Airport Link

:: in brief

Airport Link

environmental impact statement

OCTOBER 2006

BRISBANE CITY
Dedicated to a better Brisbane

Queensland Government

SKM Connell Wagner
JOINT VENTURE

Contents

1. Introduction

1.1 Background to the Airport Link Project

1.1.1 Strategic Planning

The Queensland Government and Brisbane City Council has long recognised the need for a balanced and integrated response to the traffic and transport issues arising from sustained population growth and economic activity in the South East Queensland region.

The *South East Queensland Regional Plan* and the *South East Queensland Infrastructure Plan and Program 2005 – 2026* have been promulgated by the Queensland Government to provide a framework for sustainable development in the region in response to the forecast population growth over the twenty years to 2026.

The *South East Queensland Infrastructure Plan and Program* (SEQIPP) provides in-principle support for the Airport Link Project as part of an integrated approach to addressing the future transport needs of Greater Brisbane. SEQIPP identifies

a need to address public transport infrastructure, freight transport links to the Australia TradeCoast, supporting active transport choices, and improving road infrastructure. Airport Link is a key element of the road infrastructure identified in SEQIPP as being necessary to cater for increasing travel demand based on sustained regional population growth.

The Airport Link Project is also a key element of the *Transport Plan for Brisbane* and the *Trans Apex* initiative. It is intended to address deficiencies in the orbital road network of Brisbane and to provide relief to congested roads in Brisbane's northern suburbs, connect activity centres, and provide a sound basis for future traffic management. These objectives can be achieved by linking to strategic road connections allowing cross-city travel movements to bypass the Central Business District and inner suburbs.

1.1.2 Pre-Feasibility Study

Prior to undertaking this Environmental Impact Statement (EIS), the Brisbane City Council commissioned the *TransApex* pre-feasibility study into the most desirable means of delivering the Airport Link Project. The pre-feasibility study, completed in March 2005, found that the Airport Link Project was both financially and technically viable and would:

- support integrated land use and sustainable transport outcomes;
- improve access to Brisbane's middle and inner-ring northern suburbs;
- reduce traffic congestion on certain arterial roads in the northern suburbs;
- provide for efficient cross-city traffic, leading to environmental and economic benefits for the community;
- improve journey times for trips in the northern suburbs;
- facilitate improved access to the airport, seaport and Australia TradeCoast;
- lead to desired land use and economic outcomes by supporting inner-city urban renewal; and
- support Council's vision as outlined in *Living in Brisbane 2010*.

1.1.3 Detailed Feasibility Studies

Following the pre-feasibility study, the Queensland Government and the Brisbane City Council resolved to proceed to detailed feasibility studies. These studies include:

- an engineering feasibility study culminating in a preliminary concept design on which the EIS is based; and
- an environmental impact statement (EIS), including a traffic and transport analysis.

The Airport Link Project has been investigated and the concept developed in parallel with and during the course of this EIS process. The EIS investigations included a comprehensive process of community and stakeholder engagement and consultation. The EIS and consultation processes were integrated with the design development process to address community and technical issues as they arose, with the intended outcome being a robust and sustainable project.

Should the Airport Link Project proceed, subsequent phases in project development will include a tendering phase and a construction phase, ahead of operation. The intended operational life of the Airport Link Project is in the order of 100 years.

1.2 Who are the Proponents?

The Queensland Government and the Brisbane City Council are the Proponents for this detailed feasibility phase of the Airport Link Project. The agencies of the Queensland Government with a key interest in the detailed feasibility study process are the Department of Main Roads, Queensland Transport and Queensland Treasury. The detailed feasibility study is being managed out of Brisbane City Council's Major Infrastructure Projects Office on behalf of the Proponents. All parties have long and established records in the delivery of major infrastructure projects.

On completion of the Coordinator-General's EIS Evaluation Report process, the Proponents will determine whether or not to proceed to the next phase of the Project (ie the tendering phase).

The contractual arrangements between the Proponents and a tenderer are not the subject of discussion in this EIS. However, it is understood that the arrangements may be drawn up as a 'public private partnership', generally following the guidelines for this purpose provided by the Queensland Government.

1.3 What is the purpose of the EIS?

This EIS has been prepared in response to the terms of reference set by the Coordinator-General in accordance with Sections 29 and 30 of the *State Development and Public Works Organisation Act 1971*. The purpose of the EIS is to describe the existing environmental conditions, to assess the potential impacts of the Airport Link Project and to provide information on which the Coordinator-General's evaluation report can be based. The EIS is also an important tool for informing both decision-makers in the Queensland Government and the Brisbane City Council, as well as key community stakeholders and the community at large.

1.3.1 Consultation & Engagement

Outline

The Airport Link Project differs from most other major transport projects delivered in Brisbane in recent years, in that it is proposed to be situated through mostly inner suburban areas undergoing a process of demographic change. From the outset, it was evident that community interest in the development of the project concept was high and would remain so through the concept development and project implementation phases.

Consequently, preparation of this EIS, the concept design and reference design has relied on a multi-layered approach to consultation. Consultation activities have been directed to:

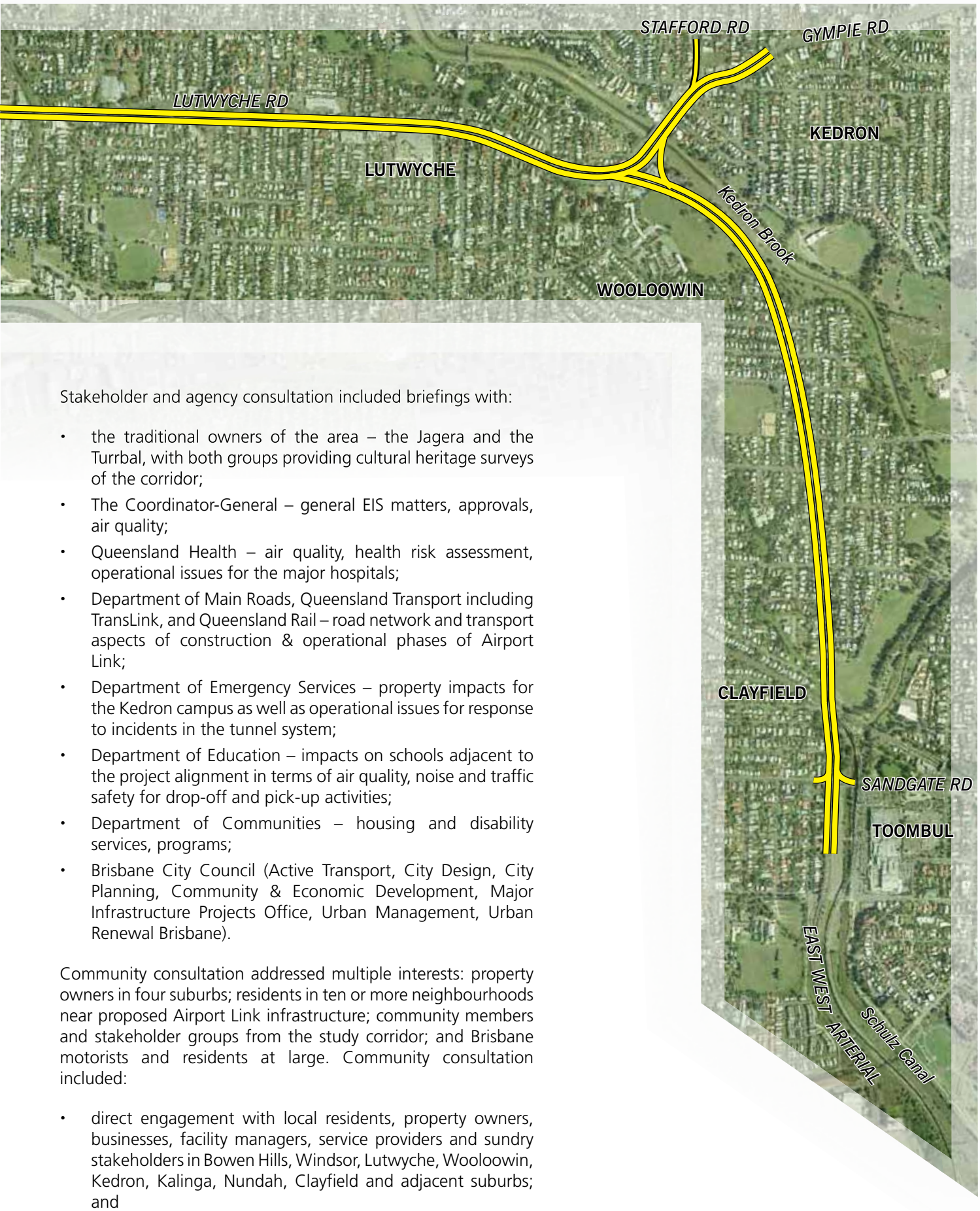
Figure ES-1 Airport Link Alignment

- government interests – Commonwealth, State and local government entities;
- stakeholder interests – ranging from peak bodies, major landowners and industry groups, through to indigenous groups; and
- community interests – including community action groups, local interest groups, community liaison groups, community information sessions and local residents.

For all sectors, the approach entailed dissemination of detailed information about the project design and potential impacts to each of those groups through a range of media and communications techniques. The consultation process provided a number of opportunities for governmental agencies, stakeholders and community members to participate in consultation and to learn about the Project and its potential benefits and impacts.

Processes & Participation

The Commonwealth Minister of the Environment and Heritage was formally consulted through a referral of the Airport Link Project under the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* to determine whether the project was a 'controlled action' under the Act. The Minister's delegate responded, in a letter dated 19 January 2006, that the Airport Link Project, as documented, was a controlled action, due to the proposal to place spoil at a site currently not approved for such works and with potential to impact on the Moreton Bay and Ramsar wetland. That spoil placement site was removed from the Project and a request was made for a reconsideration. In a letter dated 20 March 2006, the Minister advised that on the basis of the new information the Project is not a controlled action under the EPBC Act.



Stakeholder and agency consultation included briefings with:

- the traditional owners of the area – the Jagera and the Turrbal, with both groups providing cultural heritage surveys of the corridor;
- The Coordinator-General – general EIS matters, approvals, air quality;
- Queensland Health – air quality, health risk assessment, operational issues for the major hospitals;
- Department of Main Roads, Queensland Transport including TransLink, and Queensland Rail – road network and transport aspects of construction & operational phases of Airport Link;
- Department of Emergency Services – property impacts for the Kedron campus as well as operational issues for response to incidents in the tunnel system;
- Department of Education – impacts on schools adjacent to the project alignment in terms of air quality, noise and traffic safety for drop-off and pick-up activities;
- Department of Communities – housing and disability services, programs;
- Brisbane City Council (Active Transport, City Design, City Planning, Community & Economic Development, Major Infrastructure Projects Office, Urban Management, Urban Renewal Brisbane).

Community consultation addressed multiple interests: property owners in four suburbs; residents in ten or more neighbourhoods near proposed Airport Link infrastructure; community members and stakeholder groups from the study corridor; and Brisbane motorists and residents at large. Community consultation included:

- direct engagement with local residents, property owners, businesses, facility managers, service providers and sundry stakeholders in Bowen Hills, Windsor, Lutwyche, Wooloowin, Kedron, Kalinga, Nundah, Clayfield and adjacent suburbs; and

- provision of information to the general community through newsletters, displays, the dedicated information telephone line, email, stakeholder briefings, the website, fact sheets and media liaison.

Newsletters were distributed to approximately 147,000 households on five separate occasions up to and during the preparation of the EIS. The newsletters sought to inform people about the detailed feasibility studies, the corridor assessment outcomes, the design development and the impact assessment outcomes.

Participation in the consultation process has been high, with approximately 2,100 people attending community information sessions, approximately 630 people attending staffed library displays, and approximately 2,700 community inquiries through the 1800 telephone service, project email and comment forms provided with Newsletter 1. Direct consultation in these activities sought to provide more detailed information around the themes covered in each of the newsletters, including concept design development, property impacts, neighbourhood amenity, traffic and access, construction impacts, visual amenity and air quality.

1.3.2 On-going Process

The EIS is being displayed for comments and submissions from the community, stakeholders and government agencies. Written submissions received in relation to the EIS are taken to be submissions relating to a subsequent development application for impact assessable development under the *Integrated Planning Act 1997* (IPA).

The Coordinator-General will assess the EIS against the terms of reference and will have regard for the submissions received. The Coordinator-General may ask the Proponents for additional information as a consequence of this assessment and review process.

Submissions to this EIS should be in writing, signed by each person making the submission, state the name and address of each person making the submission and state the grounds of the submission and the facts and circumstances relied on in support of those grounds. Submissions should be addressed to:

Airport Link Project Manager
The Coordinator-General
PO Box 15009
City East, Qld 4002
or email:
airportlink.manager@coordinatorgeneral.qld.gov.au

Copies of all submissions will be provided to the project Proponents. Submissions will be regarded as public documents unless confidentially is specifically requested. Identical 'form letters' submitted separately but by multiple parties will be treated as one submission.

Submissions should be received by the Coordinator-General on or before the last day of the submission period.

Finally, the Coordinator-General will issue an evaluation report on the EIS and may recommend that the project proceed, proceed subject to conditions which may be included in the report, or ought not to proceed. It is possible that the project could be modified as a consequence of a submission made to this EIS. Any change of significance to the project described and assessed in this EIS may become the subject of further evaluation by the Coordinator-General, or even the subject of further investigation, consultation, display and assessment.

2. What is the Airport Link Project?

2.1 What is the Purpose of the Project?

The Airport Link Project is intended to ease traffic congestion in the northern suburbs by providing an alternative, high-speed link with the Central Business District (CBD) bypass network and beyond, for airport and northern suburbs traffic using the East West Arterial, Sandgate Road, Gympie Road and Lutwyche Road.

The Airport Link Project will link the Brisbane Airport to southern and south-western suburbs via the North-South Bypass Tunnel (NSBT) and to western suburbs via the Inner City Bypass, completing another sector of the City's orbital road network. The project will provide a range of other connections including linking the Brisbane Airport and Australia TradeCoast with the north-western suburbs, and linking the northern suburbs with the CBD. The Airport Link Project is one of a number of transport initiatives to manage the effects and demands of sustained population growth while adhering to a strategy of seeking to build a better, more liveable city.

At the broad strategic level, there are beneficial outcomes expected from the Airport Link Project, including:

- easing of traffic congestion on key arterial roads in the northern suburbs, such as Lutwyche Road and Sandgate Road, and improving travel time reliability, particularly for freight vehicles and surface public transport;
- creating opportunities for enhanced public transport operations on freed-up surface arterial roads, possibly supported by high-occupancy vehicle (HOV) and bus lanes on Lutwyche Road and HOV lanes on Sandgate Road;
- improving the travel environment of pedestrians and cyclists on the surface network and providing flexibility for travel mode share;
- relieving congestion-induced constraints on accessibility and mobility in the inner northern suburbs by providing an alternative high-speed, underground route for cross-city, orbital and radial trips;
- easing congestion-related air pollution along the benefited arterial routes and with little impact, if any, to the regional airshed while catering for increased travel demand;
- reducing road traffic noise for properties fronting the benefited arterial routes (eg Lutwyche Road, Sandgate Road);
- enhancing connections between the major employment centres, such as the CBD, Royal Brisbane Hospital and the University of Queensland, with the Brisbane Airport and the Australia TradeCoast;
- creating manageable and beneficial impacts on land use patterns in the inner northern suburbs, as areas blighted by traffic congestion become available for redevelopment and other areas have reduced potential for blight as a consequence of future traffic congestion;
- responding to existing and forecast future traffic congestion with greatly reduced surface impacts as compared with the provision of additional road capacity as surface improvements either to existing arterial roads or as new roads requiring property acquisitions and extensive surface works.

2.2 What is the Project?

2.2.1 Airport Link Overview

The Airport Link Project is a system of road tunnels, with the main running tunnels approximately 5.7km in length and the overall project being approximately 6.7km in length. The Project will be constructed mostly in rock below Lutwyche Road to Kedron and then under the suburbs of Wooloowin and Clayfield. It will link with the NSBT, the Inner City Bypass and Lutwyche Road in the south, with Gympie Road and Stafford Road in the north-west, and with Sandgate Road and the East West Arterial in the north-east. The Project will include:

- two separate parallel north-south tunnels each carrying three lanes of traffic in each direction between Bowen Hills and Kedron;
- two separate east-west tunnels each carrying two lanes of traffic in each direction between Kedron and Clayfield;
- tunnel portals at Bowen Hills, Kedron and Clayfield, with cut and cover and transition sections at each to connect with the surface road network;
- elevated structures across Enoggera Creek linking the mainline tunnels in Windsor with the ICB and the surface road network in Bowen Hills;
- elevated structures across Kedron Brook linking Lutwyche Road, Kedron Park Road and the mainline tunnels from the south with Gympie Road and Stafford Road to the north;
- safety systems including safety exits, fire protection and monitoring systems;
- a ventilation system to manage air quality in the tunnels and near portals, including an elevated ventilation outlet near each of the connections in Bowen Hills, Kedron and Clayfield;
- surface road improvements at local intersections and around the connections to the tunnel; and
- allowances in the design for concurrent or subsequent implementation of the Northern Busway Project.

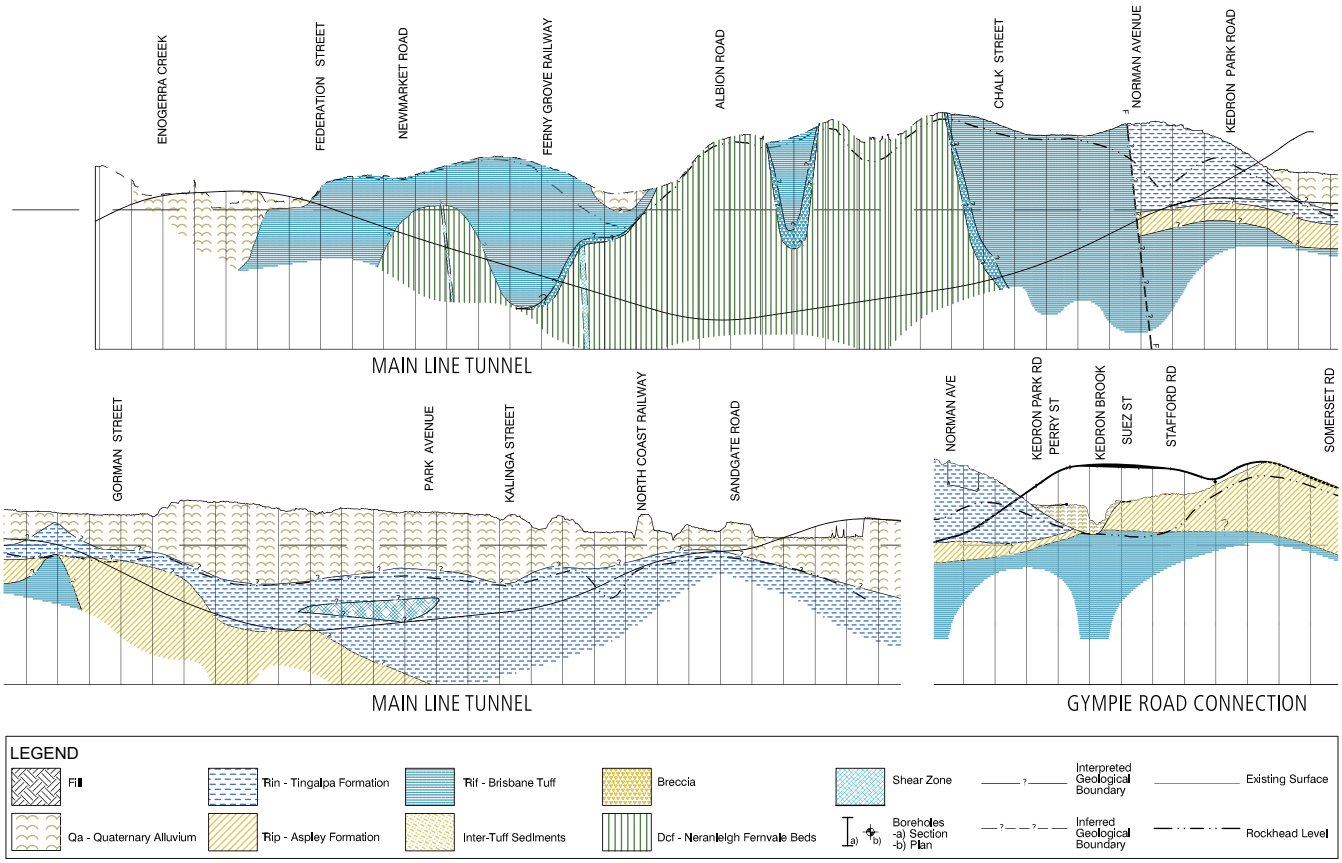


Figure ES-2 Longitudinal Alignment

The general plan of the tunnel is shown in **Figure ES-1** and its longitudinal alignment is shown in **Figure ES–2**.

2.2.2 Project Design

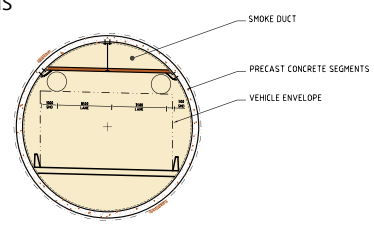
There are many aspects to tunnel design, including road design, tunnel construction, ventilation design, structural design aspects and design of surface buildings and works. Volume 2 of the EIS provides illustrative drawings as indications of how construction of this type might be carried out. Such drawings include plans, cross-sections and longitudinal sections.

In-Tunnel Road Design

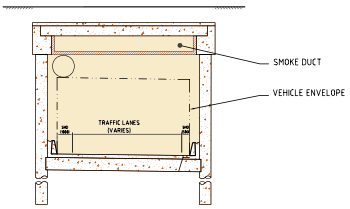
To achieve the project objectives and to remain consistent with the performance of motorways within the Brisbane urban road network, the mainline tunnels from Windsor to Clayfield are designed for a speed of 90km/h but will be signposted for maximum speed of 80km/h. Slower design speeds have been adopted for connections to the local road network at each connection.

The desirable maximum vertical grades adopted for the Airport Link Project are 5% for inclines and 7% for declines.

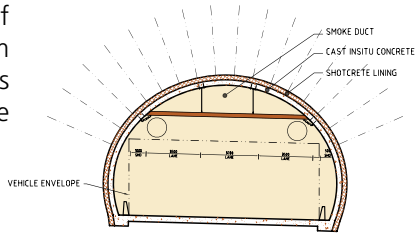
Such grades take into account the effects of steeper grades on vehicle speeds and the quantity of vehicle emissions with regards in-tunnel traffic safety and ventilation system requirements. Due to surface constraints, it was necessary to exceed these values in certain areas of the ramps. A minimum grade in each tunnel of 0.5% was adopted to ensure adequate performance of the longitudinal drainage system.



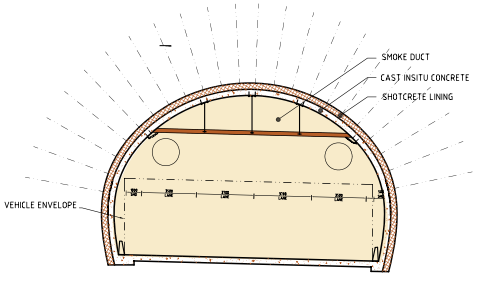
STANDARD TWO LANE TBM TUNNEL SECTION



STANDARD CUT AND COVER TUNNEL SECTION



STANDARD THREE LANE ROADHEADER TUNNEL SECTION



STANDARD FOUR LANE ROADHEADER TUNNEL SECTION

It is intended that each tunnel between Bowen Hills and Kedron has three traffic lanes whereas the tunnels between Kedron and Clayfield will each have two lanes. The configuration of traffic lanes and shoulders will allow sufficient room for traffic to pass a broken-down vehicle. The clearance height and the lane configuration have been factored into the reference design for the tunnel ventilation system.

Surface Road Design

The surface road connections are to be designed and constructed in accordance with accepted standards. Key criteria for the surface road designs include:

- assuring road users of safe and efficient traffic conditions; and
- avoidance of congestion that could lead to queuing back into the tunnels.

The surface roads in Windsor and Bowen Hills will connect with the NSBT via an extensive array of road connections. Some of these require elevated road structures over Enoggera Creek to connect the Airport Link Project with the Inner City Bypass (ICB) westbound, the NSBT and with O'Connell Terrace and Campbell Street. The connections from O'Connell Terrace have the potential to impact on The Mews apartments if there is no mitigation in the design treatments. Detailed design studies are required to investigate the most appropriate means of providing this linkage while minimising the impacts on the visual amenity of The Mews.

The surface roads connecting the Project with Gympie Road and Stafford Road in Kedron will involve elevated structures to provide free-flowing traffic conditions from those roads to and from the tunnels. In order to accommodate the predicted traffic flows through this location, the Project will involve an extensive surface footprint as well as the elevated roads crossing Kedron Brook. Furthermore, the potential road traffic noise in this location may require extensive mitigation measures, which in turn could impact on nearby residential properties in terms of their scale and alteration of streetscape values. Detailed design studies are also required to investigate the most appropriate response for this locality, having regard to the required traffic functions and the character and amenity.

The surface road connections at Clayfield are to be situated in Kalinga Park just to the west of Sandgate Road, resulting in the removal of a number of mature trees and placing road infrastructure in an area of local open space value. The urban design and landscaping treatments of these connections will need to address local community concerns in terms of visual impact, road traffic noise, connectivity for pedestrians and cyclists, and landscape rehabilitation.

Drainage

Tunnel drainage has been designed to maintain all traffic lanes flood free from local portal inflows from rainfall. The tunnel approaches have been designed to remain above the flood level of a 10,000 ARI flood event.

The in-tunnel drainage system would respond automatically to different events. Water from storm runoff would be treated differently from spills, fire deluge water or water used to wash down the tunnel. Groundwater seepage into the tunnel would also be treated separately.

Specially designed grated inlet pits that incorporate flame traps are designed to collect stormwater from the portals, plus that carried into the tunnel on vehicles for transfer to the dedicated "clean water" sumps at the sag points of each tunnel. After passing through silt, debris and grease traps, this water would be pumped through rising mains and directed to the surface stormwater system.

Spillage, fire deluge and wash-down water captured by the tunnel stormwater drainage system, would be diverted and stored in dedicated wastewater sumps at the tunnel sag points to be pumped out and removed for treatment at an appropriate receiving facility.

Groundwater seeping into the tunnel in those lengths where the tunnel is not fully lined would be collected in a dedicated seepage water system and pumped via rising mains to the surface stormwater system.

Tunnel Ventilation

The tunnel system is to be ventilated mechanically to maintain acceptable air quality in each tunnel based on air quality standards recommended by the Permanent International Association of Road Congresses (PIARC). The reference design for this EIS will achieve the following air quality standards:

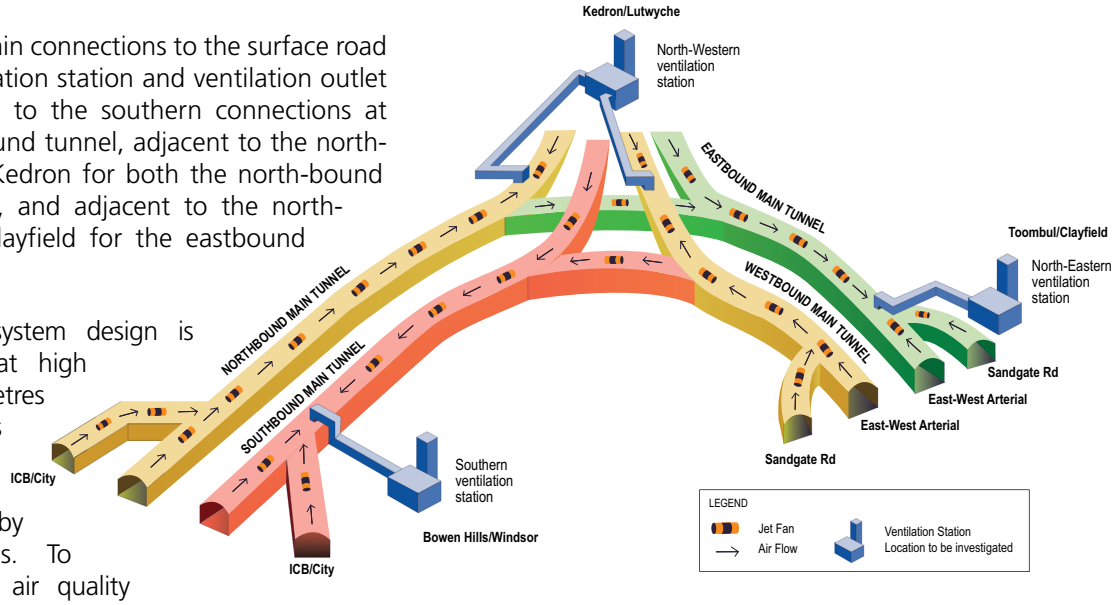
- a peak of 70ppm (parts per million) of carbon monoxide (CO) for normal traffic flows and 90ppm in extreme congestion[1];
- an average of 1ppm of nitrogen dioxide (NO_2); and
- a visibility limit of $0.005m^{-1}$.

While air flow through the tunnel will be aided by vehicle movements, known as the 'piston effect', a system of jet fans located in the roof of each tunnel will ensure air is moved towards the ventilation outlet. By drawing large quantities of fresh air in through the tunnel portals, this system dilutes the in-tunnel air as part of an overall approach to achieving high quality air conditions in the tunnel. The operation of high-speed air extraction into the ventilation outlet will draw external air back into the tunnels at the exit portals, with the aim of avoiding 'portal emissions' of vitiated air.

A ventilation outlet, supported by a fan station and potential provision for air treatment facilities, is proposed to be

1 Extreme traffic congestion is reached when traffic flows slow below 10km/hr.

situated at each of the main connections to the surface road network. That is, a ventilation station and ventilation outlet will be situated adjacent to the southern connections at Windsor for the southbound tunnel, adjacent to the north-western connections at Kedron for both the north-bound and west-bound tunnels, and adjacent to the north-eastern connection at Clayfield for the eastbound tunnel.



The tunnel ventilation system design is intended to expel air at high velocities, up to 20 metres per second, or in excess of 70km/hr, into the environment for dispersion and dilution by local climatic conditions. To achieve desired ambient air quality at ground level, the ventilation outlets are proposed to be at least 30 metres high to optimise the dispersion of air from the tunnel. While a lesser height may be less visually obvious, there may also be a slight reduction in dispersion and therefore dilution of the emitted air from the ventilation outlet. Community input during the preliminary consultation process sought an optimal air quality outcome ahead of visual impact considerations.

Each tunnel is to be equipped with a separate smoke duct to the ventilation system. The smoke ducts remove smoke from fire zones and expel it to the ventilation outlets, allowing people to be evacuated safely from fire zones within the tunnel and fire-fighters and other emergency services personnel to approach closer to a major incident site.

Emergency & Other Services

Access for emergency services is proposed by road from any of the connections. Cross-passages constructed along the tunnels at 120 metre intervals are to provide fire-proof safe havens for motorists in the event of a major incident. People could be directed from these passages into the other tunnel once traffic flows there have been controlled and determined as being safe for evacuation. Emergency services could also access an accident site from these cross-passages.

Tunnel design includes fire and life safety measures, including a deluge sprinkler system and a zone-based smoke extraction system.

When fully operational the tunnel system, including the ventilation system, would require a high-capacity connection to the State electricity supply grid. Two 11 kV feeders at the north-western connection would be supplied from different bulk supply systems. Each feeder would be capable of supplying 5 MW of power, thus providing uninterrupted power to the tunnel should there be a feeder or substation outage. All electrical systems are designed to maintain full tunnel operation in the event of failure at any connection to the grid. This full level of redundancy would be provided throughout the electrical distribution system to the final circuits. In this way, the failure of any one element ought not affect the performance of the system.

In the event of a complete failure of supply to the tunnel, an Un-interruptable Power Supply (UPS) is provided. This UPS runs the essential systems until such time as main power is restored. During this period the tunnel would be closed. Essential systems include emergency lighting, directional signs, some monitoring and controls, and some roadway lighting.

