



# BaT project

Chapter 19

Summary and conclusions



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## 19. Summary and conclusions

### 19.1 Overview

This chapter summarises the key findings of the Environmental Impact Statement (EIS) and presents the conclusions and recommendations for the Project. It provides a summary of the overall impacts, both beneficial and adverse, of the Project's construction and operating life.

This summary considers the impacts generated at a local level as well as at a wider whole of Project level. It takes into consideration the scale, intensity, duration and frequency of the impacts to demonstrate a balance between environment outcomes, social development and economic development.

The conclusions drawn from the reference design and the EIS provided in this chapter relate to:

- the Project's strategic intent of addressing the existing inner city rail and bus constraints and to respond to anticipated patronage growth on the South East Queensland rail and bus networks
- the potential benefits and impacts of the Project on the environment of the study corridor and broader areas, in both its construction and operation
- the scope of community and stakeholder interest in the Project
- the range of mitigation measures available to address impacts including community and stakeholder issues.

### 19.2 Rationale for the Project

#### 19.2.1 Employment and population growth

##### **Population growth**

South East Queensland continues to experience high levels of population growth that is placing increasing constraints on the capacity of the regional public transport network.

The population of South East Queensland is expected to grow from 3 million people in 2011 to 3.7 million by 2021 and 4.5 million by 2031. This growth is primarily expected to be in areas outside of the Brisbane local government area (LGA) in the Gold Coast, Ipswich, Sunshine Coast, Moreton Bay and Logan LGAs. The growth in population in surrounding areas will place pressure on the regional transport network with a focus on travel to and through Brisbane, particularly by road and rail. The population growth of the inner city would place pressure on inner Brisbane travel, particularly rail and bus.

The residential population of Brisbane's inner city areas is expected to double in the next 20 years. Particular growth hotspots are expected to be the inner city areas of the central business district (CBD), South Brisbane, Spring Hill, Milton, Woolloongabba, Bowen Hills and Fortitude Valley. Current planning intentions show support for growth around the Brisbane CBD, in South Brisbane and increased intensity of development in the Woolloongabba, Roma Street and Fortitude Valley areas.

##### **Employment growth**

With the forecast increase in population in South East Queensland, employment will also grow. Brisbane City is the primary commercial centre in South East Queensland and Queensland as a whole, and employment growth is expected to be focussed in Brisbane.

It is anticipated that an additional 290,000 jobs will be created within Brisbane between 2011 and 2031, with the city reaching a total employment base of almost 1.1 million jobs.

Approximately 100,000 of the additional jobs will be within the Brisbane CBD and adjacent fringe areas of Milton, South Brisbane, Fortitude Valley and Bowen Hills. The growth in office-based professional, technical and business administrative jobs that concentrate in the CBD and adjoining areas, will result in significant increases in both commuting and business trips into Brisbane from surrounding areas.

### 19.2.2 Constraints on the transport network

Peak period rail services on the Merivale Bridge (southern and eastern services) and the inner city network are close to capacity. Without the Project, the reliance on the existing Roma Street Station and Central Station for accessing the CBD via the rail network will continue. Increased population and employment growth will cause increased congestion at these stations, resulting in impacts on travel times, reliability and passenger comfort. Without actions to increase capacity, the rail network would not be able to cater for forecast growth.

The two main connections for bus services from the south, Captain Cook Bridge and Victoria Bridge, are at capacity in peak periods. Existing bus operations in the Brisbane CBD are already congested in peak periods impacting on bus reliability. The busway connection to the CBD for the Inner Northern Busway also experiences congestion. This means there is currently limited infrastructure capacity to provide additional bus services for accessing the CBD.

Many of the key road corridors to the Brisbane CBD have more than 90 per cent of available road capacity being used resulting in unstable flows, congestion, delays and poor level of service for inbound traffic. With this existing capacity constraint, the road networks will struggle to meet future demand requirements. In total across the entire network, the transport task is forecast to increase by almost 40 per cent from 2012 to 2031, to a total of almost 10.3 million trips per day. Public transport trips make up 1.1 million trips per day, leaving the road network to cater for most of the remaining 9.2 million trips per day. There is a predicted 60 per cent increase in total private vehicle kilometres between 2012 and 2031 on a congested road network. This will further increase congestion, decrease reliability and increase travel time.

### 19.2.3 Sustainable and efficient transport and land use

The Project would support the future growth and development of South East Queensland by providing improved public transport access to areas of future population and employment growth.

