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Value Management Workshop No.1 Record (June, 2002)
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Preface

This Main Report presents the findings from the F3 to Sydney Orbital Link Study. The Study applied strategic analysis to the assessment of corridor types and feasible route options to determine an acceptable and preferred option which best satisfies National Highway objectives.

A number of specific routes and associated engineering details such as interchange and ventilation layouts were developed and analysed during the course of the Study, for the purpose of determining feasibility and assessing the options. The specific routes and details described in this report do not constitute a concept proposal.

It may be necessary to read sections from the other reports, records and working papers listed below to gain a more complete understanding of the information being reported in this Main Report:

Draft Options Development Report (October 2002)
Value Management No.1 Workshop Record (June 2002)
Value Management No.2 Workshop Record (September, 2003)

Access to the Main Report is available via the study website at:


Details on how to gain access to the Working Papers can be found on the study website.

If the Government decides to further develop the recommended option this would involve the preparation of a concept proposal and an Environmental Impact Statement (EIS), including a route alignment and other details which would be developed for further assessment. Community consultation will continue through each stage of project development.
Background

The background to the study is presented in this chapter under the following headings;

i) The Study and its Objectives;
ii) The interim National Highway and the Missing F3 to Sydney Orbital Link;
iii) Previous Studies; and
iv) Contents of this Report

1.1 The Study and Its Objectives

In January 2001, the Australian and State Transport Ministers, the Hon John Anderson and the Hon Carl Scully, announced the decision to undertake a study to investigate options for a new National Highway link between the F3 Sydney to Newcastle Freeway and the Sydney Orbital motorway network.

The route selection study was commenced in early 2002. The study was funded by the Australian Department of Transport and Regional Services (DOTARS) and managed by the New South Wales Roads and Traffic Authority (RTA). Sinclair Knight Merz was commissioned to undertake the study.

The purpose of the study was to identify a route for a new high standard transport link between the F3 and the Sydney Orbital to replace Pennant Hills Road as the interim National Highway. The study area is shown in Figure 1-1.

The study objectives were:

- to investigate, plan and consult with the community on feasible transport options for the F3 to Sydney Orbital National Highway Link;
- to objectively investigate the need for an integrated transport improvement scheme which balances National Highway, the arterial network and public transport user needs;
- to use robust processes for consultation, development and assessment of options;
- to select alignments which minimise social and environmental costs;
- to develop a preferred scheme in sufficient detail for the purpose of an EIS;
- to develop an economically justifiable solution(s); and
- to recommend solutions that can be financed through government or private sector funding.

The Study timeframe is 20 years.
Figure 1-1: The Study Area

Investigation between Kariong and Sydney Orbital, from Dean Park to the M2 Motorway at Macquarie Park.
1.2 The Interim National Highway and the Missing F3 to Sydney Orbital Link

In 1988, the NSW Roads and Traffic Authority (RTA) completed the widening of Pennant Hills Road from the M2 Interchange to the F3 at Wahroonga. This provided a much needed capacity improvement to what is today the interim National Highway for traffic movements to and from Sydney to the north.

Prior to 1994 there was no designated National Highway route through Sydney. The National Highway terminated at Hornsby in the north and at Crossroads (near Liverpool) in the south. (Refer to Figure 1-1). In 1994 the Cumberland Highway was declared part of the National Highway system. Since then the Australian Government has provided funding for significant upgrading of this link, and has been exploring opportunities to develop an alternative National Highway through Sydney which is of motorway standard. One of these opportunities is the Western Sydney Orbital.

Construction of the Western Sydney Orbital (now known as the Westlink M7 Motorway) has commenced and is anticipated to be completed in 2006. The M7 Motorway and part of the M2 Motorway will collectively form part of the Sydney Orbital. The M7 Motorway and the M2 Motorway will then replace the Cumberland Highway as the National Highway except for the northern part of Pennant Hills Road.

The completion of the M7 Motorway will leave the remaining section of Pennant Hills Road between the M2 Motorway and the F3 Freeway as the only section of the National Highway through Sydney that is not freeway standard.

Pennant Hills Road operates as a major arterial road in the Sydney road network. From its intersection with the M2 Motorway to the F3 interchange at Wahroonga, it is generally six lanes wide and has 22 sets of traffic signals along its 9 km length. The current situation is described in Part C of this report.
1.3 Previous Studies

Over the last 15 years, there have been three major studies which have investigated a new link to connect the F3 Freeway to what is now the Interim National Highway. The NSW RTA investigation of 1988\(^1\) concluded that a surface route between the F3 Freeway and the M2 Motorway would have unacceptable social and environmental effects along what was proposed as the B2/B3 corridor, through the Lane Cove National Park. The Maunsell report of 1995\(^2\) investigated new routes to the north of Hornsby which were judged to be too expensive in terms of cost and environmental impacts.

In 1991, Road Transport - Future Directions\(^3\) reported on the need for an access controlled priority north-south route for freight vehicles between the F3 at Wahroonga and Liverpool and Campbelltown in the south to enhance the economic vitality of the City.

The NSW RailCorp (previously Rail Infrastructure Corporation (RIC)) has recently investigated options to improve rail capacity in the main northern transport corridor for rail freight and passenger operations.

This current study builds on the work of these previous studies. To date no decision has been made by government to reserve any new corridor. This is the case for both road and rail.

1.4 Contents of This Report

This Main Report presents the major findings of the Study to investigate and recommend a new transport link connecting the F3 Freeway to the Sydney Orbital. The Report is organised into nine parts as follows:

- Part A: Summary
- Part B: Introduction
- Part C: The Current Situation
- Part D: Key Issues
- Part E: Need
- Part F: Development and Assessment of Corridor Types
- Part G: Development of Assessment of Type A Corridor Options
- Part H: The Recommended Type A Option
- Part I: Main Findings, Conclusions and Recommendations

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1 F2 to F3 Connection, NSW Department of Main Roads (DMR), September 1988.
3 Road Transport – Future Directions, NSW Roads and Traffic Authority, June 1991.
2

Approach to the Study

The general method of approach undertaken in the study is described in this chapter under the following headings:

i) Study Process;
ii) Study Area and Options Development;
iii) Community Consultation;
iv) This Report; and

2.1 Study Process

The approach and the key steps that were taken to undertake this feasibility study are shown in Figure 2-1. The four stages of study can be described as:

Stage 1: Familiarisation

During Stage 1 and throughout the following stages, relevant planning and technical information was collected, including the results and findings of previous studies. The study scope was refined and field studies and traffic surveys undertaken.

Stage 2: Generation of corridor options

A list of corridor options was developed and assessed through technical studies and early feedback from the community. These corridor options were grouped into three broad corridor types for the purpose of assessment.

Stage 3: Examination of feasible options

Through the process of social, environmental and traffic assessment of the list of corridor options, feasible options that would best satisfy the project objectives were established and further assessed in more detail. The feasible options were presented to the community and submissions received. This stage also included a Value Management Workshop that provided a framework for the completion of the study.

Stage 4: Evaluation and recommendation of preferred option

The final stage evaluated the feasible options, taking into account the views received from the community and stakeholder groups. A socio-economic analysis was undertaken on the identified feasible corridor type options. The preparation of this main report and recommendation of the preferred option completes the study.
2.2 Study Area and Options Development

The study area is shown in Figure 1-1. It extends from the F3 Sydney to Newcastle Freeway at Kariong on the Central Coast, to the northern section of the Sydney Orbital at Dean Park in the west and to Macquarie Park in the east.

The land use in the study area ranges from dense urban development to expansive areas of rural land and National Parks. The established and densely developed urban areas are predominantly in the south and south-east of the study area. Developing and planned urban areas are to the west, and rural areas and National Parks to the north.

There are also varied geographic forms and features in the study area. The dominant features are the Hawkesbury River and other waterways such as Berowra Creek and the Lane Cove River. The large areas of natural or relatively undisturbed bushland that comprise the National and Regional Parks and open space areas, and the undulating topography over most of the area, pose different constraints and opportunities for possible locations for a new transport link.

The size of the study area posed challenges in identifying a logical and robust process to develop options for a new National Highway link. The process is described in Chapter 9. It followed a strategic assessment and consideration of land use and environmental constraints and urban design and landscape assessments of the study area. Engineering feasibility, especially interchange
opportunities to link with the Sydney Orbital and F3 were a major consideration in establishing the list of corridor options.

Options were sorted by corridor type (Type A, B and C) which would achieve different outcomes and their effects compared against the project objectives (Described in Chapter 10). A preferred corridor type was selected and feasible options within the preferred corridor type were developed for assessment.

2.3 Community Consultation

A comprehensive and inclusive community and stakeholder involvement program was an integral part of this study. The program was designed to encourage and maximise community participation. The study area has a large population estimated at 340,000 people, in approximately 100,000 households.

The communities and stakeholders associated with this project include:

- Residents, landowners and businesses within the study area.
- Elected Members of Federal and State Parliaments.
- Elected local government representatives.
- Federal, state and local government bodies and organisations.
- Advisory and interest groups.
- Road transport groups.
- The wider community, including road users.

The consultation activities undertaken within the Community Consultation program and the main views and outcomes from consultation are presented in Chapter 13.

2.4 This Report

This Report presents the findings of a strategic investigation into feasible options to link the F3 Freeway to the Sydney Orbital. The findings and the recommended preferred option have been based on a wide range of analyses and inputs, including:

- views received from the community
- technical studies and their findings
- outcomes from two value management workshops.

The technical studies and their findings are documented in supporting reports and seven (7) working papers which accompany this report.

2.5 The Way Forward

If a recommended option is selected for ongoing development, it would be developed into a concept proposal, following further community consultation on this option. More detailed studies would be undertaken on the concept proposal, as part of an environmental impact assessment process. The preparation of an Environmental Impact Statement (EIS) would describe the proposal in detail and its potential environmental, social and physical impacts.

The proposal would be subject to formal public and government scrutiny through the assessment and formal approval process. When the EIS has been prepared it would be placed on public display and this would provide another opportunity for the community, stakeholders and other interested parties to provide input.
3

Existing Conditions on the interim National Highway Corridor and F3 Freeway

The existing traffic conditions in the National Highway corridor, including the F3 corridor and the Main North Rail Line, are described in this chapter. This chapter is arranged under the following headings:

i) The Different Types of Users of the National Highway;
ii) Traffic Conditions on the National Highway and on the Surrounding Arterial Road Network;
iii) Public Transport, Cyclists and Pedestrians;
iv) Freight Movement in the Corridor; and

Working Paper No.4 describes the existing traffic conditions in more detail. The existing social and environmental conditions are presented in Working Paper No.5.

3.1 Functions and Types of Users of the National Highway

The designated National Highway through Sydney runs along the F3 Freeway, Pennant Hills Road and the Cumberland Highway to Liverpool and the Hume Highway in the south-west. It services a mix of trip purposes and functions:

i) Inter-regional, intra-State and inter-State travel for commercial, recreational and business related use;

ii) long distance commuter travel to/from the Central Coast to Sydney job locations;

iii) local distribution of goods to businesses, warehouses and supermarkets;

iv) local and district commuters crossing and using Pennant Hills Road for part of their journey;

v) local access for residents and businesses along the route;

vi) pedestrians and cyclists; and

vii) bus users and those accessing Pennant Hills, Thornleigh and Hornsby railway stations.

Inter-regional commuting from the Central Coast to jobs in Sydney dominates traffic on the F3 Freeway during peak weekday periods.

*The functions and types of users of a National Highway link*

A main function of a new National Highway link would be to service inter-regional travel demands of Sydney’s and the State’s road-based economy. By definition, a new link should primarily service commercial and long distance traffic. A new link would also provide improvements to the region’s arterial network as a secondary function. Local users and commuters in the corridor however would benefit from a new National Highway link which would relieve the existing routes of long distance traffic on the regional network.
Percentage of non-commuting inter-regional traffic using the National Highway

National Highways are designated and funded on the basis that their predominant use, compared to other important roads, is related to benefiting inter-regional commerce and trade. The function of a National Highway and the traffic which it services should relate to the National Highway objectives, which have a strong economic development basis.

User type (i) above relates to long distance movements directly related to commercial/economic development, consistent with the National Highway objectives.

The proportion of trips on the F3 which are non-commuting and long distance is about 60% of the total daily traffic. The proportion on Pennant Hills Road is less, because it carries a higher proportion of local trips compared to the F3. The proportion of long-distance non-commuting daily trips using Pennant Hills Road is estimated at about 23% of the total daily volume.

Central Coast Traffic

In 1996 about 22,700 people living on the Central Coast travelled to Sydney to work each weekday. In 2001, that number is closer to 25,900. Just over half of these commuters, that is about 14,250 or 55%, travel to work in Sydney by car. The number of commuter cars travelling to Sydney from the Central Coast in 2001 was estimated to be around 11,300 in the morning and again in the evening. This represented about 32% of all weekday traffic on the F3 Freeway. Of the estimated 14,250 Central Coast commuters travelling to Sydney by car:

- 2,200 travel to employment in Hornsby Shire;
- 2,200 travel to employment on the North Shore including Chatswood, St Leonards and North Sydney;
- 2,700 travel to employment in inner Sydney; and
- 7,150 travel to employment in areas in western Sydney (north west, west, and south western Sydney).

About 21% of daily heavy vehicle volumes on the F3 Freeway, estimated to be 2,400 trucks, are associated with business on the Central Coast, and travel between the Central Coast and Sydney each weekday.

The number of other business trips to/from the Central Coast is not directly available. The average proportion of business trips could make up to 50% of daily trips on the F3, of which about half could be expected to travel to/from the Central Coast.

Table 3-1 presents a best estimate of the make-up of Central Coast daily trips using the F3 to/from Sydney. The Central Coast traffic makes up about 42,500 trips or 60% of the total weekday traffic on this basis.

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2 Based on a car occupancy of 1.26. From Car Occupancy Survey by PPK in 1996.

3 This study has estimated the F3 truck volumes to be 11,300 trucks per average weekday (24 hr Average Annual Weekday Traffic, AAWT) and 9,200 trucks per day averaged over 7 days (24 hr Average Annual Daily Traffic, AADT) in 2001, Section 3.4 describes freight movement in the corridor.
### Table 3-1: Estimated trips between Central Coast and Sydney in F3 Daily Weekday Traffic Volume (2 way), 2001

<table>
<thead>
<tr>
<th></th>
<th>Average Weekday Volume</th>
<th>Estimated % of Total Average Weekday Volume (AAWT(^{(1)}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commuter Cars (two-way trips)</td>
<td>22,600</td>
<td>32</td>
</tr>
<tr>
<td>Business Trips</td>
<td>17,500</td>
<td>25</td>
</tr>
<tr>
<td>Heavy Vehicle Trips</td>
<td>2,400</td>
<td>3</td>
</tr>
<tr>
<td>Sub Total</td>
<td>42,500</td>
<td>60</td>
</tr>
</tbody>
</table>


\(^{(1)}\) Assuming F3 total average weekday volume (AAWT) was 71,300 in 2001.

---

**The Functions of Pennant Hills Road and Pacific Highway South of Wahroonga**

Pennant Hills Road is characterised by a high proportion of long distance commercial vehicle movements when compared with similar arterial roads in Sydney, including the Pacific Highway. The Pacific Highway predominantly serves local and district travel including commuting from northern suburbs to jobs in the eastern part of Sydney. The Pacific Highway also provides access to the F3 to/from eastern Sydney and is used as a main route for commuters from the Central Coast into eastern Sydney.

Because Pennant Hills Road and the Pacific Highway are key arterials in the city's road network, they principally serve the region’s economy. They also support the national economy and will continue to play an important economic development role into the future.

### 3.2 Traffic Conditions on the National Highway and on the Surrounding Arterial Road Network

The F3 Freeway links to Pennant Hills Road at Wahroonga. It is important in the context of assessing traffic conditions on the interim National Highway since F3 traffic can affect travelling conditions on the interim National Highway along Pennant Hills Road.

The existing interim National Highway route through Sydney is congested during commuter peak periods. Traffic congestion is also building up during weekday business hours. There are periods of congestion during recreational peaks on weekends and holidays. Congestion results in delay and unreliable travel times for businesses and can lead to major disruptions to long distance traffic movements, particularly at times of traffic incidents.

The other major arterial roads used by long distance traffic to and from the north that are affected by similar congestion are the Pacific Highway and Ryde Road/Lane Cove Road. Local roads in the corridor are also affected by congestion as a consequence of the high volumes on the arterial roads. The effects on local roads have been excluded from this study.

The existing Daily Traffic Flows and average 10 year traffic growth per year on the main road network are shown on Figure 3.1 and Table 3-2.
Table 3-2: Summary of existing traffic volumes on Major Arterials in the Northern Sydney Road Network, 2002

<table>
<thead>
<tr>
<th>Highway</th>
<th>F3 (at Hawkesbury River)</th>
<th>Pennant Hills Rd (N of Boundary Rd)</th>
<th>Pacific Highway (S of Telegraph Rd)</th>
<th>Ryde Rd/Lane Cove Rd (at de Burghs Bridge)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Vehicles</td>
<td>71,200</td>
<td>75,600</td>
<td>63,500</td>
<td>77,400</td>
</tr>
<tr>
<td>Trucks (1)</td>
<td>9,200(2)</td>
<td>7,000</td>
<td>3,400</td>
<td>4,100(4)</td>
</tr>
<tr>
<td>Average Day Traffic (AADT)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Vehicles</td>
<td>71,300(3)</td>
<td>76,600</td>
<td>64,100</td>
<td>84,900</td>
</tr>
<tr>
<td>Trucks (1)</td>
<td>11,300(2)</td>
<td>8,800</td>
<td>4,000</td>
<td>4,900(4)</td>
</tr>
<tr>
<td>Average Weekday Traffic (AWT)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Vehicles</td>
<td>69,400(3)</td>
<td>69,200</td>
<td>61,300</td>
<td>64,600</td>
</tr>
<tr>
<td>Trucks (1)</td>
<td>3,800</td>
<td>2,600</td>
<td>1,600</td>
<td>2,000(4)</td>
</tr>
</tbody>
</table>

Source: Traffic Volume Data for Sydney Region 2002, and traffic counts undertaken for this study in July 2003.

(1) Trucks over 3.5 tonnes gross weight over 24 hours.
(2) 2001, estimated from classified counts undertaken in July 2003.
(3) AADT from RTA 2002 data scaled by AAWT and AAVE factors from 2001 Hawkesbury Region Traffic Volume Data.
(4) Truck percentage and peak characteristics assumed the same as for Pacific Highway. Actual counts are not available.
F3 traffic volumes and congestion

Some sections of the F3 south of Kariong are four-lane (dual 2 lanes) and some six-lane (dual 3 lanes). Traffic along the F3 corridor has been increasing at an average rate of 3% per year over the last ten years. Average annual daily traffic flows (AADT) at the Hawkesbury River Bridge have increased from 53,000 vehicles in 1992 to some 71,200 vehicles in 2002.

During holiday periods traffic flows can be much higher than the annual average daily flows and severe congestion can occur, especially on the four-lane sections of the freeway and on the approaches to Wahroonga.

Heavy commercial vehicles contribute about 13% of this traffic or 9,200 trucks (AADT) of which about 50% are articulated vehicles. The average weekday truck volumes (AAWT) are higher at 11,300 trucks per weekday.

Morning peak hour flows southbound along the F3 at the Hawkesbury River currently average 3,700 vehicles per hour (2002). On the two-lane sections of the F3, the design capacity is equivalent to about 3,700 vehicles per hour in the peak direction, and about 5,600 vehicles per hour in the peak direction on its three-lane sections4.

The two-lane sections of the F3 between Kariong and the Hawkesbury River are currently being widened to three lanes5.

Traffic volumes and congestion on Pennant Hills Road and Pacific Highway

The two main roads connecting to the southern end of the F3 at Wahroonga are the existing interim National Highway (Pennant Hills Road) and the Pacific Highway. Both of these roads have four-lane and six-lane sections. Much of the heavier vehicle traffic on the Pacific Highway feeds, in turn, onto Ryde Road/Lane Cove Road, a six-lane arterial road, at Gordon. Both roads are subject to significant congestion during peak periods, and have heavy traffic flows throughout the day. Pennant Hills Road has a much higher volume of long distance traffic including heavy commercial vehicles by comparison.

Traffic growth over the past 10 years on Pennant Hills Road has averaged 3 to 4% per year. The relatively high growth on Pennant Hills Road in the 1990s reflects the growth in traffic between southern and western Sydney and the north and the effects of the construction of the M2 Motorway. Traffic growth on Pennant Hills Road over the last 5 years has been around 2-3% per year. The average traffic growth on the Pacific Highway has been steady at about 1% per year. The Pacific Highway has been running at capacity over many years and traffic growth is more constrained on that route as a result.

The annual average daily traffic volumes (2002) are approximately 75,600 vehicles on Pennant Hills Road (at the Pennant Hills Railway Bridge) and 63,500 vehicles on the Pacific Highway (south of Telegraph Road in Pymble). (Refer to Figure 3.1).

The effects of the high traffic volumes, especially trucks (which have been growing at a rate of between 4 to 5% per year over the last 10 years) on Pennant Hills Road and adjacent access roads such as Boundary Road, are described by some people as intolerable. Road users, subject to serious congestion-induced travel delays, and local residents living along Pennant Hills Road, as a result of this traffic, suffer noise and vehicle exhaust emissions, community severance effects and a high risk of road crashes.

4 The theoretical design capacity of the F3 — the point at which its Level of Service (LoS) changes from D to E - is between 1,800 and 2,000 vehicles per hour per lane during peak periods. A roadway with Level of Service D is operating close to its limit of stable flow, with all drivers being severely restricted in their freedom to select their desired speed and to manoeuvre in the traffic stream. At Level of Service E traffic volumes are close to or at capacity and there is virtually no freedom to select desired speeds or manoeuvre in the traffic stream.

5 Widening of the four-lane sections south of the Hawkesbury to six lanes would cater for peak flows up until 2021. Widening south of the Hawkesbury River is likely to be required before 2011 to avoid increasing congestion and delay over the next 10 years. See Section 4.3, Table 4.3.
Peak travel speed can be used as an indicator of roadway congestion. Average peak travel speeds on Pennant Hills Road (and the Pacific Highway) are below 25 km/h and can often be as low as 14 km/h.

Another indicator of a roadway’s congestion is its volume/capacity ratio (VCR). Both Pennant Hills Road and Pacific Highway have high VCRs. The morning peak VCR for Pennant Hills Road is over 1.1 (that is, actual traffic volumes exceed the road’s theoretical capacity), while that for Pacific Highway is over 1.2. A VCR of 1.0 or more normally indicates an economic need (or warrant) for improvement.

The theoretical design capacity of Pennant Hills Road is between 1,000 and 1,300 vehicles per hour per lane, or 3,000 to 3,900 vehicles per hour in the 3-lane peak direction depending on section of the road and number of traffic signals. This is significantly less than the lane capacity of the F3 freeway, because of the “friction” associated with traffic movements from side street access and at traffic signals. In 2001 traffic flows in the morning peak direction on Pennant Hills Road at the Pennant Hills Railway Bridge averaged 2,900 vehicles per hour, close to its capacity.

The theoretical design capacity of the Pacific Highway is about 1,000 vehicles per lane per hour. The design capacity of Ryde Road/Lane Cove Road is slightly higher than Pacific Highway at 1,300 vehicles per hour per lane, or 3,900 vehicles per hour (3 lanes) in the peak direction and less side road friction from local access traffic. In 2001 the traffic flows in the morning peak direction averaged 3,600 vehicles per hour on the Pacific Highway south of Telegraph Road and 4,000 vehicles per hour on Lane Cove Road at de Burghs Bridge, Macquarie Park.

Road congestion on these routes has substantial negative socio-economic effects and imposes high costs on road users and industry. It is also detrimental for the environment as it encourages traffic to use unsuitable local roads, impacts the quality of life of people who live nearby, wastes fuel and increases emissions of local and regional pollutants and greenhouse gases. It also forces “peak spreading” even when this involves unwanted adjustments of travel, work and production schedules and practices.

Pennant Hills Road and the Pacific Highway, which are already operating at or beyond their capacities during peak periods, are expected to experience continued traffic growth in the future. (See Section 4.2) Since movements are at capacity during most peak periods, traffic volumes will generally grow outside the current peak periods.

### Poor road safety performance

Traffic congestion is often associated with poor road safety performance. An indicator of road safety performance is the number of road crashes per kilometre per year. Table 3-3 summarises the road safety performance of Pennant Hills Road and Pacific Highway.

<table>
<thead>
<tr>
<th>Road Section</th>
<th>Average serious and fatal crash rate (per km of route per year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pennant Hills Road (north of M2)</td>
<td>16</td>
</tr>
<tr>
<td>Pacific Highway (north of Ryde Road)</td>
<td>23</td>
</tr>
<tr>
<td>Sydney Network arterial road average</td>
<td>10</td>
</tr>
</tbody>
</table>

Crash rates on Pennant Hills Road (north of the M2) and Pacific Highway (north of Gordon) were significantly higher than the average across the Sydney Road Network between 1999 and 2001, which indicates that road safety conditions on these roads are well below average (see Table 3-3). The recorded three-year average crash rate in the National Highway corridor is nearly double the Sydney arterial road network average. The number of serious and fatal road crashes along Pennant Hills Road north of the M2 was 114 in 2001.
Through-Traffic

The term through-traffic refers to trips which have their origins and destinations outside the area of concern. It is traffic which is travelling through an area without stopping. In this study we use the term to traffic which has origins/destinations north of Wahroonga and south of the M2 Motorway.

Figure 3.2 illustrates in broad terms the through-traffic distribution of traffic on the F3 with origins/destinations south of the M2 Motorway (on Pennant Hills Road) or the Pymble interchange (on the Pacific Highway).

About 54% of the F3 traffic at Wahroonga are classified as through traffic using this definition. For every 5 through-vehicles travelling south on the F3 at Wahroonga, three (3) travel down the Pacific Highway and two (2) travel down Pennant Hills Road.

The distribution of through-trucks is quite different. For every 3 heavy vehicles travelling down Pacific Highway about 8 heavy vehicles travel along Pennant Hills Road. This is described further in Section 3.4.

Figure 3.2: Through Traffic Distribution (Traffic on the F3 with origins/destinations south of the M2 Motorway)

3.3 Public Transport, Cyclists and Pedestrians

Local bus services in the corridor suffer delays caused by the volume of traffic on the local road network joining or crossing Pennant Hills Road. Access to rail stations by bus, car, bicycle or on foot is affected by traffic congestion for all but those living in the most immediate area. Pedestrians often face long delays waiting to cross the Pacific Highway or Pennant Hills Road at signal-controlled...
crossings. These impacts all reduce the attractiveness and efficiency of sustainable modes of transport in this area.

**Rail Passengers**

Rail is the principal long-distance public transport service in the Sydney–Central Coast corridor. CityRail's "intercity" services between Sydney, the Central Coast and Newcastle, and Countrylink train services between Sydney and Moree, Armidale, Murwillumbah and Brisbane make up a significant proportion of these services.

These longer distance rail services suffer from two major factors:

- Capacity limitations, particularly on the rail network between the Central Coast and the Sydney CBD (these limitations also handicap rail freight movements as described in Section 3.4), and
- Dispersed origins/destinations on the Central Coast and in Sydney, and especially in western Sydney, making it difficult to provide high service levels and good interchange facilities.

In addition, the circuitous, steep and tightly curved surface rail route necessitated by the rugged terrain around the Hawkesbury River combines with the rail capacity limitations to prevent the delivery of high speed rail services in this corridor.

There are two primary rail lines operating in the main northern transport corridor:

- Main North Rail Line, Sydney – Strathfield – Epping – Hornsby – Central Coast and beyond
- North Shore Line, Sydney – North Sydney – Chatswood – Hornsby

Most of the key lines within the Sydney metropolitan area are already operating at or beyond their maximum "robust" train frequencies including the Main North Rail Line and the North Shore line. This
is a critical factor which results in the high saturation levels and need for the current “sectorisation” of the network to reduce the interdependence of one sector/line’s operation on another.

Capacity across the Harbour (Sydney Harbour Bridge) is also a major constraint point where additional capacity is unlikely to be realised in the near future. The Harbour Bridge is currently operating at capacity with 20 trains per hour (one way) crossing it in peak periods (the theoretical limit is 18 to 20 trains per hour).

In addition there are several other factors which reduce the capacity of the existing northern service:

- Large number of junctions with low speed limits.
- The shortage of daytime train “stabling” areas (rolling stock parking during off-peak times).
- The lack of modern train control centres.

The metropolitan rail network is now so congested that peak CityRail operations are extremely sensitive to interruptions which can result in delays occurring and escalating on the Main Northern Line.

The existing rail passenger task in the corridor is shown in Table 3-4.

**Table 3-4:** Existing Corridor Demand, Passenger Flows (1), 2002

<table>
<thead>
<tr>
<th>Morning Peak Period, 0600 – 0800 Southbound only:</th>
<th>Peak Hour</th>
<th>2 hr Peak</th>
</tr>
</thead>
<tbody>
<tr>
<td>F3</td>
<td>4,700</td>
<td>8,900(2)</td>
</tr>
<tr>
<td>Rail</td>
<td>4,700</td>
<td>6,800(3)</td>
</tr>
<tr>
<td>Total</td>
<td>9,400</td>
<td>15,700</td>
</tr>
<tr>
<td>% by Rail</td>
<td>50%</td>
<td>43%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>All Day Southbound Daily Flow only:</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>F3</td>
<td>39,000(4)</td>
<td></td>
</tr>
<tr>
<td>Rail</td>
<td>13,500</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>52,500</td>
<td></td>
</tr>
<tr>
<td>% by Rail</td>
<td>26%</td>
<td></td>
</tr>
</tbody>
</table>

Source: Based on RTA 202 counts and information provided by NSW RailCorp (formerly NSW Rail Infrastructure Corporation) (updated for growth from 1996 to 2002).

Notes: (1) For Newcastle-Sydney corridor Central Coast flows make up the majority of morning peak flows
(2) Excludes trucks and bus passengers. Based on 7600 2 hour peak vehicles in 2002, assuming a car occupancy of 1.26 from PPK surveys of 1996.
(3) Based on 6,000 rail passengers in 1996.
(4) Based on 71,200 vehicle count (2002) and 1.26 average vehicle occupancy. Excludes trucks and buses.

Overall, rail currently has a 26% share of all southbound passenger trips in the corridor over the day and about 43% during the morning peak period. The percentage share of commuter trips to/from the Central Coast is also about 43%.

The primary focus of public transport services to and from the Central Coast is on the Sydney CBD and North Shore areas. While rail has a 70% mode share for work trips between the Central Coast and the Sydney CBD, car travel is the dominant mode for commuting trips to the outer and western suburbs.

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Bus Services

The main operators providing bus services within the study area include:

- **Shorelink** – Commuter, school and shopping services serving rail stations in the Hornsby – Gordon – Lindfield corridor.

- **Westbus** – Bus services focused on Parramatta and providing direct links between the Hills District and North Sydney/Sydney via the M2 busway.

- **Glenorie Bus Company** – Commuter connections between the Hills District and Hornsby and Pennant Hills stations. Also operates Hills Transit direct buses between the Hills District and North Sydney/Sydney via the M2 busway.

- **Harris Park Bus Company** – Services based on Harris Park station to the east of Parramatta.

- **Forest Coach Lines** – Frequent services east of the Pacific Highway serving Chatswood and Pymble stations. Also operates some shopping and student services to and from Macquarie University and shopping centre.

- **Sydney Buses** – Government bus services in the south of the study area.

Most of the bus services in the study area are provided by private bus operators. As a consequence, there are limited integrated ticketing facilities. Most train stations are fed by bus services. A number of purpose built bus-rail interchanges have been constructed at stations such as Hornsby and Gosford. These interchanges provide a local distributor function along the corridor as they link rail stations to residential areas and serve places off the rail network.

Bus and coach services linking Sydney with the Central Coast, northern and north-western New South Wales and Brisbane also contribute to long-distance public transport.

**Cyclists and Pedestrian Movements**

The road and public transport infrastructure system must also cater for the requirements of cyclists and pedestrians. They are small groups compared with the majority of travellers but represent an important component contributing to the sustainability of the Sydney urban system.

There is limited connectivity between cycle paths in the region. Existing on-road cycle paths are located:

- Along Pennant Hills Road between Boundary Road at Pennant Hills and M2 at Carlingford.

- From Victoria Road at West Pennant Hills, to Bellamy Street, Stevens Street and Yarrara Road at Pennant Hills and to the Esplanade and Chilvers Road at Thornleigh.

- Along Kissing Point Road at Turramurra, to off-road cycle path through the Lane Cove Park to join the M2 cycle path at North Epping.

- Along the M2 Motorway between Pennant Hills Road and Ryde Road / Lane Cove Road.

Records of the numbers of current cyclists and pedestrians along the existing cycle routes are not available. However, data on the modes used for travel in the morning peak are available from the Transport Data Centre’s 1997/98 Household Travel Survey. This data is presented in Figure 3.3.

In addition to commuting, many people cycle on weekends for recreational purposes. When taking into account all travel purposes, the percentages of cycling and walking would be higher than the figures presented in Figure 3.3. Nevertheless, the proportion of all trips that would be by cycle would still be less than one percent.
3.4 Freight Movement in the Corridor

A brief description of the estimated freight tonnages and movements in the corridor is presented in this section. Chapter 4 describes the growth in road transport in the corridor and Chapter 6 describes future scenarios for rail freight growth and the likely traffic effects on the National Highway from increased investment in rail.

**Rail Freight**

Most of the railway lines used by freight trains in the greater metropolitan region are shared with passenger services. An average of 15 to 18 rail freight trains per day travel in the study corridor. Almost all are operated as unit trains including general-purpose inter-modal trains with mix-and-match loading.

The current tonnage of contestable freight, that is freight for which both road and rail compete, is about 32 million tonnes per year\(^7\) in the corridor. This traffic would be long distance general freight and generally have trip distances more than 300 km. Most bulk freight such as coal and wheat is moved by rail. The main contestable products moved are containers, petroleum, steel and general freight (including interstate express trains).

The current rail share of the contestable freight market on the Main North Rail Line is about 5 million tonnes per year or about 14% of total freight moved (by net tonnage)\(^8\). Section 4.3 discusses the growth in this freight market.

Current rail freight tonnages (1998/99) in the corridor have been estimated to comprise:

- 4.2 million gross tonnes (about 2.4 million net tonnes) of “through traffic” – traffic originating south of Sydney and terminating north of Gosford (eg. Melbourne-Brisbane)

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\(^7\) ABS Survey of Motor Vehicle Usage for Year Ended October 2000.

\(^8\) Freight Scoping Study Final Report for Rail Infrastructure Corporation by Sinclair Knight Merz, December 2002.
- 4.5 million gross tonnes (about 2.6 million net tonnes) originating or terminating in Sydney

About 50% of rail freight traffic can be classified as through-Sydney traffic, that is traffic on trains without an origin or destination in Sydney.

The overall rail market share is likely to be lower than 14%, since local road truck movements have been excluded from the above corridor estimates.

Rail freight operation in the greater metropolitan region is severely constrained by long-standing curfew restrictions. The “curfew” prevents rail freight movements on the Main Northern line, and other lines used by commuter trains in the Sydney metropolitan area. Freight train movement is banned on weekday peak periods between 6 and 9 am and 3 and 6 pm. At other times two freight train paths per hour are available, catering for both interstate and intrastate freight services. The different operational speeds and performance characteristics of passenger and freight services cause freight trains to be held in sidings to allow faster passenger trains to overtake, reducing the efficiency and reliability of the freight services.

Other constraints on the rail freight service in the greater metropolitan region include:

- The rail freight network does not directly feed into many newer industrial areas.
- The complexity of rail operations and infrastructure required to service existing demand for relatively small rail-road inter modal freight terminals.
- The additional cost and down time as a result of double handling (loading trucks from the base location, loading the train from trucks, loading trucks from the train, and off loading the trucks at their destination).

Passenger and freight rail services are both handicapped by capacity constraints on the Main North Rail line between Gosford (above) and North Strathfield.

The potential for expansion in rail freight transport is restricted, since it competes with road trucks both on price and convenience and with passenger rail services on rail access to the Sydney network.

New and extended passing loops and other track amplifications on the Main North Line between the Hawkesbury River and the dedicated metropolitan rail freight lines to Flemington would be required to improve rail freight operations in the corridor.
Provided these obstacles are adequately addressed, growth in long-distance rail freight on the Main North line could be accommodated in the future to hold its current modal share (that is growth of 3.25% pa) and, depending on the level of investment, increase its modal share for growth rates in excess of 3.25% pa. This would have a relatively small effect on the growth of road freight on the F3 corridor. This is discussed in Section 4.3 and in Chapter 6.

**Road freight traffic**

There has been considerable growth in the road freight task in the Central Coast–Sydney corridor in recent years. Of the 71,200 vehicles per day currently (2002) using the F3 at the Hawkesbury River bridge, it is estimated that about 9,200 (12.6%) are heavy vehicles, including about 4,600 articulated trucks, many of them undertaking long-distance trips during night time hours.

The corresponding figure for Pennant Hills Road just south of the Comenarra Parkway is 7,000 (AADT) heavy vehicles (9%), including 3,500 articulated trucks. The corresponding average weekday volume is 8,800 trucks. About 20% of these heavy vehicles are servicing the local shops and commercial centres. In 2001 the Pacific Highway (at Bobbin Head Road) carried 4,000 heavy vehicles (6%), including 1,300 articulated trucks.

**Figure 3.4** and **Figure 3.5** show the hourly distributions of truck movements in both directions during daylight hours at the Pennant Hills Road/F3 junction and on the Pacific Highway south of the F3 junction.

**Figure 3.4:** Number of Southbound Heavy Vehicles per hour August 2001

![Figure 3.4](image)

**Figure 3.5:** Number of Northbound Heavy Vehicles per hour August 2001

![Figure 3.5](image)

9 Road freight growth is estimated at 3.25% pa over the next 10 years. Rail freight tonnages moved would need to grow above this to capture overall modal share.

10 Based on an intercept survey of freight vehicle movements in northern and western Sydney in August 2001.
Classified traffic counts were collected over a 7-day period in July 2003. The proportion of trucks in the daily traffic volumes by time of day is summarised in Table 3-5.

### Table 3-5: Heavy Commercial Vehicle (HCV) Proportions of Total Traffic Volumes in the Corridor, July 2003

<table>
<thead>
<tr>
<th>Location</th>
<th>Average Weekday (5 days)</th>
<th>24 Hour</th>
<th>6AM – 6PM</th>
<th>% of 6AM - 6PM / 24 hour</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>% HCV to Total Traffic</td>
<td>% Articulated CV to Total Traffic</td>
<td>% HCV to Total Traffic</td>
</tr>
<tr>
<td>F3</td>
<td></td>
<td>13%</td>
<td>6%</td>
<td>8%</td>
</tr>
<tr>
<td>Pennant Hills Road – at Railway Bridge</td>
<td></td>
<td>10%</td>
<td>5%</td>
<td>9%</td>
</tr>
<tr>
<td>Pacific Hwy - South of Telegraph Road</td>
<td></td>
<td>6%</td>
<td>2%</td>
<td>5%</td>
</tr>
</tbody>
</table>

Source: Working Paper No.4

Figure 3.6 provides a best estimate of the 24-hour truck origin/destination distributions. Figure 3.7 illustrates the travel zones used to describe this distribution.

The results from the two surveys (August 2001 and July 2003) indicate:

- The F3 and Pennant Hills Road carry more than twice the total number of HCV’s than the Pacific Highway;
- The number of articulated trucks on the F3 and Pennant Hills Road is nearly four time the number on the Pacific Highway;
- The ratio of trucks during day time hours to the total number of trucks during the day is approximately 70% on the F3 and Pennant Hills Road, and 80% on the Pacific Highway;
- Truck volume during the weekend is approximately one third the truck volumes during the weekday.

While no direct count of commercial vehicles carrying dangerous goods was undertaken, about 5% of all trucks have been estimated to carry dangerous goods from recent ABS statistics.
Figure 3.6: Origins/Destinations of Trucks on the Interim National Highway

**Southern origins/destinations**

- North-East Sydney: 13%
- North-West Sydney: 15%
- Western Sydney: 18%
- Sydney City & Inner Suburbs: 30%
- South / South-West Sydney: 24%

**Northern origins/destinations**

- North-East Sydney: 8%
- North-West Sydney: 26%
- Central Coast: 19%
- Newcastle/Hunter: 22%
- North / West NSW / Qld: 25%

Road freight traffic on the F3 corridor is expected to continue to increase in the future, even if a significant increase in rail freight can be achieved. This is discussed in Section 4.3.
3.5 Social and Environmental Impacts of National Highway Traffic

Existing traffic volumes along Pennant Hills Road reach 75,000 vehicles per day (AADT). During an average weekday the number of heavy trucks is 8,800 and half of these are articulated vehicles carrying 40 gross tonnes or more. This high proportion of trucks within the general traffic stream creates considerable adverse social and environmental impacts.

The study team has received hundreds of submissions and met with many people who live along or within close proximity of Pennant Hills Road, telling us of some of these effects. Amongst them are:

- Mothers with children frightened to cross the highway even at pedestrian crossings for fear of heavy trucks not stopping.
- Risk of crashes to local drivers from the behaviour of truck drivers and their vehicles, which often run along the highway three abreast.
- The truck noise which is 24 hours, causing some to use ear-muffs inside their house and during night time to sleep.
- The vehicle emissions which change direction with the prevailing wind.
- The soot on curtains and at front doors of houses close to Pennant Hills Road.
• The trucks that have crashed-through front hedges to narrowly miss bedrooms.
• The long queues of traffic on side streets such as Boundary Road causing traffic congestion and daily delay and frustration to local residents and commuters alike.

These external costs of transport:
• road crashes and road trauma;
• traffic exhaust fumes and particulates (soot);
• urban smog and CO₂ emissions (greenhouse);
• traffic congestion; and
• noise, especially truck noise at night

are incurred across Sydney, and not just in the National Highway corridor. However they are more prominent along Pennant Hills Road as a result of the high proportion of trucks and the high volumes of long distance commercial articulated trucks using Pennant Hills Road.

The existing social and environmental conditions in the study area, including in the National Highway corridor, are described in Working Paper No.5: Social and Environmental Studies Report.
Traffic Growth in the National Highway Corridor

Traffic growth is described in this chapter under the following headings;

i) Population and Employment Growth;

ii) Growth in Passenger Transport;

iii) Growth in Road Passengers; and

iv) Growth in Road Freight Transport.

4.1 Population and Employment Growth

The population of the Sydney Region¹ is forecast to grow from just over 4 million today to 5 million by around 2021 and 6 million by around 2042.

Much of this growth is likely to occur in the outer areas, given that there are few other options for affordable housing growth. In Sydney, high-priced housing is concentrated in the inner areas surrounding the CBD and lower-priced housing is mainly situated on the outskirts. It is unlikely that the inner ring of suburbs will take more than a small proportion of the additional 2 million people expected by 2042, however urban infill will accommodate up to half of this growth within the other established suburbs of the city.

The growth in the outer areas is likely to be heavily focussed on the north-west, the south-west and the Central Coast: areas directly served by the F3 and the Sydney Orbital.

In 1996, the population distribution in Sydney was 1.8 million people east of Parramatta (48%), 1.7 million west of Parramatta (45%) and 260,000 on the Central Coast (7%).

By 2021, with a forecast total Sydney Region population of 5 million people, the distribution would have shifted, with 2.25 million people east of Parramatta (45%), 2.35 million west of Parramatta (47%) and 400,000 on the Central Coast (8%).

As the population of the Sydney Region approaches 6 million, what are now considered outer areas would have populations equivalent to those of other Australian cities. The west and south-west, served by major centres such as Blacktown, Penrith, Liverpool and Campbelltown, would, for instance, have populations similar to the current population of Adelaide.

In a Sydney Region of 6 million people, the areas east of Parramatta (excluding the Central Coast), would have some 2.5 million people (42%), western Sydney would have some 3 million people (50%) and the Central Coast some 0.5 million (8%).

¹ In this report the term “Sydney Region” is used, consistently with the 1968 Sydney Region Plan, to describe all of Sydney’s local government areas, including Gosford and Wyong, and the term “Greater Metropolitan Region” is used, consistently with the 1995 strategy Cities of the Future, to describe the combination of the Sydney Region, Newcastle and Wollongong regions.

In about 40 years, by which time the “Sydney Region” will have a population of some 6 million people, both of these regions will fall within a wider “Sydney conurbation”, comprising the Greater Metropolitan Region, the rest of the Hunter Region, the rest of the Illawarra Region, the Southern Highlands (including the Wingecarribee local government area to Goulburn) and the area west to Lithgow and Bathurst.
Within the wider Sydney conurbation, the Hunter Region is likely to have around 1 million people, taking the total population of the areas influencing the F3 and the Sydney Orbital to around 7 million people by 2042. The scale of development in the Sydney Region is also likely to influence growth to the west, beyond the Blue Mountains to the Central West, in the Southern Highlands and possibly also the ACT.

**Industrial and centres-based employment**

As the last of the 20th century industrial areas in the eastern half of the Sydney Region are redeveloped for housing and offices, there will be a major shift to the large employment areas in the western half of Sydney. The 600 ha area at Moorebank, three times the size of the North Ryde industrial zoned land, and the 400 ha at Eastern Creek, twice the size of North Ryde, are examples of this redevelopment trend.

Employment in the North Ryde industrial area (Macquarie Park) could double following the opening of the Parramatta Rail Link, which will have three stations in this area. With the removal of floor space restrictions this area could cater for up to 40,000 workers.

The distribution of centres-based employment will also change. Employment in Parramatta could reach 100,000. In the east, over the next 40 years employment in North Sydney could reach 50,000, St Leonards 40,000, Chatswood 30,000 and the Airport/ former Central Industrial Area 90,000. In the west, Blacktown, Penrith and Liverpool could each reach 50,000 and Campbelltown, Castle Hill and Rouse Hill could range between 30,000 and 50,000 people.

**Dispersed employment**

About half of all employment in the Sydney Region is dispersed rather than in the major industrial areas and other employment centres. This dispersed employment is generally distributed in proportion to the residential population, although the proportion of employment at dispersed locations is higher in outer areas than in inner Sydney.

A major consequence of the changes in population distributions will therefore be a shift of employment, along with community facilities such as hospitals, tertiary education institutions, commerce and retailing, broadly in line with the population shifts. In other words, local employment (for teachers, retail workers, construction workers, etc) will shift to the outer areas to serve their rapidly expanding populations.

