BaT project

Chapter 16
Hazard and risk

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16. Hazard and risk

16.1 Introduction

The purpose of this chapter is to identify and describe the hazards and risks associated with the Project which have the potential to cause adverse impacts to the health and safety of people, and damage to property within and surrounding the study corridor.

This chapter addresses section 10.23 to section 10.27 of the Terms of Reference (ToR).

16.1.1 Methodology

This assessment focusses on the study corridor defined in **Chapter 1 – Introduction**, however, consideration was also given to impacts outside of the study corridor, where relevant.

An assessment of Project related hazards and risks has been undertaken in accordance with Australia/New Zealand Standard (AS/NZS) ISO 31000: 2009 Risk Management – Principles and Guidelines. This includes:

- hazard and receptor identification
- risk analysis
- risk evaluation
- risk treatment.

Hazard and receptor identification

A hazard is something that may harm a receptor, being a natural, built or social aspect of the environment. Hazards considered by the assessment include those that may arise in either the construction or operational phases of the Project, and include accidents, spills, fire and abnormal events as well as hazardous chemicals used, stored, processed or produced during delivery. Receptors included people and property, with additional, more relevant chapters assessing risks to the natural environment and heritage. This includes flooding (refer to **Chapter 9 – Hydrology**) and noise and vibration (refer to **Chapter 11 – Noise and vibration**).

Risk analysis

The analysis of risk considers the consequence and likelihood of harm. Typically the risk analysis assumes actions to manage harm are not undertaken or present. Criteria to compare and evaluate Project risks were developed and are detailed in **Table 16-1** and **Table 16-2**.

Table 16-1 Criteria for likelihood

Risk Element	Rating	Definition
Likelihood	Rare	Probability of occurrence 5 per cent or less
	Unlikely	Probability of occurrence between 6 per cent and 30 per cent
	Possible	Probability of occurrence between 31 per cent and 60 per cent
	Likely	Probability of occurrence between 61 per cent and 90 per cent
	Almost Certain	Probability of occurrence 91 per cent or greater

Table 16-2 Criteria for consequence

Risk Element	Rating	Definition	
		People	Property
Consequence	Insignificant	No injury	No property damage Nuisance not exceeding standards
	Minor	One or more minor injuries	Slight/ temporary damage and change in exposure levels to one or more properties Temporary nuisance exceeding standards
	Moderate	One serious injury	Significant but temporary damage to property Nuisance exceeding standards
	Major	2-10 serious injuries	Sustained damage to property lasting many months Nuisance which may not be able to be mitigated
	Severe	One or more fatalities	Long term and possible permanent loss of property Nuisance which cannot be mitigated

Risk evaluation

The risk of harm may be evaluated through semi-quantitative methods. This approach standardises the assessment of risk and priority for management. An overview of the matrix used in the evaluation of Project risk is provided in **Table 16-3**.

Table 16-3 Risk matrix

Likelihood (frequency)	Consequence (impact)				
	Insignificant	Minor	Moderate	Major	Severe
Almost Certain	Medium	High	High	Extreme	Extreme
Likely	Medium	Medium	High	High	Extreme
Possible	Low	Medium	High	High	High
Unlikely	Low	Low	Medium	Medium	High
Rare	Low	Low	Medium	Medium	High

Risk treatment

The level of risk identified during assessment is used to determine the requirement and extent of treatment/ management. Levels of risk and the approach to management on the Project were subsequently defined as:

- extreme – excessive risk to people and property requiring significant and urgent actions to reduce or avoid the risk
- high and medium – implement mitigation measures to reduce the risk to as low as practicable
- low – monitor and manage the risk to the extent necessary.

Residual risks are typically re-assessed after management has been applied. This considers the effectiveness of applied actions and whether the remaining risk is acceptable. Additional actions may be applied if the residual risk is too high. This approach has been applied during the assessment of Project risks with an outline of the proposed integrated emergency management planning procedures provided in **section 16.4**.

16.1.2 Legislative and policy framework

The Commonwealth and State legislation, policies, standards and guidelines relevant to the assessment of hazards and risks include:

- AS/NZS ISO 31000: 2009 Risk Management – Principles and Guidelines
- *Work Health and Safety Act 2011*
- *Work Health and Safety Regulation 2011*
- *Transport (Rail Safety) Act 2010*
- AS 1940 Storage and Handling of Flammable and Combustible Liquids
- AS 2187 Explosives – Storage, Transport and Use
- AS 2670 Evaluation of Human Exposure to Whole-body Vibration
- Australian Dangerous Goods (ADG) Code.