Specifically, the Project would:

- address the constraints of the regional rail network by providing additional capacity across the Brisbane River in to the Brisbane CBD. This would improve accessibility from areas in the south and east to the inner city activity centres through the provision of improved access to high quality public transport
- address the capacity constraints of the bus network across the Brisbane River and into the Brisbane CBD. This would improve access for commuters using the busway network from the north and south and remove many buses from the CBD road network
- support the delivery of the preferred land use patterns and the urban development densities envisaged in the *South East Queensland Regional Plan 2009-2031* (SEQ Regional Plan) and the Brisbane City Plan 2014 through the provision of improved accessibility to public transport within identified growth areas

- provide improved high-frequency public transport to the inner city and Brisbane CBD through the location of the Project's stations (Woolloongabba, George Street and Roma Street), which would also support land use planning intentions
- support planned urban developments and renewal projects, including the Boggo Road Urban Village, the Princess Alexandra Hospital (PA Hospital), the Woolloongabba Priority Development Area (PDA), ongoing growth of the Queensland University of Technology (QUT), ongoing development of the Brisbane CBD including the Queen's Wharf Brisbane development, and preserve the long term city expansion opportunities associated with the Brisbane Transit Centre and Roma Street rail yard
- support strategic regional development areas to the south, such as Flagstone, Coomera and Yarrabilba. Sufficient transit access is required in these areas to allow them to develop with regional public transport connectivity to major employment and education centres, such as the Brisbane CBD.

#### 19.2.4 Economic justification

The Project would deliver benefits of approximately \$4.73 billion in present value terms (2014). The major benefits would be time savings, crowding and reliability improvements to public transport and travel time savings for road users who remain on the road network.

The estimated present value of capital costs of the Project is \$3.53 billion and \$563 million for whole of life costs giving a total cost of \$4.09 billion, which includes the cost of additional rollingstock.

Following the consideration of costs and benefits, the Project has a net present value of \$641 million and a benefit-cost ratio of 1.16.

Transport improvements have the potential to impact the wider economy through a number of different mechanisms, including changes in process, economic output, labour supply, imports and exports. The Project would effectively lower the cost for workers accessing locations of employment along the route thereby increasing productivity and the available pool of workers that firms can find suitable workers from.

### 19.3 Project objective

The Project would meet the objective to boost inner-city transport capacity and reshape the network to cater for the region's growing and changing travel demands through the provision of increased rail and bus network capacity and improved accessibility to high quality public transport. The over-arching objective of the Project aims to achieve the following economic, social and environmental outcomes:

- a more efficient, resilient and integrated passenger transport network that provides for growing demand in Brisbane and the region more broadly
- improved accessibility, utilisation and service quality of the bus and rail network (faster, more reliable trip times for users with truly integrated busway and rail)
- reduced congestion and vehicle emissions on the network
- a more robust economy for the region by facilitating economic and employment growth
- more sustainable urban development and land use patterns.

## 19.4 Project impacts and mitigation – construction phase

In its construction, the Project extends beneath a number of inner city suburbs of Brisbane, including the CBD. While the scale and intensity of the construction of the Project is significant, the impacts would be of limited duration, i.e. five years, compared with the operational benefits of the Project's design life (i.e. 100 years).

During the construction phase, local communities near the construction worksites would likely experience a number of adverse impacts that could potentially cause moderate to high levels of short-term disruption and reduced amenity. Construction impacts would be less obvious along the alignment of the tunnelling works, the material supply lines, the adopted spoil placement sites and the haulage routes. Construction worksites would be required for the Project at:

- Southern Connection (Dutton Park) – for the establishment of tunnelling activities, including the assembly and launch of the tunnel boring machine (TBM) and the dive structures
- Woolloongabba Station, George Street Station and Roma Street Station – consisting of a shaft and supporting worksite for the construction of each underground station and pass-through of the TBM
- Northern Connection (Spring Hill and Victoria Park) – consisting of a retrieval shaft for the TBM and dive structure and the establishment of the busway bridge across the Inner City Bypass (ICB).

The anticipated Project impacts are summarised as follows:

- temporary impacts, confined to the five year construction phase duration and generally localised around the Project's construction worksites
- while the construction phase would last for five years, the acute impacts would be experienced over shorter timeframes depending on the construction activities being carried out at specific locations. For example, impacts from tunnel construction such as ground-borne noise and vibration would last for approximately five to seven days for each TBM passby, except for tunnelling under the CBD, where each passby would take longer, e.g. seven to ten days
- impacts would be greatest for sensitive receivers immediately adjacent to construction worksites, particularly at the Southern Connection, George Street Station and Roma Street Station worksites
- wider ranging impacts, such as construction transport, reduce in intensity rapidly with distance from the construction worksites.

Implementation of mitigation measures, in combination with advance and on-going consultation with potentially affected owners and occupants of properties would manage the Project's identified impacts.

### 19.4.1 Construction traffic

Construction activities would have potential impacts on the major road network from delivery and spoil haulage, and the local road network in the vicinity of the construction worksites. Each of the construction worksites would require changes to local traffic and pedestrian arrangements to function effectively and safely. Specific construction traffic management plans would provide measures to mitigate the effects of construction traffic.

Management plans would address safety aspects, access arrangements at the construction worksites and for near neighbours, the movement of pedestrians and cyclists around construction worksites, workforce car parking requirements, the relocation of bus stops and taxi ranks where required, and measures to mitigate the effects of lane closures when they might be required.