**Population and employment forecasts in the study area**

Population and employment forecasts for the study area in 2021 are shown in Table 4-1. Population is forecast to grow by 25% and employment growth even higher, by 67%, compared with 2001.
Table 4-1: Population and employment forecasts in the study area

<table>
<thead>
<tr>
<th>Local Government Area</th>
<th>Population</th>
<th>Employment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2001 (Census 2001)</td>
<td>1996 (based on Travel Zone data, 1996)</td>
</tr>
<tr>
<td>Hornsby</td>
<td>145,968</td>
<td>30,889</td>
</tr>
<tr>
<td>Ryde</td>
<td>95,744</td>
<td>10,128</td>
</tr>
<tr>
<td>Ku-Ring-Gai</td>
<td>101,346</td>
<td>3,471</td>
</tr>
<tr>
<td>Baulkham Hills</td>
<td>139,404</td>
<td>6,458</td>
</tr>
<tr>
<td>Blacktown (part)</td>
<td>74,593</td>
<td>88</td>
</tr>
<tr>
<td>Total</td>
<td>557,055</td>
<td>51,245</td>
</tr>
</tbody>
</table>

Source: Draft Options Development Report (October, 2002)

(1) Excludes Central Coast which is estimated to have a population of 290,000 today (2003), growing to at least 350,000 by 2021.

(2) Based on Cox Richardson forecasts.

Desirable patterns of development

The population and employment patterns outlined above are likely to reinforce the concept of Sydney as a multi-centred region. Each sub-region would have at least one major regional centre and a number of employment zones, stitched together by a rail and bus network, the Sydney Orbital, the M4 and the F3.

In planning land-use and transport responses to the demands of population and employment growth it needs to be recognised that population growth and the redistribution of population within the Sydney Region are likely to continue irrespective of the level of new transport infrastructure provided.

Fortunately Sydney does have a comprehensive rail network, and with significant investments this network could be made to cater for some of the likely growth, particularly if a better distribution of employment locations close to the rail network could be achieved over the next 40 years. However, unless there is a major expansion of the arterial road network as well, it is likely that traffic congestion on Sydney’s transport networks will get worse and the efficiency of the region will be compromised.
The ideal will be to intensify residential and employment development around the railway stations and other public transport nodes. This is certainly more viable now than previously, because of the growing demands of smaller households. But this does not mean however, that greenfield areas will not need to be released.

To achieve a balance of workforce and employment it will be important for jobs to be created in the outer areas of the Sydney Region. Jobs have traditionally lagged at least 10 years behind population growth, so the rate of job creation will need to be accelerated in new urban areas if this balance is to be achieved and the trend to longer and longer journeys to work reversed\(^2\). This is particularly important for the Central Coast and the growth of commuter and freight movements on the F3 corridor.

It is already recognised that the M4 and M5 have made outer industrial areas far more attractive to enterprises moving out of the Central Industrial Area. For example, Huntingwood/Arndell Park are very successful industrial estates in Blacktown, principally because of their direct access from the M4, while Minto/Ingleburn, served by the M5, are almost fully built out. Similarly, it is expected that the completion of the Westlink M7 will see industry relocate close to the new motorway.

As these examples illustrate, good access to a motorway or railway transport corridor can be a significant generator of jobs in employment/industrial areas. This applies, notwithstanding the desirability of maximising the opportunities for rail to take a larger share of freight movements, especially for interstate freight (containers etc) and freight movements to and from the ports.

Areas served by the Sydney Orbital are therefore obvious locations for freight-generating land uses, with special attention being paid to those areas which also have rail access, such as Seven Hills (Blacktown) and Minto/Ingleburn (Campbelltown).

The Sydney Region's commercial centres, being largely population driven, will continue to expand broadly in line with population growth. Substantial increases in freight movements will be needed to service these commercial centres, and again good access to a reliable and efficient road network will be important, as rail is incapable of efficiently serving most of these types of local and regional freight transport demands.

**Future Land Use Assumptions Used In This Study**

The population and employment land use assumptions used in this study are based on DIPNR's Transport Data Centre (TDC) for population and employment forecasts associated with the Urban Development Program (UDP) Scenario A. Scenario A assumes that the level of UDP releases will continue according to current trends and committed release programme.

The UDP Scenario A assumptions are presented in Figure 4.1, Figure 4.2 and Figure 4.3. The data used to produce the land use figures and the growth rates are presented in Working Paper No. 4 (Transport and Traffic Studies). The Scenario A forecasts are much in line with the growth descriptions given above. Some of the major growth forecasts include:

Between 2001 and 2011

- Sydney City is assumed to have the highest population growth rate, averaging 6.7% per year.

- Camden (including the Bringelly new release area) is assumed to have the second highest population growth rate of 5.8% per year.

- Concord and Camden (Bringelly) is assumed to have the highest employment growth rates of 2.9% per year.

\(^2\) The current review of the Sydney Metropolitan Strategy being undertaken by NSW Department of Planning, Infrastructure and Natural Resources (DIPNR) would be an opportunity to develop strategies to achieve these important land use/transport goals.
Figure 4.1: Land Use Assumptions – Population

Source: Working Paper No.4
Figure 4.2: Land Use Assumptions – Employment

Figure 4.3: Land Use Assumptions – Growth Rates Population & Employment

Strathfield is assumed to have the second highest employment growth rate of 2.4% per year.

Between 2011 and 2021

Camden (Bringelly) is assumed to have the highest population growth rate of 5.5% per year.

Camden is assumed to have the highest employment growth rate of 2.9% per year.

Central Coast Growth Assumptions Used in this Study

The traffic model used in this study to forecast future transport demand in the corridor assumed the following growth in the Central Coast (see Working Paper No.5):

- The existing ratio of employment to population is 1:3.5. This existing ratio is assumed to stay constant over the next 20 years.

- By 2021, the population is assumed to increase by 70,000, mainly in Wyong.

- By 2021, 20,000 new jobs would be created, mainly in Wyong.

4.2 Growth in Passenger Transport

Growth in Personal Travel

Over the last 20 years Sydney's population has grown by an average of 1.2% per year but travel demand (in terms of passenger kilometres of travel) is estimated to have grown by about 2.7% per year, or more than twice the population growth rate.

Over the next 40 years Sydney's population is predicted to grow by a further 50% to some 6 million people. On past trends, total travel is likely to at least double in some corridors over this period, even if integrated transport planning, significant investments in rail, and travel demand management policies are implemented. Growth in the north-west sector and on the Central Coast will put increasing pressure on the F3 and the arterial roads in northern Sydney that feed the F3.

This study has assumed that travel behaviours are unlikely to change significantly over the study’s 20 year horizon and that the current dominance of car/road mode of travel, at almost 90% of the total city-wide passenger kilometre task, together with the lack of any obvious trend to alternative modes will continue over this period.

Growth in Rail Passengers

The Base Case for this study assumed that major improvements to the Main North Rail Line would be implemented from Hornsby to the Hawkesbury River by 2011 and to Gosford by 2021.

This study has assumed that as part of the Base Case, rail’s existing passenger mode share of 43% would slightly increase over the next 20 years. To achieve this, the significant capacity improvements on the Main North Rail Line would need to be implemented. If these improvements are not implemented it is likely that rail’s share of commuter traffic would fall over this period.

Longer term rail infrastructure enhancements to passenger (and freight) services may also be required to service growth beyond 2011 and could include:

- A new rail link through the Sydney CBD and North Sydney, between Eveleigh and St Leonards, to provide essential capacity relief for services on the entire suburban and inner city rail network.

- Triplication or quadruplication of the Main North line between Hornsby and Berowra.
• Quadruplication of the Main North line between Epping and Hornsby.

• Quadruplication of the Main North line between North Strathfield and West Ryde.

These major network-wide rail improvements in addition to the full capacity enhancement improvements to the Main North Rail Line would provide an opportunity for rail to increase its passenger mode share in the corridor with or without a new National Highway link to over 50% of corridor commuter trips beyond 2021.

4.3 Growth in Road Passengers

In 2021, daily traffic volumes on the major arterial roads in northern Sydney would grow by at least 30% compared with flows in 2001. Figure 4.4 presents the forecast 2021 AADT volumes on the road network. Traffic on Pennant Hills Road (at Pennant Hills railway bridge) would increase from 75,000 vehicles per day to about 96,400 vehicles per day by 2021. This increase would mainly occur between the morning and evening peak and at weekends.

By 2021 Pennant Hills Road, Pacific Highway and Ryde Road/Lane Cove Road would be subject to peak hour demands beyond their peak hour capacities:

• Pennant Hills Road: capacity 3,000 vehicles per hour, forecast demand at the Pennant Hills railway bridge 3,920 vehicles per hour;

• Pacific Highway: capacity 3,000 vehicles per hour, forecast demand south of Telegraph Road 3,970 vehicles per hour; and

• Ryde Road/Lane Cove Road: capacity 3,900 vehicles per hour, forecast demand at de Burghs Bridge 4,780 vehicles per hour.

In practice, the higher predicted peak demands compared with hourly capacities would mean that on all three roads the high traffic volumes would spread around the 7am-9am and 4pm-6pm peak periods, with the result that all three roads would experience more traffic in the inter-peak periods ie. over business hours and increasing delays would occur at intersections on the network over most periods of the day.

It is not feasible to increase the capacity of these roads through grade separation of major junctions, to cater for this growth because the critical intersection capacity constraints are located close to local urban and commercial centres such as Thornleigh, Pennant Hills, Wahroonga, Turramurra and Pymble. Grade separations of these intersections would result in unacceptable local community severance and have other significant adverse environmental, economic, social and urban amenity impacts.
By 2021 without a new F3–Sydney Orbital link:

- Increasing traffic congestion and peak spreading would occur on Pennant Hills Road and on the other routes feeding the F3. Congestion would be over 12 hours of the day and would therefore affect non-commuter traffic. It would result in increasing economic costs and a serious loss of transport efficiency and connectivity both on the National Highway corridor and also on other major northern and north–south transport corridors serving the city.

- Increasing traffic volumes along Pennant Hills Road, with a high proportion (about 18%) of heavy commercial vehicles, would increase the risk of road crashes along this built-up route compared with today.

- The environmental and social impacts of congested six-lane, at-grade road environments would continue to worsen over the day and night. A further deterioration of local amenity would be noticeable.

- The increasing adverse social and environmental effects of this traffic would spread to the non-peak business hours, that is it would affect more people over longer periods of the day.

**Table 4-2** summarises the future destinations of southbound morning peak hour traffic flows in 2021 on the main roads currently used by southbound traffic from the F3, assuming no new F3–Sydney Orbital link has been constructed before 2021.

It may be seen from **Table 4-2** that if a new F3–Sydney Orbital link were not constructed:
i) Of the peak hour southbound traffic on Pennant Hills Road in 2021:

- About 42% would be destined for the eastern side of Sydney (i.e. locations in the sectors broadly to the east of Parramatta), almost all to the north east or inner western sectors (i.e. Pennant Hills Road would carry virtually no traffic destined for the city or south east sectors)
- About 50% would be destined for north west Sydney
- About 4% would be destined for south west Sydney
- About 4% would be travelling through Sydney to the Hume Highway, south of Campbelltown.

ii) Of the peak hour southbound traffic on the Pacific Highway at Chatswood (south of Boundary Street) in 2021:

- Almost all would be destined for locations broadly east of Parramatta
- About 21% would be travelling to the city or the eastern suburbs, and
- No traffic would be travelling through Sydney to the Princes Highway or the Hume Highway south of Campbelltown.

iii) Of the peak hour southbound traffic on Lane Cove Road in 2021, including but not limited to traffic feeding off the Pacific Highway at Gordon:

- 80% would be destined for the eastern side of Sydney, almost all to the north – east or inner western sectors (i.e. like Pennant Hills Road, Ryde Road/Lane Cove Road would carry virtually no traffic destined for the city or south east sectors)
- About 20% would be destined for north west or south west Sydney, and
- No traffic would be travelling through Sydney to the Princes Highway or the Hume Highway south of Campbelltown.

These trip distribution projections indicate that Pennant Hills Road will continue to be the main route for travellers to western Sydney, to the SW and southern destinations. Pacific Highway will continue to be the main route for city and south-east destinations.
Table 4-2: The origins and destinations of forecast traffic flows\(^{(1)}\) on Pennant Hills Road, the Pacific Highway and Lane Cove road during the morning peak hour in 2021, assuming there is no new F3-Sydney Orbital Link

<table>
<thead>
<tr>
<th></th>
<th>Pennant Hills Road south of Comenarra Parkway</th>
<th>Pacific Highway south of Boundary Street, Chatswood</th>
<th>Lane Cove Road at de Burgh’s Bridge</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vehicles/hour</td>
<td>% of peak traffic</td>
<td>Vehicles/hour</td>
</tr>
<tr>
<td>Sydney City and Eastern Sydney</td>
<td>50</td>
<td>1%</td>
<td>800</td>
</tr>
<tr>
<td>Hornsby and Ku-ring-gai</td>
<td>650</td>
<td>18%</td>
<td>1,000</td>
</tr>
<tr>
<td>Northern Beaches/North Sydney/Willoughby</td>
<td>-</td>
<td>-</td>
<td>1,200</td>
</tr>
<tr>
<td>Ryde/Hunters Hill/Lane Cove</td>
<td>200</td>
<td>5%</td>
<td>450</td>
</tr>
<tr>
<td>South-East Sydney</td>
<td>-</td>
<td>-</td>
<td>50</td>
</tr>
<tr>
<td>Inner Western Sydney</td>
<td>650</td>
<td>18%</td>
<td>300</td>
</tr>
<tr>
<td>South-West Sydney</td>
<td>150</td>
<td>4%</td>
<td>-</td>
</tr>
<tr>
<td>North-West Sydney</td>
<td>1,850</td>
<td>49%</td>
<td>-</td>
</tr>
<tr>
<td>Blue Mountains</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Great Western Highway west of Mt Victoria</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Princes Highway south of Wollongong</td>
<td>50</td>
<td>1%</td>
<td>-</td>
</tr>
<tr>
<td>Hume Highway south of Campbelltown</td>
<td>150</td>
<td>4%</td>
<td>-</td>
</tr>
<tr>
<td>TOTAL</td>
<td>3,750</td>
<td>100%</td>
<td>3,800</td>
</tr>
</tbody>
</table>


\(^{(1)}\) To the nearest 50 vehicles

Traffic Growth on the F3

The total road traffic demand along the F3 corridor is projected to increase at an average rate of 1.5% per year over the next 20 years. This is about half of the rate experienced over the last ten years, and reflects a lower population growth rate in the corridor and on Central Coast than the previous 20 years.

An average growth rate of 1.5% per year will nonetheless result in average daily traffic flows of 93,700 vehicles by 2021, compared with 71,200 vehicles per day at present, assuming investment in the Main Northern line takes place before 2021. If this investment is not forthcoming, the F3 AADT would be 97,000 in 2021 (see Table 4-3), without a new link in the network.

The expected origins and destinations of morning peak-hour traffic flows on the F3 in 2021 are shown by Figure 4-5. The origins of southbound traffic on the F3 in 2021 would have the following distribution:

- Over 70% is expected to be destined for locations broadly to the east of Parramatta (ie. in the north east, inner west, city or south east sectors)
- Just over 20% will be destined for locations generally to the west of Parramatta (the north west or south west Sydney sectors)
- Less than 5% will be travelling through Sydney to the Princes Highway, and
- Less than 5% will be travelling through Sydney to the Hume Highway.

Origins for northbound traffic in the morning peak is slightly different but show a similar pattern predicted for southbound traffic movements.
Figure 4-5: Traffic Origins and Destinations of morning peak-hour traffic flows on the F3 in 2021

1. Sydney City and Eastern Sydney
2. Hornsby and Ku-ring-gai
3. Northern Beaches/North Sydney/Willoughby
4. Ryde/Hunters Hill/Lane Cove
5. South – East Sydney
6. Inner Western Sydney
7. South – West Sydney
8. North – West Sydney
9. Blue Mountains
10. Central Coast
Table 4-3 presents forecast traffic flows (both peak hour and AADT) on the F3 at the Hawkesbury River crossing in 2021 with (Base Case) and without improvements to the Main Northern rail line.

The morning peak hour flows southbound along the F3 at the Hawkesbury River are forecast to increase between 4,000 and 4,400 vehicles per hour by 2011, depending on whether the first stage of the Main Northern rail line is improved by 2011.

The current widening of the F3 to three lanes in each direction would satisfactorily accommodate peak demand of up to 5,600 vehicles per hour in the peak direction. Table 4-3 indicates that the widening of the remaining four-lane sections south of the Hawkesbury to six lanes should be undertaken as soon as possible following the current works.

By 2021 peak traffic levels would be below the peak direction capacity of the Freeway even if the assumed investments in the Main Northern rail line are not forthcoming.

Table 4-3 indicates that a widened F3 to 3 lanes in each direction would provide an acceptable level of service up to 2026.

Growth beyond 2026 is likely to require further widening of the F3, beyond six lanes, and/or the provision of an alternative route between Kariong and Sydney with or without the investment in rail. It should also be possible to stage the widening of critical sections of the southbound carriageway to seven lanes by adding climbing lanes. In combination with incident management and intelligent transport systems, this could increase the southbound capacity of the F3 to about 6,000 vehicles per hour without the need for the full eight lanes.

Table 4-3: Predicted Traffic Volumes on the F3 at Hawkesbury River Crossing

<table>
<thead>
<tr>
<th>Year</th>
<th>Forecast traffic volumes at Hawkesbury River crossing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Base Case includes Main North Rail line improvements</td>
</tr>
<tr>
<td></td>
<td>Peak hour flow in peak direction (2)</td>
</tr>
<tr>
<td></td>
<td>Light Vehicles</td>
</tr>
<tr>
<td>2002</td>
<td>3,700 (3)</td>
</tr>
<tr>
<td>2004</td>
<td>3,700</td>
</tr>
<tr>
<td>2011</td>
<td>4,000</td>
</tr>
<tr>
<td>2021</td>
<td>4,400</td>
</tr>
<tr>
<td>2026</td>
<td>4,700</td>
</tr>
</tbody>
</table>

Source: Working Paper No.4

(1) Without new National Highway Link.

(2) Based on a one hour to two hour ratio of 0.53.

(3) Source: RTA Traffic Volume Data for Hunter Region 2002 (page 152) for 1 hour period between 7am-8am. Flows are higher in 6am-7am period (3950 mean) and highest recorded at Mooney Mooney is 4,064 vehicles between 6am-7am.
4.4 Growth in Road Freight Transport

Over the last 30 years, heavy truck travel (ie. travel by trucks of 3.5 gross tonnes or more) on Australian roads has increased at a rate faster than economic growth. Heavy truck travel has tripled over this period\(^3\), whereas the relative share of rail freight has declined due to its disadvantages in terms of door-to-door cost, transit time, reliability and service availability (the last aspect covering flexibility and convenience).

The growth in the non-bulk interstate freight task (tonnes moved) compared with GDP growth is shown in Figure 4-6. The trend of the freight task annual growth equalling a slightly higher rate than GDP growth is likely to continue for the foreseeable future in Australia, as there is as yet no evidence in industrialised countries of any saturation in the freight task. Freight prices in real terms are likely to continue to decrease, while trends in logistics point to more rather than less use of road transport for freight – in particular:

- the increasing requirement for full logistics services as opposed to line haul operations only;
- the increasing use of high productivity trucks for long haul freight, involving larger vehicles and new vehicle configurations;
- the increasing adoption of new technologies to improve freight movement efficiencies in urban areas, such as electronic data interchange and real time freight tracking systems.

Figure 4-6   Growth in Non-Bulk Freight Task Compared with GDP Growth, 1971-2000.

\(^3\) Bureau of Transport Economics, “Trends in Trucks and Traffic”, Information Sheet No.15, 1999
The study predicted growth in freight tonnage in the F3 corridor on the basis of this relationship because of the significance of the corridor for freight movement at both the State and national levels. Current rail freight tonnages and road freight tonnages moved in the corridor were estimated based on studies for RIC, truck surveys for RTA and estimates of average loads carried in the ABS Survey of Motor Vehicle Usage. Rail’s future share of the contestable freight transport market in the corridor was assumed to stay at its current level in predicting future heavy vehicle movements in the corridor.

**Freight Growth on the National Highway**

Total tonnes moved by articulated trucks in the F3 corridor in 2001 is estimated to be about 32 million tonnes, based on an average load per articulated truck trip of 19 tonnes\(^4\). This can be compared with an estimated 5 million tonnes by rail, giving rail about 14% of the contestable freight market. However, the overall rail market share will be less than this estimate because of the high proportion of rigid trucks in the corridor that are travelling shorter distances and making trips for which rail is not competitive. Based on an average load per rigid truck trip of 4.5 tonnes, there is an additional 8 million tonnes of road freight annually, giving an overall rail market share in the F3 corridor of 11%.

By 2021, the F3 will carry about 75 million tonnes or just over 200,000 tonnes per day, assuming rail maintains its share of the contestable freight market. The total truck volume in 2021 is expected to be about 17,500 heavy trucks per day, including about 8,700 articulated trucks each day.

Figure 4-7 illustrates the estimated number of heavy trucks on the arterial network in 2021.

**Figure 4-7: 24 hour truck volumes in 2021**

\(^4\) ABS Survey of Motor Vehicle Usage for Year Ended October 2000 (Data Service).
Demand Management and Sustainability

Demand management and sustainability in the context of Sydney’s transport systems mean reducing the city’s dependence on cars and car use to maintain a balance between mobility and the environment. The NSW Department of Infrastructure, Planning and Natural Resources (DIPNR) places a growing importance on demand management. The policy of demand management before demand satisfaction (that of increasing capacity of the existing road transport network to meet demand) has been recommended by recent authoritative studies¹ in this country and internationally.

The three (3) main policy levers government has to influence behaviour and manage demand are²:

i) land use planning (population and employment distribution and density);

ii) pricing (eg road pricing, tolls and parking fees); and

iii) infrastructure provision (eg. better use of existing infrastructure, public transport priority, more public transport services).

There are differences of policy however, as to how demand management is applied to urban road networks in Sydney, between existing developed parts of the city (eastern) compared with the developing parts (western Sydney and Central Coast).

Demand management ahead of new infrastructure may well be a starting point, but is it appropriate to apply to the National Highway, the peak road network which enables economic development and Sydney to remain competitive in the region?

This chapter briefly describes some of the demand management and sustainability issues which will need to be addressed in the further planning of a new National Highway link in Sydney. It is arranged under the following headings:-

i) Land Use, Transport and the National Highway;

ii) Road Pricing and the National Highway;

iii) Providing the Right Mix of New Infrastructure; and

iv) Recognising Transport’s Social Costs.

5.1 Land Use, Transport and the National Highway

Sydney in 20 years time is predicted to remain very much as it looks and operates today. Patterns of land use in outer areas would be different as described in Section 4.1, but the city would function and move much as it does today.

Land use planning offers long term opportunities to find an acceptable mix of transport services for new release areas and to a lesser extent, to infill development in the developed parts of the city.

¹ For example, Sustainable Transport for Sustainable Cities. Warren Centre, University of Sydney (2001).

The most significant contribution land use planning can have to reduce car dependency is ensuring population and employment density, especially along the main transport corridors, are high enough to support early provision of public transport services, especially rail. A second important effect relates more to population and employment distributions than density; that of the desirability of reducing the average trip length on the network, which has been increasing over recent years as a result of urban sprawl.

Land use development assumptions on the Central Coast and in western Sydney are important inputs to this study. The population and employment growth assumptions used in this study are consistent with DIPNR’s median forecasts for a metropolitan population of 5 million people by 2021.

It is likely that Sydney will remain the most popular destination for inbound immigrants to Australia for many years to come and that population growth will be undiminished. As long as this is the case there will be continued pressure for increased provision of transport infrastructure and to use existing infrastructure more effectively. Over the next 20 to 30 years, it is likely that car use will maintain, or even increase, its high modal share. Transport pricing, in particular road user charging, appears the most likely way forward to achieve governments sustainability goals, other than long term land use planning which must remain a primary policy tool.

Traffic composition and volumes on the National Highway in and around Sydney are influenced by State government’s new housing release policy. Presently about 32% of the total trips on the F3 Freeway are commuter trips from the Central Coast. The planned new release areas in Wyong Shire will add to the existing commuter travel demand on the National Highway.

The F3 and Pennant Hills Road will continue to be congested with commuter trips during peak periods unless a substantial change in employment opportunities occurs on the Central Coast or another transport corridor is provided.

Due consideration should be given to encourage employment growth on the Central Coast and the Newcastle and the Hunter region be developed in parallel with further development of the Central Coast, to reduce the pressure on the National Highway south of the Kariong interchange. An appropriate opportunity to address these issues would be as part of the current review of the Sydney Metropolitan Strategy being undertaken by DIPNR.

5.2 Road Pricing and the National Highway

Road pricing is a policy option which can have significant and efficient outcomes depending on the objectives which it is used for. Road tolls are one possible form of road pricing.

Two principal objectives can be considered for transport pricing:

i) to facilitate the appropriate allocation of transport resources so that appropriate investment signals are provided to decision makers; and

ii) to provide an appropriate level of cost recovery.

The economic argument for pricing urban roads is based on obtaining the best return from available resources. Roads in congested areas are a scarce resource. The efficiency of their use will be improved by prices which reflect the costs of use. The costs of road congestion are the delays experienced by road users when traffic levels are such that movements are impeded. Prices may not be available or preferred as a means of reducing road congestion for a variety of reasons. Non-price rationing measures are also available to reduce congestion costs.

An efficient road pricing scheme is one which is able to vary prices by time and location to reflect differences in user costs. The costs of other externalities of road use (eg. noise, air pollution) should also be included with congestion costs in an efficient pricing system. The existing charging

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mechanisms of registration fees and fuel taxes do not have these characteristics. Tolls also have the potential to be used in this manner.

**Revenue raising and Tolls**

Cost recovery is not an issue in the pricing of road use; revenues raised more than cover the costs of road construction and maintenance. Nevertheless, revenue raising to expand capacity may be an objective of pricing for the use of urban roads, as in the case of Sydney’s tollways.

Fuel taxes and tolls have the greatest potential with respect to revenue raising from urban road users. However tolls are difficult to avoid, except by using alternative routes and can have wide coverage and the charge can generally be set at a high level. Tolls can also have high collection costs, including delays (although electronic tolling is reducing operating costs).

**Reducing congestion**

Road pricing is aimed at improving efficiency by reducing congestion costs. A road pricing scheme may relate to a single area or be a regional-wide scheme. It could also be applied to a single corridor to provide priority to certain user types.

A regional-wide scheme for road pricing would not be restricted to the same extent as it can legitimately affect both area-destined or through traffic. The payment is for use of congested roads over a wide area, where the level of congestion may vary throughout the area. Some means of electronic vehicle identification and payment for use is likely to be required. Although methods exist, considerable development, design and education/publicity work would be required prior to introduction in Sydney. The recent success in London provides decision makers in Sydney with a ready example which could be developed for Sydney’s conditions.

The implementation of a road pricing scheme could not proceed in isolation. Associated measures to support success are improved public transport services, incentives for car/van pooling, and parking controls. These measures are likely to improve public acceptability as would a revenue neutral scheme, i.e. one that lowered existing road user charges so that total revenues collected remained the same.

**Non-price measures**

An alternative to price measures to reduce congestion costs is a range of non-price measures. Non-price measures could also be complementary to any road pricing scheme. The non-price measures include allowing congestion, traffic restraint, peak spreading, car/van pooling, improved public transport, and parking supply/price controls.

**Application of pricing on the National Highway Corridor**

The application of a toll to a new F3 to Sydney Orbital link in Sydney would reduce the economic efficiency of the investment but improve the affordability of the project as will be seen in Chapter 17. It

4 The City of London area-wide pricing scheme is the first of what is expected to be many applied in the UK. A carrot and stick approach is being used to reduce traffic in the area affected by up to 20%.

The New Transport Package Approach, means that in the UK at least congestion charging is available to government. Powers to implementation rest with County Councils and City Councils (who may need powers from central government). In Sydney a similar approach could have the following aspects:

i) new legislation under NSW Transport Act  
ii) develop scheme  
iii) consult properly  
iv) show that it will reduce congestion  
v) demonstrate all features and need are justified under new legislation.
could be argued that a toll on a National Highway is counter productive to the Highway's economic objectives. This may be mitigated by adopting a toll regime that encourages heavy vehicles to use the tollway. Without a toll the new link would be more difficult to fund.

Applying corridor pricing to the F3 to manage the demand on the F3 could, at times of high congestion, be a legitimate policy, subject to political acceptance. One approach could be charging a toll at the F3 on-ramps from the Central Coast to regulate commuter use of the National Highway.

Alternative non-price measures fall more naturally to government, including peak spreading, and this is happening today on the F3. Other non-price measures could include improved public transport services to Sydney and to Newcastle.

A further pricing policy consideration in respect to the increasing congestion levels on the F3 would be to re-introduce the toll on the F3 in order to facilitate an appropriate allocation of transport resources under congested conditions. This could also be extended to assist in the funding of upgrades of the F3.

This study investigated the traffic effects on the National Highway from significant investment in public transport in the corridor. A Public Transport only option (i.e. no investment in a new National Highway and instead investment in rail public transport to/from the Central Coast and in Sydney) was further investigated. The results are presented in Chapter 6.

5.3 Providing the Right Mix of New Infrastructure

There is little doubt that providing new road infrastructure will attract traffic, mostly redistributed traffic and some diverted trips from other modes to the new investment (see Chapter 16). The provision of public transport infrastructure is less likely to be economically or financially justified based on existing assessment techniques and much caution is needed to invest in appropriate public transport projects.

In the National Highway corridor, (the Main North Rail Line from Hornsby to Wyong) competes with road (F3 Freeway). The existing Central Coast traffic mode share is about 43% rail and 57% road respectively during commuter periods.

Some who have provided submissions to this study have argued that government investment should primarily be in rail for both passengers and freight and not in roads. This issue was addressed by assessing the transport outcomes of future scenarios including:

i) Public Transport Infrastructure Improvements Scenarios. These scenarios assumed various levels of major investments in rail capacity would take place in the corridor. The likely outcomes of these scenarios are described in Chapter 6.

ii) Public Transport Only Option A future scenario where rail investments mentioned in Action for Transport 2010 were brought forward to 2010, without any investment in a new National Highway link. The likely outcomes of this scenario are reported in Chapters 6 and 17.

Transport Network Improvement and Policy Assumptions used in this study

Road assumptions

The NSW RTA forward network improvements were assumed to be completed, as the basis for developing the study's network model. Major improvements included:

- F3 widening to 6 lanes by 2011 (Wahroonga to Karijori)
- Westlink M7 and Lane Cove Tunnel built and Gore Hill Freeway widened by 2011

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5 Action for Transport 2010, NSW Department of Transport.
• M2 widened to 6 lanes, east of Windsor Road by 2021

**Rail assumptions**

The Main North railway line capacity improvements (for freight and passengers) were assumed for modelling purposes to be completed generally according to *Action for Transport 2010*, including:

• Hornsby – Hawkesbury capacity upgrade by 2011
• Hawkesbury – Wyong capacity upgrade by 2021
• Parramatta – Chatswood line by 2011

**Transport Policy assumptions**

• No significant change to freight modal share over time in the corridor (that is, rail freight growth would keep pace with road freight growth estimated at 3.25% pa over the period).
• Rail passenger mode share in peak periods would increase from 2011 as a result of the assumed rail investment in the corridor.
• Value of corridor time savings – average $20 per hour (in 2003 dollars).
• No significant change in transport pricing.
• No significant shift in travel behaviour over time.
• Continued supply of fossil fuel for transport.

These provide the basis of the Base Case scenario against which options were modelled and evaluated. Sensitivity tests were undertaken on key assumptions to provide a range of likely outcomes in the assessment of options. These are described further in the Working Papers and in Chapter 17.

5.4 Recognising Transport’s Social Costs

For passenger traffic in Sydney, the last 30 years has been a period of significant growth. Traffic volumes have increased on average by about 2-3% per year and have in total more than doubled over this period.

Car ownership has increased significantly over the last 30 years. At the same time growth in the relative share of private transport is matched by a complementary decline in public transport. Underlying these changes are the improvement in real incomes and a divergence in the real price of private and public transport. The real price of private motoring has actually fallen over the last two or three decades.

The community has significantly benefited in many ways from the growing use of the road system. We value the flexibility and personal security afforded by private vehicles. The road network certainly provides people with considerable choice over where to live in relation to their work and an ability to pursue a wider range of social activity.

The increase in the use of road transport has brought with it the growing community concerns for a cleaner, safer and quieter environment.

Those concerned with the quality of the environment have claimed to this study, that the general public should not tolerate the environmental degradation associated with increasing road transport.
They have argued strongly about the need for greater public transport, more freight on rail and recognising the phenomena of “induced traffic” from new road construction\(^6\).

The existence of the social costs of transport (traffic noise, exhaust emissions, etc), growing in Sydney as they are with traffic growth, may not have been fully recognised within road project assessments.

No one would wish to deny that road transport inflicts external costs on society. But there are also external benefits from road transport too. Most road projects provide traffic congestion relief to road users and improved amenity to some residents. A new National Highway link in Sydney is such an example where, if an acceptable link can be found, it would improve local amenity and generate significant external benefits of reduced traffic, vehicle exhaust fumes, noise, and risk of road crashes. Benefits in the form of greater opportunities for property development and land use betterment could also occur as a result of the improved accessibility.

It is not the purpose of this study to develop values of road transport external costs. However, the effects of a new National Highway link in Sydney’s transport network would be significant in terms of its social benefits. The assessment of external costs and benefits of the options for a new National Highway link are described in Chapter 12 of this report.

In Sydney, as in most large cities, typically external costs, excluding traffic congestion costs, to the community amount to less than 10% of total transport costs. Typically, congestion costs (reduced average speed from intersection delay, stop/start at traffic lights, delay caused by crashes, etc) amount to about 10% of total costs\(^7\). Ballpark comparison from Europe and the US\(^8\) would indicate that generally, the relative values of external non-congestion costs of transport are (as of proportion of total costs):

- Accidents = 5.5 percent of total transport costs
- Noise = 1.5 percent of total transport costs
- Air pollution = 1.5 percent of total transport costs
- Climate = 1.5 percent of total transport costs

**The willingness to avoid social and environmental costs**

The existence of external costs of road transport is not in dispute, however, their evaluation and assessment within project assessment framework is not so clear cut. The main external costs of road transport are broadly classified and shown in Figure 5-1.

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6 South Turramurra Environment Protection (STEP) submission, dated 3 Oct 2003. The issue of induced traffic is discussed in Chapter 16 of this report.


8 The true costs of Road Transport Blueprint No.5. Maddison et al C Earthscan London, 1996.
External costs are divided into effects that arise from road use or those that road users impose on others (intra-sectoral) and those which are imposed on the rest of society (environmental or inter-sectoral externalities). A further distinction is made between environmental externalities (e.g., harming the environment) and those concerning social environments. Figure 5.1 also includes effects that arise from vehicles not in motion (e.g., disposal of vehicles etc).

In 1989, the NSW Government of the day accepted community concerns relating to a surface road linking the F3 to the M2 Motorway through the Lane Cove National Park. This resulted in the project not proceeding at that time because of these potential environmental effects on the Park and on those that use the Park. A similar decision was taken more recently by the Carr Government on the issue of the proposed Epping to Chatswood rail line bridge in the Lane Cove National Park. Due to community concerns a decision was made to put the rail line in tunnel.

The history of community concern over infrastructure proposals on Lane Cove National Park, led Ministers Anderson and Scully to announce at the outset of this study that no surface route would be allowed through Lane Cove National Park nor through important bushland areas. A further condition was given that widening Pennant Hills Road was not an acceptable option.

The willingness of Government to avoid social and environmental impacts of surface infrastructure projects in Sydney has seen major projects being constructed in tunnel, including the Eastern Distributor and M5 East Freeway. In all cases, while these projects result in external benefits not costs, they result in very high capital costs and higher operational costs, placing these projects on the limit of economic acceptability and affordability. This issue is discussed further in Chapter 17.
Rail and Public Transport Scenarios

The likely outcomes of different future growth scenarios in rail for both passenger and freight services in the corridor are presented in this chapter.

It is based on a strategic analysis described in Working Paper No.4 Transport and Traffic Studies.

The growth scenarios tested were as follows:

Scenario (A) No further investment in rail capacity enhancements;
Scenario (B) Rail enhancements to maintain rail's current market share, passenger and freight. This is the Base Case;
Scenario (C) Significant investment in rail to increase rail's market share, passengers and freight.

The above scenarios were tested with a new National Highway link developed.

Scenario (D) A fourth scenario was tested called the "Public Transport Only Option" which replaced the investment in the new link with a new passenger rail service to western Sydney in addition to Scenario (C).

6.1 The Four Transport Scenarios

**Scenario (A): No Further Rail Capacity Enhancements**

If there were no changes to rail services, and no road improvements in the corridor, morning peak hour rail passenger demand on the Main Northern railway line between the Central Coast and Berowra, would grow by up to 18% over the decade, ie to 2011.

Existing rail services would effectively keep pace with growth in rail passenger demand, particularly from the Central Coast, up until 2011. Forecast growth is expected to be 1 – 2% pa, ie about 18% over 10 years. After 2011, under this scenario, passenger growth would not be satisfied by rail and some passengers would use their cars and the F3.

Existing rail freight services could continue its long term trend, which would result in rail losing market share of general freight, with the consequent shift to road and the F3.

**Scenario (B): Rail Capacity Enhancements to Maintain Market Share**

To achieve current market share in passenger and freight services would require RailCorp to invest significantly in the corridor in keeping with Transport 2010 proposals and this study’s Base Case infrastructure improvement assumptions¹. It was assumed that this level of investment would allow rail freight tonnages to grow in line with freight transport demand, ie predicted at 3.25% pa and for rail passenger services to maintain its Central Coast mode share of 43% over the 20 year period to 2021.

¹ See Working Paper No.4.
Scenario (C): Investment to Increase Rail Market Share

To increase rail’s freight market share would require growth beyond 3% pa. This is possible provided substantial network-wide capacity enhancements are introduced from 2011 onwards. To test the effects of such an improvement, this study assumed a market share of 23% could be reached by 2021, ie an average growth rate of 6% pa to 2021.

Such an investment would provide the necessary access for freight trains to gain a 22 hour a day service in the corridor from 2021.

Scenario (D): Public Transport Only Option

A scenario was tested which advanced the proposed rail improvements in Transport 2010 by 10 years. Additional rail services from the Central Coast to western Sydney by 2010 were assumed in place of a new National Highway link.

The results of all four tests are presented below.

6.2 Rail Freight Outcomes

The following outcomes were assessed for rail freight.

Scenario (A): Rail freight continues its long-term trend of 2% volume growth per year, resulting in rail market share (of contestable freight) falling to 11% in 2021, compared with its current share of 14% in the corridor.

Under Scenario (A), there will be an additional 300 articulated trucks per day travelling on the F3 compared to rail maintaining its current share of the contestable freight market (Base Case – Scenario (B)). This addition represents about 3% of the total number of articulated trucks per day projected to be travelling on the F3 in 2021. This would be about one year’s growth in contestable road freight.

Scenario (B): The Base Case assumes that improvements on the Main Northern railway line will facilitate rail to maintain its current estimated 14% share of the contestable freight market over the next twenty years. This requires an annual rail freight growth of 3.25% or 1.7 times the past trend rate.

Under the Base Case, Scenario (B), there would be no change to the levels of freight tonnages moved on the National Highway corridor than predicted in this study.

Scenario (C): Rail market share increases to 23% in 2021, requiring an annual rail freight growth rate of 6% or three times the past trend rate.

Under Scenario (C), there would be a reduction of 950 articulated trucks per day travelling on the F3 in 2021, compared to rail maintaining its current share of the contestable freight market. This reduction represents about 12% of the total number of articulated trucks per day projected to be travelling on the F3 in 2021. This would be equivalent to about four years’ growth in contestable road freight.

The main conclusion from this assessment is that if rail freight services had the opportunity to compete equally with road transport and that rail achieved a significant increase in its mode share of contestable freight as a result of a large investment in rail capacity enhancement on the rail network and in the corridor, the effect would be to reduce the number of trucks on the F3.

In 2021 under this high rail growth scenario, the number of trucks removed from the F3 AADT would be about 950 articulated trucks and about the same number non-articulated trucks, ie 1,900 trucks per day out of a total of 17,500 trucks in 2021 in the Base Case.

2 See Chapters 7, 9 and 10 of Working Paper No.4.
The number of tonnes of freight removed from the F3 would be about 24,000 tonnes per day in 2021.

Under this high rail freight growth scenario about 1,200 trucks would be removed from Pennant Hills Road, including 600 articulated trucks per day in 2021, compared with the 13,300 trucks per day predicted to use Pennant Hills Road at that time under the Base Case. This can be compared with the 7,000 trucks a day (AADT) using Pennant Hills Road today.

6.3 Rail Passenger Outcomes

Compared with the Base Case the effect of Scenario (A) would lead to a fall in rail’s share of corridor traffic after 2011. Without the rail investment, it is estimated that about 800 passengers would change to their cars and use the F3 in 2011 each weekday. That is about 650 cars in the 2 hour morning peak or 350 cars in the morning and evening peak hour, equivalent to a 1,300 vehicle increase in the F3 AADT in 2011.

The effect would be more pronounced in 2021. Some 1,800 rail passengers would shift to road each weekday morning, equivalent to 750 cars per peak hour. This would be equivalent to an additional 3,000 vehicles in the F3 AADT in 2021.

Scenario B would maintain rail passenger current mode share with no significant effect on road transport demand.

Scenario C would result in significant increase in peak period rail travel in the corridor compared to the Base Case.

6.4 The Public Transport Only Option

One of the assumptions in the Base analysis of this study is that rail track capacity improvements to the Main Northern Line will take place as proposed in Action for Transport 2010:

(i) Stage 1: capacity upgrades from Hornsby to Hawkesbury before 2011, and
(ii) Stage 2: capacity upgrades from Hawkesbury to Warnervale/Wyong by 2021.

These improvements would provide additional train paths into the Sydney rail network and allow for the expected freight and passenger growth over this period and maintain rail’s passenger mode share (Scenario (B)).

The infrastructure costs associated with the upgrade of the Main Northern Line between Hornsby and Warnervale are expected to be about $2 billion in 2003 dollars, but their justification relates to benefits well beyond the F3 to Sydney Orbital corridor.

A “Public Transport Only” option was considered as an alternative to the investment in a new road link between the F3 and Sydney Orbital. The effects of this option on changes in road travel demand and modal shares in the corridor were assessed and compared against the new link’s objectives.

The ‘Public Transport Only’ option is based on the implementation of all planned rail infrastructure improvements plus additional expenditure in lieu of expenditure on the road link. The long term rail proposals for the Sydney area were advanced to be implemented by 2010. These proposals improve public transport access to western and north western Sydney and include:

- North-West Rail Link
- Full Chatswood to Parramatta rail link
- Main Northern line upgrade Hornsby to Wyong
- Quadruplication of Strathfield-Hornsby line.

It also included completion of the bus Transitways listed in Action for Transport 2010.
In addition, two completely new train services linking the Central Coast with Parramatta and Western Sydney were included in the 2021 model runs. The proposed new train services would require up to 12 new 4 car trains (Central Coast – Parramatta service) and up to 10 new 4 car sets (Epping – Emu Plains service). At current price levels this additional rolling stock would cost about $250m (2003 dollars).

The Public Transport Only option was assessed without the F3 to M2 road link in the network and the impacts compared with the Base case forecasts. The analysis indicated that the total number of trips with an origin or destination in the corridor by all modes would change little compared with the new road link or “Public Transport Only” option. Although the rail developments overall lead to a major increase in rail travel – passenger numbers are 21% higher in 2011 and 28% higher in 2021 – there would be no significant change in modal shares for trips with an origin or destination in the corridor.

The most successful elements of the proposed rail network enhancements are the new links between north western and western Sydney and the Lower North Shore and Sydney CBD. These new rail services would lead to a diversion of traffic on the routes crossing Pennant Hills Road and an increase in local traffic due to rail commuters using car to access local stations. Consequently, by 2021, traffic levels on Pennant Hills Road and Pacific Highway would not be significantly different under the Public Transport Only option than they are in the Base Case (Scenario (B)).

The analysis indicated that it would be difficult to achieve the transport objectives set for the F3 to Sydney Orbital link by upgrading public transport alone. However, potential public transport enhancements would lead to an increase in the volume of public transport travel and overall mode share and therefore serve wider community transport objectives.
The Need for a New National Highway Link

There are three main reasons why a new National Highway is needed to replace Pennant Hills Road.

i) To support State and National economic development

The existing interim National Highway route using Pennant Hills Road will not be able to continue to provide a reliable service to businesses reliant on long distance road transport on the National Highway which would carry an expected 96,400 vehicles including up to 16,700 heavy trucks per week day along Pennant Hills Road by 2021 without a new link; and

ii) To reduce social and environmental impacts at the regional and local level

To reduce traffic noise, exhaust emissions, physical severance effects and the risk of road crashes impacting on thousands of people living in close proximity to Pennant Hills Road.

iii) To provide for travel that cannot be catered for by rail

Because rail freight transport and the Main North Rail Line would not be able to carry the expected growth in freight demand in the corridor, even with the necessary investment to increase rail's carrying capacity and mode share.

7.1 National and State Development Need

The Sydney region is economically the most valuable region in Australia. It has a higher proportion of international business than other State capitals. It also generates the largest number and the highest value of employment positions. This employment growth leads to a growth in population and consequently Sydney is growing more quickly than the rest of the country. Efficient transport systems are an essential requirement to service this economy and its development.

The majority of commercial transport demand in NSW and south-eastern Australia is served by road freight, mostly with origins or destinations in Sydney. Without a National Highway system that is up to the task of linking together the coastal areas from the Hunter to the ACT, the economy of Sydney, its surrounding region, and the State as a whole could be compromised.

7.2 Regional and Local Needs

The existing volumes of 8,800 trucks per weekday, of which about half are 40 gross tonne or more articulated vehicles using Pennant Hills Road, impact significantly on the urban fabric and the people who live and work along Pennant Hills Road. Pennant Hills Road functions as a National Highway, but it is not designed for continued use as a National Highway.

The Pennant Hills Road crash rate is double the Sydney average with 114 fatal and serious crashes occurring in 2001 on the section north of the M2 Motorway.

There is an existing need for a new link. Once the M7 Motorway is completed in 2006 there will be an even greater need, as the completed Orbital would provide greater accessibility and interconnectivity around the city.

The interim National Highway would be unable to effectively service future growth in long distance travel as congestion and traffic delays increase out of commuter peak periods and into business hours.
of the day. Increasing congestion will constrain the ability of the interim National Highway to serve its function for long distance traffic and reduce the reliability of the national route.

