



F3 TO SYDNEY ORBITAL LINK STUDY

options development report

draft

october 2002

Preface

This Options Development Report presents the Stage 2 findings from a preliminary investigation of options for the F3 to Sydney Orbital Link Study. The Study applied strategic analysis to the assessment of corridor types and feasible route options to determine which options should be studied in more detail in Stage 3.

A number of specific routes and associated engineering details were investigated and analysed during the course of the Stage 2 Study, for the purpose of determining feasibility and assessing the options. The specific routes and details described in this Report should be seen in this context.

The F3 to Sydney Orbital Link Study is being documented in a Main Report which is supported by this Options Development Report, records of Value Management Workshops and seven Working Papers as follows:

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

Value Management No.2 Workshop Record (September, 2003)

Working Paper No 1: Community Consultation Report

Working Paper No 2 Engineering Design and Costings Report

Working Paper No 3 Urban Design, Landscape and Visual Assessment Report

Working Paper No 4 Traffic and Transportation Report

Working Paper No 5 Social and Environmental Studies Report

Working Paper No 6 Tunnel Investigations Report

Working Paper No 7 Economics and Finance Report

It may be necessary to read the Main Report and Working Papers to gain a more complete understanding of the study's overall findings.

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

<http://commcons.skm.com.au/f3tosydneyorbital>

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

If 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.

Contents

Preface

Contents	i
-----------------	----------

Summary	1
----------------	----------

1 Introduction	11
-----------------------	-----------

1.1 Study process	12
-------------------------	----

1.2 Key issues.....	12
---------------------	----

1.3 Study and project objectives	14
--	----

1.4 The structure of this report.....	14
---------------------------------------	----

2 Background: existing traffic conditions, basic parameters and need for a new F3-Sydney Orbital link	15
--	-----------

2.1 Existing traffic conditions on the National Highway corridor and adjacent arterial roads	15
--	----

2.2 Patterns of growth in the Sydney Region	22
---	----

2.3 Future transport demand and movement patterns	26
---	----

2.4 Future conditions on the National Highway corridor without a new F3–Sydney Orbital link	33
---	----

2.5 Future conditions on the F3 Freeway	35
---	----

2.6 The need for a new F3–Sydney Orbital link and its objectives.....	37
---	----

3 Community consultation process and inputs	39
--	-----------

3.1 The study’s community consultation processes	39
--	----

3.2 Identification of community issues for consideration in the study.....	41
--	----

4 The process of corridor option development	45
---	-----------

4.1 Development process	45
-------------------------------	----

4.2 Land-use considerations.....	46
----------------------------------	----

4.3 Economic and regional development.....	50
--	----

4.4 Urban design, landscape and visual assessment considerations	51
--	----

4.5 Social and Environmental Considerations	54
---	----

4.6 Engineering considerations.....	61
-------------------------------------	----

5 The corridor options investigated	73
--	-----------

5.1 Grouping of corridor options	73
--	----

5.2 The ‘base case’	75
---------------------------	----

5.3	Type A corridor options	77
5.4	Type B corridor options	81
5.5	Type C corridor options	89
5.6	Estimates of properties affected by each option	95
5.7	Construction cost estimates	96
6	Assessment and short-listing of corridors for further investigation	99
6.1	Options assessment framework	99
6.2	Preliminary assessment of options against link objectives using the results of the preliminary technical studies	102
6.3	Overall Assessment of Types A, B and C	105
6.4	Assessment of the Type A (eastern) options	113
6.5	Assessment of the Type B and Type C options and identification of options for further investigation outside this Study	119
7	Conclusions from the preliminary study and recommendations for further investigation	129
7.1	Preliminary study outcomes	129
7.2	Recommendations for further detailed investigations	133

List of Figures

Figure 1.1:	The study area	11
Figure 1.2:	The study process	13
Figure 2.1:	Hourly southbound truck traffic flows on Pennant Hills Road and the Pacific Highway south of the F3 in August 2001	18
Figure 2.2:	Hourly northbound truck traffic flows on Pennant Hills Road and the Pacific Highway south of the F3 in August 2001	18
Figure 4.1:	Overview of the study's processes for developing and assessing corridor options	45
Figure 4.2:	Land use constraints in the study area	49
Figure 4.3:	Overview of the study's processes for taking account of urban design considerations	52
Figure 4.4:	Character zones and landform constraints in the study area	53
Figure 4.5:	An example of biophysical constraints (endangered flora and fauna) in the study area	57
Figure 5.1:	Broad corridor types	73
Figure 5.2:	The corridor options developed and assessed during the preliminary stages of this study ...	76
Figure 5.3:	Option 1 - M2 at Macquarie Park to F3 at Wahroonga	77

Figure 5.4:	Option 2 - M2 at North Epping to F3 at Wahroonga	78
Figure 5.5:	Option 3 - M2 at Pennant Hills Road to F3 at Wahroonga	79
Figure 5.6:	Option 4 - M2 at Pennant Hills Road to F3 at Asquith.....	80
Figure 5.7:	Option 5 - M2 at Windsor Road, Baulkham Hills, to F3 at Mt Colah	81
Figure 5.8:	Option 6 - M2 at Windsor Road, Baulkham Hills, to F3 at Mt Colah, via Round Corner	82
Figure 5.9:	Option 7 - Western Sydney Orbital at Quakers Hill Parkway, Quakers Hill, to F3 at Mt Colah.....	83
Figure 5.10:	Option 11 - Western Sydney Orbital at Dean Park to F3 at Berowra, via Riverstone	84
Figure 5.11:	Option 13 - M2 at Pennant Hills Road to F3 at Mt Colah via railway line.....	85
Figure 5.12:	Option 14 - Brooklyn to Somersby via railway line	86
Figure 5.13:	Option 15 - Western Sydney Orbital at Dean Park to F3 north of Mt Ku-ring-gai, via Middle Dural and Galston.....	87
Figure 5.14:	Option 17 - Western Sydney Orbital at Kings Langley to F3 north of Mt Ku-ring-gai, via Round Corner and Galston	88
Figure 5.15:	Option 8 - Western Sydney Orbital at Quakers Hill Parkway, Quakers Hill, to F3 north of the Hawkesbury, via Dural.....	89
Figure 5.16:	Option 9 - M2 at Windsor Road to F3 north of the Hawkesbury, via Dural	91
Figure 5.17:	Option 10 - Western Sydney Orbital at Dean Park to F3 north of the Hawkesbury, via Riverstone.....	92
Figure 5.18:	Option 12 - Western Sydney Orbital at Sunnholt Road, Acacia Gardens, to F3 north of the Hawkesbury, via Annangrove.....	93
Figure 5.19:	Option 16 - Western Sydney Orbital at Dean Park to F3 north of the Hawkesbury, via Annangrove.....	94
Figure 6.1:	Option assessment processes and stages.....	101
Figure 6.2:	The Type A (generally short to medium term) and Types B and C (longer term) groupings of options	104
Figure 6.3:	Typical Average Daily Traffic Relief on the Interim National Highway and arterial roads from Type C	107
Figure 6.4:	The Type A (eastern) Options 1 (red), 2 (yellow), 3 (blue) and 4 (magenta)	114
Figure 6.5:	The Type B and Type C Options, as developed for the Strategic Review of Feasible Options value management workshop on 26 June 2002.....	121
Figure 6.6:	The Type C options recommended for further investigation, connecting the Sydney Orbital/M2 at Quakers Hill Parkway or Norwest Boulevard with the F3 north of the Hawkesbury River.....	127
Figure 6.7:	The concept of an “inland” longer-term transport link between the New England Highway and the Sydney Orbital is also recommended for further investigation. Potential corridors include Putty Road, Wisemans Ferry and Peats Ridge corridors	128

Figure 7.1: The three Type A (eastern) options recommended for further detailed investigation 130

Figure 7.2: Type C (western) corridor options for further investigation 132

List of Tables

Table 2-1: Accident rates 17

Table 2-2: Population and employment forecasts in the study area 24

Table 2-3: Estimated Future Corridor Demand, Passenger Flows⁽¹⁾ - Base Assumptions⁽²⁾ 27

Table 2-4: Estimated Future Corridor Demand Passenger Flows⁽¹⁾ - No Rail Capacity Enhancements⁽²⁾ 28

Table 2-5: Origins and destination movements 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 30

Table 2-6: Forecast (modelled) traffic flows and origins and destinations on the F3 south of Ku-ring-gai Chase Road during the morning peak hour in 2021, assuming there is no new F3-Sydney Orbital link 32

Table 2-7: F3 capacity considerations (Wahronga to Kariong section) 36

Table 4-1: Criteria used to develop and assess corridor options 47

Table 4-2: Conservation reserves in the study area 56

Table 5-1: Indicative number of properties crossed or passed under, wholly or partly, by each of the preliminary options. (other than Option 14, which has been excluded from further analysis) 95

Table 5-2: Indicative construction cost estimates for the preliminary corridor options. (other than Option 14, which has been excluded from further analysis) 96

Table 6-1: Strategic assessment of the generally best-performing options against new link objectives 103

Table 6-2: Network Travel Costs and Benefits – Comparison of Type A and Type C 106

Table 6-3: Transport assessment results, comparing the effects of Type A, B and C corridors 108