### **Construction workforce car parking**

The provision of car parking for the construction workforce would be delivered through on-site parking at most of the construction worksites.

Where on-site parking capacity is insufficient, overflow parking and shuttle buses would be provided from the additional off-site parking facilities near the Southern Connection construction worksite and the Northern Connection construction worksite.

Workforce car parking would not be provided for the George Street Station and Roma Street Station construction worksites. Due to their inner city locations, it is anticipated that the construction workforce would use public transport and the existing commercial car parks located near to the construction worksites.

### **Construction haulage routes**

Construction spoil would be taken to any of five spoil placement sites, which are:

- Brisbane Airport
- Swanbank
- Pine Mountain
- Larapinta
- Port of Brisbane.

Access to the five spoil placement sites would occur via arterial roads, such as the ICB, Old Cleveland Road, Ipswich Road, the Pacific Motorway, CLEM 7 tunnel and Airport Link. Local road access would only be required where access to the arterial roads from the construction worksites and adopted spoil placement site is required (e.g. Boggo Road, Southern Connection).

Peak hour intersection modelling for the haulage routes associated with each of the spoil placement site options identify negligible to minor increases in queuing and delay at most of the critical network intersections. Where the spoil haulage activities have the potential to adversely impact on the traffic, such as during peak periods within the CBD and inner city, varying haulage times have been proposed.

### **Impacts at construction worksites**

Each construction worksite has been examined to determine the potential impact of construction on pedestrians and cyclists, buses, parking, adjacent development and access, emergency services, special events and general traffic operation.

Management plans would be implemented at each construction worksite to manage potential impacts of construction on traffic and transport. Overall, the impacts of construction are considered to be manageable, with a minimum level of change to existing traffic conditions.

## **19.4.2 Construction noise and vibration**

### **Tunnel construction**

The TBM and roadheaders would operate underground for 24 hours a day, seven days a week, only ceasing for a daily maintenance period.

The noise and vibration modelling undertaken for tunnel construction predicts that:

- ground-borne vibration levels would result in no exceedances of the goal for cosmetic damage or the stricter goal for cosmetic damage in heritage buildings
- the night-time residential vibration goal would be exceeded, although for a relatively short period, i.e. less than one week for the TBM passby outside of the Brisbane CBD and 7-10 days within the CBD
- the ground-borne noise goal would be exceeded for less than one week at residential dwellings located within the vicinity of the TBM passby. There are also five hotels in the CBD where levels would exceed the night-time ground-borne noise goal for up to ten days.

The following management strategies are proposed to minimise the impact of the TBM tunnelling works:

- comprehensive advance notice would be provided, in the localities near the tunnel alignment. Part of the consultation process would include information regarding the monitoring program, which may require involvement from residences located above the tunnel alignment
- building condition surveys would be conducted where it is considered there may be potential risk for cosmetic damage
- other mitigation measures, agreed with the affected parties, where the relevant goals are exceeded.

### Connections and station construction

During construction, activities likely to generate noise impacts at each of the connections and stations include the demolition of existing buildings and construction worksite establishment, excavation using rock breakers, drill and blast techniques, and other construction plant, general earthworks and removal of spoil. Specifically at the connections, noise would be generated by the establishment of the rail and busway surface works, including the portal connections and the busway bridge over the ICB.

Generally, below ground construction activities at each site would be carried out for 24 hours per day, seven days a week. Where possible, night time works would be confined to within the tunnel and the acoustic sheds.

Throughout the environmental impact assessment, the worst case scenario has been adopted to model possible mitigation measures that may be necessary to meet the environmental goals. To this end ventilated acoustic sheds would be established at the construction worksites for the Southern Connection and underground stations to minimise airborne noise (and dust) impacts on nearby sensitive receivers. The noise and vibration modelling undertaken for connection and station construction predicts the following impacts at each construction worksite:

- At the Southern Connection – for airborne noise, minor exceedances of the daytime goal and the night-time sleep disturbance goal are predicted for residential receivers adjacent to Railway Terrace. More significant daytime and night-time goal exceedances are predicted at Quarry Street during the excavation of the micro-TBM retrieval shaft. A range of potential measures including, hoarding and work hour restrictions are identified to mitigate impacts. Significant exceedances of the ground-borne night-time noise goals are predicted for the Leukaemia Foundation ESA Village (ESA Village). Vibration from rock breaking is predicted to exceed the night-time vibration goal at ESA Village and marginally exceed the floor vibration tolerance for the electron microscope located within the basement of the Ecosciences building. Minimal risk of cosmetic building damage is predicted. **Chapter 18 – Draft Outline EMP**, provides a framework for identifying, mitigating, monitoring and managing environmental impacts during the construction and commissioning phases of the Project.

