BaT project

Appendix J
Hazard and risk

Appendix J. Hazard and risk

Table J-1 Identified hazards and description of risks related to the Project

Ref	Identified hazard	Description of risk	Potential causes	Impacts assessed	Risk analysis (without mitigation)			Risk treatment	Risk analysis (with mitigation)		
					L'hood*	Cons**	Risk		L'hood*	Cons**	Risk
Project phase: construction											
1	Collapse or subsidence	Tunnel collapse or ground subsidence during tunnel excavation/ construction activities leading to: • potential fatality • damage to equipment within the tunnel • injury or illness to surrounding community leading to road closures or evacuation of residents • damage to buildings and infrastructure at ground level • damage to buried infrastructure (eg gas services lines, storm water drains,	Unexpected engineering fault High groundwater pressure Unexpected groundwater inflow Water path created by investigation drill hole Unexpected weathered rock at tunnel face	Health and Safety Property damage	P	S	H	Geotechnical investigations to be undertaken and analysed to determine most appropriate design and construction method for the conditions Detailed design and construction methods will consider: ground conditions; effects of vibration from tunnel boring machine (TBM); adjacent infrastructure effects of excavation close to weathered zones; tunnel face stability analysis; other tunnels, existing utility lines and deep foundations Ground conditions would be inspected as the work face progresses – local areas of instability would be pinned and meshed as required Best practice construction practices to be employed by construction team Safety management plan (SMP), 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

Ref	Identified hazard	Description of risk	Potential causes	Impacts assessed	Risk analysis (without mitigation)			Risk treatment	Risk analysis (with mitigation)		
					L'hood*	Cons**	Risk		L'hood*	Cons**	Risk
		deep foundations, other tunnels)									
2	Fire or explosion	Fire or explosion in tunnel during excavation activities leading to potential fatality and damage to property.	Inadequate confined space controls Inadequate gas monitoring Methane gas from a methane bearing fissure entering the tunnel Presence of ignition sources	Health and safety Property damage	P	S	H	Best practice construction practices to be employed by construction team 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 atmosphere	R	S	H
3	Exposure to noxious or toxic atmospheres	Exposure to noxious or toxic atmospheres during construction due to fire leading to adverse health and safety impacts to construction workforce.	Inadequate ventilation	Health and safety Property damage	P	S	H	Best practice construction practices to be employed by construction team 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
4	Dust generation	Excessive dust emissions generated by earthworks during construction affecting	Inadequate dust emissions controls	Health and safety	P	MI	M	Ongoing community consultation with affected landowners to provide opportunities for affected landowners to have input into mitigation	U	MI	L

Ref	Identified hazard	Description of risk	Potential causes	Impacts assessed	Risk analysis (without mitigation)			Risk treatment	Risk analysis (with mitigation)		
					L'hood*	Cons**	Risk		L'hood*	Cons**	Risk
		nearby residents.						measures Possible techniques could include the use of water trucks, dust screens, washing of houses, air conditioning (to reduce the need to open windows), offset distances, new technologies during construction that reduce the amount of dust produced			
5	Dust generation	Excessive dust emissions generated by spoil removal or transport affecting nearby residents.	Inadequate dust emissions controls	Health and safety	LI	MI	M	Conveyer belts (if used) will be enclosed to transfer spoil/ waste material into trucks/ carriages to avoid spills off conveyor Controls for material haulage, such as covering loads or wetting material to reduce airborne dust emissions	U	MI	L
6	Emissions	Elevated hydrocarbon concentrations at ground level due to construction and transport routes at nearest residential properties.	Inadequate emissions controls	Health and safety	LI	MI	M	Emission controls on plant and equipment during construction Selection of transport routes to consider air quality impacts on surrounding areas	U	MI	L
7	Cumulative impacts	Cumulative impacts of other developments (eg Woolloongabba, Boggo Road and RNA developments) impact on the project eg shared use of planned spoil haulage routes,	Inadequate traffic/ public/ commuter management plan	Health and safety	LI	MI	M	Impact of other developments to be considered during the development of the construction methodology for the Project Alternative 'backup' spoil haulage routes and site accesses to be developed where possible	U	MI	L