Table 6-4: Summary of Social Effects of Corridor Types 110

Table 6-5: A Summary of Environmental Impacts of Corridor Types 112

Table 6-6: Economic Performance of Types A, B and C Corridors 113

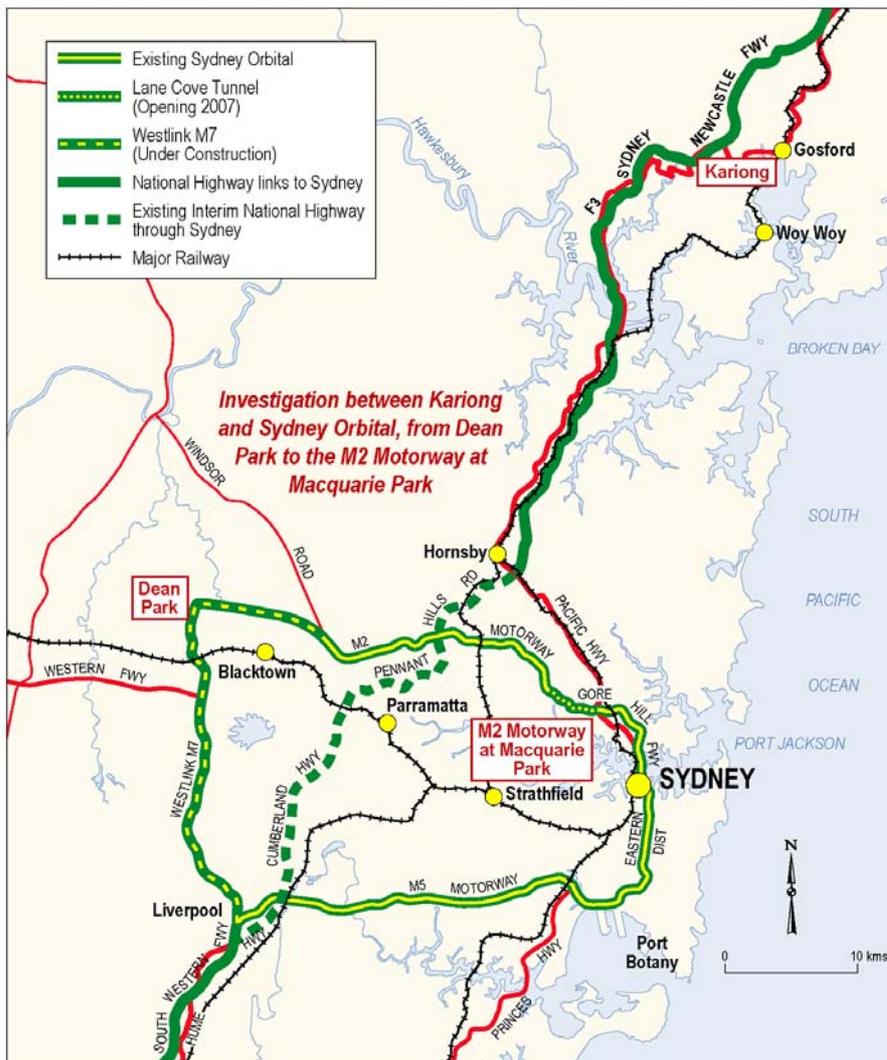
Table 6-7: Summary of assessments of the western options by workshop participants
Note: A number of these “original” options have subsequently required modification. * 120

Summary

This *Options Development Report* describes the findings of preliminary technical studies into a new National Highway link between the F3 and the Sydney Orbital and the development and preliminary assessment of options for this new link.

The study area, shown in **Figure A** below, lies between Dean Park, Macquarie Park and Kariong.

Figure A: The study area



Key issues

The key issues being addressed in this study relate to the direct and indirect effects of the development of a major transport corridor in northern Sydney, including:

- The transport needs of long distance commercial traffic that service the Sydney economic region, including the many regional centres dependent on Sydney markets

- Population and employment growth and distribution in the region over the next 20 years, and beyond and the growth in transport demand
- The expected doubling of freight movements and logistics demands on the eastern seaboard over the next 20 years, servicing manufacturing, export business and local distribution
- Sustainable transport needs, including opportunities to increase rail's share of freight movements and opportunities to improve long distance, regional and commuter passenger transport in the corridor
- The growth of commuter traffic between Sydney and the Central Coast and the costs and trade-offs of providing infrastructure for inter-State, regional and commuter traffic in the same National Highway corridor
- Other travel demand management issues in the face of a forecast 60% increase in travel demand over the next 20 years, including induced traffic and its effects from the introduction of new infrastructure and ways of reducing road travel in accordance with State and national transport policies
- The spread of increased traffic volumes and congestion, with increasingly severe adverse impacts in some corridors, including the interim National Highway along Pennant Hills Road, where these impacts have already reached unacceptable levels
- The relatively high road crash rates and safety concerns in the National Highway corridor especially along Pennant Hills Road, and
- The affordability of new infrastructure in an increasing costly built environment and an environmentally responsible society

Much of the preliminary work undertaken during this study has focussed on the physical (land use, engineering, terrain, and urban design) and environmental and social feasibility of developing alternative infrastructure link options between the F3 and the Sydney Orbital, with the strategic issues listed above setting the scene.

These issues have been addressed to the extent necessary to assess feasible options for further investigation.

The objectives of a new link replacing Pennant Hills Road

Pennant Hills Road now carries an average of nearly 75,000 vehicles per day at Pennant Hills. Between 9% and 11% of these are heavy vehicles, a large numbers of them articulated vehicles. The accident rate on the interim National Highway route is significantly higher than the average for Sydney arterial roads and the levels of congestion and delays are high, especially during peak periods. The resultant detrimental social and environmental effects, including community severance, traffic noise and exhaust emissions, are becoming increasingly unacceptable.

A new transport link would need to satisfy transport, social and environmental objectives.

The following objectives have been developed to guide work undertaken in the study:

- *Planning objectives:*
 - 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, and

- Serve the future growth needs of long-distance transport.
- *Project objectives:*
 - Provide a high standard link that integrates with the regional transport network
 - Minimise social and environmental impacts during construction and operation
 - Provide opportunities for improved public transport, and
 - Be economically justified and affordable to government.

Grouping of 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.

The broad corridor options were found to fall into three strategic groups, or types of corridor options.

The three types, referred to as A, B and C, are shown diagrammatically in **Figure B** on the next page.

Type A refers to the more easterly options, with most of their length in tunnel, which would connect the F3 Freeway at Wahroonga to the M2 Motorway.

The Type A corridor options are an extension of the F3 corridor south to the M2 Motorway and they rely on the F3 corridor as the major transport corridor into Sydney from the north.

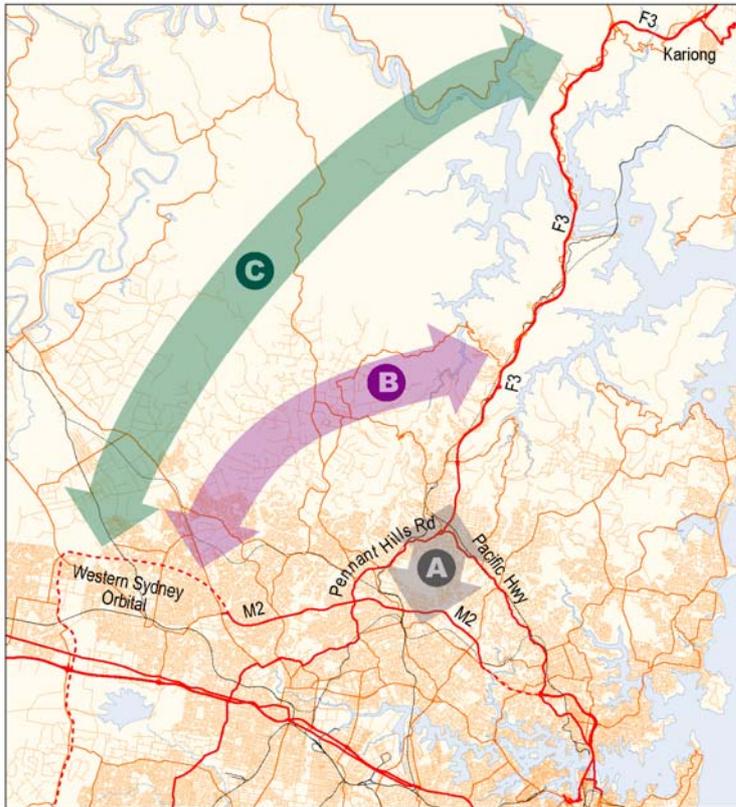
The Type B corridor options bypass the developed areas of Hornsby. As with Type A, the Type B options would rely on the F3 corridor as the major transport link into Sydney from the north.

Type B are the central options that would connect the Sydney Orbital between Pennant Hills Road and Dean Park to the F3 Freeway north of Hornsby but south of the Hawkesbury River.

Type C are the western options, which would connect the Sydney Orbital between Pennant Hills Road and Dean Park with the F3 Freeway north of the Hawkesbury River and would require a new crossing of the Hawkesbury River.

The Type C corridor options would provide a direct transport link for long distance traffic to and from western Sydney, bypassing the M2 Motorway and F3 Freeway south of the Hawkesbury River. Type C would also act as a second major corridor into Sydney, providing additional capacity to the F3 Freeway.

Figure B: The broad corridor types that have been investigated



Assessment of corridor types

A strategic option assessment framework was developed to assess each of the corridor options against transport, urban design, social, environmental and economic criteria. A summary of this assessment is shown in Table 1.

The findings of the work carried out in this preliminary study demonstrate that Type A options are preferred to Types B and C in terms of addressing the objectives of a new link. Type A options provide the greatest relief to Pennant Hills Road while providing the required benefits with respect to safety, congestion relief, port/market accessibility and facilitation of public transport improvements over the next 20 years. Type A options are also preferable on social, economic and environmental criteria.

Type A options compared with Type B options

Type B options have two critical strategic weaknesses compared to Type A (see **Table 1**).

- They would not relieve Pennant Hills Road as well as Type A, which is a major objective of a new link, and;
- They would have significant impacts upon the Berowra Valley, its bushland and scenic value. The community has expressed a strong view against any option that adversely effects the parks and reserves in the Berowra Valley.

The Type B options would effect more properties and be more expensive to construct. Type A options would also have a higher economic performance than Type B options.

For these reasons, Type A options are preferred over Type B.