- Woolloongabba Station – minor exceedances (3 dBA) of the daytime airborne noise goal are predicted at the nearest residential receivers along Vulture Street and more significant noise goal exceedances are predicted for St Nicholas Cathedral. Hoarding up to 6m has been proposed as part of a range of potential mitigation measures with the provision of a low performance acoustic enclosure over the construction worksite. Excavation and spoil haul out activities are also predicted to marginally (1 dBA) exceed the night-time residential noise goal at the receivers on Vulture Street. The predicted ground-borne noise and vibration levels indicate compliance with the relevant goals.
- George Street – significant exceedances of the daytime and night-time noise goals are predicted for the residential and accommodation receivers near to the construction worksite on George Street if rock breaking occurs. Vibration due to rock breaking is also predicted to exceed the night-time vibration goal for residential receivers. A marginal exceedance of the 2 mm/s vibration goal for heritage structures is predicted for Harris Terrace during the initial stages of heavy rock breaking of the station shaft. It is recommended that vibration measurement trials are carried out for rock breaking during the detailed design stage of the Project to accurately determine the extent of the impact and to allow sufficient time to develop an appropriate management strategy.
- George Street Station – once installation of the acoustic enclosure is complete, airborne noise levels from the site would decrease significantly. Alternative construction methods such as drill and blast techniques have been considered in order to mitigate the potential impacts.
- Roma Street – significant exceedances of the daytime and night-time airborne noise goals arising from piling and rock breaking are predicted for the receivers within the Parkland Boulevard residential building located adjacent to the construction worksite. A ventilated acoustic shed has been proposed as a potential mitigation measure. Vibration levels during rock breaking at the Parkland Boulevard building are also predicted to exceed the night-time vibration goal. Consideration has been given to alternative construction methods such as drill and blast techniques in order to mitigate the potential impacts.
- Northern Connection – minor exceedances of the daytime noise goal are predicted for residential receivers adjacent to Gregory Terrace with the provision of an acoustic hoarding.

### **Construction traffic**

With mitigation, the increase in road traffic noise due to the Project spoil traffic is predicted to be less than 2 dBA on all roads identified for construction haulage. Changes in noise levels of 2 dBA or less are considered to be undetectable to the human ear and are therefore negligible. The absolute maximum noise levels associated with vehicle passbys would not be altered by the Project construction vehicles, although the frequency of such events would increase.

### **Construction noise and vibration management**

A range of potential airborne noise mitigation is proposed such as ventilated acoustic sheds, hoarding and possible surface work hour restrictions. It is recommended that vibration monitoring is carried out for rock breaking and drill and blast activities to accurately determine likely impacts and allow mitigation measures to be assessed and reviewed for their effectiveness.

During construction weekly inspections would be undertaken to ensure that noise and vibration controls are being implemented and are effective, and changes to construction methods or complaints, are responded to appropriately.

#### **19.4.3 Air quality impacts during construction**

The primary emissions from the construction of the Project would be dust related as airborne and deposited particulate matter.

These emissions would arise with the establishment of each construction worksite, through demolition and site clearance and the operation of plant and equipment, as well as the removal of excavated material (spoil) from tunnelling and station shaft excavation activities. Dust deposition and deposited particulate matter emissions are not considered a risk to human health.

A dust deposition objective of 130 mg/m<sup>2</sup>/day as a maximum monthly average was adopted for the management of potential nuisance impacts for the Project. No exceedances of the dust deposition objective are predicted for the Project's construction modelling scenarios at the sensitive receivers. A construction dust monitoring plan would be prepared as part of the Construction EMP.

The Construction EMP would specify measures for managing nuisance dust impacts and controlling exhaust emissions from plant and equipment. Regular air quality monitoring at the nearest sensitive receivers to the construction worksites would be undertaken to assess compliance with relevant objectives.

#### 19.4.4 Socio-economic impacts

##### **Socio-economic**

Construction of the Project would have some impacts on communities within the study corridor. Communities in the vicinity of construction worksites are most likely to experience impacts, which would result from an influx of construction workers and associated traffic, disruptions to local access routes, as well as the scale, intensity and duration of construction, including concerns over dust, noise and vibration impacts. These impacts have the potential to alter the existing amenity of the local areas, the amenity of local parks, community health and safety, pedestrian and cycle movements, access to local businesses and community cohesion.

The construction phase would result in a number of socio-economic benefits including creation of direct and indirect employment opportunities and increased demand for goods and services from businesses near to the Project's construction worksites due to the influx of construction workers.

While the scale and intensity of the construction undertaking is significant, the impacts would be of limited duration, compared with the long-term operational benefits of the Project. An important mitigation measure would be the provision of timely and comprehensive information and consultation with potentially affected communities and residents about the Project's construction activities. This would assist to manage stress and anxiety levels, and ensure community safety in areas around the construction worksites.

##### **Land use**

Twenty-one properties would be impacted by surface works. These properties are owned by the State Government or a Government Owned Corporation. Impacted properties contain office space, open space, transport infrastructure, health and education land uses.

About 276 properties, mostly residential, would be impacted by volumetric acquisition, where the Project passes beneath the property. Volumetric acquisition requires the resumption of a portion of land below the surface of the property. The balance of the property would not change ownership nor require the relocation of occupants.