Ref	Identified hazard	Description of risk	Potential causes	Impacts assessed	Risk analysis (without mitigation)			Risk treatment	Risk analysis (with mitigation)		
					L'hood*	Cons**	Risk		L'hood*	Cons**	Risk
		traffic diversions, congestion leading to injuries or illness.									
8	Traffic accidents	Congestion and increased traffic generated as a result of the project leading to increased risk of traffic accidents and impacting kerbside activity safety, capacity and noise issues for local and regional routes.	Inadequate traffic/ public/ commuter management plan	Health and safety	LI	MI	M	Undertake detailed traffic and intersection analysis to determine traffic impacts of the Project Undertake construction site location assessments Comply with ADR81 noise testing for trucks Choose appropriate travel route and hours of haulage Develop contingency site access where possible Ongoing community consultation	U	MI	L
9	Traffic accidents	Traffic accident due to changed road conditions during construction (eg Increase in heavy vehicles on the road, traffic diversions, closures arising from construction parking and haulage route requirements) leading to injury to road users (including drivers/ pedestrians/ cyclists) and/ or construction	Lack of awareness of changed traffic conditions	Health and safety Property damage	LI	MI	M	Contractor to develop and implement a Traffic Management Plan Contractor to develop and implement a Safety Management Plan and an Emergency Response Plan Community notification of changed traffic conditions, appropriate use of road side signage indicating changed traffic conditions Reduction in posted speed limits adjacent to worksite areas if required Establish designated parking areas for construction team Community consultation on haul route requirements	U	MI	L

Ref	Identified hazard	Description of risk	Potential causes	Impacts assessed	Risk analysis (without mitigation)			Risk treatment	Risk analysis (with mitigation)		
					L'hood*	Cons**	Risk		L'hood*	Cons**	Risk
		workers.						Ensure construction haulage routes are planned prior to construction and that they are sufficient for the volume of traffic generated by the project Contractor to monitor compliance with using the approved haulage routes/ parking areas Contingency 'backup' routes to be developed where possible			
10	Road surface conditions	Damage to road surfaces due to construction traffic (eg haulage vehicles and construction equipment) and transport routes leading to unsafe road conditions for motorists.	Inappropriate haulage roads	Health and safety Property damage	U	MA	M	Ensure construction haulage routes are planned prior to construction using approved haulage routes Road surface assessment to be undertaken to assess appropriate haulage routes Regular road surface inspections throughout construction of the project	R	MA	M
11	Traffic accidents	Accidents involving pedestrian and cyclists during construction when crossing roads (eg Roma Street/ Alice Street/ CBD areas) in the vicinity of Project worksites and haulage routes.	Inadequate Traffic Management Plans	Health and safety	U	MA	M	Contractor to develop and implement a Traffic Management Plan during construction Access impacts are identified prior to construction and alternative access arrangements provided where possible Communication procedures developed and implemented to facilitate community consultation with affected land owners	R	MA	M
12	Hazardous building	Exposure to asbestos resulting in injury/	Inadequate hazardous	Health and safety	U	MA	M	Specialised/ licensed contractors to be engaged Undertake investigations, testing and monitor	U	MI	L