Table 1: Summary assessment of broad corridor types

Criteria	Measure	Corridor assessment			Comment
		Type A	Type B	Type C	
Transport Improvements					
Traffic volumes on new link	Average daily traffic in 2021 (untolled)	70-105,000	30-50,000	30-50,000	
Traffic congestion relief to existing National Highway corridor along Pennant Hills Road	Average daily traffic in 2021 (untolled)	20-40,000	2,000-12,000	4,000-10,000	
Daily truck relief to interim National Highway	Truck AADT	4,000-11,000	Up to 3,000	Up to 2,000	
Road safety changes on arterial Road Network	Savings in fatal and serious crashes per year	10-15	5-10	Less than 5	Based on current crash rates
Opportunity to improve public transport	Potential for re-allocation of road space on Pennant Hills Road for buses	High	Low	Low	All three corridor types offer some opportunities
Improved access to ports and centres of economic activity for long distance freight movement	Savings in travel time to major freight centres	Significant. Improved access to Port Botany	Some	Some. Improved access to Western Sydney	Majority of centres will remain in eastern Sydney
Land use and regional development	Improved regional accessibility	Good access to eastern Sydney	Improved access	Supports NW sector development and access to western Sydney	All three support State development objectives. Type C corridors serve western Sydney in the longer term
Social effects					
Properties affected	• Number directly affected on the surface	20-130	80-450	300-600	Broad corridor assessment. Tunnel options would have little impact on properties above tunnel alignment
	• Number of residential properties passed under	350-600	10-1,400	10-700	
Change in severance, traffic emissions including noise impacts along Pennant Hills Road	Reduction in adverse effects	Significant reduction	Some noticeable reduction	Likely to be no noticeable change	Preliminary assessment
Urban design, landscape and visual assessment effects	Acceptability of urban design character and landscape changes	High	Medium	Low	Preliminary assessment
Environmental effects					
Impact on bushland and National Parks	Land area affected	Low – Not significant	High – Significant impact on Berowra Valley	High – given length of corridor	Easterly options of Type A may have some impact in Lane Cove National Park
Impact on threatened fauna species	Probability of impact	Low	Medium	Medium	Preliminary assessment based on National Parks database
Effect on water quality	Number of water crossings likely to be effected	Low	Medium	Medium	Preliminary assessment
Heritage effects	Probability of impacts on known sites	Low	Medium-High	High	Preliminary assessment
Economic effects					
Reduction in user costs	Estimated travel time savings	Significant	Some	Some	
Strategic capital costs estimates	\$ billion (2001 prices)	1.1 – 2.4	1.5 – 3.3	2.7 – 3.9	Assuming Design and Construction (D&C) method of delivery
Benefit Cost Ratio	-	1.2 – 1.4	0.1 – 0.4	0.1 – 0.3	

Type A options compared with Type C options

Type C options would not satisfy the link objectives as well as Types A and B, or address the National Highway needs as well (see Table 1). Traffic modelling indicates that Type C corridor options would provide little relief to Pennant Hills Road in the short term. Furthermore, there is estimated to be relatively small traffic demand for a road in this broad corridor in the next 20 years, until the planned development of Western Sydney and the northwest sector takes place.

The Type C options (up to 55 km in length) are longer than Type A (up to 10 km in length) and would affect many more properties, bushland, rural areas and areas of National Parks. The community has expressed a strong view against any option that adversely impacts on National Parks and reserves. Type C options would also require a new crossing of the Hawkesbury River and impact on the scenic value of the area.

On economic performance grounds Type A is likely to be economically justified, whereas Type C options are not likely to be justified.

For these reasons, Type A options are preferred over Type C.

The F3 corridor to Kariong

Type A options rely on the existing F3 corridor south of Kariong and the Type B options similarly rely on part of the existing F3 Freeway south of Kariong. Both corridors rely on the existing crossing of the Hawkesbury River. A strategic assessment indicates a need to widen the F3 Freeway to 6 lanes between Wahrenonga and Kariong to accommodate the predicted traffic growth in the F3 corridor before 2011. This need is largely driven by the predicted growth in population and commuter travel demand from the Central Coast and will be required even if investment is made to upgrade the Main North Rail line. Further capacity improvements to the F3 Freeway are likely to be required and/or demand management measures introduced beyond the time frame of this Study (2021).

The conclusions of the preliminary investigations

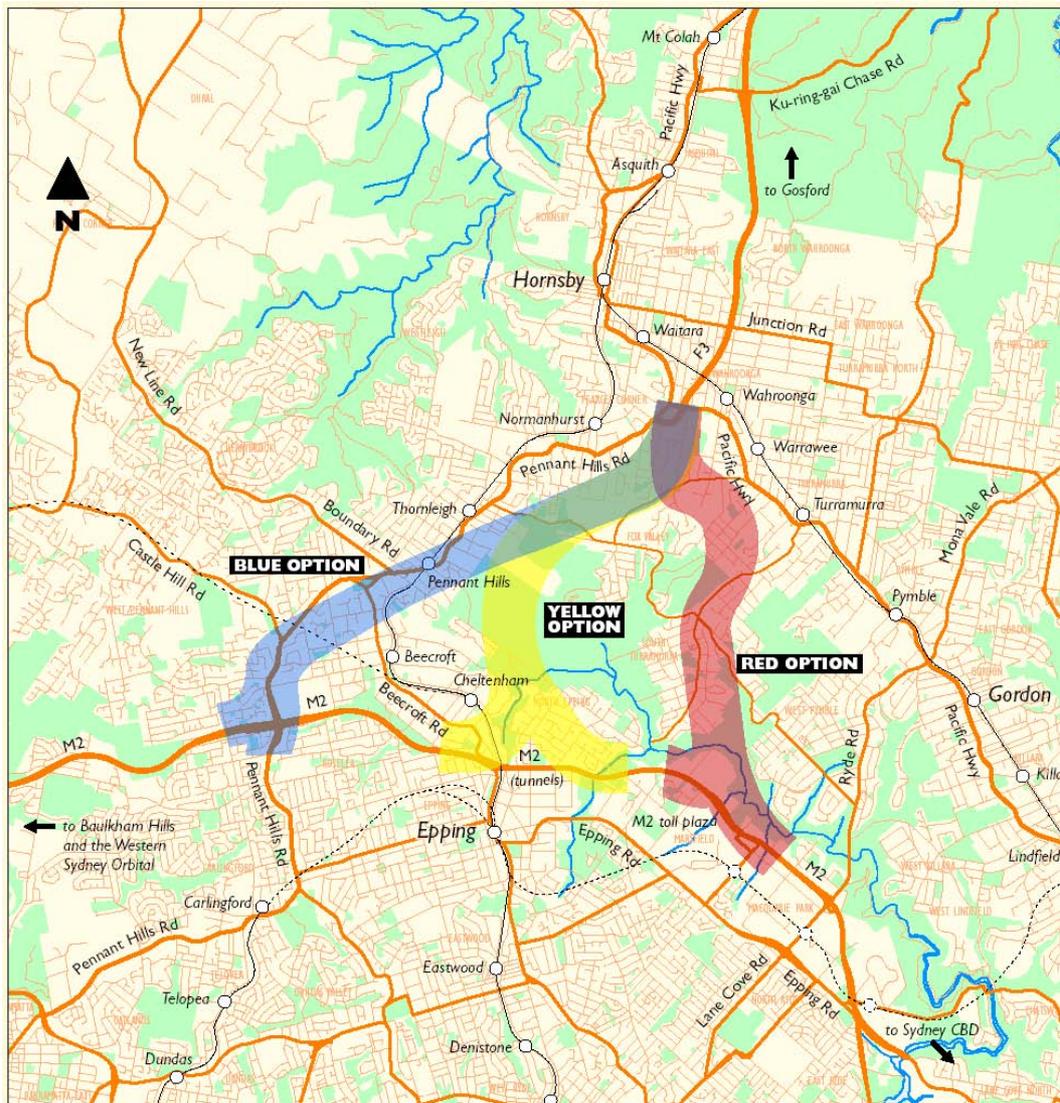
Corridor options for further investigation, that satisfy the objectives of a new link

The preferred option would need to accommodate the transport needs of the National Highway over the next 20 years.

The Type A eastern group of corridor options was identified as best satisfying the objectives of a new link, including traffic relief of Pennant Hills Road over this timeframe. It is likely that at least one of the Type A options would be acceptable on environmental, social and economic grounds.

Three feasible Type A Corridor options have been identified for further investigation. They are shown in **Figure C** on the next page and described as the Blue, Yellow, and Red options.

Figure C: The three Type A (eastern) options recommended for detailed investigation



The Blue option: M2 at Pennant Hills Road to F3 at Wahroonga

This option would have southern connections to the M2 Motorway and Pennant Hills Road at Carlingford and a northern connection to the F3 Freeway at Wahroonga. An intermediate interchange at Boundary Road/Beecroft Road in Pennant Hills should also be investigated.

The option would include and provide for:

- Approximately 8 km of the main tunnel route, mostly in dual three-lane or two-lane tunnels
- Tunnelling under Pennant Hills Road (Pennant Hills), the Main North Railway line, Pennant Hills Road (Normanhurst), and
- No major waterway crossings.

Alternative Blue option alignment

Following consultation with community groups, suggestions were made for the Blue option to follow more closely the existing alignment of Pennant Hills Road in tunnel underneath Pennant Hills Road. The investigation of the Blue option in Sage 3 will address different route alignments joining the F3 Freeway at Wahroonga with the M2 Motorway at the Pennant Hills Road interchange.

The Yellow option: M2 at North Epping to F3 at Wahroonga

This option would have dual southern connections to the M2 Motorway, on either side of the existing M2 tunnel at Terrys Creek to the east and Beecroft Road to the west, and a northern connection to the F3 Freeway at Wahroonga.

The option would include and provide for:

- A 2.5 km single lane dual tunnel eastern connection with the M2 and a 2.0 km single lane dual tunnel western connection with the M2, with these tunnels joining a 6.5 km long dual two-lane or three-lane main tunnel alignment
- Tunnelling under North Epping, Devlins Creek Valley, Pennant Hills Park, Lane Cove National Park, Sydney Adventist Hospital, Coups Creek Valley and Exeter Road, and
- Major waterway crossings at Devlins Creek, Lane Cove River and Coups Creek.

The Red option: M2 at Macquarie Park to F3 Freeway at Wahroonga

This option would have a southern connection to the M2 Motorway at Marsfield, immediately to the west of the existing tollbooths, and a northern connection to the F3 Freeway at Wahroonga.

The option would include and provide for:

- Approximately 6.5 km of the route being in dual three-lane or two-lane main tunnels
- Tunnelling under the Macquarie Park sporting fields, Kissing Point Road, Comenarra Parkway, Twin Creeks Reserve, Lucinda Avenue South and Exeter Road, and
- Major waterway crossings at Lane Cove River, Mitchell Creek and Coups Creek.

An alternative within the Red option involving a bridge crossing of the Lane Cove River should also be investigated. If this approach were acceptable, it would alleviate steep tunnel gradients at the southern end of the link.

Longer term options for further consideration

The F3 Freeway is being widened to six lanes over the length between Kariang and the Hawkesbury River. These works will be completed in 2004. Requirements for future widening of the F3 to accommodate traffic growth as part of the National Highway's needs will be investigated in more detail during the following stages of this study. By around 2021 however, it is likely that the F3 corridor will be subject to demands beyond the 6-lane capacity of the road, even if programs to upgrade rail infrastructure and services to increase rail's freight and passenger market shares in the corridor are implemented. Accordingly, further improvements are likely to be needed to the F3 Freeway, beyond the time frame of this Study (2021). However there are significant uncertainties in predicting travel demand beyond 2021. An assessment of longer-term land use and transport needs would be required to be undertaken within the State planning processes.