Tunnel illumination in zones allows motorists' vision to adjust gradually from the ambient conditions to in-tunnel driving conditions. Other lighting elements provided in tunnels would include:

- directional signage, guiding pedestrians towards the cross passages in the event of an incident; and
- exit signage and emergency lighting in cross passages and egress tunnels.

Integration with proposed Northern Busway

The detailed feasibility studies for the Airport Link Project have investigated opportunities for integration with the proposed Northern Busway in concept development and possibly in project delivery. The Northern Busway is proposed to connect the Inner Northern Busway (INB) at the Royal Children's Hospital (RCH) at Herston with Windsor, Lutwyche,Kedron, Chermside, Aspley and Bracken Ridge. The reference design alignment for the mainline Airport Link tunnels has been based on accommodating the proposed Northern Busway including the replacement of the existing bridge over Kedron Brook to carry three lanes of outbound Lutwyche Road traffic plus the Northern Busway. The Kedron Brook section of the proposed busway, including the bus station and worksites,is located

directly adjacent to proposed Airport Link surface works. The potential for particular service integration features between Airport Link and the proposed Northern Busway will depend on the detailed design and concurrent construction options for both projects.

2.2.3 Project Delivery (Construction)

Methods

Under the reference project, the tunnel system is to be constructed by several means and to achieve depths below ground level in the order of 60 metres. While the actual construction methods chosen for the Airport Link Project will be determined following the tendering process and detailed design and construction planning, it has been assumed for the purpose of assessment in this EIS that the four most commonly used construction methods likely to be engaged on the Project are:

- Cut and cover construction – construction of surface entries by a 'cut and cover' technique typically involving the use of excavators, with work at depth being conducted after surface covers, or lids, have been put in place to contain noise and other impacts;
- Tunnelling by roadheaders – a technique, possibly for the north - south tunnels and near other surface connections, to achieve required cross-sections for the designed lane widths and configurations with low impacts in terms of regenerated noise and vibrations at the surface;
- Tunnelling by a tunnel boring machine – possibly using an earth pressure balance machine between Kedron and Clayfield where poorer geotechnical conditions require the tunnels to be lined as soon as possible after excavation to prevent groundwater drawdown and settlement impacts on surface properties; and

Tunnel Boring Machine (TBM)

- Tunnelling by drill and blast techniques – may be employed in areas requiring particularly careful construction works such as those in proximity to sensitive land uses or in areas where the rock hardness is greater than is desirable for economic tunnelling by machine.

In broad terms the construction program would reflect several distinct tasks, including:

- establishment and preliminary site works, including construction of the sheds over each of the tunnel portals;
- demolition of existing buildings and modification to utilities;
- constructing surface roadworks;
- undertaking 'cut and cover' works adjacent to Kedron Brook to connect the north-south and east-west tunnels and at Clayfield and Toombul to connect with the East West Arterial;
- new bridgeworks over Enoggera Creek at the southern connection and over Kedron Brook at the north-western connection;
- modifications to existing structures, such as the Bowen Bridge Road bridge, the Horace Street bridge, access ramps onto the Inner City Bypass and the Lutwyche/ Gympie Road bridge over Kedron Brook;
- tunnelling construction works on the mainline tunnels between Windsor and Kedron, most likely using roadheaders from each end; and
- tunnelling construction works on the mainline tunnels between Kedron and Clayfield, most likely using TBM(s) to address local ground conditions and groundwater regimes.

The construction methods and the timing and location of construction activity ultimately will be determined finally after detailed design and construction planning is completed. Major changes from the construction method described in this EIS may require further investigation and possibly consultation with potentially affected communities.

Construction Traffic Management

During during construction, a carefully programmed and managed traffic and access strategy to minimise disruption to daily traffic operation would include traffic diversions and management in:

- Lutwyche Road in Windsor, Lutwyche and Kedron;
- Bowen Bridge Road and Federation Street;
- O'Connell Terrace, Mayne Road and Campbell Street, Sneyd Street and Horace Street;
- Kedron Park Road, Gympie Road and Stafford Road; and
- Sandgate Road, East West Arterial Road near their intersection.

Access would be modified to the following streets:

- Norman Street, Perry Street, Colton Avenue and Windsor Avenue;
- Suez Street and Swan Street; and
- Leckie Road and Arnott Street;

The approach to be taken to traffic management during construction will be resolved through the development of comprehensive construction traffic management plans prior to the commencement of construction works. Consultation and community awareness programs would provide information about planned changes in traffic conditions during construction.

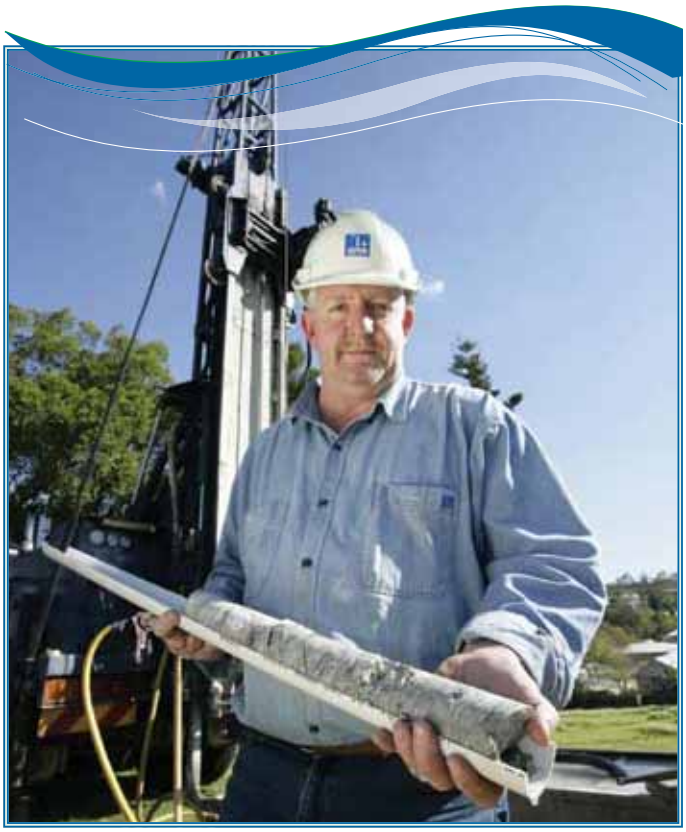
Construction Worksites

Construction worksites will be established:

- at the southern connection in Windsor, on land situated between Federation Street, Lutwyche Road and Enoggera Creek, adjacent to the NSBT worksite. Other construction works will be conducted in O'Connell Terrace, Campbell Street and around NSBT infrastructure;
- at the north-western connection in Kedron and Lutwyche, the work site will be divided into two areas:
  - one area will be between the north and south-bound carriageways of Lutwyche Road between Norman Avenue and Kedron Brook, after the northbound carriageway is relocated further to the west in early project works; and
  - the other will be to the north of the Lutwyche Road/Kedron Park Road intersection over most of the existing Emergency Services site; and
- at the north-eastern connection in Kalinga Park Clayfield and along the northern side of the East West Arterial and south of Schulz Canal.

Each of the worksites will include one or more worksheds and other enclosures to control and mitigate the impacts of construction, such as noise and dust. It is proposed that activities supporting tunnelling works be conducted within the worksheds, while construction spoil is to be stored, handled and loaded into haulage vehicles within acoustic and ventilated enclosures. Construction spoil may be moved around within the worksites by conveyor, to access the most convenient spoil loading areas with the least impact.

The sheds will be large enough to allow spoil to be stockpiled and loaded into trucks for removal from the site. To keep pace with the rate of tunnelling, removal of spoil from the site could be continuous 24 hours per day during the working week and 12 hours on Saturday (ie 6.30am Monday to 6.30 pm Saturday, with no haulage at any time on Sundays or public holidays).



While the scale and bulk of the worksheds may be out of context with the localities in which they are to be situated, they will be in place only for the construction phase and will provide protection from construction impacts. The external treatments of the sheds and worksite landscaping should take into account and seek to mitigate the potential visual impact of these structures.

Construction Works

Construction works are likely to proceed from more than one worksite at any one time. It is also likely that, once works have progressed below the surface and have been covered, construction will proceed in two shifts over a 24-hour day. Works conducted above the surface, except for spoil haulage, will be limited to the usual hours of work (6.30am – 6.30pm Monday to Saturday, with no work on Sundays or public holidays) to maintain acceptable levels of amenity for neighbours. Some out of hours work may be necessary to avoid undue traffic disruptions, such as the transport and installation large construction equipment or components to worksites.

Spoil

Large amounts of spoil will be removed from each worksite. Approximately 2,400,000m^3 of loose spoil will be removed from the Airport Link excavations. Depending on the final construction method, it is likely that the major proportion of spoil will be removed from the north-western worksite

(about 1,400,000m^3), with about 700,000m^3 being removed from the southern worksite and about 300,000m^3 through the north-eastern worksite. A number of potential spoil placement sites have been identified during the investigations for the EIS. They include:

- land proposed for the Gateway Upgrade Project at or near the old Brisbane airport site in the Australia TradeCoast Central precinct;
- land at Clunies Flat in the Port of Brisbane;
- land in the Port of Brisbane at Fisherman Islands; and
- Proposed recycling facility at Viola Place, Eagle Farm.

Spoil placement will require careful management to avoid impacts such as dust and wind erosion, soil erosion and sedimentation due to surface run-off, and the spread of pests (eg. fire ants and weeds).

While the Contractor might find suitable alternative sites, approval for the use of such sites may be required prior to commencement of placement. The preferred haulage route to a spoil placement site includes the preferential use of the arterial road network of the City and the region and the avoidance of local roads, in particular residential streets.

The use of rail for spoil haulage has been investigated for the removal of spoil through the southern worksite owing to the proximity of rail infrastructure in Mayne and Bowen Hills. There is no conveniently located or accessible rail infrastructure for rail haulage of spoil from other worksites. It should be noted that rail haulage requires double handling, at least at the point of arrival prior to placement at one of the placement sites nominated above.

2.2.4 Tunnel Management

Operation and maintenance of the tunnel system requires an integrated approach involving the tunnel operators, the Brisbane City Council, the Queensland Government, including Department of Emergency Services, Queensland Transport, the Environmental Protection Agency, and other key stakeholders. The daily operation of the tunnel also requires an integrated approach to traffic management, incident responses, air quality management, toll collections and general maintenance.

Tunnel Control Centre

A tunnel control centre is required to monitor and control a number of services for the safe and effective operation of the tunnel. The tunnel control centre would be a dedicated building near one connection for swift access. It will include:

- the incident control room supporting fire protection and emergency services;
- the traffic control room and communications room;
- support workshops; and
- other office space.

All data collected by the in-tunnel monitoring systems will be processed for reporting purposes and the entire tunnel operating services will be controlled from this location. It may also provide water tankers with water for the tunnel wash down operations and house the pressure booster for use by the fire brigade. Parking and marshalling areas for maintenance and emergency vehicles are also required.

Electronic Tolling System

The Airport Link Project is proposed on the basis of an electronic tolling system. No booths for cash payment are to be used. Payment of the toll is likely to be by E-Toll where motor vehicles using the tunnel need to be fitted with transponders. A process would be needed to handle casual users. While it is desirable that the toll transponders will enjoy inter-operability with other tolled roads in Australia, this is a matter for contractual resolution should the Proponent decide to proceed with the Project. Should inter-operable tollways be established for the Airport Link Project, patrons could then access other tolled roads, which in South East Queensland, include the Gateway Motorway, the Logan Motorway, and on its completion, the North-South Bypass Tunnel.

Monitoring, operation and administration of the tolling system may be performed at the Tunnel Control Centre or off-site.

2.3 EIS & Approvals

Within the applicable legislative regime for the Airport Link Project, this EIS has identified a range of approvals necessary before the project can proceed. In addition to these approvals, the Airport Link Project has to be approved in the financial context and from a tendering standpoint.

2.3.1 Environmental Impact Statement

The Airport Link Project was declared a significant project for which an EIS is required under section 26(1)(a) of the *State Development and Public Works Organisation Act 1971* (SDA) in October 2005. Consequently, the Project has to be assessed through an environmental impact statement process in accordance with terms of reference established by the Coordinator-General. The EIS will be evaluated by the Coordinator-General who will then issue a report. That report may be subject to a number of conditions. In addition, the report becomes a concurrence agency response in relation to any development application made under the *Integrated Planning Act 1997* (IPA). Alternatively, if required, the Coordinator-General's report may inform a decision by a Minister to designate all or part of the Airport Link Project for community infrastructure under the IPA.

2.3.2 State Legislation

The Airport Link Project will constitute 'development' as defined under the IPA. Aspects of the Airport Link Project are likely to constitute assessable development, either the IPA, or under the provisions of Brisbane *City Plan 2000*. Approvals for the Airport Link Project under State legislation are likely to include those activities set out in **Table 2-1**.

■ *Table 2-1 – Approvals*

Activity	Approval	Determining Authority
Development		
Operational works including tidal works	Coastal Protection and Management Act (IDAS process under IPA)	BCC, EPA
Operational work (removal, disturbance or destruction of a marine plant)	Fisheries Act (IDAS process under IPA)	DPIF
Building work	IPA	BCC
Reconfiguration of a lot	IPA	BCC
Material change of use for ERA	Environmental Protection Act, (EP Act) IPA	BCC, EPA
Material change of use involving contaminated land	EP Act, IPA	BCC, EPA
Environmental		
Disposal permit to contaminated land	Environmental Protection Act	EPA
Cultural Heritage	Aboriginal Cultural Heritage Act, Queensland Heritage Act, IPA	DNRMW, Qld Heritage Council
Other		
Works on a State road	Transport Infrastructure Act	DMR
Works in a Rail corridor	Transport Infrastructure Act	QT, Qld Rail
Local actions (eg blasting)	Local laws	BCC

Table Notes:
DNRMW – Department of Natural Resources, Mines & Water

EPA – Environmental Protection Agency

DMR – Queensland Department of Main Roads

DPIF – Queensland Department of Primary Industries & Fisheries

Windsor War Memorial Park

Any aspect of assessable development under *City Plan*, which is not included in a designation of community infrastructure, will require a development approval before commencement of the activity triggering the development (eg operational works). Other aspects of development, such as a material change of use for an environmentally relevant activity, will require a development approval regardless of any designation for community infrastructure.

Prior to construction, other development approvals may be required with the coming into force of further amendments to the IPA, as other State legislation is rolled into IPA, and amendments to the *Transport Planning and Coordination Act 1994* take effect with regards works on State-controlled roads.

3. The Need for the Project

The Airport Link Project has been proposed to respond to population growth and related increases in travel demand in Brisbane. It should also be considered as part of a wider, balanced solution to regional and local imperatives for integrated planning and transport infrastructure delivery.

3.1 Problem Definition

The Transport Plan for Brisbane, TransApex and the South East Queensland Regional Plan (SEQRP) identify the need for a system of motorway-standard orbital roads to address the high-levels of congestion in Brisbane and enhance accessibility. These plans and policy objectives also include initiatives for public transport as well as alternatives such as walking and cycling. These are required to support the desired urban form for the predicted population growth in SEQ over the next two decades.

Brisbane's transport infrastructure has not always been implemented in response to demand, or strategically developed to encourage sustainable travel behaviour. The result is a transport network that:

- has a predominantly radial, CBD focus with few if any options to bypass the city centre on existing surface roads;
- has poor road connectivity between Brisbane Airport, the CBD and western areas;
- has limited capacity on major roads like the Western Freeway, Riverside Expressway and Lutwyche Road;
- ends motorways at arterials producing a discontinuous motorway system;
- draws traffic though local centres;
- has high numbers of signalised intersections along major roads like Lutwyche Road, Sandgate Road, Gympie Road;
- consists of poorly defined traffic routes that are difficult to navigate; and
- inhibits the movement and patronage of public transport.

Sandgate Road, Toombul

Even with major increases in non-motorised and public transport travel, the existing road network will not sustain future travel demands generated by growth in population and the economy. A range of transport infrastructure solutions are becoming critical and increasingly urgent to maintain a liveable city.

3.1.1 Population growth

South-East Queensland has experienced high and sustained population growth since the 1980s, growing at an average of 55,300 persons each year (or over 1,000 people per week) between 1986 and 2004. It is estimated that by 2026, SEQ will be home to 3.71 million people – an increase from 2.77 million in 2006 at an average increase per year from 2001 to 2026 of 50,000 people.

Brisbane is the fastest growing metropolitan area in Australia. The Brisbane metropolitan area growth represents more than a quarter of all projected population growth in Australia over the next 25 years from 1.8 million in 2004 to 2.6 million in 2026.

Table 3-1 presents estimated populations, employment and person trips for the Brisbane metropolitan area for the ABS Medium Series population scenario. As land use and growth patterns vary across the metropolitan area, changes to travel demand are forecast, particularly at key locations served by the Project such as Brisbane Airport, the Australia TradeCoast (ATC) North precinct and Chermside regional centre.

Table 3-1 Brisbane Metropolitan Area Population Forecasts

Year	Population [1]	Employment [2]	Total Person Trips [3]
2004	1,773,000	804,800	6.1 million
2012	2,074,500	1,025,400	7.2 million
2016	2,221,500	1,130,900	7.7 million
2022	2,439,600	1,253,500	8.4 million
2026	2,583,700	1,320,500	8.8 million

Table Notes:

[1] Source: Australian Bureau of Statistics – Medium Series, 2005.

[2] Employment opportunities consistent with ABS Medium population projection.

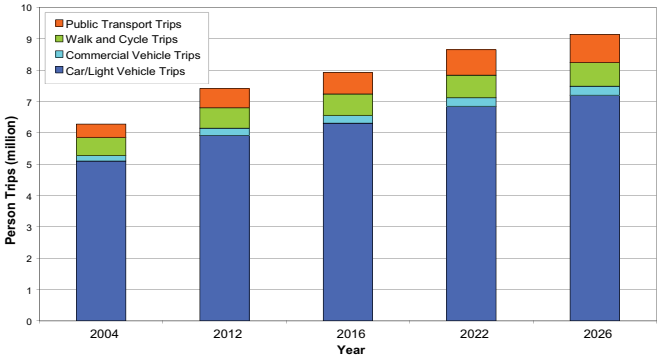
[3] Trips by all modes including walk/cycle on an average weekday.

3.1.2 Increased Vehicle Trips

Growth in population and consequent travel demand is placing enormous pressure on Brisbane's existing road and public transport services – particularly in the CBD and the inner suburbs.

Figure 3-1 summarises the estimated growth in the travel task (in terms of person trips) by the various travel modes – vehicle, public transport, and walk/cycle travel. This demonstrates how travel demand is forecast to grow in a sustained manner across all modes.

■ *Figure 3-1: Forecast Growth in Average Weekday Travel Demand Within Brisbane Metropolitan Area (including commercial vehicles)*



Average weekday traffic volumes have been forecast for roads in the Brisbane Metropolitan Area for the years 2012, 2016, 2022 and 2026, for a road network that does not include the proposed Airport Link. Estimated average weekday traffic volumes for 2004 have also been identified to allow comparison. The travel demand forecasts incorporate the effects of significant enhancements in public transport. **Table 3-2** summarises the growth in travel demand at the metropolitan level.

■ *Table 3-2: Forecast Growth in Weekday Travel Demand - Metropolitan Area*

Parameter	2004	2012	2016	2022	2026
Person Trips by Motorised Travel Modes	5,519,200	6,530,200	6,987,900	7,657,400	8,093,700
Public Transport Trips	415,400	607,100	677,000	807,200	895,600
% PT Trips	7.5%	9.3%	9.7%	10.5%	11.1%
Car/Light Vehicle Trips	3,611,000	4,239,800	4,534,300	4,940,700	5,216,500
Commercial Vehicle Trips	177,600	231,000	249,700	272,200	287,600
Total Vehicle Trips	3,788,600	4,470,900	4,783,900	5,212,900	5,504,100
% Growth in Vehicle Trips compared to 2004		18%	26%	38%	44%

These forecasts show that even with significant growth in public transport mode share, a sustained growth in vehicle travel demand is indicated both at the Brisbane Metropolitan area level and within the Inner North area. In the metropolitan area 44% more vehicle trips are expected by 2026, even with the number of public transport trips more than doubled. Within the study corridor, north-south travel movements within the Inner North area are forecast to increase by 49% between 2004 and 2026, a sustained growth rate of 1.8% pa. East-west demands are forecast to grow by 55% to 65% in a similar period, a growth rate of over 2.0% pa. These growth trends are similar for commercial vehicle movements, indicating that the adverse effects of truck travel through the surface network in the Inner North areas to the rapidly growing Australia TradeCoast (ATC) precinct will become even more significant over time.

The Airport Link Project has been considered in *TransApex* and the Transport Plan for Brisbane as part of a balanced and integrated approach to relieve inner-city congestion and address the City's transport challenges. Other measures include enhanced public transport services on important routes, and enhanced opportunities for cycle and pedestrian trips, providing greater flexibility in the transport system.

3.1.3 Issues with Existing Road Network

Brisbane's existing road network originated as a pattern of intercity links to other towns and regional centres. The major roads that grew from these early transport links now form a series of radial corridors focused on the CBD. Ipswich Road, Lutwyche Road, Logan Road and the Pacific Motorway are examples of the radial structure of Brisbane's existing road network. More recent projects such as the Gateway Motorway, ICB, Logan Motorway and NSBT have been constructed or are planned to address deficiencies in the road network structure.

3.1.4 Declining Levels of Service

The impact of through traffic is evident from the analysis of average peak travel speeds for some of the major cross-city routes. With increased demand and higher congestion levels, there is a general decline predicted in the level of service on the road network in future years. Peak period journey travel times are forecast to increase significantly compared to the current level. For example, without the Airport Link Project, and with enhanced mode share to public transport, traffic volumes through the Lutwyche shopping precinct would grow by over 30% by 2026.

Figure 3-2 illustrates the forecast decline in travel speed for two examples of typical journeys through the Inner North area. By 2016, for an AM peak period trip from Chermside to Fortitude Valley, an average travel speed of 25 km/hr is forecast compared to 31 km/hr currently. This declines to less than 20 km/hr by 2026. A more severe deterioration is forecast for the PM peak, with forecast 2026 northbound PM peak speed of only 14 km/hr.

Similarly, on Sandgate Road, even greater growth would occur due to its proximity to the ATC precinct and its connecting role to the Brisbane CBD. Almost a doubling of current traffic levels is likely by 2026, and a sharp decline in level of service would be associated with this demand growth. An AM peak period southbound trip from Hendra to Milton in 2026 would experience an average travel speed of 27 km/hr (compared to 40 km/hr currently), with the PM peak speed of only 20 km/hr for the northbound trip.

Increasing levels of congestion on the road network will have a range of consequences:

- daily patterns of life for people suffer due to wasted travel time and increased fuel costs;
- the environment is degraded due to increased emissions from congested traffic conditions;
- public transport users in buses suffer due to delays and unreliability;
- local amenity and safety for street system users such as pedestrians and cyclists is diminished;
- both industry and the community are impacted by higher transport costs for goods and services;
- businesses and residents in inner areas served by the congested networks experience restrictions to their accessibility; and
- community safety and security are compromised due to delays for emergency vehicles.

Assessment of travel demand in Brisbane's inner north indicates that on the arterial roads currently about 60% of trips are cross-city, 35% are destined for the Central City, with only 5% local traffic. Much of the traffic congestion in the arterial network in the inner north of Brisbane's radial road system is caused by traffic wanting to get "somewhere else" but being forced to use the roads through the suburbs.

Lutwyche Road

3.2 Project Justification

The justification for proceeding with the Airport Link Project can be found in a number of key performance indicators, including network performance, travel time savings, savings in vehicle operating costs, reduced environmental costs and reduced social impacts.

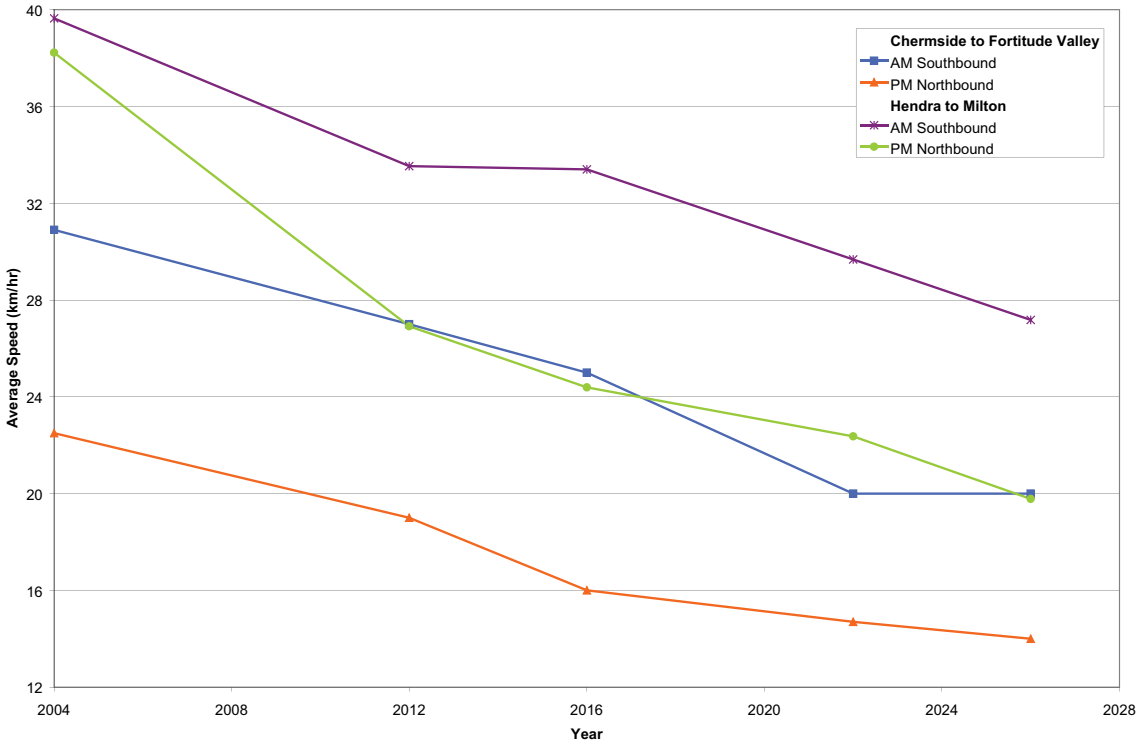
3.2.1 Network Performance

The traffic analysis indicates that Airport Link will be effective in shifting traffic flows from lower order roads in the network (local, district and suburban routes) and travel to motorway routes. The arterial road network also benefits by reductions in travel distance and time. A very small (<0.2%) increase in overall vehicle kilometres of travel in the network is forecast. An overall 1 to 2% reduction in the vehicle hours of travel within the overall Metropolitan Area is indicated, together with an increase in overall average network speed reflecting a general lowering of congestion. These effects are shown graphically in **Figure 3-3**.

3.2.2 Travel Times

There are substantial benefits available in travel speed, and therefore reduced travel times.

■ *Figure 3-2: Forecast Decline in Travel Speed on Key Routes Without Airport Link*



■ *Figure 3-3: Changes in Network Performance (2026)*

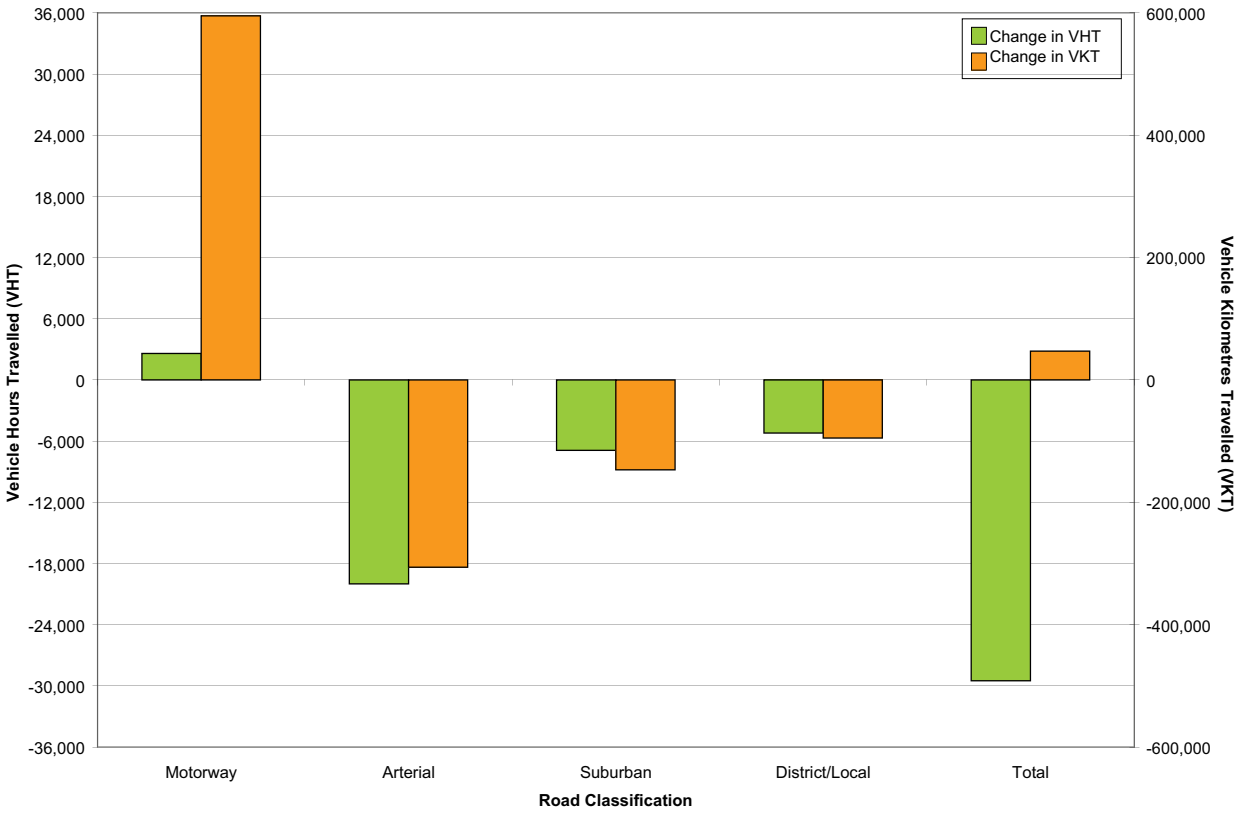


Table 3-3 provides evidence of the travel time benefits of the Airport Link Project for the road network.

Table 3-3: Effects of Airport Link on Travel Times (AM Peak Hour)

Key Routes	Without Airport Link (mins)	With Airport Link (mins)		Time Benefits (mins)	
		Via APL	Surface	Via APL	Surface
2004					
Chermside to Fortitude Valley	14				
Nundah to Fortitude Valley	14				
East Brisbane to Chermside	20				
Stafford to Hendra	11				
Hendra to Milton	17				
2012					
Chermside to Fortitude Valley	17	9	14	7	3
Nundah to Fortitude Valley	16	10	13	6	2
East Brisbane to Chermside	19	13	17	6	1
Stafford to Hendra	13	9	12	4	1
Hendra to Milton	20	14	19	6	1
2022					
Chermside to Fortitude Valley	22	11	16	11	6
Nundah to Fortitude Valley	19	10	14	9	5
East Brisbane to Chermside	23	17	22	6	1
Stafford to Hendra	19	11	15	7	4
Hendra to Milton	22	15	20	7	2

Without the Airport Link Project, the traffic modelling outputs indicate travel times across the inner northern suburbs network will increase as travel demand increases and congestion on the surface road network intensifies. At the same time, service reliability and travel times for surface-bound public transport would also be declining.

With the Airport Link Project, there will be significant travel time savings for cross-city trips with the Project, for journeys both through the tunnels and along the surface roads which benefit from reductions in congestion caused by Airport Link. For example, the travel time for a trip from Chermside to Fortitude Valley would be reduced by approximately 44% in 2012 and by 49% in 2022. The travel time for a trip from East Brisbane to Chermside would be reduced by approximately 32% in 2012 and by approximately 26% in 2022. The travel time for a trip from Stafford to Hendra would be reduced by approximately 33% in 2012 and by approximately 39% in 2022.