Ref	Identified hazard	Description of risk	Potential causes	Impacts assessed	Risk analysis (without mitigation)			Risk treatment	Risk analysis (with mitigation)		
					L'hood*	Cons**	Risk		L'hood*	Cons**	Risk
	materials	illness due to disturbance of asbestos containing materials during construction activities or demolition of buildings containing asbestos.	building materials management plan					levels Appropriate personal protective equipment (PPE) to be worn Encapsulation Implement treatment and disposal procedures			
13	Contaminated land	Exposure of workers and the community to contaminated land (eg service stations, land fill sites, existing rail corridor) due to the disturbance of contaminated soil or groundwater during construction or excavation activities.	Contamination from adjacent contaminated sites Disturbance/ migration of contaminated groundwater Ground gas accumulation in underground infrastructure Disturbance of asbestos containing materials Unforeseen contamination	Health and safety	U	MA	M	Investigations at potentially contaminated work sites in accordance with the NEPM and QLD Guideline for Contaminated Land Professionals (DEHP, 2012) Contractor to develop contaminated land management plans and monitor compliance Barriers to prevent public access to construction areas Management and prevention of dust emissions Controls for material haulage, such as covering loads or wetting material to reduce airborne dust emissions Supervision of construction activities by a suitably qualified person EMP outlining mitigation plans for the construction and operation phases. Disposal permits for removal and/ or disposal of contaminated soil in accordance with the ep act Compliance with workplace health and safety procedures during construction and operation	R	MA	M

Ref	Identified hazard	Description of risk	Potential causes	Impacts assessed	Risk analysis (without mitigation)			Risk treatment	Risk analysis (with mitigation)		
					L'hood*	Cons**	Risk		L'hood*	Cons**	Risk
								including use of PPE, hygiene controls and inspections			
14	Fire ants	Spreading of fire ants due to equipment/ vehicles moving between construction zones/ transport of spoil leading to stings to animals/ people.	Equipment/ vehicles moving between construction zones Transport of spoil	Health and Safety	P	MI	M	Works to be undertaken in accordance with an approved Fire Ant Management Plan, if required Spoil to be covered during transportation	U	MI	L
15	Injury to workers during construction	Injury to workers during construction due to: • unsafe work practices or process failures • non-compliant scaffolding • inadequate housekeeping practices • insufficient lighting • inadequate maintenance of equipment	Inadequate job safety and environmental analysis Lack of training and supervision	Health and safety	U	MA	M	Compliance with Workplace Health and Safety Regulations Regular inspection to ensure ongoing compliance by contractor, state safety authorities including Work Health and Safety Queensland and Office of Fair and Safe Work Queensland Inspections by national safety regulator Safety awareness training provided to construction workforce Plant and equipment inspections undertaken prior to their use on site Mandatory PPE standard to implemented by contractor	R	MA	M
16	Air traffic	Cranes and lifting equipment interfering with air traffic leading to potential fatalities.	Lighting Collision	Health and safety Property damage	R	S	H	Compliance with OLS standards for Archerfield Airport and Brisbane Airport Operational Airspace requirements	R	S	H

Ref	Identified hazard	Description of risk	Potential causes	Impacts assessed	Risk analysis (without mitigation)			Risk treatment	Risk analysis (with mitigation)		
					L'hood*	Cons**	Risk		L'hood*	Cons**	Risk
17	Rollingstock accident	Rollingstock accident 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 track or adjacent worksites.	Inadequate communication Inadequate isolations Inadequate maintenance	Health and safety Property damage	U	S	H	Contractor to develop and implement a Traffic Management Plan Contractor to implement a Safety Management Plan and an Emergency Response Plan Communication procedures to be developed and implemented between construction team and rail operator to provide advanced Notification of changed conditions to rail operator and staff Provide alternative transport/ services if required Discussion with rail operator regarding the temporary reduction in speed of rail services if required Construction methodology to comply with Queensland Rail standards in terms of track isolations Regular maintenance of rail infrastructure (including track, signals and associated infrastructure) in accordance with relevant standards	R	S	H
18	Electrocution	Work within a live rail environment leading to potential injury or fatality to construction workers.	Lack of training Inadequate procedures for high risk works Inadequate electrical safety controls (eg isolation)	Health and safety	U	S	H	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 Isolation of rail electrical infrastructure prior to undertaking works (where possible) Track protection officer to be present during	R	S	H