This preliminary assessment has identified two other types of corridors which could be developed in the longer term, that is beyond 2021, and which deserve further consideration as part of investigations outside this study:

- i) The Type C western corridors shown in **Figure D**, connecting the Sydney Orbital at Quakers Hill Parkway or Norwest Boulevard with the F3 Freeway north of the Hawkesbury River, and
- ii) An inland transport link between the New England Highway and the Sydney Orbital, with the potential use of the Putty Road corridor, or Wisemans Ferry–Broke/Cessnock corridor or a Peats Ridge–Yarramalong–Broke/Cessnock corridor.

In the longer term, beyond 2021, an inland western route could be required depending on future inter-regional traffic growth, with the F3 Freeway continuing to serve commuter and freight travel needs to and from the Central Coast.

Investigations of the long distance transport needs beyond 2021 should be seen as part of a strategic land use/transport investigation, involving wider consultation with the community and other stakeholders, councils, the RTA, the Department of Planning and other government agencies.

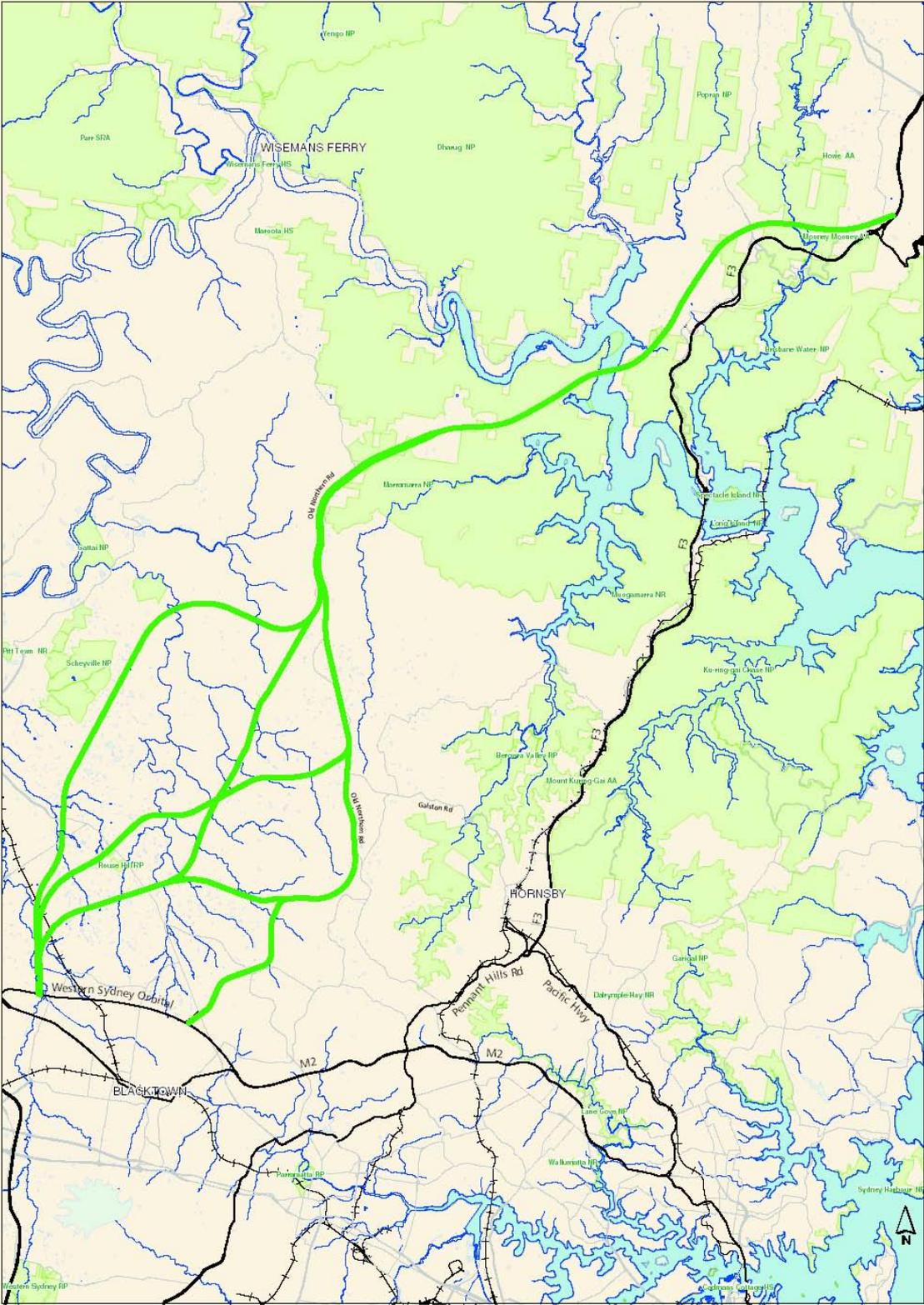
Further detailed investigations in Stage 3 of this Study

The key areas for further study should include:

- The development of concept engineering designs for the three Type A options (Blue, Yellow and Red), including interchange treatments, typical options for the location of ventilation stacks and cost estimates (shown in **Figure C**)
- Alternative Blue option tunnel alignments between F3 Freeway at Wahroonga and the M2 Motorway interchange with Pennant Hills road, to the same level of analysis as the Blue, Yellow and Red options.
- An assessment of the Type A options in terms of their social, environment and economic effects, within the study's agreed assessment framework
- An investigation of the potential to re-allocate road space on Pennant Hills Road for public transport, cyclists and/or pedestrians
- An investigation of opportunities to move more freight by rail in the corridor
- An investigation of public transport improvement opportunities in the corridor, including a "public transport only" option
- An investigation of the potential to widen the F3 Freeway beyond six lanes with the existing road reserve
- An investigation of tolling regimes, funding scenarios and "Public Private Partnership" opportunities for a new National Highway.

The investigations listed above will examine how government can invest in integrated transport infrastructure improvements, including rail, as part of the preferred National Highway scheme linking the F3 to the Sydney Orbital.

Figure D: The Type C (western) corridor options connecting the Western Sydney Orbital with the F3 Freeway north of the Hawkesbury River, which could be required to be planned as part of infrastructure needs for future inter-regional traffic growth, beyond 2021



1

Introduction

The purpose of this study is to investigate options for a new National Highway connection between the Newcastle Freeway (F3) and the Sydney Orbital. The new connection will replace Pennant Hills Road as the National Highway route.

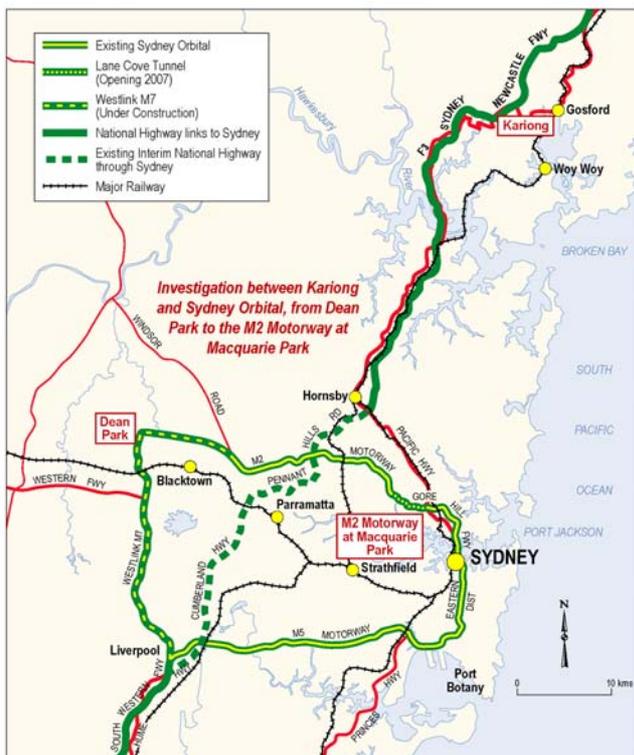
The study is being funded by the Federal Department of Transport and Regional Services (DOTARS) and is being coordinated by the NSW Roads and Traffic Authority (RTA).

This *Options Development Report* describes the development and preliminary assessment of options for a new National Highway link between the F3 and the Sydney Orbital. It is based on the findings of preliminary technical studies that have been undertaken at a strategic level of analysis for the purpose of selecting feasible options for further development and study.

The *Final Report* on the outcomes of the study is planned for completion in 2003, following an extended community consultation program.

The study area is shown in **Figure 1.1**. The area under investigation is bounded by the M2 Motorway and Western Sydney Orbital (collectively called the ‘Sydney Orbital’) to the south, Dean Park to the west, Macquarie Park to the east and Kariong to the north

Figure 1.1: The study area



1.1 Study process

This report summarises the results of Stage 2 of a four-stage study process, summarised in .

Accordingly, this report does not:

- address the best way to provide traffic relief to the existing interim National Highway, or
- report on public transport improvements as alternatives to road-based options.

Stage 3 of the study will investigate public transport and other modal options, to assist in the evaluation and selection of a preferred scheme. These investigations will be reported in the Final Report.