Upon completion of the Project, land used for construction and not required for permanent surface works would be rehabilitated and may be available for redevelopment where appropriate, subject to relevant planning and development assessment procedures.

### Indigenous cultural heritage

The Project has the potential to impact on residual or intangible Indigenous cultural heritage values within the study corridor, particularly at Woolloongabba, Roma Street and Spring Hill. Indigenous cultural heritage would be managed through the preparation of a Cultural Heritage Management Plan (CHMP) approved in accordance with the *Aboriginal Cultural Heritage Act 2003* (ACH Act).

### Non-Indigenous cultural heritage

The Project may result in impacts on non-Indigenous heritage in locations where State Heritage Places are located near to the Project's alignment, such as along George Street or within Victoria Park. Impacts may include vibration, settlement, disruption to the heritage setting and disruption to public access. The implementation of construction management measures, such as ongoing monitoring, dust management and construction activities avoiding heritage places, would assist in mitigating potential impacts on heritage values in the study corridor.

#### 19.4.5 Other potential environmental impacts

##### Flooding

The Project has been designed to provide flood immunity for the tunnel and underground stations from the 1 in 10,000 AEP event in regional flooding (riverine and creek events) and from the 1 in 100 AEP event in local (overland flow) events. The aim of this design approach is to minimise the risks of flood damage to the Project to as low as reasonably practicable.

During construction, the Project may be at risk to drainage issues from overland flow at the Southern Connection, Roma Street Station and the Northern Connection construction worksites. Suitable design of the on-site stormwater network would be undertaken during detailed design to manage impacts of overland flow.

##### Groundwater

Excavation of the tunnel and station shafts has the potential to draw groundwater to the voids. This has the potential to result in reductions in groundwater availability for groundwater users, impacts to groundwater dependent ecosystems (GDEs), inflow of contaminated groundwater to the tunnel and station caverns and exposure of potential acid sulphate soils (PASS) through oxidation, resulting in the acidification of groundwater.

The existing beneficial use of groundwater within the study corridor is considered to be low, given its poor quality and limited extraction opportunities present. The extent of groundwater drawdown is not predicted to extend to the majority of the locations where GDEs may be present. Groundwater drawdown may occur within small areas of the City Botanic Gardens, near to Alice Street, and along the banks of Brisbane River, although the level of groundwater dependency in these areas is likely to be relatively low.

Contaminated groundwater is likely to exist in the vicinity of contaminated sites within the study corridor, such as within the existing and former rail corridor sites and sites within the CBD that were formally used for fuel storage activities. However, groundwater inflow to the tunnel is expected to be low. Any contaminant fluxes would also be correspondingly low. Groundwater entering the tunnel and the underground stations would be captured and treated prior to disposal.

The oxidation of PASS as a result of drawdown is possible around the George Street Station, although the overall risk is considered to be low. Further quantification and characterisation would be undertaken in drawdown zones where areas of ASS may exist. Should the presence of ASS be confirmed, remediation measures would be put in place prior to construction of the station.

### Surface water quality

Vegetation clearing, earthworks and spoil stockpiling associated with the Project's surface works have the potential to cause sedimentation within waterways if the appropriate control measures are not in place. Adequate sediment and erosion control measures at construction worksites would be implemented to reduce discharges of sediment into the receiving environment.

Oils, fuels, chemicals, hazardous substances and litter also have the potential to enter surface waters via runoff from construction worksites, causing contamination. Water quality treatment control devices would be designed and implemented at the Project's construction worksites to avoid the potential release of contaminants to surface waters.

### Topography, geology, geomorphology and soils

The potential for settlement impacts to property during construction of the Project are generally negligible to very slight, with impacts to private property not expected. A precondition survey of all structures predicted to be affected by settlement would be undertaken to enable any damage to be made good.

Detailed specific soil investigations would be undertaken at each construction worksite to identify the erosion risk areas and to inform the development of soil erosion prevention techniques and onsite management plans. Erosion and sediment control plans would be developed during the detailed design phase of the Project and incorporated into the EMPs prepared for construction phase of the Project.

The potential for wide-spread disturbance of ASS as a consequence of construction works is considered to be low and manageable. Field investigations would be required to support detailed design, to confirm the presence or absence of ASS and to manage the potential impacts on both surface water and groundwater.

### Land contamination

The potential for land contamination to occur during construction would be greatest at the construction worksites, where surface soils would be disturbed. Construction activities, such as shafts for underground stations, tunnel drive structures and portals, mostly occur within railway corridors or in areas where contaminated land may be present.

Detailed investigations would be carried out prior to commencement of the Project works in accordance with the 'Queensland Guideline for Contaminated Land Professionals' (DEHP, 2012). In accordance with the *Environmental Protection Act 1994*, a disposal permit would be required for the removal and disposal of contaminated soil from land recorded on the Environmental Management Register and Contaminated Land Register to an off-site location.