Although not directly applicable to the Project, the Queensland State Planning Policy (SPP) provides guidance on the requirements for risk management within the community.

16.2 Existing environment

The study corridor is located within the inner suburbs and the Brisbane Central Business District (CBD). This area includes residential communities, retail, commercial and industrial business, health facilities, public open space and infrastructure such as rail, road and public utility plant.

The receptors within the study corridor that could be potentially exposed to Project hazards include:

- residential communities, heritage places, health facilities and other sensitive receptors adjacent to the stations, ventilation outlets, dive structures, temporary construction worksites, transport routes and spoil placement areas
- commuters who would use the bus and train networks associated with the Project
- motorists, pedestrians and cyclists who use the existing pedestrian, road, bus and train networks surrounding the Project
- the workforce constructing and operating the Project.

16.3 Impact assessment

An assessment of Project related hazard and risks was undertaken in accordance with the method described in **section 16.1.1**. A number of potential risks were identified, analysed and subsequently evaluated with a ranking between ‘high’ and ‘low’. There were no risk scenarios identified with a risk ranking of ‘extreme’.

All risks are presented in the risk register (refer to **Appendix J**) with further discussion on those with a ranking of high or greater provided as follows.

16.3.1 Identification

Construction

The assessment identified a number of construction activities that may generate or result in hazards. They include:

- operation of vehicles and construction equipment in the confined tunnel and station areas, leading to the potential for spillages, fire, poor air quality and collisions
- storage of hazardous substances in relatively compact construction worksites
- construction failures and accidents including tunnel and station collapse or subsidence, flooding and worker injuries and death
- the use of oils, fuels and other hazardous chemicals including explosives, and their transport to construction areas
- possible underground inflow of pollutants such as hydrocarbons and toxic chemicals
- the transport of excavated materials to disposal areas
- tunnel boring that may generate vibration causing property damage within the study corridor.

Hazardous chemicals

Hazardous chemicals can pose a risk to the health and safety of communities and individuals, and the natural and built environment. These risks require adequate management to avoid the potential for adverse impacts.

Hazardous chemicals are defined as substances that, because of their chemical, physical and/ or biological properties, have the potential to cause harm to persons, property, or the environment. Dangerous goods are defined under the *Work Health and Safety Act 2011* (schedule 1, part 1, item 1 (6)). Flammable or combustible substances are defined as per the *Work Health and Safety Regulation 2011* (Section 53 (2)).**Table 16-4** identifies potential hazardous chemicals likely to be used, stored, processed or produced during construction of the Project.

Table 16-4 Hazardous chemicals

Hazardous chemical	Potential uses	Description of usage
Explosives	Explosives may be required where the drill and blast construction method is employed for sections of tunnel and underground station construction. The use, transport and storage of explosives if required will be in accordance with AS 2187 Explosives – Storage, Transport and Use.	May be required where drill and blast construction method is employed for sections of tunnel and underground station caverns.
Oils and lubricants	Oils and lubricants used in construction and maintenance activities. Oils and lubricants are generally classified as combustible liquids. Accordingly, these substances shall be stored and handled in accordance with AS1940-2004 The storage and handling of flammable and combustible liquids.	Small volumes required for maintenance works of fixed and mobile infrastructure.

Hazardous chemical	Potential uses	Description of usage
Diesel fuel and petroleum fuels	Construction equipment and trucks. These products are generally classified as flammable and combustible liquids. Accordingly, these substances shall be stored and handled in accordance with AS1940-2004 The storage and handling of flammable and combustible liquids.	Fuels contained within construction equipment used during construction phase.
Flammable gases	Welding gases may be required for construction and maintenance activities. The transport, use and storage of flammable gases will be in accordance with AS4332-2004 The storage and handling of gases in cylinders.	Small volumes of welding gases may be required during construction and maintenance activities.
Hydraulic fluids	Hydraulic fluids contained in machinery and equipment (e.g. excavators, cranes and lifting equipment). These products are generally classified as flammable and combustible liquids. Accordingly, these substances shall be stored and handled in accordance with AS1940-2004 The storage and handling of flammable and combustible liquids.	Small volumes of hydraulic fluids contained within machinery and equipment may be required during construction and maintenance activities.
Chemical substances	A number of chemical substances will be required during the construction of the Project. Where various classes of dangerous goods are to be stored in a designated Hazardous Chemical Store, this storage area shall be designed and constructed in accordance with AS/NZS 3833-2007 The storage and handling of mixed classes of dangerous goods in packages and intermediate bulk containers.	Small volumes of chemical substances may be stored within dedicated chemical storage areas.
Cement and Concrete Batching	Will be required during construction. The use and storage of cement and concrete batching shall be in accordance with *AS3780-2008 The storage and handling of corrosive substances.*	Will be transported, used and stored during construction.
Bitumen/ asphalt	Will be required during construction. Bitumen or asphalt is classified as a Class 9 Substance and should be managed in accordance with *AS/NZS 4681-2000 The storage and handling of Class 9 – miscellaneous substances*. Where heated it may also be classified as a combustible liquid, and therefore, AS1940 will also apply.	Will be transported, used and stored during construction.