Ref	Identified hazard	Description of risk	Potential causes	Impacts assessed	Risk analysis (without mitigation)			Risk treatment	Risk analysis (with mitigation)		
					L'hood*	Cons**	Risk		L'hood*	Cons**	Risk
								high risk construction works if required			
19	Infrastructure interactions	Construction works and equipment (eg crane booms) interfering with/ damaging other infrastructure, properties (eg overpasses, ICB, roads, Exhibition/ Roma St/ Central stations) due to close proximity/ access restrictions in urban environments.	Interactions with infrastructure	Health and safety Property damage	U	MA	M	Existing infrastructure closures as required prior to construction activities and alternative routes identified for the duration of the closure to eliminate the presence of people in high risk areas Construction methodologies in place to ensure appropriate clearances between equipment and existing structures are maintained during construction EMP to detail appropriate measures to minimise impacts to properties/ places	R	MA	M
20	Inadequate emergency response	Inadequate emergency response resulting in increased impact to people in an emergency situation during the construction of the Project.	Inadequate emergency response procedures Inadequate training Inadequate consultation with emergency services	Health and safety Property damage	U	S	H	Safety Management Plan and Emergency Response Plan/ procedures to be developed for implementation during emergency situation. State emergency service departments consultation 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 Emergence Response Plan/ Procedures and improvements made where identified	R	S	H

Ref	Identified hazard	Description of risk	Potential causes	Impacts assessed	Risk analysis (without mitigation)			Risk treatment	Risk analysis (with mitigation)		
					L'hood*	Cons**	Risk		L'hood*	Cons**	Risk
21	Flooding/ drainage	Flooding of site works during construction leading to injury to people and or damage to property/ infrastructure.	Meteorological event Overland stormwater Underground stormwater Groundwater seepage River flooding Mechanical failure of flood protection equipment	Health and safety Property damage	U	MA	M	Contractor to undertake hydraulic modelling to ensure that overland flows, underground flows and seepage are appropriately addressed through all phases of construction Incident management procedures to include flood mitigation measures Appropriate mechanical redundancies to be included during construction Development of a pre-dewatering and/ or drainage system within elevated groundwater areas Detailed hydrogeology investigations to be conduct of the area prior to construction	R	MA	M
22	Vibration	Significant vibration during tunnelling leading to damage to existing buildings/ contents and potential sleep disturbance to local community.	Earthworks Tunnelling equipment Tunnel boring machine	Health and safety Property damage	LI	MA	H	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 a sleep nuisance is present, where necessary, residents to be temporarily relocated during certain periods of construction Complaints process implemented Monitoring of vibration to be undertaken where appropriate (ie on a complaints basis)	U	MA	M

Ref	Identified hazard	Description of risk	Potential causes	Impacts assessed	Risk analysis (without mitigation)			Risk treatment	Risk analysis (with mitigation)		
					L'hood*	Cons**	Risk		L'hood*	Cons**	Risk
								Use alternative, less intrusive construction techniques where practicable ie cut and cover construction techniques at portals			
23	Noise	Earthworks generate excessive noise or vibration at sensitive receptors leading to community impacts/ generation of nuisance	Earthworks Tunnelling equipment Tunnel boring machine	Health and safety Property damage	P	MO	M	Noise barriers, appropriate hours of construction, acquisitions, alternative acoustic techniques, monitoring, community engagement, building treatments such as insulation	P	MI	M
24	Noise and vibration	Over pressure/ ground vibration if blasting is required for the construction of the infrastructure leading to vibration nuisance/ sleep disturbance and potential damage to nearby houses/ buildings.	Drill and blast construction activities	Health and safety Property damage	LI	MI	M	Construction methodology to include restricted hours of blasting which is acceptable to the community Use alternative construction less intrusive construction techniques where practicable Monitoring of vibration to be undertaken where appropriate (ie on a complaints basis)	P	MI	M
25	Hazardous substances and dangerous goods	Storage, handling, use and transportation of hazardoussubstances or dangerous goods leading to injury or illness to construction personnel or the public.	Non-compliant storage, use and transportation of hazardous substances	Health and safety	U	S	H	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	R	S	H