A new F3 to Sydney Orbital link would provide a continuous motorway standard service for commercial vehicles travelling north from Sydney. A new link would also provide a high standard route into Sydney from the north for the predicted large increase in commercial freight vehicles using the National Highway.

7.3 Public Transport’s Role

This study has demonstrated (see Chapter 6) that public transport and in particular rail transport is unlikely to satisfy future growth in transport demand in the corridor. Rail and bus public transport play an important part in the corridor, however road traffic volumes are expected to increase significantly (about 30%) by 2021 compared with today, and truck traffic volumes are likely to nearly double on the National Highway over this period even with rail (passengers and freight) holding its mode share over this period.

Even if rail freight was to achieve three times its historical growth in the corridor and increase its mode share from 14% to 23% by 2021, the F3 and Pennant Hills Road would only carry about 950 and 600 less articulated trucks respectively each day.

7.4 Existing and Continuing Future Needs

There has been a significant loss of amenity along the 9 kms of Pennant Hills Road over the last 10 years or so, as a result of the increasing level of external effects of the National Highway traffic, including from the large daily volumes of heavy trucks.

There has been a general increase in congestion and crashes in the corridor resulting in significant delay to long distance commercial and truck traffic in the corridor and in road trauma.

There is a strong case, for a new National Highway link to replace Pennant Hills Road on transport, economic, social and environmental grounds. The completion of the M7 Motorway in 2006 will place additional traffic pressure on Pennant Hills Road. The expected growth of road transport in the corridor, the increasing external costs that this will generate and the continuing need for the National Highway to support and enable Sydney to continue to be competitive in the regional economy, all add to the case for a new National Highway link to replace the interim route.
The National Highway Planning Objectives

This chapter provides the planning framework to assess improvements to the National Highway. It is arranged under the following headings:

i) The Current National Highway Objectives;

ii) Planning Objectives;

iii) The 20 Year Planning Horizon;

iv) Alleviate Poor Travelling Conditions on the National Highway;

v) Improve Amenity for People Living and Working along Pennant Hills Road;

vi) Improve Travel Reliability for Inter-Regional Commercial and Freight Transport; and

vii) Servicing Future Growth of Road Freight Transport.

8.1 The Current National Highway Objectives

The National Highway represents the peak road classification in this country. It is a road network around Australia which the Australian government has funded since the 1960’s to promote national and regional economic development. A new link should support the current National Highway objectives which are to:

- facilitate overseas and interstate trade and commerce;
- allow safe and reliable access by a significant proportion of Australians to major population centres;
- minimise the cost of the National Highway to the Australian community;
- support regional development; and
- contribute to ecologically sustainable development.

8.2 Planning Objectives

The two major strategic planning policy instruments of the NSW Government in respect to transport infrastructure, the Sydney Metropolitan Plan and Action for Transport 2010 do not make specific mention of a new National Highway linking the F3 to the Sydney Orbital. Both of these documents are currently under review. This report will represent a major input to these reviews as well as provide the Federal and State governments with a recommended policy direction in respect to inter-regional transport infrastructure improvement in its own right.

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1 The Sydney Metropolitan Plan, Department of Urban Affairs and Planning (1991).

The NSW Department of Infrastructure, Planning and Natural Resources (DIPNR) sets guidelines on the acceptability and needs assessment of major transport investments. The need for a new link is a major consideration, as too are the planning objectives of the project.

The following planning objectives which a new National Highway link would need to satisfy have been developed for the purpose of this study:

- **Alleviate existing poor travelling conditions** (traffic congestion and high number of road crashes) on the interim National Highway and the surrounding network.

- **Improve local amenity** (reduce traffic, air and noise emissions; reduce severance) for people living and working along Pennant Hills Road.

- **Improve travel reliability** and reduce operating costs of long-distance commercial and freight transport on the National Highway.

- **Serve the future growth needs** of long-distance transport.

### 8.3 20 Year Planning Horizon

The planning horizon for this study is 20 years which is an accepted timeframe for such studies. The planning objectives relate to this horizon. The study has not predicted future conditions beyond 2021. This is important to the outcome of the study and its recommendations. The recommendations are therefore based on assessments of link options which best meet 20 year planning objectives. It is not practical to adopt a longer planning horizon due to the difficulty of forecasting population growth and its distribution. A longer or shorter planning horizon could potentially alter the study recommendations.

### 8.4 Alleviate Poor Travelling Conditions on the National Highway

**Poor road safety performance in the corridor**

Traffic congestion is often associated with poor road safety performance. Crash rates on Pennant Hills Road and the Pacific Highway were significantly higher than the average across the Sydney Road Network in 1999 and 2001, which indicates that road safety conditions on these roads are below average. The recorded 3-year average crash rate in the National Highway corridor is nearly double the Sydney road network average. The number of serious and fatal road crashes along Pennant Hills Road north of the M2 in 2001 was 114.

**Pennant Hills Road**

The M7 Motorway and the western section of the M2 Motorway will replace the Cumberland Highway section of the National Highway when the M7 Motorway is completed in 2006. However, Pennant Hills Road north of the M2 Motorway will remain as part of the National Highway, as a critical arterial road in Sydney’s northern network.

Today, Pennant Hills Road carries an average of up to 75,000 vehicles per day and it is currently operating near capacity during peak periods, causing long delays to long-distance road users in peak periods and at times of traffic incidents.

Delays occur during morning and evening peak periods on roads joining and crossing Pennant Hills Road, such as Boundary Road, Beecroft Road and Comenarra Parkway due to the large through-volumes on Pennant Hills Road.

**Sydney to Newcastle Freeway (F3)**

Traffic along the F3 corridor has been increasing at an average rate of 3% per year over the last ten years. Average annual daily traffic flows at the Hawkesbury River Bridge have increased from about
53,000 vehicles in 1992 to some 70,000 vehicles in 2001. During holiday periods traffic flows can be much heavier than the daily average.

The F3 Freeway south of Kariong is currently operating at its capacity over peak periods, resulting in unstable flow conditions and delays to road users.

The current widening of the four-lane sections to six lanes between Kariong and the Hawkesbury River will relieve congestion and delay over this section.

**Pacific Highway**

The Pacific Highway is an important State Highway which is currently operating at capacity in peak periods south of the F3. There are few opportunities to increase its peak capacity within the road corridor. Further growth in travel demand between the F3 and the Central Business Districts of the City, North Sydney and Chatswood and to areas such as Lane Cove and Macquarie Park Industrial Area, is likely to be accommodated outside morning and evening peak periods. This in turn will result in traffic congestion and road user delays extending across the day.

### 8.5 Improve Amenity for People Living and Working along Pennant Hills Road

Traffic along Pennant Hills Road is predicted to increase to between 95,000 and 100,000 vehicles per day by 2021. This will result in traffic congestion extending to most times of the business day. The number of large commercial vehicles, which currently represents 10% of total traffic, is predicted to nearly double over this period, ie from about 7,000 to 13,500 vehicles per day.

The forecast traffic demand in the corridor has taken into account the likely effects of planned and proposed improvements to rail public transport and rail freight infrastructure between Sydney and the Central Coast. These initiatives would permit rail to play a much greater role, especially for freight in the future. However, these initiatives by themselves, would not be sufficient to overcome the traffic congestion on the F3 and Pennant Hills Road nor accommodate much of the expected growth of transport demand in the corridor.

Without the proposed tunnel, as traffic volumes increase, so too will the social impacts of increasing community severance along Pennant Hills Road. There will be higher risks of road crashes along the corridor, and increasing traffic noise and air quality impacts from vehicle emissions over longer periods of the day, thereby diminishing the quality of life of people living and working in the vicinity of Pennant Hills Road.

Air quality may improve despite higher traffic volumes due to vehicle and fuel improvements.

**Widening Pennant Hills Road is not an option**

An enhanced route between the F3 and the Sydney Orbital is not proposed to be provided by further major upgrades of the existing surface connections, as Pennant Hills Road is widened to its full potential. Any further upgrades would have to be in the form of grade separation of intersections at a significant number of locations. This could result in further dislocation and severance to communities based along these routes. Widening Pennant Hills Road is not considered to be an acceptable solution, as it would result in unacceptable property impacts and worsening severance.

**The need to provide better transport in the corridor**

Traffic congestion, air quality and noise are issues of major concern. Significant improvements have been made in the transport sector to achieve cleaner fuels, and improved emission controls have been implemented over the last decade. As the Sydney Region develops, it will be important to avoid reducing air quality by continuing to reduce emissions from vehicles, reducing traffic congestion and promoting the use of more sustainable modes of transport wherever feasible, especially public transport, walking and cycling.
The provision of an improved National Highway link between the F3 and the Sydney Orbital has the potential to reduce traffic levels on the surface arterial roads in northern Sydney (Pennant Hills Road, Pacific Highway and Ryde Road/Lane Cove Road). This would provide an opportunity to improve local, bus-based public transport by using the freed-up road space.

Investment in rail based freight and passenger transport alone would not provide sufficient traffic relief to release the road capacity necessary to provide space for bus priority. Access to rail stations in the corridor would still be subject to traffic congestion. Even with significant improvements to public transport infrastructure, service upgrades and high quality interchanges, there is unlikely to be a major shift in the proportion of trips from cars to trains and buses in the corridor.

On the other hand, a new National Highway transport link has the potential, by encouraging travellers into their cars, to offset efforts to increase the use of longer distance public transport, especially rail services to and from northern Sydney suburbs and the Central Coast. For these reasons, the development of public transport improvement opportunities and demand management are an important part of the total transport strategy that is needed.

8.6 Improve Travel Reliability for Inter-Regional Commercial and Freight Transport

The interim National Highway will be unable to effectively service future growth in long distance travel as congestion and traffic delays increase out of commuter peak periods and into business hours of the day. Increasing congestion will constrain the ability of the interim National Highway to serve its function for long distance traffic and add further uncertainty to the reliability of the national route.

The development of the Sydney motorway network including the Sydney Orbital (particularly the M7 Motorway), will greatly assist commercial freight vehicles to access centres of important economic activity, including freight centres and Port Botany. A new F3 to Sydney Orbital link would provide a continuous motorway standard service for commercial vehicles travelling north from Sydney. A new link would also provide a high standard route into Sydney from the north for the predicted large increase in commercial freight vehicles using the National Highway.

8.7 Servicing Future Growth of Road Freight Transport

**Predicted population growth over the next 20 years**

The growth in road freight arises from economic growth which is associated with population growth.

Population and employment growth forecasts are an important aspect of investigation and form the basis of the transport demand for a new link.

The population of the Sydney Region is forecast to grow from just over 4 million today to 5 million by around 2021. Most of this growth is predicted to occur in the outer areas, principally the north-west, the south-west and the Central Coast, areas directly served by the F3 and the Sydney Orbital.

Over half of Sydney’s population growth over this period is predicted to occur in western Sydney, most notably in the North-West (Rouse Hill) and South-West (Bringelly). Urban infill in eastern Sydney is also a major component of this predicted growth. The population of the Central Coast is predicted to increase by 25% over the next 20 years.

**Effects of growth on transport demand on the National Highway**

National Highways form the key links between major regions across the States and Territories. Sydney has a comprehensive rail network that can be enhanced to cater for some of the additional transport demand generated by this population growth. Significant rail investments are required and planned, which should result in a better distribution of employment locations close to the rail network as well as catering for transport growth over the next 20 years. Additional arterial roads will also be
required in new release areas in the North West and South West. There will be a significant increase in road use on the main routes linking regional centres including use of the National Highway.

It will be important for jobs to be created in the outer areas of the Sydney Region to achieve a balance of workforce and employment. Jobs have traditionally lagged at least 10 years behind population growth, so the rate of job creation would need to be accelerated in new urban areas if this balance is to be achieved and the trend to longer journeys to work reversed. This is particularly important for the Central Coast and the growth of commuter and freight movements on the F3 corridor.

Freight-generating land uses, in particular those with good access to motorways, have been significant generators of jobs in employment and industrial areas over the last 20 years. This is likely to continue, notwithstanding the desirability of maximising the opportunities for rail to take a larger share of freight movements, especially for interstate freight and freight movements to and from the ports.

The Sydney Region’s commercial centres are likely to continue to expand, broadly in line with population growth. Substantial increases in freight movements would be needed to service these commercial centres. Good access to a reliable and efficient road network would be important, as rail is incapable of efficiently serving most of these types of local and district freight transport demands.

By 2021 transport demand on the F3 is expected to increase from 71,200 vehicles per day (AADT) to 93,700 vehicles per day, an increase of 32%. Heavy trucks will increase by around 90% over this period.

By 2021 transport demand on Pennant Hills Road is expected to increase from 75,000 to 96,400 vehicles (AADT), an increase of 30%. Heavy trucks on Pennant Hills Road are predicted to increase by 93%.

As the traffic grows, there will be greater pressures to improve the efficiency of the National Highway in support of the State’s and the country’s economy.
Options Development Process

The process of developing broad options for a new National Highway link are described in this chapter. It is presented in the following sections:

i) Introduction;
ii) Land Use Considerations;
iii) Economic and Regional Development;
iv) Urban Design, Landscape and Visual Assessment;
v) Social and Environmental Effects; and
vi) Engineering Considerations.

9.1 Introduction

The process used in developing a “long list” of options for potential new National Highway corridors between the F3 and the Sydney Orbital is summarised in Figure 9.1. More detail is provided in the Working Papers and in the Options Development Report.

The following factors were considered in the development process:

- Land use opportunities and constraints
- Economic and regional development
- Urban design, landscape and visual assessments
- Social and environmental impacts, and
- Engineering feasibility.

The first step in the process was to identify feasible locations for major interchanges along the F3 Freeway and the Sydney Orbital. Several possible locations were identified from an assessment of:

- Land availability, both existing and future land uses and extent of urban land development
- Engineering design standards including interchange requirements
- Traffic operational characteristics of the adjacent road network
- Environmental constraints, such as the location of woodlands and watercourses
- Steepness of terrain and constructability, and
- Connectivity to the regional transport network.

The next step was to connect feasible interchange locations with possible broad corridors in which a future National Highway Link could be built. This process resulted in a range of possible corridor
options that connect the Sydney Orbital and the F3 Freeway. A number of these options were suggested by members of the community during the consultation process.

Once the feasible locations of a new link connection to the F3 Freeway and Sydney Orbital were determined, corridors were generated through a process of constraint/opportunity mapping based on field survey and technical study of the planning criteria shown in Table 9-1.

Figure 9.1: Overview of the study’s processes for developing and assessing corridor options

<table>
<thead>
<tr>
<th>Planning data</th>
<th>Transport demand</th>
<th>Community views</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban form</td>
<td>Population and employment forecasts</td>
<td>Inputs from community involvement program, including community focus groups</td>
</tr>
<tr>
<td>Environmental constraints</td>
<td>Travel demand forecasts (roads and other modes, including public transport)</td>
<td></td>
</tr>
<tr>
<td>Social effects</td>
<td>Testing of future network scenarios</td>
<td></td>
</tr>
<tr>
<td>Field surveys</td>
<td></td>
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</tr>
</tbody>
</table>

Initial development of options

- Investigation of potential interchanges and network connections
- Engineering route investigations
- Development and refinement of corridor options

Initial assessment of options

- Assessments of options using environmental, social, transport and economic criteria
- Strategic review of options (including first Value Management Workshop)
- Development and refinement of feasible corridor options for further detailed investigation.
Table 9-1: Criteria used to develop and assess corridor options

| Land use | • Avoidance of impacts on existing urban areas or areas in advanced stages of planning, particularly residential areas and property  
| • Avoidance of impacts on National Parks, Nature Reserves, regional reserves and land zoned for environmental protection purposes. |
| Urban and regional development | • Support for regional, State and national development  
| • Access to ports, industrial and regional centres |
| Engineering feasibility | • Constructability of tunnels, interchanges and bridges  
| • Terrain constraints |
| • Impact on existing roads |
| • Ability to stage construction of the project |
| Urban design, landscape and visual factors | • Protecting existing built, natural, scenic and heritage values and views  
| • Fitting into Sydney’s planned development areas  
| • Minimising severance and improving access including interconnectivity with the existing and planned transport network.  
| • Minimising land form changes and visual impacts |
| • Regional and local land form and visual assessment, including land form, structures, tree cover, activity, visibility |
| Social and environmental considerations | • Potential for improving environment, especially conditions for local traffic, pedestrians and cyclists.  
| • Social (including severance, accessibility, property impacts and regional access)  
| • Environmental (including impacts on vegetation, reserves, fauna, habitat, water courses, water quality, heritage, and potential noise based on closeness to residential and employment land) |

Source: Draft Options Development Report (October, 2002)

These constraints included existing residential areas, urban growth areas, industrial/business zoned land, parks and reserves and physical landforms. The constraints were incorporated on a digital map of the study area which enabled an assessment of how the broad corridor options could be designed to fit the identified link interchange options, given the various physical, social and environmental constraints.

9.2 Land Use Considerations

Land use across the northern Sydney metropolitan area is a major factor in the identification of potential transport corridors.

Land use patterns, densities and interactions are the bases for trip origins and destinations. The type of land use and the intensity to which it is developed primarily determines the travel demand to particular locations, including the number and type of vehicles used.

The major land-use issues taken into account in the identification of corridor options were:

• The impact of a link on existing land use, and
A route’s influence on future patterns of growth and development within the study area.

A new National Highway corridor has the potential to have a substantial direct impact in terms of land take, dislocation and severance of land uses at a local level. It also has the potential to be a major influence on patterns of land use growth and change in northern Sydney.

**Land use opportunities**

Future urban areas represent the greatest opportunity to integrate planning of a new transport corridor with urban development. In existing urban areas, in contrast, conflicts are likely to arise, particularly if the corridor is located within existing residential areas.

A new road would potentially impact directly on residential areas through land take and by changing the demand for land for certain purposes.

DIPNR is currently focussing mainly on residential development in its planning for urban release areas. However, it was recognised in this study that a new corridor could significantly increase accessibility to major industrial and employment areas, particularly those developing in western Sydney.

It was therefore been seen as appropriate to identify options which would provide a high level of access to these areas.

In addition, consideration was given to the potential to rezone land close to the corridor(s) for industrial or other production-related land uses. Opportunities are greatest in urban release areas within the Blacktown Council area, such as Marsden Park. However, this would require a policy shift by the NSW Government, and might necessitate the identification of additional urban release areas to cater for shorter-term demand for residential land.

On a broader level, the potential for the development of employment and industrial areas in metropolitan Sydney is concentrated on areas with existing capacity in the western Sydney region. These areas would be more directly served by a corridor connecting to the Sydney Orbital either towards the western end of the M2 or on the Western Sydney Orbital.

**Land use constraints**

While opportunities to rezone land for industrial and employment purposes on the urban fringe in urban areas do exist, the potential for urban redevelopment and land use changes as a result of the link is constrained by factors such as community expectations and property values.

In established urban areas, high property values are a significant impediment to major redevelopment, particularly in the case of changes from residential uses to employment uses which might be advantaged by being close to the road.

Existing urban areas within the study area are predominantly residential, and have therefore been seen as a major constraint on the corridors, at least as far as surface options are concerned.

Newly established residential areas, or those where planning is well advanced, also present constraints on corridor development. In these areas there are expectations, and in many cases a level of investment, that rely on a particular form of development or patterns of land use. Any major changes to the planning or release of these areas as a result of the project would not be viewed favourably by other government agencies, the development industry or the community.

Land that is already zoned for urban purposes, or is in the advanced stages of planning (ie. with draft LEPs or local environmental studies underway), has therefore generally been considered a constraint on the project.

The exception to this has been where the land is already identified for industrial or commercial purposes that would benefit substantially from the project's accessibility benefits and where the amenity reduction associated with proximity to a major road would not be as substantial as in other areas.
Conservation areas—national parks, nature reserves and regional reserves and land identified under local planning instruments for environment protection purposes - are a major constraint on corridor options, particularly for above-ground routes. These conservation areas are particularly concentrated in the north and east of the study area.

The construction of a major road through such lands would be inconsistent with the management objectives of those lands, and would be likely to result in substantial community opposition. Serious consideration of tunnelling options was therefore undertaken for those sections of the corridor options traversing conservation areas.

In the absence of established road reservation corridors, the implications of a surface route through established urban areas are also substantial, in terms of impacts on local communities, disruptions to urban form and function and the costs of land acquisition. Tunnelled rather than surface corridors were considered in these areas as well.

9.3 Economic and Regional Development

The strategic importance of the different types of options to economic and regional development was broadly assessed in terms of support for development policies and access to important centres of economic activity, including ports.

All options would distribute traffic to the Sydney Orbital in Sydney, with the easterly options more directly servicing eastern Sydney and the established centres, the airport, Port Botany and freight rail-heads.

As industry relocates west over time (with the opening of the Westlink M7 Motorway assisting in reducing transport distribution costs in western Sydney), the westerly options would provide improved access to the western region of Sydney from the north.

To the north, all options would link with the F3 to the west of Gosford and there would be no significant difference between them in regional development terms.

9.4 Urban Design, Landscape and Visual Assessment

Consideration of urban and regional design within route selection was an important component of the route assessment process. (The process is described in Working Paper No. 3). The key issues and objectives of this assessment were to:

- Protect the existing built, natural, scenic and heritage values of the region
- Fit into Sydney’s planned growth areas and recognise the development potential of the corridor
- Enhance land values within the corridor wherever possible
- Minimise community severance
- Improve community access including conditions for local traffic, pedestrians and cyclists, and
- Improve public space through corridor opportunities.

The approach taken to include urban design considerations in this study, and in particular the development of corridor options, summarised in Figure 9.2 involved:

- The establishment of a methodological framework for summarising major constraints influencing the location of link options, and the development of a rating table for the assessment of regional and local character
- Assessments of the potential for the visual effect (visual contrast) and visual sensitivity (visibility) of each landscape character area to change, and its visual absorption capability
• Initial evaluations of the corridor options in terms of their urban design advantages and disadvantages, utilising an assessment framework that identifies key urban design criteria and landscape and visual criteria for assessment, and

• Summarising the options recommended for more detailed evaluation.

Figure 9.2: Overview of the study’s processes for taking account of urban design considerations

- Project Objectives
- Study Objectives
- Urban design, landscape and visual opportunities and constraints
- Summary of major issues
- Regional and local visual character assessment and development of character rating table
  - Landform
  - Structures
  - Tree cover
  - Water character
  - Activity
  - Visibility
- Visual effect: contrast
- Visual sensitivity: visibility
- Potential visual impact within character zones
- Development of Corridor Options
  - Based on traffic, environmental, planning, urban design, landscape and visual criteria
- Assessment of Corridor Options
  - Opportunities
  - Constraints
- Recommended shortlist of options for further detailed investigation
Figure 9.3 maps the character zones and landform constraints that were used to develop (and later to assess) the corridor options during the preliminary stages of the study.

Figure 9.3: Character zone and landform constraints in the study areas
9.5 Social and Environmental Effects

The many potential social and environmental effects of a new road link were assessed under the following headings:

- Water quality and aquatic communities
- Conservation reserves and terrestrial ecology
- Indigenous heritage
- Non-indigenous heritage
- Social impacts
- Climate and air quality
- Noise impacts

**Water quality and aquatic communities**

The study area covers several parts of the Hawkesbury/Nepean catchment, including the entire Berowra Creek catchment and parts of the South Creek (Eastern Creek and Bells Creek) and Cattai Creek (O’Haras Creek) catchments. Part of the Lane Cove River catchment also lies within the study area.

In general, the areas of each waterway catchment that drain urban or agricultural areas - predominantly the upper reaches of the catchments – tend to have poor water quality, while the reaches further downstream that drain bushland, nature reserves and National Parks tend to have fair to good water quality.

Looking south from Berowra lookout to the Hawkesbury River
A review of available information on the aquatic biota and habitats of the various waterways provided, in general, the same conclusions as in the water quality study. The aquatic biota are healthier and more complex in areas which drain natural areas, while clear evidence of pollution impacts is found in the watercourses in urban areas.

A strategic assessment of hydraulics concluded that if the new link was developed in the vicinity of the Eastern and South Creek and Cattai Creek floodplains there could be some significant environmental impacts, because of the closeness of urban development and the potential for high property value damage. Any route through these areas would require intensive analysis and would be likely to require significant lengths of suspended roadway.

**Conservation reserves and terrestrial ecology**

Biological constraints were identified, described and mapped as part of the provision of biological inputs to the corridor options assessment, refinement and selection process.

There are a number of National Parks, Nature Reserves and Council Bushland Reserves within the immediate study area. These reserves are listed in Table 9-2.

<table>
<thead>
<tr>
<th>Table 9-2: Conservation reserves in the study area</th>
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<tbody>
<tr>
<td>Marramarra National Park</td>
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<td>Dharug National Park</td>
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<td>Popran National Park</td>
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<tr>
<td>Cattai National Park</td>
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<tr>
<td>Scheyville National Park</td>
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<tr>
<td>Lane Cove National Park</td>
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<tr>
<td>Rouse Hill Regional Park</td>
</tr>
<tr>
<td>Berowra Valley Regional Park</td>
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<tr>
<td>Muogamarra Nature Reserve</td>
</tr>
</tbody>
</table>

Source: Working Paper No. 5

In addition, there are several larger National Parks, such as Ku-ring-gai Chase National Park and Brisbane Water National Park in the broader study area, although they would not be directly affected by most of the corridor options considered.

The study area encompasses five local government areas, including those of the Gosford, Hornsby and Baulkham Hills Shire Councils. Throughout the study area many small parcels of vegetated land owned and managed by these councils have been reserved under appropriate land use zones.
Flora/Fauna

The study identified and mapped known threatened species as an input to constraints analysis.

A description of the threatened fauna and flora is provided in Working Paper No.5.

Indigenous Heritage

The study area has nine Indigenous Places registered in the National Estate Register.

The NPWS database identifies 966 sites within the Hawkesbury Plateau sandstone geology of the study area. These sites include shelters with art deposits, rock engravings, axe grinding grooves, stone arrangements, middens and open campsites. NPWS records also indicate there are 136 sites within the Cumberland Plain geology of the study area, most of them open scatters of artefacts varying in size from several to thousands of artefacts. Other site types present are isolated artefacts, quarry sites and scarred trees.

There is one native title claim in the southern section of the study area, with the Darug Tribal Aboriginal Corporation representing the claimants. Details of the exact location of the many components of this claim would be required to be mapped from data supplied by the National Native Title Tribunal, in follow-on studies.

Non-indigenous heritage

Investigations of the locations of known non-indigenous heritage sites involved searches of the Heritage Registers of the Australian Heritage Commission, the State Heritage Register and the LEP Heritage Schedules of Ryde, Ku-ring-gai, Hornsby, Blacktown, Baulkham Hills and Gosford councils.

Most of the study area north of Berowra is within National Park, State Forest, farmland or other areas in which there has been minimal impact. Some pristine natural areas have been identified in heritage lists, but it is considered that the only additional items within these areas would be original settlement access ways, early settlement sites and evidence of early farming. These sites are most likely to be associated with rivers or major creeklines.

South of Berowra the study area has been more heavily settled, with both residential and industrial development, and it is within these settled areas that the majority of heritage items and archaeological remains are likely to be located.
Social impacts

An overview of social issues of the study area included a review of census data, descriptions of the characteristics of communities and the potential social impacts of the proposal, and a preliminary analysis of issues likely to be of concern to residents.

Typical population densities of 6–10 dwellings per hectare are found:

- In the established and developing north-western suburbs such as Quakers Hill, Acacia Gardens, Parklea, Stanhope Gardens, Glenwood, Bella Vista, Baulkham Hills, Castle Hill and Cherrybrook
- Along Pennant Hills Road (West Pennant Hills, Beecroft, Pennant Hills, Thornleigh and Normanhurst)
- Along Beecroft Road (Cheltenham and North Epping), and
- Along the Pacific Highway spine (Wahroonga, Waitara, Hornsby, Asquith, Mount Colah, Mount Ku-ring-gai and Berowra).

Lower density suburbs adjoin these suburbs along the main transport spines.

To the north and north-west there are larger rural/residential properties, National Parks and reserves.

Community services and facilities, employment areas and commercial areas are generally located within or near the established or growing population centres.

Significant light industrial or commercial centres are found in Quakers Hill, Bella Vista, Baulkham Hills, Castle Hill, Hornsby and Mount Ku-ring-gai, and there are heavy industrial areas at Thornleigh and Hornsby.

Climate and air quality

Roadway projects are not known to have a significant effect on climate in the study area. It is possible, however, that local changes in wind patterns could occur if the project were to significantly alter the surrounding terrain.

Emissions from vehicles on a roadway depend on a number of factors, including the number of vehicles, the stop/start nature of the traffic flow and its average speed, the grade of the road and the mix of vehicles. In general, a congested road with numerous intersections will generate higher emissions than a free-flowing road with no intersections, while steeper grades and a higher percentage of heavy vehicles also generate higher emissions.

The principal environmental air quality difference between surface roads and tunnels arises from their point(s) of emission. Air pollutants from surface roads are released as a "line" source at or close to ground level, while tunnels are usually ventilated via stacks well above ground level, thereby increasing atmospheric dispersion (provided the stacks are sited appropriately).

Although one of the primary issues associated with tunnels is a negative public perception of ventilation stacks, which are often seen as a new pollution source, in most cases the surrounding areas experience improved local air quality, because of the reduction of congestion on surface roads.

Noise impacts

The primary criteria for assessing the traffic noise and vibration impacts of the options are the effects on amenity in residential areas and the effectiveness and nature of the mitigation measures for managing these impacts.

To minimise noise and vibration impacts the corridor options either divert around the fringes of urban areas or tunnel under these areas.
9.6 Engineering Considerations

**Engineering design process**

Use was made of a Geographic Information System (GIS) digitised database to log each of the major physical, environment and social factors as constraints/opportunities on a series of satellite imagery bases. This allowed integration of the individual factors to be assessed distinctly and in conjunction with one another.

Corridor options were developed using this digitised overlay technique and selected from an integrated assessment of the key land use, social and environmental factors within the study area.

Topography, existing interchanges, surrounding land uses and other environmental constraints all limit the locations that might be used for connections with the new link.

The possible connection points identified in developing the options were:

- **M2 Motorway/Sydney Orbital:**
  - Toll booths at Marsfield
  - M2 tunnel near Beecroft Road, Epping
  - Pennant Hills Road at West Pennant Hills
  - Windsor Road at Baulkham Hills
  - Norwest Boulevard at Kings Langley
  - Sunnyholt Road at Acacia Gardens
  - Quakers Hill Parkway at Quakers Hill, and
  - Dean Park.

- **F3 Freeway:**
  - Wahroonga
  - Asquith
  - Mt Colah
  - Mt Ku-ring-gai
  - Berowra
  - Mt White, and
  - Calga.

A number of intermediate interchanges that were considered to provide local access to the link. Possible interchange locations identified included:

- Pennant Hills Road and Beecroft Road intersection at Carlingford
- Castle Hill Road East of Rogans Hill
- Old Northern Road at Dural and Glenorie
- Old Windsor Road and Windsor Road at Kellyville, Vineyard and McGraths Hill
- Cattai Ridge Road at Maraylya, and
- Pitt Town Road at Kenthurst.

Once the possible F3 and Sydney Orbital connections were identified, various links were made to generate preliminary concepts for options.

These preliminary links were considered, primarily to provide coverage of the study area, to avoid duplication of the existing major routes and to address the project objectives, especially the need to relieve Pennant Hills Road and cater for the growth of long distance traffic.
Following the broad linking of nodes, the corridor options were progressively developed and refined in the light of topography and the locations of national parks and other conservation areas, waterways, existing outer urban communities, existing road corridors and other factors.

The link would be designed in accordance with the relevant RTA and Austroads publications and Australian Standards. In addition to these standards, a number of additional criteria were adopted, as outlined in Working Paper No. 2.

**Access to the Sydney Orbital – M2 toll booths at Macquarie Park**

The main considerations of access to the Sydney Orbital and the F3 would include:

- No direct connection to roads south of the M2.

- No access to the east-bound ramp from the M2 to Christie Road and no access from the west-bound ramp from Herring Road to the M2. (Access to and from Macquarie would be via the M2 ramps at Lane Cove Road.)

- A need to construct ramps around the existing toll booth plaza. The tolling arrangements should not need to change significantly.

**Access to the Sydney Orbital - M2 tunnel near Beecroft Road**

The layout of an interchange at this location would need to address existing and proposed infrastructure including:

- The Main North Rail Line, which passes over the M2 between the tunnel and Beecroft Road
- The Epping bus interchange and associated busways
- Terrys and Devlins Creeks
- The Beecroft Road bridge and interchange
- The new Parramatta Rail Link, now under construction, and
- The proposed future North West Rail Link from Epping to Castle Hill and Mungerie Park.

The main considerations of an interchange at the M2 tunnel would include:

- No direct connection with Beecroft Road, and
• East-bound and west-bound ramps on either side of the M2 tunnel.

Access to Sydney Orbital – M2/Pennant Hills Road

Any new interchange at this location would have to be designed and constructed around the existing M2/Pennant Hills Road full diamond interchange. In addition, there are tolling facilities on the west-facing ramps to and from Pennant Hills Road and a central busway ramp to the east of the interchange, and a similar west-facing busway ramp, as indicated in the M2’s 1992 Environmental Impact Statements and a 1995 Review of Environmental Factors concerning later design changes at this intersection, will be constructed in the future. The RTA owns land on the northwest side of the interchange, and Pennant Hills Golf Club is immediately to the northeast of the interchange.

The main considerations of an interchange at this location would include connections to and from Pennant Hills Road, south of the M2.
Access to Sydney Orbital – other potential interchange points

M2/Windsor Road

Any new interchange at this location would have to be designed and constructed around the existing M2/Windsor Road interchange. This interchange is currently a half diamond with east-facing ramps, but west-facing ramps, including a central busway ramp, will be constructed in the future.

Other considerations at this location include the M2 bridge over Darling Mills Creek to the east and the Watkins Road bridge over the M2 to the west.

Western Sydney Orbital/Norwest Boulevard

An interchange at this location could include a full diamond at Norwest Boulevard or a split diamond at Norwest Boulevard and Old Windsor Road. A connection to Old Windsor Road would provide access through to the Cumberland Highway.
**Western Sydney Orbital/Sunnyholt Road**

An interchange at Sunnyholt Road would provide a connection through to Blacktown.

However, the Western Sydney Orbital/Sunnyholt Road interchange, not yet constructed, will include a full diamond plus busway connections, and only limited space is available for any additional interchange.

**Western Sydney Orbital/Quakers Hill**

An interchange at this location would be on the Eastern Creek floodplain, so it would have to be built on structures designed to avoid impacts on the significant flooding patterns of this creek. Current land uses at this site are semi-rural.

**Western Sydney Orbital/Dean Park**

An interchange at this location, near Richmond Road where the Western Sydney Orbital will turn to the south, would need to consider a possible future Castlereagh freeway extension to the west.

**Access to F3 at Wahroonga**

The existing half diamond interchange at this location allows access from the Pacific Highway to the F3, with the F3 providing a direct connection to Pennant Hills Road. A connection between the new link and the F3 at this location would need to consider:

- A connection to Pennant Hills Road
- Use of a full diamond or a split diamond at the Pacific Highway, and
- The short distance from the existing F3 junction at Pennant Hills Road to the Pacific Highway/Pennant Hills Road intersection at Pearces Corner.

**Other F3 interchanges**

Other interchanges on the F3 would need to consider:

- Probably half diamond interchanges with no south-facing ramps
- Possible connections using existing ramps
- The existing F3/Pacific Highway/railway cross section
- The constraints of National Parks and other conservation areas, and
- Distances from existing interchanges and allowances for traffic to manoeuvre and change lanes to use interchange ramps.
Looking north along the F3 from the Church Street bridge at Mt Ku-ring-gai

Looking south along the F3 from the Church Street bridge at Mt Ku-ring-gai

Looking north along the F3 at Berowra

Looking south along the F3 at Berowra

Looking south along the F3 at Berowra, with the Main North railway line and Berowra station on the right
Investigation and Assessment of the Broad Corridor Types

This chapter presents the different corridor types investigated and their assessment. It is arranged under the following headings:

i) Type A, B and C Corridor Options;
ii) Strategic Assessment of Corridor Types;
iii) Transport Assessment of Types A, B and C Corridors;
iv) Social Effects Assessment of Corridor Types A, B and C;
v) Environmental Assessment of Corridor Types A, B and C;
vi) Economic Assessment of Corridor Types A, B and C;

vii) F3 Capacity Issues; and
viii) Conclusions.

A more complete presentation of the assessment of the Corridor Types can be found in the draft Options Development Report.

10.1 Type A, B and C Corridor Options

A large number of corridor options were considered and it was convenient to group them into strategic types of corridors to understand their relative advantages and disadvantages with respect to satisfying the new National Highway Link objectives.

For the purposes of strategic comparisons, 17 broad corridor options were identified and classified into three groups, or types, of corridor options, referred to in this report as Types A, B and C and shown diagrammatically in Figure 10-1.

Type A Corridors

Type A corridors include the more easterly options, which generally form a southern extension of the F3 corridor to connect with the M2 Motorway.

All the Type A options would be mostly in tunnel under existing roads and/or residential areas. Some Type A options would involve a tunnel under the Lane Cove River and Lane Cove National Park.

Type A corridor options range from an easterly alignment connecting with the M2 Motorway at Macquarie Park, to a westerly alignment, generally following Pennant Hills Road and connecting with the M2 Motorway at the existing M2/Pennant Hills Road Interchange.

Type A corridor options would continue to use the F3 as the major road transport link between Sydney and the north.
Type B Corridors

Type B corridors include options within the central study area that would connect the Sydney Orbital between Pennant Hills Road and Dean Park to the F3 between Wahroonga and the Hawkesbury River. The options would bypass the developed areas of Hornsby.

Type B corridor options would generally consist of above ground sections and tunnels under existing residential areas. Most options would cross the Berowra Creek Valley with major bridge structures. Some options would include tunnels under the Mt Colah area and Castle Hill, Cherrybrook and West Pennant Hills residential areas.

Type B corridor options would continue to use the F3 corridor, north of Mt Colah/Berowra as the major road transport link between Sydney and the north.

Type C Corridors

Type C corridors include the more westerly options which would connect the Sydney Orbital between Windsor Road and Dean Park with the F3 north of the Hawkesbury River.

All Type C options would consist of above ground and tunnelled sections, and a major new crossing of the Hawkesbury River. It is also assumed that some tunnel sections would be required under Marramarra National Park. Most options would involve above ground sections through the Schofields/Kellyfield/Annangrove area and run along parts of the existing Old Northern Road alignment in the Glenorie area. Some options would also include tunnels under existing residential areas at Baulkham Hills and Castle Hill.

Type C options would form a second major road corridor between Western Sydney and the north. Traffic would continue to use the F3 corridor north of Mt White as the major transport link between Sydney and the north.
Figure 10-2: The corridor options assessed during the preliminary stages of this study
The long list of corridor options developed for assessment is, shown in Figure 10-2. A description of each option is presented in the draft Options Development Report.

**Type A**
1. M2 at Macquarie Park to F3 at Wahroonga
2. M2 at North Epping to F3 at Wahroonga
3. M2 at Pennant Hills Road to F3 at Wahroonga
4. M2 at Pennant Hills Road to F3 at Asquith

**Type B**
5. M2 at Windsor Road, Baulkham Hills to F3 at Mt Colah
6. M2 at Windsor Road, Baulkham Hills to F3 at Mt Colah via Round Corner
7. Sydney Orbital at Quakers Hill Parkway, Quakers Hill to F3 at Mt Colah
11. Sydney Orbital at Dean Park to F3 at Berowra via Riverstone
13. M2 at Pennant Hills Road to F3 at Mt Colah via Railway Line
14. Brooklyn to Somersby via Main North Rail Line\(^1\) alignment
15. Sydney Orbital at Dean Park to F3 north of Mt Ku-ring-gai
17. Sydney Orbital at Norwest Boulevard at Kings Langley to F3 north of Mt Ku-ring-gai

**Type C**
8. Sydney Orbital at Quakers Hill Parkway, Quakers Hill to F3 north of Hawkesbury via Dural
9. M2 at Windsor Road to F3 north of Hawkesbury
10. Sydney Orbital at Dean Park to F3 north of Hawkesbury via Riverstone
12. Sydney Orbital at Sunnyholt Road to F3 north of Hawkesbury
16. Sydney Orbital at Dean Park to F3 north of Hawkesbury via Annangrove

The grouping of corridors turned out to reflect some quite fundamental differences in the abilities of the groups of options to provide relief to Pennant Hills Road and longer-term opportunities for the growth of long distance transport in the F3 corridor.

**Properties affected**

A strategic analysis was carried out to determine the likely number of properties that each of the options would cross or pass under, as follows:

- The Type A corridor options were allocated a width of 50 metres and the Type B and C options were allocated a width of 100 metres, reflecting the fact that the Type A options would mostly be in tunnel.
- The analysis determined the number of separate land packages that each option crossed.

\(^1\) While the option was initially considered, it was not taken forward for assessment since it would principally serve the objective of relieving the F3 Freeway as opposed to the interim National Highway.
• The analysis does not separate partially affected properties from those totally affected.

• No analysis was made to determine the numbers of properties that would need to be purchased, compared with those that would require some property adjustment.

The results of this analysis are included in Table 10-1.

Table 10-1: Indicative number of properties crossed or passed under, wholly or partly, by each of the long list of options.

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
<th>Total length (km)</th>
<th>Direct(^{(1)})</th>
<th>Indirect(^{(2)})</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type A corridor options</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>M2 at Macquarie Park to F3 at Wahroonga</td>
<td>7</td>
<td>35</td>
<td>350</td>
</tr>
<tr>
<td>2</td>
<td>M2 Tunnel (east of Beecroft Road) to F3 at Wahroonga</td>
<td>8</td>
<td>130</td>
<td>350</td>
</tr>
<tr>
<td>3</td>
<td>M2 at Pennant Hills Road to F3 at Wahroonga</td>
<td>9</td>
<td>70</td>
<td>510</td>
</tr>
<tr>
<td>4</td>
<td>M2 at Pennant Hills Road to F3 at Asquith</td>
<td>11</td>
<td>20</td>
<td>600</td>
</tr>
<tr>
<td>Range</td>
<td></td>
<td></td>
<td>20-130</td>
<td>350-600</td>
</tr>
<tr>
<td><strong>Type B corridor options</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>M2 at Windsor Road, Baulkham Hills to F3 at Mt Colah</td>
<td>19</td>
<td>80</td>
<td>1400</td>
</tr>
<tr>
<td>6</td>
<td>M2 at Windsor Road, Baulkham Hills to F3 at Mt Colah via Round Corner</td>
<td>20</td>
<td>180</td>
<td>980</td>
</tr>
<tr>
<td>7</td>
<td>Sydney Orbital at Quakers Hill Parkway, Quakers Hill to F3 at Mt Colah</td>
<td>30</td>
<td>450</td>
<td>260</td>
</tr>
<tr>
<td>11</td>
<td>Sydney Orbital at Dean Park to F3 at Berowra via Riverstone</td>
<td>45</td>
<td>290</td>
<td>10</td>
</tr>
<tr>
<td>13</td>
<td>M2 at Pennant Hills Road to F3 at Mt Colah to via Railway Line</td>
<td>15</td>
<td>0</td>
<td>450</td>
</tr>
<tr>
<td>15</td>
<td>Sydney Orbital at Dean Park to F3 north of Mt Ku-ring-gai</td>
<td>34</td>
<td>390</td>
<td>20</td>
</tr>
<tr>
<td>17</td>
<td>Sydney Orbital between Old Windsor Road and Norwest Boulevard at Kings Langley to F3 north of Mt Ku-ring-gai</td>
<td>26</td>
<td>450</td>
<td>10</td>
</tr>
<tr>
<td>Range</td>
<td></td>
<td></td>
<td>80-450</td>
<td>10-1400</td>
</tr>
<tr>
<td><strong>Type C corridor options</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Sydney Orbital at Quakers Hill Parkway, Quakers Hill to F3 north of Hawkesbury via Dural</td>
<td>54</td>
<td>600</td>
<td>10</td>
</tr>
<tr>
<td>9</td>
<td>M2 at Windsor Road to F3 north of Hawkesbury</td>
<td>46</td>
<td>390</td>
<td>700</td>
</tr>
<tr>
<td>10</td>
<td>Sydney Orbital at Dean Park to F3 north of Hawkesbury via Riverstone</td>
<td>51</td>
<td>300</td>
<td>10</td>
</tr>
<tr>
<td>12</td>
<td>Sydney Orbital at Sunnyholt Road to F3 north of Hawkesbury</td>
<td>44</td>
<td>370</td>
<td>15</td>
</tr>
<tr>
<td>16</td>
<td>Sydney Orbital at Dean Park to F3 north of Hawkesbury via Annangrove</td>
<td>48</td>
<td>350</td>
<td>25</td>
</tr>
<tr>
<td>Range</td>
<td></td>
<td></td>
<td>300-600</td>
<td>10-700</td>
</tr>
</tbody>
</table>

Source: Draft Options Development Report (October, 2002)

Notes:
(1) Properties requiring full or strip acquisition.
(2) Properties passed under by tunnel, whose title would be effected.

**Construction cost estimates**

Comparative strategic cost estimates were prepared for each option as shown in Table 10-2 based on preliminary engineering design.

No allowance was made for the possible costs associated with the upgrades of the existing F3 Freeway or M2 Motorway that may be required to cater for any increased demand resulting from the construction of this link.
Table 10-2: Indicative construction cost estimates of the preliminary options(1).