Operation

The risk assessment undertaken for the EIS identified a number of operational activities that may generate or result in hazards. They include:

- passenger safety incidents including personal safety and injury
- staff and vehicle accidents and incidents in the tunnel including during maintenance works
- major train or bus incidents including derailment, collision and fire
- acts of terrorism[1] leading to major fires and explosions resulting in injury to passengers and staff

[1] Includes violence or threats of violence, especially bombing, kidnapping, and assassination, carried out for political purposes.

- tunnel and other structural components fail, collapse or subsidence including station and tunnel ventilation failure
- maintenance in a live rail corridor
- flooding and inundation from both surface and groundwater sources.

16.3.2 Analysis and evaluation

Construction

Analysis and subsequent assessment identified a number of hazards (refer to **Table 16-5**) that have the potential to result in 'high' risks.

Table 16-5 'High' risks during construction pre-mitigation

Risk register ref	Description of risk	Impacts assessed	Risk evaluation (pre-mitigation)		
			L'hood*	Cons**	Risk
1	Tunnel collapse or ground subsidence during tunnel excavation/ construction activities	Health and safety Property damage	P	S	H
2	Fire or explosion in tunnel during excavation activities	Health and safety Property damage	P	S	H
3	Exposure to noxious or toxic atmospheres during construction due to fire	Health and safety Property damage	P	S	H
16	Cranes and lifting equipment interfering with air traffic leading to potential fatalities	Health and safety Property damage	R	S	H
17	Rollingstock accident on existing rail lines due to communication failure, signal failure or changed conditions during construction leading to injury or potential fatality to Queensland Rail staff, passengers, public and/ or construction workers on adjacent construction worksites	Health and safety Property damage	U	S	H
18	Work within a live rail environment leading to potential injury or fatality to construction workers	Health and safety	U	S	H
20	Inadequate emergency response resulting in increased impact to people in an emergency situation during the construction of the Project	Health and safety Property damage	U	S	H
22	Vibration during tunnelling leading to potential sleep disturbance to local community	Health and safety Property damage	LI	MA	H
25	Storage, handling, use and transportation of hazardous substances or dangerous goods leading to injury or illness to construction personnel or the public	Health and safety	U	S	H
26	Release of hazardous chemicals as a result of a natural hazard event e.g. a flood leading to adverse health and safety effects to construction personnel or the public	Health and safety	U	S	H

*Note: *L'hood refers to likelihood; **Cons refers to consequence*

R = Rare; U = Unlikely; P = Possible; LI = Likely

S = Severe; MA = Major; H = High

The construction phase hazard scenarios identified with a pre-mitigation 'high' risk rating include tunnel collapse/ subsidence and tunnel fire. Due to the nature and extent of construction activities for the Project, the potential consequence of these risk scenarios is not insignificant. The hazard scenarios are typical of major construction projects that would be expected where mitigation measures, as detailed in **section 16.4**, are not implemented.

Operation

Analysis and subsequent evaluation identified a number of hazards (refer to **Table 16-6**) that have the potential to result in 'high' risks.