3.2.3 Vehicle Operating Costs

Road projects can directly affect the cost of operating vehicles through improved traffic flow and better road conditions. Vehicle operating cost (VOC) savings will be derived from improved road conditions that impose less stress on vehicles. **Table 3-4** shows the findings by road type and vehicle segment.

Table 3-4: Present Value of Vehicle Operating Costs

Vehicle Type	Cars	Heavy Vehicles	Total
Road Type	Present Value ($)	Present Value ($)	Present Value ($)
Motorway	-$300,148,273	-$163,504,210	-$463,652,483
Expressway	$7,724,965	$691,863	$8,416,828
Arterial	$330,099,266	$250,461,338	$580,560,604
Suburban	$119,136,240	$84,124,667	$203,260,908
District	$62,869,731	$38,159,023	$101,028,754
Local	$30,548,209	$23,207,791	$53,756,000
Present Value ($)	**$250,230,138**	**$233,140,472**	**$483,370,610**

The potential savings of $483.4 million (present value terms) in vehicle operating costs is considered a significant benefit from the Project and reflects the improvement in traffic conditions both for the surface road network and the tunnel traffic flows.

3.2.4 Environmental Costs of Traffic Congestion

Congested traffic conditions produce more emissions than free-flowing traffic, affecting air quality particularly at the roadside. The character of traffic noise is also different and less predictable than that produced by efficient traffic streams. Noise from congested roads sometimes requires noise barriers, which are visually obtrusive and affect local breezes.

The operation of the Airport Link Project will reduce total travel time (VHT), resulting in a reduction in emissions. There may also be reduced emissions from less time spent sitting idling and accelerating at intersections and on heavily congested roads. While the monetary value of environmental gains is uncertain, and the marginal and average costs differ between environmental effects, the estimated environmental benefit of the project is of the order of $11 million.

3.2.5 Social Costs of Traffic Congestion

In addition to the more readily identified economic costs, traffic congestion has a range of social costs at both household and community level which are less readily quantified. Some of the social costs of traffic congestion include:

- diminished environmental conditions in the urban area (air pollution, traffic noise);
- diminished urban amenity as convenience and accessibility within the urban area becomes constrained;

- constrained social interaction as accessibility reduces;
- increased risk of traffic accidents, leading to increased risk of injuries and fatalities;
- reduced opportunities for efficient and accessible public transport, necessary for people with low incomes or constrained mobility; and
- increased travel times, especially in commuting, leading to reduced recreation or family time.

Measures to relieve traffic congestion, such as the Airport Link Project and other transport infrastructure provided for in the SEQIPP, will have flow-on benefits for social well-being and livability in the areas benefitting from reduced traffic congestion. With the improvements in travel times, accessibility and relief in traffic congestion on major inner northern arterials, such as Lutwyche Road and Sandgate Road, the Airport Link Project is expected to contribute to improved social conditions in the study corridor.

3.2.6 Livability

The concept of 'livability' has been embraced for some time by Brisbane's community. Brisbane City Council adopted this vision in its *Living in Brisbane 2010* document. The Airport Link Project would make positive progress towards many of the liveability indicators, and particularly to accessibility and prosperity.

Brisbane's urban form has historically encouraged a strongly car-oriented culture. A balanced strategy ensures transport developments are socially, economically and environmentally sustainable. A high quality orbital road network will remove unnecessary through-traffic from major centres, residential areas and lower order roads. The Airport Link Project is a key element in the *TransApex* road network policy intended to facilitate north-south and airport traffic, and avoid the necessity for traffic to pass through the CBD, Fortitude Valley and a number of inner northern arterial roads such as Lutwyche Road, Sandgate Road and Kingsford Smith Drive.

While the prime goal of the Airport Link is to relieve traffic congestion the Project will create a range of other possible opportunities to enhance the liveability of Brisbane including a range of opportunities for bus priority, cycle, pedestrian and inner city urban design improvements.

3.2.7 Economic Benefits of Airport Link

The economic net benefits, expressed in net present value terms ($2006) flowing directly and indirectly from the Airport Link to the City are in the range of $0.64 billion to about $1.9 billion over the 30 year assessment period. If the net employment benefits are factored into this assessment, the net benefit could be as high as $2.5 billion. Combined with the traffic benefits for the City's road network, this positive outcome will complement and strengthen the City's future development.

The Project will also contribute significantly to employment in the region. During the construction phase there would be an increase in Queensland employment and gross state product. The impact on employment in SEQ would range from 6,011 FTEs (full-time employees) when the construction starts, possibly in 2008, to 2,285 FTEs during the last year of construction possibly in 2012.

3.3 Summary of Benefits of Airport Link

Easing road traffic congestion in the inner northern suburbs will enhance their livability, particularly if the freed road capacity is taken up by enhanced public transport services, improved cycle links and more comfortable and attractive pedestrian connections.

Airport Link will provide a high-speed underground link catering for cross-city trips between major economic generators including the Brisbane CBD and the ATC precinct including Brisbane Airport. Airport Link will also support the regional road network by providing a high-speed underground link for radial and orbital trips. Specific examples of Airport Link's regional road network role include:

- a motorway-standard connection to the NSBT and the southern and eastern suburbs, and to the ICB and the southern and western suburbs via Coronation Drive and Milton Road;
- an improved arterial orbital route connecting Stafford Road and the East-West Arterial, easing congestion on Kedron Park Road-Rose Street- Junction Road; and
- increased radial arterial road capacity, allowing public transport initiatives in the Lutwyche Road corridor (eg Northern Busway), and improved amenity and road safety along both Lutwyche Road and Sandgate Road corridors.

Other benefits of the Airport Link are summarised as:

- relieving traffic congestion and improving travel time reliability, particularly for freight vehicles and surface public transport supporting competitiveness of industry and business;
- creating opportunities for enhanced public transport operations on freed-up surface arterial roads, possibly supported by HOV and bus lanes on Lutwyche Road and HOV lanes on Sandgate Road;

- improving the travel environment of pedestrians and cyclists on the surface network and providing flexibility for travel by reducing traffic demands on the local road system;
- creating manageable and beneficial impacts on land use patterns in the inner northern suburbs, as areas presently blighted by traffic congestion become available for redevelopment and other areas have reduced potential for blight as a consequence of future traffic congestion;
- easing congestion-related air pollution within the corridor along the benefitted arterial routes and little impact, if any, to the regional airshed while catering for increased travel demand;
- reducing road traffic noise for properties fronting the major arterials to benefit from reductions in traffic congestion (eg Lutwyche Road, Sandgate Road); and
- responding to existing and forecast future traffic congestion with greatly reduced surface impacts as compared with the provision of additional road capacity as surface improvements either to existing arterial roads or as new roads requiring property acquisitions and extensive surface works.

4. Project Development

4.1 Initial Development of the Project

The Airport Link Project has its genesis in the *Strategic Transport Opportunities for Brisbane* (BCC, 2003), which identified a range of transport strategies, including the upgrading of road capacity for cross-river and cross-city travel. A key element of that study was the NSBT and what has since developed into the Airport Link Project.

Since then, both the *Transport Plan for Brisbane* and the *TransApex* initiatives have been developed to investigate an integrated approach to resolving the City's on-going transport challenges. The *TransApex* pre-feasibility study (BCC 2004) found the Airport Link Project to be technically and financially feasible.

The *South-East Queensland Infrastructure Plan and Program 2005 – 2026* (SEQIPP) identifies the Airport Link as a key element in improving road infrastructure, and as part of an over-arching strategy for transport infrastructure to cater for anticipated population growth and consequential growth in travel demand through to 2026.

The *TransApex* pre-feasibility study found, in comparison to the alternative Kingsford Smith Drive Link, the Airport Link:

- had better potential for travel time savings with greater reduction in kilometres travelled;
- would allow traffic to connect to other elements of the motorway network, including the NSBT and the ICB;
- would not cause congestion on the eastern end of the ICB (as would be the case with the Kingsford Smith Drive option);
- would reduce traffic congestion on Gympie Road and Sandgate Road; and
- would carry approximately twice as much traffic as the Kingsford Smith Drive Link.

Accordingly, the Queensland Government and the Brisbane City Council agreed to progress to detailed feasibility studies of the Airport Link Project. Concurrently with this initiative, *TransLink* initiated similarly detailed studies into the Northern Busway Project to provide dedicated north and southbound buslanes through the same corridor between Herston and Kedron.

Corridor Assessment

The *TransApex* Prefeasibility Report (BCC 2005) identified and investigated two possible corridor options for the Airport Link Project. Although both corridors provided similar strategic connectivity benefits, they differed fundamentally in terms of construction and secondary levels of connectivity.

The first task of the Airport Link Detailed Feasibility Study was assessment of the two corridor options. This study recommended that the detailed feasibility study continue with the western option only. The western corridor extends from Bowen Hills to Kedron with Lutwyche Road generally as its midline, before swinging east beneath Wooloowin and Clayfield to the East West Arterial at Sandgate Road. The western corridor was chosen as it would allow:

- better opportunities to connect Airport Link to other road and public transport projects;
- the construction to be in tunnel, reducing impacts on the community during and after construction; and
- opportunities for integration with the Northern Busway in concept development, and possibly in project delivery.

4.2 Options for Concept Development

During the course of preparing this EIS, many options for the Airport Link Project were developed and evaluated against the project objectives, engineering and environmental constraints, and wider objectives concerning sustainability and the Council's strategic directions for liveability.

Key considerations included:

- the tunnel alignment within the defined western corridor;
- the tunnel profile – whether there should be one tube or two, whether there should be two lanes or three in each tube, and what the design speeds and rates of climbing should be;
- the arrangements for connections to the surface road network, particularly at the Southern Connection before and after knowledge of the NSBT Changed Project became available, and at Kedron, as to how to cross Kedron Brook with the required number of traffic lanes; and
- the method and standards for tunnel ventilation, including the best locations for the ventilation outlets.

4.2.1 Tunnel Alignment

Having chosen the western corridor, the concept design phase of the feasibility study sought the best tunnel alignment within the identified corridor. The likely alignment of the mainline tunnels would run north from Bowen Hills and Windsor, beneath the Lutwyche Road corridor, to Kedron to minimise property impacts and because of generally good geotechnical conditions for tunnelling along this alignment. After making surface connections to Gympie Road and Stafford Road on the existing and on new structures at the Gympie Road bridge over Kedron Brook the mainline tunnels would proceed generally east between Kedron Brook and

Kedron High School, then beneath Wooloowin, north of Melrose Park, to connect directly with the East-West Arterial beneath Sandgate Road.

During concept development, numerous variations on this general alignment were considered. For example, one option provided city connections to the surface at Lutwyche Road and Albion Road, in the vicinity of the Windsor War Memorial Park. This was passed over in favour of connecting to the central city via O'Connell Terrace and Campbell Street in Bowen Hills because of:

- impacts on the heritage listed Windsor War Memorial Park;
- the extra traffic approaching this tunnel access would lessen the diminution of surface traffic congestion achieved by the below-ground tunnel; and
- the desirability of making the city connection beyond the southern extremity of the tunnel.

Lutwyche Road, north-bound

An option investigated at Kedron had the tunnel alignment well to the west of Lutwyche Road north of Bradshaw Street, to avoid interference with the Emergency Services Facility at Gympie Road. However, this greatly increased the property impacts and generally required a much wider bridge structure over Kedron Brook.

The alignment through Wooloowin was originally beneath Melrose Park but shifted to the north to an alignment of potentially better geotechnical conditions for tunnelling and to avoid potentially contaminated land beneath Melrose Park.

Some adjustments by way of improvement to the alignment may yet be identified in the tendering or detailed design stages.

4.2.2 Tunnel Profile

The tunnel profile refers to the cross-section of each of the 'tubes' as well as the longitudinal section of the overall tunnel system. Factors influencing the design and profile of the tunnel included:

- the geological conditions, including the hydrogeology, particularly along the Kedron Brook flood plain, and the requirement to prevent groundwater and stream intrusion during construction and operation;
- the preferred design speed and traffic capacity for in-tunnel traffic;
- the vertical alignment of the tunnels, having regard to climbing grades for commercial traffic;
- the number of traffic lanes required, in relation to tunnel length or tunnel enlargement where exit ramps diverge out of the tunnels;
- the air flow required to achieve in-tunnel air quality criteria;
- the requirements for in-tunnel operational services, emergency services and facilities, communications and surveillance requirements, directional signage, vehicle height;
- the drainage requirements for groundwater, stormwater and wastewater collection, treatment and discharge;
- the road geometry and external factors such as existing building foundations or structures; and
- the ease and costs of construction.

The most significant factor in determining the number of traffic lanes to be accommodated in the tunnels was the projected traffic demand. The design review process concluded that the best configuration for safety and efficiency was to construct two parallel tunnels throughout with all traffic in each tunnel travelling in the same direction. In the north to south aligned tunnels between Bowen Hills and Kedron, the tunnels should each accommodate three traffic lanes while the east to west aligned tunnels between Kedron and Clayfield should each accommodate two traffic lanes. Approaching the exit ramps at Kedron an extra lane would be required in the north to south tunnels meaning an expansion of the tunnel profile to four traffic lanes. Many other factors influenced the tunnel profile at a more detailed scale of design.

4.2.3 Connections to the Surface Road Network

The connections to the surface road network have provided the greatest challenges with many different options being considered. The challenges arise from a combination of existing traffic congestion on some of the approach roads, existing transport and other infrastructure, existing road network limitations, and a range of physical constraints including flooding, geology and topography.

Considering these issues, the Airport Link Project objectives and the pre-feasibility study outcomes, the solutions considered had a number of common elements including:

- connections to the NSBT, the ICB and O'Connell Terrace/ Campbell Street in the Bowen Hills/Windsor area;
- connections to Gympie Road and Stafford Road in Kedron adjacent to Kedron Brook; and
- connections to Sandgate Road and the East West Arterial in Clayfield and Toombul.

Bowen Hills – Windsor Southern Connection

This area, between O'Connell Terrace, Federation Street, Lutwyche Road and the Mayne rail depot, needs to accommodate complex road connections between Airport Link, the NSBT, the ICB and the local road network to the city. Nine options for this connection were investigated in the concept design stage and further design refinements were undertaken when the NSBT Changed Project design became known in May 2006. Major design criteria included:

- provide connections from Airport Link to NSBT Changed Project and Airport Link to ICB westbound;
- maintain, or improve, existing traffic movements on the surrounding road network;
- align the connection to minimise effects on sensitive properties and infrastructure such as the ICB substation, the Rosemount Hospital, the Queensland Railways (QR) corridor, Mayne rail yard and the Boral concrete batching plant;
- accommodate Horace Street levels under the ICB and the Horace Street bridge link levels and Enoggera Creek and its associated flood protection / immunity requirements;
- vertical alignment of the connection to maintain existing road network surface levels (ie ICB, Lutwyche Road) and to meet future road connection levels (ie NSBT Changed Project);
- pedestrian and cycle movements along the Enoggera Creek corridor from Mann Park to Bowen Park, to be established as part of the NSBT Changed Project, to be maintained, and pedestrian connections from Windsor East to the community facilities south and west of Lutwyche Road also maintained;
- disturbance to Enoggera Creek waterway and associated riparian vegetation to be kept to a minimum;
- Mayne Rail Depot to the east of Enoggera Creek to be maintained with allowance for an additional track on the northern side of the railway corridor running south from the Depot; and
- allowance for integration opportunities with the Northern Busway.

Further Concept Development of the Southern Connection

On 27 April 2006, RiverCity Motorway (RCM) was announced as the preferred tenderer for the NSBT. RCM proposed a design for the NSBT connection to Lutwyche Road and ICB at Bowen Hills which differed from the NSBT Reference Project evaluated in the Coordinator-General's Report of August 2005. The changes from the Reference Project embodied in the RCM design have subsequently been evaluated by the Coordinator-General and hereafter are referred to as the NSBT Changed Project. As a consequence, the Airport Link concept was further developed to achieve an acceptable connection with the NSBT Changed Project in Windsor and Bowen Hills. The NSBT Changed Project is not affected by the proposed reference design for Airport Link. On the contrary the Airport Link design has been refined to connect with the NSBT Changed Project at Bowen Hills and Windsor. The detailed design phase of Airport Link should include close coordination with RCM to ensure effective connections between the two projects in design, construction, operation and maintenance.

Gympie Road & Stafford Road – North-western Connection

Gympie Road is a major northern arterial connecting northern communities within and beyond the City to the city centre, whereas Stafford Road provides for east-west trips from the north-western suburbs and south-western suburbs to the Brisbane Airport, Port of Brisbane and Australia TradeCoast (ATC) precinct.

Due to the multiple trip movements through this confined part of the City's road network, 25 design options were investigated in the concept design stage. The Gympie Road and Stafford Road intersection on the northern side of Kedron Brook and the intersection of Gympie Road, Lutwyche Road and Kedron Park Road south of Kedron Brook are very complex traffic arrangements. Adding to that complexity is the presence of important community facilities such as the Kedron State High School, the Wooloowin State School, the Department of Emergency Services complex and St Andrew's Anglican Church, and established residential areas. Major design criteria were:

- connect Gympie and Stafford Roads with Airport Link tunnel in both directions;
- maintain existing traffic movements including weaving movements, and pedestrian movements at the Lutwyche Road/Kedron Park Road/Gympie Road intersection and the Gympie Road/Stafford Road intersection;
- maintain vertical alignment to existing road levels, (ie, Lutwyche, Gympie, Kedron Park and Stafford Roads), including Kedron Brook bridge, and to meet Kedron Brook flood protection/immunity requirements;

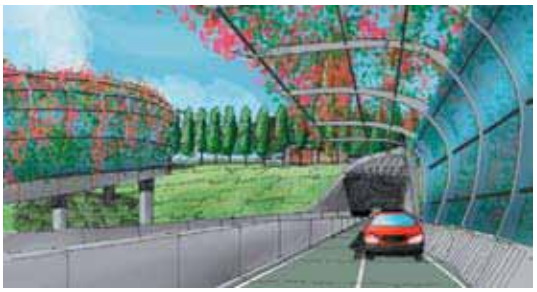
- minimise impacts of horizontal alignment on the Kedron Brook bridge and adjacent properties, while catering for the Northern Busway, Kedron Park Hotel, Energex substation on the corner of Gympie and Stafford Road and minimising property impacts;
- maintain pedestrian and cycle connections, including those along Kedron Brook (eg to Kedron State High School, Wooloowin State School);
- minimise disturbance to Kedron Brook waterway and associated riparian vegetation;
- maintain local traffic access (eg Colton Avenue, Windsor Avenue, Leckie Road, Lasseter Street, Park Terrace); and
- allow for integration opportunities with the Northern Busway.

East West Arterial – North-eastern Connection

The north-eastern connection aligns directly with the East West Arterial. The connection with Sandgate Road requires its conversion from a T-junction into a 'fast diamond' intersection. Forecast traffic flows in this area necessitated development of seven different design options. Key factors influencing the siting of the portals and design of the road connections were:

- the poor subsurface geotechnical conditions including the extent of stream alluvium beneath Wooloowin and Kalinga Park;
- storage capacity of left and right-turning traffic from Sandgate Road into the tunnel;

Southern connections and ventilation station (no mitigation)



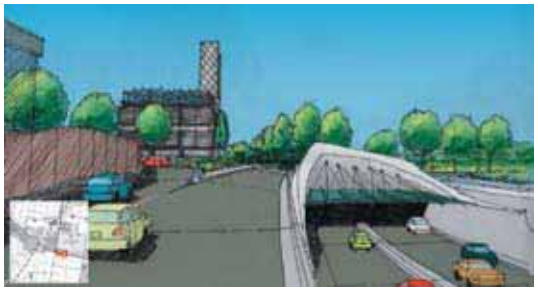
Southern connections and ventilation station (with mitigation)

North-west ventilation station at Kedron (no mitigation)

North-west ventilation station at Kedron (with mitigation)

North-west connections from Lutwyche Road and ventilation station (with mitigation)

North-east ventilation station on Sandgate Road (no mitigation)



North-east ventilation station and East–West Arterial portals (no mitigation)

North-east ventilation station and East–West Arterial portals (with mitigation)

- vertical alignment of the tunnel to be below the railway line embankment, and Sandgate Road to connect with the East West Arterial while avoiding Airtrain pylons;
- the flooding potential in Schulz Canal;
- diversion of the creek that flows through the culverts under the North Coast Railway to be planned for construction and operation to minimise impact on Kalinga Park; and
- major sewer, optic fibre, and gas pipelines and facilities.

Design of this connection evolved with new options addressing different constraints progressively. The alignment east of Sandgate Road was moved slightly to the north to minimise property impacts. The off-ramp to Sandgate Road was moved further north to avoid the Airtrain abutment and piers. The left turn lane from Sandgate Road to the East West Arterial was designed on piers to avoid flooding impacts. The capacity of the off-ramp to Sandgate Road was increased to avoid queuing back into the tunnel.

4.2.4 Ventilation Systems & Outlets

Tunnel ventilation systems aim to maintain acceptable in-tunnel air quality by diluting the concentration of vehicle emissions to achieve international standards for in-tunnel air. Longitudinal ventilation provides a most effective means of managing in-tunnel air quality and minimising the impacts of vehicle emissions from the tunnels on ambient air quality.

During development of the reference project, a number of locations were investigated for siting ventilation outlets. It was determined during the development of the ventilation system concepts that three ventilation stations and ventilation outlets would be required for the Airport Link Project. They would need to be situated near the surface connections in Windsor, Kedron and Clayfield, but the final location could be within a range of about 500 metres from the extraction point. A number of possible locations were considered for the ventilation outlets at each connection with shortlists of three, two and four at the southern, north-western and north-eastern connections respectively.

The candidate sites for each of the three ventilation stations and outlets were nominated to the community for comment during the preliminary community consultation.

The primary criterion for site selection was the performance of the ventilation outlet in terms of the stringent goals for ambient air quality. Other criteria included community, environmental and construction and operational matters. Each of the preferred sites for each ventilation station were modelled and found to achieve acceptable goals in terms of dispersion, dilution and ground level concentrations of key air quality parameters (CO, NO_2 and particulates). The modelling study suggested that 30 metre high outlets will give better dispersion results than 20 metre high outlets although the latter also achieved acceptable levels of critical air quality parameters.

4.3 'Do Nothing' Option

From section 2 of this Executive Summary describing the need for the Project, it is clear that the 'do nothing' option will:

- not address the continuing demand for congestion-free travel through the northern suburbs, nor increased demand for travel to and from the Brisbane Airport, arising from forecast population growth[2], increased economic activity and increased lengths of journeys;
- not provide an integral component in a balanced and integrated approach to transport planning, through the planned and orderly increase in road capacity on key routes, in step with planned enhancements to public transport capacity and enhancements to the pedestrian and cycle networks which provide additional flexibility in the overall transport network of the City[3];
- contribute to a decline in the City's competitive economic base due to increased costs associated with greatly increased traffic congestion along important routes;
- contribute to a decline in the City's liveability as measured against the Council's well-established strategic directions.

With the strong emphasis placed on integrated transport planning in the SEQ region and in Brisbane in recent years, combined with the forecasts for strong, sustained regional population growth for at least the next 20 years, there is a clear need for action in responding to the City's existing and future traffic congestion challenges. The appropriate response to the challenge is the integrated approach to road capacity, public transport and travel demand management established through the various transport plans.

2 Draft Regional Plan, Office of Urban Management, Qld Govt, 2004

3 Brisbane Transport Plan 2002 – 2016, BCC, 2003; Transport 2007, Qld Transport, 2001.

5. Traffic & Transport

5.1 Study Approach

A well-established process for assessment of traffic and transport impacts, consistent with and responding to the terms of reference for this EIS, was applied as follows:

- areas likely to be affected by traffic and transport aspects of the Project were defined;
- suitable data relevant for use in the study were collated;
- traffic and transport demand modelling and forecasting approaches were established, with model validation and sensitivity testing of the modelled results undertaken to ensure fitness for purpose;
- the existing status of the transport network was described;
- forecast transport demands and conditions were derived for the transport network without, and with, the Project. The differences between the derived forecast conditions for scenarios without, and with, the Project were assessed;
- the effects of the Project on traffic, public transport, cyclists and pedestrians were determined by examination of these differences; and
- using a similar process, the cumulative effects of the Project, if implemented in conjunction with the Northern Busway, were assessed.

5.1.1 Modelling & Forecasting

Traffic and transport modelling was used to describe and assess the existing traffic flows and transport system performance, supplementing traffic counts and other observed data to generate estimates of existing conditions via modelled data. Modelling was also employed to forecast traffic conditions and network performance at specific years in the future.

The modelling used a range of inputs to predict transport and traffic demand including:

- land use descriptors – population and demography, employment and education enrolments within small geographic areas;
- travel characteristics – trip-making rates, vehicle occupancy for different trip purposes[4];
- user preference surveys – specific behaviour characteristics for potential toll road users from a survey of over 800 residents;
- road network changes – existing and planned or likely future road infrastructure, and road tolls, for the various forecasting years; and
- public transport – existing and likely future public transport services, their coverage and frequency, for the various forecasting years.

The modelling of future transport networks, both without and with the Airport Link Project, includes the scenario where the NSBT is implemented and operational. The NSBT Project is a planned major cross-river toll road, connecting Bowen Hills and Woolloongabba, with an intermediate link to the eastern suburbs at Kangaroo Point.

Other major road projects included in all future transport network modelling are:

- the Gateway Upgrade Project (GUP), the planned duplication of the tolled Gateway Bridge and upgrading of the Gateway Motorway on each side of the Brisbane River; and
- the Brisbane Airport Northern Access, planned by the Brisbane Airport Corporation as a new access road connecting to the new northern deviation of the Gateway Motorway created with GUP, to primarily serve the domestic and international terminals at Brisbane Airport.

Modelling of a separate scenario, which considers the cumulative effects of the proposed staged implementation of the Northern Busway, a major public transport improvement in northern Brisbane, has also been undertaken.

Future traffic and transport conditions were modelled and assessed at two levels. Existing and future conditions for the Brisbane metropolitan area were modelled at a strategic level to analyse city-wide transport network implications of the Airport Link Project. This strategic modelling also accounted for areas of influence outside the study corridor, such as Brisbane's CBD and the ATC area, which includes Brisbane Airport. The strategic model used in the study was based on the Brisbane Strategic Transport Model (BSTM), with specific enhancements incorporated to enable more accurate forecasting.

Key model improvements included using more up-to-date input data, and more sophisticated representation of the delays typically experienced at intersections along a route.

Modelling at a more detailed local level, covered inner northern Brisbane, addressed localised traffic and transport effects of the Airport Link Project within the suburbs of Wooloowin, Clayfield, Kedron, Gordon Park, Lutwyche, Albion, Windsor and Bowen Hills. At the local level, the effects of the Project on local intersection performance were examined using aaSIDRA software with data extracted from the city-wide model.

4 A survey undertaken in 2003/2004 of the travel behaviour of a sample of Brisbane households

Future traffic and transport conditions with the Project, such as travel demand, travel times, travel speeds and the operating level of service of the road network and intersections, were forecast for 2012 (the forcast year of Project opening), 2016, 2022 and 2026 for scenarios without, and with, the Project.

5.2 Existing Transport System Performance

Existing traffic levels, movement patterns, road network performance and intersection operating characteristics were determined from a range of observed and modelled data for the Brisbane Metropolitan area and Inner North area. **Table 5-1** presents a summary of current traffic flows across the inner northern road network.

Key findings from the assessment of the existing traffic and road transport conditions are:

- highly congested traffic conditions occur during peak periods at several locations along the Gympie Road-Lutwyche Road-Bowen Bridge Road corridor, where there are 23 sets of traffic signals and two signalised pedestrian crossings in the 5.8 km between Kedron and Herston;
- on the Sandgate Road-Abbotsford Road corridor, where there are 18 sets of traffic signals and two signalised pedestrian crossings in the 6.0km between Toombul and Bowen Hills, congestion also occurs and in particular, traffic conditions in the Albion area are problematic;
- the typical weekday traffic volumes on Lutwyche Road of 60,000 vpd, and 40,000 to 50,000 vpd on Sandgate Road, represent a major proportion of the traffic task in inner north Brisbane;
- both roads carry a significant proportion, around 60%of vehicles making cross-city travel movements, in addition to functioning as important routes for radial or CBD oriented traffic, and local traffic to land-uses along the routes. Sandgate Road also serves as a commonly utilised route for travel to the Airport/ATC area;
- travel speed on both the Lutwyche Road and Sandgate

Table 5-1: Existing (2004/05) Traffic Volumes – Inner Northern Brisbane (two way totals)

Road	Location	Average Weekday Traffic Volumes (AWDT)[1]	Average Daily Traffic Volumes (AADT)[2]
Motorway			
East – West Arterial	East of Widdop Street, Hendra	23,000	21,200
Arterial			
Rode Road	West of Sandgate Road, Wavell Heights	19,300	17,800
Stafford Road	West of Richmond Street, Kedron	22,500	21,200
Gympie Road	North of Broughton Road, Kedron	59,100	55,900
Sandgate Road	North of Schulz Canal, Toombul	52,200	48,100
Nudgee Road	North of East-West Arterial, Hendra	11,300	10,100
Kedron Park Road	East of Lutwyche Road, Kedron	17,600	16,200
Rose Street	Melrose Park, Wooloowin	10,700	10,000
Junction Road	West of Sandgate Road, Clayfield	18,200	17,000
Sandgate Road	South of Junction Road, Clayfield	37,000	34,100
Lutwyche Road	North of Stoneleigh Street, Lutwyche	59,600	56,400
Sandgate Road	South of Bonney Avenue, Albion	35,900	32,900
Lutwyche Road	South of Newmarket Road, Windsor	60,300	56,900
Abbotsford Road	South of Burrows Street, Bowen Hills	54,800	48,900
Inner City Bypass	West of Breakfast Creek Road, Hamilton	26,800	23,900
Kingsford Smith Drive	East of Cooksley Street, Hamilton	65,600	59,200
Inner City Bypass	West of Bowen Bridge Road, Herston	65,900	59,800
Suburban			
Shaw Road	At Kedron Brook, Wooloowin	14,100	12,500
Maygar Street	West of Lutwyche Road, Windsor	8,300	7,700
Albion Road	East of Lutwyche Road, Windsor	15,100	13,700
Newmarket Road	West of Lutwyche Road, Windsor	17,600	16,700
District Access			
Dickson Street	North of Wride Street, Wooloowin	10,400	8,400

Table Notes: Source: BCC, DMR, 2005 Surveys

1) AWDT - Average of the five (5) working days

2) AADT - Average of the full seven (7) day week.

Road corridors is significantly lower than the posted speed limit on these roads during typical peak periods. Travel speed fluctuates widely along the corridor due to traffic delays at numerous locations;

- at the metropolitan level, public transport mode share has improved between 1992 and 2004 and person trip-making rates are stable or slightly declined;
- motorised travel has increased to 80% of total modal use at the metropolitan area level from 77% in 1992, indicating the dominance of vehicle demand;
- bus services in the Inner North area are affected by congestion on the road system, with most bus services running with longer travel times and slower speeds than general traffic, particularly on Sandgate Road. On Lutwyche Road the inbound transit lane offers some benefits to bus travel times in the AM peak. However, no similar benefit is available for outbound travel in the evening peak;
- Lutwyche Road (6.5% - 9.4%) and Sandgate Road (5.2%-8.0%) carry quite high proportions of commercial vehicles. Nudgee Road (15.9%) and Kingsford Smith Drive (11.1%) have higher commercial vehicle usage.

5.3 Future Conditions without Airport Link

Conclusions to be drawn regarding traffic growth and network performance characteristics from assessment include:

- a progressive decrease in travel speeds due to increased congestion is forecast, due to increased travel demand on the road network;
- traffic on Lutwyche Road through the Lutwyche shopping precinct would grow by over 30% from 60,000 vehicles per day (vpd) at present to 77,500 vpd by 2026, with congestion and journey time variability progressively increasing;
- intersections along Lutwyche Road, which provide key local traffic connectivity, such as Chalk Street, Maygar Street and Albion Road, will operate with very high delays for the side-road traffic movements;
- due to its proximity to the contributory influence of the ATC North precinct, and the inter-connection it provides to the Brisbane CBD, Sandgate Road would experience almost a doubling of traffic levels from 36,000 vpd through the Albion area to over 71,000 vpd by 2026;
- intersections in, and around the Albion shopping and commercial area would become the most severely congested locations in the Inner North area; and
- roads through the local area would experience further pressure from through-traffic, often termed "rat-runners", when commuters seek to avoid the highly congested arterial routes. As an example, on Shaw Road through Wooloowin, traffic is expected to grow by over 30% by 2026, further eroding residential amenity, and Junction Road is expected to have a 79% traffic increase over the same period.