<table>
<thead>
<tr>
<th>Option</th>
<th>Surface(2) ($ million)</th>
<th>Tunnel ($ million)</th>
<th>Major bridges(3) ($ million)*</th>
<th>Property acquisition(4) ($ million)</th>
<th>Planning &amp; Design Costs ($ million)</th>
<th>Total length(5) (km)</th>
<th>Total cost ($ billion)(6)</th>
<th>Average cost per km ($ million/km)</th>
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<tbody>
<tr>
<td>1</td>
<td>$24</td>
<td>$1,100</td>
<td>$0</td>
<td>$10</td>
<td>$81</td>
<td>7</td>
<td>$1.1–1.3</td>
<td>$190</td>
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<tr>
<td>2</td>
<td>$42</td>
<td>$1,500</td>
<td>$0</td>
<td>$10</td>
<td>$110</td>
<td>8</td>
<td>$1.6–1.9</td>
<td>$190</td>
</tr>
<tr>
<td>3</td>
<td>$33</td>
<td>$1,600</td>
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<td>$10</td>
<td>$120</td>
<td>9</td>
<td>$1.7–2.0</td>
<td>$180</td>
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<tr>
<td>4</td>
<td>$120</td>
<td>$1,900</td>
<td>$0</td>
<td>$15</td>
<td>$150</td>
<td>11</td>
<td>$2.1–2.4</td>
<td>$180</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Range</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$1.1–2.4</td>
</tr>
</tbody>
</table>

Type B corridor options

<table>
<thead>
<tr>
<th>Option</th>
<th>Surface(2) ($ million)</th>
<th>Tunnel ($ million)</th>
<th>Major bridges(3) ($ million)*</th>
<th>Property acquisition(4) ($ million)</th>
<th>Planning &amp; Design Costs ($ million)</th>
<th>Total length(5) (km)</th>
<th>Total cost ($ billion)(6)</th>
<th>Average cost per km ($ million/km)</th>
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<tr>
<td>5</td>
<td>$180</td>
<td>$2,600</td>
<td>$0</td>
<td>$60</td>
<td>$190</td>
<td>19</td>
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<tr>
<td>6</td>
<td>$530</td>
<td>$1,700</td>
<td>$0</td>
<td>$210</td>
<td>$130</td>
<td>20</td>
<td>$2.6–2.9</td>
<td>$130</td>
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<tr>
<td>7</td>
<td>$850</td>
<td>$650</td>
<td>$270</td>
<td>$420</td>
<td>$69</td>
<td>30</td>
<td>$2.3–2.6</td>
<td>$78</td>
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<td>11</td>
<td>$1,000</td>
<td>$630</td>
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<td>$2.1–2.4</td>
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<td>13</td>
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<td>$1,400</td>
<td>$900</td>
<td>$10</td>
<td>$210</td>
<td>15</td>
<td>$2.5–2.8</td>
<td>$200</td>
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<td>15</td>
<td>$920</td>
<td>$130</td>
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<tr>
<td>Range</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$1.5–3.3</td>
</tr>
</tbody>
</table>

Type C corridor options

<table>
<thead>
<tr>
<th>Option</th>
<th>Surface(2) ($ million)</th>
<th>Tunnel ($ million)</th>
<th>Major bridges(3) ($ million)*</th>
<th>Property acquisition(4) ($ million)</th>
<th>Planning &amp; Design Costs ($ million)</th>
<th>Total length(5) (km)</th>
<th>Total cost ($ billion)(6)</th>
<th>Average cost per km ($ million/km)</th>
</tr>
</thead>
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<tr>
<td>8</td>
<td>$1,000</td>
<td>$760</td>
<td>$350</td>
<td>$800</td>
<td>$84</td>
<td>54</td>
<td>$2.7–3.3</td>
<td>$51</td>
</tr>
<tr>
<td>9</td>
<td>$630</td>
<td>$1,800</td>
<td>$350</td>
<td>$620</td>
<td>$160</td>
<td>46</td>
<td>$3.6–3.9</td>
<td>$75</td>
</tr>
<tr>
<td>10</td>
<td>$850</td>
<td>$920</td>
<td>$350</td>
<td>$450</td>
<td>$96</td>
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<td>$350</td>
<td>$520</td>
<td>$99</td>
<td>44</td>
<td>$2.9–3.2</td>
<td>$61</td>
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<tr>
<td>16</td>
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<td>$950</td>
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<td>$310</td>
<td>$99</td>
<td>48</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$2.7–3.9</td>
</tr>
</tbody>
</table>

Source: Options Development Report (Draft, October 2002)

Notes:
1. The analysis was based on information prepared for Value Management Workshop in June 2002. The information for Type A options was refined as more work was done.
2. At grade interchanges assumed for this strategic assessment.
3. Allows for major bridges in tunnel and bridge sections.
4. Broad estimates only based on unit rates.
5. Excludes the length of access ramps.
6. These are cost estimates, based on strategic analysis, assuming at-grade interchanges at June 2002. Later analysis provided a slightly different cost range (see Table 4 of the Summary Report):
   - Type A: $1.5 to $2.2 billion (2003 dollars)
   - Type B: $1.6 to $3.4 billion (2003 dollars)
   - Type C: $2.7 to $3.6 billion (2003 dollars)

Cost estimates were generally been prepared assuming a two lane dual carriageway standard, based on an 80 km/h to 110 km/h design speed. The cost estimates for the tunnels in the eastern options (1, 2, 3, 4 and 13) were based on dual three-lane tunnels, but with no new grade separation at the existing interchanges.

In preparing the cost estimates, a number of broad assumptions were made about the location of tunnels, including:
- Tunnels to be generally required below heavily developed areas.
• Tunnels to be generally required below National Parks/wilderness areas.

• Where the height of cuts and fills would exceed approximately 40 metres, it was assumed that tunnels or bridges would generally be used.

The difference in cost between the inner urban and outer urban tunnels reflects an expectation that more complex tunnel arrangements will be required for exit and entry tunnels on inner urban tunnels. The outer urban tunnels would be expected to have only simple single entry and exits points, i.e. the main tunnel portals.

An allowance was included for professional costs, including planning, design, project management and administration. An allowance for service relocations and contingency was also included.

10.2 Strategic Assessment of Corridor Types

Options assessment framework

An assessment framework was developed to compare options on the basis of a wide range of effects, including strategic effects, transport, environmental, social and economic criteria. Its purpose was to derive a short-list of options for further more detailed study.

The key steps in the identification of options taken forward for more detailed analysis were:

i) Strategic Assessment of Options Against Project Objectives - An initial assessment of all the options against the overall project objectives. This also allowed grouping the options with similar characteristics and performances against these objectives.

ii) Technical Assessment - An assessment of options in terms of a wide range of criteria:

− Traffic and transport benefits
− Strategic urban and regional development issues
− Engineering feasibility
− Social and environmental impacts
− Urban design and landscape requirements,
− Capital costs and affordability, and
− Economic returns.

iii) Assessment by Interest and Stakeholder Groups - An initial identification of the issues associated with the various options that are likely to be of importance or concern interest and stakeholder groups. This is primarily to assess whether some issues might affect the selection of the feasible options. The following interest groups were considered.

− Travellers (cars, commercial, bus, rail, pedestrians and cyclists)
− Occupiers (residents, commercial office, retail, industrial, schools, hospitals, open space users, etc).
− Individuals and organisations concerned with the intrinsic values of the study area (National Parks, EPA, Councils, environmental groups, etc), and
− Government organisations concerned with economic and development issues (net community benefit, economic efficiency, finance, regional development and tourism).

Preliminary assessments of the options were presented by the project team at a Strategic Review of Feasible Options value management workshop held in Sydney on 26 June 2002. The outcomes of this workshop were then fed back into further technical assessments of the options, along with other inputs from the RTA, DOTARS, and the first round of the community focus group meetings held in June and July 2002.
This process led to the initial conclusions reached, as documented below.

**Strategic assessment of options against project objectives**

The options were assessed in terms of their likely strategic performance in meeting the link’s planning and project objectives.

Table 10-3 summarises a broad assessment of each of the options against the link objectives.²

<table>
<thead>
<tr>
<th>Objective</th>
<th>Assessment timeframe</th>
<th>Type A (eastern) options</th>
<th>Type B options (using existing F3 Hawkesbury River crossing)</th>
<th>Type C options (with new Hawkesbury River crossing(s))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved F3 to Sydney Orbital connection linked to regional network</td>
<td>Over next 10–20 years</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Longer term, beyond 2021</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Improved safety on the existing National Highway and surrounding corridor</td>
<td>Over next 10–20 years</td>
<td>✓</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Longer term, beyond 2021</td>
<td>✓</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Improve travel reliability and reduce costs of inter regional commercial vehicle movements on the interim National Highway</td>
<td>Over next 10–20 years</td>
<td>✓</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Longer term, beyond 2021</td>
<td>✓</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Reduce arterial road congestion and improve urban amenity, especially along Pennant Hills Road</td>
<td>Over next 10–20 years</td>
<td>✓</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Longer term, beyond 2021</td>
<td>✓</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Provide opportunities to improve public transport along the interim National Highway</td>
<td>Over next 10–20 years</td>
<td>✓</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Longer term, beyond 2021</td>
<td>✓</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Meet inter regional commercial transport needs, including improved access to Sydney ports</td>
<td>Over next 10–20 years</td>
<td>✓</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Longer term, beyond 2021</td>
<td>✓</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Source: Draft Options Development Report (October, 2002)

Notes:

✓ denotes achievement or substantial achievement.

X denotes expected lack of achievement.

This assessment concluded broad differences between two groups of options and how well these groups of options satisfy the link objectives:

- Type A options (Options 1, 2, 3 and 4), could be implemented within an 8–15 year timeframe to provide relief to northern Sydney arterial roads including Pennant Hills Road. These routes would serve improved access to eastern and western Sydney.

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² With the exceptions of Option 13, which would not be feasible to construct, and Option 14, which would not in itself provide an F3-Sydney Orbital link.
• Type B and C Options, which, over a longer 20–40 year timeframe, would generally fulfil the objective of meeting inter regional transport needs as Sydney grows. They would not, however, provide significant traffic relief to the interim National Highway corridor, including Pennant Hills Road (see below).

These longer-term options fall into two subgroups. The first group, the Type B (central) options (Options 5, 6, 7, 11, 15 and 17), join the F3 south of the Hawkesbury River and therefore are reliant on the existing Hawkesbury F3 crossing. The second group, the Type C (western) options, involve a new Hawkesbury crossing or crossings and join the F3 north of the Hawkesbury (Options 8, 9, 10, 12 and 16).

10.3 Transport Assessment of Type A, B and C corridors.

Transport Performance of Corridors

The great majority of traffic on the interim National Highway and approaching Sydney on the National Highway (F3) from the north is headed for destinations within urban Sydney, rather than seeking to pass through or around it.

In considering the transport performance of the various options, the following effects are apparent:

− the further west the new link, the less traffic will use it;
− the closer the new link is aligned to Pennant Hills Road, the more traffic relief to Pennant Hills Road;
− the closer the new link is aligned to Pennant Hills Road, the more truck traffic will use it.

Project and National Highway Transport Objectives

• Relieve congestion on the interim National Highway

Pennant Hills Road is currently congested with a traffic volume of about 75,000 vehicles per day. The Type A corridor would provide the most traffic relief to Pennant Hills Road and would achieve a reduction in traffic volume of the order of 20% to 40% in 2021.

The Type B and C corridor provides less relief. For both Type B and C corridors, the options which connect to the Westlink M7 furthest to the west, perform the poorest. For all Type A, B and C corridors, the traffic relief would be less if the new link was tolled.

About 20% of trucks currently travelling on Pennant Hills Road have local origins/destinations. The remaining 80% of these trucks would potentially use a Type A tunnel link. The Type A corridor would reduce truck traffic on Pennant Hills Road by about 65%. Type B and C corridors would remove less than half as many trucks as Type A. This is because the majority of trucks on Pennant Hills Road and the F3 have destinations in the east, centre and in the south of Sydney, which are not as well served by Type B and C corridors.

• Improve travel reliability on the new National Highway

With all of the new corridors proposed to be built to freeway standards, there would be no noticeable difference between them. All of the corridor types over the next 20 years, would operate at acceptable levels of service within their capacity.

• Serve future growth needs of long-distance traffic

Long distance freight traffic is forecast to double during the next 20 years. Most long distance traffic on the F3 has an origin or destination within Sydney. The proportion of long distance traffic that would use each option over the next 20 years, depends on how conveniently they serve major commercial
and industrial areas of Sydney. Type A corridors would be used by the highest percentage of long-distance traffic and Type C by the least.

- **Provide opportunities for improved public transport**

All three corridor types would make car travel more attractive and result in some reduction in public transport usage. Type A corridors would provide sufficient spare capacity in Pennant Hills Road to add bus or High Occupancy Vehicles (HOV) lanes should they be appropriate. Type B and C corridors do not provide such an opportunity.

- **Facilitate overseas and interstate trade and commerce**

Type A corridors would provide more direct access to Sydney’s commercial and industrial areas, interchange facilities, and ports and airport than Types B and C.

- **Safe and reliable access to major population centres**

Safety and reliability of travel on the National Highway would be improved by reducing both the amount of congestion and the volume of traffic on Pennant Hills Road. Type A corridors would have the greatest benefit.

Type A options would perform better than Types B and C in relation to the link’s transport objectives. Type A options would remove more traffic from Pennant Hills Road and best satisfy the National Highway objectives. All options would provide a safer and more reliable route than the present interim National Highway.

**Assessment of Type C Corridor**

There was much debate with community groups and individuals during consultation concerning the relative traffic merits of Type C compared with Type A. Type C corridor is therefore further assessed here.

The traffic model used to guide the traffic analysis showed that traffic volumes are predicted to increase in western Sydney, which could be serviced by a Type C option.

Type C would provide more direct access to western Sydney from the north. It would also provide a route choice for long distance travellers especially at times of traffic accident and bush fires along the F3. Some trips to/from western Sydney using the Type C corridor would benefit from reduced transport costs compared with using other routes.

The general growth of traffic generated from the established eastern Sydney suburbs, including inner west the airport and ports, would continue to congest the major eastern arterial roads including Pennant Hills Road, during peak periods over the 20 year planning horizon.

The analysis also indicated, that from an overall network assessment there would be less transport cost saving benefits to Type C compared to Type A as a result of traffic redistribution on the network and continuing congestion on the interim National Highway and surrounding arterial roads. Compared to Type A, Type C would yield similar, slightly higher vehicle kilometres travelled (VKT), but higher vehicle hours and overall higher vehicle operating costs on the network. This is indicated by the comparison given in Table 10-4.
Table 10-4: Network Travel Costs and Benefits – Comparison of Type A and Type C

<table>
<thead>
<tr>
<th>% Change in network costs compared with Base Case(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle Hours</td>
</tr>
<tr>
<td>------------</td>
</tr>
<tr>
<td>Type A(2)</td>
</tr>
<tr>
<td>Type C(3)</td>
</tr>
</tbody>
</table>

Notes:
(1) For 2 hour AM peak in 2021 with no link toll.
(2) Comparing Type A with the Base Case indicates fewer network hours (2.3% less hours) but a slight increase in vehicle kilometres (0.4%). Overall improved network performance would result.
(3) Comparing Type C with Base Case indicates slightly fewer network vehicle hours (-0.8%) and a slight increase in vehicle kilometres (0.3%).

Figure 10-3 illustrates typical traffic volumes on a Type C link in 2021 at the Hawkesbury River crossing(3). It also shows typical traffic relief to Pennant Hills Road, Pacific Highway and Ryde Road from the Type C corridor.

Of the typical 30,000 vehicles per day using Type C in 2021, about 20% would be heavy vehicles and about 5,000 vehicles would be re-distributed to/from western Sydney from the rest of the network including from the Central Coast.

About 50% of the traffic taken off Pennant Hills Road by Type C would be heavy vehicles, about 4,000 trucks including 2,000 articulated vehicles shown in Figure 10-3. The traffic relief from Type A would be higher. (Refer to Table 10-5).

Figure 10-3 also shows that the F3 would carry about 70,000 vehicles per day with Type C in the network in 2021, ie about the same volume of vehicles as carried out by the F3 today (2001).

It can be concluded from this analysis that on traffic grounds a Type C option would not satisfy the National Highway objectives over the 20 year planning horizon as well as Type A.

Figure 10-3: Typical Average Daily Traffic Relief on the Interim National Highway and arterial roads from Type C

<table>
<thead>
<tr>
<th>Typical Traffic Relief</th>
</tr>
</thead>
<tbody>
<tr>
<td>AADT</td>
</tr>
<tr>
<td>------------------------</td>
</tr>
<tr>
<td>F3</td>
</tr>
<tr>
<td>Pennant Hills Road</td>
</tr>
<tr>
<td>Pacific Highway</td>
</tr>
<tr>
<td>Ryde Road</td>
</tr>
</tbody>
</table>

(3) Traffic volumes would be higher on a Type C link further south where local traffic would add to the volumes on the link.
Overall Assessment

The results of the preliminary traffic assessment indicate that the Type B and Type C options would not relieve Pennant Hills Road of inter-regional traffic as much as Type A options. **Table 10-5** summarises the traffic analysis based on the outputs of the transport model developed for the purpose of this study.

**Table 10-5:** Transport assessment results, comparing the effects of Type A, B and C corridors

<table>
<thead>
<tr>
<th>Transport Improvements</th>
<th>Measure</th>
<th>Type A</th>
<th>Type B</th>
<th>Type C</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic volumes on new link</td>
<td>Annual average daily traffic (AADT) in 2021 (untolled)</td>
<td>70–105,000</td>
<td>30–50,000</td>
<td>30–50,000</td>
<td></td>
</tr>
<tr>
<td>Traffic congestion relief to Pennant Hills Road (existing National Highway corridor)</td>
<td>AADT in 2021 (untolled)</td>
<td>20–40,000</td>
<td>2,000-12,000</td>
<td>4,000-10,000</td>
<td></td>
</tr>
<tr>
<td>Daily truck relief to interim National Highway</td>
<td>Truck AADT</td>
<td>4,000-11,000</td>
<td>Up to 3,000</td>
<td>Up to 2,000</td>
<td>Based on current crash rates</td>
</tr>
<tr>
<td>Road safety changes on existing National Highway corridor</td>
<td>Savings in fatal and serious crashes per year¹</td>
<td>10–15</td>
<td>5–10</td>
<td>Less than 5</td>
<td></td>
</tr>
<tr>
<td>Opportunity to improve public transport</td>
<td>Potential for re-allocation of road space on Pennant Hills road for buses</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
<td>Type A offers opportunities to improve bus running times along Pennant Hills Road. Type C offers greater benefits for buses using the F3.</td>
</tr>
<tr>
<td>Improved access to ports and centres of economic activity for long distance freight movement</td>
<td>Savings in travel time to major freight centres</td>
<td>Significant (to/from eastern Sydney and Port Botany)</td>
<td>Some (to/from western Sydney)</td>
<td>Some (to/from western Sydney)</td>
<td>Type A options offer a more direct route to Sydney ports.</td>
</tr>
</tbody>
</table>


(1) Typical AADT volumes on Type C at the Hawkesbury River crossing would be 20-30,000 vehicles per day in 2021 (refer Figure 10.3).

(2) Current fatal and serious injury crash rate is about 114 per year on Pennant Hills Road north of M2.

### 10.4 Social Effects Assessment of Corridor Types A, B and C

**Impact on Communities**

Corridor Types A, B and C all have the potential to impact negatively on the social structure of those communities they pass through.

Type A options are mostly in tunnel. Direct impacts on nearby properties and severance effects would be small. Most impacts would be limited to access points, tunnel portals, interchanges, and tunnel ventilation stacks which would be generally located in already heavily trafficked areas.

Recent experience in Sydney has demonstrated the willingness of the community and government to place higher monetary values on the avoidance of social and environmental impacts from new surface roads in built-up areas, compared with the significantly high difference in costs of tunnel construction.

Types B and C are longer and would include above ground sections traversing both rural and residential built environments. They would be new routes in relatively lightly trafficked areas and have
the potential to adversely impact a large number of people. New severance issues may be introduced to communities, particularly by the longer Type C corridor options. The presence of an above ground freeway standard road, and associated ramps, interchanges and infrastructure, would be likely to have a significant impact on the community character and amenity of these areas.

Type A, B and C corridors would all involve long tunnelled sections and would require the use of ventilation stacks. The locations of stacks would need to be carefully considered during any EIS in order to minimise impacts on the surrounding environment and residential areas.

**Property Effects**

The likely numbers of properties affected along each corridor are shown in Table 10-6. Type A would effect the least and Type B the highest number of properties.

**Urban Design Effects**

The Type A corridor would result in the lowest impacts in relation to urban design criteria, including maintaining existing townscape qualities and impacts on existing and future town land uses. The Type C corridor would have the least acceptability with the most changes to existing land use patterns.

**Local Amenity Along Pennant Hills Road**

The greater the reduction of truck and vehicle volumes along Pennant Hills Road, the better the local amenity would be for people living and working along Pennant Hills Road. The benefits would include reduced noise levels, improved air quality and a lower level of community severance.

Type A options would offer the greatest improvements in amenity. They would provide the largest level of relief to Pennant Hills Road by removing 20-40,000 vehicles per day, including up to 11,000 trucks in 2021 when untolled. In comparison, Type B and C options would remove less than 12,000 vehicles per day, including up to 3,000 trucks when untolled.

Reduced levels of traffic along Pennant Hills Road would also allow for urban design and landscaping initiatives to be carried out, further enhancing amenity.

A reduction in severance would mean improved accessibility for local residents, including pedestrians and cyclists. Currently pedestrians face long delays waiting to cross Pennant Hills Road, which serves to discourage pedestrian access to shops, railway stations and bus stops.

**Table 10-6 Summary of Social Effects of Corridor Types**

<table>
<thead>
<tr>
<th>Social Criteria</th>
<th>Corridor Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Potential adverse changes to the character of communities</td>
<td>Low</td>
</tr>
<tr>
<td>Change in severance, traffic emissions including noise impact along Pennant Hills Road</td>
<td>Significant improvement</td>
</tr>
<tr>
<td>Number of properties affected:-</td>
<td></td>
</tr>
<tr>
<td>• Directly on the surface(1)</td>
<td>20-130</td>
</tr>
<tr>
<td>• Indirectly(2)</td>
<td>350-600</td>
</tr>
<tr>
<td>Acceptability of urban design character changes(3)</td>
<td>High</td>
</tr>
</tbody>
</table>

Notes:

(1) Full or strip acquisition.
(2) The number of properties located over tunnel whose title would be effected.
(3) In terms of maintaining existing townscape quality and minimising adverse change to existing and future land use patterns.
Overall Type A options would best improve local amenity along Pennant Hills Road. Type A options would also have the lowest adverse social impact in the study area.

10.5 Environmental Assessment of Corridor Types A, B and C

**Land Use**

Type A options would be mostly in tunnel under existing roads and residential areas, with surface works only at connecting points and possibly some mid-route points.

Type B options would involve above-ground and tunnel sections, passing through rugged creek valleys, bushland, semi-residential/rural areas and tunnels under developed residential areas.

Type C options would traverse similar land types as Type B, and also involve a connection to the F3 in rugged terrain near Mt White, a new crossing of the Hawkesbury River and a tunnel under Marramarra National Park.

**Impact on Threatened Fauna Species**

The preliminary assessment based upon National Parks database indicates a low to medium probability of significant impacts to threatened fauna species. The Type A corridor would have the lowest impact. The B and C corridors are judged to have higher probable effects, given their longer surface lengths.

**Impact on Bushland and National Parks**

In terms of land area affected Types B and C corridors could have a significant impact on bushland and National Parks.

Some of the Type A options could have some impact on Lane Cove National Park. Type C corridor would have a significant impact on Marramarra National Park. The biggest impact would result from Type B through Berowra Valley. The community has expressed a strong view against any option that adversely impacts on Berowra Valley and its bushland.

**Water Quality**

All three corridors would traverse waterways, with varying impacts. Some easterly Type A options would traverse the Lane Cove River Valley, where a tunnel would be required to pass under the river. The use of a tunnel would result in minimal direct impact on water quality and ecology.

The Type B corridor would traverse the Berowra Creek Valley, where a bridge would carry the new link. This would have the potential to impact on existing water quality and ecology. Other small creeks and waterways exist along the corridor, where similar issues could be encountered.

The Type C corridor would involve a major new crossing of the Hawkesbury River and the impact on water quality and ecology would need to be well managed. The Type C corridor would pass over many other small creeks and waterways with the attendant risk of impact on the many small creeks and tributaries running along its length.

**Air Quality**

By providing a free-flowing route, compared to the existing congested stop-start conditions experienced along Pennant Hills Road, reductions in vehicle emissions would be achieved with all options.

Air quality along Pennant Hills Road would be improved most with the Type A corridor, due to the greatest level of traffic congestion relief it would provide. In terms of overall emissions, Type A would have the lowest number of vehicle kilometres travelled and therefore lower vehicle exhaust emissions, with Type C the highest.
Landscape and Visual Impacts

The Type B corridor would have the higher visual impact on the Berowra Creek Valley and Berowra Valley Regional Park. The impacts of a high level bridge and approaches across the valley would result in a high and unacceptable level of visual disturbance. Similarly, the Type C corridor would have high impact on the Hawkesbury River and Marramarr National Park.

Heritage

There would be a higher risk of impact on indigenous heritage locations from the construction of the Type C route compared with Type B and A. Furthermore, the Type C corridor would traverse areas that are subject to Native Title claims.

A summary environmental assessment is shown in Table 10-7. Overall, Type A options would have less environmental impact than Types B and C.

Table 10-7 A Summary of Environmental Impacts of Corridor Types

<table>
<thead>
<tr>
<th>Environmental Criteria</th>
<th>Corridor Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact on Bushland/National Parks</td>
<td>A</td>
</tr>
<tr>
<td>Impact on Bushland/National Parks</td>
<td>Low</td>
</tr>
<tr>
<td>Potential Impact on threatened fauna species</td>
<td>Low</td>
</tr>
<tr>
<td>Effect on Water Quality (2)</td>
<td>Low</td>
</tr>
<tr>
<td>Effect on Air Quality (3)</td>
<td>Improve most</td>
</tr>
<tr>
<td>Impacts on character landscape (4)</td>
<td>Low</td>
</tr>
<tr>
<td>Heritage effects – probable impact on known sites</td>
<td>Low</td>
</tr>
</tbody>
</table>

Notes

(1) In the opinion of most community respondents, the impacts on Berowra Valley Regional Park were considered unacceptable.

(2) In terms of major waterways crossed.

(3) Based on congestion relief.

(4) Adverse landform modifications and reduced landscape character.

10.6 Economic Assessment of Corridor Types A, B and C

Economic performance of Corridors

Economic benefits of transport corridors are measured by determining the total change in motorists’ travel time and distance travelled. This is measured across the whole road network, because some impacts from redistributed traffic may occur on other parallel routes. The benefits are compared with the whole-of-life costs of the corridors to assess their overall value.

Type A, B and C corridors with the project included in the road network all result in a slight increase in the number of trips compared to the situation without the project. However, economic benefits accrue to the additional trips, as well as to existing trips on the network. This has resulted in benefit-cost ratios (BCRs) in the range of 1.2 to 1.4 for four lane Type A corridors, assuming the link is untolled.

Type B and C corridors would have relatively less economic benefits than Type A corridors because they attract less traffic away from the congested Pennant Hills Road and hence there will be less travel time saved. In addition, Type B and C corridors would have substantially higher construction costs than Type A.
A cost-benefit analysis of Type B and C corridors compared to Type A corridors (all four lane projects) indicates that they would have much lower economic performance than Type A corridors. In other words, in all cases the benefits associated with Type B and C corridors would be less and would be outweighed by the construction costs of Type B and C corridors. This is summarised in Table 10-8.

Combining these results, Type A corridors would be the only ones with a BCR likely to be above 1. Types B and C corridors would have much lower BCRs, in the range of 0.1 to 0.4.

All of the corridor Types A, B and C would have other less tangible benefits such as encouraging regional development, improving the safety and reliability of travel on the National Highway, and improving access to major ports and airports. Type A corridor options would have the greatest benefit in improving access to ports and airports due to their central location in Sydney.

**Financial performance of Corridors**

The financial performance of the corridor types relates to their construction and operating cost, ability to stage delivery, and the ability of government to recover any revenue from them. Generally, the lower cost options, are more financially attractive. All three Types A, B and C corridor options would cost in excess of $1.5 billion (2003 dollars) to deliver, making funding the project a significant issue. Type A options would have lower construction costs, and hence would be easiest to fund.

Due to the inclusion of several kilometres of tunnels in all corridor options, operating and maintenance costs for the project would be significant, estimated up to $16 million per annum.

For all Type A, B and C corridors it would be possible to place a toll on traffic using the corridor. Type A corridors are likely to generate the highest revenue, due to their higher traffic volumes.

<table>
<thead>
<tr>
<th>Economic Criteria</th>
<th>Corridor Type (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Strategic Capital Cost Estimate</td>
<td>1,500 to 2,200</td>
</tr>
<tr>
<td>Operational Cost Estimate</td>
<td>7 to 10 per year</td>
</tr>
<tr>
<td>Benefit Cost ratio</td>
<td>1.2 to 1.4</td>
</tr>
<tr>
<td>Support regional development</td>
<td>Yes</td>
</tr>
</tbody>
</table>

(1) These results are as determined for the strategic comparison of the alternative corridors. Later investigations of the specific Type A options resulted in changes to those costs. It would be expected that a more detailed investigation of the Type B and C corridor options would result in similar changes to the cost and economic performance of those corridors.

Overall Type A corridor options would have the best economic performance, against both project and National Highway economic objectives. Type A options would be easier for government to fund than Types B and C.

**10.7 F3 Capacity Issues**

Corridor Type A options rely on the existing F3 corridor and the existing crossing of the Hawkesbury River which is a constraint to growth beyond 2021 if current trends in population and employment continue over this period.

While most community groups consulted were in favour of options which provide relief to Pennant Hills Road, there was a strong view expressed that government should plan now for infrastructure beyond 2020. Furthermore these same groups were in favour of further investigation of Type C which was judged by many to be needed, recognising the increasing pressure on the F3 Freeway and its ability to service growth in inter regional transport.

The proposed link would greatly improve connectivity between the Sydney Orbital and the F3 Freeway. The capacity of the F3 Freeway would also influence operations of the new link. There will
be a need to increase the capacity of the F3 over some sections south of the Hawkesbury River crossing by 2011. Further capacity enhancements and/or demand management measures are likely to be required beyond the timeframe of this study (2021).

An investigation into the planning need for a new northern transport corridor could be considered as part of the current review of the Sydney Metropolitan Strategy by the NSW Department of Infrastructure, Planning and Natural Resources. Such an investigation is outside the scope of this study, or National Highway planning.

10.8 Conclusions

The analysis demonstrated that the Type A corridor best satisfies the National Highway objectives over the 20 years planning horizon.

Of the Type A options investigated, three options shown in Figure 10-2 Red (Option 1), Yellow (Option 2) and Blue (Option 3) were taken to the next stage of investigation. The details of the Type A options assessment are given in the Options Development Report.

A fourth Type A option based on the Purple alignment (modified Option 4 shown on Figure 10-2), was also considered further and modified in the next stage. The modified Purple Option follows Pennant Hills Road and the Main North Rail Line, mostly in tunnel from the M2 to the F3 at Wahroonga.

The Type B corridor options would not satisfy the National Highway objectives on transport grounds and they would have a high capital and environmental cost. The Type B corridor options were also judged by the community to be unacceptable on environmental impact grounds and were not considered further.

The Type C corridor options would also have significant environmental effects which would need to be managed. They would also have an uncertain economic justification. However, the capacity limitations of the combined F3/Type A link corridor would justify at least the further investigation of longer term needs for inter-regional transport and its growth beyond 2021 as part of a wider land-use strategic review of Sydney's long term development.
11

Options Development

This chapter presents indicative arrangements for the Type A options. Indicative feasible interchange arrangements were developed and shown for the purpose of the assessment of the Type A options.

These arrangements are examples only, and should not be regarded as representing any preferred concept proposal. Details such as local environmental impacts, land requirements, tunnel ventilation effects, would be determined in detail at the concept design stage and through the Environmental Impact Statement (EIS) study, should the project proceed to an EIS.

11.1 Project Objectives

A new National Highway link should satisfy both planning and project objectives. Planning objectives were described in Chapter 7. The following project objectives were developed to guide the assessment of options. A new link should:

i) provide a high standard access controlled motorway that integrates with the regional transport network,

ii) minimise social and environmental impacts during construction and operation,

iii) provide opportunities for improved public transport,

iv) be economically justified and affordable to government.

The Type A options were assessed against these objectives. An assessment framework was established which included criteria under these broad objectives, against which the options were assessed. The assessment of options is presented in Chapter 12 and the assessment framework in Section 12.1.

11.2 The Purple, Blue, Yellow and Red Options

Four typical Type A options are presented – Purple, Blue, Yellow and Red options.

All four options would be constructed mostly in tunnel with portals and connections to the existing road arterial network mostly built within the existing road reserves. A summary description of each option is presented below. More detail is given in the Working Papers.

All four options are shown on Figure 11-1 as broad corridors or bands of 500 metres width which provide an indicative route for each option, sufficient for the purpose of comparative assessment. Within each broad corridor an indicative feasible horizontal and vertical alignment was established to guide the assessment with attention paid to surface sections, at the tunnel portals and at interchanges.

Description of the Purple Option

The Purple option has its northern connection with the F3 at Wahroonga, and a southern connection to the M2 at the existing Pennant Hills Road/M2 interchange. Its alignment generally follows the alignment of Pennant Hills Road some 30-40 metres below the surface.
The Purple option includes dual 2km long tunnels from the F3, a short (500 metres) section where it daylights in an open trench adjacent to the railway corridor and in the vicinity of the Brickyard Park at Thornleigh. From Thornleigh dual 5.5km long tunnels would terminate at the the M2 interchange.

The dual tunnels would be two or three lanes in each direction.

North of Pennant Hills Railway Station the tunnels would be excavated under the existing railway corridor. The railway corridor is 40m wide and the road tunnels would be constructed wholly underneath this railway reserve. The longer, southern tunnels could pass over the top of the proposed North West Rail Link tunnels.

**Figure 11-1: Feasible route options**

The interchange at the northern end, at Wahroonga, would directly connect the new link to the F3, the Pacific Highway and Pennant Hills Road. The northern interchange would cater for all existing traffic movements between the F3 and Pennant Hills Road as shown by **Figure 11-2**.

The southern interchange would directly connect the new link to the M2 and Pennant Hills Road. The new link/M2 interchange would allow for direct travel to and from the west. Travel to and from the south on Pennant Hills Road could be grade separated or via a surface connection. Connections with the M2 to and from the east would be available via a surface connection to Pennant Hills Road as shown by **Figure 11-3**.
Figure 11-2: *The Purple Option Northern Interchange - possible arrangements with the F3 Freeway and Pacific Highway*

Figure 11-3: *The Purple and Blue Options Southern Interchange - possible arrangements with the M2 and Pennant Hills Road*
The Purple Option has no major impacts on existing infrastructure, although the access to Frith Avenue, Edwards Road and Russell Avenue in Wahroonga would need to be addressed.

The construction of the Purple Option would require the acquisition of some of properties at the northern interchange. At the southern interchange a number of existing properties, most of which are currently owned by the RTA, would be affected. A number of properties along the main alignment above the tunnels whose title would be required to be changed, would also be indirectly affected.

The key engineering elements of the Purple option are as follows:

- Distance between northern and southern interchanges of 8 km.
- Total road length of 25 km including ramps.
- Total lane length of 54 km.
- Total lane length in tunnel of 44 kilometres.
- Average grade of 2.1%.
- Average grade of main alignment of 1.5%.
- Maximum grades on main alignment of 3.5% (up and down) at the northern interchange.
- Maximum grade of 6% (up and down) on the south facing ramps from Pennant Hills Road in Wahroonga.
- Maximum grade of 6% (up and down) on the bridges over the existing M2 Motorway / Pennant Hills Road interchange in Carlingford.

Construction

The construction of the Purple northern interchange would require the work to be undertaken in stages. Due to the tunnel portals being located adjacent to the existing north facing ramps for the Pacific Highway, some temporary works would be required to maintain the existing traffic flows while the tunnelling is occurring. The widening of the north facing ramps onto the F3 Freeway to allow for three lanes would require works to be done under traffic. The construction of the south facing ramps from Pennant Hills Road could be staged once the link has been opened. This would reduce the traffic on Pennant Hills Road and therefore improve the constructability of these ramps. Similarly, the construction of the south facing ramp from the Pacific Highway could be undertaken following the opening of the link to reduce the impact on traffic and improve constructability.

The construction of the southern interchange would require construction of two bridges over the existing M2 Motorway / Pennant Hills Road interchange.

Description of the Blue Option

The Blue option would have its northern connection with the F3 at Wahroonga. It would also have a southern connection to the M2 at the existing Pennant Hills Road/M2 interchange similar to the Purple option. It generally follows a route to the east of Pennant Hills Road, some 30-40 metres below the surface.

The main dual tunnels would be approximately 8km in length. The tunnels would pass under Coups Creek.

The dual tunnels would be two or three lanes in each direction. The northbound tunnels would run at a 6% gradient up to Wahroonga and require a passing lane in the northbound tunnel.

The interchange at the northern end at Wahroonga, would directly connect the new link with the F3, the Pacific Highway and Pennant Hills Road. It would cater for all existing traffic movements between the F3 and the Pacific Highway and Pennant Hills Road as shown by Figure 11-4.
The southern interchange would directly connect the new link to the M2 and Pennant Hills Road similar to the Purple option. The new link/M2 interchange would allow for direct travel to and from the west. Travel to and from the south on Pennant Hills Road could be grade separated or via a surface connection. Connection with the M2 to and from the east would be available via a surface connection to Pennant Hills Road as shown by Figure 11-3.

The Blue Route has no major impacts on the existing infrastructure. The layout of the northern interchange would affect Eastbourne Avenue between Exeter Road and Lucinda Avenue. A bridge over the link would be required to maintain this road for local traffic.

Figure 11-4: The Blue, Yellow and Red Northern Interchange – possible arrangements with the F3 and Pacific Highway

The construction of the Blue Route would require the acquisition of some properties at the northern interchange. This is particularly associated with the widening of the Pacific Highway and the construction of the ramps between Pennant Hills Road and the link. A number of properties along the main alignment above the tunnel whose title would be required to be changed would be indirectly affected.

The key engineering elements of the Blue option are as follows:

- Distance between northern and southern interchanges of 8 km.
- Total road length of 34 km including ramps.
- Total lane length of 69 km.
- Total lane length in tunnel of 50 km.
- Average grade of 2.8%.
- Average grade of main alignment of 2.4%.
Maximum grades on main alignment of 6.0% (up and down) at the northern interchange.

Maximum grade of 7.5% up and 6.2% down on the south facing ramps from Pennant Hills Road to the link in Wahroonga.

**Construction**

At the northern interchange the portals for the main through alignment would be located in an open area currently owned by the RTA, which would allow the commencement of the tunnel construction clear of the existing roadworks. The connection to the tunnels would require the existing level of the F3 Freeway to be lowered below the Pacific Highway bridge. This would require staging of the construction works to allow the connection to Pennant Hills Road to remain open while the level is lowered. This activity would require the use of narrow lanes below the bridge in order to facilitate construction. The widening of the north facing ramps onto the F3 Freeway to allow for three lanes would require works to be done under traffic. The construction of the ramps connecting to the Pennant Hills Road intersection would require some staging in order to construct the necessary bridges across the new works.

**Description of the Yellow Option**

The Yellow option would have its northern connection to the F3 at Wahroonga, and a dual southern connection to the M2, either side of the existing M2 tunnels in North Epping. At the M2, the eastern connection would join the M2 Motorway at Terrys Creek with the western connection west of Beecroft Road.

This option would involve dual main tunnels of 6.5km each with two or three lanes. The Yellow option would pass under Devlins Creek, Lane Cove River and Coups Creek. It would be approximately 15 to 20 metres below Lane Cove River and Coups Creeks. One of the ramps would be below Terrys Creek, and the other would be above the Creek as a bridge.

The northern interchange (at Wahroonga) would directly connect the new link with both the F3 and the Pacific Highway/Pennant Hills Road. It would cater for all existing traffic movements between the F3 and the Pacific Highway, and Pennant Hills Road. The northern interchange would be the same as for the Blue and Red Options – see Figure 11-4.

The southern interchange (with the M2) would directly connect the new link with the M2 to and from both the east and west. Connections with roads to and from the south, such as Lane Cove Road and Pennant Hills Road, would be via the M2 Motorway shown in Figure 11-5.
A number of property acquisitions would be required for the eastbound on ramp of the southern interchange. The construction of the westbound on ramp, would require some acquisition from and modifications to the Epping Heights Primary School. A number of properties along the main alignment above the tunnel whose title would be required to be changed would be indirectly affected.

The key engineering elements of the Yellow option are as follows:

- Distance between northern and southern interchanges of 6.5 km.
- Total road length of 36 km including ramps.
- Total lane length of 60 km.
- Total lane length in tunnel of 38 km.
- Average grade of 2.8%.
- Average grade of main alignment of 2.4%.
- Maximum grades on main alignment of 6% (up and down) at the northern interchange.
- Maximum grade of 7.5% up and 6.2% down on the south facing ramps from Pennant Hills Road to the link in Wahroonga.
- Maximum grade of 3.2% up and 6.9% down for the southern interchange at Epping.

**Construction**

The construction of the southern interchange would involve the connection of ramps to the existing motorway clear of any other ramps or interchanges. This would result in a relatively simplified construction compared to other routes.

The Yellow option would require an additional lane on the M2 Motorway between the east facing ramps and Lane Cove Road. In addition to widening the existing carriageway, this would require the modification or reconstruction of a number of existing bridges along this length. As part of the
construction of the southern interchange, the existing pedestrian bridge at Murray Farm Road would also need to be reconstructed. As with the Blue Route, the layout of the northern interchange would affect Eastbourne Avenue between Exeter Road and Lucinda Avenue.

**Description of the Red Option**

The Red option would have its northern connection to the F3 at Wahroonga, and a dual southern connection to the M2 at Macquarie Park, either side of the existing M2 toll plazas. It would involve dual main tunnels of approximately 6.5km in length, each with two or three lanes. The tunnels would pass approximately 15 metres under the Lane Cove River and Coups Creek.

The northern interchange (at Wahroonga) would directly connect the new link with the F3, the Pacific Highway and the Pennant Hills Road. It would cater for all existing traffic movements between the F3 and the Pacific Highway, and Pennant Hills Road. The northern interchange would be similar to the interchange for the Blue and Yellow Options – see Figure 11-4.

The southern interchange would directly connect the M2 to and from both the east and west. Connections with roads to and from the south, such as Lane Cove Road, would be via the M2. The M2 would need to be widened between Herring Road and Lane Cove Road as shown by Figure 11-6.

Tunnelling under the Lane Cove River would mean steep grades of about 6% between the river and the M2. Steep grades would require heavy vehicles including trucks to change gears and use more fuel and this has the potential to increase vehicle emissions. It would be possible to minimise these impacts if the tunnels under the river at this point were replaced with a bridge. This would allow flatter road grades and shorter main tunnels. This alternative would also provide vehicle operating cost savings over the life of the project. However, experience with other recent proposals in the area demonstrates that an above-ground crossing of the Lane Cove River in the Lane Cove National Park may not have broad community acceptance, and it was not considered as part of this option.

*Figure 11-6: The Red Option Southern Interchange – possible arrangements with the M2 Motorway*

For the purpose of this assessment a tunnel underneath the Lane Cove River was assumed.
The Red Option has no major impacts on the existing infrastructure. As with the Blue and Yellow options, the layout of the northern interchange would affect Eastbourne Avenue between Exeter Road and Lucinda Avenue. It would also require some property acquisition to accommodate the widening of the Pacific Highway and construction of the ramps between Pennant Hills road and the link.

Some strip acquisitions would be required along the southern side of the M2 Motorway, west of Lane Cove Road to allow for the construction of the east facing ramps. A number of properties along the main alignment above the tunnel whose title would be required to be changed would be indirectly affected.

The key engineering elements of the Red option are as follows:

- Distance between northern and southern interchanges of 6.5 km.
- Total road length of 30 km including ramps.
- Total lane length of 58 km.
- Total lane length in tunnel of 38 km.
- Average grade of 3.7%.
- Average grade of main alignment of 3.5%.
- Maximum grades on main alignment of 6% (up and down) at the northern interchange.
- Maximum grade of 7.5% up and 6.2% down on the south facing ramps from Pennant Hills Road to the link in Wahroonga.
- Maximum grade of 5.3% up and 6.6% down for the southern interchange at Marsfield.

**Construction**

The construction of the west facing ramps for the southern interchange would be relatively simple, as they are clear of other ramps and interchanges. The construction of the east facing ramps would be more difficult as separate ramps would be required for the M2 Motorway and Lane Cove Road to avoid weaving of traffic. The construction of the ramps connecting to Lane Cove Road would require the reconfiguration of the existing ramps and the extension of the off ramp by approximately 500 metres. The construction of the ramps to the M2 Motorway would require some modification to the existing lanes in order to make room for the ramps. This would require a staged construction approach including a number of traffic switches during the course of construction.

**11.3 The Base Case Option**

The “Base Case” for this study is defined as the situation without the development of a new F3 to Sydney Orbital link.

The “Base Case” assumes:

- The M7 Motorway of the Sydney Orbital (linking the M5 to the M2, and scheduled for completion in 2006) will form part of the 2011 base road network
- Other road projects assumed by the RTA for the purpose of traffic modelling, and in particular:
  - The 2011 base road network would include six lanes on the F3 between the Hawkesbury River and Kariong (scheduled for completion by 2004), six lanes on the F3 between Wahroonga and the Hawkesbury River (no commitment yet, but required by 2011 at the latest) and the widening of the M2 to six lanes plus bus lanes between Windsor Road and Abbott Road, and
The 2021 base road network would include six lanes on the M2 east of Windsor Road, plus the widening of Pennant Hills Road to six lanes between the M2 and James Ruse Drive and the widening of Schofields Road to four lanes.

- Both stages of the Parramatta Rail Link between Parramatta and Chatswood via Epping would be in operation by 2011, and the section of the Main North railway line between the Central Coast and Hornsby be upgraded by 2021.

The “Base Case” is assumed not to involve major capital or operating expenditures on roads in the existing corridor.

Note that the Base Case assumptions listed above are not necessarily current proposals or policy views of the NSW and Australian Governments.
Type A Options Assessment

The Type A Options Assessment is presented in this chapter under the following headings:

i) Assessment Process;

ii) Assessment of Main Effects;

iii) Pair Wise Comparison of Options;

iv) Main Effects by Interest Groups;

v) Value Management Workshop Outcomes; and

vi) Conclusions.

12.1 Assessment Process

An impact assessment framework was used to undertake the assessment of the Type A options. This framework allows the joint consideration of quantified and unquantified effects of options, including economic, social and environmental effects as well as how well overall objectives of the relevant transport strategies are met. The detailed assessment of Type A options was conducted using a wide range of criteria, covering:

- Strategic Development Objectives (including strategic urban development);
- Transport and Traffic Benefits;
- Urban Design, Landscape and Visual;
- Engineering Design (including tunnel design criteria);
- Social Effects;
- Environmental Effects;
- Economics; and
- Affordability.

Quantified Effects of Options

The key quantified effects of the options are captured in a Road User Benefit Cost framework, undertaken in line with the RTA Economic Analysis Manual. Assessment of changes in transport and road user welfare was examined including incremental changes, valued in money terms, compared to the Base Case, for the following parameters:

- project capital costs;
- project recurrent costs;
- vehicle operating cost savings;
• user travel time cost savings; and
• accident cost savings.

Non-Quantified Effects of Options

There is a range of environmental, social and strategic impacts of the project options which are not amenable to measurement in monetary terms. Moreover, these projects display public good (non-market) characteristics with impacts that will not necessarily be restricted to the stakeholders who are affected by road use and other quantified impacts.