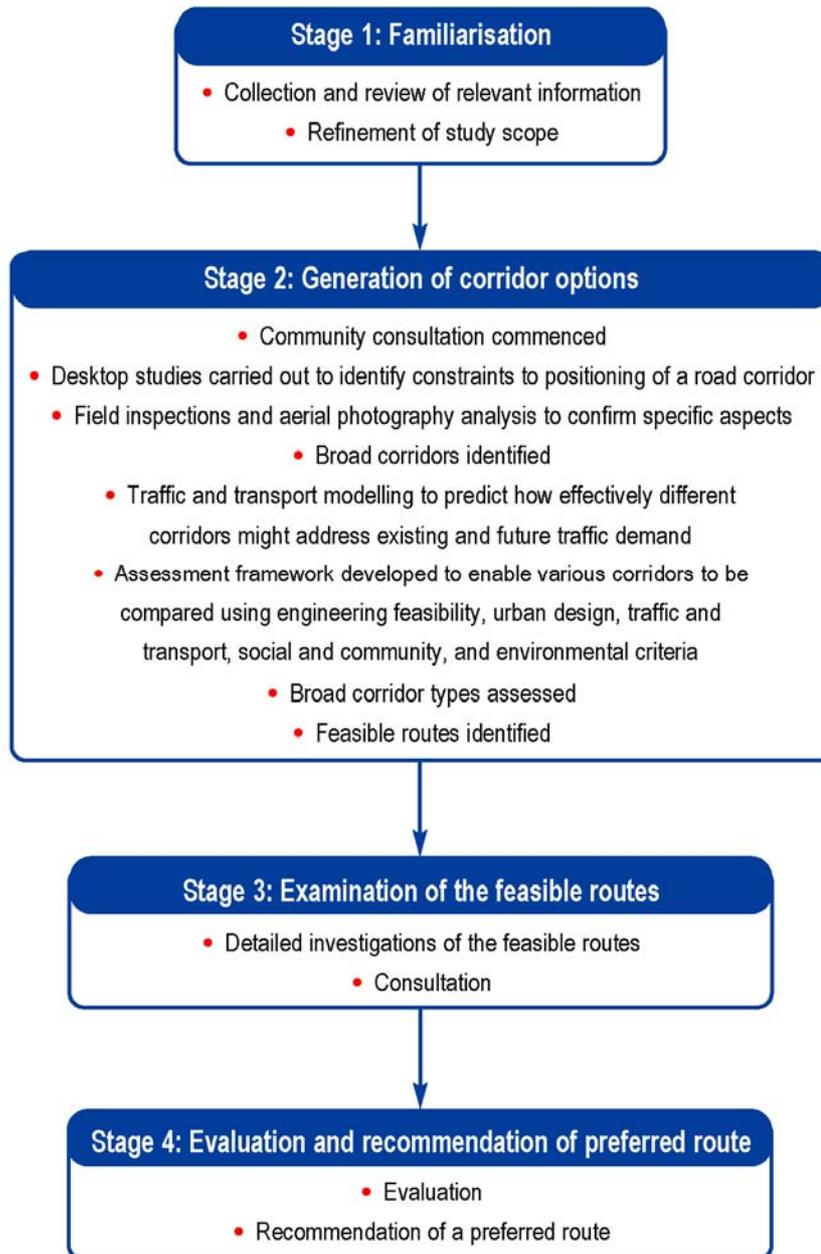
1.2 Key issues

The study has gained valuable input from stakeholders, community groups and individuals, including those concerned with the intrinsic value of the study area to help identify issues related to land use and transport in the area and in particular to a proposed new National Highway link. The study area has over 100,000 households and its population is forecast to increase by about 25% over the next 20 years. Some of the key issues related to a new National Highway link are described below.

There are many economic, social and environmental issues that need to be taken into account in determining the nature and timing of the best acceptable scheme for a new National Highway link between the F3 and the Sydney Orbital, including:

- The transport needs of long-distance commercial traffic that services the Sydney economic region, including the many regional centres dependent on Sydney markets
- Population and employment growth and distribution in the region over the next 20 years and beyond, and the resultant growth in transport demand
- The expected doubling of freight movements and logistics demands on the eastern seaboard over the next 20 years, servicing manufacturing, export business and local distribution
- Sustainable transport needs, including opportunities to increase rail's share of freight movements and opportunities to improve long distance, regional and commuter passenger transport in the corridor, consistent with the Federal Government's draft AusLink policy
- The growth of commuter traffic between Sydney and the Central Coast and the costs and trade-offs of providing infrastructure for inter-State, regional and commuter traffic in the same National Highway corridor
- Other travel demand management issues in the face of a forecast 60% increase in travel demand over the next 20 years, including induced traffic and its effects from the introduction of new infrastructure and ways of reducing road travel in accordance with State and national transport policies
- The spread of increased traffic volumes and congestion, with increasingly severe adverse impacts in some corridors, including the interim National Highway along Pennant Hills Road, where these impacts have already reached unacceptable levels
- The relatively high road crash rates and safety concerns in the National Highway corridor especially along Pennant Hills Road, and
- The affordability of new infrastructure in an increasingly costly built environment and an environmentally responsible society

Figure 1.2: The study process



Much of the work undertaken has focussed on the physical and environmental feasibility of developing alternative transport link options between the F3 and the Sydney Orbital, taking the strategic issues listed above into account.

These issues have been addressed to the extent necessary to assess feasible options within a policy context, sufficient to determine feasible options for further investigation.

The Final Report will provide recommendations on a preferred transport infrastructure scheme and comment on the broader land use and transport policy issues affecting the continuing development of the National Highway program over the next 20 years.

1.3 Study and project objectives

The following objectives have guided the work undertaken in the study:

- Planning objectives:
 - 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, and
 - Serve the future growth needs of long-distance transport.
- Project objectives:
 - Provide a high standard link that integrates with the regional transport network
 - Minimise social and environmental impacts during construction and operation
 - Provide opportunities for improved public transport, and
 - Be economically justified and affordable to government.

1.4 The structure of this report

The following considerations have guided the work undertaken in the study and which are described in this Report:

- Chapter 2: The factors which have generated the need for a new F3–Sydney Orbital National Highway link and which set the basic parameters for this new link, including the objectives listed above.
- Chapter 3: The study’s community consultation processes and the inputs received from the community to date.
- Chapter 4: The factors taken into account in the development of an initial long list of corridor options for the new link.
- Chapter 5: The study’s base case (with no new link) and the corridor options developed for assessment.
- Chapter 6: Assessments of these options and the shortlisting of corridor options for more detailed investigation following this report; and
- Chapter 7: The conclusions of the preliminary study investigations and recommendations for further study.

2

Background: existing traffic conditions, basic parameters and need for a new F3-Sydney Orbital link

2.1 Existing traffic conditions on the National Highway corridor and adjacent arterial roads

The National Highway connects to Sydney from the north via the F3 Freeway. It then passes through Sydney via Pennant Hills Road and the Cumberland Highway and connects with the Hume Highway and the F5 in southwest Sydney (refer to **Figure 1.1**). The existing National Highway route through Sydney is congested during commuter and business hours. Congestion results in unreliable travel times and can lead to major disruptions to inter-regional traffic movements.

F3 Freeway traffic volumes and congestion

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

Heavy vehicles contribute around 11% of this traffic. Additional commercial travel occurs in cars and light commercial vehicles.

During holiday periods traffic flows are much heavier than the annual average flows and severe congestion can occur, especially on four-lane sections of the freeway and on the approaches to Wahroonga (the F3 south of Kariong has a mixture of four-lane and six-lane sections).

The design capacity of the F3 — the point at which its Level of Service changes from D to E — is 1,860 vehicles per hour per lane during peak periods¹.

This design capacity is equivalent to about 3,700 vehicles per hour in the peak direction on the two-lane sections of the freeway and 5,600 vehicles per hour in the peak direction on its three-lane sections.

Morning peak hour flows southbound along the F3 Freeway at the Hawkesbury River currently average over 3,700 vehicles per hour in some periods.

Over the next few years the four-lane sections of the F3 between Kariong and the Hawkesbury River are being widened to six lanes. Widening of the four-lane sections south of the Hawkesbury to six lanes will 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. In the longer term (after 2021) further widening and/or an alternative route is likely to be required. This is discussed in Section 2.5 below.

¹ 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.

Traffic volumes and congestion on Pennant Hills Road, the Pacific Highway and Lane Cove Road

The two main roads feeding the southern end of the F3 at Wahroonga are the existing National Highway link (Pennant Hills Road) and the Pacific Highway. Both of these roads have a mixture of 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.

Traffic growth over the past 10 years on Pennant Hills Road has averaged 7.5% per year, while the average for the Pacific Highway has been about 2% per year. The faster growth on Pennant Hills Road reflects the growth in traffic between southern and western Sydney and the north and the effects of the construction of the M2. The Pacific Highway has been running at capacity over many years, and traffic growth is more constrained on that highway as a result.

Since 1999, traffic growth on Pennant Hills Road has dropped back to around 2.0% per year.

Annual average daily traffic flows today (2002) are approximately 76,000 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).

Both roads are subject to significant congestion during peak periods, and have heavy traffic flows throughout the day, especially Pennant Hills Road, which has a higher volume of long distance traffic including heavy commercial vehicles.

The effects of the rapidly increasing and now high traffic volumes on Pennant Hills Road are frequently described as intolerable. This is true for road users, subject to serious congestion-induced travel delays, and for local residents living along Pennant Hills Road, who as a result of this traffic, suffer noise and exhaust fumes, community severance and a high risk of road crashes.



Off peak traffic on Pennant Hills Road near its junction with the Comenarra Parkway

Peak travel speed can be used as an indicator of roadway congestion. Average travel speeds on Pennant Hills Road and the Pacific Highway are both low, at below 25 km/h at Pennant Hills and Pymble respectively, and can often be as low as 10–15 km/h.

Another indicator of a roadway's congestion is its volume/capacity ratio (VCR). Both of these links have high VCRs: the morning peak VCR for Pennant Hills Road is 1.13, while that for Pacific Highway is 1.21. A VCR of 1.00 or more normally indicates a need for improvement.

The design capacity of Pennant Hills Road is around 1,000 vehicles per hour per lane, or 3,000 vehicles per hour in the peak direction. This is significantly less than the design lane capacity of the F3 Freeway, because of the "friction" associated with the need to accommodate side street access and intersection controls. In 2001 traffic flows in the morning

peak direction on Pennant Hills Road at the Pennant Hills Railway Bridge averaged 2,935 vehicles per hour, close to the capacity of a three-lane section of road.

Similarly, the design capacity of the Pacific Highway is around 1,000 vehicles per lane per hour (or about 3,000 vehicles per hour in total in the peak direction for the three-lane sections). The peak design capacity of Ryde Road/Lane Cove Road is around 1,300 vehicles per hour per lane, or 3,900 vehicles per hour in the peak direction. In 2001 the traffic flows in the morning peak direction averaged 3,585 vehicles per hour on the Pacific Highway south of Telegraph Road and 4,050 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, damages 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, as discussed in Section 2.4 below. Since movements are at capacity during most peak periods, traffic volumes will grow around and 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.

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 in 1999 and 2001, which indicates that road safety conditions on these roads are well below average (see **Table 2-1**). The recorded three-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 was 114 in 2001.

Table 2-1: Accident rates

Road Section	Serious and Fatal Crash Rate (per km of route per year)
Pennant Hills Road (north of M2)	16
Pacific Highway (north of Ryde Road)	23
Sydney Network average	10

Road freight traffic

There has been considerable growth in the freight task in the Central Coast–Sydney corridor in recent years.

Of the 70,000 vehicles per day using the F3 at the Hawkesbury River bridge in 2001, about 9,000 (12.6%) were heavy vehicles, including over 4,000 articulated trucks, many of them undertaking inter-regional trips².