Ref	Identified hazard	Description of risk	Potential causes	Impacts assessed	Risk analysis (without mitigation)			Risk treatment	Risk analysis (with mitigation)		
					L'hood*	Cons**	Risk		L'hood*	Cons**	Risk
								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, eg Diesel fuel Tanks, Cement Silos, Bitumen Storage Vessels Transfer points and related spill containment			
26	Hazardous substances and dangerous goods	Release of hazardous chemicals as a result of a natural hazard event eg a flood event leading to adverse health and safety effects to construction personnel or the public.	Non-compliant storage, use and transportation of hazardous substances	Health and safety	U	S	H	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. 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,P29 sand	R	S	H

Ref	Identified hazard	Description of risk	Potential causes	Impacts assessed	Risk analysis (without mitigation)			Risk treatment	Risk analysis (with mitigation)		
					L'hood*	Cons**	Risk		L'hood*	Cons**	Risk
								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**).			
27	Wildlife hazards	Increase in wildlife hazards as a result of the Project leading to damage to property/ plant/ equipment and injury or illness to users of the tunnel and the community eg Tunnel lights (insects are attracted to the lights, in turn attracting birds that feed on them), waste bins (birds and animals forage on waste bin contents), creek/ drain clearing (exposing invertebrates to birds), clearing and levelling of sites for developments which expose soil and cause depressions (attracting water and other birds), stockpiling soil	Disruption of natural habitats	Health and Safety Property Damage	U	MO	M	Appropriate fencing and guarding of critical plant and equipment to prevent access from wildlife. Consideration of wildlife hazards in the Environmental Management Plan/ Design Report (eg guarding for plant and equipment) Consideration of wildlife hazards in the waste management plans and design including, covered bins and appropriate location of waste storage locations, appropriate collection times for general waste removal. Consideration of wildlife hazards in the Incident management plan	R	MO	M

Ref	Identified hazard	Description of risk	Potential causes	Impacts assessed	Risk analysis (without mitigation)			Risk treatment	Risk analysis (with mitigation)		
					L'hood*	Cons**	Risk		L'hood*	Cons**	Risk
		(exposing invertebrates to birds; providing habitat for fox dens).									
Project phase: operation											
1	Climate change	Changing climate conditions impacting on the Project eg increased rainfall and increase river rise levels leading to change in flooding characteristics; increased temperatures leading to buckling of tracks/ rail infrastructure.	Change in climate conditions not accounted for in design	Health and Safety Property Damage	U	MA	M	Incorporate design recommendations for climate change to improve flood and extreme weather event immunity	R	MA	M
2	Inadequate Emergency Response	Inadequate emergency response resulting in increased impact to people and property in a potential emergency situation during the operation of the Project.	Inadequate emergency response procedures Inadequate training Inadequate consultation with emergency services	Health and safety Property damage	U	S	H	Safety Management Plan and Emergency Response Plan/ procedures to be developed and deployed efficiently. State emergency service departments to be involved in the development of these plans to ensure their access and Management requirements are captured appropriately Roles and responsibilities are to be clearly stated and understood by all parties involved Training exercises to be undertaken to determine the efficiency of the – emergence	R	S	H