The non-market nature of these resources does not however imply that they do not generate economic welfare. The non-quantified effects were assessed via a ranking approach. The rankings were derived in a participative process combining the output from the technical studies within each area and feedback from the Value Management workshops, shown in Section 12.5.

Pair Wise Analysis of Options

A pair wise analysis approach was used to identify the preferred options.

This framework is based on rankings developed by assessing each option against the assessment criteria identified. The preferred option under each criteria is identified and these results combined to provide the option ranking under each criteria group. The rankings derived are based on the results of technical studies within each area of investigation. It should be noted that the assessment tables only identify those criteria against which, the Option performance diverges.

The assessment in each technical area is based on the work undertaken for the Technical Working Papers as provided as part of the study process. Each assessment table is followed by the summary assessment result in each area.

Options were assessed against each other in a pair wise analysis to yield the preferred option. The preferred option was assessed against the Base Case. The results of the pair wise analysis and the description of the key performance measures which determined the relative desirability of options are provided in Section 12.3.

12.2 Assessment of Main Effects

An assessment by each main effect are presented below.

Strategic Development Objectives

The principal strategic objective which the feasible Type A options need to be assessed against can be stated as:

“To enable the effective and efficient movement of inter-regional transport (people and goods) to access Sydney economic markets over the next 20 years”.

The type A options are assessed against strategic development criteria shown in Table 12-1. The assessment indicates that:

• Purple and Blue Options would be relatively more effective in connectivity to the arterial network at the M2;
• Red Option would most effectively meet the National Highway objectives of improved access to ports and centres of economic activity;

1 The answer to the question as to whether monetised benefits (or costs) are outweighed by environmental and social benefits (or costs), requires government policy direction and decisions within the broader ESD and triple bottom line accounting framework.
Purple and Blue options would have the most effect (relative to other options) in supporting the key Transport 2010 objectives, particularly in relieving traffic congestion for inter-regional traffic, clean air objectives and supporting an increase in public transport mode shares and improved access to Western Sydney;

Purple and Blue are preferred in terms of supporting national and regional development objectives as they would provide a more direct route for a larger number of long distance commercial vehicles than for Yellow and Red;

Purple and Blue are preferred for their role in providing access to industrial centres in Western Sydney and enabling access from north west Sydney to the Central Coast.

Red is preferred in terms of providing access to Sydney and North Sydney CBDs and linking the Central Coast with these employment centres.

Overall, the assessment according to Strategic Development criteria indicates the following:

- The Purple option is preferred under these criteria, marginally above the Blue option; and
- The Yellow option ranks last.

The strategic development assessment table is shown below in Table 12-1.

### Table 12-1: Strategic Development

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Measure</th>
<th>Options</th>
<th>Comments and Preferred Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Strategic Transport Development</td>
<td>Complete the missing gap in the National Highway Network</td>
<td>Purple: 1, Blue: 1, Yellow: 3, Red: 3</td>
<td>Purple and Blue are more effective in connectivity to the arterial network at the M2. They both allow through traffic to southern origins and destinations in Sydney to travel without detour or stopping. Purple/Blue provide a more direct link to the arterial network along existing and future commercial traffic desire lines.</td>
</tr>
<tr>
<td></td>
<td>Transport Connectivity</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Facilitate overseas and interstate trade and commerce</td>
<td>Purple: 3, Blue: 3, Yellow: 2, Red: 1</td>
<td>Red is most effective on meeting objectives of improved access to ports.</td>
</tr>
<tr>
<td></td>
<td>• Improved access to ports</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Improved access to centres of economic activity</td>
<td>Purple: 1, Blue: 1, Yellow: 3, Red: 3</td>
<td>Purple and Blue are more effective in providing direct route improvement for commercial vehicle origins/destinations in central and western Sydney.</td>
</tr>
<tr>
<td></td>
<td>Support NSW Govt. Transport Objectives</td>
<td>Purple: 1, Blue: 2, Yellow: 3, Red: 3</td>
<td>Purple is more effective in relieving traffic congestion for long distance traffic. None of the options reduce total vehicle kilometres travelled (VKTs) (indeed they would be expected to have a small increase in overall travel on the network. In addition, with the capacity improvements a small (less than 1% of corridor traffic) induced effect would occur. Furthermore, the capacity improvements would generate a mode shift (up to 5%) from rail to road in the corridor for all options.</td>
</tr>
<tr>
<td></td>
<td>Transport 2010 Objectives</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Criteria</td>
<td>Measure</td>
<td>Options</td>
<td>Comments and Preferred Option</td>
</tr>
<tr>
<td>----------</td>
<td>---------</td>
<td>---------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>Purple</td>
<td>Blue</td>
<td>Yellow</td>
<td>Red</td>
</tr>
<tr>
<td>• Increase public transport (PT) mode shares</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>• Clean Air Objectives</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Assist in the wider NSW Planning Objectives of Developing Metropolitan Sydney</td>
<td>Facilitation of Planning Objectives</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>(b) National and Regional Development</td>
<td>Support National Development</td>
<td>Facilitate movement between Brisbane-Sydney-Melbourne</td>
<td>1</td>
</tr>
<tr>
<td>Support State and regional Development (GMR)</td>
<td>Access to Sydney’s growing economy in Western Sydney</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Access travel time to &quot;ports&quot; (KSA / Botany / Enfield)</td>
<td>Distance from Hornsby to KSA, Botany &amp; Enfield</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>(c) Sydney’s Metropolitan Land Use Development</td>
<td>Access to industrial centres</td>
<td>Ease of Access to Western Sydney</td>
<td>1</td>
</tr>
<tr>
<td>Access to regional centres</td>
<td>Distance to the Sydney-Nth Sydney CBDs. Together, these are 5 times the size of Parramatta</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Enable growth of regional centres</td>
<td>Distance to main employment zones of Sydney from Central Coast</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Most direct link to Hunter and Central Coast from NW</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
### Traffic and Transport Objectives

The key findings from the traffic and transport analysis are:

- **Traffic Relief to Pennant Hills Road** – The traffic relief to Pennant Hills Road would be about 35,000 vehicles per day, after traffic redistribution, with an untolled Blue or Purple link in the network in 2011. A new untolled Purple or Blue link would remove up to 11,000 heavy vehicles from Pennant Hills Road in 2021. The existing road space on Pennant Hills Road could then be re-allocated to four lanes of general traffic from six, allowing greater provision for buses, cyclists and pedestrians and access to Pennant Hills and Thornleigh rail stations.

  Traffic levels on Pennant Hills Road would be reduced by about 20,000 vehicles per day with the Yellow and Red options by 2011. The traffic volume on Pacific Highway would be 3,500 to 4,000 vehicles per day lower with the Red option.

- **Inter-Regional Traffic** – the strategic development criteria also shed light on the traffic and transport performance of the options in relation to long distance traffic. National and regional development criteria indicate that the Purple and Blue Options perform best in facilitating inter-regional movements including between Brisbane-Sydney-Melbourne, providing improved access to regional NSW and Western Sydney.

- **Freight** – the traffic and transport assessment indicates that the Red Option performs relatively well in terms of reducing freight transit times and improved access to ports (Botany, Enfield and Kingsford Smith Airport). This result is also borne out in the strategic development assessment where Red performs the best in terms of linking the east to the North Sydney and Sydney CBDs and providing a link between the Central Coast and Sydney’s employment zones.

  The Purple and Blue Options perform well in terms of improved access for commercial traffic between north and south of Sydney to northern destinations and access to Western Sydney.

- **The Effect of a Toll** – A number of tolling options were investigated to understand their effects on the viability of the project and between options, if tolls were adopted. Of these options, a toll of $3.50 (for cars and trucks) was found to be optimum in terms of toll revenue stream maximisation (see Chapter 17 Section 17.2). A $3.50 toll (for cars and trucks) on the new link would reduce daily traffic on the new link by as much as 50% (see Table 12.2(a)). The tolled volume would reduce to about 40,000 vehicles per day compared with 70,000 vehicles per day on the Blue or Purple option in 2011, and traffic volumes on Pennant Hills Road would increase from about 55,000 to about 65,000 with a tolled F3/M2 link. Tolling the new link would reduce the achievement of the link’s objective of reducing traffic on Pennant Hills Road.

  The reason for the high diversion with the inclusion of a toll is the already high costs of travel in this corridor, including the M2, M7 and Lane Cove tolls, and the comparative small travel time savings gained (10-15 minutes in 2011) by using the new link compared with using Pennant Hills Road.

- **Network Effects and the influence of the M2 toll** – The Purple/Blue options perform the best in terms of traffic relief from Pennant Hills Road, when assuming the existing M2 toll regime will continue over the next 20-30 years. If however, the M2 tolls could be removed the Red and Yellow options would perform much better in terms of reduced network–wide costs. In such
circumstances the Red and Yellow options would be preferred with or without a new link toll in place.

- **Redistributed and Induced Traffic** – Overall traffic levels increase by about 20% in the corridor as a result of traffic redistribution into the area (due to improved accessibility) and diverted from public transport. In addition, the new link is expected to generate about 1,000 (almost 1% of Base Case traffic levels) completely new vehicle movements per day or “induced traffic”. The Blue and Purple route options incur the highest level of induced traffic.

- **Integrated Transport** – The Purple/Blue Options would also present an opportunity to improve the overall effectiveness of the transport system by providing the conditions for improved public transport reliability and integration in the corridor, particularly along Pennant Hills Road.

The road space which could be released by the diversion of traffic from Pennant Hills Road, Pacific Highway and the adjoining roads in northern Sydney could be used to improve the attractiveness for other users, including for users of the local bus network.

Overall, the assessment according to Traffic and Transport criteria indicates the following:

- The Purple or Blue Options are preferred due to their better performance in terms of traffic relief on the key arterial roads in northern Sydney, particularly Pennant Hills Road.

The detailed traffic and transport assessment table is presented below in Table 12-2.

**Table 12-2: Traffic and Transport Assessment**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Measure</th>
<th>Purple</th>
<th>Blue</th>
<th>Yellow</th>
<th>Red</th>
<th>Comments and Preferred Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Traffic Congestion Relief</td>
<td>Total vehicles on link in 2021</td>
<td>Annual Average Daily Traffic (AADT)</td>
<td>45,800</td>
<td>45,800</td>
<td>22,400</td>
<td>27,100</td>
</tr>
<tr>
<td></td>
<td>Tolled ($3.50)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Untolled</td>
<td>79,800</td>
<td>79,800</td>
<td>67,500</td>
<td>70,100</td>
<td>Purple or Blue</td>
</tr>
<tr>
<td></td>
<td>Surface Traffic Relief in 2021 (untolled)</td>
<td>Pennant Hills Road (north of Boundary Road)</td>
<td>All vehicles</td>
<td>AADT</td>
<td>43,800</td>
<td>43,800</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trucks</td>
<td>AADT</td>
<td>10,600</td>
<td>10,600</td>
<td>8,000</td>
</tr>
<tr>
<td></td>
<td>Pacific Highway (untolled) (south of Telegraph Road)</td>
<td>All vehicles</td>
<td>AADT</td>
<td>-</td>
<td>-</td>
<td>6,700</td>
</tr>
<tr>
<td></td>
<td>Ryde Road/Lane Cove Road (untolled) (at de Burghs Bridge)</td>
<td>All vehicles</td>
<td>AADT</td>
<td>6,200</td>
<td>6,200</td>
<td>7,400</td>
</tr>
<tr>
<td>Criteria</td>
<td>Measure</td>
<td>Options</td>
<td>Comments and Preferred Option</td>
<td></td>
<td></td>
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<td>----------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
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<td>--------------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>(b) Traveller Benefits</strong> <em>(untolled)</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Network travel time savings</td>
<td>million veh hrs in 2021 (2 hour-AM Peak)</td>
<td>Purple 3.37</td>
<td>Blue 3.37</td>
<td>Yellow 3.26</td>
<td>Red 3.36</td>
<td>Purple or Blue</td>
</tr>
<tr>
<td>VKT savings (existing travellers - using corridor)</td>
<td>Additional million vkt in 2021 (2 hour-AM Peak)</td>
<td>Purple 14.4</td>
<td>Blue 14.4</td>
<td>Yellow 1.43</td>
<td>Red 8.47</td>
<td>Yellow, then Red</td>
</tr>
<tr>
<td><strong>(c) Road Safety</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Road crashes (corridor)</td>
<td>Number of fatal and serious crashes reduced per year in the corridor(1)</td>
<td>Purple 15</td>
<td>Blue 15</td>
<td>Yellow 10</td>
<td>Red 15</td>
<td>Purple, Blue or Red</td>
</tr>
<tr>
<td>Crash savings (network)</td>
<td>Rank - vkt at lower accident rate</td>
<td>Purple 3</td>
<td>Blue 3</td>
<td>Yellow 1</td>
<td>Red 2</td>
<td>Yellow</td>
</tr>
<tr>
<td>Vehicle speed (network)</td>
<td>km/hr</td>
<td>Purple 31.87</td>
<td>Blue 32.08</td>
<td>Yellow 32.07</td>
<td>Red 32.07</td>
<td></td>
</tr>
<tr>
<td><strong>(d) Opportunities for public transport improvements</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scope for long term public transport developments in the interim National Highway corridor.</td>
<td>Rank(2)</td>
<td>Purple 1</td>
<td>Blue 1</td>
<td>Yellow 3</td>
<td>Red 3</td>
<td>Purple or Blue</td>
</tr>
<tr>
<td>Improve local services</td>
<td>Access to rail station</td>
<td>Purple 1</td>
<td>Blue 2</td>
<td>Yellow 2</td>
<td>Red 2</td>
<td>Purple</td>
</tr>
<tr>
<td>Regional services improvement</td>
<td>Access to regional centres (Hornsby, Parramatta, Blacktown, Penrith, Chatswood) in northern Sydney</td>
<td>Purple 1</td>
<td>Blue 2</td>
<td>Yellow 2</td>
<td>Red 2</td>
<td>Purple</td>
</tr>
<tr>
<td>Improved PT accessibility</td>
<td>Locally</td>
<td>Yellow 2</td>
<td>Purple 1</td>
<td>Blue 1</td>
<td>Red 4</td>
<td>Yellow</td>
</tr>
<tr>
<td>To/from Western Sydney</td>
<td>AADT on Pennant Hills Road</td>
<td>Purple 1</td>
<td>Blue 1</td>
<td>Yellow 3</td>
<td>Red 4</td>
<td>Purple or Blue</td>
</tr>
<tr>
<td><strong>(e) Cyclists and Pedestrians</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opportunities to improve local and regional facilities</td>
<td></td>
<td>Blue 1</td>
<td>Purple 1</td>
<td>Yellow 2</td>
<td>Red 2</td>
<td>Blue or Purple</td>
</tr>
<tr>
<td><strong>Traffic and Transport Rank</strong></td>
<td></td>
<td>Purple 1</td>
<td>Blue 2</td>
<td>Yellow 3</td>
<td>Red 4</td>
<td>Purple or Blue</td>
</tr>
</tbody>
</table>


1. The corridor includes Pennant Hills Rd, Pacific Highway and the new tunnel link.
2. Ranking. In the above table a rank of 1 indicates the best rank and 4 the worst on a score of 1 to 4.
3. The final rank is derived by aggregating the rankings of the options against each traffic and transport assessment criteria.
**Urban Design, Landscape and Visual**

The Urban Design, Landscape and Visual assessment analyses the four options in terms of legibility and integration, visual impacts, connectivity and potential to limit or guide future land uses, and landscape potential.

A number of urban design outcomes are available for the Purple Option in particular and these have been assessed. The potential benefits to Pennant Hills Road are significant. These include opportunity to provide better pedestrian amenity, improved streetscape character, improved local bus routes and integrated furniture selection.

By assessing the options against the project objectives and urban design, landscape and visual principles the Purple option is preferred for the following reasons:

- Connection of the central coast and northern suburbs to the key Sydney Road network;
- Provision of an effective National Highway link for through traffic;
- Provision of an effective solution to journey to work and recreational destinations;
- Integrated transport network- providing connections for rail, road, bus, pedestrians and cyclist networks;
- Achieves strong legibility for the motorist;
- Minimises visual impacts on local communities;
- Reduces the extent of landscape lost during construction;
- Provides for opportunities for new landscape;
- Reduces the potential areas of isolated, sterile land;
- Reduces the requirement for extensive built form including portals, bridges, retaining walls and noise barriers;
- Maintains existing pedestrian access and movement patterns in most areas; and
- Minimises the footprint of impacts.

The ventilation structures provide the most difficult resolution of locations and will require further assessment in detail.

Overall, the assessment according to Urban Design criteria indicates the following:

- The Purple option is preferred under these criteria, as it has the lowest incidence of negative impacts.

The detailed urban design, landscape and visual assessment is presented in **Table 12-3**.
### Table 12-3: Urban Design, Landscape and Visual Assessment

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Options</th>
<th>Preferred Option</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Purple</td>
<td>Blue</td>
</tr>
<tr>
<td>Visual Impacts on residents</td>
<td>16</td>
<td>14</td>
</tr>
<tr>
<td>Loss of existing landscape (trees)</td>
<td>16</td>
<td>14</td>
</tr>
<tr>
<td>Noise amelioration required</td>
<td>15.3</td>
<td>14</td>
</tr>
<tr>
<td>Extensive bridges and walls required provides high</td>
<td>15.3</td>
<td>13</td>
</tr>
<tr>
<td>Impacts on natural pursuits, walking trails, etc</td>
<td>17</td>
<td>17.5</td>
</tr>
<tr>
<td>Creates/isolates sterile land</td>
<td>15</td>
<td>14</td>
</tr>
<tr>
<td>Potential property impacts – resumption or land take</td>
<td>16.3</td>
<td>15</td>
</tr>
<tr>
<td>Severs pedestrian access and existing movement</td>
<td>18</td>
<td>16</td>
</tr>
<tr>
<td>Legible motorists environment</td>
<td>17</td>
<td>13.5</td>
</tr>
<tr>
<td>Potential for new landscape</td>
<td>15.7</td>
<td>16</td>
</tr>
<tr>
<td>Footprint of Impacts</td>
<td>16</td>
<td>15</td>
</tr>
<tr>
<td>Total impact severity</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Urban Design – Rank</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>


**Notes:**
- Assessment scoring system for these criteria: Score in 10 to 20 range: 20 is best; 10 is worst; Overall impact significance.
- The final rank is derived by aggregating the rankings of the options against each urban design, landscape and visual assessment criteria.
Environment Effects

This section presents a summary of the investigations undertaken in the following areas:

- Air quality issues, including Ventilation Stacks
- Water Quality & Aquatic Ecology
- Terrestrial Ecology
- Noise
- Land Use
- Indigenous Heritage
- Non-indigenous Heritage

The main findings from the analysis of environmental effects are:

- Purple performs the best in terms of air quality issues, except for the number of required ventilation stacks, which are the lowest with Yellow (3 compared with 4);
- Purple and Blue perform the best in terms of all aquatic and terrestrial ecology criteria;
- Yellow or Red perform the best in terms of minimising localised noise impacts around the southern interchanges, while Purple is preferred in terms of the localised noise around the northern interchanges;
- Purple exhibits the minimum land take and impact;
- Purple performs best against indigenous heritage, while Yellow exhibits the minimum effect on non-indigenous heritage.

The overall rankings of Options, against the key environmental criteria, is summarised below in Table 12-4, while the detailed assessment of environmental effects is presented in Table 12-5.

Table 12-4:  Overall Rankings of Environmental Effects (1)

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Purple</th>
<th>Blue</th>
<th>Yellow</th>
<th>Red</th>
<th>Preferred Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Quality</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>Purple</td>
</tr>
<tr>
<td>Water Quality/Aquatic Ecology</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>Purple/Blue</td>
</tr>
<tr>
<td>Terrestrial Ecology</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>Purple/Blue</td>
</tr>
<tr>
<td>Noise</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>Yellow</td>
</tr>
<tr>
<td>Land Take</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>Purple</td>
</tr>
<tr>
<td>Indigenous Heritage</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>Purple</td>
</tr>
<tr>
<td>Non-indigenous Heritage</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>Yellow</td>
</tr>
<tr>
<td>Environmental – Rank – Overall</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>Purple</td>
</tr>
</tbody>
</table>

(1) Refer to Table 12.5 for more detail.

The overall environmental rankings were determined by aggregating the rankings of options against each of the environmental criteria. Rank 1 is best, rank 4 worst in a score of 1 to 4.

Overall, the assessment according to Environmental impact criteria, indicates that the:

- Purple option is preferred under these criteria; and
- The Red Option is least preferred.
Table 12-5: Environmental Effects

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Options</th>
<th>Comments and Preferred Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Air quality issues</td>
<td>Purple Blue Yellow Red</td>
<td></td>
</tr>
<tr>
<td>Average annual CO emission per km of tunnel in 2011 (t/km)</td>
<td>120 160 170 130 Purple</td>
<td></td>
</tr>
<tr>
<td>Likely required number of ventilation stacks</td>
<td>4 4 3 4 Yellow</td>
<td></td>
</tr>
<tr>
<td>Average annual CO emission per stack (t/km/stack)</td>
<td>30 40 60 30 Purple</td>
<td></td>
</tr>
<tr>
<td>Impact from stacks to ground-level (Rank)</td>
<td>1 2 3 4 Purple</td>
<td></td>
</tr>
<tr>
<td>Change in traffic on major arterial road network in 2011</td>
<td>-13% -13% -12% -10% Purple/Blue</td>
<td></td>
</tr>
<tr>
<td>(b) Water Quality &amp; Aquatic Ecology (1))</td>
<td>Low Low Low to Medium Medium (due to cut/cover at Mars Creek) Purple/Blue</td>
<td></td>
</tr>
<tr>
<td>Degree of direct impact (direct effect) on the waterway (earthworks, creek diversion, dredging etc)</td>
<td>Low Low Low to Medium (effects on Devlins and Terrys Creeks) Medium (due to cut/cover at Mars Creek) Purple/Blue</td>
<td></td>
</tr>
<tr>
<td>Potential for indirect effect (construction site or road runoff in the creek catchment)</td>
<td>Low Low Medium Medium Purple/Blue</td>
<td></td>
</tr>
</tbody>
</table>
| (c) Terrestrial Ecology                       | Low Low Low to Medium Low/Medium – Medium/Media
<table>
<thead>
<tr>
<th>Criteria</th>
<th>Options</th>
<th>Comments and Preferred Option</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Purple</td>
<td>Blue</td>
</tr>
<tr>
<td>(d) Noise(^{(2)})</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Localised impacts</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>surrounding the southern</td>
<td></td>
<td></td>
</tr>
<tr>
<td>interchanges</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Localised impacts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>surrounding the northern</td>
<td></td>
<td></td>
</tr>
<tr>
<td>interchanges(^{(3)})</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(e) Land Take</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(hectare)</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>(f) Indigenous Heritage(^{(4)})</td>
<td>None</td>
<td>Medium</td>
</tr>
<tr>
<td>(g) Non-indigenous</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heritage(^{(4)})</td>
<td></td>
<td>High</td>
</tr>
</tbody>
</table>


Notes:
1. All options perform equally well in terms of sensitivity of the waterway (habitat quality or presence of threatened species);
2. Criteria 4 = high negative impact, 0 = neutral, -4 = high positive impact;
3. All options perform equally well in terms of acoustic impacts on wider surface roads;
4. Assessment scoring system for these criteria include the physical measure of impact and the significance of the impact (e.g. High/Medium/Low)

**Social Effects**

Assessment of the Options against the key social criteria indicate that:

- Blue, Yellow and Red perform the best in terms of minimising the extent of severance to communities;

- Purple and Blue yield the largest benefits in terms of improvements in local and regional accessibility; and

- Purple minimises the potential direct land take and exhibits the lowest number of properties over the tunnel.

In terms of the Red Option, a tunnel is preferred to the bridge over Lane Cove River due to:

- No noticeable increase in noise at residences; and

- Low visual impact.

Overall, the assessment according to Social Impact criteria indicates the following:

- The base Purple option is preferred under these criteria; and

- The Yellow Option is least preferred.

The detailed social effects assessment tables are shown below in Table 12-6.
### Table 12-6: Social Effects

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Measure</th>
<th>Base Case</th>
<th>Options</th>
<th>Comments and Preferred Option</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Purple</td>
<td>Blue</td>
</tr>
<tr>
<td>(a) Severance impact</td>
<td>Extent of severance to communities and pedestrian movements</td>
<td>Potential severance at Brickyard Park</td>
<td>No severance from tunnel</td>
<td>No severance from tunnel</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Purple</td>
<td>Blue</td>
</tr>
<tr>
<td>(b) Local Accessibility impact</td>
<td>Moderate to high adverse</td>
<td>Moderate benefits</td>
<td>Moderate benefit</td>
<td>Low benefit</td>
</tr>
<tr>
<td>(c) Regional Access benefits</td>
<td>Benefits to regional accessibility</td>
<td>Nil</td>
<td>Moderate to High</td>
<td>Moderate to High</td>
</tr>
<tr>
<td>(d) Property directly Affected</td>
<td>No. of properties required</td>
<td>0</td>
<td>20-80</td>
<td>50-130</td>
</tr>
<tr>
<td>(e) Visual impacts and acceptability of ventilation stacks</td>
<td>Expected visual impacts and number of ventilation stacks</td>
<td>Moderate to high</td>
<td>Moderate to high</td>
<td>Moderate Low to Moderate</td>
</tr>
</tbody>
</table>

Social Impacts – Rank

<table>
<thead>
<tr>
<th>Rank</th>
<th>Purple</th>
<th>2</th>
<th>4</th>
<th>3</th>
</tr>
</thead>
</table>


The overall social effects rankings were determined by aggregating the rankings of options against each of the social criteria.

### Engineering Effects

The assessment identified the four feasible tunnel options and investigated the extent to which these meet Austroads design standards for a National Highway.

The key tunnel issues addressed in relation to long urban tunnels included:

- Fire and life safety
- Psychology of tunnel use
- Ventilation (including tunnel air quality control)
- Tunnel gradients
- Construction
- Impacts on other infrastructure, including rail lines

All the above have a significant effect on the project complexity and its construction and operating costs. Each of the key considerations were addressed at a strategic level of investigation to determine both feasibility and cost to acceptable confidence levels. A full risk analysis would be part of the project EIS process at a later stage.

The probability of a major incident in a tunnel is low. However, the consequences of such an event can be high. The design of long urban tunnels needs to address fire and other safety threatening situations. To this end designers address tunnel architecture, ventilation, fire detection/suppression systems, control and communications to ensure that the risk of incident and its impact is minimised.
Together with good design there is the need for ongoing driver education and awareness. At the concept design stage, all aspects of fire and life safety would be considered in a comprehensive incident management plan. These aspects are non negotiable in any of the options selected. That being said the Fire and Life safety matters can be addressed in the Purple option in the most cost effective manner as compared to the other options.

The tunnels of the options would range in length between 5km and 8km. These long tunnels raise a number of issues related to driver psychology and driver behaviour. These issues can in practice affect both traffic flow and tunnel safety. Measures that will enhance the tunnel from a driver’s perspective, should be considered including gentle tunnel grades, using three traffic lanes in each tunnel rather than two, wider traffic lanes and shoulders on each side of the carriageway. Enhanced tunnel entry and exit portal design and clearly identified emergency escape routes are other measures.

The possible tunnel ventilation design adopts the longitudinal method of ventilation using jet fans. Tunnel enlargements and ducting near tunnel portals would be required to direct air back from the portals to limit portal emissions. Air extraction and fresh air intake points would be spaced at 2km to 3km intervals along the tunnel. In some cases quite long ventilation tunnels could be required to reach the ventilation shafts at a suitable site. The ventilation system in each of the north and southbound tunnels would operate independently with no air transfer between tunnels.

Tunnelling conditions in the study area are mostly sandstone rock and surface shale. Sandstone rock is an ideal tunnelling medium. In the case of the Purple route long lengths of tunnel may have to be excavated in shale, which may impact on the tunnelling rate and tunnel support. The most suited excavation methods for the expected ground conditions are roadheaders or Tunnel Boring Machines. Tunnel support in shallow cover areas near tunnel portals may require canopy tubes and steel sets to support soft ground and control surface settlement. For the majority of tunnelling, however, the tunnel support would consist of shotcrete and permanent rock bolts. The tunnel profile in shale having a slightly higher crown than for tunnels excavated in sandstone.

There is a need for field site investigations to be carried out, particularly along the Purple route to confirm the interface between the shale and underlying sandstone.

The construction duration of all of the options range between 3 and 5 years and will require considerable tunnelling resources to complete within this time frame.

The Purple and Blue options would have portals adjacent to Pennant Hills Road as part of the Southern Interchange. The Purple option would also have portals in the F3 and in the Pennant Hills Road corridors as part of its northern interchange. The Blue and Purple option cross the proposed alignment of the North West Rail Line but there is no difficulty in co-ordinating this such that the impact is minor. The Purple Option runs under the main North Rail Line corridor from Pennant Hills station northward for 2 kilometres. Whilst it can be constructed at a depth which will not constrain rail operations once the tunnel is complete there may be construction and legal matters to be resolved in the interim.

It is important for the effective operation of the tunnels and to minimise vehicle operation costs, to minimise tunnel gradients. This is because traffic, especially large commercial vehicles, generates higher exhaust emissions on steeper grades. To cater for National Highway standards a maximum gradient of 4.5% has been adopted as a guideline. Only the Purple Option has been able to meet this criterion on the main alignment and all options exceed it on some access ramps.

The Engineering effects assessment is shown below in Table 12-7.

Overall, the assessment according to Engineering Design criteria indicates the following:

- The Purple option is preferred under these criteria.
- The Purple option is preferred to the Red option due to the significantly reduced average road gradings.
- The Blue Option is least preferred.
There were some community concerns regarding a bridge crossing the Lane Cove River for the Red option, however this is not preferred on social and environmental impact grounds.

**Table 12-7: Overall Ranking of Options According to Engineering Effects**

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Purple</th>
<th>Blue</th>
<th>Yellow</th>
<th>Red</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire &amp; Life Safety(^{(1)})</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Driver Psychology</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Ventilation(^{(2)})</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Construction(^{(3)})</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Impacts on existing Infrastructure</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Gradient</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Overall Ranking (high rank is preferred ie. 4 is preferred to 2 etc.)</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>


1. All options would be designed to high fire and life safety. The Purple Option would be built as two tunnel sections, thereby offering easier tunnel access at time of incident.

2. The steeper grades of Blue, Red and Yellow would result in higher vehicle emissions and greater ventilation costs compared to Purple.

3. The Purple Option would have higher flexibility in the number of concept design alternatives that could be considered.

**Capital Cost Estimates and Economic Assessment**

The assessment indicates that the Type A feasible options involve capital expenditure of between $1.5 billion and $1.8 billion (2003 dollars) over the period 2007/08 to 2010/11. Incremental operation and maintenance costs are estimated to be between about $7 million and $9 million per year (2003 dollars).

The main RUCBA showed that the four feasible options are economically viable in the ‘no toll’ scenario, with the Purple and Red options being the most economically attractive. The benefit-cost ratio (BCR) of these two options is 1.2. There is also no difference between the Purple option and the Red option on the basis of net present value (NPV).

In the $3.50 toll scenario, only the Purple option is close to being economically viable. The BCRs for the four options range between 0.7 and 1.0. The NPV of the Purple option is negative $57 million in the ‘no toll’ scenario, showing the impact of the toll on traffic using the Link and on reducing the effectiveness of congestion relief on Pennant Hills Road.

The sensitivity analysis generally does not alter the overall outcome with respect to relative levels of economic return and the ranking of feasible options. In the ‘no toll’ scenario, the Purple option or the Red option is indicated, while in the $3.50 toll scenario the Purple option is indicated.

The capital cost estimates and economic results of the options are given in Table 12-8 and Table 12-9. Costs are rounded to the nearest $5 million in 2003 dollars.
### Table 12-8: Capital Cost Estimates and Economic Assessment – No Toll Scenario

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Measure</th>
<th>Options</th>
<th>Comments and Preferred Route by Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Purple</td>
<td>Blue</td>
</tr>
<tr>
<td>Strategic Capital Costs</td>
<td>$ million (2003)</td>
<td>1,565</td>
<td>1,715</td>
</tr>
<tr>
<td>Transport User Net Benefit (at 7% discount rate)</td>
<td>NPV ($ million 2003)</td>
<td>260</td>
<td>145</td>
</tr>
<tr>
<td></td>
<td>BCR</td>
<td>1.2</td>
<td>1.1</td>
</tr>
<tr>
<td>Economics – Rank</td>
<td></td>
<td>=1</td>
<td>4</td>
</tr>
</tbody>
</table>


### Table 12-9: Capital Cost Estimates and Economic Assessment – Toll Scenario

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Measure</th>
<th>Options</th>
<th>Preferred Route by Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Purple</td>
<td>Blue</td>
</tr>
<tr>
<td>Strategic Capital Costs</td>
<td>$ million (2003)</td>
<td>1,670</td>
<td>1,825</td>
</tr>
<tr>
<td>Transport User Net Benefit (at 7% discount rate)</td>
<td>NPV ($ million 2003)</td>
<td>-60</td>
<td>-150</td>
</tr>
<tr>
<td></td>
<td>BCR</td>
<td>1.0</td>
<td>0.9</td>
</tr>
<tr>
<td>Economics-Rank</td>
<td></td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

12.3 Pair Wise Comparison of Options

Options were compared against each other and the Base Case in a pair wise comparison process to determine the option which best meets the objectives of the link.

**Overall Comparative Assessment**

A summary of the overall comparative assessment of options is shown in Table 12-10. The Base Case is included as an option for comparison.

**Table 12-10: Summary Ranking of Options**

<table>
<thead>
<tr>
<th>Strategic Criteria</th>
<th>Base Case</th>
<th>Purple</th>
<th>Blue</th>
<th>Yellow</th>
<th>Red</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategic Development</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Traffic and Transport</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Urban Design/Visual/Landscape</td>
<td>5</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Environmental Effects</td>
<td>na(2)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Social Effects</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Tunnel/Engineering Effects</td>
<td>na(3)</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Economics(4)</td>
<td>5</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Affordability(5)</td>
<td>na</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

Notes

(1) Rank 1 is best – Rank 5 is worst
(2) In general, if a project is not being developed for mainly environmental reasons as in this project, then environmental impacts of options are usually no better, or slightly worse than the existing situation but are mitigated to acceptable levels under the project options.
(3) Engineering Criteria are not explicitly judged against the Base Case as they are only relevant to Build option comparisons (Base case ranking is therefore not relevant).
(4) Using the no-toll scenario as the basis for assessment.
(5) Based on capital costs. Base Case ranking is not relevant as it does not involve capital expenditure.

Figure 12.1 also shows this summary presented graphically. Overall it can be seen that the Purple Option is preferred under every criteria.

Red versus Yellow

The overall ranking against the key assessment criteria indicates that the Red Option is preferred to the Yellow Option (refer to Table 12-10). The Red Option ranks the same as or better than the Yellow Option for six out of the eight assessment criteria. However, the rankings indicate that the Red Option does not perform well in terms of certain aspects of the traffic and transport criteria, particularly in relation to public transport, relief of surface traffic and long distance heavy vehicle routing. Yellow is also ranked relatively higher than Red in terms of environmental effects.

Overall Red is preferred.
Red Option - Bridge versus Tunnel

The relative desirability of a bridge versus tunnel scenario in the Red Option in Lane Cove National Park was raised with the community. It was addressed against environmental, social, engineering and tunnel criteria. The desirability of the bridge versus tunnel varies according to the types of criteria being examined.

The tunnel option is preferred in the environmental assessment given the relatively greater potential impacts of the bridge option on noise, indigenous sensitivity and aquatic and terrestrial ecology. The preference for the tunnel is also reflected in the social effects assessment. An expected high level of noise and visual impacts along with the unknown degree of community acceptance for a bridge, renders the tunnel preferred. The engineering assessment also support the tunnel option based primarily on the relative constructability of the tunnel option.

The Red Option with a tunnel under Lane Cover River is preferred.

Purple versus Blue

The overall ranking against the key assessment criteria indicates that the Purple Option performs significantly better than the Blue Option. The Purple Option ranks better than the Blue Option for each assessment criteria. In fact, the Purple Option is the best performing option relative to all criteria.

In particular, the Purple Option out performs the Blue Option in the following areas:

- Traffic and Transport –in terms of public transport opportunities and access to local and regional public transport;
- Urban Design, Visual and Landscape – in terms of visual impacts on residents, noise amelioration required, potential property impacts and pedestrian access;
• Environmental effects – in terms of air quality issues, land take and impact on indigenous heritage;

• Social Effects – in terms of property effects and number of properties over tunnel;

• Affordability – the Purple Option is preferred particularly in terms of the relatively lower project capital costs and hence, the lower government contribution required, compared to the Blue Option; and

• Economics – the Purple option is preferred in terms of its higher BCR and net present value.

Purple is preferred.

Purple versus Red

The overall ranking against the assessment criteria indicates that the Purple Option performs significantly better than the Red Option. The Purple Option is preferred to the Red Option in terms of all criteria, except economics, against which both options are assessed as performing at the same level.

In particular, the Purple Option out performs the Red Option in the following areas:

• Traffic and transport benefits – particularly in terms of corridor relief to other arterial roads; scope for long term development of public transport and encouraging diversion of heavy vehicles off Pennant Hills Road;

• Environmental effects – particularly in reference to potential effects on water quality, aquatic and terrestrial ecology, and indigenous heritage.

Purple is preferred.

Purple versus Base Case

The Purple Option out performs the Base Case in terms of each criteria. In fact, in relation to all criteria, the Base Case is the least preferred of all the Options, while the Purple Option is the best performing.

12.4 Main Effects by Interest Groups

The result of the pair wise assessment is extended to highlight the distributional aspects of the options. The distributional analysis recognises that the significance of the effects of each option, as assessed according to the criteria above, will differ according to the impacted interest group assessed. The assessment of effects by interest group shown in Table 12-11 indicates that:

• Purple option performs the best across all of the key interest groups;
  - Purple would yield significant travel and accident cost savings and (jointly with Blue) maximise improvements in amenity for travellers;
  - Purple would minimise the number of properties directly affected and maximise (jointly with Blue) the improvement of amenity for occupiers such as residents; and
  - Purple and Blue would provide significant improvement in amenity for parts of the community which use facilities such as parks, churches etc.

The distributional assessment indicates that the Purple option is preferred. However, strong opposition to the Purple option using the Brickyard Park at Thornleigh was received from Hornsby Council and many residents living close to the Park.
# Table 12-11: Summary of Option Effects by Interest Group

<table>
<thead>
<tr>
<th>Interest Groups</th>
<th>Measure</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Purple</td>
</tr>
<tr>
<td><strong>Group 1: Travellers</strong></td>
<td>Travel and Accident cost savings</td>
<td>Significant</td>
</tr>
<tr>
<td>• Users of Light Vehicles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Long Distance Travellers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Users of Heavy Vehicles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Pedestrians and Cyclists</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improvement in amenity(^2)</td>
<td>Significant</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Group 2: Occupiers</strong></td>
<td>No of properties directly affected</td>
<td>20-80</td>
</tr>
<tr>
<td>• Residential</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Commercial/Shops</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Schools</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improvement in amenity(^2)</td>
<td>Significant(^3)</td>
</tr>
<tr>
<td></td>
<td>(noise, exhaust emissions, severance etc.)</td>
<td></td>
</tr>
<tr>
<td><strong>Group 3: Users of Facilities</strong></td>
<td>Improvement in amenity</td>
<td>Significant(^3)</td>
</tr>
<tr>
<td>• Community/Sports Centres</td>
<td>(as above)</td>
<td></td>
</tr>
<tr>
<td>• Parks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Churches</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Group 4: Policies for conserving and enhancing the area</strong></td>
<td>Air quality along Pennant Hills Road</td>
<td>Significant</td>
</tr>
<tr>
<td>• Air Quality</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Heritage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Water Quality</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Landscape</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Urban Design</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Impact on water quality</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Visual impacts(^4)</td>
<td>Moderate</td>
</tr>
<tr>
<td><strong>Group 5: Transport Development and Economic Policies</strong></td>
<td>Total traffic relief to interim National Highway ³AADT in 2021</td>
<td>35-40,000</td>
</tr>
<tr>
<td>• Transport Development</td>
<td>Truck traffic relief to interim National Highway Truck AADT in 2021(^5)</td>
<td>About 11,000</td>
</tr>
<tr>
<td>• Economic Development</td>
<td>Improved Access to Sydney Ports</td>
<td>Less Direct</td>
</tr>
<tr>
<td>• Improve urban amenity</td>
<td>Improved Access to Western Sydney</td>
<td>Good</td>
</tr>
<tr>
<td></td>
<td>Opportunities to encourage more use of Public Transport(^6)</td>
<td>Moderate</td>
</tr>
<tr>
<td><strong>Group 6: Financial Implications</strong></td>
<td>Total Estimated Capital cost(^7)</td>
<td>$1.560</td>
</tr>
<tr>
<td>• Benefit cost ratio compared to Base Case(^5)</td>
<td>BCR</td>
<td>1.2</td>
</tr>
</tbody>
</table>

**Notes:**

1. Steep north-bound tunnel grades increase truck operating costs over Purple.
2. Based on traffic relief along interim National Highway and potential to reallocate road space on Pennant Hills Road.
4. Makes allowance for impact from tunnel portals and potential ventilation stack locations: Purple (4 stacks), Blue (4), Yellow (3), Red (4).
5. Assumes no toll.
6. From reallocation of Pennant Hills Road road space as a result of traffic relief.
12.5 Value Management Workshop Outcomes

The options assessment process provided input to and was informed by a Value Management (VM) workshop which was held over two days on Wednesday and Thursday, 17 / 18 September 2003.

The workshop participants assessed each feasible tunnel route option against the objectives that the new link should meet. The options were considered twice, once on the basis of a toll being applied and also without a toll.

It was decided to simply place a star against the options that performed best against a particular criterion. No attempt was made to measure the degree to which one option out performed another. If any options were rated equally, then a star was awarded to each of those options.

Table 12-12 and Table 12-13 summarise the results of the workshop assessment.

Table 12-12: Type A Options – Two Lane – Tolled\(^1\)

<table>
<thead>
<tr>
<th>Objective / Selection Criteria</th>
<th>Purple</th>
<th>Blue</th>
<th>Yellow</th>
<th>Red</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meets National Hwy objectives</td>
<td>✷</td>
<td>✷</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Affordable</td>
<td>✷</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benefit to Cost Ratio</td>
<td>✷</td>
<td>✷</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimises Social Impacts</td>
<td>✷</td>
<td>✷</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Best for Air Quality</td>
<td></td>
<td>✷</td>
<td>✷</td>
<td>✷</td>
</tr>
<tr>
<td>Best for the General Environment</td>
<td>🅃</td>
<td>🅃</td>
<td>🅃</td>
<td>🅃</td>
</tr>
<tr>
<td>Minimises National Parks Impacts</td>
<td>🅃</td>
<td>🅃</td>
<td>🅃</td>
<td>🅃</td>
</tr>
<tr>
<td>Minimises legislative impacts</td>
<td>🅃</td>
<td>🅃</td>
<td>🅃</td>
<td>🅃</td>
</tr>
<tr>
<td>Best for Tunnel Operations</td>
<td>🅃</td>
<td>🅃</td>
<td>🅃</td>
<td>🅃</td>
</tr>
<tr>
<td>Minimises Visual Impact</td>
<td>🅃</td>
<td>🅃</td>
<td>🅃</td>
<td></td>
</tr>
<tr>
<td>Best for Public Transport Operations</td>
<td>🅃</td>
<td></td>
<td>🅃</td>
<td></td>
</tr>
<tr>
<td>Best for Pennant Hills Rd</td>
<td>🅃</td>
<td></td>
<td>🅃</td>
<td></td>
</tr>
</tbody>
</table>

(2) The ✷ indicates that an option performed best in respect of this criterion.
Table 12-13: Type A Options – Two Lane Un-tolled(1)

<table>
<thead>
<tr>
<th>Objective / Selection Criteria</th>
<th>Purple</th>
<th>Blue</th>
<th>Yellow</th>
<th>Red</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meets National Hwy objectives</td>
<td>✴️</td>
<td>✴️</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Affordable</td>
<td>✴️</td>
<td>✴️</td>
<td>✴️</td>
<td>✴️</td>
</tr>
<tr>
<td>Benefit to Cost Ratio</td>
<td>✴️</td>
<td>✴️</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimises Social Impacts</td>
<td>✴️</td>
<td>✴️</td>
<td></td>
<td>✴️</td>
</tr>
<tr>
<td>Best for Air Quality</td>
<td>✴️</td>
<td>✴️</td>
<td></td>
<td>✴️</td>
</tr>
<tr>
<td>Best for the General Environment</td>
<td>✴️</td>
<td>✴️</td>
<td></td>
<td>✴️</td>
</tr>
<tr>
<td>Minimises National Parks Impacts</td>
<td>✴️</td>
<td>✴️</td>
<td></td>
<td>✴️</td>
</tr>
<tr>
<td>Minimises legislative impacts</td>
<td></td>
<td></td>
<td></td>
<td>✴️</td>
</tr>
<tr>
<td>Best for Tunnel Operations</td>
<td>✴️</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimises Visual Impact</td>
<td>✴️</td>
<td>✴️</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Best for Public Transport Operations</td>
<td>✴️</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Best for Pennant Hills Rd</td>
<td></td>
<td></td>
<td></td>
<td>✴️</td>
</tr>
</tbody>
</table>


(2) The ✴️ indicates that an option performed best in respect of this criterion.

A summary of the key workshop outcomes is given below.

- The Yellow and Blue Corridor Options were considered to be the least attractive.

- The Red Corridor Option had merits if not tolled, however, from an overall perspective, it could not be recommended in preference to the Purple Option.

- The Purple Corridor Option was adjudged to best satisfy the project objectives, either tolled or not tolled, and was therefore recommended to be taken to the next and more detailed stage of the study.

- It was further agreed that a statement would be included in the Link Study Report to address community concerns regarding the need for an additional road link to Sydney from the north. The wording of such a statement will be agreed between the parties prior to publication of the final document.

- It was confirmed that the Type A Corridor was superior to either Type B or Type C in meeting project objectives.

On the basis of the information presented in the course of the workshop, the following represents the unanimous views of the group:

- The Purple Corridor Option was adjudged to best satisfy the project objectives, either tolled or not tolled.
12.6 Conclusions

The key conclusions of the assessment of the Type A options are:

- Of the four options there is a clear result that the Purple Option is preferred, in that it is judged to satisfy the National Highway planning and project objectives better than Blue, Yellow or Red and that it would perform best overall in terms of technical criteria. It would also be more acceptable in terms of social and environmental impacts at this level of assessment.