The corresponding figures for Pennant Hills Road just south of the Comenarra Parkway were about 7,000 heavy vehicles (9%), including 3,500 articulated trucks. About 20% of these heavy vehicles were servicing the local shops and commercial centres. The Pacific Highway at Bobbin Head Road carried 3,500 heavy vehicles (7%), including 1,200 articulated trucks.

² These truck figures are based on 12 hour day time surveys over 7 days. The 24 hour volumes and the average weekday truck volumes are higher.

These figures show Pennant Hills Road now carries nearly twice as many heavy vehicles and three times as many articulated trucks as the Pacific Highway — and its traffic flows have been increasing at a much faster rate.

Figure 2.1 and **Figure 2.2** 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. These data are based on an intercept survey of freight vehicle movements in northern and western Sydney conducted for the RTA by Masson Wilson Twiney in August 2001³.

Figure 2.1: Hourly southbound truck traffic flows on Pennant Hills Road and the Pacific Highway south of the F3 in August 2001.

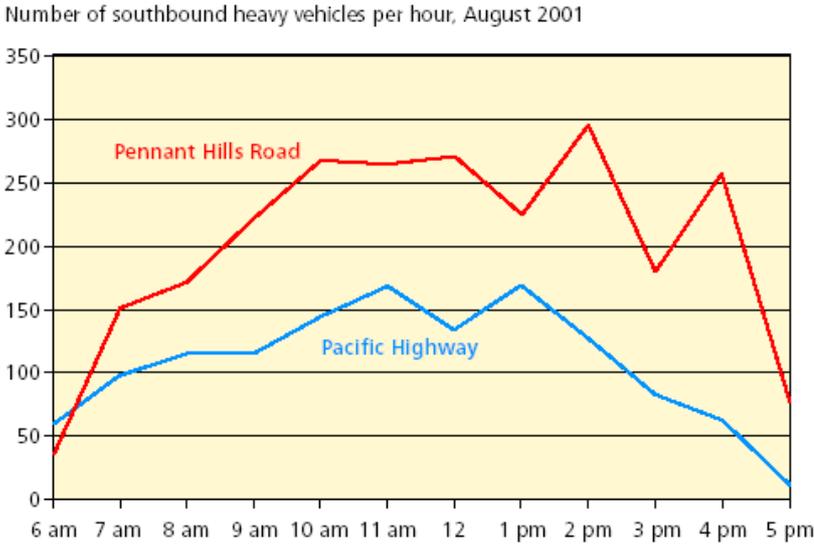
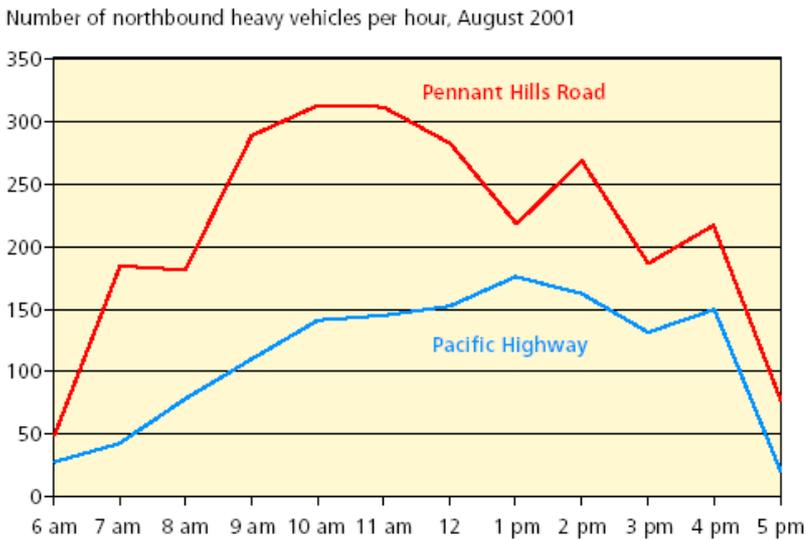


Figure 2.2: Hourly northbound truck traffic flows on Pennant Hills Road and the Pacific Highway south of the F3 in August 2001



³ Masson Wilson Twiney, *Freight Vehicle Movements in Northern and Western Sydney*, for the NSW RTA, August 2001.

These figures indicate two different profiles, with Pennant Hills Road again carrying approximately twice as much truck traffic as the Pacific Highway.

From a sample of 12 hour truck movements in the Masson Wilson Twiney study,

- Northern origins/destinations: 21% had northern trip origins or destinations on the Central Coast, 24% in the Newcastle and Hunter region, 8% at locations further to the north or west, 35% within north west Sydney and 12% within north east Sydney
- Southern origins/destinations: 30% had southern trip origins or destinations in the Sydney city and inner suburbs, 24% in south and south west Sydney, 18% in western Sydney, 15% in north west Sydney and 13% in north east Sydney



In other findings of note,

- 20% of truck movements were purely local movements, that is entirely within north east and north west Sydney, not long distance movements, and
- The most common single type of truck movement was between the city and inner suburbs and north west Sydney (Hornsby/Baulkham Hills).

Few, if any, truck movements between the F3 and the Sydney Orbital would be expected to use routes not captured by these surveys.

Road freight traffic on the F3 corridor is expected to continue to increase in the future, even if a significant increase in rail freight movement can be achieved. This is discussed in Section 2.3 below.

Rail freight traffic

A “curfew” prevents rail freight movements on the Main North Rail Line, and other lines used by commuter trains in the Sydney metropolitan area, during the weekday commuter peak periods. 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 causes many freight trains to be held in sidings to allow faster passenger trains to overtake, reducing the efficiency and reliability of the freight services.

Interstate and intrastate freight train services on the Main North Rail Line currently account for about 14% of the total freight market along the Central Coast–Hornsby corridor⁴.

Rail's mode share is restricted by the effects of the curfew on rail freight movements in the Sydney Region during commuter peak periods and other capacity and service reliability limitations on the Main North and North Coast lines, particularly north of the Central Coast on the interstate route to Brisbane.

The most significant infrastructure constraints affecting rail freight operations in the Sydney Region are identified in Action for Transport 2010, and include significant rail capacity upgrades to the Main Northern Line between Hornsby and the Central Coast.

Provided these constraints are adequately addressed, significant growth in long-distance rail freight on the Main North line is likely in the future, but this is likely to have relatively small effect on the growth of road freight on the F3 corridor, as discussed in Section 2.3 below.



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

⁴ The calculation of rail and road freight mode shares is complex, because different reporting procedures are used for freight carried by the two modes and for the various freight market segments. This estimate is based on information from Rail Infrastructure Corporation and the Australian Bureau of Statistics and refers to contestable freight in the corridor.

Public transport

The absence of a high-quality National Highway link south of the F3 at Wahroonga places considerable pressure on local transport systems on and between Pennant Hills Road and the Pacific Highway.

The local bus network suffers delays caused by the volume of traffic on the local road network, while access to rail stations by bus, car or 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 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. 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.

These longer distance public transport services suffer from two major factors:

- Capacity limitations, particularly on the rail network between the Central Coast and Sydney (these limitations also handicap rail freight movements), 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 combines with the rail capacity limitations to prevent the delivery of high speed rail services in this corridor. Both these factors are being addressed in the planning of rail infrastructure improvements, as described above.

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 (*Commuting from Sydney’s Fringe*, Transport Data Centre, Transport NSW, July 2000). Overall, rail currently has a 43% share of all peak (2 hr) trips in the corridor between the Central Coast and Hornsby.



Passenger rail services between the Central Coast and Sydney are constrained by the Main North line’s capacity limitations and its steep, circuitous alignment, especially on the climb from the Hawkesbury River to Cowan.

2.2 Patterns of growth in the Sydney Region

Population growth: the shift to the west

The population of the Sydney Region⁵ 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, because there are few other options for affordable housing growth. In contrast to most European and North American cities, 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.

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.

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 this 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 will have some 3 million people (50%) and the Central Coast some 0.5 million (8%).

Within the wider Sydney conurbation, the Hunter Region is likely to have around 1 million people, taking the total population of the areas under the influence of 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, in the Southern Highlands and possibly also the ACT.

The population distribution in a Sydney Region of 6 million people will be different to today's, with a major shift in the proportion of the total population living in the west.

In 1996, for example, the distribution 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 significantly, with 2.25 million people east of Parramatta (45%), 2.35 million west of Parramatta (47%) and 400,000 on the Central Coast (8%).

Employment growth

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 of 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 would have three stations in this area. With the removal of floor space restrictions this area could cater for up to 40,000 workers.

⁵ 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 of Goulburn) and the area west to Lithgow and Bathurst.

The distribution of centres-based employment will also change.

Employment in the Sydney CBD is likely to stabilise at around 240,000 workers, with the space per person increasing as Sydney competes with other world financial centres such as London, New York, Tokyo and Shanghai.

Employment in Parramatta could reach 100,000. In the east, over the next 40 years employment in North Sydney could reach 50,000 (compared with 40,000 today), 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 2-2**. Population is forecast to grow by 25% and employment growth even higher, by 67%, compared with today.

Table 2-2: Population and employment forecasts in the study area

Population		
Local Government Area	2001 (Census 2001)	2021 (Cox Richardson projection)
Hornsby	145,968	181,000
Ryde	95,744	103,000
Ku-Ring-Gai	101,346	111,000
Baulkham Hills	139,404	196,000
Blacktown (part)	74,593	107,000
Total	557,055	698,000
Employment		
Local Government Area	1996 (based on Travel Zone data, 1996)	2021 (Cox Richardson projection)
Macquarie–Lane Cove (477,496,784,785)	30,889	46,000
Hornsby–Waitara (467,650)	10,128	11,500
Castle Hill (755,756)	3,471	7,000
Norwest (753,754)	6,458	13,000
Rouse Hill (751)	88	3,000
Marsden Park (680)	211	5,000
Total	51,245	85,500

Notes:

- (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 will 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 40 years' time Sydney could be a "City of Cities", with each regional centre being linked by rail and bus services and the major freight-generating employment areas being located close to a major transport corridor. Industrial land located in low proximity to such corridors could be rezoned for residential or some other use.

This "City of Cities" concept can be compared with the area within 50 km of Manchester in the UK, a region of the same size as the Sydney Region and already housing 6 million people. This area contains the cities of Liverpool, Sheffield, Leeds, Stoke and Bradford, all generally self-contained and each with a clear identity.

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 will occur 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 that greenfield areas will not need to be released.

In a “City of Cities” it will be important for each area to have a balance of jobs and workforce. While there is no guarantee that the resident workforce will take up the local jobs, without an even balance between the workforce and employment opportunities there is little possibility of self-containment.