Ref	Identified hazard	Description of risk	Potential causes	Impacts assessed	Risk analysis (without mitigation)			Risk treatment	Risk analysis (with mitigation)		
					L'hood*	Cons**	Risk		L'hood*	Cons**	Risk
								response plan/ procedures and improvements made where identified Enhanced fire and life safety and ventilation requirements for the project			
3	Flooding/ drainage	Flood event leading to water ingress into station access ways, station and/ or tunnels during operation causing injury to commuters and employees and or damage to property/ infrastructure.	Meteorological event Overland stormwater Underground stormwater seepage River flooding Mechanical failure of flood protection measures	Health and safety	U	MA	M	Operator to implement an Emergency Response Plan to identify relevant evacuation procedures for the stations and the tunnels Design of at risk stations to include appropriate flood mitigation measures (eg flood gates) Design to include appropriate redundancies for mechanical infrastructure such as pumps	U	MA	M
4	Noise and vibration	Increased vibration and/ or regenerated noise due to the operation of the Project underground infrastructure leading to public nuisance and/ or damage to building/ contents.	Underground operations	Health and safety Property damage	U	MO	M	Design to incorporate track vibration isolation	U	MI	L
5	Noise	Increased noise due to operation of the Project surface infrastructure	Surface operations	Health and safety	U	MO	M	Noise modelling to be undertaken during design Barriers to be included and permanent acquisitions to be considered where required	U	MI	L

Ref	Identified hazard	Description of risk	Potential causes	Impacts assessed	Risk analysis (without mitigation)			Risk treatment	Risk analysis (with mitigation)		
					L'hood*	Cons**	Risk		L'hood*	Cons**	Risk
		leading to a public noise nuisance.									
6	Noise	Noise generation from the operation of ventilation mechanical plant during the operation of tunnel and station ventilation system leading to noise nuisance to the general public.	Ventilation system operation	Health and safety	U	MO	M	Design to incorporate attenuation/ silencers where necessary	U	MI	L
7	Crowd risk	Capacity of stations exceeded crowding during public events such as Ekka, Bridge to Brisbane, sporting and entertainment events leading to injury to people and community nuisance.	Exceeding design capacity	Health and safety	U	MO	M	A station management procedure to be developed in consultation with Emergency Services This procedure must detail an evacuation plan as well as identify the threshold limit for the number of commuters allowed	U	MI	L
8	Equipment breakdown	Major equipment breakdown eg failure of traction power; failure of signalling; damage to rail, ventilation system, substation, switchboards, escalators and lifts; failure at Control	Inadequate maintenance Inadequate emergency response procedures or incident management	Health and safety Property damage	U	MO	M	Maintenance schedule and procedures to be developed by operator to ensure efficient operation of plant and equipment Operator to develop and implement an incident management plan including emergency evacuation plan for the tunnel	U	MI	L

Ref	Identified hazard	Description of risk	Potential causes	Impacts assessed	Risk analysis (without mitigation)			Risk treatment	Risk analysis (with mitigation)		
					L'hood*	Cons**	Risk		L'hood*	Cons**	Risk
		Centre leading to injury to persons or damage to property.	plans								
9	Fire	Fires leading to injury/ possible fatality and/ or damage to property/ environment due to: Fire in Station area eg fire in a back-of-house area, an escalator or elevator pit, on a platform, on a concourse, or involving a vehicle (bus or train) or; Fire in Tunnel area eg fire involving a vehicle, equipment room/ niche fire, trackway debris fire.	Arson Maintenance activities Vehicle fire (train, bus) Equipment failure (eg fault with overhead traction power wiring)	Health and safety Property damage	U	S	H	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, trackway fire, platform or concourse fire Maintenance schedule and procedures to be developed by operator to ensure efficient operation of plant and equipment Consultation with Queensland Rail to ensure acceptable fire and life safety considerations for future rolling stock specifications Consultation with Brisbane transport and Translink 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
10	Exposure to toxic atmospheres due to fire	Exposure to noxious or toxic atmospheres to users of the tunnel due to fire leading to adverse health and	Inadequate ventilation	Health and safety	U	S	H	Ventilation systems are designed to ventilate the underground stations and tunnels and to control and extract smoke during emergency fire scenarios Ventilation equipment is located at each end of	R	S	H