- The Purple Option was also judged to be the preferred option from the results of a planning Value Management Workshop of government stakeholders in September 2003.

- Under a tolled scenario the benefits of the link and its effectiveness in relieving congestion along Pennant Hills Road would significantly reduce.

- While the Purple Option performs well in terms of traffic relief along the National Highway which benefits the majority of inter-regional users the most, the Red Option has similar benefits in terms of network traffic effects. Under the untolled scenario, the Red Option would yield marginally smaller travel time savings for existing travellers in the corridor, compared with the Purple Option. However, the Red Option would perform better in terms of the incremental increase in VKT. Existing travellers in the corridor would travel additional network kilometres under the Purple Option compared with Red, to secure a similar but slightly greater time saving.
Community Consultation

The Community Consultation program was an important part of the process to determine an acceptable link option. The findings from consultation are described in this chapter under the following headings:

i) Consultation Program; and

ii) Stakeholder Views.

13.1 Consultation Program

Consultation Process

A comprehensive community involvement program was an integral part of the study. The program was designed and managed to afford the broader community the opportunity to make a demonstrable input to the process, and to ensure that the requirements of the community were adequately and appropriately managed and addressed.

The route selection process for this project was expected to attract significant public debate. At the time of study commencement, the proposed link had already received extensive regional print, radio and television media coverage through its announcement, in conjunction with the release of the Western Sydney Orbital (now M7 Motorway) Environmental Impact Statement (EIS) and subsequent planning approval. Due to the size of the study area and the significant involvement of communities involved in the M7 Motorway and M2 Motorway projects, as well as those affected by the previously abandoned B2-B3 corridor, it was expected that there would be considerable community interest in this project.

Public Information days were held at five locations in May 2002 and Route Option Displays were held at 4 locations in August 2003 over a 6 week period
Stakeholders

The study area extended over seven Local Government Areas (LGA). The population of the study area was estimated to be approximately 340,000 people, equating to approximately 100,000 households. Relatively small proportions of the communities in the study area speak languages other than English. Other languages include Italian, Chinese and Arabic.

The study area includes a wide diversity of industrial and commercial activities and the business communities were recognised as an important part of the community.

The Community Involvement Program included activities to meet the information and participation needs of all stakeholders.

Stakeholders associated with this project can be grouped into the following:

- Elected Members of Federal and State Parliaments
- Elected representatives of local government
- Officers of Federal government agencies
- Officers of State government agencies
- Officers of Local government agencies
- Local government organisations
- Advisory and interest groups
- Road transport groups
- Residents within the Study Area
- Businesses within the Study Area
- Potentially affected land owners (and ultimately affected land owners)
- Organisations with significant interests in the project or the area adjoining the proposed route of the project.
- The wider community (including road users).
- The media.

Communication Processes and Activities

The communications processes and activities throughout the community involvement program were designed to achieve the objectives for the community consultation program. They included:

- Initial communication with key stakeholders at study commencement
- Establishing a 1800 freecall number and maintaining it throughout the study
- Establishing a web site for the study, with email and comment facilities. The web pages were updated throughout the study and all public study documents were placed on the sites. Documents included Ministerial statements, Community Focus Group (CFG) meeting notes, newsletters, the Background Report

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1 City of Blacktown, City of Parramatta, City of Ryde, Gosford City, Baulkham Hills Shire, Hornsby Shire, Ku-ring-gai Shire
Offering and undertaking briefings to key stakeholders at study commencement and at the time of the route options display. All seven Councils in the area were briefed on both occasions and Wyong Shire Council also requested briefings. Other groups that were briefed included progress associations, civic trusts, chambers of commerce and other community/environmental organisations.

Community activities/displays and key project information were advertised in the local and national media.

A Planning Focus Meeting was held on 17 April 2002, attended by representatives of Federal, State and Local Government agencies, and peak transport bodies.

Community Focus Groups (CFGs) were established to help the study team to identify community issues, assist in communicating facts about the study, and help distribute information to those potentially affected by the study and to the broader community. It was expected the groups would include people who represent various local interests relevant to the study.

People were asked to nominate for a Community Focus Group by completing a Nomination Form. While it was stated that this information would be used to decide on the membership of the Group, everyone who nominated for a CFG was included.

The intention at the start of the study was to establish four Community Focus Groups (CFGs), which were geographically dispersed. Each group was to meet twice before the route options display, and once towards the end of the options display period.

Nominations for the CFGs were called for through the study Newsletter No.1, advertisements in the media and through the study website. The response was poor, with relatively few nominations and limited geographic spread. In an endeavour to expand the membership of the CFGs, follow up calls and letters to stakeholder groups were initiated. From the nominations received it was possible to form two groups. The most convenient meeting location for the groups, given where the members live, were Dural and Pennant Hills. These groups met three times: at study commencement; during the development of options and during the period of the route options display.

At the time of the route options display, several people inquired about the CFGs and completed Nomination Forms. A third CFG was established to ensure that everyone who nominated had the opportunity to participate in a CFG. All of the people who nominated at that time were included in the third CFG that met once, during the period of the route options display.

Two Newsletters were issued during the study. Both newsletters were distributed to all households and to businesses in the study area. SKM engaged a professional distribution company to distribute the Newsletters, which numbered 115,000 in the case of Newsletter No.1 and 117,500 in the case of Newsletter No.2. Newsletters were posted to everyone on the study mailing list and to all CFG members at the time. The Newsletters could also be viewed and downloaded from the study website. Copies of the Newsletters were also provided to the Councils for their office counters and libraries.

− Newsletter No.1 was issued at the commencement of the study, in April 2002. Its purpose was to introduce the study, provide general background and identify the study area and process, and explain how interested stakeholders could get more information and/or be involved in the project and a CFG.

− Newsletter No. 2 was issued at the time of the route options display, in July 2003. Its purpose was to present the process for identifying options, describe the feasible options and provide a preliminary comparison of the corridor Type A options.

A Background Report was prepared concurrently with Newsletter No.2. Its purpose was to provide further explanation of the information in the Newsletter. The Background Report was not mass produced or distributed. It was made available through the study website, at display locations and posted on request. The Report was posted to all CFG members. Copies were made available to Councils for their use and to place in libraries.
Public displays were held during the course of the study. These were a forum where the community could meet some of the study team and have informal discussions with them on aspects of the study. The displays were advertised in local and national media. Concurrent with the Information Day displays at the shopping centres, identical display material was placed at the seven Councils, and posters and Newsletters were made available to Councils to place in libraries and community facilities.

**Public Information Days** were held at 5 locations, in May 2002. Staff attended each display on two occasions. It was estimated that some 2,000 people visited the displays. Contact ranged from detailed and lengthy discussion to picking up a Newsletter in passing.

**Route Options Displays** were held at 4 locations, in August 2003. Staff attended the displays at Gosford and Dural on two occasions, and the displays at Hornsby and Carlingford on 6 occasions. It was estimated that well in excess of 2,500 people attended the route options display. The mode of attendance varied from lengthy discussion with team members (up to an hour in some cases) to those who took a Newsletter in passing.

All comments received by phone and in writing (email, post, fax) were recorded on the study database. Comments relating to route options and study investigations were communicated to the study team.

During the period of the route options display, all submissions were reviewed and the issues and comments noted in a submissions database.

### 13.2 Stakeholder Views

#### Identification of issues at study commencement

The number of people who participated in the consultation process during its early stages was small, compared to the total population in the study area, but there was commonality of broad issues raised.

Key concerns at that stage ranged from strategic issues – such as encouraging improved public transport, increased freight to rail, and the need to link growing residential and employment areas – to specific issues, such the need to avoid damage to Lane Cove National Park. Other issues raised included: the need to apply sustainable principles to the study, the consideration of induced traffic, the design capacity of the new link, tolls, impacts on communities and environmental impacts particularly from ventilation stacks and concern about the safety of tunnels in relation to fire and traffic incidents.

There were differing views about the B2-B3 corridor as a route in that some queried why a surface route was ruled out of consideration.

These continued to be recurring themes through the study.

#### Consultation on broad options

CFG meetings were held in late July 2002 when the broad corridor options (Types A, B and C) had been identified. The CFG groups were asked for feedback on these three broad options.

At that stage there were varying views on the relative advantages and disadvantages of the three broad corridor types. Many commented that while Type A would be needed in the short term, the governments should be taking a longer term view in relation to a western route and a second crossing of the Hawkesbury River. There was also considerable comment on the capacity of the M2 and the F3 if a Type A option was progressed.

At that stage it was understood that the Type A options would be tunnel options, and that appeared to be acceptable provided that appropriate pollution control measures were placed on the ventilation stacks.

There continued to be strong debate about the new link as a road solution, rather than focussing on other integrated transport management measures including public transport, demand management, freight to rail and dedicated routes for heavy traffic.
More concerns were raised in relation to the potential scale and significance of environmental impacts of the Type B options than either Type C or Type A although concerns about the impact of Type C options on the National Parks and the Hawkesbury River were raised.

**Consultation on feasible options**

The feasible options were on display for 10 weeks, from 25 July to 3 October 2003.

A total of 991 submissions were received during this period and the week following the nominated closing date. The majority of submissions were individual letters, albeit that many were based on a number of versions of similar text and also many were from numerous individuals from the same household. There were a few petitions, one signed by 142 people.

All but one of the Councils in the study area made submissions. National road transport organisations including the National Road Transport Association and the NRMA made submissions.

The purpose of seeking public comment on the route options was to seek specific feedback on the issues associated with each corridor Type and particularly the Type A options. It is important to note that the purpose of analysis was to indicate trends and relativities of views of those who participated in this consultation activity. No suggestion is made either way as to whether these views are necessarily representative of the community as whole.

Caution must also be exercised in relation to analysing the relative importance of an issue as compared across the study area. There were high concentrations of submissions from particular geographic areas, with reasonably commonly held views about the potential impacts of options on those areas and hence support for, or opposition to, specific options.

An analysis was made of the origin of submissions, by postcode. **Figure 13-1** shows that the largest number of submissions originated from Wahroonga (20%) and Turramurra (14%), with the next greatest number originating from Normanhurst (9%) and Thornleigh (6%). Together, submissions from these areas comprised 52% of the total received.

**Figure 13-1: Percentage of Submissions Received by Suburb**
The 10 most often raised issues, in decreasing order of number of times raised, are listed below and shown on Figure 13-2. It is noted that when taken together, issues 1 and 2 (ventilation stacks and air quality) are overwhelming as the most raised issue.

1. Ventilation stacks (predominantly questions about the number and location)
2. General concerns about air quality and impacts of vehicles and tunnel emissions (included comments about air quality impacts from the open trench described as part of Type A Purple option)
3. Noise
4. Support for further investigation of public transport options, rather than road solutions
5. Health impacts from vehicle and tunnel emissions, including impacts on health from exposure of toxins if the Brickyard pit is used for the Type A Purple option
6. Adverse impacts on schools and hospitals
7. Issues about traffic modelling on Pennant Hills Road
8. Impacts on Lane Cove National Park
9. Longer term transport needs for Sydney
10. Impact on property values

Figure 13-2: Major Issues from Community Consultation
Key Outcomes

Comments on the project

Many people expressed support for the new link and to relieve the traffic congestion on Pennant Hills Road and many also sought relief to existing traffic congestion on the Pacific Highway. Many submissions and conversations described first hand experience of the existing poor travelling conditions and diminished local amenity caused by the current level of use of Pennant Hills Road, particularly by heavy vehicles.

The project is supported by road transport industry groups. Completion of this link is critically important in enhancing the road infrastructure of Sydney and will deliver considerable social and economic benefits to the city as well as to businesses based locally and elsewhere.

The project was not supported by all. Many submissions advocated a more comprehensive review of the transport needs of Sydney and for greater focus on integrated transport solutions. In some submissions it was argued that the cost, in the order of $2 billion, would be better spent on rail. It was submitted that options to improve public transport had not been adequately considered. It was argued that Sydney needs investment that will shift travel demand to mass transit and freight onto efficient rail networks.

Project timing and cost

The 20-year time horizon for the study was considered by many residents, community organisations, some Councils and transport groups as being relatively short for the significant investment required. It was submitted that the project benefit of the link disappears within 15 years of construction and therefore does not achieve the project of addressing future growth of long distance transport.

Many expressed strong opposition to a toll on the new link. It was argued that a toll would discourage drivers from using the new link with consequent traffic diversion and congestion on untolled roads. In this context, it was noted that the figures presented in the public information documents indicated the untolled traffic figures only and that information had not been provided on the impacts of tolls on these figures.

Many submissions described the immediate need for the project and considered a 2007 start to be too late. This comment was also made frequently at the public displays by people who live along Pennant Hills Road. They described the pollution, noise they suffer and the generally unsafe traffic and travelling environment that exists now.

Comment on Type A options

It was generally acknowledged that the Type A corridor options would best meet the shorter-term objectives of the project by providing earlier traffic relief to Pennant Hills Road. However, many submissions were received that recommended that a more strategic long-term view needs to also be pursued as long-distance transport needs would only be serviced by the Type A options until the year 2021. On this basis the Type B and Type C options should be continued to be examined so that the longer-term transport growth needs of Sydney and the State (post 2021) can be preserved through their incorporation in the short-term planning and zoning processes, before it is too late.

While some supported the Type B option, there was strong support for further investigation of a Type C option, on the basis that a long term solution (addressing a time frame of 50 years) was needed. It was argued that increasing traffic from the Central Coast would ultimately saturate the F3 and the new link, and an alternative route would be required. Another issue raised was the need to provide for a second crossing of the Hawkesbury River as an alternative route during bushfires or in the case of an accident or other action destroying the existing Hawkesbury River Bridge, or rendering it unpassable.
Some argued for a Type C option rather than a Type A option because vehicles carrying dangerous goods would not be permitted to use a tunnel and hence these vehicles would not be removed from Pennant Hills Road.

Public comment as expressed in submissions, at displays and at the Community Focus Groups was strong on this issue. While many acknowledged the need to address the problems of Pennant Hills Road as quickly as possible, some described this as the “band-aid” solution; and were very forceful in their view that planning is urgently needed for a much longer term solution – through further investigation of a Type C option. It was argued that the Type A options are an expensive stop-gap measure that will not solve regional traffic congestion.

A caveat to support for the Type A route options in principle, was the adequacy of the F3 Freeway and interchanges from Wahroonga to Kariong to cater for the additional traffic it attracts and, if required, capacity upgrade prior to a Type A option being constructed.

Some contended that all four options are unacceptable as they result in poor traffic and transport outcomes. The Yellow and Red options would simply direct more commuter traffic into the CBD, Chatswood and North Sydney areas, which are already suffering from current congestion levels. Further, these two options are based on poor traffic management principles, as a route headed south-east would mix freight transport with the commuter peak streams. Both the Red and Yellow options are unacceptable as they simply funnel more vehicles toward the CBD and do not achieve the stated objectives of reducing traffic on Pennant Hills Road and facilitating long distance and commercial freight.

Of those submissions that identified a preference for an option, the majority expressed support for Type A Purple option and there was least support for Type A Red option.

**Figure 13-3: Percentage of Submissions which Supported a Particular Option**

The Purple option appeared to receive the greatest support on the basis that it best meets the transport objective, minimises social and environmental effects and satisfies the economic test. This is shown in Figure 13-3. Many submissions commented on the equity of selecting this option as the people living along Pennant Hills Road already live with the impacts, and have made property decisions with this knowledge, that this route has long been known as the orbital route through Sydney and furthermore that they would also most benefit from a tunnel option.

The location of a tunnel that generally follows Pennant Hills Road and the existing rail corridor also located the new corridor generally below the existing road and hence below a similar area of properties.
The Purple option passes along a relatively level elevated ridge with no substantial valleys or river crossings and this was considered an advantage in terms of minimising steep grades at either end and crossing under watercourses, that would eventuate with other options.

The opportunity to achieve optimal grades and a relatively uniform tunnel depth was identified as assisting in minimising environmental impacts. Overall, it was suggested that the environmental and social impacts from the Purple option would be less significant than for other options.

In relation to the transport network it was contended that the Purple option enables a shorter route for access to and from the western and southern Sydney markets and to Port Botany and linkage to the Westlink M7. It provides the best opportunity for traffic from western Sydney to access areas north of Sydney, has the potential to reduce traffic volume on Pennant Hills Road and improve the amenity for existing residents and provides a better opportunity for an interchange at M2/Pennant Hills Road.

Notwithstanding the above, it is considered that the Type A Purple option would not achieve community acceptance in its current form. Significant opposition to the Purple option originated from the Normanhurst/Thornleigh area, mostly associated with the proposed open trench in the vicinity of the Brickyard Park. Schools, hospitals, aged care facilities and houses are located in close proximity to this area.

The brickyard also has a history of being used for the disposal of putrescible waste and there was alarm that this area may need to be excavated for road construction. Concerns about the road development and in relation to the possible exposure of toxic material from the pit include impacts from emissions from the trench; potential impacts developmental and health impacts, noise, and overall impacts on amenity. Furthermore, Hornsby Council is progressively developing community and sporting facilities at the Brickyard Park.

Many reasons were put forward in opposition the Red option. Foremost among these was that it would be an abrogation of the government’s commitment to the abandonment of the B2-B3 corridor. It is considered that the high number of submissions from the Warringah/Turramurra area reflect the depth of feeling on this issue. A large number of people wrote about having purchased/built homes and developed their properties with the understanding that further highway development would not be considered in that corridor. Many submissions were received from residents in Kingsley Close, an area that was released for urban development following the abandonment of the B2-B3 corridor.

It was argued that both the Federal and State Governments had promised that no properties would be affected in the vicinity of the F3 and B2-B3 corridor – and that all four Type A options violate this promise. This has significant implications for the design of a northern interchange.

Red was commonly argued to be the least viable, as it was perceived to be the longest and would have the greatest impact on homes. Much of the area where the Red option is located is characterised by high density of residential development. Red was argued to represent poor economic benefit.

Other issues with the Red option included potential impacts on the Lane Cove River. There was concern that tunnels through certain geological formations under the Lane Cove River could have a substantial impact on the flow regime of the river. Many expressed concern that the steep grades at the southern end of this option for it to go under the River, would lead to a decision for a bridge crossing instead.

Another important issue was the potential for direct or indirect adverse impacts on flora and fauna, and wildlife corridors, of the Lane Cove Valley. The intrinsic value and amenity of the Valley could also be impacted by air and noise pollution. It was argued that it would have maximum impact on heritage values compared to other options, and impact on Urban Conservation Area No.26 in Ku-ring-gai.

It was argued that the Red option is too indirect for Orbital traffic and many vehicles would still use Pennant Hills Road, and that it would encourage traffic into the city. It was argued this option would funnel more cars onto Sydney’s already congested feeder roads, rather than reducing traffic congestion on major existing roads and reducing freight transport costs. The potential for induced traffic was raised.
Other issues for consideration

Ventilation Stacks and Air quality

The single most important set of issues raised in submissions was in relation to air quality, including the need for ventilation stacks. Significant concern was expressed about the potential number and location of the stacks and the proposed method of treatment. These details are not available at this stage and there was criticism that people could not make informed comment on the option without this (and other) technical information. There was considerable commonality in community expectation for the tunnel emissions to be filtered and for best practice technology to be applied.

The history of the M5 East tunnel and the Lane Cove tunnel were cited as evidence of the controversy associated with ventilation stack proposals, including the build up of toxicity in the tunnels. The issues of filtration of particulates are likely to become matters of intense public interest.

Many correspondents raised the fact that, by comparison with the proposed Lane Cove tunnel, there is no industrial land in the vicinity of the Type A options and that ventilation stacks would have to be located in open space or residential areas. Concern was expressed over the potential adverse impacts on sensitive receivers such as schools and hospitals in the area, including the Seventh Day Adventist Hospital.

Some correspondents requested that a health risk assessment be carried out as part of detailed investigations.

Impact on properties

There was considerable concern in relation to the need to acquire properties for the new link and the destruction of family homes and other developments. The issue of decreased property values was of concern to many residents and Councils. It was submitted that the possibility of a new link in the vicinity of a property, or the anticipation of a tunnel under a property would result in a decrease in property value.

It was argued that a decision on a preferred option should be made as soon as possible.

Design

Some argued that 2 lanes would not be sufficient for the long term, and given the difficulty of widening a tunnel in the future, the new link should be three lanes in width. It was argued that the third lane should be constructed, even if it is not operational for some time.

Many residents, particularly those living at the northern end of the Type A options requested that the tunnel should commence along the existing F3 corridor, with no property impacts in this area. A detailed submission outlined a proposal for a tunnel to commence up to 1 km north of the Pacific Highway junction to minimise traffic congestion in the event of an accident, and to avoid impacts on bushland and avoid unnecessary detrimental impact on numerous residential properties.
The Purple Option Description

This chapter presents a description of a typical alignment of the Purple Option – the option presented to the community for the purpose of comparing the four Type A options. This description is illustrative only and is one of many different arrangements which could be designed within the Purple corridor. The detail shown is not meant to be described as the preferred concept proposal. Such an option would be developed as part of an Environmental Impact Statement (EIS) process, if the project proceeds to that stage.

The Purple Option is described and presented under the following headings:

(i) General description;
(ii) Interchange and portal arrangements (see Working Paper No.2);
(iii) Tunnel design and ventilation (see Working Paper No.6);
(iv) Urban design and landscape (see Working Paper No.3) and;
(v) Associated works as part of the project.

14.1 General Description

The general alignment of the Purple Option is shown in Figure 14.1.

Two-lane main tunnels

Following a review of the traffic forecasts (see Chapter 16) and the economic analysis (see Chapter 17) of an alternative two and three-lane tunnel arrangement, it was decided on technical grounds that the main tunnels should be two-lane in each direction for a tolled link or three-lanes in each direction if the link is untolled. This would provide sufficient capacity in the tunnel up to 2021.

Brickyard Park

The alignment could pass in a trench close to the open space at Brickyard Park at Thornleigh. Hornsby Council is currently redeveloping the open space adjacent to the Park to include community facilities and a sports complex, including a golf driving range.

Considerable concern was expressed by Hornsby Council during consultation and from residents in Thornleigh to any impacts on the Park and adjoining property (see Chapter 13).

The current Purple Option's alignment could be located on the western edge of the park between the Park and the Main Northern railway line. (See Figure 14.9 in Section 14.4). This alignment could minimise effects on the Park as discussed in Chapter 18.

Ventilation Stacks

This study investigated the location and effects of tunnel ventilation stacks of the Type A options in sufficient broad detail to provide a comparison of options. Working Papers No. 3 (Urban Design, Landscape and Visual Assessment), No. 4 (Social and Environmental Studies) and No. 6 (Tunnel Investigations Report) provide the level of detail which was investigated for the purpose of this study.
The ventilation structures provide the most difficult issues to resolve and would require assessment in detail at the EIS stage.

The length of tunnel along the Purple Option route could require possibly three but more likely four ventilation structures.

### 14.2 Interchange and Tunnel Portal Arrangements

*Figure 14.2* and *Figure 14.3* provide a concept arrangement for the Northern Interchange and Southern Interchange respectively currently developed for the Purple Option.

The northern interchange would have works within the existing F3 road reserve which would extend up to the Edgeworth David Avenue overbridge.

The southern interchange would have works south of the M2 Motorway along Pennant Hills Road as far south and including the North Rocks Road intersection.

**Northern interchange and portals**

The major feature of the possible interchange layout is the inclusion of one way sections of road on the Pacific Highway between Pennant Hills Road and the F3 Freeway and on Pennant Hills Road between the F3 Connection and the Pacific Highway. In order to provide the necessary movements through the interchange following the inclusion of the one way sections, a south facing ramp would be required to allow traffic to access the existing F3 Freeway / Pennant Hills Road link.

The main advantages of this layout over a similar layouts investigated with two way flow on these sections of road are as follows:

- the overall number of lanes could be reduced and therefore the proposed works remain within the existing road reserve; and

- the number of phases required for the traffic signals could be reduced with significant efficiency gains.

The existing right turn from the Pacific Highway (westbound) to the F3 Freeway (northbound) could be widened to allow for three right turn lanes in place of the current two lanes. Similarly the reverse movement from the F3 Freeway (southbound) to the Pacific Highway (eastbound) could also be widened to three lanes.

*F3 Freeway at Pearces Corner looking south from Pacific Highway overbridge*
Note:

This sketch shows an indicative alignment of the Purple Option. It does not represent a concept proposal.
Figure 14.2: Possible Northern Interchange – Base Layout – Purple Option
Figure 14.3: Possible Southern Interchange – Purple and Blue Routes – Base Layout
The existing right turn from the F3 Freeway (southbound) to the Pacific Highway (westbound) could be eliminated with this movement catered for by allowing right turns F3 Freeway (southbound) to Pennant Hills Road (northbound).

The inclusion of the south facing ramp from the Pacific Highway would be required to complete the loop created by the one way sections of road and therefore enable the existing movements to be undertaken. This ramp could also allow for relatively easy access to and from the Pennant Hills Road portals for traffic south of the portal locations. The loop created by the ramp allow for a relatively easy U-turn to be undertaken by these vehicles rather than requiring the use of minor roads to complete this movement.

In order to eliminate weaving movements generated by a conflict from F3 Freeway southbound traffic and traffic from the new south facing ramp from the highway, each wanting to turn left or right onto Pennant Hills Road, the traffic from the freeway could be split into right turn and left turn lanes on the northern side of the Pacific Highway. These lanes could then be directed either side of the new ramp from the highway.

Traffic from Pennant Hills Road (northbound) to the F3 Freeway (northbound) could continue on the existing arrangement as could traffic from Pacific Highway (southbound) to F3 (northbound).

Although some movements would be made longer by this arrangement compared to existing movements (eg from the Pacific Highway (westbound) to the Pacific Highway (northbound)) the number of signalised intersection that the effected vehicles would need to pass (and potentially be stopped by) could remain the same.

The tunnel portals associated with the connection between the proposed link and the F3 Freeway could be located north of the Pacific Highway overbridge. The portals for the south facing ramps could be located in Pennant Hills Road between Edwards Road and Frith Avenue.

*F3 Freeway looking north from existing Pacific Highway overbridge*
Widening would be required on the F3 Freeway between the Pacific Highway and Edgeworth David Avenue. This could require the widening of the existing bridges across the freeway at the railway line, Alexandra Parade and Edgeworth David Avenue. While four lanes could be achieved below the bridges at the railway line and Edgeworth David Avenue through the modification of the existing abutments, the bridge at Alexandra Parade is likely to require rebuilding. The narrowing of the lane and shoulder widths at these locations may reduce the need to modify the existing bridges.

**Impact on existing F3 Freeway and Pacific Highway intersection**

The major change to this interchange would be the removal of the right turn movements from the F3 Freeway (southbound) to the Pacific Highway (westbound) and the widening of the movements between the F3 Freeway and the Pacific Highway (east) to three lanes each. The right turn that could be removed would be catered for by allowing right turns from the F3 Freeway (southbound) to Pennant Hills Road (northbound).

Traffic heading west on the Pacific Highway would need to be directed onto the new south facing ramp and then onto the existing F3 Freeway link to Pennant Hills Road where it would turn right or left onto Pennant Hills Road.

Right turn lanes could be provided from the Pacific Highway (eastbound) to allow traffic to connect back to Pennant Hills Road (southbound) as the straight movement southwards along Pennant Hills Road could be removed for the one way system.

Other movements could remain as per the present arrangements.

**Existing F3 Freeway/Pennant Hills Road intersection at Wahroonga looking south**

**Impact on existing F3 Freeway and Pennant Hills Road intersection**

This junction could be re-configured to allow traffic from the F3 Freeway to turn either right or left into Pennant Hills Road. The left turn from the link to Pennant Hills Road could be made free-flow depending on the requirements for pedestrian crossings.
Pacific Highway and Pennant Hills Road Intersection

Due to the inclusion of the two sections of one way road this intersection could be modified to direct traffic in accordance with the new system.

All traffic from Pacific Highway (southbound) could be directed onto the Pacific Highway (eastbound).

Traffic from Pennant Hills Road (northbound) to the Pacific Highway (northbound) could be free-flow depending on the requirements for pedestrian crossings.

Access Ramp Gradings

The gradings for access ramps could be generally less than 4%, with the exception of the ramps between Pennant Hills Road and the link, which would be approximately 6%.

Southern Interchange and Portals

The Purple option could connect to the M2 Motorway at Pennant Hills Road in Carlingford.

The base interchange option features a set of portals for connection to the M2 Motorway (west) and Pennant Hills Road (southbound), located north west of the existing interchange.

Connections through the main portals would include:

- A separate portal could be located on the eastern side of Pennant Hills Road for connection from the link to the M2 Motorway (eastbound) via the existing M2 ramps. The northbound movement from Pennant Hills Road to the Link includes a portal located south of the M2 Motorway and therefore removes this movement from the existing interchange.

- M2 Motorway (eastbound) to link (northbound) via the existing off ramp then a surface connection to the link.

- M2 Motorway (westbound) to link (northbound) via the existing off ramp and interchange then a surface connection to the link.

- The link (southbound) to the M2 Motorway (westbound) via a bridge over the existing interchange to the existing on ramp.

- The link (southbound) to Pennant Hills Road (southbound) via a bridge over the existing interchange.

As an alternative to this layout, tunnel connections are possible between the link (southbound) and Pennant Hills Road (southbound) and between the link (southbound) and the M2 Motorway (westbound). This would eliminate the need for bridges over the existing interchange.
Impacts on Existing Intersections

The existing M2 Motorway / Pennant Hills Road interchange could be slightly modified to include a northbound connection to the proposed link for traffic from the motorway (westbound) via Pennant Hills Road. The traffic undertaking these movements would already do so as part of the existing configuration, so no adverse impacts are expected.

Traffic from the link (southbound) connecting to the M2 Motorway (eastbound) would use the existing intersection. Due to the relatively low volume of traffic expected to use this connection, no adverse impacts are expected. Other intersections would be unaffected, except for the widening at North Rocks Road intersection (see Chapter 16, Section 16.5).

Access Ramp Gradings

The maximum gradings for the ramps would be approximately 6%. This grade would relate to the bridge over the existing interchange and to the tunnel below the existing intersection.

Pedestrian Access

Due to the construction of the tunnel portals to the north west of the existing interchange, the footpath in this area would need to be moved with access along the eastern side of Pennant Hills Road retained. Existing pedestrian crossings at Copeland Road intersection and the M2 interchange could be used to transfer pedestrians to the eastern side of Pennant Hills Road.

A more detailed study will be required to optimise pedestrian access through this interchange.
14.3 Tunnel Design and Ventilation

Psychology of Tunnel Use

The Purple Option alignment of the main dual tunnels section south of Thornleigh is at least 5.5kms long. Long tunnels, greater than 3km, require special attention with regards to driver comfort from a driver psychological point of view. Some drivers are inclined to regard tunnels as threatening because they experience some kind of discomfort or even fear which probably increases with tunnel length\(^1\). Some surveys suggest that between 5% and 8% of drivers suffer from some form of phobia that would be triggered by use of long tunnels. The willingness to drive in long tunnels is also important if the tunnels are to be financed by means of a toll as these drivers may seek an alternative route.

In open road design in Australia, there is a height restriction under bridges of 5.3m. Tunnels restrict both the driver’s vertical and horizontal space. The restriction in height in tunnels in Sydney is based on the height of heavy vehicles. The 2.5km long Sydney Harbour Tunnel, for example, has a height restriction of 4.3m. The recently completed 4km long M5 East Freeway Tunnel has a height restriction of 4.6m because of the volume of container traffic.

Restrictions in width and height may have several consequences. First of all, they create a sense of confinement, thereby influencing the drivers’ uncertainty and sometimes feelings of discomfort.

The tunnel width would have an impact on the lane capacity as some drivers reduce their travel speeds due to perceived ‘narrowness’ of the tunnel. The assumed Purple Option tunnel cross-section profile assessed is shown in Figure 14.4.

Tunnel Profiles

The assumed tunnel profile (Figure 14.4) is based on safety and driver needs in long tunnels and on anecdotal driver experience in long tunnels operating on the Sydney and Melbourne network. This issue is discussed further in Working Paper No.6.

Apart from geological conditions the main factors influencing the shape of the tunnel profile are method of construction, ventilation requirements and other tunnel services, the number of traffic lanes and height clearance requirements. All NSW tunnels currently include provision for emergency pedestrian access by the provision of a walkway located behind a New Jersey barrier on the right hand side of the tunnel. Apart from portal areas, driven tunnelling would be either in sandstone or shale rock. The Purple Option alignment would, based on current geological information, be excavated in sandstone and shale. The impact of shale on the tunnel profile is relatively minor, however, it would result in a tunnel profile with a higher arch than if the tunnel was excavated in sandstone rock and a resultant increased cross-sectional area. Typical final tunnel cross sections for both sandstone and shale excavated tunnels are shown in Figure 14.4.

The preferred tunnel cross-sectional profile, given the high up to 20% percentage of heavy commercial traffic predicted to use this tunnel is a 2-lane tunnel, with 4m lane widths and 0.5m shoulders against the New Jersey side barriers giving a total carriageway width of 9m. For 3-lane tunnels 3.5m lane widths with 0.5m shoulders are the preferred minimum dimensions giving a carriageway width of 11.5m.

The traffic lane widths recommended are no less than 3.5m with 0.5m shoulders against the side New Jersey Barriers except on one side of a single lane tunnel where a 2.4m shoulder has been assumed for traffic passing or a vehicle broken down in the tunnel. The traffic height clearance in the tunnel is assumed at 4.6m.

The longitudinal profile is shown in Figure 14.5.

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\(^1\) Refer to Working Paper No.6.
Figure 14.4: Typical Tunnel Cross Sections

(a) Assumed tunnel cross section for a long tunnel in shale showing 2 wide lanes and shoulder

(b) Assumed Tunnel Cross-Section In Sandstone Of Single Lane Access Ramp With Wide Shoulder For Breakdown Vehicles
### Longitudinal Section Along Mainline Control

**Pennant Hills - Thornleigh Road Tunnel**

**Table: Alignment Details**

<table>
<thead>
<tr>
<th>Station</th>
<th>M.A.E.</th>
<th>M.A.E.</th>
<th>M.W.E.</th>
<th>M.W.E.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
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<td>10.00</td>
</tr>
<tr>
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<td>20.00</td>
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</tr>
<tr>
<td>30.00</td>
<td>30.00</td>
<td>30.00</td>
<td>30.00</td>
<td>30.00</td>
</tr>
</tbody>
</table>

**Tunnel Portal**

- Brickyard Park
- Open Cut Road

---

**Notation:**
- This sketch illustrates indicative arrangements for the purpose of comparing feasible options only; they do not constitute a scheme proposal.
- If the government decides to further develop the recommended option, an E.I.S. scheme including route alignment and other details will be developed for further assessment. Community consultation will continue throughout.
Ventilation

The tunnel ventilation method proposed is longitudinal using jet fans. Tunnel enlargements and ducting near tunnel portals would be required to direct air back from the portals to exhaust air shafts. Air extraction and fresh air intake points would be spaced at 2km to 3km intervals along the tunnel. In some cases quite long ventilation tunnels are required to reach the ventilation shafts at a suitable site preferably, the ventilation system in each of the north and southbound tunnels would operate independently with no air transfer between tunnels.

Apart from the tunnels required for vehicular traffic there will be a number of driven tunnels required to connect the vehicular tunnels to the ventilation shafts. The tunnels would be partitioned with concrete walls to provide two fresh air injection and two tunnel air extraction ducts. For example, the fresh air tunnels could be replaced by fresh air entry shafts located above the main tunnel drives, thus saving the cost and operation of long fresh air supply tunnels. It would be expected that these tunnels would be excavated by roadheaders whether in shale or sandstone rock.

In addition to separate ventilation tunnels there are some cases where the standard tunnel profile has been enlarged to incorporate a ventilation duct back to an exhaust air shaft. In recent conditions of approval for long tunnels, the NSW Department of Environment and Conservation (DEC) requirements do not allow dispersion of polluted tunnel air via the tunnel portals.

Issues would need to be resolved concerning the location and number of ventilation exhaust stacks. The other type of ventilation stack required would be for the injection of fresh air into the tunnel which, from a public perspective, only have a visual impact.

Further discussion of ventilation stacks can be found in the appendices of Working Paper No.5 – Social and Environmental Report for this study.

Air Quality in the Tunnel

It is expected that emissions from conventional motor vehicles will continue to reduce significantly over the next 10 years, to match the large reductions already achieved over the last 30 years. These results will be achieved by the implementation of new standards for fuels, being introduced into Australia for the first time, along with vehicle emission standards (known as Australian Design Rules or ADRs). The ADRs will progressively bring Australia’s emission standards into line with Euro 3 and Euro 4\(^2\).

Construction

Tunnelling conditions would be in shale and sandstone (see Figure 14.5). The most suited excavation methods for these ground conditions are roadheaders or Tunnel Boring Machines (TBM). Tunnel support in shallow cover areas near tunnel portals may require canopy tubes and steel sets to support soft ground and control surface settlement. For the majority of tunnelling, however, the tunnel support would consist of shotcrete and permanent rock bolts. The tunnel profile in shale having a slightly higher crown than for tunnels excavated in sandstone.

The construction duration would be about 4 years and will require considerable tunnelling resources to complete within this time frame.

The Purple Option would have the potential to be readily constructed in stages. This is because access could be gained to multiple sites early in the construction program and thus providing an opportunity to optimise the construction program and spread the construction resources required over a longer period by staging.

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\(^2\) As an example, Euro 4 would reduce carbon monoxide in cars from 2.1 g/km (current ADR) to 0.5 g/km and particulates from 0.05 g/km to 0.025 g/km. The change in particulates for heavy duty diesel (trucks) would be reduced from 0.36 g/km to 0.03 g/km by 2006/7. Euro 4 is due to be introduced as an Australian Design Rule (ADR) by 2006/07.
14.4 Urban Design and Landscape

The Purple Option would achieve a number of urban design, visual and landscape advantages as well as providing opportunities that go beyond the road itself. As most of the road would be in tunnel the major areas where it would interface with the community and the existing urban structure is at the northern and southern interchanges. Should the tunnel come to the surface near Brickyard Park (Hornsby Council’s Dartford Road Sports Complex), there would be impacts in that area. These areas also provide opportunities for upgrading of existing facilities in association with the open cut section of the road.

**Northern Interchange at F3 Freeway**

This interchange would provide significant improvements to existing traffic movements whilst reducing the extent of changes and maintaining the existing ‘footprints’ of the interchange.

The alterations to the northern interchange could result in the following impacts.

This interchange could provide improved legibility over the existing interchange and creates a simplification of the traffic movements at the intersections within the overall interchange, by making them one way. This may decrease legibility in the short term due to the significant change to the Pacific Highway and Pennant Hills Road sections of the interchange, however over time these changes would reduce the potential for traffic conflicts. The function of the interchange would be improved and provide both north and southbound access to the F3. The geometry of the intersection would be also improved and would create a clearer legibility for motorists travelling along Pennant Hills Road.

The required split of traffic north of the Pacific Highway into separate lanes to turn either right or left at Pennant Hills Road would add more decision points for motorists at this intersection.

In operational terms the interchange would become a large roundabout with the potential for movements one way to connect with each of the feeding roads from it. With good landscape treatment and clear portal design the legibility of this intersection will be retained. Access to the residential areas within the centre of the interchange is retained and traffic conflicts would be reduced by the one way system.

Visual impacts could be minimised due to the absence of over bridges and additional high level connections. Two portals and approach ramps would be located on Pennant Hills Road. These would provide for clear movement to and from the portals.

A number of large trees along the highway would be affected by this acquisition and it would be important to plant additional species early to remediate these potential negative impacts.

Potential new landscape could be accommodated within the wider portion of the Pacific Highway. The existing traffic impacts at this interchange could be significantly reduced and the landscape improved by ensuring that the maximum quantity of existing trees is retained. Potential landscape treatment at the F3 interchange is shown on Figure 14.6. Opportunity for new landscape within the central median above the tunnel is shown in Figure 14.7 and highlights the potential softening effects within the existing road easement.
Figure 14.6: Potential Landscape Treatment at F3 Interchange, looking South

Key design considerations at Portal Approach:
- Safety and comfort
- Legibility
- Clear views are retained
- Open driver perception at entrance to tunnel

ELEVATION TUNNEL PORTAL LOOKING SOUTH

ELEVATION EXISTING SITUATION
The existing interchange would be complicated by the additional traffic movements required as a result of the tunnel and portal connections. The legibility would also reduce slightly by the over bridges at the western approach to the interchange from the M2, creating visual complications to the approaches. The over bridge connecting Pennant Hills Road as a grade separated link over the interchange would also result in visual complications, increasing the decision making points required at the interchange. The existing toll structures would be removed to accommodate the M2 to Pennant Hills Road west facing ramps.

The existing interchange is unattractive and visually intrusive. The existing shotcrete retaining structures on the M2 at the east of the interchange require improvement. The visual impacts associated with the additional works would not significantly increase the already negative impacts at this interchange. This, however should not ignore the potential to improve the interchange and create a more attractive, resolved and legible interchange for both the motorist and the residents surrounding the interchange. Most of the residents views are orientated away from the interchange apart from some properties on the south west.

Affects on Pennant Hills Golf Course could be limited as the footprint of road works is located outside the golf course.

This interchange would require detailed design resolution if the option is adopted and all of the potential traffic movements included in the clearest manner.
Additional landscape could be accommodated adjacent to the interchange. It would be important for these areas of additional landscape to provide visual screening of the new ramps particularly to the north west of the interchange, where the extent of road is approximately double the footprint of the existing interchange.

Figure 14.8 shows potential landscape treatments which could be implemented.

Figure 14.8: Potential Landscape Treatments at the Southern M2 Interchange, looking North
Brickyard Park

The current Master Plan for the Park, as outlined in Hornsby Council’s Local Environmental Plan, could be varied to accommodate an open cut adjacent to the railway reserve. This might involve significant alterations on the design for the Park. A sketch layout shown in Figure 14.9 outlines how the open cut could be included within the park design minimising impact on the existing facilities.

Figure 14.9: Possible Alignment of Purple Option Adjacent to the Dartford Road Sports Complex at Brickyard Park, Thornleigh

The legibility of the route as it passes through the edge of the park would be improved, due to the increase in natural light and the orientation benefits associated with this for the drivers.

The visual impacts within the park would occur as a result of potential noise barriers, however there is ample location for adjacent screen planting. Two tunnel portals would be required, along with a bridge over the area of cut at Dartford Road. Dartford Road would also require realignment east and should be located with adjacent vegetation to provide a visual context for the tunnel.

The potential for landscape treatment at the park is high. The following design principles should be adopted in the siting of any open cut area within the park.

- The visual impacts on the future Brickyard Park could be reduced by locating the open cut as close to the existing rail corridor as possible
- The loss of existing landscape and open space could be minimised in the siting of the open cut area.
- Ensure land isolated between the rail and road corridor would be minimised or avoided
• The potential to provide additional landscape and screening adjacent to the alignment could be maximised. This would assist in screening of any required noise barriers, potential use of mounding for noise barriers and the integration of the portals into the surrounding landscape.

• Retain maximum amount of existing landscape where possible

• Realign Dartford Road to minimise impacts

14.5 Associated Works as Part of the Project

The Purple Option would require some improvements to Pennant Hills Road south of the M2 and improvements to Pennant Hills Road in the form of road space re-allocation opportunities.

**Pennant Hills Road South Improvements**

The capacity of Pennant Hills Road south of the M2 Motorway to North Rocks Road was identified as a restriction on the southbound traffic leaving the tunnel in 2021. This was particularly the case at the intersection of Pennant Hills Road and North Rocks Road. Without this improvement the following could occur for both northbound and southbound traffic:

• For northbound traffic, there could be extended queuing south of North Rocks Road and under utilisation of the new link.

• For southbound traffic, there could be the likelihood of queuing back into the tunnel, which would adversely affect the driving conditions and also require increased ventilation.

In order to reduce these risks, the Pennant Hills Road / North Rocks Road intersection should be upgraded to improve the through traffic movements. A preliminary assessment of this upgrade scheme indicated that acquisitions would be required along Pennant Hills Road to allow the required number of traffic lanes at the intersection.

A possible layout for at the North Rocks Road intersection is presented in Figure 14.10.

*Figure 14.10: A Possible Pennant Hills Road/North Rocks Road Intersection layout, part of the Purple Tunnel Project*
The possible layout would be operating at or near capacity by 2021. It should be noted that the significant number of lanes required at the southern approaches related to the PM flows. During the PM peak, two strong movements run separate phases. The first is the through movement from the southern approach, and the second is the left turn movement from the western approach. These movements are the transpose of the AM peak flows.

During the AM peak flows the main movements are the through and right movements from the northern approach. Both movements can be accommodated in the same phase. Hence, the number of lanes required for the through movement at the northern approach is less than the through movement at the southern approach.

An alternative option to reduce the lane configuration required at this intersection would be to reduce the capacity of the left turn from the western approach to the northern approach. The latter would discourage the left turners from using North Rocks Road intersection, in particular during the evening peak. On the other hand this option would increase the rat-runs via Oakes Road and Aiken Road.

Road Space Reallocation and Urban Design Improvements on Pennant Hills Road

The Purple Link option would allow opportunities for significant improvements to the urban amenity along Pennant Hills Road. The existing six traffic lanes could revert to 4 general traffic lanes with bus priority to realise benefits to other users. Wider pavements and a cycleway could also be considered. This is shown by Figure 14.11.

This could provide the potential to revitalise Pennant Hills Road as a neighbourhood connecting road, with the added benefits of decreased traffic along its length. The potential benefits from the reallocation of road space on Pennant Hills Road could include:

- Better pedestrian amenity from reduced surface traffic volumes.
- Potential to provide an improved streetscape character with the addition of street trees, improved pedestrian footpaths, dedicated bicycle lanes, or bus lanes.
- The improvements to the local bus routes along Pennant Hills Road with features such as bus jump starts and integrated bus shelters.
- Street furniture that is complementary for the full length of the road including; seating, tree guards, bollards, kerbs, fences and pedestrian control devices.

This could result in a positive outcome for Pennant Hills Road and the character of this road from the project and improve the surface road environment for the local motorists, pedestrians, rail and bus commuters and cyclists using this road.

F3 Widening up to Edgeworth David Avenue

The northern interchange at Pearces Corner would required works within the existing F3 road reserve to be extended up to the Edgeworth David Avenue overbridge.

Improvements to Local Roads

Due to the construction of the significant length of the link within tunnel, local roads are generally not physically disturbed by the link. The proposed link interchanges would affect some local roads, including:

- Frith Avenue, Edwards Road and Russell Avenue – the layout of the Northern Interchange may change access to these streets due to the tunnel portals for the south facing ramps.