Table 16-6 'High' risks during operation pre-mitigation

Risk register ref	Hazard scenario	Impacts assessed	Risk evaluation (pre-mitigation)		
			L'hood*	Cons**	Risk
2	Inadequate emergency response resulting in increased impact to people and property in a potential emergency situation during the operation of the Project	Health and safety Property damage	U	S	H
9	Fires leading to injury/ possible fatality and/ or damage to property/ environment	Health and safety Property damage	U	S	H
10	Exposure to noxious or toxic atmospheres to users of the tunnel due to fire leading to adverse health and safety impacts	Health and safety Property damage	U	S	H
11	Terrorist attack on public transport infrastructure	Health and safety	R	S	H
16	Traffic accident involving pedestrians, cyclists or vehicles	Health and safety	R	S	H
20	Train accident/ collisions within the tunnel or portal	Health and safety Property damage	U	S	H
21	Bus accident/ collisions within the tunnel or portal	Health and safety Property damage	U	S	H
22	Injury or fatality at an underground station platform due to impact from rollingstock	Health and safety	R	S	H

*Note: *L'hood refers to likelihood; **Cons refers to consequence*

R = Rare; U = Unlikely

S = Severe; H = High

Hazards during operation of the Project generally include accidents or collisions involving rollingstock or fires in the tunnel. Given the volume of people and nature of properties affected by the Project, the potential consequence of these risk scenarios is not insignificant. However, these are hazard scenarios typical of major tunnelling projects that would be expected where mitigation measures, as detailed in **section 16.4**, are not implemented.

16.3.3 Summary

The preliminary risk assessment has identified a number of potential hazards to people and property arising from the Project's construction and operation. The application of mitigation measures generally would reduce the risk rating of the hazard and lower the residual risk. The most significant risks identified in this assessment are associated with the need to evacuate the tunnel and stations in the event of an emergency situation (e.g. tunnel collapse, tunnel fire).

The cumulative impact of other infrastructure projects (e.g. Legacy Way) and future infrastructure projects (e.g. Queen's Wharf Brisbane) has been considered in the preliminary risk assessment. To mitigate these cumulative impacts (e.g. community concerns regarding change in exposure levels and decreased public health), a number of controls are proposed for the Project. Cumulative impacts will be considered in the development of the construction methodology for the Project. The Project's cumulative impacts, both in terms of impact over time and impact in combination with other infrastructure projects, is discussed in **Chapter 17 – Cumulative impacts**.

16.4 Impact management

Risk management is a continual process which requires treatment, monitoring and review. The Project has committed to an ongoing process of risk management, which would include the development of a Risk Management Plan by the Proponent to identify the roles and responsibilities of specific personnel during construction and operation.

The preliminary risk assessment would form the basis of the Risk Management Plan, which would be prepared in consultation with the Department of Community Safety in cooperation with the Coordinator-General and should consider the requirements of the Hazard and Risk Assessment Planning Scheme Policy of the Brisbane City Plan 2014.

The risk register (refer to **Appendix J**) describes the control measures for the range of risk scenarios during the construction and operation of the Project. These control measures are designed to reduce the likelihood of the identified hazards, or reduce the severity of the consequences resulting from the identified hazards, to people and property within and adjacent to the Project.

Following the application of control measures, the likelihood ratings for the 'high' risk scenarios have been reduced to 'rare' or 'unlikely'. However, the consequence rating of any event which has the potential to result in a fatality; long-term and possible permanent loss of property; or nuisance which cannot be mitigated, is rated as 'severe' in line with the risk assessment criteria defined in **Table 16-2**.

Therefore, there are a number of risks with a residual consequence rating of 'severe'. Overall, the residual risk ranking of any hazard with a 'rare' or 'unlikely' likelihood but a 'severe' consequence is considered to be a 'high' risk. Management measures will be implemented to reduce these risks to as low as reasonable practicable and will be subject to continue refinement during Project construction and operation.

An overview of measures specific to the 'high' risks identified during construction and operation are provided as follows.

16.4.1 Construction

Actions to manage construction risks with a ranking of 'high' are described in **Table 16-7**.

Table 16-7 Management measures for post-mitigation 'high' risks during project construction