To achieve this 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. 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 Department of Defence land at Moorebank with direct access to the M5 will be highly sought after when it becomes available.

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.

Achieving sustainable transport

Traffic congestion, air and noise pollution are issues of major concern to Sydney residents.

As the Sydney Region develops it will be essential to reverse past trends of worsening congestion and pollution by promoting the use of more sustainable modes of transport, especially public transport, walking and cycling, and reducing car dependency in meeting transport demand.

This will enable suitably modified and expanded transport networks to cope in a more sustainable manner with the growing population and increasing freight and commercial transport.

Major improvements to public transport will be required to achieve the objective of more rail and bus users and fewer car travellers, particularly considering the significant proportion of car trips, including those on the National Highway, that have dispersed origins and destinations.

These improvements will need to include network infrastructure investments, service upgrades and quality interchanges.

As already discussed, public transport can be utilised to reinforce the development of employment in selected key centres. Although measures to encourage people to use non-motorised modes (walking and cycling) are to be encouraged, they are unlikely by themselves, or in combination with the land-use approaches discussed above, to achieve a significant shift away from car travel.

The provision of an improved National Highway link between the F3 Freeway and the Sydney Orbital has the potential to improve the attractiveness of local, bus-based public transport. This would be a result of removing through-traffic from the surface road network and thereby providing better opportunities to deliver a more comprehensive range of public transport destinations.

At the same time, however, a new road link has the potential to adversely affect efforts to increase the use of longer distance public transport, and especially rail services to and from northern Sydney suburbs and the Central Coast, by attracting travellers into their cars. This effect could have contributed to the 4% downturn in rail patronage on the East Hills line which occurred following the opening of the M5 East. Similar effects were also recorded in eastern suburbs–North Sydney rail patronage following the opening of the Eastern Distributor and North Shore line patronage following the opening of the Gore Hill freeway.

Analysis of redistributed traffic, modal shift and induced traffic effects will therefore be an important part of the further investigations.

Longer term National Highway needs for a ‘global city’

As the Australian capital city with the best chance of becoming a “global city”, Sydney will be competing with regional rivals such as Singapore, Shanghai, Hong Kong, Tokyo, Los Angeles, San Francisco, Seattle and Vancouver to serve the Asia Pacific Region. As the Sydney Region develops it needs to be made as attractive as possible to global enterprises which have the choice of establishing anywhere in the world. Efficient transport systems are an essential requirement for regional leadership.

Sydney has some major advantages, such as its climate and livability, its English-speaking business environment and a skilled workforce. However, its infrastructure also needs to function efficiently, freight-generating sites need to be readily accessible to the ports and airports and close to the skilled workforce. There needs to be good access to and from the region, to cater for a considerable increase in freight movements between Sydney and Brisbane, the North Coast, the Hunter, the Central Coast, the Illawarra, the Southern Highlands, the ACT and Melbourne. The majority of commercial transport demand will be 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 and the State could be compromised.

2.3 Future transport demand and movement patterns

The results of the preliminary analyses of future demand for travel in the National Highway corridor are outlined below.

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, even if integrated transport planning,

significant investments in rail, and travel demand management policies are implemented. In particular, 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.

Due to the current dominance of car/road mode of travel, at almost 90% of the total city-wide passenger kilometre task, and the lack of any obvious trend to an alternative mode, it is appropriate to assume that travel behaviours are unlikely to change significantly over the study's 20 year horizon.

Interactions between rail and road commuting

Estimates of future passenger flows in the main northern corridor are given in **Table 2-3** and **Table 2-4** based on this study's findings.

Table 2-3 presents estimates of the Base Case with improvements to the Main Northern rail line from Hornsby to the Hawkesbury River by 2011 and to Gosford by 2021. **Table 2-4** presents estimates of similar southbound flows, assuming no rail enhancements are implemented.

Table 2-3: Estimated Future Corridor Demand, Passenger Flows⁽¹⁾ - Base Assumptions⁽²⁾

Average Morning Peak Period, 0600 – 0800 Southbound only						
	2002		2011		2021	
	7-8am ⁽³⁾ Peak hour	2 hour peak	Peak hour	2 hour peak	Peak hour	2 hour peak
F3	4,700	8,900	5,200	9,600	5,600	10,600
Rail	4,700	6,800	5,600	8,300	7,000	10,400
Total	9,400	15,700	10,800	17,900	12,600	21,000
% by Rail	50%	43%	52%	46%	56%	49%
Average All Day Southbound only						
	2002		2011		2021	
F3	39,000		44,900		48,000	
Rail	13,500		15,900		17,900	
Total	52,500		60,800		65,900	
% by Rail	26%		26%		27%	

Source: Based on RTA traffic counts, the Study's corridor traffic model and information provided by NSW Rail Infrastructure Corporation.

Notes:

- (1) Excludes trucks and buses.
- (2) Assumes Main North Rail Line enhancements as in Action for Transport 2010.
- (3) Peak hour on F3 is 6-7am and is slightly higher at 4,900 passengers.

Table 2-4: Estimated Future Corridor Demand Passenger Flows⁽¹⁾ - No Rail Capacity Enhancements⁽²⁾

Average Morning Peak Period, 0600 – 0800 Southbound only						
	2002		2011		2021	
	7-8am ⁽³⁾ Peak hour	2 hour peak	Peak hour	2 hour peak	Peak hour	2 hour peak
F3	4,700	8,900	5,500	10,200	6,600	12,400
Rail	4,700	6,800	5,300	7,700	6,000	8,600
Total	9,400	15,700	10,800	17,900	12,600	21,000
% by Rail	50%	43%	49%	43%	47%	41%
Average All Day Southbound only						
	2002		2011		2021	
F3	39,000		45,500		50,000	
Rail	13,500		15,300		15,900	
Total	52,500		60,800		65,900	
% by Rail	26%		25%		24%	

Source: Based on RTA traffic counts, information provided by NSW Rail Infrastructure Corporation and output from the Study's traffic model.

Notes:

- (1) Excludes trucks and buses.
- (2) No rail enhancement to Main North Line.
- (3) Peak hour on F3 is 6-7am and is slightly higher at 4,900 passengers.

This study has assumed, that as part of the Base Case, rail's passenger mode share would slightly increase over the next 20 years (**Table 2-3**). To achieve this, the significant capacity improvements on the Main North Line proposed in Action for Transport 2010 would need to be implemented. If these improvements are not implemented it is likely rail's share of commuter traffic would fall to levels shown in **Table 2-4**.

The percentage of peak rail passenger flows would increase slightly over the period if rail capacity is enhanced, as shown in **Table 2-3** from 43% in the morning 2 hours in 2002 to 49% in 2021.

Rail's current 43% share of daily commuter trips on the Central Coast to Hornsby corridor could be likely to increase by 2011, assuming the rail infrastructure improvements on the Main North line would be implemented. Mode share could be as high as 55% by 2011. **Table 2-3** suggested that if the rail services are improved, rail's passenger share in the corridor of southbound peak morning flows would increase from 43% today to 46% by 2011, and total southbound volumes would remain much the same at 26% rising to 27% by 2021.

Longer term rail infrastructure enhancements to attract and cope with passenger (and freight) demand beyond 2011 would 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 (by between 2011 and 2021)
- Triplication or quadruplication of the Main Northern line between Hornsby and Berowra (by 2021)
- Quadruplication of the Main Northern line between Epping and Hornsby (by 2021)

- Quadruplication of the Main Northern line between North Strathfield and West Ryde (by 2021)

These major network-wide rail improvements in addition to the full capacity enhancement improvements to the Main North line would provide an opportunity for rail to increase its passenger mode share in the corridor with or without a new National Highway link over the next 20 years beyond the 49% suggested in **Table 2-3**.

Freight transport

The Central Coast–Hornsby corridor freight transport market is projected to increase by 3-4% per year over the next 20 years.

This estimate, based on likely trends in population growth, land-use activity and economic growth, suggests that freight linehaul and distribution movements along, to and from the National Highway, will at least double by 2021.

Provided the substantial and costly pre-2011 rail infrastructure improvements listed above are implemented, forecasts prepared for Rail Infrastructure Corporation suggest rail freight volumes will increase even faster, at a rate of 6% per year from 2011, taking rail's freight market share from 14% today to 23% in 2021 (based on net tonnes carried).

While this would take some heavy vehicles off the National Highway, the impacts on road freight traffic would be relatively minor.

An increase in rail's market share to 23% would reduce the number of articulated heavy vehicles travelling on the F3 in 2021 by only 950 vehicles, or by about 10%. There would still be twice as many articulated vehicles travelling on the F3 in 2021 as there are now, even after allowing for the increase in the average load per articulated vehicle as a result of continuing efficiencies in the road freight transport industry.

In the longer term economic growth is likely to continue to increase truck volumes to levels well in excess of the volumes able to be attracted to rail.

Traffic demand on Pennant Hills Road, the Pacific Highway and Lane Cove Road without a new F3–Sydney Orbital link

Table 2-5 summarises the expected 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. This analysis is taken from the results of the Study's traffic network model.

It may be seen that if a new F3–Sydney Orbital link were not constructed,

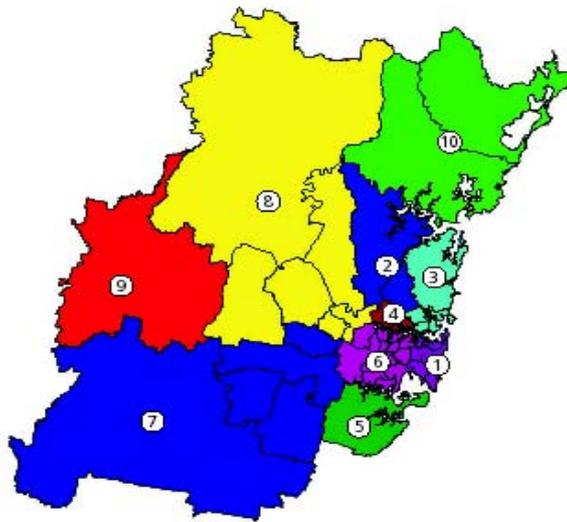
- Of the peak hour southbound traffic on Pennant Hills Road in 2021:
 - About 42% would be destined for the eastern side of Sydney (i.e. locations in the sectors broadly to the east of Parramatta), almost all to the north east or inner western sectors (i.e. Pennant Hills Road would carry virtually no traffic destined for the city or south east sectors)
 - About 50% would be destined for south west Sydney
 - 4% would be travelling through Sydney to the Princes Highway south of Wollongong, and
 - 4% would be travelling through Sydney to the Hume Highway, south of Campbelltown.