5.4 Operational Effects

5.4.1 Demand for Airport Link

Once operational, Airport Link is forecast to fulfill a traffic function of regional significance. Airport Link would function as part of a network of cross-city connections between the northern and southern, and northern and western suburbs of Brisbane. It would also provide an important link between two major economic activity centres in the region, namely the ATC North precinct and the Brisbane CBD.

The forecast Airport Link traffic volumes are significant within the regional network context and are identified in **Table 5-2**. Weekday traffic flows on the Airport Link Project north-south tunnel are forecast as 93,150 vpd in 2026, with an additional 25,750 vpd using the east-west ramps.

Table 5.2: Airport Link Overall Traffic Use Summary – Average Weekday Traffic Volumes (vehicles) 1

Project Element	2012 Opening [2]	2012 Daily	2026 Daily
North-South Tunnel	51,000	72,850	93,150
East-West Ramps	16,400	23,350	25,750
Total Airport Link	67,400	96,200	118,900

Table Notes:
(1) EIS traffic forecast is based on full (north-south) journey toll of $3.64 and part (east-west) journey toll of $2.43 expressed in $2006 including GST.

(2) 2012 opening volumes are estimated as typically 70% of the traffic model forecast as use of the new toll road typically builds up over the first years.

The north-south tunnel carries predominantly cross-city traffic (50%), and also has significant proportions of radial or CBD oriented trips (33%), Airport/ATC North precinct traffic (15%) and a small amount of local traffic (2%). This breakdown demonstrates that Airport Link fulfils an important function as part of a network of cross-city connections between the northern and southern, and northern and western suburbs of Brisbane. It also provides an important link between two major economic activity centres in the region, namely the ATC North precinct and the Brisbane CBD.

The east-west ramps cater primarily for traffic use related to the ATC North precinct including Brisbane Airport (52%) and cross-city travel (43%), with a small amount of local traffic (5%). The overall proportion of daily project use related to

the Airport/ATC North area is 24%, with the majority (20%) related to land-uses within the Brisbane Airport Corporation Master Plan area.

5.4.2 Traffic Volume Effects, Mitigations and Benefits

The effects of the Project on feeder routes have been assessed by comparing the differences between the derived forecast conditions for scenarios with and without Airport Link. The Airport Link Project is predicted to have a wide effect on route choice within the network, resulting in several heavily trafficked north-south arterial roads in the broader northern network likely to experience traffic reductions and improved operations. Examples of such improved operations in 2026 include Kingsford Smith Drive (-3%), Nudgee Road (-19%), Enoggera Road (-13%) and South Pine Road (-12%).

Airport Link will provide improved amenity on many roads in the inner northern suburbs due to forecast traffic reductions. The following additional traffic benefits are forecast in 2026:

- reductions in daily traffic of 25% on Lutwyche Road through the Lutwyche shopping area, and 28% on Sandgate Road at Albion;
- reductions in daily traffic levels on suburban and district roads, such as Shaw Road (-16%), Dawson Street (-8%) and Dickson Street (-28%), which presently experience strong peak travel demands from north-south commuter traffic seeking to avoid congestion on the arterials;
- strong reductions (23-28%) in east-west traffic on the Junction Road-Rose Street route through residential areas of Wooloowin and Clayfield;
- relief of traffic congestion on key east-west links between Gympie and Sandgate Roads north of the Project, such as Rode Road (-24%) and Hamilton Road (-16%); and
- reduction of commercial traffic by 49% from north-south surface routes from Webster Road across to Nudgee Road.

Some impacts of the operation of the Airport Link Project on feeder roads are predicted. Several roads at the southern connection will experience increased traffic demands. However, the range of Airport Link network connections provided disperses the level of impact, such that no significant adverse impacts are forecast. On the busiest links, where capacity issues are most critical, much smaller changes are forecast, including minor increases of 2-3% on the ICB and 5-6% on Bowen Bridge Road.

At the north-western connection the most significant effect occurs on Stafford Road where an increase in demand of over 50% is forecast compared to future traffic levels without the Project. This is due to the combined role of this link catering for travel demand for both east-west and north-south movements. The resulting traffic volumes of 45,000 vpd in 2026 are within the mid-block traffic lane capacities of a well-managed four (4) lane arterial route. Satisfactory levels of service could be achieved with the implementation of traffic management measures along the route. These are recommended as mitigations and could include one or more of the following, delivered through a local traffic management plan:

- parking management/restrictions at intersection approaches;
- formalisation of turn lane pockets at side streets where signalised intersections are not provided;
- construction of a raised median along Stafford Road where double centre line exists at present;
- potential implementation of additional signalised intersections at side-streets;
- facilities for public transport, such as indented bus bays; and
- facilities for pedestrians and cyclists.

The predicted operational impacts of Airport Link on Gympie Road diminish quite rapidly north of the Gympie Road connections. However, an operational traffic management plan, developed in consultation with local businesses, should address management measures such as signal co-ordination to accommodate increased traffic on the approaches of this arterial corridor connecting to the Project. Such measures could be implemented in conjunction with Airport Link in the north-western connection at the Stafford Road/Gympie Road intersection and at the Gympie Road / Broughton Road intersection. Local area traffic management measures would minimise the potential for use of the local roads in this precinct by through traffic.

Traffic volumes on Sandgate Road north reduce with the Airport Link Project, due to the re-distribution of travel movements from northern areas to the east-west toll road to access the East-West Arterial Road. This effect will reduce traffic congestion at the access to Toombul shopping centre.

5.4.3 Network Performance Effects

The impact of the Airport Link Project on the performance of the metropolitan road network has been described in section 3.2.1. **Table 5-3** also summarises the beneficial effects, showing that the Project reduces the travel on lower order roads in the network and redistributes travel to motorway routes. This is desired as a key strategic outcome for the Project.

5.4.4 Intersection Performance Effects

The effect of the Airport Link Project on the performance of key signalised intersections within the network has been assessed, as well as intersections along the surface road network that will benefit due to diversion of traffic to Airport Link. The key intersections examined include:

- intersections in the Gympie Road-Lutwyche Road corridor;
- intersections along the Stafford Road corridor;
- intersection in the Sandgate Road-Abbotsford Road corridor;
- intersections on the feeder roads in the Bowen Hills and Fortitude Valley area;
- intersections along Kingsford Smith Drive; and
- intersections in the local road network between Lutwyche Road and Sandgate Road.

An overall improvement is predicted in operating conditions along the Sandgate Road corridor, enhancing the operation of intersections both north and south of the Project, benefitting both vehicular and pedestrian movements. In the Lutwyche Road corridor south of the Kedron Park Road intersection, the Airport Link Project will create improvements in intersection operations at key intersections such as Albion Road-Lutwyche Road, Junction Road-Rose and Street-Park Road. This creates opportunities for the use of some road capacity for pedestrian improvements and/or public transport priority. Along Stafford Road, the level of service at some intersections will decline with the Project due to the increase in traffic volumes. Some arterial corridor traffic management measures along Stafford Road, as highlighted previously, may be necessary to achieve greater traffic capacity and reduce delays.

In some locations, grade separation has been incorporated within the Project to ensure that traffic accessing or egressing the Project tunnels can connect in an unimpeded manner to

Table 5-3: Network Performance Without and With Airport Link

Road Type	Without Airport Link			With Airport Link			Difference		% Difference	
	VHT(1)	VKT(2)	Speed km/h	VHT	VKT	Speed Km/h	VHT	VKT	VHT	VKT
2012										
Motorway	272,900	22,103,000		277,100(3)	22,290,000(4)		4,200	187,000	1.5%	0.8%
(Airport Link)	-	-		-	331,000		-	331,000	-	-
Arterial	464,300	20,819,000		452,600	20,550,000		-11,700	-269,000	-2.5%	-1.3%
Suburban	170,100	8,186,000		165,700	8,075,000		-4,400	-111,000	-2.6%	-1.4%
District	98,900	3,329,000		97,200	3,291,000		-1,700	-38,000	-1.7%	-1.1%
Local	53,800	1,317,000		53,000	1,295,000		-800	-22,000	-1.5%	-1.7%
Total	**1,059,900**	**55,754,000**	**52.6**	**1,045,600**	**55,833,000**	**53.4**	**-14,300**	**79,000**	**-1.3%**	**0.1%**
2026										
Motorway	408,800	30,070,000		411,400(3)	30,255,000(4)		2,600	185,000	0.6%	0.6%
(Airport Link)	-	-		-	410,000		-	410,000	-	-
Arterial	608,000	25,238,000		588,000	24,932,000		-20,000	-306,000	-3.3%	-1.2%
Suburban	225,400	10,224,000		218,500	10,077,000		-6,900	-147,000	-3.1%	-1.4%
District	132,800	4,129,000		129,300	4,065,000		-3,500	-64,000	-2.6%	-1.6%
Local	93,100	1,608,000		91,400	1,577,000		-1,700	-31,000	-1.8%	-1.9%
Total	**1,468,200**	**71,269,000**	**48.5**	**1,438,500**	**71,317,000**	**49.6**	**-29,700**	**48,000**	**-2.0%**	**0.1%**

Table Notes:

(1) VHT - Vehicle Hours Travelled on Average Weekday

(2) VKT - Vehicle Kilometres Travelled on Average Weekday

(3) Includes AL Tunnel VHT

(4) Excludes AL Tunnel VKT

the connecting road network and not encounter a signalised intersection for a considerable distance. For other locations, where traffic exiting the tunnel will encounter a potential stop point, an analysis of the level of service and queuing at the exit has been undertaken. In all cases this was found to be satisfactory.

The need will remain for a complex range of traffic movements at the surface road intersections in the vicinity of the access points at Kedron and at Clayfield. As a result, these intersections will operate with some congestion during peak periods with the Project. These effects are principally related to the increased concentration of east-west traffic movement. For these key intersections, traffic signal co-ordination should be implemented to ensure that key movement streams using the surface road routes are not unduly delayed.

Traffic on the un-tolled surface routes passing through the Kedron and Clayfield intersections will find that intersections further along Lutwyche Road and Sandgate Road will be less congested, so the overall effect on travel time on the surface route will be improved.

5.4.5 East-West Arterial & Nudgee Road

The East-West Arterial intersections with Gateway Motorway and Nudgee Road are on a key approach route to the ATC precinct, an area which is forecast to experience a substantial growth in traffic demand due to increased employment and economic activity. It is noted that the present performance of these intersections is a matter of community concern as expressed through the preliminary consultation process for this EIS.

Both the East-West Arterial/Nudgee Road signalised intersection and the East-West Arterial/Gateway Motorway ramps/Airport Drive roundabout are currently highly congested and experience heavy delays and queuing during peak periods. The Gateway Upgrade Project when completed in 2011, will re-direct some traffic movements, however continued travel growth will create pressure for capacity improvements at these locations. In the absence of improvements, operating conditions during peak periods would be poor in 2011 and continue to degrade, worsening significantly in terms of queuing and delay. A clear need for improvements to be undertaken is evident, regardless of Airport Link.

In 2012 Airport Link adds 12% in the AM peak and 3% in the PM peak to total volumes at the Nudgee Road intersection, and 4% in the AM peak and 5% in the PM peak to volumes at the Airport Drive roundabout. There are some traffic distribution changes through these intersections with Airport Link, which slightly improve forecast conditions, however the pressure for capacity improvements would still remain.

A detailed investigation of the most suitable form of upgrading to be undertaken at this location to achieve a long-term solution for network operations in this area is warranted. In accordance with SEQIPP 2006-2026, a study to examine the long-term transport access needs of the ATC precinct has commenced under the direction of Queensland Transport.

Local Traffic Effects

The Airport Link Project would require some changes to local traffic arrangements through access restrictions or changes. Local access effects have been assessed in the following areas:

- North-western Connection
  - Kedron East Precinct (east of Gympie Road) – minor impact that can be managed;
  - Gordon Park Precinct (south of Stafford Road) – moderate effects with Project design shaped to minimise adverse impact;
  - Kedron West Precinct (north west of Gympie Road/Stafford Road intersection) – minor impact on local access, however implementation of local area traffic management measures recommended to address potential pressure from increased traffic on adjacent arterial roads on precinct;
  - Emergency Services Complex (at Kedron Brook) – satisfactory alternative access arrangements need to be established from Park Road with site re-configuration; and
  - Lutwyche Precinct (west of Lutwyche Road) – moderate impacts on local traffic access with Project design features to minimise adverse effects.
- North-eastern Connection
  - Toombul precinct – overall beneficial effect on local traffic due to reduced traffic levels on Sandgate Road.
- Southern Connection
  - between Federation Street and O'Connell Terrace (east of Bowen Bridge Road) – moderate impacts on local traffic access with Project design features to minimise adverse effects; and
  - Royal Brisbane Hospital (RBH) – overall beneficial effect on traffic access for RBH due to forecast traffic reductions near access and provision of high quality route via Airport Link for flexibility in emergency situations.

Benefits for Bus Travel

During peak hours Lutwyche Road and Sandgate Road will have significant traffic reductions and increased travel speeds on the surface road bus routes. These are the highest utilised corridors for bus services in the Inner North area, so the Project will yield travel time savings and improved travel time reliability for bus passengers. An overall average travel time improvement of 37% to 40% in the peak hours in 2022 is forecast for a CBD trip, compared to the scenario without the Project. This is equivalent to a travel time saving of approximately 6 minutes in travel time for bus commuters.

The Project creates the opportunity for a new bus route between the City and the growing employment and activity areas within ATC North precinct to utilise the east to west tunnel of the Airport Link and travel express to Nudgee Road. Services could gain access from Lutwyche Road at the north-western connection. This new route is under consideration in TransLink's forward planning.

There will only be minor effects to existing bus stops due to the Project, all of which can be suitably accommodated within the design.

Effects on Pedestrians and Cyclists

Airport Link will have some effects on existing infrastructure for pedestrian and cycle movements around the tunnel portals and their connections to the surface road network. The Project's design has ensured that connectivity will be maintained in those localities. Opportunities to improve local pedestrian and cyclist accessibility in conjunction with the Project have been identified. Key changes in the design include:

- linkages to existing and planned pedestrian and cycle paths through Windsor to the established pathways through Bowen Hills and Fortitude Valley;
- reinstatement and maintenance of the key links through Kedron and Lutwyche, in particular, the key route along Kedron Brook and the connections to the Kedron State High School, the Department of Emergency Services and the Wooloowin Primary School;
- reinstatement and maintenance of the key linkages along and across Schulz Canal in the vicinity of Kalinga Park, to connect the residential areas of Eagle Junction with the Toombul railway and bus stations and the Toombul shopping centre; and
- replacement of pedestrian crossings at the intersection of Sandgate Road and East-West Arterial.

Road Safety

The Airport Link Project is predicted to lead to an overall improvement in road safety, although there are varied outcomes on individual routes. Key findings are:

- an overall reduction in crashes on major routes within the Inner North area (including the Airport Link) of 9 % by 2022;
- forecast reduction in road crashes on the Bowen Bridge Road/Lutwyche Road/Gympie Road corridor, Sandgate Road/Abbotsford Road corridor and the Kedron Park Road-Park Road-Rose Street- Junction Road corridor of over 20% in 2022 with the Project; and
- due to increased traffic volumes associated with its function as a feeder route for Airport Link, the need for mitigation works along Stafford Road has been identified previously.

Cumulative Impacts with Northern Busway

The features and timing of the proposed Northern Busway (Royal Children's Hospital to Kedron) included within the traffic and transport model were based upon the proposed Northern Busway concepts publicly available in June 2006 for the staged implementation of that project. The staged implementation of the Northern Busway involves changes to the surface road operation and lane provision on Lutwyche Road. The overall effect is that two general travel lanes in each direction will be available on Lutwyche Road between Newmarket Road and Stoneleigh Street with the Interim Busway, matching to the existing two general traffic lanes in each direction on Lutwyche Road between Stoneleigh Street and Bradshaw Street.

The Northern Busway would provide a high quality public transport system in the inner northern suburbs, complementing the rail system and providing increased opportunities for interchanging between modes using TransLink's integrated ticketing system. This would enable convenient travel by public transport to a wide range of trip destinations both within and beyond the Central City.

Pedestrians and cyclists along Kedron Brook

The Northern Busway service plan for 2012 would result in a daily total of approximately 1,400 services crossing Enoggera Creek rising to 3,300 by 2026 compared to 800 bus services at present. At Lutwyche, currently serviced by 660 buses per day, bus numbers would rise from over 900 daily in 2012 to 2,400 daily by 2026. The plan includes a new bus service between the City and ATC North area via the Northern Busway, diverting at the Kedron Brook Busway Station to use the Airport Link east to west tunnel to the East-West Arterial.

The overall benefits to bus users of the Northern Busway are expected to lead to an increase in bus patronage in the corridor due to the improved public transport services and the greater travel reliability, comfort, safety and convenience provided by a Busway system. A summary of the key findings of the cumulative impacts assessment are:

- Weekday traffic flows on the Airport Link Project are marginally higher in the cumulative effects scenario with the Northern Busway. The perceived attractiveness of the surface road route changes compared to the Airport Link tolled route. There is also replacement of Airport Link trips to the Central City by cross-city and cross-river movements. Typically Central City travellers find use of improved public transport an attractive option.
- A very similar range and scale of traffic effects on connecting roads will occur in the cumulative scenario, compared to the effects of the Project alone. Similar intersection performance will occur on feeder roads to the Project and at surface road intersections in the vicinity of the connections.
- The scale of traffic reductions with the cumulative scenario on roads within the Inner North area is generally similar to the Project only case, with the exception of Lutwyche Road, which experiences somewhat greater traffic reductions due to the Northern Busway effects. For example, on Lutwyche Road compared to a network without Airport Link, a decrease in traffic of 39% is forecast in 2026 with the combined projects, which is greater than the 25% reduction with Airport Link only.
- The overall effects on road network performance are quite similar to the Airport Link only scenario, with beneficial transfer of some of the road travel task from lower to higher order roads in the network.
- The cumulative impact of the Airport Link and the Northern Busway on travel times and speeds shows similar benefits to the Airport Link project case. This indicates that the allocation of some of the road space freed-up by traffic reductions due to the Airport Link to public transport use (as proposed in the Northern Busway interim staging) does not significantly affect travel time on this route for general traffic. The travel time along the alternative surface route remains substantially better than would prevail in the future scenario without Airport Link.
- Some additional effects on local access will occur in the Northern Busway if implemented in conjunction with Airport Link, such as moderate impacts due to use of Swan Street for bus access/egress, albeit on a very low bus frequency basis. These arrangements are not expected to encourage additional traffic use of the local streets such as Swan Street due to other local management measures proposed. The Northern Busway will have some local access effects along Lutwyche Road for both the Interim and Ultimate Busway scenarios.
- The implementation of the Northern Busway in conjunction with the Airport Link will have additional beneficial effects on pedestrians and cyclists, such as new pedestrian connections at Kedron for the proposed bus station.
- The Bowen Bridge Road-Lutwyche Road-Gympie Road corridor between Herston and Kedron would experience significant additional safety benefits with the inclusion of public transport initiatives and further reduction of surface traffic. In other areas, there are only minor differences in expected crash effects in the combined Project scenario compared to the Airport Link only case.

5.5 Construction Effects

During construction, traffic and transport impacts may occur in the area surrounding the three construction worksites at Windsor, Kedron and Clayfield, due to physical changes or temporary traffic management, or more widely due to construction traffic on haulage and delivery routes.

Detailed construction traffic management plans (CTMPs) will be required for each work area to describe the management and mitigation measures to be adopted. Preparation of these plans will include detailed analysis of operational effects along affected routes and at affected intersections. The CTMPs will consider the convenience and safety of all road users, including public transport, pedestrians and cyclists. During construction, conditions around the work sites and on the haulage routes will be monitored, and the CTMPs modified as necessary to address any issues that arise.

The operations of access points, including the East-West Arterial/Sandgate Road intersection, will be examined in detail in the CTMPs for each site. If necessary, modification to the East-West Arterial/Sandgate Road intersection, which forms part of the Airport Link Project may be brought forward to facilitate signalised access to the adjacent worksite.

Haulage of construction spoil

From an assessment of the options of road, rail, conveyor,

pipeline and water transport, road transport is considered to be the only practical form of transportation for spoil haulage for this project.

Haulage is proposed to be carried out 24 hours a day for the five working days and 12 hours on Saturday to 6.30pm, to minimise impact on traffic flows. The spoil haulage scenario is based on road haulage to the Airport Gateway Upgrade and the Port of Brisbane sites using trucks, typically tip truck and quad dog combinations with a 22m^3 (approx 33 tonnes) capacity. **Table 5-4** shows the amount of spoil conservatively estimated at the three main worksites and the estimated truck movement for these sites.

With this arrangement the average haulage traffic generation will be 5 truck loads an hour from the north-western connection. This level of traffic is a very small addition to current traffic volumes, and is unlikely to significantly affect traffic flow on the haul routes. Delivery traffic is expected to be substantially lower than haulage volumes, and the delivery routes are, similarly, not expected to be adversely affected.

Spoil Haulage Routes

The worksites identified for the Airport Link Project all provide direct access to major roads. Preliminary investigation has identified potential haulage routes between the three connection areas and the potential designated spoil sites. The haul route from the southern worksite would likely follow Bowen Bridge Road, Gregory Terrace (or Campbell Street once the new Airport Link ramps were constructed) onto Breakfast Creek Road, Kingsford Smith Drive and the Gateway Arterial to the Port of Brisbane.

Spoil haulage routes from the north-western worksites would likely include Lutwyche Road and then follow the same route as for spoil haulage from the southern connection site to Kingsford Smith Drive, then to Australia TradeCoast Central or across the Gateway Bridge to the Port of Brisbane. Spoil from the north-eastern worksite would be limited to material from the cut and cover road construction. This would likely be taken along the East-West Arterial to the Australia TradeCoast Central site.

The construction traffic management plans would need to include consideration of the haulage traffic anticipated from the NSBT. Until the third quarter of 2009, background traffic flow on Kingsford Smith Drive will include trucks hauling spoil from the NSBT northern construction site. This is expected to overlap with lower intensity early works on Airport Link. During the peak construction period for total Airport Link and NSBT haulage on Kingsford Smith Drive, early in 2009, background traffic would include approximately 10 trucks per hour from the NSBT. At this time, the indicative scenario for Airport Link indicates an average of 4 trucks per hour would use this road. Although the incremental increase is small, if necessary to maintain network performance, Airport Link related haulage operations on this road could be limited to outside peak periods.

Local Traffic Flow Impacts

Temporary construction works that may affect traffic flow in the area surrounding the work sites during the construction period would include the following:

- temporary traffic diversions;
- realignment of traffic lanes;
- partial road closures, for works staged to minimise any disruptions to traffic flow or property access; and
- intersection operational changes.

Detailed analysis will be required during the preparation of the construction traffic management plans to ensure that local traffic flows and intersection performance due to the construction traffic is acceptable. If necessary, haulage and deliveries will be managed to outside peak times.

Other Aspects

Staging of works at all sites will allow the existing number of through lanes to be provided past the sites at most times, though temporary alignment changes would be required. As a result, the level of through traffic intrusion into adjacent areas is expected to be small. Occasional short duration partial closures are likely, for example for intersection works. These would be scheduled to minimise their impact.

The indicative work sites are able to accommodate all construction related parking demand, as well as queuing haulage vehicles. Alternatives for management of parking at the southern connection could also include extending parking into Byrne Street, which would no longer cater for

Table 5-2: Estimated Average Truck Generation – Spoil Removal

Site Location	Estimated Volume of Spoil Generated (m^3)	Duration (months)	Average Rate of Spoil Removal Per Day	Average Number of Truck Loads Per Day	Hours of Spoil Removal	Average Hourly Loaded Truck Movements
South	450,000m^3 277,500m^3 loose	32	1,100	50	24	2
North-West	975,000m^3 1,462,500m^2 loose	30	2,630	115	24	5
North-East	185,000m^3 675,000m^3 loose	16	870	40	24	2

residential access, or bussing workers to the site from car parking areas within the RNA Exhibitions Grounds. Conditions on streets adjacent to the worksites should be monitored, but no safety or amenity impact due to construction parking or queuing is expected.

Bus routes and schedules would not be affected by construction. Seven bus stops in the three construction areas would require temporary relocation during some stages of the works. Suitable interim locations close to the existing bus stops are available in each case.

Construction of the cut and cover sections at the north-eastern connection would have some impact on the North Coast Railway, with some overnight closures and an expected four (4) weekend closures required. This will involve some inconvenience to passengers who will be conveyed by bus around the work area, and may result in rescheduling of some freight operations. A smaller number of overnight closures will also be required on the Airport Line nearby, and the Exhibition Line near Campbell Street at the southern connection. Although the Airport Link will pass beneath the Ferny Grove Line in Windsor, this section of works will be roadheader driven tunnel construction and no impacts on rail operations on this line are expected.

Emergency vehicle access to the Royal Brisbane Hospital complex will not be affected significantly by the works. The Emergency Services Complex in Kedron will be relocated to an adjacent site before construction begins, and construction is not expected to significantly affect its access.

Pedestrian and cyclist access, including pedestrian crossings, will be maintained around all work areas, though some temporary diversions will be required. A temporary pedestrian/cycle bridge over Schulz Canal will be provided near Sandgate Road. This could be retained permanently as part of an enhanced pedestrian and cycle network.

5.6 Traffic & Transport Conclusions

For the investigations undertaken for this study, it is evident that the Airport Link would fulfill a range of traffic and transport needs. These are:

- Airport Link will address strategic gaps in Brisbane's road network, providing an enhanced road connection to the intra-state road system and the regionally significant roads that fulfil both radial and orbital functions in Brisbane. These improvements will facilitate cross-city travel movement catering for increasing travel demand, major economic activity and employment nodes serving the region (eg Brisbane CBD and the Australia TradeCoast precinct, including Brisbane Airport).
- Airport Link creates opportunities to enhance public transport operations on surface roads, particularly on Lutwyche Road where freed-up road space could be used either for bus, or transit (high occupancy vehicle) lanes. In particular, potential for a cost-effective staging of the Northern Busway would be available.
- Airport Link would relieve traffic congestion and improve travel time reliability. Users of the toll road facility, and the un-tolled surface roads, would benefit from travel-time savings, particularly freight vehicles.
- The environment for pedestrian and cyclist travel on the surface network would be improved with Airport Link, by reducing traffic demands on the local road system. Walking and cycling networks provide flexibility for travel as well as significant health and environmental benefits.
- Airport Link would generally improve the amenity of inner urban redevelopment areas such as Albion and Lutwyche, locations in close proximity to high quality public transport, by reduction in vehicular traffic. Consolidation of inner urban areas supports aspirations for a more compact urban form in South East Queensland.

While some adverse effects have been identified and assessed, the study shows clear support for the Project as a key component in an overall strategy to improve the efficiency of Brisbane's road network.

6. Environmental Conditions & Impacts

The existing environmental conditions in the study corridor have been described as the bases for impact assessment of the Airport Link Project. The environmental conditions of interest include:

- land use and planning;
- waste management;
- topography, geomorphology, geology and soils;
- groundwater quality;
- surface water quality;
- air quality;
- noise and vibration;
- flora and fauna;
- cultural heritage, including indigenous cultural heritage;
- social conditions;
- economic conditions;
- hazard and risk issues; and
- urban design and visual conditions.

6.1 Land Use & Planning

6.1.1 Existing Conditions

At the strategic level, urban growth in the SEQ region is guided by the *Regional Plan* and *City Plan*. The SEQ Regional Plan is supported by the SEQIPP, which identifies the Queensland Government's priorities for infrastructure delivery, to ensure the timely provision of infrastructure to support sustainable urban development. The Airport Link is listed in the SEQIPP as part of the orbital road network in the Brisbane metropolitan area.

At the city or local level, the study corridor traverses Brisbane's inner northern suburbs. Many of these areas are undergoing change and redevelopment in response to increasing pressures from population growth and real estate prices, which are being managed by the City Plan and its constituent Local Plans.

6.1.2 Predicted Land Use Impacts

Land use impacts within the study corridor are likely to be associated with acquisition of properties, changes to access, traffic movement, and amenity and redevelopment opportunities provided through the redevelopment of sites not required for construction.

The Airport Link Project is expected to relieve traffic congestion and provide opportunities for enhanced public transport, particularly along Lutwyche Road and Sandgate Road. Land use change could be expected to follow these improvements and will need to be managed to ensure that the advantages of land use change are optimised and that potential impacts are avoided or minimised.

At the southern connection, land use change is anticipated to increase development intensity along Lutwyche Road, in response to improved accessibility, increased development pressure, changes in amenity and opportunities to redevelop sites following construction for commercial or multi-unit residential developments. It is expected that Windsor (East) will undergo significant land use change associated with redevelopment opportunities over and around the construction area generally.

At Kedron, changes to traffic movement patterns and amenity resulting from the Airport Link Project are likely to contribute an increase in intensity of development along Stafford Road and Gympie Road, north of the tunnel portal. Residential land uses in Wooloowin and Clayfield are not expected to change as a result of the Airport Link Project.

Building heights in close proximity to the ventilation outlets will need to respect and maintain the operational performance of the outlets at each end of the tunnel system. At present, local planning and City Plan provisions restrict building heights to levels well below the likely height of the ventilation outlets.

Property Impacts

The Airport Link Project will require the acquisition of interests in land for surface connections and surface works, and the acquisition of volumetric interests in land for sub-surface works. The acquisition of land could occur either through private treaty with individual property owners or by a statutory process of acquisition conducted in accordance with the *Acquisition of Land Act 1967*. The acquisition of interests in surface properties will affect the localities around the surface connections at Windsor and Bowen Hills, Lutwyche and Kedron, and Clayfield. The acquisition of interests in volumetric properties will affect the study corridor extending from Windsor to Lutwyche, and from Lutwyche through Wooloowin to Clayfield.

As an indication of the requirement for surface properties for the reference project, approximately 146 properties would be required. Of these, approximately 31 are held in public ownership. Approximately 11 properties (public and privately owned) are vacant and 7 properties are reserves for open space or similar public purposes. Nearly half the surface properties required are situated in the Lutwyche and Kedron areas to provide for the north-western connections.

6.1.3 Proposed Mitigation for Land Use Changes

Through amendments to City Plan, redevelopment could occur in ways consistent with desired planning outcomes. Local planning outcomes ought to be developed for areas near each of the connections through the Neighbourhood Planning or local planning process being pursued by the Brisbane City Council. Urban regeneration initiatives would also seek to avoid some of the more commonly occurring effects of uncoordinated development of infrastructure, land and community structures. There are a number of locations in the study corridor which would benefit from the implementation of land use programs, which would complement the ultimate planning for the transport corridor.

6.2 Waste Management

6.2.1 Waste Streams

The Airport Link Project has the potential to generate a range of liquid and non-liquid waste materials, primarily in the construction phase of the project. The key waste streams include:

- demolition waste (building and structure materials, kerbs and pavements);
- building waste (packaging materials, scrap metal, timber formwork, pallets, plastic wrapping, cardboard);
- general waste from construction compounds; and
- liquid wastes from construction (dust control water, vehicle maintenance wastes, spillage from chemical or oil storage, groundwater inflow) and operation (groundwater inflow, pavement run-off, wash down water) of the tunnel.

6.2.2 Waste Management Strategies

Measures that involve waste minimisation and management fall within the categories of reduce, re-use and recycle.

Reduce

The contractors appointed to construct the project will be required to identify opportunities for reducing waste generation on site. Strategies for reducing waste would be detailed in the contractor's waste management plan and may include:

- considering materials and products with recycled content for use wherever cost-and-performance competitive, and where they are environmentally preferable to the non-recycled alternative;
- encouraging employees and sub-contractors to avoid and reduce waste wherever possible.