Risk register reference	Impact	Management measure	Risk analysis (post-mitigation)		
			L'hood*	Cons**	Risk
1	Tunnel collapse or ground subsidence during tunnel excavation/ construction activities	• Targeted site-specific ground investigations • Geotechnical investigations to be analysed to determine most appropriate design and construction method for the conditions • Ground investigations will consider: ground conditions; effects of vibration from the tunnel boring machine; effects of excavation close to weathered zones; tunnel face stability analysis; other tunnels, existing utility lines and deep foundations need to be addressed in the early planning stages • The Project will implement appropriate measures to mitigate any detrimental effects to other infrastructure • Monitoring and analysis during construction • Safety Management Plan, Emergency Response Plan/ Procedures and incident management procedures to be developed to manage such a situation • Emergency training and coordination with State emergency departments	R	S	H
2	Fire or explosion in tunnel during excavation activities	• Safety Management Plan, Emergency Response Plan/ Procedures and incident management procedures to be developed to manage such a situation • Emergency training and coordination with State emergency departments • Confined space controls including gas detection, adequate ventilation • Cold cutting methods used in known presence of potential flammable atmospheres	R	S	H
3	Exposure to noxious or toxic atmospheres during construction due to fire	• Safety Management Plan, Emergency Response Plan/ Procedures and incident management procedures to be developed to manage such a situation • Emergency training and coordination with State emergency departments • Confined space controls including gas detection, adequate ventilation	U	MA	M

Risk register reference	Impact	Management measure	Risk analysis (post-mitigation)		
			L'hood*	Cons**	Risk
16	Cranes and lifting equipment interfering with air traffic leading to potential fatalities.	• Compliance with OLS standards for Archerfield Airport and Brisbane Airport Operational Airspace requirements	R	S	H
17	Rollingstock accident on existing rail lines due to communication failure, signal failure or changed conditions during construction leading to injury or potential fatality to Queensland Rail staff, passengers, public and/ or construction workers on adjacent construction worksites	• Proponent to develop and implement a traffic/ public/ commuter management plan • Proponent to implement a safety management plan and an emergency response plan • Communication procedures to be developed and implemented between Proponent and rail operator to provide advanced notification of changed conditions to rail operator and staff • Provide alternative transport/ services, if required • Adherence to railway speed restrictions in the vicinity of Project works, where required • Construction methodology to comply with Queensland Rail standards in terms of track isolations	R	S	H
18	Work within a live rail environment leading to potential injury or fatality to construction workers	• Risk Management Plan is to establish procedures for communication with all Project stakeholders, including Queensland Rail • Appropriate training provided on the hazards associated with work within a live rail environment • Permitting systems issued on the basis of a risk assessment prior to work activity commencing in line with legislation requirements • Isolation of rail electrical infrastructure prior to undertaking works (where possible) • Track Protection Officer to be present during high risk construction works if required	R	S	H

Risk register reference	Impact	Management measure	Risk analysis (post-mitigation)		
			L'hood*	Cons**	Risk
20	Inadequate emergency response resulting in increased impact to people in an emergency situation during the construction of the Project	• Risk Management Plan is to establish procedures for communication with all Project stakeholders, Queensland Rail, Brisbane City Council, Translink Transit Authority, Department of Community Safety etc. • Safety Management Plan and Emergency Response Plan/ Procedures to be developed for implementation during emergency situation • Consultation with Queensland Fire and Emergency Services (QFES) in the development of plans to ensure access and management requirements are appropriately addressed • Roles and responsibilities are to be clearly stated and understood by all parties involved • Training exercises to be undertaken to determine the adequacy of the Emergency Response Plan/ Procedures and improvements made where identified • Within 12 months of the commencement of construction works, a simulated emergency response exercise is to be conducted in conjunction with the Department of Community Safety (DSC), on at least one occasion	R	S	H
22	Vibration during tunnelling leading to potential sleep disturbance to local community	• Undertake dilapidation surveys to be conducted prior to construction as well as detailed modelling to determine the area of influence • Communication procedures developed and implemented which facilitate ongoing community consultation with potentially affected communities to assist in determining best mitigations • Where sleep disturbance is proven to be caused and unable to be mitigated, residents may need to be temporarily relocated during certain periods of construction, where necessary • Complaints process implemented through the Construction EMP • Monitoring of vibration to be undertaken, where appropriate (i.e. consistent with the principles outlined in the Construction EMP)	U	MA	M