## 19.5 Project impacts and mitigation – operations phase

The operational impacts generated by the Project are predicted to be mostly beneficial over the 100 year design life of the Project. The Project benefits accrue for both local and regional communities, populations and businesses.

The main beneficial impacts associated with operation of the Project include:

- provision of additional rail and bus river crossings to alleviate capacity constraints on the Merivale Bridge (rail) and the Victoria Bridge (bus) as well as in the CBD
- improved accessibility to high quality public transport within South East Queensland and Brisbane
- provision of high quality public transport within identified proposed future growth areas
- improved public transport travel times and reduction in passenger crowding compared with the Project not proceeding
- effectively lowering the cost for workers accessing locations of employment along the route thereby increasing productivity and the available pool of workers that firms can find suitable workers from.
- benefits amounting to \$4.73 billion in present value terms (2014), delivered through time savings, crowding and reliability improvements to public transport and travel time savings for road users who remain on the road network
- reduction in the growth of road traffic congestion compared with the Project not proceeding.

The main potential adverse impacts associated with the operation of the Project would include:

- small exceedance of ground-borne noise goals at ESA Village near to the Southern Connection
- due to airborne noise at sensitive receivers near to the Southern Connection, an additional noise barrier has been proposed to reduce operational noise levels to Queensland Rail's planning levels. Restrictions on the location and height of barriers limits the ability to achieve compliance at all receivers
- potential for groundwater drawdown into drained areas around the tunnel and stations, decreasing over the life of the Project
- permanent volumetric acquisitions of land surrounding the tunnel and underground stations, although these acquisitions would not impact on any existing or approved buildings or developments. Compensation would be provided for volumetric acquisitions in accordance with the *Acquisition of Land Act 1967*
- permanent surface acquisition of State Government and government owned corporation owned land, including land currently used for open space, offices, transport infrastructure, health and education and car parking.

### 19.5.1 Local traffic impacts

Traffic modelling shows that the Project would have limited impacts on local traffic operations. Minor increased traffic delays could be experienced around George Street Station due to increased pedestrian activity and changed pedestrian and traffic arrangements. The operational performance of key intersections in the precinct is not expected to be significantly impacted.

### 19.5.2 Noise and vibration impacts

#### Ground-borne noise and vibration

The ground-borne noise modelling indicates that with the implementation of appropriate trackforms, compliance with the ground-borne noise goals at all sensitive receivers would be achieved. It is predicted that the nominated vibration goals would be complied with at all sensitive receivers. This includes vibration levels for the electron microscope at the Ecosciences precinct and all research and medical facilities within the study corridor, including the PA Hospital, the QUT and St Andrew's War Memorial Hospital.

## Airborne noise

At the Southern Connection, airborne noise from rail operations is predicted to exceed Queensland Rail's planning levels at 29 sensitive receivers. An additional noise barrier has been proposed to reduce the operational noise levels to Queensland Rail's planning levels. Restrictions on the location and height of barriers would limit the ability to achieve compliance at all receivers.

For bus operations at the Southern Connection, airborne noise at all noise sensitive receivers is predicted to meet the relevant noise criteria.

At the Northern Connection, road traffic noise at three educational buildings (St Joseph's College buildings) and two health buildings is predicted to exceed the TMR Code of Practice 65 dBA  $L_{A10}$  (1 hour) noise criterion. Also at the Northern Connection, airborne noise at one health building is predicted to exceed the TMR Code of Practice 69 dBA  $L_{Amax}$  noise criteria. Noise mitigation has not been recommended at any of these noise sensitive receivers as all exceedances are due to the operation of the existing road networks and not the Project. Noise levels at all locations, attributable to only the Project, would be significantly below the applicable criteria (at least 15 dBA below the relevant criteria).

At the Northern Connection, airborne noise from rail operations at all sensitive locations is predicted to comply with Queensland Rail's operational planning levels in 2031.

### 19.5.3 Air quality impacts

Operation of the Project would generate emissions from buses, including combustion related gases and particulate matter, but levels are not considered to be a risk to human health. While not a pollutant, there is also potential for small increases in temperature in close proximity to the extraction points of the ventilation outlets.

An overall slight improvement in regional air quality would be expected from the Project compared to the without the Project.

### 19.5.4 Socio-economic impacts

#### Socio-economic

The Project would support the achievement of the transport and transit outcomes in the SEQ Regional Plan by fostering compact urban form and connecting communities. The Project would support a sustainable approach to population growth, and the ongoing role and function of the Brisbane CBD as the primary centre for commerce and employment in Queensland. Future, sustainable population and employment growth in these areas would benefit from high quality public transport connections offered by the Project.

Permanent changes to the social environment include the minor loss of some open space at Victoria Park north of the ICB, and changes to areas around the Project stations (such as improved streetscape). In particular, the Project may act as a catalyst for the revitalisation of the areas surrounding the stations, leading to opportunities for the establishment of new businesses to capitalise on the increased pedestrian activity accessing the stations.