- Existing Bridges – there are a number of local roads that currently cross over or below the F3 Freeway and M2 Motorway that could require modification or reconstruction. These include:
  - Edgeworth David Avenue bridge over F3 Freeway – reconstruction of abutments.
  - Alexandra Parade bridge over F3 Freeway – reconstruction.

The above improvements would need to be fully assessed once the Purple Option proposal is developed.
Figure 14.11: Possible Typical Treatment of Re-allocating Road Space on Pennant Hills Road

(a) Possible Typical Cross Section – Cycle lane on both sides

(b) Possible Typical Cross Section 2 – Cycle lane on one side

(c) Typical Plan
Chapter 15

Social and Environmental Effects

This Chapter summarises the major social and environmental effects of the Purple Option. More detailed descriptions are given in Working Paper No.5. It is arranged under the following headings:

i) Land Use and Zoning;
ii) Terrestrial Ecology;
iii) Water Quality and Aquatic Ecology;
iv) Air Quality;
v) Noise Impacts;
vi) Heritage;
iii) Social Impacts;
ix) Energy;
ix) Ventilation Stack Issues; and

15.1 Land Use and Zoning

Permissibility of Land Use

Relevant Council planning policy instruments were reviewed and the permissibility of roads identified within the zones through which the route would pass. With the exception of Special uses 5(a) zone in Ku-ring-gai, roads are permissible with consent.

The prohibition of roads within this zone may affect the permissibility of the proposal, and whether it can be assessed under Part 5 of the EP&A Act. Where a proposal is prohibited, it may not be carried out, either with or without development consent. Likely options to proceed with prohibited development is through amendment of the relevant environmental planning instrument or the addition of the project to the schedule of projects covered by State Environmental Planning Policy (SEPP) 63 – Major Transport Projects. Inclusion of the project in the SEPP would allow the project to be assessed under the provisions of Part 5 of the EP&A Act.

Direct impacts on land use

Estimates of direct impacts on existing land uses where the route would be at the surface, below the surface but in cutting, or constructed through cut and cover methods is contained in Table 15-1. These estimates are based on generic road corridor dimensions.

The Purple Option would impact on approximately 2.4 ha of residential land, 0.5 ha of industrial land and 0.5 ha of open space. There would be no impacts on community land.

Open space impacts at Brickyard Park, would result in partial fragmentation of the area, with effects on the amenity and useability of this local area. However, the proposal would revert to tunnel construction near the eastern edge of the park (near Dartford Road) allowing limited connectivity between areas north and south of the proposed road.
Impacts on open space land are considered likely to have an impact on a greater proportion of the population than impacts on residential land, because open space is a communal resource that has a limited supply.

When assessed against the scale and regional significance of the proposed link, the overall land take requirements of this option would be relatively small. For a project of this size, direct impacts on land use would be largely avoided by constructing the majority of the link in tunnel.

**Table 15-1: Purple Route - Estimated Land take by Land Use Zone**

<table>
<thead>
<tr>
<th>Land use zone</th>
<th>Area (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>24,000</td>
</tr>
<tr>
<td>Commercial</td>
<td>1,000</td>
</tr>
<tr>
<td>Industrial</td>
<td>5,500</td>
</tr>
<tr>
<td>Special Uses (Community)²</td>
<td>-</td>
</tr>
<tr>
<td>Open Space³</td>
<td>5,000</td>
</tr>
<tr>
<td>Sub-total of above land uses</td>
<td>35,500</td>
</tr>
<tr>
<td>Special uses (Transport)/road reserve¹</td>
<td>15,500</td>
</tr>
<tr>
<td>Total</td>
<td>51,000</td>
</tr>
</tbody>
</table>

Notes:

1. includes land zoned Special Uses 5 (road widening, existing roads, future roads) and land reserved for future roads or road widening purposes.
2. includes land zoned Special Uses 5(a). This generally includes churches, schools and other community facilities or government land.
3. includes both public and private recreation zoned land, and land reserved for future open space purposes.

### 15.2 Terrestrial Ecology

**Assessment of impacts**

The Purple Option would involve tunnelling which would effectively impose minimal impact to flora and fauna species and habitats, including threatened species and endangered populations and communities. Surface disturbance would occur at tunnel entrances and on/off ramps associated with interchange locations and proposed ventilation stack locations.

Several areas of relative significance in terms of local biodiversity, provision of potential habitat for threatened species and endangered populations were identified. Such areas are restricted mainly to the more intact bushland areas associated with the Lane Cove River, Lane Cove National Park and Pennant Hills Park. Important habitats are absent from the heavily built up urban areas, where there are few areas of remnant vegetation and these are limited to occasional retained trees and small fragmented patches in the landscape. Given the absence of critical habitat features from these areas, impacts on threatened fauna are likely to be minimal in urban areas.

Threatened fauna species likely to utilise the habitats potentially affected by the Purple Option corridor include those species most adapted to a modified landscape and the more mobile and widespread species which are capable of dispersing distances and navigating between patches of remnant habitat. The potential for the Purple Option to impose adverse impacts on these species is minimal, particularly given the relatively small scale of clearing required in relation to the available habitat, the isolated nature of the potential habitat and the degree of disturbance currently documented in the area.

Potential impacts to terrestrial ecology are summarised in Table 15-2 below.
Table 15-2:  Purple Option - Potential Threatened Flora and Fauna Impacts

<table>
<thead>
<tr>
<th>Significant Biological Feature</th>
<th>Purple Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Threatened flora and fauna species known in the locality (ie 10 km radius)?</td>
<td>Yes</td>
</tr>
<tr>
<td>Threatened flora or fauna species identified within proposed surface disturbance area?</td>
<td>No</td>
</tr>
<tr>
<td>Is habitat for threatened flora and fauna considered likely to occur?</td>
<td>No</td>
</tr>
<tr>
<td>Has a recovery plan been approved for a threatened species potentially occurring in the area?</td>
<td>No</td>
</tr>
<tr>
<td>Will conservation areas be directly or indirectly impacted by the proposal?</td>
<td>No</td>
</tr>
<tr>
<td>Significant biological features present</td>
<td>Fauna habitats include a small strip of bushland owned by the RTA at the proposed F3 Freeway interchange. The quality of this habitat deteriorates towards the southern end of this site, which becomes a poor quality remnant in terms of naturalness and extent of weed invasion. Small area of bushland at the corner of Pennant Hills Rd and Dartford Rd contains a number of larger trees and dead standing trees which have tree hollows providing habitat for hollow-dependent fauna.</td>
</tr>
<tr>
<td>Potential impacts of loss of significant features on fauna</td>
<td>Loss of potential tree hollow resources at these locations could potentially have a small impact on populations of tree-roosting bats.</td>
</tr>
<tr>
<td>Significance of fauna habitat values potentially disturbed</td>
<td>Low in comparison to bushland remnants in surrounding less disturbed areas.</td>
</tr>
<tr>
<td>Significance of habitat for threatened species</td>
<td>Unlikely to be significant, given its location and relative isolation</td>
</tr>
<tr>
<td>Summary assessment</td>
<td>Comparative assessment of impact: Low</td>
</tr>
</tbody>
</table>

Source: Working Paper No.5

The analysis of the Purple Option impacts detailed below has been based on the presence of significant biological features in proximity to the route, including potential habitat for threatened species and endangered populations as listed in the TSC Act.

The status of Endangered Ecological Communities (EECs) and endangered populations for the Purple Option is given in Table 15-3 below.

Table 15-3:  Endangered Ecological Communities (EECs) and Populations

<table>
<thead>
<tr>
<th>Significant Biological Feature</th>
<th>Purple Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endangered Ecological Communities (EECs)</td>
<td>No EECs present along proposed route or surface areas impacted by proposal</td>
</tr>
<tr>
<td>Endangered Populations</td>
<td>An endangered population of Gang-gang Cockatoo Callocephalon fimbriatum is known in the Hornsby and Ku-ring-gai LGAs. Individuals could potentially utilise small bushland remnants associated anywhere along the route. The Darwinia fascicularis subspecies oligantha is also an endangered population known to occur in the Baulkham Hills and Hornsby LGA.</td>
</tr>
</tbody>
</table>

Source: Working Paper No.5
The Purple Option would have a relatively low overall impact on threatened species, endangered populations and communities and on biodiversity in general. This is based on the lack of significant habitat for threatened species and endangered populations and absence of endangered communities and the extent of modification and degradation to existing fragmented vegetation along these routes.

Mitigation measures

Any small scale clearing of vegetation associated with the northern and southern interchanges would be unlikely to impose a significant impact on threatened species, ecological communities, populations or their habitats identified in this report. However, consideration would be given to avoiding vegetation and habitat which has some unique value or potential to regenerate. Such areas are considered locally significant in an otherwise modified landscape.

15.3 Water Quality and Aquatic Ecology

Assessment of impacts

Water quality and aquatic ecology in the catchments where the Purple Option would be located were assessed using existing data. The water quality was found to be generally of poor to medium quality, showing strong influence from urban development within the catchments. Aquatic flora and fauna generally reflects the water quality in terms of its diversity and composition. No species or communities listed as threatened under the schedules of the Fisheries Management Act, 1994 were found or are likely to occur within the waterways.

Following a detailed assessment of water quality and the presence of aquatic ecology within the study area, the potential impacts of the Purple Option on water quality and aquatic ecology were assessed according to the following criteria:

- Degree of direct impact (direct effect) on the waterway (earthworks, creek diversion, dredging etc);
- Sensitivity of the waterway (habitat quality or presence of threatened species); and
- Potential for indirect effect (construction site or road runoff in the creek catchment).

The proposed interchange and tunnel portal works at Pearces Corner would be within the catchment of Coups Creek, which drains to Lane Cove River. The works would be a sufficient distance from the creek such that, with the provision of appropriate management controls, minimal impacts on the waterway would be anticipated.

The tunnel emergence on the edge of the old Brick Pit at Brickyard Park would not result in any water runoff to receiving waters, and no impact was assessed at this location.

The portals located at the southern interchange would all be sufficient distance from receiving waters such that, with the provision of appropriate management controls, no impacts on the various waterways would be anticipated.

The major issues considered in the assessment are summarised in Table 15-4.
Table 15-4: Summary Assessment of Purple Option – Aquatic and water quality

<table>
<thead>
<tr>
<th>Criteria / Option</th>
<th>Purple Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree of direct impact (direct effect) on the waterway (earthworks, creek diversion, dredging etc)</td>
<td>Low</td>
</tr>
<tr>
<td>Sensitivity of the waterway (habitat quality or presence of threatened species)</td>
<td>Low to Medium</td>
</tr>
<tr>
<td>Potential for indirect effect (construction site or road runoff in the creek catchment)</td>
<td>Low</td>
</tr>
</tbody>
</table>

Source: Working Paper No.5

Mitigation measures

The following general safeguards or mitigation measures should be considered should the Purple Option be further developed or implemented:

- Establishment of a water sampling study and surveys of aquatic flora and fauna at key locations within the catchment. The sampling locations and design would depend on the route chosen but should be adequate to allow a baseline for analysis of impacts on receiving waters and aquatic communities during construction and operation. Water quality sampling should include toxicants which may be of concern from road runoff. Aquatic sampling should also be designed to assess if the Adams Damselfly (a threatened species listed on the schedules of the Fisheries Management Act) is located within the area of the alignment chosen;

- The construction environmental management plan to provide for the preparation of an integrated Soil and Water Management Plan to manage runoff during construction activities;

- The operational Environmental Management Plan (EMP) would provide procedures for the management of drainage systems. Water quality ponds and other structures devised to manage runoff from the roads should be accordance with EPA (1997) and the Department of Housing (1998) requirements.

15.4 Air Quality

Air quality impacts from the operation of a tunnel would arise in two ways:

- Emissions of pollutants carried with the air used to ventilate the tunnel; and

- Impacts arising from changing traffic flows on surface roads due to the introduction of the tunnel into the road network.

Assessment of impacts

Preliminary dispersion modelling was undertaken for air vented from stacks located along the Purple Option. Results from the dispersion modelling, including a summary of the stack sources for the Purple Option, the estimated annual emissions for years 2011, 2016 and 2021 and hourly air emissions from each stack are provided in Table 15-5. This table shows the highest pollutant concentrations predicted in the modelling region. Concentrations presented would be due to emissions from the ventilation stacks only. That is, they would not include existing concentrations in the area due to non-modelled sources.
Table 15-5: Purple Option - Predicted peak ground-level concentrations due to stack emissions

<table>
<thead>
<tr>
<th>Pollutant and averaging period</th>
<th>2011</th>
<th>2016</th>
<th>2021</th>
<th>Relevant Air Quality Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum 1-hour CO (mg/m³)</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
<td>31</td>
</tr>
<tr>
<td>Maximum 8-hour CO (mg/m³)</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>10</td>
</tr>
<tr>
<td>Maximum 1-hour NO2 (µg/m³)</td>
<td>51</td>
<td>50</td>
<td>50</td>
<td>245</td>
</tr>
<tr>
<td>Annual NOx (µg/m³)</td>
<td>1.2</td>
<td>1.2</td>
<td>1.2</td>
<td>60</td>
</tr>
<tr>
<td>Maximum 24-hour PM10 (µg/m³)</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
<td>50</td>
</tr>
<tr>
<td>Annual PM10 (µg/m³)</td>
<td>0.06</td>
<td>0.06</td>
<td>0.06</td>
<td>30</td>
</tr>
</tbody>
</table>

Source: Working Paper No.5

The results show that:

- Air quality impacts of the Purple Option would not vary significantly from 2011 the year of opening to 2021;
- Predicted concentrations at ground-level due to stack emissions would be within relevant air quality goals; and
- The predicted 1-hour average NO2 ground-level concentrations would consume the greatest fraction of the air quality goal.

It is likely that, with further improvements to vehicle technology and fuel standards, the concentrations in the future years (especially 2016 and 2021) would be lower than those presented in Table 15-5.

Based solely on the emissions from the modelled tunnel configurations and stack characteristics, the results in Table 15-5 indicate that the Purple tunnel option would result in relatively low ground-level air pollutant concentrations. The results from the dispersion modelling show that emissions from the Purple Option would be able to comply with relevant air quality goals.

A summary of the air quality issues is given in Table 15-6.

Table 15-6: Purple Option - Summary of air quality issues

<table>
<thead>
<tr>
<th>Air quality issues</th>
<th>Purple option</th>
<th>Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average annual CO emission per km of tunnel in 2011 (t/km)</td>
<td>119</td>
<td>M</td>
</tr>
<tr>
<td>Proposed number of ventilation stacks</td>
<td>4</td>
<td>L</td>
</tr>
<tr>
<td>Average annual CO emission per stack (t/km/stack)</td>
<td>30</td>
<td>M</td>
</tr>
<tr>
<td>Relative Impact from stacks to ground-level (based on results from Table 15-5)</td>
<td>1</td>
<td>H</td>
</tr>
</tbody>
</table>

Source: Working Paper No.5

(1) Performance rank (1=most preferred on basis of air quality issue, 4=least preferred on basis of air quality issue)
(2) Importance (H=High, M=Medium, L=Low)
The Purple option was preferred over other options considered, from an air quality perspective, based on predicted traffic information, tunnel designs and notional stack locations and using 20m high stacks in all the dispersion modelling.

**Mitigation measures**

The reduction in surface traffic on the major arterial roads expected for the Purple Option would play a significant part in improving air quality in the region. These reductions have been considered in estimating the impacts of the tunnel options.

A more detailed assessment will be required at the EIS stage of the project.

### 15.5 Noise Impacts

**Assessment methodology**

Because the Purple Option would be primarily in tunnel, acoustical issues would be associated with the access roads to the tunnels, redistributed traffic from other roads and tunnelling works. The road link is assumed to open in 2011 and thus, consistent with RTA/EPA procedures, the 10 year period used to form the basis of acoustical assessments is 2021. Traffic flows were prepared for both the tolled and no-toll options. However, assessment outlined below is based on the “with toll” option, as this would result in more vehicles being on the surface roads, and would therefore be considered the worst case situation.

**Expected Relative Changes in Road Traffic Noise**

The Calculation of Road Traffic Noise (CORTN) algorithms were used to determine the change in future traffic noise levels for for 2021 (10 years after project opening). Key issues relate to the impacts of traffic volumes compared with the base case and the noise impacts at above-ground locations such as northern and southern interchanges, portals and surface roads. Overall, the impact of the Purple Option proceeding (ie the difference in 2021 with or without the project) was found to be generally low, as the majority (>71%) of the changes in the road traffic noise would be within 1 dB (A). Ninety four percent of the changes would be within 2 dB (A).

The Purple Option would result in positive benefits at the Pacific Highway (south of Telegraph Rd), and Pennant Hills Rd (Nth of Boundary), due to reductions in traffic levels. The northern intersection includes changes at the intersection of the F3 and Pennant Hills Road. The link “through tunnel” portals could be located north of the Pacific Highway overpass, with additional portals in Pennant Hills Road.

This intersection option would not be a source of significant operational noise into the local area, and it would be expected that there would be some benefits to residents between the portal(s) on Pennant Hills Road and the existing F3 turnoff. At the southern interchange, the Purple Option would include a “through tunnel” portal at grade approximately 250 m north of the M2 motorway, exposing a number of dwellings to increases in road traffic noise. Barriers would be a viable noise control option.

The Purple Option would involve construction of a bridge over Pennant Hills Road, making it a three level interchange. Noise controls on such a bridge structure could not be considered a viable option, and it is possible that this could lead to some acoustical impacts, the extent of which could only be determined at the detailed design stage.

**Tunnelling Considerations**

Noise from tunnel construction has risen as an environmental issue over several successive infrastructure projects in Sydney and it is possible that night-time construction activities may need to be mitigated for noise impacts.

The Department of Environment and Conservation (DEC) does not have any clear guidelines for regenerated noise during construction. However there is a trend of increasingly more stringent criteria
on successive projects. The level of regenerated noise is dependent on the equipment used and the intervening rock strata.

The study has not considered the locations of the construction portals. Noise from construction portals can result in a high level of impact due the quantity and type of fixed plant (extraction fans, dust collectors, compressors etc) and the number of truck movements required for the removal of spoil. Ideally therefore portals should be located as far away from residents, to avoid conflict and restrictions to operations.

15.6 Heritage

Indigenous Heritage Assessment

No indigenous heritage sites were identified in the vicinity of the Purple option and no items would be directly impacted by the proposed tunnel works or the identified areas of “cut and cover” works associated with tunnel portals and approaches. No areas of potential archaeological deposit (PADs) were identified.

Although there are no recorded sites above the tunnel within 100m of the alignment, there is a potential for indirect damage from tunnelling activities to “sandstone sites” in the immediate vicinity of the alignment. “Sandstone sites”, including rock shelters with art and archaeological deposit, engravings, grinding grooves and wells may be present and would have a potential to crack when subjected to vibration and/or subsidence. Areas of exposed sandstone in the Normanhurst area, Trelawney Street and Normanhurst Boys High School were identified as particularly sensitive.

Non-Indigenous Heritage Assessment

Hornsby Council has identified three items in the council area as having Regional significance. As this terminology is no longer used, it is possible that these items may be considered for State Heritage Listing. They include the remains of the Maltworks, Pomona and garden and Loreto College, grounds, gates and cemetery.

The Brickworks wall on Pennant Hills Road at the Dartford Road end is the only listed site which may be directly impacted by the Purple option.

Heritage Conservation Areas were identified in or near the proposed tunnel alignments:

- The Interwar housing study Precinct 26 (The Ku-ring-gai Urban Conservation Area), which is adjacent to F3 Freeway, is listed by the National Trust. The works associated with the interchange with Pacific Highway are located within this area;
- The Wahroonga Conservation area, registered on the Hornsby Shire Council LEP Schedules, is located at the northern end of the proposed tunnel, adjacent to and west of the current F3 corridor. The tunnel alignment would pass within 25m of the area;
- The Beecroft Conservation area (Hornsby Shire Council) extends south-west from Boundary Road/Azalea Crescent to Hull Road. The tunnel passes beneath the area; and
- The Crescent Conservation area, located east of Pennant Hills Road, Beecroft, between Hampden Road and Harold Avenue. The tunnel is located under Pennant Hills Road, to the west of the area.

Mitigation measures

There is a potential for indirect damage from tunnelling associated activities to items identified directly above or within 50m of the proposed tunnel alignments. A detailed assessment of potential impacts to identified indigenous and non-indigenous heritage items from tunnel construction will need to be undertaken. It should also be noted that impacts to individual items within the identified Heritage Conservation Areas should be assessed in relation to the Planning and Heritage conditions set down by Hornsby and Ku-ring-gai Councils for these Conservation areas.
15.7 Social Impacts

**Accessibility improvements**

Accessibility improvements would provide opportunities for regional access and improve traffic levels (for heavy and light vehicles) on nearby arterials. At a local level, the Purple Option would minimise impacts to local access for residents.

By broadly following Pennant Hills Road and the Northern Rail Line, the Purple option would improve regional accessibility between the south (from the Cumberland Highway), the west (Sydney Orbital), the east (the M2) and the north (F3). At the same time, it would provide substantial traffic relief to Pennant Hills Road, thus increasing local accessibility and amenity for local residents in vehicles, on foot and on bicycles.

Local accessibility would improve where traffic levels on major arterials are reduced. With the reduction of traffic on Pennant Hills Road, local traffic would flow more freely through the area north of the M2 and the pedestrian environment would also improve.

Pedestrian access would be restricted along the southern side of the Pacific Highway/F3 on/off ramps interchange. Similarly, the multi-level intersection proposed at the junction of the M2/Pennant Hills Road extension could potentially impact adversely on pedestrians. Both locations would need careful design to mitigate potential barriers to local movements.

The Purple Option would improve regional and local accessibility.

**Direct Property impacts**

The F3/Pacific Highway/Pennant Hills Road interchange for the Purple option would require the direct acquisition of 1 property (at Pacific Highway and Lucinda Road) and some strip acquisition (approximately three properties) along the Pacific Highway.

Along Pennant Hills Road, north of the M2, approximately 6 properties on the western side of Pennant Hills Road would need to be fully acquired. These are currently owned by the RTA. South of the M2, widening along the western side of Pennant Hills Road could require the partial or full acquisition of approximately 22 properties. The exact number of acquisitions would depend on detailed design.

Although significant, with potential direct impacts on approximately 30 properties in total, the Purple Option would have the lowest impacts of all options examined.

**Indirect Property Impacts**

Although tunnelling during construction and operation is unlikely to result in noise or vibration impacts on all but a few properties due to its expected depth, there would be concerns by individuals about tunnelling under their houses. Tunnelling would affect property titles through the addition of a horizontal strata title.

The Purple Option was developed in an attempt to minimise indirect property impacts and at the same time to utilise existing infrastructure corridors for the proposed roadway. As a consequence, indirect property impacts are relatively minor – it is estimated that this option has the fewest properties of all options located above the proposed alignment, passing under approximately 185 properties south of Pearces Corner.

Properties within the ‘loop’ made by the existing F3/Pennant Hills Road and Pacific Highway connection would not be impacted directly, but the tunnel would be bored beneath these properties, which would cause some concerns amongst residents although the resulting environment for residents of these properties would be improved.
Changes in Community Character and Amenity

Although the Purple Option has the potential to change the character of established areas in several ways, the presence of surface level ramps and interchanges would likely have the most significant impacts. Residents on or near properties required for construction of ramps or interchanges would experience major changes to adjacent land uses and hence to the character of the community in which they live, possible property acquisition, air, noise and visual impacts, neighbourhood severance and changes to local access. The scale of impacts would vary with the existing neighbourhood characteristics, land ownership and land uses.

Overall, the proposed new interchanges and surface roadworks would occur within existing road corridors.

Under the Purple option, there is potential for change to the character of the Pearces Corner area. Although direct property acquisition should be largely unnecessary in this area, tunnelling and ramp/intersection design in the area encircled by the F3, Pennant Hills Road and the Pacific Highway could result in changes to access and the character of this area. In addition, alternative proposals considered for the intersection design would position on/off ramps in the RTA road reserve, which runs parallel to Lucinda Avenue. Depending on the design, this could introduce a major roadway to what is currently bushland backing onto residential properties, thus substantially changing the character of this area for residents. This land has been the subject of discussions for rezoning as a reserve.

By locating the Purple Option under or within the existing railway corridor or under Pennant Hills Road, community impacts would be limited to its surface components adjacent to Brickyard Park, near Thornleigh Station and at the southern interchange with the M2 and Pennant Hills Road.

The Brickyard Park area would be directly affected, changing from open space and bushland to a smaller area of open space bounded by a busy transport corridor. The location of the corridor within the Park would depend on the design of the Purple Option, but severance effects and land use change could be minimised if the corridor were to be located to one side of this Park, thus leaving a large area remaining for community uses.

The Purple Option also offers significant potential for traffic relief on Pennant Hills Road, thus improving local air quality, the local noise environment and the amenity of nearby areas. A summary of its potential impacts is given in Table 15-7.

<table>
<thead>
<tr>
<th>Table 15-7: Purple Route - Social Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Criteria</strong></td>
</tr>
<tr>
<td>Severance impact</td>
</tr>
<tr>
<td>Local Accessibility impact</td>
</tr>
<tr>
<td>Regional Access benefits</td>
</tr>
<tr>
<td>Property Effects</td>
</tr>
<tr>
<td>- direct land take</td>
</tr>
<tr>
<td>- properties over tunnel</td>
</tr>
<tr>
<td>Visual impacts and acceptability of ventilation stacks</td>
</tr>
</tbody>
</table>

Source: Working Paper No.5
Mitigation Measures

Mitigation measures that would reduce potential social impacts of a preferred scheme include:

- Design options to minimise land take;
- Design options to minimise tunnelling under houses;
- Provide information for residents and the community about potential impacts of tunnelling under properties and its effect on property titles through the addition of a horizontal strata title;
- Provide compensation for property acquisition in accordance with legislative requirements and guidelines;
- Provide noise amelioration during construction and operation;
- Ensure an effective communication and information provision continues through the design and construction phases in order to alleviate stress and anxiety;
- Monitor impact of proposal on property prices through the area.
- The location of ventilation stacks in positions of low visibility and use of visual screening is preferred.
- Design proposal so as to minimise potential health impacts of ventilation stacks. Stacks should meet EPA air quality goals and be located at a ‘safe’ distance from residential properties and other sensitive or ‘valued’ land uses.
- Minimise changes to the character of established residential areas and the quality of open spaces/recreational areas.

15.8 Energy

Energy is used by the project during its construction and operation. No detailed assessment of energy used during construction of the various options has been undertaken at this stage.

The method for calculating net energy use during operation of the tunnel relies on base traffic data sourced for the option to estimate fuel usage by vehicles using the tunnel, and the calculation of energy used in the tunnel operation, especially ventilation.

The increased fuel consumption and consequent Greenhouse Gas (CO₂) emissions were calculated for the 2001, 2011 and 2021 Base cases for the Purple option, using standard conversion factors for petrol.

Fuel used, fuel mass and CO₂ emissions are shown for the purple option in Table 15-8.

**Table 15-8: VKT and Calculated Fuel Used, Fuel Mass and CO₂ Emissions**

<table>
<thead>
<tr>
<th>OPTION</th>
<th>Million VKT per annum</th>
<th>Fuel Used (ML)</th>
<th>Fuel Mass (kt)</th>
<th>CO₂ Emissions (kt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001 Base</td>
<td>14.0</td>
<td>2.1</td>
<td>1.7</td>
<td>6.1</td>
</tr>
<tr>
<td>2011 Base</td>
<td>15.7</td>
<td>2.4</td>
<td>2.0</td>
<td>6.9</td>
</tr>
<tr>
<td>2011 Purple</td>
<td>15.9</td>
<td>2.4</td>
<td>2.0</td>
<td>6.9</td>
</tr>
<tr>
<td>2021 Base</td>
<td>17.6</td>
<td>2.6</td>
<td>2.2</td>
<td>7.7</td>
</tr>
<tr>
<td>2021 Purple</td>
<td>17.8</td>
<td>2.7</td>
<td>2.2</td>
<td>7.8</td>
</tr>
</tbody>
</table>

Source: Working Paper No.5
Aside from fuel consumption, other energy consuming activities would include ventilation, lighting and associated information and ITS equipment at stations, water quality management devices and traffic control/communication. Ventilation energy requirements can only be estimated when details of fan sizes and locations are known, but estimates from other operational tunnel projects in Sydney suggest these figures may be high.

Maintenance energy consumption associated with the F3-to-Orbital is expected to represent a small proportion of the total energy consumed during operation over the life of the project. The life of individual components and equipment would vary. It is therefore difficult to estimate the energy required in maintaining a safe and functional route. However, efficient maintenance practices, aimed at eliminating or minimising disruption to traffic movement, would provide energy savings in relation to vehicle travel time and fuel consumption.

Potential energy savings could be attained during the construction period by adopting efficient work practices, implementing procedures to minimise materials and energy wastage and conducting staff education. As far as practicable, activities that would disrupt peak traffic flows would be undertaken during off-peak periods and major electrical energy consuming work during off-peak load periods.

During operation, efficient maintenance work practices would be implemented to eliminate or minimise disruption to traffic movement. Maintenance would be undertaken in the lowest traffic volume conditions where practicable.

15.9 Ventilation Stack Issues

The indicative locations of the ventilation stacks were chosen as potential sites in the general area that a ventilation stack would be required. In each area, a number of potential locations were identified, and one of those from each area carried forward for the air modelling analysis. The selection of preferred locations would require much more detailed environmental planning assessment when the concept design and EIS are undertaken.

15.10 Waste and Resource Management

Management of waste during construction and operation would assist in minimising environmental impacts and meeting the principles of ecologically sustainable development (ESD). Specific requirements for waste minimisation and management would be examined in the EIS for the preferred option and set out in an Environmental Management Plan (EMP) and the contractor’s Waste Management Plan.
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Traffic and Transport

The traffic and transport characteristics of the Purple Option are described in this chapter under the following aspects:

i) Traffic volumes and redistributed traffic;
ii) Levels of service of the new link;
iii) Interchange operations;
iv) Results of sensitivity tests on key traffic variables;
v) Associated works; and
vi) Integrated transport improvements.

More details on the traffic and transport studies are presented in Working Paper No.4.

Traffic volumes are presented for 2011 and 2021, the future years for which traffic forecasts are available using the Sydney Metropolitan Traffic Model developed by the Transport Data Centre.

16.1 Traffic Volumes

In the year of opening, 2011, the Purple Option would carry 69,500 vehicles per day (AADT) untolled and 38,900 vehicles under a tolled scenario. The breakdown of tunnel volumes by light vehicles and trucks is shown in Table 16-1 for years 2011 and 2021.

The tunnel would provide travel time benefits to users of the northern Sydney road network and for long-distance National Highway users, including commuters from the Central Coast to western Sydney destinations. The effect of the tunnel in the network would be to increase the traffic in the corridor as traffic would redistribute from other routes on the network. There would also be a diversion of passengers from Central Coast rail services to the Highway, equivalent to about 700 passengers 1 in the morning peak period in 2011. In proportion terms, this modal shift from rail is about 8% of the predicted 2 hour morning rail flows in 2011. The amount of this redistribution and mode shift is about 20% of the corridor volumes without a new link.

Redistributed trips to the tunnel would come from existing trips on the network. The tunnel would also induce new trips to the network. These trips, called "induced trips" have been estimated to be less than 1% of the Base traffic flows in the corridor.

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1 This shift from rail would be equivalent to about 1.5% of the 2011 AADT traffic volume on the Highway or 600 vehicles in the peak morning period (2 hours) and about 1,200 vehicles per weekday in 2011.

2 Current peak hour rail patronage from Central Coast is about 4,650 passengers (2001), increasing to 5,600 in 2011 (Based on information provided by RailCorp). The 2 hour peak demand in 2011 is estimated at 8,300 passengers.

3 There has been limited research in Australia on the implications of induced traffic. An initial appraisal of the relationship between induced demand and road investment is contained in ARR Research Report 229 – Induced Demand and Road Investment – an Initial Appraisal. The report examines studies from the US and UK. Further discussion on Induced Demand is presented in Working Paper No.4, Appendix E.
### Table 16-1  Tunnel Average Daily (AADT) Flows, 2011 and 2021

<table>
<thead>
<tr>
<th>Flow Direction</th>
<th>Vehicle Type</th>
<th>2011</th>
<th>2021</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$3.50 Toll</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northbound</td>
<td>Cars</td>
<td>15,900</td>
<td>18,000</td>
</tr>
<tr>
<td></td>
<td>Trucks</td>
<td>4,000</td>
<td>5,400</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>19,900</td>
<td>23,400</td>
</tr>
<tr>
<td>Southbound</td>
<td>Cars</td>
<td>15,200</td>
<td>17,200</td>
</tr>
<tr>
<td></td>
<td>Trucks</td>
<td>3,800</td>
<td>5,200</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>19,000</td>
<td>22,400</td>
</tr>
<tr>
<td>Two-way</td>
<td>Cars</td>
<td>31,100</td>
<td>35,200</td>
</tr>
<tr>
<td></td>
<td>Trucks</td>
<td>7,800</td>
<td>10,600</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>38,900</td>
<td>45,800</td>
</tr>
<tr>
<td></td>
<td>$0 Toll</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northbound</td>
<td>Cars</td>
<td>31,500</td>
<td>35,400</td>
</tr>
<tr>
<td></td>
<td>Trucks</td>
<td>4,000</td>
<td>5,400</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>35,500</td>
<td>40,800</td>
</tr>
<tr>
<td>Southbound</td>
<td>Cars</td>
<td>30,200</td>
<td>33,800</td>
</tr>
<tr>
<td></td>
<td>Trucks</td>
<td>3,800</td>
<td>5,200</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>34,000</td>
<td>39,000</td>
</tr>
<tr>
<td>Two-way</td>
<td>Cars</td>
<td>61,700</td>
<td>69,200</td>
</tr>
<tr>
<td></td>
<td>Trucks</td>
<td>7,800</td>
<td>10,600</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>69,500</td>
<td>79,800</td>
</tr>
</tbody>
</table>


### 16.2 Levels of Service of the New Link

The level of service (LoS) of a road is described by the average traffic conditions along it, including traffic speed, traffic flow and delay. LoS criteria are usually described within a range from A to E. A LoS of A can be described as good with stable and predictable conditions. A LoS of E can be described as poor with unstable and unpredictable delays. Table 16-2 footnote 2 shows the LoS criteria used for multi-lane highways.

#### Toll versus No Toll

Table 16-2 summarises the peak hour flows for two and three lane tunnel configurations of the Purple Option. The tunnel configurations were modelled with $0 and $3.50 toll for 2011 and 2021.

In the opening year 2011, the tunnel volume would be about 69,500 vehicles per day (AADT), untolled. The volume would fall to about 38,900 vehicles per day with a $3.50 toll⁴.

The reasons for the high toll diversion (about 44%) are:

(i) the effect of increasing tolls and perceived user costs in the corridor, given the cumulative effect of the M2, Lane Cove Tunnel and new link tolls for a large number of users; and

(ii) the relatively small travel time savings from using the new link, compared with using Pennant Hills Road, even allowing for the reallocation of road space on Pennant Hills Road. The time savings without a toll in the year of opening (2011) would be 10 minutes in the peak, compared

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⁴ The $3.50 toll would provide the highest revenue returns. The financial analysis (see Chapter 17) assumed $3.50 for all vehicles including trucks.
with 15 minutes with a tolled tunnel\(^5\). Time savings at other periods of the day and weekend would be less.

### Table 16-2  Estimated Tunnel Peak Hour Flows\(^{(1)}\) and Levels of Service\(^{(2)}\)

<table>
<thead>
<tr>
<th>Option</th>
<th>2011</th>
<th>2021</th>
<th>2011</th>
<th>2021</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Peak hr Traffic</td>
<td>LoS</td>
<td>Peak hr Traffic</td>
<td>LoS</td>
</tr>
<tr>
<td>$3.50 Toll</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Lane Tunnel NB</td>
<td>1,200</td>
<td>B</td>
<td>1,300</td>
<td>B</td>
</tr>
<tr>
<td>2 Lane Tunnel SB</td>
<td>2,000</td>
<td>C</td>
<td>2,200</td>
<td>D</td>
</tr>
<tr>
<td>3 Lane Tunnel NB</td>
<td>1,200</td>
<td>A</td>
<td>1,300</td>
<td>A</td>
</tr>
<tr>
<td>3 Lane Tunnel SB</td>
<td>2,000</td>
<td>B</td>
<td>2,300</td>
<td>C</td>
</tr>
<tr>
<td>$0.0 Toll</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Lane Tunnel NB</td>
<td>2,600</td>
<td>D</td>
<td>2,700</td>
<td>D</td>
</tr>
<tr>
<td>2 Lane Tunnel SB</td>
<td>3,200</td>
<td>E</td>
<td>3,700</td>
<td>E/F</td>
</tr>
<tr>
<td>3 Lane Tunnel NB</td>
<td>2,700</td>
<td>C</td>
<td>2,800</td>
<td>C</td>
</tr>
<tr>
<td>3 Lane Tunnel SB</td>
<td>3,600</td>
<td>D</td>
<td>4,200</td>
<td>D</td>
</tr>
</tbody>
</table>


(1) Traffic flows have been rounded to the nearest hundred.

(2) LoS Criteria for Multilane Highways

<table>
<thead>
<tr>
<th>Free-Flow Speed</th>
<th>Criteria</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>80 km/h</td>
<td>Maximum density (pc/km/ln)</td>
<td>7</td>
<td>11</td>
<td>16</td>
<td>22</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>Average speed (km/h)</td>
<td>80.0</td>
<td>80.0</td>
<td>80.0</td>
<td>77.6</td>
<td>74.1</td>
</tr>
<tr>
<td></td>
<td>Maximum volume capacity ratio (v/c)</td>
<td>0.28</td>
<td>0.44</td>
<td>0.64</td>
<td>0.85</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>Maximum service flow rate (pc/h/ln)</td>
<td>560</td>
<td>880</td>
<td>1280</td>
<td>1705</td>
<td>2000</td>
</tr>
</tbody>
</table>

**Two versus Three Lane Level of Service**

The two and three lane tunnel configurations would have similar AADT volumes. By 2021 peak spreading is likely to occur in the two lane tunnel as the peak hour becomes congested. The predicted daily flows for the new link are presented in Table 16-1.

The alignment of the Purple option running underneath Pennant Hills Road ridge would be at grades of between 2 to 3%. The Highway Capacity Manual procedure for Multi Lane Divided Highways was used to estimate the Level of Service for the two and three lane tunnel configurations, with and without a toll. See Table 16-2.

The peak hour flows were used to calculate the expected level of service for the two and three lane tunnel configurations. A summary of this analysis is presented in Table 16-2.

---

\(^5\) Time savings are based on user cost savings from the analysis. It does not allow for specific factors effecting behaviour such as perceived safety and avoiding traffic lights and intersections. It could be that these estimates of travel time savings are conservative.
Table 16-2 indicates that when tolling the new link, the tunnel will operate at an acceptable level of service for both the two and three lane configurations up to 2021, although delays would be experienced on some days in the later years.

With the untolled link, the two-lane tunnel configuration would operate near or at capacity in the opening year, 2011. The two-lane tunnel configuration would be operating at level of service F in the peak direction by 2021.

The three-lane tunnel configuration will operate at a satisfactory level of service for both 2011 and 2021. The three-lane tunnel would have spare capacity to cater for future growth beyond 2021.

The conclusion from this analysis is that the link should be constructed as two lanes with a toll or three lanes without a toll.

Optimum Toll Value

The optimum toll value was derived from an investigation of a range of toll from $0 to $4.50, with increments of $0.50. The toll revenue was calculated for each $0.50 toll increment. Working Paper No.4 presents this analysis. It was found that at the peak period in 2021 a $3.50 toll per user (including trucks) would generate the maximum revenue from the toll. A summary of this analysis is presented in Figure 16.1.

Figure 16.1 Optimum Toll Value in 2021, for Peak Period Only

The revenue for the southbound tunnel will continue to increase with increasing toll. However, the total two-way revenue will decrease when increasing the toll above $3.50. This indicates that the toll elasticity of the southbound direction is lower than the northbound direction. This is also shown by Figure 16.3.

With a toll value up to $3.50, the northbound tunnel contributes between 35 – 40% of the total daily revenue. Increasing the toll values above $3.50 will reduce the contribution of the northbound tunnel to between 25 – 30% of the total daily revenue.

The project has moderate toll elasticity\(^6\) up to $3.50 toll. Increasing the toll higher than $3.50 would likely result in a significant increase in the toll elasticity of car users. The high sensitivity of car drivers

\(^6\) The toll elasticity is a measure of the sensitivity of the patronage forecasts to the assumed toll parameters in the model. The toll elasticity can be defined as the ratio of the change in traffic flow divided by the ratio of the change in input toll value.

For the purpose of this study, the toll elasticity was calculated for the northbound tunnel, southbound tunnel, and the two tunnels combined.
could be attributed to the relatively moderate time saving expected from the project and the cumulative effects of existing tolls for some users. That means some road users would be willing to pay a certain toll value ($3.50), beyond that they will use the surface network. The results of a toll elasticity analysis are shown in Figure 16.2.

**Figure 16.2  Toll Elasticity**

![Toll Elasticity Graph](image)

The data presented in Figure 16.2 indicates that the northbound direction has higher elasticity than the southbound direction. This is expected as the surface network in the northbound direction is less congested during the AM Peak, hence people will not be willing to pay high toll values in this direction.

The daily toll revenue for the new link is presented in Table 16-2. It can be seen that over the day the toll revenue is similar for a $3.50, $4.00 and $4.50 toll. This assumed no change in the toll elasticity of truck use.

**Figure 16.3  Daily Toll Revenue 2021**

![Daily Toll Revenue Graph](image)
Travel Time on New Link

Journey time surveys were undertaken during the AM peak in June 2003. The existing travel time ranged between 11 to 28 minutes on Pennant Hills Road, and between 16 – 32 minutes on Pacific Highway depending on journey time within the peak period and level of road incidence on Pennant Hills Road and Pacific Highway. A summary of the travel time survey is presented in Figure 16.4.

Figure 16.4  June 2003 Travel Time Survey – Pennant Hills Road & Pacific Hwy

Observations during the June 2003 survey indicated that Pennant Hills Road is running with high traffic flows during peak hours. Any disturbance to the traffic flows can cause significant delays. This is one of the main factors contributing to the high variability in travel time along the Highway.

The travel time saving for the new link in comparison to the alternative surface routes would depend on the toll value assumed in the analysis. The predicted travel time saving for the Purple option is presented in Figure 16.5.
The new link without a toll will offer approximately 10 minutes saving in comparison to Pennant Hills Road in 2011, the opening year. The time saving when tolling the new link at $3.50 would increase to approximately 15 minutes in 2011. The toll would deter people from using the tunnel, hence the tunnel would have lower traffic flows and faster travel speed as a tollway.

The time saving of the new link in comparison to using the Pacific Hwy route is lower. Untolled the new link would save approximately five minutes. With $3.50 toll the link would have approximately 10 minutes saving.

The above analysis did not include specific factors that road users may consider when selecting their journey route. These factors could include:

- Safety;
- Reliability in travel time;
- Reduced delays and queues at at-grade intersections; and
- Reduced emission and wear and tear as a result of stop-start at intersections.

Including the above factors could result in higher perceived travel time saving for the new link, and hence increased tunnel patronage.

### 16.3 Interchange Operations and Queuing in the Tunnel

The findings of an assessment of the proposed interchange arrangements are described in Working Paper No.5. The proposed interchanges were assessed for 2021 AM and PM and for untolled and $3.50 toll scenarios.

For the southern interchange, the analysis indicated that a three level interchange would not provide the necessary capacity to cater for the tunnel flows. Hence, a four level interchange would be needed. This is shown in Figure 14.3 in Chapter 14.
Northern Interchange – One-way System (see Figure 14.2 in Chapter 14)

This option will have sufficient capacity to cope with 2021 traffic for the $0 and the $3.50 toll. There would be no queuing effects in the tunnel for traffic exiting the tunnel at this interchange in 2011 and 2021.

The at grade intersections within the proposed system would operate at a satisfactory level of service (A to C) for both the tolled and the untolled scenarios in 2011.

Southern Interchange – Four-Level Interchange (see Figure 14.3 in Chapter 14)

This interchange would have sufficient capacity to cope with 2021 traffic for the $0 and the $3.50 toll without queuing in the tunnel.

The at-grade signalised intersection will operate at a level of service C in 2021 for both the tolled and the untolled scenarios which is an acceptable level of operation.

The downstream capacity of Pennant Hills Road south of the M2, particularly at the North Rocks Road intersection, would need improvement to avoid congestion on the surface and queuing back from the surface intersection, preventing southbound traffic exiting the tunnel.

16.4 Sensitivity Tests

Sensitivity tests were undertaken on the following key variables to determine a range of likely traffic outcomes which were used to guide the economic justification of the Purple Option (see Chapter 17):

- traffic growth in the corridor;
- effect of rail investment in Northern line to enhance capacity (passenger and freight);
- modal shift effects of new link (from rail to road).

Traffic Growth Consideration

The Base land use assumptions resulted in an overall traffic growth in the corridor (F3 and the new Link) of between 1 and 2% pa, which is lower than the historical growth rates of 3% pa over the past 10 years.

A range of future growth scenarios were used to test the effects on corridor traffic volumes, ranging from an average of 1.5% pa (Base) to 3% pa (Historical) growth rate. The effects are shown in Table 16-3.

Based on population and employment growth, assumptions used in the Base Case are sensitive to the tunnel volumes. Table 16-3 suggests that without a toll, the tunnel volumes would be 93,700 vehicles in 2021 assuming a 3% pa overall traffic growth over the next 20 years. This would be about 15% more traffic compared with the corresponding Base growth assumption. A similar percentage increase would occur for a tolled tunnel.