Risk register reference	Impact	Management measure	Risk analysis (post-mitigation)		
			L'hood*	Cons**	Risk
		• Use alternative, less intrusive construction techniques where practicable e.g. cut and cover construction techniques at portals • Baseline monitoring of vibration to establish existing conditions and monitoring to measure the impact of the Project			
25	Storage, handling, use and transportation of hazardous substances or dangerous goods leading to injury or illness to construction personnel or the public	Each hazardous chemical storage facility shall be designed and constructed with the applicable Australian Standards and shall specifically address the following key requirements: • separation distances in relation to protected works, on-site facilities and boundaries • use of firewalls (where required) and fire protection provisions against the relevant standards and regulations • specific spill containment measures in accordance with the relevant Australian Standards • ventilation requirements (natural or mechanical) to achieve compliance under the relevant Dangerous Goods Regulations and Standards • bulk containers and bulk storage, e.g. diesel fuel tanks, cement silos, bitumen storage vessels • ensure that the storage of flammable and combustible liquids complies with AS 1940 and the *Work Health and Safety Act 2011* • transfer points and related spill containment	R	S	H
26	Release of hazardous chemicals as a result of a natural hazard event e.g. a flood event leading to adverse health and safety effects to construction personnel or the public	• Storage in accordance with the *Work Health and Safety Act 2011* and *Work Health and Safety Regulation 2011* • Specific control measures for the management of accidental discharge of hazardous chemicals would be determined during detailed design in accordance with the relevant requirements	R	S	H

Risk register reference	Impact	Management measure	Risk analysis (post-mitigation)		
			L'hood*	Cons**	Risk
		• A comprehensive water quality monitoring plan and contingency plan would be detailed during Project development. This would be in accordance with requirements under the Department of Transport and Main Roads Technical Specification 51 – Environmental Management (MRTS51). MRTS51 details the specific requirements for the management of accidental discharge of contaminants • A combination of one or more management measures may be employed, including oil and grit separators, gross pollutant traps, trash racks, screens, detention basins, sand filters, filter strips, buffer zones, grassed swales and water quality ponds (Treatment and control measures for the management of accidental discharge of contaminants are discussed in more detail in **Chapter 9 – Hydrology**)			

*Note: *L'hood refers to likelihood; **Cons refers to consequence*

R = Rare; U = Unlikely

S = Severe; MA = Major

M = Medium; H = High

16.4.2 Operation

Actions to manage operational related risks with a ranking of 'high' are described in **Table 16-8**.

Table 16-8 Management measures for post-mitigation 'high' risks during project operation

Risk register reference	Impact	Management measure	Risk analysis (post-mitigation)		
			L'hood*	Cons**	Risk
2	Inadequate emergency response resulting in increased impact to people and property in a potential emergency situation during the operation of the Project	• Safety Management Plan and Emergency Response Plan/ Procedures to be developed and deployed efficiently • Consultation with QFES in the development of these plans to ensure their access and management requirements are captured appropriately • Training exercises to be undertaken to determine the efficiency of the Emergency Response Plan/ Procedures and improvements made where identified • Fire and life safety (including ventilation for emergency conditions) addressed in the Project design	R	S	H
9	Fires leading to injury/ possible fatality and/ or damage to property/ environment	• Ventilation system that allows for normal operations as well as emergency fire conditions • The fire and life safety design of the system has been designed for a number of fire scenarios including bus fire, train fire, undercar fire, track way fire, platform or concourse fire • Maintenance schedule and procedures to be developed by operator to ensure efficient operation of plant and equipment • Consultation with QFES and Queensland Rail to ensure acceptable fire and life safety considerations for future rolling stock specifications • Consultation with QFES and Brisbane Transport and Translink Transit Authority to ensure acceptable fire and life safety considerations for proposed future bus vehicles • Operator to develop and implement incident management procedures including Emergency Response Plan/ Procedures	R	S	H

Risk register reference	Impact	Management measure	Risk analysis (post-mitigation)		
			L'hood*	Cons**	Risk
10	Exposure to noxious or toxic atmospheres to users of the tunnel due to fire leading to adverse health and safety impacts	• Ventilation systems are designed to ventilate the underground stations and tunnels and to control and extract smoke during emergency fire scenarios • Ventilation outlets to be located away from sensitive receptors to prevent impacts during fire incidents • Fire and life safety passenger management suite of management measures • Ventilation equipment is located at each end of the underground stations	R	S	H
11	Terrorist attack on public transport infrastructure	• Operator to develop and implement incident management procedures including Emergency Response Plan/ Procedures • Adopt appropriate counter terrorism measures (e.g. surveillance procedures, security etc.)	R	S	H
16	Traffic accident involving pedestrians, cyclists or vehicles	• Design to incorporate appropriate pedestrian and cycle linkages to the stations including the addition of safety features such as traffic islands and designated crossings	P	MI	M
20	Train accident/ collisions within the tunnel or connection	• Implementation of the European Train Control System (ETCS L2) has been incorporated for the underground sections of the Project. This system incorporates Automatic Train Protection to maximise safety and virtually eliminates risk of derailment and collision • The Project rail systems design incorporates the existing Queensland Rail 25kV traction and overhead electrification system and allows for integration with the existing signalling and communication system • Consideration of inter-operability with the existing rail network and systems • Regular maintenance of rail infrastructure (including track, signals and associated infrastructure) in accordance with relevant standards • Rail lines separated by barrier • Experienced drivers and driver training	R	S	H

