electrical plant. The cut-and-cover portion of the works dictates somewhat the layout of the vertical transportation.

It is expected that the temporary works for these cut-and-cover excavations will be very robust in order to prevent damage to existing high-rise buildings adjacent to the station sites. Before and during the station construction works, extensive monitoring systems for ground movements will be required.

It is anticipated that station caverns will be constructed using roadheaders with a temporary and permanent lining installed.

Station fit-out will occur after the tunnelling works have passed through and will include ventilation, mechanical and electrical fit-out, permanent civil works, architectural finishes and installing rail and rail systems. Commissioning of the station and rail systems will then follow.

5.4.3 Surface Works

Most of the proposed surface works at the southern and northern portals significantly interface and impact on the existing operational railway network, so the network will need to remain operational as these works are delivered. Delivery will need to be staged into manageable, safe and reliable increments acceptable to Queensland Rail. These works will be subject to the Queensland Rail's corridor safety requirements.

Where possible, surface rail works will be carried out offline, which may involve temporary slewing of tracks. Other works will typically be carried out during evenings or weekend possessions.

5.4.3.1 Southern Portal

Much of the enabling works interface with the existing Queensland Rail operational network and therefore will involve complex brownfield urban rail construction. As with all brownfield urban rail works, detailed planning will be required to enable Queensland Rail to appropriately programme, in advance, the many weekend and night-time track possessions likely to be needed for the project.

The interface and interaction between the permanent CRR works and the existing rail track will thus be key to the construction of the southern portal. The two cut-and-cover portals will also need to be installed beneath the existing freight rail overpass, while keeping it operational.

The position of Boggo Road station has been determined to minimise impact on rail operations by avoiding, where possible, cut-and-cover works in the rail corridor at Park Road station. Minor platform closures will be required to allow for the construction of the new bridge and accesses.

The construction of the station across the Eastern Busway will need to be staged to allow for busway operations.

5.4.3.2 Northern Portal and Exhibition Rail Loop

The northern portal will have to be constructed within a narrow corridor between the Exhibition and freight holding lines.

As the main construction works are close to the Grammar schools, providing access for materials and removal of soil will be confined. Slewing of the existing rail tracks will be required to construct the new works through to the Exhibition station.

5.4.3.3 Mayne Yard

There will need to be extensive rail changes through Mayne Yard, from alignments through to buildings, controls and overheads. It is expected that Queensland Rail will do most of these works in advance of the CRR Project. However temporary track arrangements for stabling and other activities may still need to occur to suit operations and construction staging.

There is no construction over the operating electrified railway. Suitable protection works between the existing rails and the underpass will minimise the impact of construction on rail operations.

5.4.4 Commissioning

As part of the completion of the new CRR Project, a program of testing will be undertaken over a commissioning phase. The commissioning phase will test all of the elements of the project individually, as coordinated systems and as an overall project-wide system. This system will work through the functionality, operation and integration with the existing systems and procedures of key stakeholders including Queensland Rail and the Queensland Fire and Emergency Services (QFES).

As this is a complicated new part of an existing railway network, there is a lot of new infrastructure, mechanical and electrical equipment, FLS systems and rail systems to be integrated into the existing network and tested for functionality. While factory acceptance testing of individual items and site acceptance testing of these items will always be required, there is need for a coordinated approach to testing the functionality and interoperability of new systems that are being introduced into the existing network. The commissioning phase will undertake this coordinated approach to testing, training and operation.

The commissioning phase will include the following:

- commissioning of the four new underground stations including their additional mechanical and electrical equipment required for standard operations, the FLS systems and their associated safety and communication systems
- testing and commissioning of the tunnel systems including the FLS systems and the tunnel ventilation, including smoke control
- commissioning of the surface works that connect the tunnel into the existing network
- commissioning of the rail systems including traction power, track work, signalling and communications
- training of drivers for the new rail environment and training of station staff working in underground stations.

The commissioning of the above items will require specific plans and testing regimes to be developed. It will also require coordination and liaison with affected stakeholders including Queensland Rail, QFES, Queensland Police and Queensland Ambulance Service to ensure that the functionality of the newly introduced systems can be successfully implemented.