The effect of not implementing rail capacity enhancement in the corridor to maintain rail’s current mode share would effectively increase tunnel volumes by about 7-8% in 2011, compared to the Base Case which assumes these rail improvements will be implemented.
Table 16-3  Traffic Volumes (AADT) in Purple Tunnel - Sensitivity Analysis Results

<table>
<thead>
<tr>
<th>Vehicle Type</th>
<th>$3.50 Toll 2011</th>
<th>$3.50 Toll 2021</th>
<th>$0 Toll 2011</th>
<th>$0 Toll 2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cars</td>
<td>31,100</td>
<td>35,200</td>
<td>61,700</td>
<td>69,200</td>
</tr>
<tr>
<td>Trucks</td>
<td>7,800</td>
<td>10,600</td>
<td>7,800</td>
<td>10,600</td>
</tr>
<tr>
<td>Total</td>
<td>38,900</td>
<td>45,800</td>
<td>69,500</td>
<td>79,800</td>
</tr>
</tbody>
</table>

Base Case - with rail improvements\(^{(1)}\) (3.25% pa - truck growth)

<table>
<thead>
<tr>
<th>Vehicle Type</th>
<th>$3.50 Toll 2011</th>
<th>$3.50 Toll 2021</th>
<th>$0 Toll 2011</th>
<th>$0 Toll 2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cars</td>
<td>34,100</td>
<td>38,200</td>
<td>64,700</td>
<td>72,200</td>
</tr>
<tr>
<td>Trucks</td>
<td>8,000</td>
<td>11,100</td>
<td>8,000</td>
<td>11,100</td>
</tr>
<tr>
<td>Total</td>
<td>42,100</td>
<td>49,300</td>
<td>72,700</td>
<td>83,300</td>
</tr>
</tbody>
</table>

Sensitivity A - without rail improvement\(^{(2)}\)

<table>
<thead>
<tr>
<th>Vehicle Type</th>
<th>$3.50 Toll 2011</th>
<th>$3.50 Toll 2021</th>
<th>$0 Toll 2011</th>
<th>$0 Toll 2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cars</td>
<td>31,100</td>
<td>41,800</td>
<td>61,700</td>
<td>82,900</td>
</tr>
<tr>
<td>Trucks</td>
<td>7,800</td>
<td>10,700</td>
<td>7,800</td>
<td>10,700</td>
</tr>
<tr>
<td>Total</td>
<td>38,900</td>
<td>52,500</td>
<td>69,500</td>
<td>93,600</td>
</tr>
</tbody>
</table>

Sensitivity B - Historical Traffic Growth at 3% pa

<table>
<thead>
<tr>
<th>Vehicle Type</th>
<th>$3.50 Toll 2011</th>
<th>$3.50 Toll 2021</th>
<th>$0 Toll 2011</th>
<th>$0 Toll 2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cars</td>
<td>31,100</td>
<td>41,800</td>
<td>61,700</td>
<td>82,900</td>
</tr>
<tr>
<td>Trucks</td>
<td>7,800</td>
<td>10,700</td>
<td>7,800</td>
<td>10,700</td>
</tr>
<tr>
<td>Total</td>
<td>38,900</td>
<td>52,500</td>
<td>69,500</td>
<td>93,600</td>
</tr>
</tbody>
</table>

Notes:

(1) Rail passenger and freight maintains current mode share in corridor.
(2) A maximum of 3,000 additional cars per weekday would use the corridor and 600 additional trucks in 2021.

**Effects of Rail Capacity Improvements on F3 and Link Traffic Volumes**

The effect of not implementing the rail improvement on the Purple tunnel traffic volume would be to increase volumes beyond those given in Table 16-1 and Table 16-2. This would reinforce the earlier finding (Section 16.1) that under a no toll scenario, the tunnel should be built to a Dual-three lane standard. This conclusion would be further reinforced if traffic growth in the corridor exceeded the assumed average of 1.5% pa over the next 20 years.

Table 16-4 provides a comparison of F3 traffic flows, for peak and AADT conditions, with and without improvements to the Northern line. With the Northern line improved for passenger and freight services to maintain their current mode share, the F3 would operate at acceptable service levels in the southbound morning peak direction. By 2021 the F3 would carry 96,500 vehicles per day (AADT).

If no investment in the Northern line is forthcoming over this period, the F3 would reach its peak capacity a few years before 2021. The F3 daily volume in 2021 would be about 100,500 vehicles (AADT), of which 18% would be heavy trucks.

The analysis has shown that widening of the F3 Freeway (from Dual two lanes to Dual three lanes) from Kariong to Wahroonga would be required before 2011 irrespective of either the construction of a new link or capacity improvements to the Main Northern rail line.

Furthermore, the analysis has demonstrated that during the morning peak, the widened (to 3 lanes) southbound lanes of the F3 would be operating at capacity in 2021 without the capacity enhancements of the Main Northern rail line.

Without rail improvements, beyond 2021, the National Highway (F3 Freeway and the new Purple tunnel link) would be operating below acceptable levels of service. There would appear to be a strong case for both:

(i) considering strategies to reduce commuter demand from the Central Coast including introducing demand management strategies and encouraging employment growth on the Central Coast; and
(ii) considering the need for a second northern transport corridor (road or rail) including a new crossing of the Hawkesbury River.

If the need for a second northern corridor is established, a reservation should be preserved for a second corridor as part of the North-West Regional Structure Plan being prepared by the NSW Department of Planning, Infrastructure and Natural Resources.

**Table 16-4 Predicted Traffic Volumes on the F3 at Hawkesbury River Crossing**<sup>(2)</sup>

<table>
<thead>
<tr>
<th>Year</th>
<th>Forecasts traffic volumes at Hawkesbury River crossing with New Link Built</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Includes Main Northern line improvements (BASE)</td>
</tr>
<tr>
<td></td>
<td><strong>AADT</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Year</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Year</strong></td>
</tr>
<tr>
<td>2002</td>
<td>3,700</td>
</tr>
<tr>
<td>2004</td>
<td>3,700</td>
</tr>
<tr>
<td>2011</td>
<td>4,600</td>
</tr>
<tr>
<td>2021</td>
<td>5,000</td>
</tr>
<tr>
<td>2026</td>
<td>5,400</td>
</tr>
</tbody>
</table>

Source: Working Paper No.4

(1) Assumes overall traffic growth rate at 1.5% pa to 2021 compared with 3.00% pa of previous 10 years.

(2) Volumes at Edgeworth – David Avenue at Wahroonga would be slightly higher.

**The Shift from Rail When the New Tunnel Link is Operational**

The analysis also indicates that in the first year of operation (2011), the new tunnel Link is likely to attract from rail the equivalent of up to 700 vehicles onto the F3 during the morning peak 2 hours. This mode shift would be equivalent to an additional peak period train or an 8% mode share from rail in 2011. The effect of the mode shift is included in **Table 16-3**.

**16.5 Associated Works not Part of the Project**

The Purple Option would require consideration of associated improvements which would not be directly part of the project. No investigation was undertaken on local roads in the corridor. Further investigation of the necessary associated works should be undertaken at the concept design stage when the proposal is fully developed for the purpose of an EIS.

The associated works would include:

- M2 widening;
- F3 widening; and
- Improved access to Hornsby from the National Highway.
**M2 Widening**

The M2 Motorway is currently two lanes in each direction (Dual two-lanes). The traffic growth in the M2 corridor would require widening of the east bound carriageway east of Old Windsor Road from 2011, and three lanes in each direction by 2021.

The M2 Motorway between Abbott Road and Pennant Hills Road will be incorporated as a part of the National Highway following the opening of the M7 Motorway in 2006. The Purple tunnel would not add significant traffic to the M2 traffic flows. In the morning peak, an estimated 200 additional vehicles per hour eastbound would be attracted to the new tunnel via the M2 in 2011. No new works would be required on the M2 from the construction of the Purple tunnel.

**F3 Widening**

Congestion on the F3 will build-up on the two lanes sections south of the Hawkesbury River, following completion of the current widening project north of the river in 2004. The F3 Freeway would need widening to three lanes in the southbound direction following the current widening works.

The analysis indicates (see Table 16-4) that further widening beyond dual three lanes would be required south of the Kariong interchange from 2020, without rail improvements in the corridor and from 2026 if the Main Northern rail line gains capacity enhancements for commuter and freight services. This assumes average traffic growth rates of 1.5% per year up to 2021. If actual growth rates are higher, then the levels of service on the F3 will fall more quickly than Table 16-4 suggests.

**Improved Access to Hornsby**

There is an opportunity to improve access to Hornsby to/from the F3 by providing north facing ramps at Ku-ring-gai Chase Road. Such an improvement would be likely to provide significant benefits from improved access to Hornsby.

**16.6 Integrated Transport Improvements**

The reallocation of road space on Pennant Hills Road would provide opportunities to implement bus priority schemes. It would also assist regional bus services from Hornsby, Pennant Hills to Blacktown, Parramatta and Penrith. This study has not investigated the justification of bus improvement measures. More detail is given in Working Paper No.5.

The Purple link should be considered as part of an integrated land use and transport opportunity which could improve all transport modes in the National Highway corridor. The Purple Option would allow associated works to be planned and designed as part of an integrated scheme. The integrated scheme could include:

- reallocation of road space on Pennant Hills Road to allow wider footpaths, a cycleway and bus priority measures;
- improved access for buses and park and ride commuters to Pennant Hills Road and Thornleigh rail stations;
- redevelopment of Pennant Hills and Thornleigh railway stations, including new commuter arrangements and related urban development around the stations;
- development of Pennant Hills railway station as a sub-regional interchange (in association with urban development);
- provision of regional bus services from Hornsby, Pennant Hills to Blacktown, Parramatta and Penrith using Pennant Hills Road and the M2;
• improved long-distance bus and rail services from the Central Coast to western Sydney destinations. (In the longer term, this would also require improvements to the F3 (above the proposed widening to 3 lanes in each direction) or a new transport corridor beyond 2021.)
Cost Estimates and Economic Justification

This chapter provides a summary of the cost estimates and economic justification of the Purple Option which are reported in Working Paper No.7. It is arranged under the following headings:

i) Indicative Capital and Operating Costs (Dual Two Lane & Dual Three Lane);

ii) Toll and No Toll;

iii) Economic Justification;

iv) Method of Delivery; and

v) Conclusions

17.1 Indicative Capital and Operating Costs (Dual Two Lane & Dual Three Lane)

Table 17-1 summarises the estimates of indicative capital costs for the Purple option. Costs are expressed in 2003 prices. They have been presented separately for the Link, for other roads and for a tolling system if required. The indicative capital expenditure schedule assumed for the evaluation is also shown in Table 17-1, assuming land acquisition in 2006/07, construction starting in 2007/08 with expenditure spread over a four-year period (with a timing profile of 20%, 30%, 30% and 20%) and the tolling system in 2010/11.

Table 17-1 also contains indicative estimates of incremental operation and maintenance (O&M) costs for the Purple option compared to the Base Case. Indicative annual O&M costs for the Link are based on estimates of $155,000 per lane km for the dual 3 lane tunnel and $180,000 per lane km for the dual 2 lane tunnel. Annual electronic tolling costs are assumed to be $2.3 million, based on RTA estimates for the Western Sydney Orbital (Westlink M7) Study updated to 2003 prices.

17.2 Toll and No Toll

Two indicative tolling scenarios were adopted for the analysis – no toll on the Link and a fixed toll of $3.50 per vehicle on the Link. Tolls between $0.50 and $4.50 per vehicle were tested to determine the optimal toll level in terms of revenue collected.

In addition, the following toll regime for Link traffic using the M2 was adopted:

- for the Purple option, $3.30 for traffic using the M2 east of the Link or $1.60 for traffic using the M2 west of the Link¹;

The effect of the toll would be to reduce the economic efficiency of the investment compared to funding from consolidated revenue. This situation arises because of the reduction in traffic volumes using the new road when tolled compared to when operated as a toll-free route, with traffic remaining on the arterial road system with its lower level of service. However, tolling as a separate funding

¹ These toll levels were selected to be consistent with the M2 levels at the time of the analysis.
mechanism provides an alternative funding source to Government, thereby improving the affordability of the project to Government.

17.3 Economic Justification

The Purple option was evaluated by conventional road user cost-benefit analysis (RUCBA) on an incremental basis from the Base Case, defined as the road network without the development of the Link. Also, it was assumed in the Base Case that capacity improvements for the Main Northern railway line were to be implemented (refer Section 11.3) and that current rail market shares in the F3 corridor (for passengers and freight) would be maintained over the next 20 years.

Table 17-1: Indicative Capital and Operating Costs Summary ($ million, 2003 prices)

<table>
<thead>
<tr>
<th></th>
<th>Base Case</th>
<th>Purple Option</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Dual 3-lane</td>
</tr>
<tr>
<td><strong>Indicative Capital Costs(1)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>By Component</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land acquisition</td>
<td>0</td>
<td>36</td>
</tr>
<tr>
<td>Construction(2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Link</td>
<td>0</td>
<td>1,793</td>
</tr>
<tr>
<td>* Other(3)</td>
<td>0</td>
<td>21</td>
</tr>
<tr>
<td>* Tolling system(4)</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>0</td>
<td>1,858</td>
</tr>
<tr>
<td><strong>By Year(5)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2006/07</td>
<td>0</td>
<td>36</td>
</tr>
<tr>
<td>2007/08</td>
<td>0</td>
<td>363</td>
</tr>
<tr>
<td>2008/09</td>
<td>0</td>
<td>544</td>
</tr>
<tr>
<td>2009/10</td>
<td>0</td>
<td>544</td>
</tr>
<tr>
<td>2010/11</td>
<td>0</td>
<td>371</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>0</td>
<td>1,858</td>
</tr>
<tr>
<td><strong>INDICATIVE INCREMENTAL OPERATION &amp; MAINTENANCE (O&amp;M) COSTS(6)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Link O&amp;M</td>
<td>0</td>
<td>7.0</td>
</tr>
<tr>
<td>Tolling</td>
<td>0</td>
<td>2.3</td>
</tr>
</tbody>
</table>

Notes:

(1) Based on ‘Design Construct’ (D&C) method of project delivery. For ‘Build Own Operate Transfer’ (BOOT) method, allow an additional $100 million for project development costs.

(2) Includes contingency allowance at 30% except for tunnel works (15%).

(3) Widening of Pennant Hills Road between M2 and North Rocks Road intersection.

(4) Includes allowance for initial marketing costs.

(5) Expenditure on land acquisition assumed to occur in 2006/07, on construction over the following four years (20%, 30%, 30%, 20%) and on tolling systems in 2010/11.

(6) For 2011/12 and each year thereafter.

The measures of road user benefits adopted in the RUCBA differ for existing vehicle trips in the corridor and for vehicle trips that are redistributed to the corridor by the inclusion of the Link in the road network (the latter include trips diverted from public transport).
• For existing corridor trips, benefits are measured as the savings in vehicle operating and travel time costs and avoided accident and external costs with the Purple option compared to the Base Case.

• For trips redistributed to the corridor, benefits are measured as half the reduction in average vehicle operating, travel time and accident costs with the Purple option compared to the Base Case, net of incremental external costs associated with these trips.

The RUCBA has been undertaken in accordance with the RTA Economic Analysis Manual procedure and excludes the community benefits associated with a tunnel avoiding the social and environmental impacts of surface roads. These benefits could be quantified by measuring the willingness to accept the higher capital and operating costs of a tunnel.

The results of the RUCBA of the Purple option at 7% real discount rate are shown in Table 17-2. The table shows that:

• In the ‘no toll’ scenario, both the dual 2 lane and dual 3 lane projects are economically viable. The dual 2 lane project is the most economically attractive, with a benefit-cost ratio (BCR) of 1.2 compared to 1.1 for the dual 3 lane project. The respective net present values are $259 million and $70 million.

• In the $3.50 toll scenario, only the dual 2 lane project is close to being economically viable with a BCR of 1.0 (rounded up). The NPV reduces to negative $57 million, showing the impact of the toll on the volume of traffic using the Link and on reducing the effectiveness of congestion relief on Pennant Hills Road.

Situations which would impact favourably on the absolute levels of economic return for the Purple option are:

• A decrease in construction cost – the BCR would increase by 0.1 for 10% reduction in construction cost.

• A scenario of bus improvements designed to improve accessibility to the north west region and utilise road space released by operation of the new Link – the BCR would increase by 0.3 (assuming that there are no additional net bus operating costs).

• A scenario where the planned rail infrastructure improvements to the Main Northern Line between Sydney and Central Coast/Newcastle are not implemented – although results cannot be compared directly with those of the main RUCBA because this scenario involves a respecification of the Base Case, indications are that the economic attractiveness of the Link would be improved considerably (BCR increase of around 0.2).

• The impact of increasing peak congestion in the Study Area on unit vehicle operating cost in the Base Case relative to the Purple option (ie. unit vehicle operating costs rise over time as surface road congestion increases in the Base Case) – net present value would increase by about $60 million if Study Area travel accounts for 10% of total network travel or by about $120 million if Study Area travel accounts for 20% of total network travel. However, the BCR would change only slightly.

17.4 Method of Delivery

In addition to the traditional model for road development of funding from consolidated revenue, two broad funding options involving the application of tolls have been adopted for preliminary funding analysis – a government-owned corporation or a conventional private sector Build Own Operate Transfer (BOOT) model.

A decision to fund development on the traditional basis is principally a function of:

• the availability of funding from consolidated revenue, given the competing claims on government funds;
the inability to construct a viable toll revenue stream to attract private sector involvement; and
government policy.

### Table 17-2: Results of Road User Costs-Benefit Analysis (2003 prices)\(^{(1)}\)

<table>
<thead>
<tr>
<th>Purple Option Incremental to Base Case</th>
<th>No Toll</th>
<th>With $3.50 Toll</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dual 3-lane</td>
<td>Dual 2-lane</td>
</tr>
<tr>
<td>Present Value</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital Costs ($m)</td>
<td>1,282</td>
<td>1,085</td>
</tr>
<tr>
<td>Benefits(^{(2)})($m)</td>
<td>1,352</td>
<td>1,344</td>
</tr>
<tr>
<td>Net Present Value ($m)</td>
<td>70</td>
<td>259</td>
</tr>
<tr>
<td>NPV/Capital Cost</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Benefit-Cost Ratio</td>
<td>1.1</td>
<td>1.2</td>
</tr>
<tr>
<td>Internal Rate of Return</td>
<td>7%</td>
<td>9%</td>
</tr>
<tr>
<td>First Year Rate of Return</td>
<td>8%</td>
<td>9%</td>
</tr>
</tbody>
</table>

Note:

(1) At 7% real discount rate.

(2) Benefits are expressed net of incremental operating and maintenance costs and net of external costs and loss of public transport fare revenue associated with traffic redistribution and mode shift.

A more detailed analysis would be required to evaluate alternative funding options such as physical tolling, “shadow” tolling and service payments against the conventional model of funding from consolidated revenue. This would include consideration of the different economic and traffic management outcomes each of these options produces and government attitude to use of each funding technique.

### 17.5 Conclusions

The Purple option operating as a dual two lane tollway is likely to be economically justified given:

- the closeness of its BCR of 1.0 to passing Treasury’s economic efficiency test (a BCR in excess of 1.0) in the main RUCBA;
- the indicative improvement in the economic results under the alternative public transport scenarios evaluated; and
- the exclusion of community benefits associated with a tunnel avoiding the social and environmental impacts of surface roads.

In view of the high capital cost of the link, a number of mechanisms for private sector participation were investigated.
Purple Option Refinement

During the course of the option assessment process and following the assessment of the Type A options and community consultation, alternative concepts to the Purple Base Option were investigated to determine their initial feasibility. Consideration was given to potential locations for trench sections that could break the long tunnel length to improve safety, air quality management and cost minimisation reasons, or for reasons to reduce adverse amenity effects of the Purple Base Option.

Possible refinements to the Purple Option are described in this chapter under the following headings:

i) Varying Tunnel Length;
ii) Intermediate Access;
iii) Shared Rail Corridor; and
iv) Land Use and Transport Development Opportunities in the Purple Corridor.

18.1 Varying Tunnel Length

The tunnel could be built as a single long tunnel without openings or could be broken down into two or more sections.

An 8.0km long single length dual tunnel could be constructed between the two proposed interchange points at the F3 and M2. In most respects the scheme would be similar to the Purple Base Option but without the open trench adjacent to Brickyard Park. While the traffic operation would be similar, a long tunnel would not provide the flexibility of two shorter tunnels for emergency vehicles and incident management. A single long tunnel would also be more expensive to operate in terms of ventilation costs although capital construction costs would be similar. A long tunnel would probably need four ventilation stacks as would the Purple Base Option.

While this investigation has indicated the feasibility of building and operating a single tunnel 8.0km long, a scheme with two or more shorter tunnels would be preferred for the above reasons.

18.2 Intermediate Access

Intermediate openings may be either in open space such as Brickyard Park, or combined with intermediate access points.

Central Access

A central opening north of Pennant Hills Station would divide the Purple tunnel into two approximately equal sections. This opening could be located in the industrial area between Pennant Hills Road and the railway line (refer to Working Paper No.3 for more detail). At this location, Pennant Hills Road currently follows a curvilinear alignment that generally follows the railway line.

This alternative has only been investigated in enough detail to determine its engineering feasibility. The arrangement of any interchange was not investigated, although there are opportunities to realign Pennant Hills Road that could improve the interchange layout.
The 12m deep open trench could be covered for about 100m of its length to allow for an at-ground level roundabout. Two north facing and two south facing ramps to and from the Motorway link would join at the Central Interchange. The roundabout could have two or three traffic lanes. The feasibility of the interchange would need to be assessed at the concept design stage.

The new Motorway exit and entry ramps could be on grades of less than 6%. At this grade the ramps would be at least 250m long. This would allow for smooth vertical transitions to align with the Motorway and the Central Interchange.

The Central Interchange would be connected to Pennant Hills Road via three exiting traffic lanes and with two entry lanes from Pennant Hills Road. Both the Central Interchange and the intersection at Pennant Hills Road and Pomona Street could be controlled by traffic lights, although it is preferable that the roundabout traffic is free flowing. If the Central Interchange is controlled by traffic lights, two traffic lanes would be required on the two ramps entering the interchange. It is also desirable that the left turning lane on the Pennant Hills Road from the Central Interchange is an uncontrolled merging lane.

The advantages of the Central Access alternative over the Purple Base option would be:

- better access for emergency vehicles to address tunnel fire and life safety risks;
- better tunnel and day to day operation ventilation for fire emergency;
- traffic could more easily divert to Pennant Hills Road at time of incident;
- better pollution management overall;
- improved driver satisfaction and tunnel use as a result of less driver concerns to travel in long tunnels;
- higher traffic use of the tunnel and higher toll revenue if a tollway;
- reduced operating costs.

Overall, the Central Access alternative has considerable merit subject to the acceptability of property acquisition and traffic operational feasibility. The concept should be investigated further with other alternatives as part of developing the recommended option.

**Southern Access**

A Southern Access could be constructed as an alternative to an opening north of Pennant Hills Station. A trench opening could be constructed in the vicinity of Boundary Road and Beecroft Road. This concept could possibly daylight the Purple tunnel in a trench of about 400 metres long between Boundary Road and Beecroft Road intersections. The best location for the opening from an engineering viewpoint would be opposite Observatory Park as this is located in an existing dip in the terrain.

In order to construct this alternative, some residential properties would probably need to be acquired. These would most likely be on the western side of Pennant Hills Road. The number of properties required to construct the opening would depend on the length of the opening required, although it is expected that around twenty to thirty properties would be required.

A Southern Access Interchange could comprise a southern portal within Pennant Hills Road and north-bound exit to Pennant Hills Road and Boundary Road. A northern portal located on Pennant Hills Road could allow a south bound exit to Boundary Road and a north-bound entry from Boundary Road via Pennant Hills Road.

The inclusion of north facing and south facing ramps was also investigated at this location. The arrangement investigated included south facing ramps, south of Beecroft Road and north facing ramps north of Boundary Road. This arrangement allows for traffic from Beecroft Road and Boundary Road to access the link in either direction. Due to the existing terrain around the Boundary Road/Beecroft Road opening, the ramps would need to be relatively steep or relatively long although this requirement
would not impact their feasibility. Preliminary investigation would suggest that entry and exit ramps could be constructed between 4-6% grades from a 12 metre deep trench. Construction of the ramps would be undertaken by dropping one of the existing lanes into the tunnel and would not require additional acquisitions.

This alternative could be considered either on its own or in conjunction with an opening at or near Brickyard Park as included in the Purple Base Option. On its own, this opening could break the link into one short and one long tunnel. In conjunction with an opening near Brickyard Park, this alternative would break the link into three shorter tunnels of about 2½kms each.

The Southern Access option could provide the following benefits:

- Increases use of the tunnel and opportunities for connection with Pennant Hills by providing on and off ramps. This would increase access to the surrounding community including Thornleigh, Cherrybrook, Westleigh and Pennant Hills.
- Provide more open road in cut, and length of day light and thereby reduce tunnel operating costs.
- Improve access for emergency vehicles.

Relocation of the Opening at Brickyard Park

Following consultation with Hornsby Council and community groups in Thornleigh, the alignment of the Purple Option in the vicinity of Brickyard Park was adjusted to minimise local surface impacts. The re-alignment was incorporated into the Purple Base Option and is shown on Figure 14.9.

Any alignment of the Purple Option which uses land at Brickyard Park would need to be the subject of further public consultation. It would be possible to eliminate this opening by using other alternatives.

18.3 Shared Rail Corridor

The shared rail alternative could provide an open trench, within the existing rail corridor between Pennant Hills Station and Dartford Road, Normanhurst. A strip acquisition of land adjacent to the rail corridor could be required. A potential section illustrating the alternative cross sectional proposal within the existing rail easement is shown in Figure 18.1. The lanes associated with the north and southbound carriageway could be located one above the other to the west of the rail lines.

The benefits of this option would be:

- Provides two extra rail tracks over 2kms and potentially two new rail stations.
- Reduced tunnel length (by 2kms) and reduced tunnel operating costs.
- Opportunity to access Pennant Hills Road and Boundary Road with north facing on/off ramps thereby increasing traffic usage of the link and reducing surface traffic. The possible construction of ramps north of Pennant Hills Station and near Boundary Road/Beecroft Road would both be feasible from an engineering perspective.
- Noise amelioration would be restricted to the edge of the railway boundary and could be included as Railway fencing.
- No land would be isolated by the road, and existing pedestrian and vehicular circulation is accommodated within existing bridges.
- A legible motorists environment would be created, with decreased requirements for ventilation structures.
- Natural light could be provided to this section, and the length of tunnels would be decreased.
- The footprint of impacts could be reduced.
Flow on benefits to an integrated transport network could occur from rail and land use redevelopment opportunities in Thornleigh and Pennant Hills.

**Figure 18.1:** Potential Section through shared rail corridor in cutting

18.4 Land Use and Transport Development Opportunities in the Purple Corridor

**Potential Development and Integrated Public Transport Opportunities**

Some of the many Purple Option alternatives provide significant urban development opportunities around the rail stations along the Northern Rail line. The Shared Rail Corridor alternative proposes that the motorway could emerge from tunnel after Normanhurst Station near Dartford Road and join within the existing rail corridor beside existing rail lines in an open cut, returning to tunnel before Pennant Hills station. This alternative also could provide an opportunity as part of the scheme to provide two additional rail tracks as a future partial up-grade to the Northern rail line.

The merging of the motorway with the rail in the same corridor would provide urban development opportunities for Thornleigh and Pennant Hills stations. Pennant Hills could take on the role of a sub-regional centre similar to the role of Epping. Thornleigh could develop as a district centre, similar to Gordon on the North Shore line. These alternatives would require clear integration, and cooperation between RailCorp, development of broad planning requirements and meet RTA/DOTARS and DIPNR objectives.

Currently Pennant Hills is a predominantly residential area with a district shopping centre and a component of commercial use. The merging of the motorway corridor with the rail corridor could see this centre transformed into an integrated shopping centre, commercial and transport interchange. This potential future scenario for Pennant Hills would be reinforced by the Chatswood to Epping rail line, currently under construction, which allows trains to travel from Hornsby to Chatswood via Epping.

The alignment of the motorway corridor with the rail corridor also provides opportunities to provide additional station car parking. This would service car – rail commuters travelling from regional areas such as Cherrybrook, Dural, Glenorie and the central coast to the City CBD, and Chatswood.

With the up-grade of Pennant Hills Station as a major regional transport interchange, further development opportunities could be encouraged around and above the station area. This potential development area is bounded by Pennant Hills Road and the extent of the current shopping precinct on the eastern side of the rail line. This could encourage the possibility of building over the rail...
corridor in this location. Increased residential density, increased retail at street level and commercial usage could be accommodated.

These integrated public transport opportunities could also be developed in various ways for the other Purple option alternatives. They include the urban design opportunities that go beyond the motorway itself and could result in land use and public transport benefits.
Main Findings and Conclusions

The main findings and conclusions of this study are presented in this chapter under the following headings.

i) Existing Conditions on the interim National Highway;
ii) Traffic Growth on the National Highway;
iii) Demand Management and Sustainability;
iv) Rail and Public Transport Scenarios;
v) The Need for a New Link
vi) Assessment of Corridor Types A, B and C;
vii) Assessment of Type A Options;
viii) Key Outcomes from Community Consultation;
ix) Traffic and Transport Findings;
x) Cost Estimates and Economic Justification;
xi) Social and Environmental Effects; and
xii) Purple Option Refinement.

The main recommendations are presented in Chapter 20.

19.1 Existing Conditions on the interim National Highway

Road traffic on the National Highway corridor (F3 Freeway and Pennant Hills Road), has grown by 3 to 4% annually over the last 10 years. Pennant Hills Road carries up to 75,600 vehicles per day (AADT) of which 7,000 are heavy trucks over 3.5 gross tonnes. About half of these trucks are six, eight and nine axle articulated vehicles carrying up to 40 gross tonnes or more. The average weekday volume of trucks is 8,800. About 30% of these trucks, mostly articulated vehicles, travel at night.

Average annual daily traffic flow on the F3 at the Hawkesbury River bridge was 71,200 in 2002. The number of trucks was 9,200. The average weekday volume was higher at 11,300 trucks.

The morning southbound peak hour flows on the National Highway are close to capacity on the F3 and Pennant Hills Road. Pennant Hills Road users experience congestion and delay in peak periods, peak-spreading into business hours and a higher than the Sydney arterial road average (nearly double) serious and fatal road crash rate.

The Central Coast traffic makes up about 47,900 trips or 64% (nearly two thirds) of the total weekday traffic on the F3. Commuter trips are 36% of the average weekday volumes. The proportion of trips on the F3 which are non-commuting and long distance is about 64% of the total weekday traffic. The proportion on Pennant Hills Road is less, because it carries a higher proportion of local trips compared to the F3. The proportion of long-distance non-commuting weekday trips using Pennant Hills Road is estimated at 23% of the total weekday volume.

Rail is the main long-distance public transport service in the corridor. The capacity restrictions of the Main Northern Rail Line from Gosford to the Sydney CBD limit the number of commuter and daily freight trains accessing the Sydney network.
Passenger rail currently has a corridor daily mode share of 28%. Its peak hour mode share is higher at 45%. The percentage share of commuter trips to / from the Central Coast is 43%.

There are a number of private long-distance bus and coach services linking Sydney with the Central Coast and more northern destinations, including a service to Sydney airport. Very few buses use Pennant Hills Road.

Rail freight’s corridor mode share of contestable freight is 14% (5 million net tonnes). The F3 carries 36 million tonnes of contestable freight per year, of which about 24 million tonnes or 70,000 tonnes per day is moved along Pennant Hills Road.

These high traffic volumes incur a significant loss of urban amenity for those people living and working along Pennant Hills Road from high levels of traffic noise, severance and vehicle emissions.

19.2 Traffic Growth on the National Highway

Population and employment forecasts for Sydney and the Central Coast suggest that the underlying traffic growth in the corridor would average between 1 and 2% annually over the next 20 years. This is about half the growth rate of the previous 10 years.

Traffic volumes would however reach close to 100,000 vehicles per day on both Pennant Hills Road and the F3 in 2021, causing increasing pressure on the National Highway. Peak hour conditions on Pennant Hills Road would spread to business hours, adding to congestion and delay in the corridor for long-distance users.

The proportion of truck traffic on the National Highway would increase from 9% to 14% (13,300 trucks per day) on Pennant Hills Road and from 13% to 19% (17,500 trucks per day) on the F3. These forecasts assume the proposed capacity enhancements for the Main North Rail line are implemented. Traffic volumes on the F3 without this rail investment would be slightly higher.

19.3 Demand Management and Sustainability

Of the three levers government has to influence travel behaviour and manage transport demand, land use planning offers long term opportunities to develop an acceptable mix of transport services and to reduce car dependency. Due consideration should be given to encourage employment growth on the Central Coast and in the Hunter region to reduce the pressure on the National Highway south of the Kariong interchange.

Pricing is a much under-utilised policy tool on urban networks. However, the application of road pricing on the National Highway could discourage its use by long-distance traffic and go against the Highway’s objectives. A tolled National Highway could reduce efficiency and the appropriate allocation of resources. This could be mitigated by adopting a concessional toll regime for trucks. A tollway is more likely to provide an appropriate level of cost recovery through toll revenue.

A tolled National Highway however would make a new link more affordable.

The study considered a mix of new infrastructure in the main northern corridor. The Base Case assumed investment in rail to maintain its current passenger and freight modal shares. The study went further, by assessing a scenario called a Public Transport only option, which increased rail investment in place of the investment in a new highway link, to test the effects on the growth of traffic on the National Highway.

19.4 Rail Freight and Public Transport Scenarios

If rail freight services in the corridor had the opportunity to compete equally with road transport and that rail achieved a significant increase in its mode share of contestable freight from 14% currently to 23% in 2021, the effect would be to significantly reduce the number of trucks on the F3.
In 2021 under this high rail growth scenario, the number of trucks removed from the F3 AADT would be about 950 articulated trucks and about 950 non-articulated trucks, i.e., 1,900 trucks per day out of a total of 17,500 trucks in 2021 in the Base Case. This can be compared with about 9,200 trucks per day (AADT) using the F3 today.

The number of tonnes of freight removed from the F3 would be about 24,000 tonnes per day in 2021.

The effect of the rail investment on reducing the National Highway traffic volumes would be equivalent to about four year’s growth in contestable road freight.

Under this same high rail freight growth scenario, about 1,200 trucks would be removed from Pennant Hills Road, including 600 articulated trucks per day in 2021, compared with the 13,300 trucks per day predicted to use Pennant Hills Road at that time under the Base Case. This can be compared with the 7,000 trucks a day (AADT) using Pennant Hills Road today.

If the proposed planned rail investment in the corridor to hold rail’s market share is not implemented, an estimated 800 car travellers each weekday would continue to use the F3 in 2011, that would otherwise use rail. That is about 660 cars in the 2 hour morning peak or 350 cars in the morning and evening peak hour, equivalent to a 1,300 vehicles per weekday on the Highway in 2011.

The effect would be more pronounced in 2021 as the full rail improvements would be implemented. Some 1,800 car passengers would continue to use their cars each weekday morning, equivalent to 750 cars per peak hour. This would be equivalent to 3,000 vehicles on the Highway in 2021.

The analysis of the Public Transport only option indicated that it would be difficult to achieve the transport objectives set for the F3 to Sydney Orbital link by upgrading public transport alone. However, potential public transport enhancements would lead to an increase in the volume of public transport travel and overall mode share and therefore serve wider community transport objectives.

19.5 The Need for a New Link

There are three main reasons why a new National Highway is needed to replace Pennant Hills Road.

(i) Social and environmental reasons at the regional and local level

To remove the existing real and constant noise, exhaust emissions, physical severance effects and the risk of road crashes from 75,000 vehicles including 8,800 heavy vehicles each weekday impacting on thousands of people living in close proximity to Pennant Hills Road.

(ii) To support economic State and National economic development

The existing Interim National Highway route using Pennant Hills Road will not be able to continue to provide a reliable service to businesses dependent on long distance road transport on the National Highway which will carry an expected 96,400 vehicles including 16,700 heavy trucks each weekday along Pennant Hills Road by 2021.

(iii) To provide for travel that cannot be catered for by rail

Because rail freight transport and the Main Northern rail line would not be able to carry the expected growth in freight demand in the corridor, even with the necessary investment to increase rail’s carrying capacity and mode share.

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1 The existing volume of heavy trucks on Pennant Hills Road (8,800 per weekday) is more than the total AADT volumes on most sections of the National Highway around Australia.
19.6 Assessment of Corridor Types A, B and C

The study demonstrated that the Type A corridor linking the F3 at Wahroonga with the M2 Motorway, best satisfies the National Highway project objectives. The Type B corridor would have unacceptable environmental impacts on Galston Gorge and Berowra Waters regional park and should not be considered further. The Type C corridor should be considered for the needs of inter regional traffic and its growth beyond 2021 as part of a wider land use and transport investigation.

19.7 Assessment of Type A Options

The key conclusions of the assessment of the Type A options are:

i) **Transport**: The Purple Option, running underneath Pennant Hills Road, best satisfies the National Highway objectives. All four options would provide similar road user benefits, however, the Purple and Blue options would provide the preferred route for trucks over the next 20 years.

ii) **Social and Environmental Improvements**: On social and environmental grounds, the Purple and Blue options are preferred. They would yield significant social benefits to people living and working along Pennant Hills Road, as a result of the large traffic relief to Pennant Hills Road.

iii) **Economics**: The Type A options are mostly in tunnel and their capital cost estimates are high, ranging from $1.6 billion to $2.15 billion (in 2003 dollars). The economic assessment shows that the Purple option performs best.

Overall Purple is preferred.

19.8 Key Outcomes from Community Consultation

It was generally acknowledged by the community groups consulted and from submissions that the Type A corridor options would best meet the shorter-term objectives of the project by providing earlier traffic relief to Pennant Hills Road. However, many submissions were received that recommended that a more strategic long-term view be considered beyond the 2021 horizon.

Of those submissions that identified a preference for an option, the majority expressed support for Type A Purple option and there was least support for Type A Red option.

Notwithstanding the above, it is considered that the Type A Purple option would not achieve community acceptance in its current form. Significant opposition to the Purple option originated from the Normanhurst/Thornleigh area, mostly associated with the proposed open trench in the vicinity of the Brickyard Park.

The single most important set of issues raised in submissions was in relation to air quality, including the need for ventilation stacks. Significant concern was expressed about the potential number and location of the stacks and treatment of emissions.

There was considerable concern in relation to the need to acquire properties for the new link and the destruction of family homes and other developments. The issue of decreased property values was of concern to many residents and Councils. It was submitted that the possibility of a new link in the vicinity of a property, or the anticipation of a tunnel under a property would result in a decrease in property value. Particular concerns were expressed from those residents living in close proximity to Brickyard Park in Thornleigh and close to the existing Wahroonga F3 interchange.

It was argued that a decision on a preferred option should be made as soon as possible.
19.9 Traffic and Transport Findings

In the assumed opening year of 2011, the traffic volume on the new Purple option would be about 69,500 vehicles per day (AADT), untolled. The volume would fall to about 39,000 vehicles per day with a $3.50 toll\(^2\).

The reasons for the high toll diversion (44%) are:

(i) the effect of increasing tolls and perceived user costs in the corridor, given the cumulative effect of the M2, Lane Cove Tunnel, M7 and new link tolls for a large number of users; and

(ii) the relatively small travel time savings from using the new link, compared with using Pennant Hills Road, even allowing for road space reallocation on Pennant Hills Road. The time savings without a toll in the year of opening (2011) are predicted to be 10 minutes in the peak, compared with 15 minutes with a tolled tunnel\(^3\). Time savings at other periods of the day and weekend would be less.

The levels of service in the tunnel and through the northern (F3/Pacific Highway) and southern (M2/ Pennant Hills Road) interchange, would be acceptable for a two or three lane directional tunnel in 2011. The level of service of a two lane tunnel however, would be poor in peak periods in 2021 for an untolled link. The analysis shows that the link should be designed for two lanes with a toll or three lanes without a toll.

The southern interchange would require capacity improvements to be made to Pennant Hills Road south of the M2 to and including the North Rocks Road intersection, to reduce the risk of queuing in the link tunnel for southbound traffic.

The analysis has shown that widening of the F3 Freeway (from dual two lanes to dual three lanes) from Kariong to Wahroonga would be required before 2011 irrespective of either the construction of a new link or capacity improvements to the Main Northern rail line.

Furthermore, the analysis has demonstrated that during the morning peak, the widened (to 3 lanes) southbound lanes of the F3 would be operating at capacity in 2021 if the capacity enhancements of the Main Northern rail line are not implemented.

Beyond 2021, the National Highway (F3 Freeway and the new Purple tunnel link) could be operating below acceptable levels of service in peak periods. There would appear to be a strong case for both:

(i) considering strategies to reduce commuter demand from the Central Coast including introducing demand management strategies and encouraging employment growth on the Central Coast; and

(ii) considering the need for another northern transport corridor (road or rail) including a new crossing of the Hawkesbury River as part of the current review of the Sydney Metropolitan Strategy.

The Purple link should be considered as part of an integrated land use and transport opportunity which could improve all transport modes in the National Highway corridor. The Purple Option would allow associated works to be planned and designed as part of an integrated scheme. The integrated scheme could include:

- reallocation of road space on Pennant Hills Road to allow wider footpaths, a cycleway and bus priority measures;

\(^2\) A $3.50 toll would provide the highest revenue returns. The financial analysis (see Chapter 17) assumed $3.50 for all vehicles including trucks.

\(^3\) Time savings are based on user cost savings from the analysis. It does not allow for specific factors effecting behaviour such as perceived safety and avoiding traffic lights and intersections. It could be that these estimates of travel time savings are conservative.
• improved access for buses and park and ride commuters to Pennant Hills and/or Thornleigh rail stations;

• redevelopment of Pennant Hills and Thornleigh railway stations, including new commuter parking arrangements and related private-sector urban development around the stations;

• development of Pennant Hills railway station as a sub-regional interchange (in association with private sector urban development);

• provision of regional bus services from Hornsby and Pennant Hills to Blacktown, Parramatta and Penrith using Pennant Hills Road and the M2;

• improved long-distance bus and rail services from the Central Coast to western Sydney destinations.

### 19.10 Cost Estimates and Economic Justification

A new dual two lane link would cost an estimated $1,670 million (2003 dollars) to build under a BOOT method of delivery.

The Purple option operating as a dual two lane tollway is likely to be economically justified given:

i) the closeness of its BCR of 1.0 to passing Treasury’s economic efficiency test (a BCR in excess of 1.0) in the main Road User Cost Benefit Analysis;

ii) the indicative improvement in the economic results under the alternative public transport scenarios evaluated; and

iii) the exclusion of community benefits associated with a tunnel avoiding the social and environmental impacts of surface roads.

An untolled two lane Purple Option would have a BCR of 1.4, and would provide greater benefits to users of the National Highway.

### 19.11 Social and Environmental Effects

The Purple tunnel would result in a significant improvement in urban amenity (reduced severance, reduced traffic noise and improved accessibility) along Pennant Hills Road as a result of the large traffic relief to surface roads that would occur from opening the link, and the associated works of reallocation of road space on Pennant Hills Road.

The direct impact on land use and properties would be relatively small for a project of this size (about 2.4 hectares of residential land and 0.5 hectares of industrial land), given that the majority of the route would be underground and its interchanges would be built mostly in existing road reserves.

There would be no significant impact on terrestrial ecology, water quality, heritage sites or open space. Any open trench at Brickyard Park at Thornleigh however, would need to be designed to minimise impacts to an acceptable level.

Indirect property effects would relate to a change of property titles, through the addition of a horizontal strata title, for about 185 properties south of Pearces Corner. Indirect effects could occur on those properties in close proximity to the four tunnel ventilation stacks that would be required.

Overall there would be a significant improvement in air quality along Pennant Hills Road and a noticeable reduction in vehicle emissions and traffic noise for properties along Pennant Hills Road and in close proximity to Pearces Corner.
19.12 Purple Option Refinement

There are a number of urban development and public transport improvement opportunities in the Purple option corridor that would improve the overall benefits to the community of this link.

Three broad refinement alternatives have been considered:

(i) Varying the tunnel length, including a single tunnel, 8.0km long

(ii) Intermediate access, including a central access north of Pennant Hills Station, giving two tunnels, each about 3.5kms long and a southern access between Boundary Road and Beecroft Road; and

(iii) Sharing the Main North Rail Line corridor between Pennant Hills and Thornleigh stations.

The last two types of refinement would allow greater integration with the existing main transport networks (road and rail) and provide positive planning opportunities and urban design outcomes in Pennant Hills.

There are also a number of urban development and public transport improvement opportunities that would improve the overall benefits to the community of the Purple option. These include potential upgrading of the Pennant Hills and Thornleigh Railway Stations, along with the existing characteristics of the commercial and retail centres within these precincts. Parking, commuter bus and rail interchanges and re-defining the role of these centres are all opportunities that go well beyond the road itself and that could be complementary development opportunities with this project.

The Purple Option should be developed with the objectives of:

(i) Minimising adverse effects on those affected by the scheme;

(ii) Providing a scheme with a high level of integration, efficient land use and effective transport outcomes;

(iii) Maximising opportunities to improve bus transport in the corridor; and

(iv) Providing positive urban design opportunities in Pennant Hills and Thornleigh.
Recommendations and Way Forward

The main recommendations of the study are presented below.

20.1 The Preferred Option

It is recommended that the Purple Option be adopted as the preferred corridor for a new link, which best satisfies National Highway objectives between the F3 Freeway at Wahroonga and the M2 Motorway.

Planning and design of the link should be based on constructing the tunnels as two lanes in each direction if tolled or three lanes in each direction if untolled.

The new link should be designed with appropriate recognition of the high proportion of heavy vehicles (up to 18%) that would use the link.

The link should be designed for motorway to motorway design standards at its interchanges with the F3 Freeway and M2 Motorway west. Furthermore, interchange ramps should be constructed within existing road reserves as far as practicable.

The desirability of an intermediate connection with Pennant Hills Road should be considered in the development of the link.

Opportunities to reallocate road space on Pennant Hills Road should be considered, to realise benefits for other users, improve the general amenity of the area and access to Pennant Hills and Thornleigh railway stations.

Improvements needed on Pennant Hills Road south of the M2 motorway up to and including the North Rocks Road intersection should be implemented to ensure acceptable traffic flow and no queuing in the Purple link tunnels.

Improvements needed on the F3 Freeway at Wahroonga, including widening within the road reserve up to approximately Edgeworth David Avenue, should be implemented so as to ensure acceptable traffic flow and no queuing in the Purple link tunnels.

20.2 Way Forward

The following steps should be considered:

i) Governments consider the affordability of the Purple Option;

ii) Investigate alternative alignments and sub-options within the Purple corridor, and develop a concept proposal;

iii) Consult with the community on the concept proposal; and

iv) Prepare an Environmental Impact Statement (EIS) on the preferred concept proposal.
20.3 F3 Capacity Issues

The proposed link would greatly improve connectivity between the Sydney Orbital and the F3 Freeway. The capacity of the F3 Freeway would also influence operations of the new link. There will be a need to increase the capacity of the F3 over some sections south of the Hawkesbury River crossing by 2011. Further capacity enhancements and/or traffic demand management measures impacting on the F3 Freeway are likely to be required beyond the timeframe of this study (2021).

An investigation into the planning need for a new northern transport corridor could be considered as part of the current review of the Sydney Metropolitan Strategy by the NSW Department of Infrastructure, Planning and Natural Resources. Such an investigation is outside the scope of this study, or National Highway planning.