In the long-term, the Project would provide for faster, more frequent and reliable bus and train services to the Brisbane CBD and inner city areas from across South East Queensland. The Project would also provide three new inner city stations that would support growing populations and changing social environments, such as at Woolloongabba.

In addition, the Project would improve access to prominent regional infrastructure and areas of social importance such as the Brisbane Cricket Ground (Gabba Stadium), QUT Gardens Point, the Queen's Wharf Brisbane development and Roma Street Parkland.

### Land use

The Project would assist in improving regional and local passenger movements and support state, regional and local planning frameworks. The Project's integration with existing and planned public transport and land use in key locations, such as Boggo Road Urban Village, Woolloongabba, George Street and around the Roma Street Station precinct, improves accessibility and encourages public transport usage thereby further supporting State, regional and local planning intents.

Through the provision of improved public transport accessibility and efficiency, the Project would encourage the intensification of land uses around the new stations. Any redevelopment would be consistent with the development controls and intents set out in the relevant State and local government planning frameworks, including the SEQ Regional Plan and the Brisbane City Plan 2014.

The Project would not require the acquisition of privately owned land for the Project's surface elements. On the surface, the Project would occupy land currently owned by the State Government and Government owned corporations and used for open space, offices, transport infrastructure, health education and car parking. Most of these uses could be re-established at alternative locations. Sub-surface volumetric acquisitions would be required for the Project and would coincide with the tunnel and underground station caverns.

#### 19.5.5 Groundwater impacts

The potential for groundwater drawdown with the Project would occur around the drained sections of the tunnel and the underground stations. The extent of groundwater drawdown has been predicted for one, five and 10 years following tunnel construction. The rate of groundwater inflow into the drained sections of the tunnel is predicted to decrease over time after an initial high peak in the first year. The average groundwater inflows during operation is approximately 11ML/year.

In drained tunnel areas, steep vertical downward hydraulic gradients are predicted to develop between the alluvial aquifer and the fractured rock aquifer in proximity to the tunnel sections of the Project. Leakage of groundwater may occur from the alluvial aquifer to the fractured rock aquifer and ultimately to the tunnel.

Existing groundwater quality in the study corridor is variable and can be brackish to saline in quality. As a result of drainage of groundwater into the tunnel over time, there is the potential for movement of this brackish zone towards the tunnel. Discharge of saline water to the tunnel has the potential to impact upon the tunnel through the corrosion of concrete drains or potential precipitation (scaling) of calcium carbonate contributing to the clogging of concrete drainage systems. This potential issue would be addressed during detailed design and the Project's ongoing operational inspection and maintenance program.

#### 19.6 Cumulative impacts

The cumulative impacts of the Project during operation are predicted to be beneficial at the local, neighbourhood, metropolitan and regional levels over the long-term, offsetting short-term construction impacts. Beneficial long-term cumulative impacts would involve greater public transport access for commuters particularly from the south, reductions in forecast traffic congestion on main roads and reductions in forecast air and noise emissions due to increased public transport usage.

Short-term cumulative impacts experienced during construction of the Project would relate to the combined effects of noise, vibration, dust and traffic causing disruption, nuisance and loss of amenity within local communities in proximity to the Project's construction worksites. Through adoption and implementation of effective environmental management measures, a reasonable environment for living and working would be achieved for local communities surrounding construction worksites.

Construction of the Project is likely to occur concurrently with construction of a number of projects, including developments within the Boggo Road Urban Village, Queen's Wharf Brisbane and One William Street. Although not uncommon, particularly within the Brisbane CBD, construction of multiple major projects at the same time and in similar locations has the potential to increase cumulative impacts relating to disruption, nuisance and loss of amenity. There is a need for coordinated construction management in the Brisbane CBD for the Project and Queen's Wharf Brisbane once construction commences particularly with regards to traffic management. A working group comprising the Queensland Government, represented by the DTMR and DSDIP, and the Brisbane City Council would be established to prepare and implement a CBD Construction Traffic Management Plan to address the effects of construction traffic in the CBD, especially in the area bounded by Elizabeth Street, Albert Street, Alice Street and William Street.

During detailed design, the Proponent would consult with the various entities responsible for these projects in order to integrate connectivity and functionality between these developments so as to fully realise the combined significant economic and social benefits. During construction of the Project, the proponent would work closely with the entities responsible for the other projects having overlapping construction periods, in the preparation of detailed construction methods to address potential cumulative impacts.

## 19.7 Environmental management and sustainability

A Draft Outline Environmental Management Plan (EMP) has been prepared that sets out the Project's approach to environmental management. It establishes environmental design principles for the Project and environmental objectives and performance criteria for the construction and commissioning phases. It also provides outline mitigation measures to maintain the environmental values of the study corridor.