Ref	Identified hazard	Description of risk	Potential causes	Impacts assessed	Risk analysis (without mitigation)			Risk treatment	Risk analysis (with mitigation)		
					L'hood*	Cons**	Risk		L'hood*	Cons**	Risk
		safety impacts.						the underground stations			
11	Act of 'Terrorism'	Terrorist attack on public transport infrastructure leading to major fires/ explosions causing injury/ possible fatalities and/ or damage to property/ environment.	Political unrest	Health and safety	R	S	H	Operator to develop and implement incident management procedures including Emergency Response Plan/ Procedures Adopt appropriate counter terrorism measures (eg surveillance procedures, security)	R	S	H
12	Collapse or subsidence	Tunnel collapse or subsidence due to unexpected engineering fault, natural influence (ie earthquake) leading to possible fatality and injury to operational staff and public and/ or property damage at ground level.	Engineering fault Settlement Natural influences	Health and safety	U	MO	M	Geotechnical investigations to be analysed to determine most appropriate design and construction method for the conditions. Best practice construction practices to be employed by construction team Maintenance schedule and procedures to be developed and implemented by operator to ensure efficient operation of plant and equipment and stability of infrastructure Safety management plan and emergency response plan/ procedures to be developed and deployed efficiently Emergency training and coordination with state emergency departments Geological mapping and rock mass classification to identify swelling in ground materials, the potential of deterioration of strength in weathered rock to determine	U	MI	L

Ref	Identified hazard	Description of risk	Potential causes	Impacts assessed	Risk analysis (without mitigation)			Risk treatment	Risk analysis (with mitigation)		
					L'hood*	Cons**	Risk		L'hood*	Cons**	Risk
								adequate support design for long-term stability in weathered rock			
13	Unauthorised access	Trespassing or unauthorised entry to tunnel/ tracks leading to injury/ possible fatality and/ or property damage.	Trespassers Unauthorised access	Health and safety	U	MO	M	Implementation of surveillance technologies, separation techniques ie sliding doors enclosing underground stations/ fencing and awareness techniques ie signage, trespassing fines/ prosecution	U	MI	L
14	Cumulative impacts	Cumulative impact of recent infrastructure projects (eg Clem7 tunnel, Boggo Road Urban Village and tennis court, TOD in southern section) leading to community concerns regarding nuisance and decreased public health.	Cumulative impacts	Health and safety	U	MO	M	Integration with other projects where possible Provide ongoing consultation with affected communities Provide opportunities for affected landowners to have input into mitigation measures to create ownership in the process	U	MI	L
15	Disabled access	Lack of incorporation of safe access for community members with a disability.	Inappropriate access arrangements	Health and safety	U	MO	M	All stations to be compliant with the Disability Discrimination Act (1992)	U	MI	L
16	Traffic accidents	Accident involving pedestrians, cyclists and vehicles when accessing the Project	Inadequate traffic management plan	Health and safety	R	S	H	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

Ref	Identified hazard	Description of risk	Potential causes	Impacts assessed	Risk analysis (without mitigation)			Risk treatment	Risk analysis (with mitigation)		
					L'hood*	Cons**	Risk		L'hood*	Cons**	Risk
		infrastructure, specifically when crossing roads to access stations leading to injury/ possible fatality									
17	Contaminated land	Exposure of the general public to contaminated soils not removed from site.	Future excavation activities	Health and safety	U	MO	M	Where contaminated soil material remains on-site, current practices to prevent contact with the general public and the environment is to provide adequate protection or containment capping (ie to break pollutant linkage pathways) Contractor to develop an incident management plan Erosion and sediment control plans to be developed by appropriately qualified personnel and implemented	R	MI	L
18	Flood event	Flood event leading to impact on the Project area leading to injury or illness to users of the Project.	Overland runoff River rise Stormwater backflow Meteorological event Overland stormwater Underground stormwater Groundwater seepage	Health and safety Property damage	U	MA	M	Tunnel portals and station entrances elevated above target flood level Suitable design of the on-site storm water network Automated flood gates at the entry points to stations Flood boards to provide up to one metre of additional protection above the raised entrances	R	MA	M