Re-use

The re-use of waste products during construction may include:

- waste concrete and pavements to be used as hard stand areas in construction compounds;
- broken tiles to be used in fill or transferred to a building supply company;
- bricks to be used in fill that is recycling;
- asphalt to be re-used by transferring to batching plants or use as a select/earthworks coarse layer; and
- topsoil to be stockpiled and stored for reuse, if possible.

Recycle

Recycling during construction may involve or include:

- kerb and pavement materials (concrete, asphalt) to be collected and transported to crushing and recycling plants;
- provision of recycle facilities for general rubbish, ie glass, plastic, waste paper and metals, using colour-coded bins;
- transport of demolition materials to a recycling depot;
- collection and transport of steel scraps to a recycling facility;
- investigation by the contractor of the availability of treated wastewater or groundwater in-flow for use in spraying roadworks to reduce dust generation or for watering progressive landscape works;
- incorporation of a closed water recycling system on nearby concrete and / or asphalt batching plant;
- use of recycled materials to the limits of design in concrete, roadbase, asphalt and other construction materials;
- empty oil and fuel drums being collected or returned to recycling facilities; and
- training of all employees in the waste management plan and recycling opportunities.

6.3 Topography, Geomorphology, Geology & Soils

6.3.1 Existing Environment

The topography of the study corridor consists of generally undulating terrain with minor surface catchments between hills that rise to a maximum elevation of about 50m in only a few places. The north-south oriented part of the study corridor traverses two main drainage streams flowing west to east. Near the southern end of the study corridor, Enoggera Creek cuts through the Brisbane Tuff in a narrow valley filled with about 20m of alluvium forming a narrow flood plain. The major catchment divide between Enoggera Creek and Kedron Brook is a WSW-ENE ridgeline through Lutwyche averaging about 30m elevation up to 50m in the west. The main northern drainage is Kedron Brook, which is tidal in the northeast of the study corridor. Where it crosses the study corridor in the northwest, Kedron Brook has been greatly altered and straightened into a floodway and channel. The secondary Eagle Junction tributary joins Kedron Brook at Sandgate Road, after running approximately parallel to Kedron Brook across a low relief alluvial plain.

The oldest bedrock of the Brisbane area is the Neranleigh-Fernvale Formation of Devonian to Carboniferous age (420–350 million years old). During the Permian Period (about 250-300 million years ago), the Neranleigh-Fernvale Beds were exposed to weak regional metamorphism, destroying the original structure and bedding and replacing it with a metamorphic foliation attended by mineralogical alteration.

During the Late Triassic (approximately 220 million years ago) exposed Neranleigh-Fernvale Beds were covered in volcanic ash falls of the Brisbane Tuff. The ash fell on a highly irregular land surface with localised incised valleys and some isolated elevated regions. The ash falls were short-lived and progressively buried by soils, lake deposits and stream sediments. Much of the tuff was eroded and re-worked by stream action into a tuffaceous claystone. A massive eruption at the end of the Late Triassic produced a fiery gas-charged rhyolitic lava that formed a welded tuff or ignimbrite that filled a deep valley extending in a narrow north-south belt through the central Brisbane region.

On conclusion of the Triassic volcanic eruptions, rivers deposited sands and gravels along channels and floodplains to produce the conglomerates and sands of the Aspley Formation and more mature finer silts and shales of the Tingalpa Formation. After widespread erosion for some tens of millions of years, deposition of Quaternary Alluvium occurred particularly during high stands of the sea. The ground surface of the study corridor north and east of Colton Avenue, Lutwyche is covered by alluvium to an average depth exceeding 10 metres.

Soil types along the study corridor, particularly where they are to be excavated at worksites, have been identified from the Australian Soil Classification Scheme and their potential for erosion assessed as moderately to highly dispersive and their location within erosion prone floodplain areas indicates a potential for significant erosion impacts to occur if appropriate erosion and sediment control measures are not implemented and maintained throughout site works.

Recent environmental evolution has developed acid sulphate soils (ASS) in estuarine and/or swampy areas along many parts of the Australian coast. If exposed to the air these soils liberate highly corrosive leachates that can cause extensive damage to manmade structures (e.g. concrete and steel structures). Excavations in areas where they have been identified require special precautions under a variety of environmental legislative guidelines and policies. In the study corridor the floodplain of Enoggera Creek and the far north-eastern area along Schulz Canal potentially harbour ASS.

A desk top survey based on records held by BCC and EPA, reference to historical air photographs, a visual assessment from motor vehicle and other minor sources revealed 228 properties listed with potentially contaminated soils that could pose health threats if excavated or if the tunnelling mobilises the contaminants into groundwater.

6.3.2 Predicted Impacts – Topography, Geology, Soils

Construction activities for the Airport Link Project are likely to impact upon the soil resources of both the Kedron Brook and Enoggera Creek catchments, due to the surface works required to establish connections with the surface road network in Kedron, Windsor and Clayfield. Potential impacts include:

- with the dispersive soils in the study corridor, there is some risk of soil erosion by wind and water action;
- sediment-laden run-off, and loss of topsoil leading to degradation of surface water quality could occur from cleared and or excavated work areas if appropriate mitigation measures are not undertaken;
- changes in water chemistry with attendant impacts on aquatic habitats as well as steel and concrete structures in contact with the affected waters from interception of acid sulphate soils releasing acid leachate;
- release of contaminants to the environment through induced groundwater movements or uncontrolled placement of contaminated spoil; and
- settlement as a result of groundwater drawdown in alluvium or other soft sediments or as the result of load adjustment above tunnelling activities.

From the survey of properties with potentially contaminated soils or the potential to release contaminants into the groundwater the study corridor was expanded to a width of 1 kilometre on each side of Lutwyche Road. This expansion

of that part of the corridor corresponds to the limits of area in which the unlined north to south tunnels could potentially draw the watertable down by more than 1 metre. The investigation encompasses those properties where a potential impact exists for contaminants to be drawn across property boundaries.

6.3.3 Impact Mitigation – Topography, Geology, Soils

Carefully detailed and carried out management plans for any of the potential impacts, together with accurate assessment of the areas to be excavated, and careful construction and conscientious management of works, will be required to avoid or mitigate and manage potential impacts. Stakeholders, near neighbours and others who might potentially be affected by construction works as a consequence of the ground conditions along the corridor, need to be kept informed well ahead of works beginning. The draft Outline Environmental Management Plans (EMPs) indicate the processes and establish environmental objectives to be achieved in managing the impacts of construction and operation. The Contractor will be required to prepare and gain approval for detailed construction plans and management plans and to liaise appropriately with the communities in the areas affected by construction works.

6.4 Groundwater Quality

6.4.1 Existing Conditions - Groundwater

The hydrogeological regime of the tunnel route comprises two broad aquifer types, namely:

- a fractured rock aquifer system of the Brisbane Tuff, Neranleigh-Fernvale Beds or Aspley/Tingalpa Formation; and
- an isolated Quaternary alluvial system in the valley of Kedron Brook.

Geotechnical investigation revealed that Brisbane Tuff has very low porosity. In these circumstances any groundwater movements that occur, do so through secondary features such as joints or fractures.

In the alluvial deposits coinciding with the valley floors and floodplains along the study corridor, groundwater regimes are thought to have been significantly altered as a consequence of drainage and flood mitigation works over the last 150 years. Along Enoggera Creek, the alluvium is up to 20 metres thick, with groundwater resources almost certainly in direct hydraulic connection with Enoggera Creek, rising and falling with the tides. The study corridor from Kedron to Clayfield is covered by 10-20 metres of alluvium that has its groundwater regime in hydraulic contact with Kedron Brook.

During the project investigations, groundwater samples were collected at 16 standpipe monitoring bores along the study corridor. The samples were analysed for a standard suite of cations/anions and metals as well as for volatile and semi-volatile compounds. In general, the water quality in the alluvial areas can be regarded as variable, with electrical conductivity (EC) values (a general indicator of salt content) ranging between 251µS/cm and 9700µS/cm.

Groundwater contamination by semi-volatile organic compounds was detected in four boreholes and requires further investigation. All potentially contaminated sites have been identified for investigation in the pre-construction planning stage. Potentially important groundwater management implications for Kalinga Park, Melrose Park, along Kedron Brook adjacent to Gympie Road and Downey Park Northey Street area have been identified.

In general, the ground water along the study corridor is unsuitable for human consumption and for agricultural purposes such as irrigation due to elevated levels of salinity which are difficult to treat. However, some agricultural use of groundwater resources is made from a bore in the RNA Showgrounds.

6.4.2 Predicted Impacts – Groundwater

The most significant impact on groundwater and groundwater quality is the potential for drawdown into the tunnel void. Computer modelling was used to assess the areal extent and level of drawdown as a result of tunnel construction. The key findings are:

- water level drawdown occurs predominantly at the untanked (unlined) roadheader sections of the tunnel, although drawdown is also evident at the areas where the cross passages are unlined;
- water level drawdown as a result of unlined tunnel construction is aligned about the tunnel axis and is greatest at the deeper parts of the tunnels (up to 45 metres along the north to south tunnels) - that is, approximately the midlength of each driven tunnel;
- a quasi-steady-state drawdown condition would be achieved within about 5 years of construction of the tunnel. Development of the drawdown depression along the tunnel axis subsequent to this time is very slow; and
- drawdown is predicted up to 1km on each side of the tunnel alignment, along the unlined north to south tunnel but is almost negligible along the east to west driven tunnel where the use of the TBM of the EPB type will line the tunnel and virtually eliminate the potential for groundwater drawdown.

In the longer term, as the extent of groundwater drawdown created by the tunnel increases, the potential area in which

contaminants may be "captured" by groundwater movements becomes progressively larger. All mobile contaminants within this groundwater capture zone may be expected to ultimately report to the tunnel. Contaminant travel times will depend upon the contaminant itself, distance from the tunnel and the magnitude of the hydraulic gradient towards the tunnel. As groundwater inflows are expected to be low, contaminant fluxes will also be correspondingly low.

The modification in groundwater flow direction and, by inference, the movement of any contaminated groundwater will result in contamination moving under properties that otherwise may not have been on the contaminant plume flowpath. It has been established that the possibility of industry or residents attempting to secure a groundwater supply is remote. Groundwater in the non-alluvial areas of the tunnel alignment is generally well below root zone level and will become deeper as the tunnel is constructed. On this basis, the environmental impact of such an event is considered negligible. Remedial activities or contaminant management strategies are not considered warranted.

As stated above, the unlined north to south tunnel will be a permanent groundwater sink and will act to capture contaminated groundwater within the area of influence. This water will be treated prior to disposal. Construction of the tunnel will serve to intercept and treat contaminated groundwaters that would otherwise discharge to alluvial channels on route to the river.

6.4.3 Impact Mitigation – Groundwater Quality

Monitoring of the groundwater level should be undertaken until commencement of tunnelling in order to provide baseline water level data from the alluvial systems. Insufficient data are available at present to discern any seasonal trends or relationships between water levels and rainfall.

Once tunnelling commences, water level monitoring will be continued and if necessary the frequency of monitoring increased. Deviations from seasonal baseline water levels will be assessed and if necessary mitigation options formulated. It is envisaged that mitigation of any impacts will be dependent upon the location of the increased drawdown. Strategies may range from "do nothing", to an assessment of the extent of the impact and the establishment of surface irrigation networks to maintain root zone moisture content levels.

6.5 Surface Water Quality

6.5.1 Existing Conditions – Surface Water

Water Quality Objectives (WQOs) have been established by State and Local Governments and by the National Environmental Protection Council and these goals to protect environmental values reflect the ecological, social and economic values and uses of the waterway. The BCC WQOs were developed with reference to:

- the South East Queensland Regional Water Quality Management Strategy (SEQRWQMS, 1999);
- Queensland Water Quality Guidelines (EPA, 1998);
- National Water Quality Management Strategy (ANZECC/AWRC, 1992);
- Draft ANZECC Guidelines (1998); and
- the Queensland *Environment Protection (Water) Policy, 1997*.

The major waterways, intersected by the study corridor, are:

- Enoggera Creek; and
- Kedron Brook.

Both waterways have been heavily disturbed by development over more than 100 years and are considered urban waterways. Enoggera Creek and Kedron Brook each have been the subject of recent monitoring programs and have been assessed as highly variable across a range of physical, chemical and biological parameters, with various parameters exceeding the relevant guidelines particularly in Enoggera Creek. Each stream has attracted average water quality ratings. High sediment loads, increased nutrient runoff or elevated toxicants involved in the construction and operation of the Airport Link Project could conceivably affect one or more of the parameters in these disturbed ecosystems.

Enoggera Creek

Enoggera Creek water quality results from the citywide monitoring were evaluated against BCC Water Quality Objectives (BCC WQOs) and show overall compliance. In summary:

- the median values for pH and suspended solids meet the guidelines at all three Enoggera Creek monitoring sites;
- the median value for total nitrogen and total phosphorus is greater than the BCC objective at all three sites; and
- the median value for oxygen saturation, is greater than the objective value in wet or dry season.

Overall compliance with ANZECC (2000) is rated as poor, with the median value for chlorophyll–α, total phosphorus and total and oxidised nitrogen higher than guideline values at all three sites in Enoggera Creek. None of the guidelines was met consistently across the three sites in both wet and dry seasons, indicating overall poor water quality.

Brisbane City Council has prepared a draft Waterway Management Plan (WMP) for Enoggera Creek which identifies broad strategies and actions to maintain environmental values.

Kedron Brook

Kedron Brook water quality results from the citywide monitoring were evaluated against BCC Water Quality Objectives (BCC WQOs) and show overall compliance. The median values for pH and suspended solids, the median value for total nitrogen and total phosphorus and the median value for oxygen saturation at all sites all meet the BCC and Queensland WQOs. Overall compliance with ANZECC (2000) Guidelines is rated as average. Although total Phosphorus levels comply with BCC and Queensland WQOs, they do not comply with the ANZECC Guidelines at any site.

6.5.2 Predicted Impacts – Surface Water

The potential impacts on surface water quality are likely to be caused by:

- increased sediment load from wind or water erosion of exposed soils, stockpiles or other transportable earth materials left in exposed situations in work areas;
- transport of contaminants or acid sulphate soil leachates from unintentional interception of soils containing these materials and their transport by groundwater or rain event;
- transport of contaminants from wash down facilities at worksites, from stormwater runoff or accidental spillage on road pavements adjacent to worksites or from accidental spillages of hydrocarbon products or other undesirable compounds being used in the construction works or at spoil placement sites; and
- supporting bridge infrastructure at the southern and northwestern connections.

Potential impacts from placement of bridge structures in Enoggera Creek at the southern connection may include:

- the removal, pruning or shading of marine vegetation, including mangroves;
- temporary exposure of creek banks; and
- minor disturbance of the creek bed during the installation of bridge pilings, including increased turbidity.

6.5.3 Impact Mitigation – Surface Water

Containment of all waters (groundwater, rainwater runoff, wash down water etc) entering the tunnels or tunnel construction worksites to be disposed of through the proposed drainage and treatment system would mitigate these potential impacts on surface water quality. To avoid soil erosion and release of highly sediment laden water, care will need to be exercised in developing the work areas to ensure suitable sediment fencing is put in place to contain surface runoff for collection in a sediment settling pond or other appropriate treatment before release to the stormwater drainage system.

6.6 Air Quality

6.6.1 Existing Conditions – Air Quality

The Queensland EPA operates air quality monitoring sites located within 20 km of the Brisbane CBD, two of which are

in or adjacent to the Brisbane CBD. The first site is located in an elevated position at the Queensland University of Technology campus and measures visibility-reducing particles and PM_{10}. The second site is located at the Queensland Science Centre to monitor carbon monoxide (CO), ozone (O_3), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2), as well as benzene, toluene, xylene and formaldehyde.

Other air quality monitoring sites maintained by the EPA include:

- the Eagle Farm site, providing data for NO_x, O_3, SO_2 and PM_{10}, now decommissioned and replaced with a site at Pinkenba;
- the Rocklea site, providing data for NO_x, O_3, PM_{10} and $PM_{2.5;}$
- the South Brisbane site, providing data for CO, NO_2 and PM_{10}; and
- the Woolloongabba site, providing data for CO, PM_{10}, TSP and Lead.

For preparation of this EIS, additional data was sourced from a monitoring station established at Bowen Hills for the NSBT project, with further additional data now being acquired from a monitoring station at Kedron, established for the Airport Link Project.

Existing, ambient air quality in the study corridor generally is considered to be good, with no evidence of long-term or regular exceedances of the adopted goals for ambient air quality. Such exceedances as were recorded can be attributed to widespread events such as dust storms or bushfires for particulate matter air quality goals (PM_{10} and $PM_{2.5}$). There were no other measurements of criteria pollutants or air toxics which were above air quality goals. Existing local air quality in the vicinity of the proposed construction worksites is generally satisfactory. As these sites are close to major roads, considerable spatial variability in ambient pollutant concentrations can be expected, and levels in the immediate vicinity (within a few metres) of busy roads may be close to or exceed relevant ambient guidelines.

6.6.2 Predicted Construction Impacts

The main air quality impacts which may result from construction are likely to be amenity issues relating to dust and construction vehicle emissions.

Dust

The potential for air quality impacts from construction activities arise from:

- dust raised from open construction areas by wind, vehicle movements or other activities;
- dust from clearing or digging operations;
- dust from vehicle loading or unloading activities, or materials transfer operations; and
- dust falling from or blown from loaded vehicles transporting excavated material.

Open excavations and spoil handling, such as stockpiling, loading into trucks etc, are potential sources of nuisance dust and possible odour impacts on nearby sensitive places. Surface earthworks will be required for the establishment of the project offices and portal work sites and will involve typical construction methods, including excavators, graders, cranes and the like.

Vehicle Emissions

The potential for air quality impacts from construction vehicle emissions will depend on the construction method. The main sources of exhaust emissions are likely to include:

- vehicles working at the surface construction sites, including earthmoving equipment, concrete trucks, delivery trucks, truck-mounted cranes, and workers travelling to and from the sites;
- stationary plant emissions (mobile generators, dewatering pumps, concrete pumps etc); and
- vehicles and equipment operating within the underground excavation areas or within the enclosed worksheds, including front end loaders, trucks, mobile diesel generators and the like.

The potential impacts from trucks queuing adjacent to residents located near to the surface work sites and operation of diesel equipment within the underground excavation area can be avoided through effective, on-going fleet management.

6.6.3 Construction Impact Mitigation

The most effective way of avoiding nuisance from construction activities is to have in place a system that addresses the following:

- effective management of dust and odour generation;
- effective monitoring of impacts;
- effective communications with the local community on issues associated with the construction activities;
- a clearly identified point of contact should the community have comments or complaints;
- a well defined process to ensure that any issues are dealt with promptly and to a satisfactory level; and
- a well defined system of recording any incidents or complaints.

The Contractor responsible for construction will need to prepare and implement a comprehensive dust and odour management and communications system as part of a Construction Environmental Management Plan for the Project.

Management Measures for Nuisance Dust Mitigation

Typical components of the dust and odour management and mitigation strategy to be considered during the construction works will include:

- consideration of prevailing meteorological conditions wind speed and direction;
- use of water sprays, and covering loads of material transported from the sites;
- performance of excavation works at the tunnel portals within enclosed worksheds;
- installation of dust control measures in the worksites (eg truck wheel wash stations, sprays for loads, covered loads, sealed or management of internal roads);
- treatment of ventilation air from the work sheds to meet required standards; and
- regular monitoring of TSP, PM_{10} and dust deposition levels at nearest sensitive places adjacent to the work sites, and locations representative of the work space.

Management Measures for Diesel Exhaust Emissions

Management of diesel exhaust emissions will typically include:

- avoiding queuing of construction traffic vehicle fleet at the worksites;
- where possible, directing exhaust emissions from mobile and stationary plant away from the ground and sensitive receivers; and
- fitting vehicles and machinery with appropriate emission control equipment and ensuring regular maintenance.

6.6.4 Predicted Operational Impacts

The Airport Link Project will impact primarily on air quality through the operation of the ventilation system and the release of vitiated air from the ventilation outlets at Windsor, Kedron and Clayfield. The proposed ventilation system is intended to minimise the impacts of vitiated tunnel air upon the ambient environment through high-level, high speed discharge and subsequent dispersion. The detailed modelling and analysis for this impact assessment indicates that the contributions of the ventilation outlets to ambient air concentrations for particular pollutants are very low, and well below the stringent air quality goals adopted for the purpose of impact assessment.

The other source of motor vehicle-based air pollution is the major road network. As traffic congestion increases, the roadside concentrations of motor vehicle emissions also increase. The concentration of emissions diminishes rapidly with distance from the roadside. The EIS findings are presented in terms of concentrations at the kerb and then at distances of 10 metres, 30 metres and 50 metres.

Some changes in air quality along the major arterials are predicted as a consequence of changes in traffic flows due to the Airport Link Project. In some circumstances, the reductions in traffic flows are predicted to lead to reductions in roadside concentrations of vehicle emissions. In other cases, the forecast increases in daily traffic flows are predicted to lead to increased roadside concentrations of vehicle emissions. This latter scenario occurs along Gympie Road, south of Rode Road and Stafford Road, east of Webster Road. In all cases, the roadside concentrations are below the goals for ambient air quality, even though such goals are not intended to be applied to such specific locations.

Criteria for Assessment

The standards for in-tunnel air quality, derived from PIARC guidelines and set out in **Table 6-1** are consistent with the standards adopted for the NSBT Project and included as conditions for that project by the Coordinator-General[5] as modified in the Coordinator-General's Change Report[6].

Table 6-1: In-tunnel Air Quality Criteria

Carbon monoxide (CO)	70 ppm at peak traffic flows 90 ppm in extreme traffic congestion[1]
Nitrogen dioxide (NO_2)	1 ppm (average)
Visibility	0.005 m^{-1}

Table Notes:
1 Extreme traffic congestion occurs when traffic flows slow to less than 10 km/hr

Air quality standards or goals used to assess the potential impact on ambient air quality include:

- Queensland air quality goals established in Environmental Protection (Air) Policy 1997; and
- national air quality goals established in the National Environment Protection Measures (NEPM) which have been adopted where there were no set EPA criteria or the NEPM criteria were more stringent than the set EPA criteria.

It is important to note that the goals established as part of the NEPM are designed to be measured to give an 'average' representation of general air quality. That is, the NEPM monitoring protocol was not designed to apply to monitoring peak concentrations from major emission sources.

The goals adopted for ambient air quality, and provided in **Table 6-2**, are consistent with the goals adopted for the NSBT Project and included as conditions for that project by the Coordinator-General[7].

Table 6-2: Goals for Ambient Air Quality

Pollutant	Goal Unit	Measuring Period
Carbon monoxide (CO)	10 mg/m^3	8 hour maximum[1]
Nitrogen dioxide (NO_2)	246 $\mu g/m^3$ 62 $\mu g/m^3$	1 hour maximum annual avereage
Particulate matter less than 10 µm (PM_{10})	50 $\mu g/m^3$ 30 $\mu g/m^3$	24 hour maximum[2] annual mean
Particulate matter less than 2.5 µm ($PM_{2.5}$)	25 $\mu g/m^3$ 8 $\mu g/m^3$	24 hours maximum annual mean
Total suspended particulate mater (TSP)	90 $\mu g/m^3$	annual average

5 Coordinator-General's conditions for the NSBT Project, condition 17, Schedule 3 of the conditions.
6 Coordinator-Generals' Change Report dated 21 July 2006.
7 Coordinator-General's conditions for the NSBT Project, condition 17, Schedule 3 of the conditions.

■ *Table 6-3: Predicted concentrations at air quality monitoring locations*

SITE	2004	2012		2016		2026		Goal
	DM	DM	DS	DM	DS	DM	DS	
Bowen Hills								
Maximum 8-hour average CO (mg/m^3)	2.2	2.3	2.3	2.4	2.3	2.4	2.4	**10**
Maximum 1-hour average NO_2 (µg/m^3)	169	174	168	174	168	174	167	**246**
Annual average NO_2 (ug/m^3)	34	35	34	35	34	35	34	**62**
Maximum 24-hour average PM_{10} (µg/m^3)	4.2	4.2	3.9	4.0	3.6	3.7	3.3	**50**
Annual average PM_{10} (µg/m^3)	1.1	1.1	1.0	1.0	0.9	0.9	0.8	**30**
Kedron								
Maximum 8-hour average CO (mg/m^3)	2.1	2.1	2.1	2.1	2.1	2.1	2.2	**10**
Maximum 1-hour average NO_2 (µg/m^3)	146	150	156	151	158	153	162	**246**
Annual average NO_2 (ug/m^3)	30	30	31	30	31	30	31	**62**
Maximum 24-hour average PM_{10} (µg/m^3)	2.3	2.2	2.1	2.1	2.0	1.8	1.8	**50**
Annual average PM_{10} (µg/m^3)	0.4	0.4	0.5	0.4	0.5	0.3	0.4	**30**

Predictions due to modelled roads and outlets only.

DM: Do minimum or "without Airport Link"
DS: Do something or "with Airport Link"

Table Notes:

1 One day per year maximum allowable exceedance

2 Five days per year allowable exceedances, not including exceedance in ambient goals due to external events (eg dust storms, fires, major construction works)

Predicted Impacts on Ambient Air Quality

The detailed modelling and analysis for this impact assessment indicate the contributions of the ventilation outlet to ambient air concentrations for particular pollutants is very low, and well below the stringent air quality goals adopted for impact assessment. A summary of the predicted impacts on ambient air quality with (DS) and without (DM) the Airport Link Project is presented in **Table 6-3**.

Relative to the goals for ambient air quality, the contribution of each of the proposed ventilation outlets is small and much lower than the goals. The predicted highest ground-level concentrations (ie worst case) due to the operation of the ventilation outlets is presented in **Table 6-4**.

■ *Table 6-4: Highest ground-level concentrations due to ventilation outlet emissions*

Pollutant and averaging time	2012	2016	2026	Relevant air quality goal
Maximum 8-hour average CO (mg/m^3)	0.1	0.1	0.2	**10**
Maximum 1-hour average NO_2 (µg/m^3)	15	16	18	**246**
Annual average NO_2 (µg/m^3)	0.5	0.7	0.9	**62**
Maximum 24-hour average PM_{10} (µg/m^3)	0.5	0.6	0.7	**50**
Annual average PM_{10} (µg/m^3)	0.1	0.1	0.1	**30**

None of the ventilation outlets will cause an exceedance of the ambient air quality goals in a worst-case scenario.

Air Quality Along Surface Roads

From examination of the model results the highest concentrations of motor vehicle emissions for 2004 are predicted in the vicinity of the Gateway Motorway. This may be expected, given the very high traffic volumes experienced on this road. Predicted concentrations of motor vehicle emissions are highest at the kerb and decrease with distance from the kerb for all road sections. This shows the dispersion effect of distance from the source.

In assessing the magnitude of the predicted concentrations of motor vehicle emissions, an appropriate distance from the kerb should be selected based on the distance to the nearest residences. The following observations were made from the surface road dispersion model predictions:

- roads where the predicted concentrations of motor vehicle emissions for the 'with Airport Link' case are predicted to be lower than the 'without Airport Link' case, include Bowen Bridge Road, Lutwyche Road, Sandgate Road and Newmarket Road;
- roads where the predicted concentrations of motor vehicle emissions for the 'with Airport Link' case are predicted to be higher than the 'without Airport Link' case, include Gympie Road, Stafford Road and East West Arterial;
- roads where the differences in predicted concentrations of motor vehicle emissions between the 'with Airport Link' case and 'without Airport Link' cases are considered negligible, include Gateway Motorway and Airport Drive;

- improvements in local air quality are observed with reductions in surface traffic that occur as a result of diverting traffic to the tunnel;
- at distances appropriate for the nearest residences, the model predictions for all sections and future years are below the associated air quality goals.

Cumulative Effects of Northern Busway

As noted, the interim Northern Busway may proceed at the same time as the Airport Link project. This section assesses the potential cumulative impacts of the project with the interim Northern Busway.

The cumulative impacts of the project with the interim Northern Busway were assessed by examining the differences in the traffic forecasting for the Airport Link with and without the interim Northern Busway operating. The average annual daily traffic (AADT) on major roads were calculated for the two options and the results showed that most road sections were predicted to experience very little change in traffic volume as a result of the busway, and as a consequence, little change in air quality.

Air Filtration Technologies

A review of the technologies available for filtration of vitiated air from the ventilation system indicates there are two established technologies. They are:

- electrostatic precipitation for the removal of particles by way of an electric charge as they pass through an electric field;
- denitrification for the removal of oxides of nitrogen, including nitrogen dioxide (NO^2) either by chemical absorption of by catalytic conversion. Denitrification requires prior particle removal for greater effect.

From the available literature (Childs 20004 & 2006, Dix 2004 & 2006), few countries apply filtration technologies to road tunnel projects. Norway and Japan are two countries using filtration, mostly for the removal of particles for visibility reasons caused by heavy diesel truck traffic and tyre and other road debris. Only one tunnel, in Norway, has full denitrification technology installed. However, the system has not been required to operate for some time.

Predictive modelling for this EIS has found the ground-level concentrations of pollutants from motor vehicle emissions both with and without filtration of the Airport Link Project to be very similar. The differences arising solely from emission treatment for the tunnel system were difficult to detect in the modelling outputs. The modelling analysis suggests that pollutant concentrations in the study corridor are dominated by motor vehicle emissions on surface roads and that emissions treatment for each of the 6kms (approximately) of tunnels associated with the Project would result in very similar ambient air quality to the Project without emissions treatment.

Consequently, the effect on local air quality due to filtration was found to provide no benefit in terms of public health.

Provision has been made in the reference design for the installation of filtration equipment at a later date, should avances in technology and reductions in construction and operating costs be likely to achieve a beneficial outcome in ambient air quality and public health.

6.6.5 Effects on Public Health

The health risk assessment has concluded that there will be no appreciable change in community health as a consequence of the Airport Link Project, either in relation to the operations of the ventilation outlets or the changes in roadside concentrations of vehicle emissions.

The health risk assessment took into account predicted changes in air quality for key parameters including carbon monoxide, nitrogen dioxide, particulate matter and the air toxics (benzene, formaldhyde, toluene, xylene) and considered the effects of the predicted concentrations of motor vehicle emissions both in the regional airshed and at the roadside, for both acute and long-term health effects. Acute health effects include mortality and hospital emissions, and changes in lung function, respiratory symptoms and GP visits. Long-term health effects include mortality, cancer incidence and changes in lung function growth in children. The worst case forecast increases in motor vehicle emissions were taken into account. In summary, the health effects of the predicted changes in the regional airshed air quality are likely to be:

- predicted changes in **benzene, carbon monoxide** and **formaldehyde** as a consequence of Airport Link present a negligible health risk;
- predicted changes in **nitrogen dioxide** and **particulates (PM_{10} and $PM_{2.5}$)** as a consequence of Airport Link present a **negligible to extremely small** health risk, expressed in terms of hospital admissions for asthma, all respiratory conditions and cardiovascular disease.

Changes in roadside air quality from motor vehicle emissions affect far fewer people than changes in regional airshed conditions. However, the changes in roadside pollutants, since they are next to major roads, are often higher than regional changes in pollutants. To estimate the likely impact, the proximity of child care centres, schools, aged care facilities and hospitals from the major roads was also considered. Both acute and long term health effects were examined, using the same methodology as regional health effect modelling. The findings of the health risk assessment

of changes in concentrations of roadside motor vehicle emissions are summarised below:

- **Carbon monoxide** – The forecast worst case contribution of Airport Link is not expected to have an impact on health, with extremely small increases in hospital admissions for asthma, all respiratory diseases, cardiovascular diseases and mortality. Given the relatively localised increase in the roadside pollutants, this increase is extremely unlikely to have a measurable impact on community health.
- **Nitrogen dioxide (maximum 1 hour average)** – The forecast worst case contribution of Airport Link is very low and not expected to have a significant impact on health. The worst case maximum increase in roadside annual nitrogen dioxide was more obvious, although there is not likely to have a significant impact on lung function growth of adolescents being the susceptible cohort in the community.
- **Particulates (24-hour maximum or annual average PM_{10})** – The forecast worst case contribution of Airport Link is not expected to have a significant impact on health, with consequential increases in hospital admissions for all respiratory diseases, cardiovascular diseases and mortality predicted to be extremely small (eg range from 0.004-0.009 person per 100,000 people exposed to the forecast worst case increase). The forecast impact on acute symptoms in adults and children with asthma were also negligible.
- **Fine Particulates (24-hour maximum or annual average $PM_{2.5}$)** – The forecast worst case contribution of Airport Link is not expected to have a significant impact on health, with consequential increases in hospital admission for asthma, other respiratory diseases and cardiovascular diseases as result of the worst case increase in $PM_{2.5}$ is predicted to be very small (eg between 0.009-0.02 persons per 100,000 people exposed to the worst case increase). The long term increase in $PM_{2.5}$ impact was also forecast to be negligible.