Risk register reference	Impact	Management measure	Risk analysis (post-mitigation)		
			L'hood*	Cons**	Risk
21	Bus accident/ collisions within the tunnel or portal	• Consideration of inter-operability with the existing bus network and systems • Regular maintenance of bus infrastructure (including roads, signals and associated infrastructure) in accordance with relevant standards • Experienced drivers and driver training	R	S	H
22	Injury or fatality at an underground station platform due to impact from rollingstock	• Automated platform screen doors at all underground stations	R	S	H

*Note: *L'hood refers to likelihood; **Cons refers to consequence*

R = Rare; P = Possible

S = Severe; MI = Minor

M = Medium; H = High

16.4.3 Emergency management planning

Integrated management planning procedures (including evacuation plans) would be developed for the range of emergency situations identified throughout the risk assessments conducted for the Project.

Emergency management plans for the Project will integrate the responses of the owners and operators of the rail and bus infrastructure, rollingstock, rail track and passenger services, with those of the station managers and local emergency response agencies.

The proposed integrated emergency management planning procedures (including evacuation plans) are to include strategies to address:

- evacuation routes from tunnel and above and underground stations including disabled access
- procedures in the event of a fire, spillage or flooding event
- procedures in the event of a collision within the tunnel
- procedures in the event of injuries or fatalities due to impact from rollingstock
- acts of terrorism
- roles and responsibilities of key personnel involved in the emergency response
- effective communication systems/ channels in the event of an emergency.

Emergency planning and response procedures are to be further developed during detailed design in consultation with state and regional emergency service providers for both the construction and operation phases of the Project.

Consultation

Consultation has been undertaken with relevant Queensland Government agencies, such as QFES, on issues such as fire and life safety (including emergency service access points to the stations), disability access and personal safety through design. Consultation has also been undertaken with relevant emergency management authorities, including the Local Disaster Management Group.

16.5 Summary

This preliminary risk assessment has identified and assessed a list of potential hazards to people and property arising from the Project's construction and operation presented in **Appendix J**. The risk register describes the control measures for the range of risk scenarios that would reduce the likelihood of the identified hazards, or reduce the severity of the consequences resulting from the identified hazards to people and property, within and adjacent to the Project.

Following the application of control measures, the likelihood ratings for the 'high' risk scenarios have been reduced to 'rare' or 'unlikely'. However, the consequence rating of any event which has the potential to result in a fatality; long-term and possible permanent loss of property; or nuisance which cannot be mitigated, is rated as 'severe' in line with the risk assessment criteria defined in **Table 16-2**.

Therefore, there are a number of risks with a residual consequence rating of 'severe'. Overall, the residual risk ranking of any hazard with a 'rare' or 'unlikely' likelihood but a 'severe' consequence is considered to be a 'high' risk. Management measures will be implemented to reduce these risks to as low as reasonable practicable and will be subject to continue refinement during Project construction and operation.

16.5.1 Construction

The hazard scenarios during the construction phase of the Project identified in **Table 16-5** as having a 'high' risk rating before consideration of the mitigation measures that are in place are tunnel collapse/ subsidence, tunnel fire and air traffic incident. **Table 16-7** provides a summary of the potential impacts and the management measures which result in a reduction of the likelihood and/ or severity of these risk scenarios. Emergency planning and response procedures will be prepared and implemented to cover those risks with a residual 'high' risk rating post-mitigation.

16.5.2 Operation

Project operation hazard scenarios identified as having a 'high' risk rating before consideration of the mitigation measures are presented in **Table 16-6**. These hazards include accidents or collisions involving rolling stock or fires in the tunnel. **Table 16-8** provides a summary of the potential impacts and the management measures which result in a reduction of the likelihood and/ or severity of these hazard scenarios.

Hazard scenarios with a residual risk of 'high' include property damage due to fire, acts of terrorism and accidents or collisions within the tunnel.