Ref	Identified hazard	Description of risk	Potential causes	Impacts assessed	Risk analysis (without mitigation)			Risk treatment	Risk analysis (with mitigation)		
					L'hood*	Cons**	Risk		L'hood*	Cons**	Risk
			Mechanical failure of flood protection equipment								
19	Earthquake	Seismic activity leading to collapse/ damage to infrastructure leading to injury to persons and damage to property.	Inadequate controls	Health and safety Property damage	R	MA	M	The Project alignment is located in an area of very low seismicity such that earthquakes are not considered a significant hazard to the project	R	MA	M
20	Rollingstock collision	Train accident/ collisions within the tunnel due to speeding, driver error, communication failure or signal failure leading to injury to passengers and public.	Inadequate maintenance of signalling Inadequate communication Operator error	Health and safety Property damage	U	S	H	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 Queensland Rail transit authority network and systems Regular maintenance of rail infrastructure (including track, signals and associated infrastructure) in accordance with relevant standards A new signalling and train control system based on the European train control system has been incorporated for the underground sections of bat this system enables the new trains to operate efficiently at close headways Uni-directional tunnel sections separated by bulkhead	R	S	H

Ref	Identified hazard	Description of risk	Potential causes	Impacts assessed	Risk analysis (without mitigation)			Risk treatment	Risk analysis (with mitigation)		
					L'hood*	Cons**	Risk		L'hood*	Cons**	Risk
								Experienced drivers and driver training			
21	Rollingstock collision	Bus accident/ collisions within the tunnel due to speeding, driver error, communication failure or signal failure leading to injury to passengers and public.	Inadequate maintenance of signalling Inadequate communication operator error	Health and safety Property damage	U	S	H	Consideration of inter-operability with the existing Translink 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 Uni-directional tunnel sections separated by bulkhead	R	S	H
22	Rollingstock accident	Injury or fatality at one of the underground station platforms due to impact from rolling stock.	Unauthorised access to rail line Slip trip or fall onto railway	Health and safety	R	S	H	Automated platform screen doors at all underground stations	R	S	H
23	Flooding/ drainage	Increased flood risk to existing land because of the construction of BaT infrastructure leading to damage to adjacent property/ infrastructure and injury or illness to persons.	Redirection of existing overland flow paths	Health and safety Property damage	U	MA	M	Design and construction methodology to take into consideration the impact of bat construction on the flooding and hydraulics of surrounding land uses and minimise this impact where possible Hydraulic modelling to be undertaken during design	U	MO	M
24	Cyclone/ strong winds	Damage to property and infrastructure due to cyclone or strong winds or storm events.	Meteorological event	Property damage	U	MA	M	Design and construction of project infrastructure in accordance with design ratings	U	MO	M

Ref	Identified hazard	Description of risk	Potential causes	Impacts assessed	Risk analysis (without mitigation)			Risk treatment	Risk analysis (with mitigation)		
					L'hood*	Cons**	Risk		L'hood*	Cons**	Risk
25	Wildlife hazards	Damage to property or infrastructure and injury or illness to users of the tunnel and the community due to an increase in wildlife hazards as a result of the Project eg Tunnel lights (insects are attracted to the lights, in turn attracting birds that feed on them), waste bins (birds and animals forage on waste bin contents), creek/ drain clearing (exposing invertebrates to birds), reseeding following construction works (attracting seed-eating birds).	Disruption of natural habitats	Health and safety Property damage	U	MA	M	Appropriate fencing and guarding of critical plant and equipment to prevent access from wildlife Consideration of wildlife hazards in the waste management plans and design including, covered bins and appropriate location of waste storage locations, appropriate collection times for general waste removal Consideration of wildlife hazards in the incident management plans	U	MO	M

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

R = Rare; M = Medium; S = Severe; H = High

P = Possible; U = Unlikely; MI = Minor; MO = Moderate; MA = Major;