6.7 Noise & Vibration

6.7.1 Existing Conditions

Existing noise levels in the study corridor, as revealed from monitoring at 18 sites (four adjacent to each connection and six along the course of Lutwyche Road away from the connections), indicate a noise environment typical of inner suburban areas. The dominant noise source is road traffic, with some contribution at night from mechanical plant, and natural sources (insects) adjacent to Kedron Brook. The average levels of existing traffic and background noise at a selection of monitored sites in the study corridor are presented in **Table 6.5**.

On-ground measurements of vibration in the study corridor were below the lowest recognisable limit of the instrumentation and thus below the threshold of human perception.

Table 6-5: Existing Noise Levels L10 and L90 Parameters

Address	Description	Traffic Noise $L_{A10(18\ hour)}$ (dBA)	Minimum Average Background Levels + (standard deviation) L_{A90} (dBA)		
			Day 6am – 6pm	Evening 6pm – 10pm	Night 10pm – 6am
30 Wongara Street, Clayfield	Rear landing, detached dwelling, logger on upper (2nd) storey, includes a facade reflection, facing East West Arterial (behind noise barriers)	58	49(2.2)	50(4.0)	40(2.8)
86 Alma Road, Clayfield	Rear yard, detached dwelling	61	47 (4.5)	55 (2.4)	55 (3.2)
27 Parkland St, Nundah	Southern property boundary facing parkland, detached dwelling	62	53 (3.1)	50 (4.8)	42 (3.0)
72 Kalinga St, Clayfield	Rear yard, northern property boundary, detached dwelling	54	45 (2.5)	48 (5.0)	41 (2.3)
34 Park Rd, Kedron	On top of awning adjacent to canteen block, facing towards Kedron Brook and Gympie Road, at Kedron State High School	52	45 (2.5)	43 (4.7)	34 (1.4)
20 Perry St, Lutwyche	Front yard, with a facade reflection, 2 m above ground, facing Gympie Road, detached dwelling	67	58 (1.5)	55 (3.0)	47 (4.1)
30 Colton Ave, Lutwyche	Rear yard, detached dwelling	53	48 (1.8)	45 (2.2)	39 (3.1)
12 Park Tce, Kedron	Rear yard western property boundary, detached dwelling	58	50 (2.4)	48 (2.7)	40 (3.8)
46 Gallway St, Windsor	Rear verandah northwest corner, detached dwelling	54	47 (2.0)	48 (3.0)	41 (1.6)
49 Earle St, Windsor	Front yard near southern boundary, detached dwelling	54	47 (1.4)	46 (2.7)	42 (1.9)
Royal Women's Hospital	Level 5 rooftop, James Demacy Building, Royal Brisbane Hospital, facing Bowen Bridge Road	69	62 (0.5)	61 (0.6)	60 (0.5)
62 Victoria St, Windsor	Front yard, detached dwelling	56	48 (1.8)	45 (2.6)	39 (2.6)

6.7.2 Construction Impact Assessment Criteria

Noise Criteria

To achieve the objective of preserving community values for noise during construction, where reasonable and practicable, construction activity above ground and outside an acoustically-lined work enclosure, should be limited to the hours of 6.30 am to 6.30 pm Monday to Saturday, with no outside work on Sundays or public holidays.

The Airport Link Project would involve construction activity proceeding on a 24 hour basis, mostly underground, and that would likely be audible outside of the regulated construction hours.

As with the goals established in the Coordinator-General's conditions for NSBT[8], the construction noise goals for the Airport Link Project relate to goals for the avoidance of sleep disturbance for night time construction and internal noise for day time construction. The goals for avoiding sleep disturbance for night time construction are set out in **Table 6-6**.

■ *Table 6-6: Internal Noise Goals – Night Time Construction*

Activity	Environmental objective	Hours	Internal Noise Goal
Intermittent construction	Avoid sleep disturbance	18.30 – 06.30	45dBA (L_{Amax}) for residences in R1 – R3 categories 50dBA ($L_{A\ max}$) for residences in R4 – R6 categories[1]
Steady construction	Avoid sleep disturbance	18.30 – 06.30	For residences R4 – R6 categories: 40 dBA $L_{Aeq,adj\ (15\ minutes)}$ for temporary noise[2] 35 dBA $L_{Aeq,adj\ (15\ minutes)}$ for long-term noise[3] For residences within R1 – R3: 35 dBA $L_{Aeq,adj\ (15\ minutes)}$ for temporary noise 30 dBA $L_{Aeq,adj\ (15\ minutes)}$ for long-term noise

Source: Coordinator General's conditions, NSBT EIS Evaluation, condition 7, Schedule 3

For day time construction works, the noise goals for internal construction noise levels at affected adjacent premises, are derived from levels in AS/NZS 2107:2000. Day time construction noise must be assessed by a LAeq(15minute) parameter for steady noise sources and a LA10(15minute) parameter for non-steady noise sources. The goals for day time construction internal noise are set out in **Table 6-7**.

■ *Table 6-7: Internal Noise Goals – Day Time Construction*

Type of Building Occupancy	Maximum Construction Internal Noise Targets	
	Steady construction noise LAeq(15minute) (dBA)	Non-steady construction noise LA10(15minute)
Residential buildings (living areas)	45 (near major roads) 40 (near minor roads)	55 (near major roads) 50 (near minor roads)
Place of Worship	40 (with speech amplification)	50 (with speech amplification)
School music rooms	45	55
School teaching area	45	55
School library	50	60
School Gymnasium	55	65
Commercial buildings – office space	45	55
Commercial Buildings – retail space	50	60

Source: AS/NZS 2107:2000

Note: Additional "Building Occupancies" to those documented in Table 2 may apply throughout the construction period. The "maximum" levels provided in AS/NZS2107:2000 should be utilised in these instances for steady noises, with the non-steady levels set 10 dBA higher.

Because the AS/NZS 2107 design levels are expressed in terms of the LAeq parameter, some variability in a noise source is implicitly included when the average level meets the design level. For residential receptors, the implicit variability permitted by the LAeq parameter can be problematic at night. For this reason, night-time noise sources need to be assessed against sleep disturbance criteria for the LAmax parameter in addition to the AS/NZS 2107 LAeq levels.

Vibration Criteria

The environmental objectives for the management and mitigation of construction vibration relate to:

- the maintenance of reasonable conditions for living, including sleeping, and the use of properties,
- minimisation of disturbance of building contents, and in particular, vibration-sensitive building contents such as precision balances, some optical microscopes, and some electronic equipment and computer hard-drives; and
- minimisation or avoidance of cosmetic or structural building damage.

The goals for construction-related vibration, established by the Coordinator-General for the NSBT Project, being the only relevant Brisbane-based experience for tunnel construction, are set out in **Table 6-8**.

8 Coordinator-General's Report on the Environmental Impact Statement for the proposed North-South Bypass Tunnel Project, August 2005.

■ *Table 6-8: Construction Vibration Goals*

Objective	Vibration Type	Peak Particle Velocity (mm/sec)		
Avoid sleep disturbance (on a low probability of reaction)	continuous	0.5		
		Heritage buildings	**Residential**	**Sensitive commercial**
Minimal risk of cosmetic damage	Transient[1]	2	10	10
	Continuous[2]	2	5	5

Table Notes:

1 Measured in the ground directly adjacent the building of concern

2 Measured on the building foundations

For sleep disturbance, situations can exist where vibration magnitudes exceed those corresponding to a low probability of reaction, particularly for temporary disturbances and infrequent and intermittent events, such as those associated with blasting. With advanced consultation, cooperation and liaison with the occupants of potentially affected properties, significantly higher levels of short-term vibration could be tolerated by many people for construction projects. In many instances there is a trade-off between the magnitude and duration of construction related vibration (eg rock-breaking versus blasting).

Noise & Vibration Impacts – Site Preparation Works

Southern Worksite

Potential noise issues are initial daytime earthworks and night-time tunnelling activities within the proposed acoustic enclosure, at the commencement of tunnelling. The highest impacts are expected at the residences south of Federation Street, where maximum levels of noise could interfere with normal indoor living (eg interference with passive listening, resting, and conversation) over several months. Noise mitigation should be further considered to maintain a reasonable noise environment at these residences.

North-western Worksite – east of Gympie Road

While noise from site preparation may exceed goals (exceedances in range of 5 – 9dBA), the prevailing level of traffic noise will provide a mask to the construction noise, minimising any impacts. Noise from the tunnelling construction is expected to be below the design objectives and therefore not result in any significant impact. Detailed construction planning should take into account the activities and needs at Kedron State High School for accoustic screening from construction activities.

North-western Worksite – middle of Gympie Road

Potential noise issues are daytime earthworks and to a much lesser extent, night-time spoil removal inside the proposed acoustic enclosure. At adjacent residences (western side) noise from rockbreakers and other plant items will exceed the design goal (up to 30dBA for rock-breakers) and is likely to result in significant acoustical impacts (eg interference with passive listening, resting and conversation) noticeably above the prevailing levels of road traffic noise. Noise mitigation should be further examined to maintain a reasonable noise environment at these residences.

North-eastern Worksite

Construction noise impacts will occur from the daytime earthworks if mitigation and management measures are not implemented. At residences in Kalinga St and immediately south of the worksite, noise from rock-breakers and other plant items is expected to significantly exceed the design goal (up to 30dBA south of Kalinga Park, up to 5dBA in Parkland St) and is likely to result in significant acoustical impacts given the construction noise levels are noticeably above the prevailing levels of road traffic noise. To maintain a reasonable noise environment at these residences, noise mitigation measures will need to be implemented.

Control measures for noise mitigation at worksites include:

- advance notification of the time and duration of earthworks;
- temporary noise screens during site preparation at boundaries with sensitive receptors (eg Wooloowin State School, residences on Federation Street);
- localised noise screens for particularly noisy operations such as rockdrilling and rockbreaking;
- modified operation methods and times for some types of noisy machinery
- high performance acoustic enclosure over portal and spoil handling area at the southern and north-western (centre of Lutwyche Road) worksites; and
- noise screens along worksite boundaries to reduce earthmoving noise at adjoining residences.

Surface Roadworks

Southern Connection

Daytime construction of elevated structures adjacent to The Mews Apartments is predicted to result in significant exceedances of the design goal and noise is likely to be intrusive for building occupants. This level of intrusion could interfere with normal indoor living. Noise mitigation measures recommended for further consideration include:

- advance notification of the time and duration of construction;
- plant selection to consider noise emissions; and
- location of plant items to maximise distance to residences.

There are no predicted exceedances of noise goals for night-time widening of the ICB underpass primarily due to the large offset distance and the higher building façade nominated for The Mews apartments.

North-western Connection

Noise levels from daytime construction of elevated structures and cut and cover tunnelling works are likely to be found intrusive (19-23dBA above noise goals) at residences adjacent to Gympie Road and Lutwyche Road. This level of intrusion could interfere with normal indoor passive listening, resting and conversation. To maintain a reasonable noise environment, noise mitigation measures will need to be implemented, particulary with regards for the needs of Kedron State High School.

Night-time construction of elevated structures and cut and cover tunnelling works for residences directly adjacent to Gympie Rd and Lutwyche Rd would likely be found to be intrusive (24-26 dBA above the LAeq noise goals). The following mitigation measures are recommended for further consideration, guided by the 'reasonable' noise objectives for construction noise:-

- construction of noise screens around the worksite; and
- advance notification of the time and duration of earthworks.

North-eastern Connection

The highest potential for impacts at residential locations occurs during the construction of the open trough and cut and cover sections, where noise levels are predicted to significantly exceed goals by up to 28 dBA. This level of noise would likely result in acoustic impact on residences. Mitigation measures recommended around roadworks, guided by the 'reasonable' noise objectives are:

- advance notification of the time and duration of works, especially any night works;
- select construction processes and plant to minimise construction noise;
- assist owners of properties nearest the construction site to temporarily upgrade the acoustical insulation and ventilation of rooms facing the construction area;
- construction of noise screens along the southern and western boundaries of the construction site west of Sandgate Road; and
- early construction of the noise barrier south of the East-west Arterial to protect residences in Wongara St.

Vibration

To minimise vibration impacts at all worksites, it is recommended that the following be undertaken:

- advance notification of any impact piling activities or night-time road construction activities; and
- Monitoring of vibration on structures due to vibratory rolling that occurs within a nominal distance of 25m.

Underground Tunnelling Between Portals

Roadheading

Anticipated vibration levels generated by roadheading construction in the north to south tunnels would be imperceptible in buildings throughout the tunnel alignment. No vibration mitigation measures are anticipated for this type of tunnelling. However, initial noise and vibration monitoring should be undertaken to confirm that source data utilised for this assessment are applicable.

Blasting

Only daytime blasting is envisaged, if at all. Blasting generally results in short, strongly noticeable vibrations lasting one to two seconds. The normal mitigation method in relation to human impacts is to give clear and concise pre-notification to all persons in the affected area. Careful blast design is recommended to mitigate against building impacts, and if necessary, using gradually increasing trial blasts to establish safe design parameters.

Machine Tunnel Boring

Tunnel construction in the east to west tunnels is proposed to be undertaken with an Earth Pressure Balance (EPB) type of tunnel boring machine, in response to the soft and uncertain ground conditions and the risk of groundwater intrusion during construction. It is anticipated that EPB type TBM vibrations and regenerated noise will generally not be noticeable in buildings along the tunnel alignment. For much of the construction with EPB machine, vibration levels would be below the threshold of perception.

Sensitive Building Contents

A Building Sensitivity Study is recommended for the Rosemount Hospital prior to construction to establish the sensitivity of the building and contents in greater detail.

Recommended Mitigation for Tunnelling Vibration and Regenerated Noise

Impact management and mitigation strategies are recommended to minimise the effects of tunnelling vibration and regenerated noise:

- comprehensive advance notice of intended tunnelling activities in localities near the tunnel alignment;
- noise and vibration monitoring before and during tunnelling to confirm that source data utilised are applicable to this project;
- conduct night-time tunnelling subject to compliance with 'reasonable' night-time vibration and regenerated noise levels as defined above; and
- if blasting is required in the vicinity of Amarina Nursing Home or Rosemount Hospital, consideration should be given to the adoption of a lower 'reasonable' blast vibration limit of 4 mm/s.

Construction Traffic

Spoil traffic would generally not increase average traffic noise levels on spoil routes by more than about 0.5 dBA along major road corridors except for O'Connell Terrace and Montpelier Road where increases would be below 2dBA. Neither of these increases would represent a significant impact.

Night-time spoil traffic would generally not increase traffic noise levels in the quietest hour (2.00am to 3.00am) on spoil routes by more than 2dBA along major roads except for O'Connell Terrace and Montpelier Road, where the increases would be around 5dBA and 3dBA respectively. However, there are only a few residential locations along this section of the haul route. These residences are situated in predominately commercial and industrial areas. Noise mitigation measures may be required to achieve the environmental objectives for these premises.

6.7.3 Operational Impacts & Mitigation Measures

Assessment Criteria

For noise from activities described as 'beneficial assets' particularly roads, railways and airports, the Environment Protection Policy (EPP(Noise)) specifies "planning levels" for noise sensitive locations (eg residences, educational and health care facilities) which "may be used as a guide" when assessing the noise levels from an activity.

The planning levels for a public road are:

- for a State-controlled road - 68 dBA LA10(18hour);
- for all other public roads - 63 dBA LA10(18hour);
- 60 dBA, assessed as the highest 1 hour equivalent continuous A-weighted sound pressure level between 10 pm and 6 am (60 dBA LAeq(1hour)); and
- 80 dBA assessed as a single event maximum sound pressure level (80 dBA LAmax).

The *Road Traffic Noise Management: Code of Practice* (DMR), provides details for the assessment of road traffic noise for Declared Roads (ie to State-controlled roads). Different criteria and priorities apply, dependent on the road type (new or existing access/non-access controlled roads) and to receiver/land usage type (residential, educational and health, or parks and other recreational facilities).

For this project, surface works on Gympie Road north of Kedron Brook, and the East West Arterial east of Sandgate Road associated with the tunnel would be regarded as upgrading of the existing State road network in accordance with the Code of Practice.

Road Traffic Noise Local to Tunnel Portals

The EPP(Noise) identifies planning levels for traffic noise emissions from roadways, but does not specify responses to road works that may exceed planning levels. For the Airport Link Project, planning levels from the EPP(Noise) are generally already equalled or substantially exceeded at residential facades facing the major roads that connect to the tunnel.

The Northern Busway, also utilising the Bowen Bridge Road/Lutwyche Road corridor, is expected to be completed in 2022. The following situations have been modelled in accordance with the Terms of Reference:

- **Do minimum (2022)**: This scenario represents the future traffic that would have arisen in the absence of these major transport initiatives, and represents the baseline noise projections against which some of the other scenarios are compared;
- **Airport Link without Interim Northern Busway (2022)**: traffic flows including Airport Link, but excluding the Interim Northern Busway project. This scenario represents the change in traffic noise, attributable directly to the Airport Link project; and
- **Airport Link with Interim Northern Busway (2022)**: traffic flows including Airport Link and the Interim Northern Busway projects.

"Status Quo" Noise Barrier Option

The objective used to develop the "status quo" barrier option for the 2 design years (2022 and 2026) is to develop road-side noise barriers, where practical and feasible, to achieve traffic noise levels comparable to the "Do Minimum" option.

"Planning Level" Noise Barrier Option

The objective used to develop the "planning level" barrier option for the 2 design years (2022 and 2026) is to develop road-side noise barriers, where practical and feasible, to limit traffic noise levels to the 63 dBA or 68 dBA (as applicable) LA10(18hr) planning levels wherever possible. As an example of the predicted noise levels **Table 6-9** shows the modelled noise levels at the monitoring sites quoted above in **Table 6-5** that would develop by 2022 if no works were undertaken, if the Airport Link project was built without any noise mitigation measures and after mitigation measures have been built.

In general, the key finding from this assessment is that noise mitigation should be designed for compliance with the relevant planning levels (ie $L_{A10(18hour)}$ levels of 63/68 dBA). Where this cannot be achieved, the barrier design should examine the feasibility and reasonableness of maintaining the "status-quo". In all areas it is considered that the recommended noise control options represent a starting point for discussions between key stakeholders.

All barriers presented are of a feasible scale but need to be reviewed in the context of their visual impacts and urban design concepts along this corridor. Safety issues associated with sight lines also need to be considered. Long continuous commercial or residential building structures could provide noise screening in lieu of barriers, where space permits. The cost effectiveness of upgrading building envelopes could also be investigated as an alternative to barriers. An advantage of barriers, as opposed to building upgrades, is that barriers also control traffic noise increases in outdoor areas.

Road Traffic Noise Remote from Tunnel Portals

For the Years 2022 and 2026, the introduction of Airport Link is predicted to result in a small change in the levels of road traffic noise on some parts of the wider road network. Generally noise levels decrease, but at a number of locations the noise levels are predicted to increase. The expected changes in the traffic noise resulting from the introduction of the Airport Link Project and the Northern Busway Project are generally within 2dBA. Such changes are considered to be minor and unnoticeable, and will occur imperceptably over a long period of time.

For roads beyond the tunnel portals, a range of options is available for mitigation of road traffic noise impacts arising from tunnel traffic flows. Such measures could include the use of open-grade or stone mastic asphaltic road surfacing, architectural treatments to buildings, urban renewal or redevelopment and traffic management.

■ *Table 6-9: Traffic Noise Changes without AL, with AL and Mitigated with AL in 2022*

	Existing 2005 Noise Level	2022 Predicted "Do Minimum" Noise Level	2022 Predicted Noise Levels with APL - No Barriers	2022 Predicted Noise Levels with APL and NB - No Barriers	2022 Predicted Noise Levels with APL		2022 Predicted Noise Level with APL and NB	
					Status Quo Barrier Design	Plan. Level Barrier Design	Status Quo Barrier Design	Plan. Level Barrier Design
Southern Portal								
38 Federation Street	55	59	63	63	59	60	59	60
18 Federation Street	60	62	65	65	62	63	62	63
57 Earle Street	58	61	67	67	61	63	61	63
Gympie Road Portal								
20 Windsor Av	61	63	67	67	60	60	60	62
8 Perry Street	61	63	69	69	62	59	62	63
12 Park Terrace	64	66	79	79	65	66	64	66
6 Emerals St	62	64	65	65	63	64	63	64
Sandgate Road Portal								
85 Stuckey Rd	54	54	57	57	54	57	54	57
83 Alma Rd	64	65	69	69	64	63	64	63
32 Wongara Street	63	66	75	75	66	65	66	65
Hendra Secondary College	64	67	67	67	67	63	67	63
80 McIntyre St - West Building	69	73	73	73	73	66	73	66

Ventilation System Noise

Preliminary calculations of ventilation outlet noise emissions indicate that it would be feasible for noise emissions to comply with both Council policy and the normal EPA licensing requirements for stationary industrial plant. Providing that emissions at residential locations are free of distinct tonal characteristics, and are within 3 dBA of the Rating Background Level, the normal licensing requirements would allow the ventilation outlets to be developed with negligible noise impact to residents. Some additional noise reduction is required to be incorporated into the ventilation system, though the requirements are not considered excessive or restrictive.

6.8 Flora & Fauna

6.8.1 Flora & Fauna Values

The existing habitat values of parks, open spaces and creeks likely to be affected by the project were assessed in terms of terrestrial and aquatic vegetation and habitat.

Kedron Brook and its associated parklands including areas within the study corridor form a significant wildlife corridor connecting the mountains of Brisbane Forest Park and the D'Aguilar Range to Moreton Bay via Schulz Canal. Strategically, the Kedron Brook corridor is described as a riparian link, and is semi-continuous, linking urban habitat areas from the upper catchment through Enoggera Military Reserve, Sparkes Hill, Shaw Park and Grinstead Park to Moreton Bay. Kedron Brook contains a mix of vegetation types and species in its riparian zone, and enters Moreton Bay adjacent to the Ramsar wetlands and habitat for migratory species.

It is an important ecological corridor for the movement of fauna, in particular many raptor species and squirrel gliders. It is classified as a corridor of state significance by BCC as it crosses local authority boundaries and is a major bioregional connection linking the higher altitude areas of the D'Aguilar Ranges with Moreton Bay.

Vegetation at Kalinga Park and Ross Park consists of a mosaic of scattered remnant trees and planted native trees. This area has moderate habitat value as part of the riparian corridor to flowing Kedron Brook, and some large trees with hollows near Sandgate Road, which are likely to be habitat trees for arboreal mammals, bats and hollow nesting birds.

Enoggera Creek also forms an ecological corridor, and is described as a three-arm linkage from Brisbane River, following Breakfast Creek, Enoggera Creek, Ithaca Creek and Fish Creek. Corridor arms linking to Mt Cootha Reserve and the Enoggera Reservoir through The Gap have also been identified. Although the value of Enoggera Creek as a wildlife corridor has been degraded due to the level of urbanisation and the disjointed nature of riparian vegetation along the Creek, the corridor supports a band of significant mangroves, and has been classified as 'regionally significant' by the BCC. There is potential, with further revegetation efforts, to provide a better connection for the movement of fauna from Ithaca Creek to the Brisbane River.

There are no Fish Habitat Areas within the study corridor and marine mammals are unlikely to be present due to lack of habitat.

6.8.2 Impacts on Flora & Fauna

It is likely that some mangroves in Enoggera Creek will need to be pruned and others removed to allow construction of tunnel connections in Bowen Hills and Windsor East.

Bridge construction and modification at Enoggera Creek and Kedron Brook may have local impacts on aquatic flora and fauna while works are conducted in the waterways. With careful management of water quality at each of the worksites, no significant ecological impacts are expected after the project is completed.

Landscape values at Kalinga Park

Construction of the tunnel and use of Kalinga Park for a construction worksite will impact on flora and fauna due to tree clearance, including a group of eucalypts immediately south of Kedron Brook.

Spoil placement sites within the Port of Brisbane and old Brisbane Airport (Gateway Upgrade corridor) are already significantly disturbed and cleared of all remnant native vegetation. Due to the low ecological value of these sites, the placement of spoil will have a negligible impact on flora and fauna. Spoil placement sites are within the Red Imported Fire Ant restricted zone. Controls on the movement of soil from unrestricted to restricted areas do not exist, however procedures to ensure fire ants are not spread from trucks returning from the restricted areas to the construction sites would be implemented.

6.8.3 Mitigation of Flora & Fauna Impacts

Mitigation strategies identified to protect ecological values include minimising disturbance to vegetation and habitat during construction, sedimentation and erosion control, inspection of tree hollows in Kalinga and Ross Parks prior to site clearance, replanting disturbed inter-tidal areas in Enoggera Creek to allow regrowth of mangroves, and landscaping and revegetation of disturbed areas with local native species.

Recommended measures for impact mitigation include the rehabilitation of part of Schulz Canal adjacent to Sandgate Road and part of Kedron Brook between Gympie Road and Shaw Road. Other mitigation measures include landscaping and rehabilitation works in Kalinga Park and adjacent to Enoggera Creek.

6.9 Cultural Heritage

With regards to indigenous cultural heritage, both Jagera Daran Pty Ltd and the Turrbal Association Inc undertook Cultural Heritage Surveys and associated assessments as registered Native Title Claim Groups under the *Native Title Act 1993* (Cth) and recognised Aboriginal parties in accordance with the *Aboriginal Cultural Heritage Act, 2003* (Qld) (Aboriginal Parties).

Interviews with Jagara elders indicated that the area around all three proposed portals would have been important resource places. For the Turrbal people, the study corridor is part of an interconnected series of pathways. In particular, the project area follows a pathway that began near the present site of the Roma Street Railway Station and follows the route of Bowen Bridge Road and Herston Road, with branches to various campsites.

The non-indigenous cultural heritage study included a review of Commonwealth and State heritage registers, review of relevant literature and systematic surveys to locate and record cultural heritage places. Reference was also made to the BCC Cultural Heritage Manual and the Brisbane City Plan Heritage Register Planning Scheme Policy.

From a non-indigenous perspective, all of the suburbs through which the study corridor passes are part of the earliest development of Brisbane. As such, they provide examples from each of the eras of growth, construction and expansion in Brisbane, some of which are considered to have high levels of heritage significance (eg the Windsor Shire Council Chambers and War Memorial). Many of the original large homes, such as Rosemount, Oakwal and Kirkston, were sited on hills and rises in the vicinity of the study corridor. In Swan Hill, the original residential estate between Lutwyche Road, Newmarket Road, Northey Street and Green Terrace, larger homes were built on the higher slopes, while the more flood prone lower areas were associated with workers' cottages, open spaces and recreation areas.

Fording Enoggera Creek with Bowen Bridge in 1860 was the precursor of Lutwyche Road's development as the major thoroughfare, and the rapid urbanisation of the Windsor and Lutwyche areas. The laying of railway lines in 1882 saw the population of Albion and Nundah increase and the opening of a Thorroldtown stopping place between Albion and Wooloowin known as Lutwyche in 1885. Lutwyche Road has been the main thoroughfare through Windsor and Lutwyche since the opening of the bridge and the tram system that provided public transport until 1969.

Windsor Shire Council Chambers

Kalinga's initial urban development was constrained by the lack of mass public transport infrastructure servicing the area at the time when nearby suburbs such as Clayfield and Wooloowin were experiencing substantial development. Although the extension of the Sandgate railway line into the area in 1882 was a spur to development of the Shire of Toombul, the line did not directly service Kalinga. The closest stations to what became Kalinga were German Station (now Nundah) and Albion. The first significant residential housing development in the area was the advertisement of Kalinga Estate close to Eagle Junction station in 1900.

The green belt along Kedron Brook is an extensive open space element of this urban environment, which includes significant association with local heritage values and places. The Soldiers' Honour Gates that provide access to Kalinga Park through Park Avenue were officially opened in 1920 to commemorate soldiers who fell during World War I. In 1924, Diggers' Drive was opened and ran from the memorial gates eastwards to Sandgate Road. During World War II the influx of Allied personnel and operations also saw the location of

a large Army Staging Camp at Kalinga Park in the vicinity of Bertha Street.

6.9.1 Heritage Places and Sites

There are 33 recognised heritage places or sites as listed under either the Register of the National Estate (10), the Queensland Heritage Register (24) or as scheduled under the Brisbane City Plan 2000 as being of local heritage significance (21) within or in close association with the study corridor. One site of considered local heritage significance is not on any of these listings – the Police Citizens Youth Welfare Association Headquarters at 654-656 Lutwyche Road being the former Windsor Police Station. There are also three heritage areas recognised under local planning schemes (Windsor Precinct, Lutwyche Village and Residential Precincts) relevant to the study corridor.

Three (3) sites and / or areas would be directly impacted by the Airport Link Project as proposed in the reference design. These are elements of the Swan Hill residential estate located along Earle Street, the former Windsor Police Station on Lutwyche Road, and elements of Kalinga Park (including the eastern end of the original Diggers Drive alignment) between Kalinga Street and Sandgate Road. There is no evidence of remaining memorial plantings from the 1920's along the alignment of Diggers Drive east of the railway line. The eastern extent of Diggers Drive between the railway line and Sandgate Road has been covered and turfed, possibly during the latter years of the 1960's, with the final removal of the timber bridge across the significant drainage tributary into Kedron Brook during the 1974 flood.

Potential impacts on heritage sites and structures are considered possible where new roadways connect the Airport Link Project, or where tunnel portals may impact visually on heritage sites and places, or where tunnelling within close proximity of a heritage structure. The open space adjacent to Kedron Brook has been filled or highly modified and may posses an historical archaeological record during construction in this area. Sites with some potential for impact include:

- Bowen Park (Low potential for impact from adjacent roadworks);
- Brisbane General Hospital Precinct (Low potential for impact from adjacent roadworks);
- Nyamber (12 Federation Street) and Rosemount Building 20 (Dental Hut) and Building 21 (Medical Officer's Residence) (Low potential for impact from vibration and settlement);
- Wooloowin State School, Register of the National Estate and Queensland Heritage Register (low potential for impact from adjacent roadworks);
- St. Andrew's Church (low potential for impact to Lych Gate and front walls from adjacent roadworks); and
- Kedron Park Hotel (low potential for impact from adjacent roadworks).

Cultural Heritage Management Plans

Detailed Cultural Heritage Management Plans (CHMPs) for the construction phase of the project will be developed. The aim of the CHMP is to provide instructions to contractors and project owners on obligations for the protection of cultural heritage values in the study corridor. The CHMPs will cover both Indigenous and non-indigenous components

The Aboriginal CHMP(s) will be prepared in consultation with the Aboriginal Parties for the Corridor, and will follow the requirements of Part 7 of the *Aboriginal Cultural Heritage Act* 2003. Mitigation measures include:

- on-going consultation with the Jagera and Turrbal;
- all work to be undertaken in accordance with statutory requirements, set out in the *Native Title Act* 1993 (Cth) and the *Aboriginal Cultural Heritage Act* 2003 (Qld); and
- the preparation of a CHMP in consultation with Aboriginal Parties. Discussions for the establishment of the CHMP to include requirements for monitoring of construction and other disturbance in the vicinity of the project and cultural heritage induction programs for construction teams.