The Draft Outline EMP comprises a Draft Construction EMP (CEMP), which outlines the approach to environmental management for the Project's construction phase, as well as a Draft Commissioning EMP (Commissioning EMP), which outlines the approach to environmental management for the Project's commissioning phase. The draft outline EMP is intended to guide the development of more detailed EMPs and relevant sub-plans prepared by the Proponent, prior to commencement of the Project's construction. In preparing the detailed EMPs and sub-plans, the Proponent must consider any conditions imposed as part of the Coordinator-General's Evaluation Report. Any conditions imposed by the Coordinator-General would prevail over a provision in the Draft Outline EMP.

Generally, the CEMP would contain details on the management of issues associated with:

- transport
- soils, topography and drainage
- contaminated land
- landscape and visual amenity
- ecology
- groundwater
- surface water quality
- flooding
- air quality
- noise and vibration
- waste
- indigenous heritage
- non-indigenous heritage
- socio-economic
- hazards and risks

As a public transport project, the Project would deliver direct sustainability benefits. These include supporting the adoption of more sustainable travel patterns through the provision of high quality public transport infrastructure that would be integrated with areas of high density development or areas of proposed future high density development. In addition to the Project's sustainability deliverables, a range of specific initiatives which would lead to sustainable and efficient outcomes has been considered and incorporated in the Project's design.

Sustainability measures incorporated in the reference design to date include:

- ventilation systems designed to minimise energy consumption, while achieving acceptable air quality outcomes in both the ambient environment and the Project underground stations and tunnel system
- a design that is adaptable to conditions that may arise as a result of climate change, including accommodating the predicted 0.8m sea level rise scenario in 2100
- the design of underground stations and public spaces developed as part of the Project incorporate crime prevention through environmental design (CPTED) principles to maximise commuter safety
- a minimalist design with regard to the height and bulk of above-ground infrastructure, so as to avoid or minimise its impact on the visual amenity of the locality, while always achieving its functional requirements
- the incorporation of landscaping, urban design and public art treatments into the design of Project works at stations and thoroughfares accessing stations
- measures to reduce water demand, e.g. minimising the use of potable water in construction, measures to protect water quality and reducing the risk of flooding, e.g. tunnel and station design and waterproofing to limit movement of contaminated groundwater
- integration with existing transport nodes, other infrastructure and land use to maximise efficiency in travel, patronage and viability.

Further sustainability measures to be considered and advanced (where feasible) through the detailed design process include water efficient and energy efficient (renewable energy) alternatives, minimising spoil generation and investigating opportunities for the re-use of spoil in the construction of the Project.

## 19.8 Recommendations

The Project addresses the significant need to increase the capacity of public transport infrastructure across the Brisbane River to access the inner city areas of Brisbane, particularly the CBD. Parts of the current train and bus networks are operating at capacity during peak periods resulting in congestion, increases in travel times, reduction in on-time reliability and overcrowding. This situation will deteriorate in the future without investment in public transport infrastructure.

Commonwealth, State and local strategic policy frameworks recognise the need to augment the current public transport network to accommodate the future growth forecast for the region. The Project would address the strategic transport outcomes being sought by these policy frameworks.

The Project would provide an additional river crossing to the rail and bus networks resulting in substantial improvements to network capacity. This allows for growth in rail and bus services resulting in increased public transport passenger movements.

Having regard to the findings of the EIS with respect to the beneficial and adverse impacts of the Project, the following recommendations are made to the Coordinator-General:

### Recommendation 1

That the Project should be approved to proceed subject to:

- i. detailed design consistent with the Queensland Government's objectives for sustainable development and with the environmental framework presented in the EIS
- ii. detailed design embracing an innovative approach in seeking to resolve, to the extent feasible, the potential or predicted impacts of the reference design, particularly with regard to construction impacts on local residents
- iii. developing and implementing detailed environmental management plans for the construction and commissioning phases of the Project, where such plans adopt the principles, objectives and performance goals, set out in **Chapter 18 - Draft Outline EMP** as well as any Coordinator-General conditions
- iv. developing, implementing and maintaining effective mitigation measures to address and mitigate the impacts of the Project on local communities set out in **Chapter 18 - Draft Outline EMP**.

### Recommendation 2

It is further recommended to the Coordinator-General that:

- i. all necessary approvals and permits be obtained for the Project, including, but not limited to, those required under the *Sustainable Planning Act 2009*, the *Transport Infrastructure Act 1994* and related Acts, the *Aboriginal Cultural Heritage Act 2003* and the *Environmental Protection Act 1994*
- ii. measures are investigated to coordinate the construction and delivery of the Project concurrently with a number of other major projects, including developments within Boggo Road Urban Village, Queen's Wharf Brisbane and One William Street.

The Coordinator-General is requested to assess this EIS, and in preparing an evaluation report:

- i. recommend that the Project proceed
- ii. state the conditions for the Project under section 39 of the *State Development and Public Works Organisation Act 1971*
- iii. where there is no other relevant subsequent approval, impose conditions on the Project where identified as relevant environmental mitigation and management measures in this EIS, under section 54B of the *State Development and Public Works Organisation Act 1971*.