The CHMP for non-indigenous historical heritage will consist of generic instructions of management for the entire corridor, and may also include site-specific CHMPs as recommended below:

- preparation of site-specific CHMPs for each place of State significance likely to be affected;
- monitoring programs for buildings of State and local significance (Rosemount, Skilmorlie, Nyamber and Fernfield) to assess building movement, condition and groundwater drawdown;
- management plans and induction training to recognise and protect sites of heritage significance adjacent to roadworks, such as St Andrews Church, from construction related activity;
- induction training of construction crews and appointment of a heritage archaeologist during construction to manage any archaeological discoveries during construction;
- further studies, as required. Including archival recording of the houses within the Swan Hill Residential Estate and the former Windsor Police Station. Archival recording should follow *Guidelines for Photographic Recording of Heritage Items* (NSW Heritage Office, 2005) and be lodged with the State Library of Queensland and the Heritage Branch of the Environmental Protection Agency;
- investigation of the feasibility of removing those buildings within the grounds of the former Windsor Police Station that can be moved to another location, possibly one associated with another police station; and
- preparation of a management plan for Kalinga Park to recognise and protect remaining cultural heritage values

and guide the rehabilitation of construction areas. Particular park landscape features that can be retained, such as Diggers Drive, native tree plantings and remnant natural features such as the 300 year old Ironbark between the AirTrain and the North Coast Railway are to be identified and protected during the proposed works.

6.10 Social Conditions

6.10.1 Existing Social Conditions

The study corridor includes some of Brisbane's oldest suburbs and is home to approximately 50,000 people. The population of the study corridor is projected to rise by about 12% over the next 15 years.

Although predominantly residential, the study corridor accommodates a diversity of land uses including inner city and suburban neighbourhoods, major traffic and public transport infrastructure, and commercial and industrial precincts. There are four locations where community facilities are clustered in the study corridor, including at Windsor, Wooloowin, Kedron and Nundah. The study corridor also accommodates several major community facilities devoted to health, education, community support, and sport and recreation.

The study corridor had a slightly higher proportion of older people than Brisbane as a whole, although the proportion of older people is decreasing. Younger couples are being attracted to the study corridor for medium density housing options, proximity to employment and community facilities, and amenity values. The study corridor has a wide range of income types and some polarity in income distribution. Unemployment across the study corridor varied by 1.5% above or below the Brisbane average. The study corridor had a lower proportion overall of people with a tertiary qualification.

About half of the dwellings within the study corridor comprised detached dwellings, which was lower than Brisbane as a whole, but higher than other inner city areas. Bowen Hills, Lutwyche and Clayfield had the lowest proportions of separate dwellings, while Kedron and Hendra had higher proportions of detached dwellings than the study corridor average. Household occupancy was lower than Brisbane as a whole. Home ownership is lower across the study corridor than in Brisbane as a whole, but increasing in most suburbs. Housing trends and forecasts indicate increases in attached dwellings, smaller households, and couple-only households.

6.10.2 Social Impacts

Construction activities may lead to changes to the amenity and liveability for communities near to construction works due to noise, changed access to community facilities such as open space, shopping, public transport and schools, traffic diversions and construction traffic. The location of construction sites at Kedron could also impact on Kedron State High School and Wooloowin State School. A close consultative relationship with each school will be essential to maintaining an environment within which they can continue to function during the construction period.

Enoggera Creek and Kedron Brook are highly valued for the inter-suburban connectivity they offer walkers and cyclists. During construction, impacts on some parks and reserves may include changed access to and through open space areas, and proximity of worksites. Following construction, disturbed parks and reserves will be re-instated to the extent possible.

In the longer term, the Airport Link Project may improve amenity along benefitted arterial roads and in some local streets, through:

- reduction in traffic noise for community and commercial facilities along Lutwyche Road;
- protection of neighbourhood character due to reduced rat running of traffic through residential streets;
- reduction of traffic volumes on major routes, supporting a safer pedestrian environment; and
- potential for improvement to amenity in streets, which become cul-de-sacs as a result of the project.

Detailed local planning is required to address impacts arising from increased traffic flows on arterial roads and other roads due to the Airport Link Project.

At city level, significant traffic and transport benefits are achieved through decreased travel-time, reduced congestion levels, better access to major employment hubs, and transport efficiency. Whilst these benefits are substantial, negative

impacts will be felt in suburbs where portals are located, and in particular in neighbourhoods close to construction activities.

6.10.3 Mitigation of Social Impacts

Construction methodology and environmental management measures need to be designed to reduce and mitigate potential impacts of the construction and operation of the Airport Link Project.

The project design should respect community values in the study corridor, in particular, ensuring the amenity of residential neighbourhoods and community facilities adjacent to the project's traffic infrastructure is maintained to a reasonable and practicable extent. This may include designing public spaces to create safe and attractive urban spaces, designing and landscaping noise barriers to be responsive to the neighbourhood scale and values, and restoring parks adjacent to project infrastructure to maintain parkland amenity and community values.

Mitigation works aimed at providing enhancements to existing open space, reinstating pedestrian and cycle links to improve connectivity through the study corridor and capacity building to engage community members would help to manage land use change and community benefit. Successful implementation of the mitigation works would rely on managing the change process and outcomes to avoid impacts on quality of life and equity, as well as collaborative action by the Brisbane City Council, the State Government and community agencies.

Successful mitigation for the duration of the construction phase will also depend on close and ongoing communication and consultation with local residents.

During construction and operation, it is recommended that relevant agencies in both the Queensland Government and the Brisbane City Council coordinate the design and delivery of existing social policies and programs to address the less tangible social impacts and social impacts which may take some time to become manifest. Such impacts may include the loss of affordable housing and the dislocation of vulnerable residents, changes in community diversity and impacts on the utility of community facilities.

6.11 Economic Conditions

The economic assessment includes impacts on businesses in the study corridor, potential effects on property values, employment opportunities and effects, and transport economic outcomes.

6.11.1 Economic Environment

The *SEQ Regional Plan* and *SEQIPP 2006 – 2026* highlight population increases from the current 2.6 million to about 3 million by 2016 and 3.7 million by 2026. The Brisbane metropolitan area is projected to grow from 1.55 million to more than 2 million by 2016. The region is predicted to have one of the fastest growth rates of any major urban regions in Australia.

The SEQIPP identifies that population increase will generate 425,000 new jobs by 2026. The significance of Brisbane in the region is exhibited by the fact that 90% of Greater Brisbane's residents work within BCC boundaries and approximately 50% of residents from surrounding local government areas (Pine Rivers, Redcliffe and Caboolture to the north, Logan and Redlands to the south east and Ipswich to the west) travel to work in Brisbane. This trend has significant implications for cross-city travel, particularly in the morning and afternoon peaks when congestion adversely affects the network. Employment growth in the Brisbane CBD and Brisbane City's outer areas is forecast to increase by 19% and 45%, respectively, between 2006 and 2016. The ATC employment growth is forecast to increase by 95% over the same period.

About 90% of freight movements in SEQ originate or have their destination in Brisbane and urban freight movements are estimated to be growing by 4% per annum. The SEQIPP highlights the projected increase in population and subsequent expansion of economic activity and employment as the reason for the timely provision of new transport infrastructure to support this forecast growth.

Some useful economic indicators and forecasts for the Brisbane Local Government Area (LGA) that are relevant to this Project include:

- **Total manufacturing** produced $25 billion output (21% of total output). This sector is a major user of the Brisbane and regional road network for origin and destination freight movements.
- **Business services** had $12 billion (10%) output and Property Services had an output of $11 billion, reflecting the rapid growth in residential, commercial and industrial property development and market activity over recent years.
- In 2004, approximately 800,000 people were **employed** in the Brisbane Urban Footprint with over 72% of these in the Brisbane LGA. Brisbane Inner City is the largest employment generator in the region, with an estimated 223,892 people employed in the Inner City.
- Business Services and Manufacturing have the highest employment levels in the Brisbane LGA with estimates of 74,328 and 65,433, respectively. Nearly 90,000 people are employed in Business Services in the Brisbane Urban Footprint representing 11% of all workers, followed by Education at 8% and Health Services at 7%.
- Major employment areas in Outer North and Outer South Brisbane each have 8.6% of the Brisbane workforce or a total of over 100,000 people. Growth in these Outer industrial regions may be facilitated by the proposed Airport Link as it will provide a pivotal cross-city link.

The main employment generators in adjacent LGAs are Logan City and Ipswich City with 51,988 and 45,849 employees, respectively. Both of these are forecast to increase their employment contribution to the greater Brisbane area.

- **Average car ownership** in the Brisbane LGA is 1.58 cars per household decreasing towards the CBD with the Inner City having average household car ownership of 1.16. Outer West had the highest car ownership with 2.1 vehicles on average per household while the Outer North had an average of 1.68 vehicles per household. There is a higher reliance on private vehicles in the outer suburbs due to longer travel distances to work, reduced flexibility, access to public transport and a higher proportion of families living in the outer suburbs.

6.11.2 Economic Growth

Out of region exports are the key driver for growth in economic activity in the region[9]. Out of region exports in the region were $41 billion in 2004 and are estimated to grow by an average annual rate of 4% to $98 billion by 2026.

In 2004, it is estimated that 29% of out of region exports were generated in the Inner City. This is forecast to decrease to 27% in 2026 as a result of an increase in residential and commercial growth and rising land values in the Inner City which will force some of these activities to Outer areas. The main beneficiaries in the Outer regions are Outer North East, Outer East and the Outer South East in Brisbane City, and in Caboolture Shire and Ipswich City in the other LGAs of SEQ. This movement of major economic activities to outer metropolitan areas has already commenced.

9 National Institute of Economic and Industry Research, 2005, *Brisbane Long Term Planning Indicators*

High levels of productivity normally occur in areas with high levels of manufacturing and or transport services. Higher growth rates will have higher productivity as a result of economies of scale. Brisbane is forecast to experience high growth rates and levels of productivity with the Outer regions forecast to experience slightly higher levels due to location of manufacturing. Approximately 1.2 million people are expected to be employed in the Brisbane metropolitan area by 2031, which represents an increase of 67% over 2004. Brisbane City will continue to be the single largest employment generator in the region, with 330,000 to 375,000 people employed.

The combined Inner City areas are expected to grow at slightly higher rates than the Outer regions. The Inner City and Inner West are estimated to grow by 45% and 60% respectively. This is significantly higher than the remaining inner regions which are estimated to grow by a combined 15%. The demand in the Inner City will place additional pressure on our transport networks to and from the city.

6.11.3 Other Indicators

Activity Centres

Major activity centres in the sphere of influence of the Airport Link Project provide high concentrations of employment and economic activity. They include:

- Brisbane Airport;
- Port of Brisbane;
- ATC including TradeCoast Central (northern side of Brisbane River);
- shopping centres at Toombul, Chermside, Stafford and Lutwyche;
- Port of Brisbane's Eagle Farm Estate, comprising industrial warehousing, commercial offices and distribution;
- private commercial and industrial parks in the Gateway North area around Eagle Farm, Pinkenba, Hamilton and Hendra;
- other major industrial and commercial estates in the Outer North area including Geebung, Zillmere, Banyo, Brendale, Narangba and Burpengary;
- Royal Brisbane Hospital, Rosemount Hospital; and
- numerous schools including: Kedron State High School, Wooloowin State School, Windsor State School, Holy Rosary School, Hendra Secondary College.

A street survey of the Airport Link corridor identified 483 business establishments with the most common business type being "Clothing and Soft Good Retailing" at 9.73% (47 businesses). "Furniture, Houseware and Appliance Retailing" and "Other Personal and Household Good Retailing" each represented 9.52% of the total. "Specialised Food Retailing"

and "Cafes and Restaurants" represented less than 15% of the total sample.

The major economic generators in the study corridor that would be impacted by the Airport Link Project are the Royal Brisbane Hospital (RBH), Lutwyche commercial area and Toombul commercial area. Economic or community generators, including education, identified from the street survey were:

- RNA Show Grounds;
- Bowen Hills commercial centre;
- Lutwyche commercial centre;
- suburban hotels in Lutwcyhe and Kedron;
- Department of Emergency Services Complex;
- Education facilities including Kedron State High School, Windsor State School and Holy Rosary Primary School; and
- St Andrews Anglican Church.

6.11.4 Economic Analysis

The purpose of the economic assessment is to present an estimate of the net benefit of the Airport Link project drawing on cost-benefit analysis.

The most significant data inputs to the economic analysis model are capital expenditure (CAPEX) and operational expenditure (OPEX) estimates for the Airport Link project, network traffic data for Base Case and Airport Link project and the discount rate. Other critical inputs are the parameter values used in the determination of travel time savings, vehicle operating costs saving, road safety savings and environmental/externality benefits. The current DMR/AustRoads draft standards for these values are expressed in 2005 prices for use in the Airport Link model.

Major transport infrastructure projects such as the Airport Link Project will improve socio-economic opportunities in the study area by generating direct road user benefits via improved travel times, reduced travel costs, improved travel comfort, safety and improved environmental externalities.

Results of the economic analysis of Airport Link as a stand alone Project with a risk-adjusted CAPEX of approximately $2.3 billion and OPEX of around $1.3 billion over 45 years at a discount rate of 6.8% are shown in **Table 6-10**.

Table 6-10: Airport Link Economic Analysis Results

Output	Present Value ($)
Present Value of Costs	$2,239,429,888
Present Value Benefits	$2,370,540,594
Net Present Value (NPV)	$131,110,706
Benefit Cost Ratio (BCR)	1.1

The Net Present Value (NPV) is the value of the discounted total future benefits minus discounted total future costs over the 45 year concession period. A positive NPV is one economic criterion for proceeding with the Project although other non-CBA factors also need to be considered. The economic analysis of the Airport Link Project returned an NPV of $131million which indicates that the project is economically viable.

The Benefit Cost Ratio (BCR) is the discounted total benefits divided by the discounted total costs (i.e. CAPEX and OPEX). The BCR of 1.1 indicates that the present value of benefits provides a 10% return in value over the concession period for the project.

The estimated Present Value of User Benefits of the Airport Link Project is shown in **Table 6-11**.

Table 6-11: Present User Benefits

Travel time savings	$1,716,703,984	72%
Vehicle operating costs savings	$487,311,107	21%
Environmental benefits	$84,650,045	4%
Road safety benefits	$81,875,458	3%
Total User Benefits	$2,370,540,594	100%

6.12 Hazard & Risk

6.12.1 Existing Values

An analysis of potential hazards and risks, adopting an "all hazards" approach, identified hazardous activities likely to occur during construction and operation. A series of environmental and social values have been identified that could be vulnerable to potential hazards.

The natural environment including identified vegetation, surface waters providing aquatic habitats in Enoggera Creek and Kedron Brook, though much altered by urban development, holds considerable value for the local communities as it exists and thus deserves every protection possible. Those same communities living in the area and the various service facilities in their neighbourhoods need every consideration for protection from any potential hazardous event.

The motorists who will use the new tunnel roads along with the motorists, cyclists and pedestrians who will continue to use the surface roads, cycle paths and footpaths need to be able to do so confident that they are protected from hazardous events.

6.12.2 Hazard & Risk Impacts

Hazards were assessed as 'raw risks' (i.e. hazards with no mitigating measures). The assessment indicates that some of the potential hazards associated with the construction or operation of the Airport Link Project have medium to high risk. Identified hazards, their potential impacts, assessment of risk and proposed mitigation measures are shown in **Table 6-12**.

6.12.3 Mitigation of Hazard & Risk

In response to the hazards and risks associated with the Airport Link Project identified above, the following mitigation measures are proposed:

- every effort will be made to prevent dangerous goods vehicles from accessing the tunnels using the traffic management and control system. In the event the system fails to stop entry of hazardous materials and there is an accident, the Hazardous Materials Management Plan and the Incident Management Plan would be activated with containment as the first step;

Table 6-12 - Risk Assessment Matrix

Hazard	Potential environmental impact	Frequency	Impact	Risk Level	Proposed mitigation measures
Construction					
Spillage or emission from use of dangerous/ hazardous materials in the tunnel	Contamination of soil and ground or surface water	M	H	H	Comply with safety work requirements in confined spaces. Training of workforce in storage and handling of dangerous goods and spill containment procedures
Spillage of dangerous goods in tunnel or compound areas	Contamination of soil and ground or surface water from leakage Emission of fumes	M	H	H	Storage in accordance with EMP and dangerous goods standards and guidelines. Implement clean up procedures
Spillage from transport of dangerous goods en route to compound areas	Contamination of soil and ground or surface water by chemicals	M	M	M	Transport in accordance with dangerous goods standards. Implement clean up procedures. Train workforce in management handling of hazardous goods and spill containment procedures. Ensure adequate spill kits are available. Prepare Emergency Response Plan
Infrastructure collapse due to uncontrolled blasting	Dust emission Death or injury to workers Vibration damage to nearby buildings	L	H	M	Conduct structural analysis and risk assessment prior to blasting; Appropriate blast design configuration to suit locality of blast; Prepare an Emergency Response Plan
Explosion/fire from build up of heavy vehicle fumes in the tunnel or use of hazardous materials	Fume emissions Contamination of soil and surface or ground water Air contamination	L	H	M	Control volume of vehicles inside the tunnel; Provide appropriate ventilation; Monitor fume levels at work
Spillage from transport of spoil to placement areas	Water pollution through sedimentation of waterways	M	M	M	Transport as with standard practice eg Covered trucks. Implement clean up procedures
Flood and inundation	Water pollution, property damage, death or injury	L	H	M	Tunnel design and construction to appropriate standards
Operation					
Transportation of dangerous goods in the tunnel	Fire leading to death and injury of motorists, water pollution by chemicals	L	H	M	Exclude dangerous goods from the tunnel. If this fails for whatever reason employ clean-up proceedures
Spillage from transport of dangerous goods on road network	Contamination of soil and ground or surface water by chemicals from spillage or due to accident	M	M	M	Transport in accordance with EMP and dangerous goods standards and guidelines. Implement clean up procedures
Fire or explosions in the tunnel due to accidents or acts of terrorism	Death or injury of motorists, water pollution with toxic chemicals, air pollution through smoke emissions	L	H	M	Incident management plan Counter Terrorism Measures
Tunnel collapse and subsidence	Death and injury of motorists Property damage at ground surface above	L	H	M	Tunnel design and construction to appropriate standards
Flooding of works	Death or injury of motorists	L	H	M	Tunnel design and construction to appropriate standards
Upstream flood effects	Impacts on upstream residential areas	L	M	L	Structure design to prevent adverse flooding impacts

Notes: L - Low; M - Medium; H - High

- the tunnels and adjacent environs will be subject to an integrated traffic management and control system to monitor, control and respond to traffic conditions within and beyond the tunnel for air quality, road safety and incident management, congestion management and other operational benefits;
- a communication system for both audio and visual communications with tunnel operations, incident management, safety and emergency response, and traffic management will be installed to aid in hazard management if necessary;
- an integrated fire detection and protection system, supported by audio-visual communications, a deluge system and zonal smoke extraction system is proposed; and
- comprehensive emergency procedures for incident response and management services need to be established.

6.12.4 Flooding Hazards

The project design criteria include requirements to ensure an acceptable level of flood immunity. The design criterion for the tunnel ramps is immunity to a 10,000 year design flood event as a minimum. The north-eastern connection is in a flood prone area. Preliminary modelling of the effect of the proposed constructions on the area in a 100 year flood event has shown that the potential impacts can be mitigated sufficiently to avoid an adverse effect from the Project. The detailed design phase will require close assessment of potential impacts of project construction on flooding characteristics of this area.

Enoggera Creek

The additional structure required over Enoggera Creek for Airport Link has limited if any potential for increases in flood levels. Given the height of the proposed connections in linking with existing networks and the requirement for 10,000 year flood immunity, the decks of new bridges will be above the existing 100 year flood levels. The potential impact for the additional structure will be the additional piers in the waterway providing for additional headloss. In order to minimise hydraulic impact of structures the use of embankments should be minimised, the construction should be on piers, and the number of piers minimised.

Kedron Brook

In addition to flooding from the main Kedron Brook channel, there are a number of small local catchments that may contribute to flooding impact of the proposed connections. None of these catchments provide for significant transverse flows across the proposed route alignments.

Major flood mitigation works were undertaken in Kedron Brook following significant flooding that occurred during 1974. A major component of these works was the channel capacity improvements between Webster Road and Nelson Street. The Kedron Brook channel within this reach was enlarged, providing a broad channel with sufficient flow capacity to convey the 100 year flood within the channel limits.

The construction worksites are proposed to be situated above and clear of the flood channel of Kedron Brook at Gympie Road, with little if any impact on flood levels as a consequence.

Kedron Brook – Schulz Canal

Hydraulic modelling of Kedron Brook in the vicinity of the North Coast Railway found that, in flood, the main waterway areas experienced very fast moving flows (over 2 m/sec) exacerbated by water throttling through the bridge structures of the North Coast Railway and Sandgate Road. For Kedron Brook – Schulz Canal, the North Coast Railway and the Sandgate Road bridges over Kedron Brook are very inefficient in the 100 year flood event.

Upstream of the North Coast Railway at Kedron Brook

Upstream of the North Coast Railway, increased flooding in the unnamed creek from Melrose Park would be avoided by lowering the terrain at the vehicle underpass to increase the capacity to pass flooding under the rail alignment. Conveying this creek in a broad channel under the railway rather than via culverts would provide a better solution in a 100 year flood event.

Flood protection bunding of the construction area will remove floodplain storage upstream of the railway, with consequences for flooding depths in this location. Generally, water levels upstream of the railway would be increased by 40 - 70mm. The impact would be greater without increasing the capacity of the underpass through excavation for construction vehicle access. Given that the planned construction period is short and that the impacts are small, it is considered that the level and extent of potential impact upstream of the railway alignment are acceptable.

North Coast Railway to Sandgate Road

The flooding depths between the North Coast Railway and Sandgate Road would increase as a consequence of construction activities encroaching upon areas of high velocity flow in the floodplain. The level of impact would be measurable with flood levels estimated to increase by approximately 120mm in some areas. Mitigation measures, such as increasing the capacity of the unnamed creek from Melrose Park, will provide a better conveyor of floodplain flow passing through the railway underpass. This will assist in the reduction of the flood levels.

Downstream of Sandgate Road

Flooding depths downstream of Sangate Road generally would not be affected by construction. Some minimal impact occurs in the southern carpark of the Toombul shopping centre with maximum impacts of 30mm in this area. If the Kedron Brook/Schulz Canal channel downstream of Sandgate Rd was widened to mitigate long-term impacts, at the beginning of the construction phase, flood impacts in this area would be minimised. This could also potentially help improve upstream impacts.

6.13 Urban Design & Visual Environment

6.13.1 Existing Character & Environment

The urban design and visual environment assessment focussed on a number of key locations, relating primarily to areas of the surface works where direct impacts on the built urban, landscape and visual context will be most apparent. Each location has been reviewed with regard to visual elements and values of the built, landscape and visual form, including access and amenity, considerations for residents, pedestrians, cyclist and public transport users.

Bowen Hills generally comprises a commercial character, which is dominated by large-scale special uses such as the RBH complex, the RNA Showgrounds, Mayne rail yards and office park developments. The area also includes some recent multi-unit residential development. Enoggera Creek also provides an open space character and high landscape amenity. Lutwyche Road creates a strong north-south connector, O'Connell Terrace an east-west link and the ICB a strong diagonal connector. The edges of Enoggera Creek, combined with the rail line and Lutwyche Road, have created barriers to extending existing pedestrian and cycle networks. The landscape elements of this key location are centred on Enoggera Creek, Bowen Park and the north-east tip of Victoria Park.

At Kedron, the Stafford Road and Gympie Road suburban centres provide a focus for activity. The functionality of the centres is being steadily reduced by the increasing traffic flows on Gympie and Stafford Roads. The road system, topography and the spatial impacts of Kedron Brook, makes connections to these centres difficult. The north-south alignment of Gympie Road/Lutwyche Road with the east-west connector of Stafford Road and Junction Roads create the dominant movement pattern, and reduce opportunities for convenient pedestrian and cyclist movements. The Kedron Brook waterway has created a highly used pedestrian and cyclist connection. Kedron Brook is a feature of the area's character and dominates the landscape amenity of the area.

Wooloowin comprises a predominantly low-density residential character, edged by open space. The main east-west arterial connector is Junction Road and the North Coast Railway defines its eastern edge. The residential street pattern provides a good framework for pedestrian and cyclist movement, and access to Kedron Brook. The south-eastern edge is defined by the rail line that reduces pedestrian, cycle and vehicle permeability. This location provides the most intact and consistent visual character of suburban low density housing and domestic landscaping within the study corridor. Melrose Park, and its vegetation and waterways, are the dominant natural features.

The Toombul shopping centre provides a focus for the Sandgate Road area. The area also contains low density residential uses. North-south links are provided by the North Coast Railway while Melton Road provides a significant alternative north-south connection. The East West Arterial provides the dominant east-west connection supported by the Airtrain. Pedestrian and cycle paths are provided along the edges of the Schulz Canal waterway system and some adjacent open space areas. The combination of Schulz Canal and the North Coast Railway impact on connectivity, and the car parking surrounding the shopping centre reduces the centre's capacity to link into supporting pedestrian catchments. The range of built form, transport infrastructure and buildings of the major shopping centre, and residential areas dissected by a tidal waterway, has created a location of fragmented character. The fragmented nature provides a mix of spaces, ranging from waterway areas to highly degraded areas underneath the Sandgate Road bridge. Parkland along the upper and lower reaches of Schulz Canal is very well utilised and provides the local community recreation infrastructure.

This location is framed by ridge lines to the north and south with Schulz Canal (part of Kedron Brook Open Space) creating a valley running east-west. The most visible areas are to the east of the Sandgate Road ridgeline. To the west there are significant groupings of Araucaria and Eucalyptus species, other cultural plantings and weed species (eg. Camphor laurel, Chinese elm).

6.13.2 Urban Design Principles

Urban design principles were established for the study corridor, dealing with issues of commercial activity, access, visual amenity, local character, movement networks, cultural features, public access and neighbourhood character. Urban design principles proposed for the study corridor as a whole are:

- maintain compact and accessible centres with well integrated pedestrian and vehicle movement networks;
- provide or maintain well connected pedestrian, cycle and vehicle networks to centres and places of community value;

- ensure built form and open space is well integrated into local neighbourhoods to retain the sense of place within the corridor;
- protect and enhance where practicable existing and locally identifiable visual qualities which contribute to the character of the locality; and
- protect and enhance where practicable areas of significant natural value to the locality.

Urban design principles were also identified for key locations in the study corridor near proposed works.

6.13.3 Urban Design Strategies, Outcomes & Mitigation

Strategies are proposed to guide the urban design, landscape and visual concepts for the Project and the mitigation of urban design, landscape and visual impacts. These include:

- Revegetation/waterway rehabilitation – protect existing endemic vegetation. Revegetate construction worksites following construction and reinstate riparian habitat where appropriate and practicable;
- Urban Forest Treatment – create well connected and safe landscapes of diverse and high quality where the project creates open space, incorporating existing parks and open space, where possible and practicable;
- Activity Zones – create well connected and safe community areas for active or passive recreation within existing open spaces;
- Boulevard Treatment – provide significant tree planting, street furniture, public art and accessible pathways to major roads;
- Suburban Centre Improvement Schemes – create well connected and safe new opportunities or strengthen existing viability of centres through urban design and landscape treatments; and
- Design Intervention in response to infrastructure proposals – create themed urban design and landscape treatments for retaining and transition structures, flyovers, portals, ventilation outlets and sound barriers and integrate these with the existing environment of the each key location.

Urban design measures, including landscaping treatments and plantings, are intended to reduce the visual impact of surface structures. Adopting an intense screen planting program, particularly for noise barriers, will achieve an acceptable urban landscape in an intense urban corridor.

Three ventilation outlets are proposed for the Airport Link Project, at Windsor, Kedron and Clayfield. The physical design of each ventilation outlet would be determined during the detailed design stage of the Project. However, the outlets are proposed to be at least 30 m high to achieve effective air dispersion. Adopting a high-quality design response, integrating architecture and landscaping, will achieve a visually pleasing outcome, which complements the character of the locality of each ventilation outlet. In particular, the ventilation outlet at Clayfield should have regard for the proximity of residential development and the scale and form of nearby buildings. At Kedron, the building design should be consistent with the public nature of land use in and around the site.

The rehabilitation and revegetation of waterways and open space areas disturbed during construction would reduce the urban design impacts of the Project. Reconstruction of Schulz Canal to create a "natural" wetland and waterway following construction would create an attractive and 'soft' green edge to the Toombul centre.

Toombul shopping centre and Airtrain infrastructure

Pedestrian and cycle connections near worksites should be maintained, including community facilities such as schools, open space, public transport and shopping. Following construction, pedestrian and cycle links near surface connections should be enhanced. This includes from residential areas at Clayfield, to Kalinga Park, Toombul shopping centre and the railway station. At Windsor, links should be integrated to and from open space connecting the north and south banks of Enoggera Creek and the pedestrian/ cycle bridge provided by the NSBT.

7. Environmental Management

Careful management of the Airport Link Project is required during both the construction and the operational phases to maintain if not enhance the environmental conditions in the study corridor. Detailed environmental management plans (EMPs) will need to be prepared. Some aspects of the EMPs will need to be approved by the Queensland Government and the BCC, and others will need to be approved by the proponent prior to the commencement of construction and operation of the Airport Link Project. Existing laws, regulations, codes and the like determine the approval roles and responsibilities of both the Queensland Government and the BCC.

This EIS provides draft Outline EMPs for the project delivery or construction phase, and the operation phase, drawing upon the findings of the EIS studies, consultation processes, detailed design, more detailed predictive modelling and baseline monitoring.

Kedron Brook at Gympie Road

A key feature of the draft Outline EMPs is the performance-based approach taken to environmental management. This approach seeks to identify the key objectives for environmental management, having regard to technical matters and community concerns raised during consultation for the EIS. While the environmental objectives are important and must be achieved, the effectiveness of either the Contractor or the Operator in achieving them is to be measured against a range of performance criteria set out in the draft Outline EMPs. This provides a high level of flexibility for the Contractor and the Operator to plan, to deliver and to operate the Airport Link Project, while at the same time attending to the matters of community concern.

The mitigation measures set out in the draft Outline EMPs are intended to provide direction as to how the environmental objectives might be achieved, but do not preclude other means or measures which are equally or more effective.

It is anticipated that the principles of these draft Outline EMPs will form the basis for conditions imposed by the Coordinator-General and subsequently, for the detailed management plans drawn up by the Contractor and Operator of the Airport Link Project.

8. Urban Regeneration

8.1 Approach to the Challenge

The Airport Link Project provides the opportunity to deliver lasting transport, economic, community and environmental benefits to the City, if delivered within an over-arching framework of urban regeneration.

The experience with many transport infrastructure projects has seen land use and urban form change dramatically and quickly as the private sector responds to changed conditions such as improved accessibility, environmental conditions and development opportunities presented through the amalgamation of smaller lots.

The purpose for initiating a program of urban regeneration associated with the Airport Link Project is to capture potential project benefits and to seek to manage the on-going change occurring in the study corridor within a framework based in infrastructure planning and provision, and in a planning process founded on agency, stakeholder and community consultation.

The Airport Link Project has the potential to influence and benefit the City's residents and future generations for the next 100 years. Land use changes considered necessary to complement the ultimate planning for the transport corridor will be the responsibility of BCC while having regard for the framework of State policies and regional planning strategies intended to guide infrastructure and development. This strategy would form part of City Plan.

For the Airport Link Project, the urban regeneration initiatives should:

- deliver an enduring urban outcome for the foundation of the future city;
- deliver enduring urban design;
- build capacity in the communities of the corridor for enhancing their urban environment; and
- stimulate opportunities for sustainable economic development, consistent with desired urban planning outcomes.

Through amendments to City Plan, redevelopment could occur in ways consistent with desired planning outcomes. Simultaneously, City Plan amendments could facilitate the provision of community enhancements such as:

- additional open space or enhanced areas within the public realm;
- public access networks through sites to increase permeability for pedestrians and possibly motor vehicles;
- advantageous locations of public transport connections;
- supported community facilities in accessible locations (e.g. ground floor library space within a commercial development); and
- increased opportunities for affordable housing.

8.1.1 Community Expectations

From the input received, it is clear that the corridor community expects enhancements beyond 'the road' response. The consultation process conducted for the Airport Link EIS has identified the following:

- recognition of 'the problem' of traffic congestion in the northern suburbs, and the need for something to be done about it;
- concerns over construction and operational aspects (eg noise, vibration, air quality, vent location and appearance, visual impacts of surface infrastructure, traffic congestion on approach roads, and project justification);
- concerns that the surface infrastructure associated with the project will blight or otherwise create 'dead zones' in their neighbourhoods; and
- expectation that local residents should benefit from the project equally, if not more so, with the people who presently drive through their suburbs to access employment in either the CBD or at Brisbane Airport.

8.1.2 Implementing Urban Regeneration

Urban regeneration should be funded in the most cost effective way, and should deliver against 'value for money' frameworks and community expectations regarding the wise and equitable use of public resources.

The framework for urban regeneration is based on the shared approach to implementation responsibility and funding, program initiatives and redevelopment initiatives.

Program Initiatives

Program initiatives would be delivered through existing policy-based programs of the Commonwealth, State and local governments including investigation of:

- employment schemes for youth, disabled people, indigenous people and prematurely retired or long-term unemployed people, in conjunction with employment initiatives of the delivery vehicle;
- local planning to manage land use change and to achieve a high level of integration in land use and transport planning, consistent with the growth management strategy developed under the SEQ Regional Plan;
- possible participation in project construction or in community-based, project-related activities building community capacity for people who don't speak English as their first language, people with low education levels

and people with special needs; and

- the possible extension of accessible public transport for aged or disabled people to places of community importance (eg centres, employment, community facilities).

The key program initiatives will be centred on land use planning, affordable housing, employment and providing for people with a disability.

Redevelopment Initiatives

The redevelopment initiatives rely upon the process of managed land use change within the study corridor during and beyond the construction phase of the Airport Link Project. With redevelopment and rejuvenation of these inner suburbs, there is an opportunity for development to deliver a range of community facilities and amenities relevant to their needs but concurrently relevant to the framework for urban regeneration.

The scope of such initiatives should be determined through the Neighbourhood Planning process in consultation with agencies, stakeholders and the wider community.

9. Conclusions & Recommendations

The conclusions and recommendations flowing from the EIS and the investigations which informed its preparation, relate to the assessment of the Airport Link Project in relation to the terms of reference provided by the Coordinator-General, but also to an assessment of the Project in relation to the objectives and rationale for it.

While the EIS responds to the terms of reference in a comprehensive assessment of the Airport Link 'reference project', it seeks to provide also a performance-based approach to project design, delivery and implementation through draft Outline Environmental Management Plans. The EIS recognises that while the reference project presents a particular approach to the design and delivery of the Project, there may be other ways of designing or delivering Airport Link. It is important that the approach taken in the EIS is not so prescriptive as to preclude innovation in either the design, delivery or operation of Airport Link.

9.1 Rationale for Airport Link Project

The Queensland Government and the Brisbane City Council have been working towards achieving a sustainable balance between travel demand, transportation capacity and land use planning through a number of key strategies over many years. A key and underlying objective is the integration of land use planning and transport planning as the principal means for managing travel demand in the face of sustained population growth.

The provision of transport infrastructure is key to achieving a sustainable, long-term pattern of growth in the region, and in the Brisbane metropolitan area. Sustained population growth, combined with the radial road pattern and the concentration of employment in Brisbane, contributes towards a challenging transportation scenario. The surface road network is already congested as people move across the region to access jobs and high-order services. The public transport system, despite enjoying significant growth in patronage in recent years, is not keeping up with the travel demand generated from a dispersed settlement pattern, dispersed employment centres and a radial transportation network.

With increases in vehicle travel demand within the metropolitan area network, and the key travel generators within and surrounding the Airport Link corridor, a general increase in congestion is predicted on the road network across the years. Assessment of travel demand in Brisbane's inner north indicates that on the arterial roads currently about 60% of trips are cross-city, 35% are destined for the Central City and only 5% is local traffic. Much of the traffic congestion in the arterial network in the inner north Brisbane's radial road system is caused by traffic wanting to get "somewhere else" but being forced to use the roads through the suburbs.

Against this scenario, a 'do nothing' response will have severe, adverse consequences for the economic, social and environmental conditions of the City and would severely constrain its future development.

9.2 Integrated Transport Solution

The SEQIPP identifies Airport Link as a potential road infrastructure improvement to serve the Brisbane metropolitan area. SEQIPP also provides for the provision of the Northern Busway from Herston northwards to Aspley and then to Bracken Ridge. While the implementation of the Northern Busway Project may occur in stages, its implementation relies upon the relief of surface congestion, particularly in Lutwyche Road.

In addition to relieving congestion, the Airport Link Project, with the Northern Busway Project, is expected to provide additional road capacity to meet anticipated travel demand to the year 2026.

The Airport Link Project will provide an enhanced road connection for both radial and orbital functions within Brisbane, facilitating cross-city travel movement in an environment where there is increasing travel demand to, and between, major economic activity and employment nodes serving the region. These include the Brisbane CBD and the ATC precinct, including Brisbane Airport. Users of the toll road facility, and the un-tolled surface roads, would benefit from travel time savings, particularly freight vehicles. An effective integrated transport network supports competitiveness of industry and business.

The environment for pedestrian and cyclist travel on the surface network would be improved with the Airport Link Project, by reducing traffic demands on the local road system, particularly through activity centres and near public transport stations. Walking and cycling networks provide flexibility for travel as well as significant health and environmental benefits.

While some adverse effects have been identified and assessed, there is clear support for the Airport Link Project as a key component in an overall strategy to improve the efficiency of Brisbane's road network.

9.3 Economic Implications

The Airport Link Project will respond to traffic and transport demand arising from forecast population growth, commercial and industrial land use, and economic activity in the Airport Link corridor, broader Brisbane metropolitan area and surrounding local authorities.

Economic activity in the Brisbane metropolitan area is forecast to continue to expand with Brisbane Airport, the Port of Brisbane and other major commercial and industrial development in the outer North area as likely catalysts for substantial economic growth. In particular, the increase in passenger movements at Brisbane Airport over the past decade has and will continue to place pressure on the road network that feeds into the airport from the Brisbane CBD and the broader Brisbane metropolitan area. The ATC will be the location for future significant industrial and commercial development that will continue to fuel economic activity and economic growth in the broader Brisbane region. Efficient freight movements will be required to support and facilitate this projected economic activity.

In addition to increasing travel demand from population growth, the projected expansion of economic activity has also increased the need for new road infrastructure such as the Airport Link. The Airport Link Project will be a key influence on the future pattern and rate of economic development in the region and in Brisbane.

With a risk-adjusted capital cost of $2.3 billion, and a discount rate of 6.8%, the Airport Link Project will have a benefit cost ratio of 1.1, and a nett present value of $131 million over the 45 year concession period. The value of travel time savings available from the Project is $1.7 billion, in present value terms, while the value of vehicle operating cost savings is estimated to be $488 million. Road safety and environmental benefits are valued, collectively, at $167 million in present value terms.

The impact of the Airport Link Project on employment in SEQ will range from approximately 6,000 full-time employees with the commencement of construction in 2008 to approximately 2,300 full-time employees during the last year of construction in 2012.

The Airport Link Project will be a significant section of road infrastructure that will support and facilitate population and key economic growth areas in Brisbane and the region.

Lutwyche Road, Lutwyche

9.4 Design for Sustainability

The development of the Airport Link Project concept has occurred in conjunction with a comprehensive process of community consultation and environmental investigation and testing. Within the scope of the Project objectives, the process has sought to reduce, if not avoid, potential impacts from design, construction and operation. Design criteria and mitigation strategies were developed from a comprehensive consultative process involving State and local government agencies, community groups and stakeholders, including the traditional people of the area.

In addition to this integrated process, the design and construction aspects were developed within a framework of ecological sustainability relating to urban water management; air quality management; resource use, re-use and management; corridor rehabilitation and regeneration; environmental management, and community consultation and capacity building.

The Airport Link Project is significant in terms of its scale, duration of construction, and operational life. It has the potential to shape the future direction and form of development of the inner northern suburbs as traffic flows change and potential benefits and impacts are realised in local and wider areas. As development and land use activity intensify around the urban centres in the corridor, including the transport stations and areas benefitting from enhanced accessibility due to the Airport Link Project, the potential for travel demand management will increase.

Concurrently, the design development process has been modified to accommodate the implementation of the Northern Busway Project through changes in alignment and

arrangements of the surface connections. Implementation of both the Airport Link Project and the Interim Northern Busway Project will deliver significant benefits in travel demand management and will present a sustainable response to rapidly-deteriorating traffic conditions on the northern approaches to the City centre and the Brisbane Airport.

Having regard to the long-term nature of the Project, the design development process has sought to minimise long-term impacts through urban design and rehabilitation measures, and to off-set construction impacts through a range of mitigation measures which have the potential to impart long-term benefits in the communities impacted by construction. Some of these mitigation measures provide opportunities for long-term community involvement, building capacity and building awareness and ownership of important community resources in the study corridor.

9.4.1 Project Delivery Impacts & Mitigation Measures

The delivery mode for the Airport Link Project is expected to generate a range of potential physical, environmental, social and economic impacts. Some of the more significant, potential impacts and the possible mitigation measures are discussed.

Construction & Worksites

Construction worksites will be established in Windsor, Kedron, Lutwyche and Clayfield. Enclosed structures and worksheds will be erected within the worksites to manage the impacts of construction noise and dust emanating from the tunnel shafts. Spoil storage, handling and loading will also occur within acoustic lined enclosures and worksheds. The location of each construction worksite is adjacent to sensitive activities or communities, requiring construction worksite layout, operation and management to reflect and respond to those sensitivities.

Due to the scale of the worksheds, spoil and conveyor systems, there will be short-term impacts on urban character and visual amenity. The visual impacts of the workshed can be mitigated through the application of innovative designs and architectural treatments (e.g. building graphics, materials, colours, and lighting).

Rehabilitation of the construction worksites post-construction is important to mitigate potential impacts such as soil erosion, sedimentation, dust and weed growth. With land use planning, the re-use of worksites can be managed to achieve acceptable long-term outcomes, consistent with orderly planning objectives and the character of the locality.

Construction Traffic and Access

The scale of the construction project entails a significant transport task, both for materials into the construction worksites and construction spoil leaving the worksites. Construction spoil removal will generate flows of heavy vehicles along arterial roads over 24 hour periods (Monday 6.30am to Saturday 6.30pm).

A comprehensive approach to construction traffic management is necessary to deal with traffic movements on arterial roads, local traffic movements and access needs, safety, vehicle maintenance, and air quality and noise impacts.

Construction Noise and Vibration

The construction of the Airport Link Project will likely entail the use of techniques and machinery with the potential to impact on sensitive receptors through the generation of noise or vibration. The environmental effects of each construction technique are different, requiring mitigation and management measures tailored to the technique and the characteristics of the location in which they are to be employed.

The management approach is to establish goals for maintaining reasonable environmental conditions for properties above or adjacent to the construction works, having regard for their particular use (e.g. residential, commercial, community facilities, hospitals, aged care). An obligation will be placed on the Contractor to adopt such measures as necessary to achieve the goals, or, to adopt mitigation measures appropriate to the circumstances so construction can proceed and the daily life and economic activity of the City can be maintained.

An important element of the management strategy for construction noise and vibration is the procedure for receiving, handling and responding to complaints. The construction process must be supported by a comprehensive, responsive, open and accessible system for handling complaints and corrective actions.

Construction Air Quality

With the scale of construction works, including open or exposed works, (e.g. road works, cut and cover construction, worksites) there is potential for airborne dust impacts on adjacent properties. The containment of potential dust nuisance is an important aspect for effective environmental management. Management of the haulage and the placement of construction spoil are important aspects of dust control.

Regular and frequent monitoring of dust-fall at properties adjacent to the worksites will assist in ensuring the environmental objectives for construction air quality are achieved.

Groundwater Movement and Settlement

With the construction of tunnels, there is the potential for groundwater movement towards the construction. In some locations along the route for the Airport Link Project, there is the potential for some settlement of the ground accompanying groundwater drawdown. The magnitude of settlement, and the risk, is considered to be small, but important nevertheless. Considering the range of flow-on effects from groundwater movement, it is important to minimise the risk and mitigate and manage the potential impacts. Apart from detailed hydrological investigations and on-going monitoring, the most effective means of minimising the risk of groundwater intrusion for construction of the east to west tunnels is to line or water-proof the works as quickly as possible. There are a range of construction techniques to achieve this outcome. For the north to south tunnels, the potential for groundwater intrusion is much lower due to hydrogeological conditions.

Flora and Fauna

The construction works in and around Enoggera Creek, Kedron Brook and Schulz Canal have the potential to modify the urban ecology, mostly through the loss of habitat or refuge areas. These corridors are already heavily modified as a consequence of human settlement and will need effective rehabilitation and revegetation as quickly as possible after completion of the works.

There is an opportunity for a high level of community involvement in the rehabilitation process through consultation on the design and implementation of planting plans. There will be opportunities for community involvement in the rehabilitation works and on-going maintenance.

Landscape and Visual Impacts

The construction works will take place in locations, which for the most part, are highly visible in their settings. The removal of mature trees (Clayfield, Windsor), the removal of housing and other buildings (Windsor, Lutwyche, Kedron), the extent of the worksites, and the scale, height and bulk of the worksheds, will combine to impose visual impacts on the localities of each of the worksites. While such impacts are short-term, they are of some prolonged duration when compared with other construction projects.

Cultural Heritage

There are several places of cultural heritage significance along the route of the Airport Link Project. Construction in the vicinity of such places needs to be carefully executed to ensure their heritage values are retained. Construction near such places will be conducted in accordance with approved cultural heritage management plans in accordance with relevant legislation. Such plans will need to be in place prior to the commencement of construction works on or adjacent to the places of cultural heritage significance.

Social Impacts

Implementation of the Airport Link Project will require the acquisition of properties at Windsor, Kedron, Lutwyche and Clayfield. These acquisitions will cause the displacement of some long-term residents, the removal of housing stock and the loss of some street trees, which have contributed to the character of the inner northern suburbs for some time. While there is no ready mitigation measure for these impacts, there can be some off-sets in the form of urban design and landscaping treatments in and around the project works to ensure that, post construction, the Airport Link Project contributes not just to the accessibility of the City, but also to the landscape of the study corridor.

During construction, there is potential for the works to impact on the operations of community infrastructure, such as schools and other community facilities adjacent to worksites. Careful management, supported by on-going and effective consultation with program and facilities managers, is required to ensure concerns and impacts are addressed and resolved to the extent reasonable and practicable.

Land Use & Planning

During the construction phase, there is some potential for land use changes in the study corridor. This is particularly the case for the areas around the construction worksites and the surface works. Careful planning and management of the development process is required to ensure long-term land outcomes are consistent with good planning and the objectives for the area expressed in City Plan 2000. It will also be important to ensure that City Plan has realistic expectations and provisions for the study corridor, and sites adjacent to the construction worksites, to avoid the potential for unintended development outcomes.

9.4.2 Operational Impacts & Mitigation Measures

The range of potential operational impacts from the Airport Link Project is much narrower than for the project delivery or construction phase. The potential operational impacts are likely to include local traffic impacts, traffic noise, air quality (ambient air), groundwater impacts and land use and social impacts.

Local Traffic Impacts

With the introduction of major new road infrastructure, traffic flows will redistribute to take advantage either of the freed road space or the capacity of the new road. In doing so, the potential arises for traffic to use local streets or for traffic flows to become congested in local areas.

As with other parts of the road network, the BCC and the DMR work together to ensure that the road network functions well and in a manner appropriate to its structure.

However, there is no proposal to artificially constrain the road network to favour or force use of the Airport Link Project.

Airport Link will link more traffic with motorways such as the Inner City Bypass, and the arterial roads, such as Gympie Road and Stafford Road. This is an appropriate use of road space. Congestion on other arterial roads, such as Sandgate Road inbound from the East West Arterial and Lutwyche Road inbound from Gympie Road, will be reduced as a consequence of project operations. These beneficial impacts will create opportunities for public transport and other forms of transport to become more effective in addressing travel demand in the inner northern suburbs.

Traffic Noise

With the forecast increase of traffic on the arterial roads approaching the tunnel portals, there is a corresponding risk of increased traffic noise. With the reconfiguration of some of the surface roads in the immediate vicinity of the portals, the predicted increases in traffic noise are likely to be noticeable and potentially intrusive if no mitigation measures are taken.

To mitigate the impacts of road traffic noise, a conventional approach would entail the installation of noise barriers. In some locations, the barriers may need to be high (in the range of 6.0 m – 8.0 m). In themselves, barriers of this scale present impacts on the local community. Alternative measures, including urban design, landscaping and use of appropriate materials may be available to mitigate the impacts of the noise barriers.

Air Quality

An issue of critical community interest and concern is that of potential impacts on air quality from the operation of the tunnel ventilation system, and the ventilation outlets. The existing ambient air quality across the study corridor is generally good, with concentrations of motor vehicle emissions well below the stringent ambient goals adopted.

The Airport Link Project will release vitiated air from the ventilation outlets at Windsor, Kedron and Clayfield. The proposed ventilation system is intended to minimise the impacts of vitiated tunnel air upon the ambient environment through high-level, high speed discharge and subsequent dispersion.

The impact assessment indicates the contributions of the ventilation outlet to ambient air concentrations for particular pollutants is very low, and well below the stringent air quality goals adopted.

The other source of motor vehicle-based air pollution is the major road network. As traffic congestion increases, roadside concentrations of motor vehicle emissions also increase. The concentration of emissions diminishes rapidly with distance from the roadside. Some changes, both increases and decreases, in air quality along the major arterials are predicted as a consequence of changes in traffic flows due to the Airport Link Project. In all cases, the roadside concentrations are below the goals for ambient air quality, even though such goals are not intended to apply to such circumstances.

The health risk assessment has concluded that there will be no appreciable change in community health as a consequence of the Airport Link Project, either in relation to the operations of the ventilation outlets or the changes in roadside concentrations of vehicle emissions.

Groundwater

Groundwater in the study corridor is contained in two different aquifer types. Between Federation Street, and Windsor Avenue and Norman Avenue, Lutwyche, the tunnel will pass through rock with no primary porosity. In this section, the tunnel will act as a drain for groundwater. However, no measures to prevent inflow are proposed as an equilibrium will be achieved some years after construction. A drainage system with provision for a collection sump and pumping facilities are likely requirements of detailed design.

In the driven tunnels between Kedron and Sandgate Road the interception of an alluvial aquifer will require the lining of the tunnel walls against groundwater ingress immediately. The cut and cover tunnel in the alluvium, adjacent to Sandgate Road, needs to be sealed against groundwater ingress to prevent recharge of the aquifer with salt water from the intertidal Schulz Canal.

Land Use and Social Impacts

Along Lutwyche Road, land use change has been constrained in some locations by the effects of traffic congestion, such as difficult access, limited parking and land availability. The Airport Link Project is expected to relieve traffic congestion and provide opportunities for enhanced public transport along Lutwyche Road and Sandgate Road. Land use change could be expected to follow these improvements and will need to be managed to ensure the advantages of change are optimised and the costs either avoided or minimised. City Plan is the primary instrument for managing land use change in the City. It is reviewed regularly to maintain an appropriate balance in development and infrastructure planning. The potential for land use change in the study corridor should be managed through this process of regular and systematic review of City Plan.

9.4.3 Approach to Environmental Management

The physical, environmental and social impacts of construction will require a performance-based approach to mitigation and management to ensure community concerns and environmental values are retained during and post-construction. By adopting a performance-based approach, greater flexibility becomes available for the community, the

Proponent and the Contractor to communicate and resolve the most appropriate response to particular issues.

Through the draft Outline EMP, environmental objectives and performance criteria are established for the construction phase and the operational phase of the Project. The environmental objectives are intended to address community and environmental concerns about potential impacts of the Project. The performance criteria are intended to provide direction and confidence in terms of how the environmental performance of project delivery and implementation will be assessed. While mitigation measures intend to achieve the objective and performance criteria are provided in the draft Outline EMPs, there may be other solutions to effective impact avoidance, minimisation, mitigation or management.

This performance-based approach also provides a degree of flexibility for the detailed design development, construction and operation of the Airport Link Project. It may be possible to achieve the environmental objectives while also achieving improvements in each of the phases of the Project.

9.5 Urban Mitigation Works

In addition to the requirements of the draft Outline EMPs for both the construction phase and operations phase, urban mitigation works are required for implementation of the Airport Link Project. The required urban mitigation works are set out in **Table 9-1**. The costs of these mitigations would be borne by the Project.

In addition to the mitigation measures set out below, the Proponent should:

- investigate the potential for multiple use of ventilation stations, where possible and appropriate, to provide for or support community facilities or project administration, or both, prior to finalising the detailed concept design for the Project; and
- in conjunction with the coordinating committee to be established in response to the recommendations of this EIS, investigate physical and functional integration with the Northern Busway Project, to the extent possible, for the purpose of minimising and mitigating construction impacts.

While these works are required to mitigate project impacts, the intention is to undertake the works to a high standard, consistent with the over-arching desire to provide future generations with a Project that continues to enhance the liveability of the City long after construction is complete. In addition to the urban regeneration initiatives to be completed as part of the Airport Link project summarised above, there are also a range of urban design treatments proposed as part of the construction works, including:

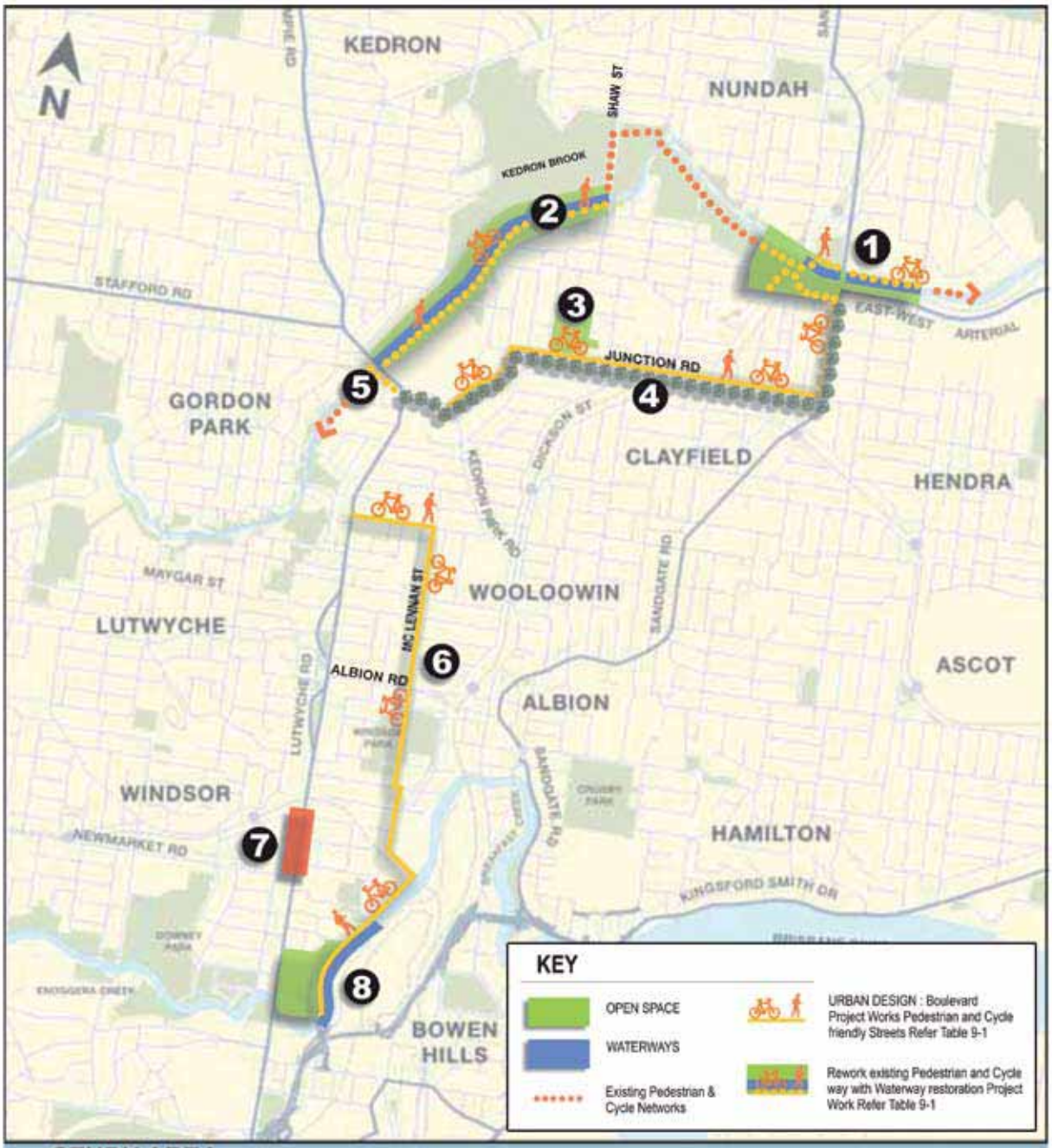
- sculptural panels for flyovers and acoustic screens;
- feature panels for concrete and earth ramps on tunnel roadways;
- portal treatments, which could include the use of steel, glass and concrete relief panels; and
- comprehensive landscaping around the portals and worksites for visual screening and relief.

■ *Table 9-1: Mitigation Works*

Category	Location	Initiative or Project Works
Urban Design	Sandgate Road (Grace Street to Junction Road) Junction Road (Sandgate Road to Rose Street) Rose Street (Junction Road to Park Road)	Boulevard works including: ■ street tree planting; ■ footpath pavement improvements; ■ lighting; and ■ selected character elements.
Pedestrian & Cycleways	Sandgate Road intersection	Reinstate pedestrian crossing at the intersection of Sandgate Road and East West Arterial intersection
	Melton Road to Kalinga Park (Diggers Drive)	Relocate pedestrian and cycle path from southern side of Schulz Canal to northern side; Provide pedestrian and cycle crossing at Melton Road
	Eagle Junction (Alma Road, Stuckey Street, Elliott Street)	Provide pedestrian and cycle connections into Kalinga Park and Kedron Brook open space corridor
Open space	Kalinga Park, Eagle Junction Ross Park, Toombul Melrose Park, Kalinga	Reinstate park & mitigate infrastructure including: ■ comprehensive landscaping at the Toombul connection; ■ planting enhancement to that section of Kalinga Park disturbed by construction activities; ■ amenities & BBQ facilities; ■ lighting (not Melrose Park); ■ children's play equipment at Kalinga Park; ■ provision of park entry to Kalinga Park from Jackson Street; and ■ adolescent/young adult facility at Ross Park.
Waterways	Schulz Canal (between Melton Road & Sandgate Road)	Ecological restoration and floodway including: ■ natural wetland reconstruction; and ■ wetland planting.
	Relocation of Kedron Brook tributary with Schulz Canal (in Kalinga Park)	Engineering works Ecological restoration and floodway including: ■ natural wetland reconstruction; and ■ wetland planting
Urban Design	Gympie Road (Kedron Brook – Broughton Road) Stafford Road (Gympie Road to Clarence Road) Park Road Kedron Park Road (Gympie Road to Park Road)	Boulevard works including: ■ street tree planting; ■ pavement improvements; and ■ lighting. Selected character elements Footpath pavement improvements in Lutwyche Rd (railway to Newmarket Rd only)
Pedestrian & Cycleways	Kedron Brook (Crossing of Gympie Road) Kedron Brook (Gympie Road to Shaw Road Brook Road	Provision of pedestrian and bikepath; Pedestrian/cycle bridge over Kedron Brook; and Extension of path through open space to Kedron Brook.

■ *Table 9-1: Project Initiatives – Mitigation (continued)*

Category	Location	Initiative or Project Works
Open Space	Kedron (east end of Fifth Ave, adjacent to Kedron Brook)	Develop park and landscaped space on DMR land: ■ comprehensive landscaping; ■ amenities & BBQ facilities; and ■ lighting.
Waterways	Kedron Brook (Gympie Road to Shaw Road)	Engineering works Ecological restoration and floodway: ■ natural wetland reconstruction; and ■ wetland planting.
Urban design	Lutwyche Road (Ferny Grove Railway to Newmarket Road)	Boulevard works: ■ street tree planting; ■ pavement improvements; ■ lighting; ■ selected character elements; and ■ footpath pavement improvements in Lutwyche Road (railway to Newmarket Road only).
Pedestrian & Cycleways	Windsor – Lutwyche (Chalk, McLennan, Lane Streets, Windsor Park, Flynn Oval)	Provision of pedestrian and bikepath; and Appropriate level of urban design treatments including theme street planting & lighting.
Open Space	Windsor (Mann Park, Flynn Oval)	Reinstate park & mitigate infrastructure: ■ comprehensive landscaping along bikepath and boundaries; ■ planting enhancement to Enoggera Creek; ■ amenities & BBQ facilities; and ■ lighting.
Waterways	Enoggera Creek (from Horace Street to Flynn Oval)	Ecological restoration: ■ wetland planting



STUDY AREA

1. WATERWAYS: Ecological Restoration and floodway Refer Table-1
2. WATERWAYS: Kedron Brook - Ecological Restoration and floodway Refer Table 9-1
3. OPEN SPACE: Melrose Park - Advanced tree planting
4. URBAN DESIGN: Sangate Rd., Junction Rd., & Rose St. Boulevard Project Works, Refer Table 9-1
5. URBAN DESIGN: Gympie Rd., Stafford Rd., Park RD., Kedron Park Rd. Boulevard Project Works Refer Table 9-1
6. PEDESTRIAN & CYCLEWAYS: Windsor-Lutwyche (Chalk, McLennan, Lane St., Windsor Park & Flynn Oval) Refer Table 9-1
7. URBAN DESIGN: Lutwyche Rd. Boulevard Project Works Refer Table 9-1
8. OPEN SPACE: Windsor (Mann Park, Flynn Oval) Refer Table 9-1

WATERWAYS: Enoggera Creek (from Horace St. to Flynn Oval) Refer Table 9-1

PROJECT INITIATIVES - PROJECT MITIGATION WORKS

9.6 Recommendations

The Airport Link Project addresses the anticipated traffic congestion in the inner northern suburbs arising from sustained population growth and economic activity in the Brisbane metropolitan area. The Project will provide an effective link between the major existing and future major employment centres in the City, while also easing traffic congestion on inner northern arterials so that public transport services can be enhanced as part of an integrated transportation response to an existing and worsening problem.

However, the scale of the Airport Link Project is such that, during construction, it will impact upon communities in Windsor, Kedron and Lutwyche, and Clayfield. During the operations phase, the Airport Link Project will have fewer impacts in very localised areas. The impacts, both during construction and operations, will require careful, performance-based management to meet community concerns and expectations.

9.6.1 Recommendation 1

Having regard for the benefits and the impacts of the Airport Link Project presented in this EIS, it is a recommendation of the EIS that the Project proceed subject to:

(a) developing and implementing detailed environmental management plans for the construction phase and the operational phase; and

(b) developing and implementing a scheme of effective urban mitigation measures such as those set out in Table 9.1 (ref. section 22.2 of this EIS).

In making the recommendation, the Coordinator-General is requested to:

(i) assess the EIS;

(ii) recommend the Airport Link project proceed;

(iii) State conditions for the Project under section 39(1)(a) of the *State Development and Public Works Organisation Act 1971*; and

(iv) recommend under section 43 of the *State Development and Public Works Organisation Act 1971* requirements for inclusion in the designation of the project corridor or land required for parts of the Project as 'community infrastructure' under section 2.6.8 of the *Integrated Planning Act 1997*, if required.

9.6.2 Recommendation 2

It is a further recommendation of this EIS to the Coordinator-General that:

(i) Necessary approvals and permits be sought for the Project including as required under City Plan, *Integrated Planning Act 1997*, *Environmental Protection Act 1994* and the *Queensland Heritage Act 1992*;

(ii) Brisbane City Council commence a program of local planning in the study corridor to address and manage the potential land use changes that might arise during the construction phase and the operational phase of the Project; and

(iii) The Queensland Government and the Brisbane City Council investigate measures to improve coordination between relevant agencies with respect to managing the impacts on the transportation network arising from the delivery of major projects in northern Brisbane and then the coordinated delivery of urban regeneration programs in the study corridor.