Table 2-5: Origins and destination movements 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

	Pennant Hills Road south of Comenarra Parkway		Pacific Highway south of Boundary Street, Chatswood		Lane Cove Road at de Burgh's Bridge	
	Vehicles/hour	% of peak traffic	Vehicles/hour	% of peak traffic	Vehicles/hour	% of peak traffic
Sydney City and Eastern Sydney	50	1%	800	21%	-	-
Hornsby and Ku-ring-gai	650	18%	1,000	26%	50	1%
Northern Beaches/North Sydney/Willoughby	-	-	1,200	32%	-	-
Ryde/Hunters Hill/Lane Cove	200	5%	450	12%	2,250	53%
South-East Sydney	-	-	50	1%	-	-
Inner Western Sydney	650	18%	300	8%	1,150	27%
South-West Sydney	150	4%	-	-	100	2%
North-West Sydney	1,850	49%	-	-	700	17%
Blue Mountains	-	-	-	-	-	-
Great Western Highway west of Mt Victoria	-	-	-	-	-	-
Princes Highway south of Wollongong	50	1%	-	-	-	-
Hume Highway south of Campbelltown	150	4%	-	-	-	-
TOTAL	3,750	100%	3,800	100%	4,250	100%

Source: Study's Traffic Model output.

- Of 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
 - Virtually none would be travelling through Sydney to the Princes Highway or the Hume Highway south of Campbelltown.
- Of 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 (ie. 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 vehicles would be travelling through Sydney to the Princes Highway or the Hume Highway south of Campbelltown.



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

These trip distribution projections indicate that if a new F3–Sydney Orbital link were not constructed,

- Pennant Hills Road and the Pacific Highway would be significant southbound routes for traffic travelling from the F3 to the north-east sector of Sydney. This traffic is forecast to be over 40% of the F3’s total peak hour southbound traffic flow in 2021. Traffic travelling from the F3 to the inner west sector of Sydney is forecast to be about 15% of the F3’s total traffic flow.
- Pennant Hills Road would be the primary southbound route for traffic travelling from the F3 to the western sectors of Sydney (about 20% of the F3’s total traffic flow), and would also be the primary southbound route for traffic travelling through Sydney (only 5–10% of the F3’s total traffic flow). It would, however, carry virtually no F3 traffic destined for the city or south east sectors of Sydney.
- Conversely, the Pacific Highway would be the primary southbound route for traffic travelling from the F3 to the city and south east sectors (10–15% of the F3’s total traffic flow), and virtually none of its traffic to these destinations would divert onto Lane Cove Road at Gordon.

Forecast traffic flows on the F3

Total road traffic demand along the F3 corridor is projected to increase at an average rate of around 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 slowing of the rate of growth of personal car travel, due mainly to the increasing saturation of car ownership
- A lower population growth rate, and
- Forecast increases in rail’s modal share for both passenger and freight traffic.

An average growth rate of 1.5% per year will nonetheless result in average daily traffic flows approaching 95,000 vehicles by 2021, compared with 71,200 vehicles per day at present.

Table 2-6 summarises the expected origins and destinations of morning peak-hour traffic flows on the F3 in 2021.

It may be seen that for peak hour southbound traffic in 2021:

- 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.

The forecast breakdown of origins for northbound traffic in the morning peak is slightly different but shows a similar pattern predicted for southbound traffic movements.

Table 2-6: Forecast (modelled) traffic flows and origins and destinations on the F3 south of Ku-ring-gai Chase Road during the morning peak hour in 2021, assuming there is no new F3-Sydney Orbital link

	Destinations of southbound traffic		Origins of northbound traffic	
	Vehicles/hour	% of peak traffic	Vehicles/hour	% of peak traffic
Sydney City and Eastern Sydney	680	12%	170	6%
Hornsby and Ku-ring-gai	990	18%	710	28%
Northern Beaches/North Sydney/Willoughby	870	16%	280	11%
Ryde/Hunters Hill/Lane Cove	600	11%	190	7%
South – East Sydney	40	1%	50	2%
Inner Western Sydney	840	15%	280	11%
South – West Sydney	130	2%	50	2%
North – West Sydney	990	18%	680	27%
Blue Mountains	–	–	< 5	–
Great Western Highway west of Mt Victoria	–	–	–	–
Princes Highway south of Wollongong	210	4%	50	2%
Hume Highway south of Campbelltown	150	3%	120	5%
Total	5,480	100%	2,560	100%

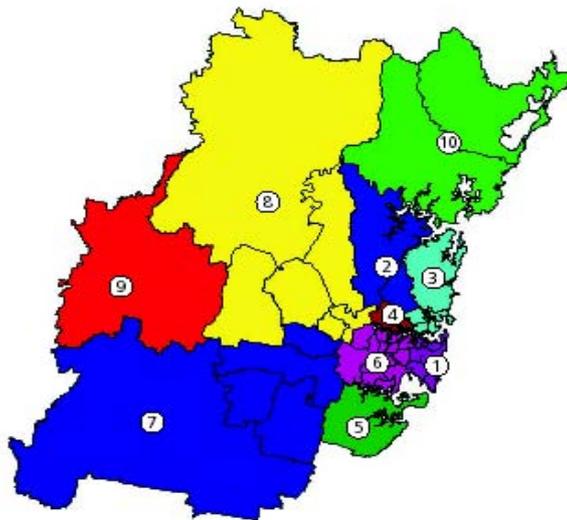
2.4 Future conditions on the National Highway corridor without a new F3–Sydney Orbital link

The traffic design capacities on Pennant Hills Road, Pacific Highway and Ryde Road/Lane Cove Road are (respectively) 1,000, 1,000 and 1,300 vehicles per hour per lane, as already discussed in Section 2.1.

All three roads experience peak traffic flows above their design capacity and are subject to significant congestion during peak periods and at other times outside the peaks.

If a new F3–Sydney Orbital link were not constructed, by 2021 these roads would be subject to demands well 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



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

It is not feasible to increase the capacity of these roads through measures such as the grade separation of major junctions, because the critical capacity constraints are located close to local urban and commercial centres such as Thornleigh, Pennant Hills, Wahroonga, Turramurra and Pymble. Grade separations would result in severances of local community activities and have other significant adverse environmental, economic, social and urban amenity impacts.

Without a new link, traffic on Pennant Hills Road (at Pennant Hills railway bridge) would increase from 75,000 vehicles per day to between 95,000 and 100,000 vehicles per day by 2021. This increase would mainly occur between the morning and evening peak and at weekends.

Therefore, without a new F3–Sydney Orbital link:

- Increasing traffic congestion on the interim National Highway corridor (Pennant Hills Road) and on the other routes feeding the F3. This would include congestion experienced by non-commuter traffic (12 hour flows), 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 of heavy commercial vehicles, would continue to increase the risk of road accidents for school children, other pedestrians, residents and road users along this built-up route. A significant reduction in long-distance and commercial traffic is required on Pennant Hills Road in order to achieve safer neighbourhoods.
- The environmental and social impacts of highly congested six-lane, at-grade road environments would continue to worsen, with a further deterioration of local amenity.
- The increasing demand in the corridor would mean increasing levels of traffic congestion. The increasing adverse social and environmental effects of this traffic would spread to the non-peak business hours, that is effect more people over longer periods of the day
- More generally, the road network between the F3 at Kariang and the Sydney Orbital would be incapable of satisfying many of the community’s wider economic, employment, environmental and social needs as the Sydney Region expands to a city of beyond 5 million people beyond 2021.



Without a new F3-Sydney Orbital link, demand on Pennant Hills Road would significantly exceed the capacity of this interim National Highway, producing severe traffic congestion and worsening social, environmental, economic and urban amenity impacts

2.5 Future conditions on the F3 Freeway

Growth up to 2021

The future conditions on the F3 Freeway will depend on the level of investment in capacity upgrades of the Main North Rail Line.

The morning peak hour southbound flows along the F3 Freeway at the Hawkesbury River are forecast to increase to at least 5,000 vehicles per hour by 2021, assuming a new F3 to Sydney Orbital link is constructed and major rail improvements are provided (**Table 2-7**). This would be within the estimated capacity of a widened F3 Freeway to 3 lanes in each direction.

The widening of the F3 to three lanes in each direction will satisfactorily accommodate up to 5,600 peak hour vehicles. However, this analysis indicates that if no significant rail capacity improvements are provided, peak hour traffic volumes on the F3 Freeway in 2021 would be in excess of its capacity.

Growth Beyond 2021

Growth beyond the next 20 years is likely to require further widening of the F3, beyond six lanes, and/or the provision of an alternative route between Kariong and Sydney to accommodate predicted demand.

The opportunities for further widening of the existing F3 alignment beyond six lanes are severely constrained by the difficult terrain. Furthermore, it is not likely to be feasible to widen the F3 to eight lanes between Kariong and Wahroonga within the existing road reserve, without widening into adjacent reserves and/or National Parks and without impacting on significant vegetation.

It should be possible, however, to widen critical sections of this alignment to seven lanes by adding climbing lanes. In combination with incident management and intelligent transport systems, this could increase the peak one-way capacity of the F3 to about 6,000 vehicles per hour.

It is forecast, however, that by 2026 peak traffic levels would exceed 6,000 vehicles per hour if the planned rail enhancements are not implemented.



Future widening of the F3 beyond six lanes will be extremely difficult, although widening to seven lanes (by adding a climbing lane) should be feasible at many locations. By 2021, however, traffic demand is expected to exceed the capacity available on the F3 even after the implementation of all feasible methods of increasing its capacity and boosting rail's share of the Central Coast – Sydney freight and commuter markets.

Table 2-7: F3 capacity considerations (Wahronga to Kariong section)

Year	Forecast traffic volumes at Hawkesbury River crossing						Limiting capacity for Level of Service (LOS) "D" in each direction ⁴	Capacity improvements required in each direction before the year shown, assuming rail investment is made ⁵
	Base		With new F3-Orbital Link					
	No new F3-Orbital Link but with rail capacity upgrades ¹		With rail capacity upgrades ²		With no rail capacity upgrades ³			
	AADT (vehicles/day)	Peak hour (vehicles/hour)	AADT (vehicles/day)	Peak hour (vehicles/hour)	AADT (vehicles/day)	Peak hour (vehicles/hour)		
2002	71,200	3,700	71,200	3,700	71,200	3,700	3,700 (2 lanes) north of Hawkesbury River Crossing	3 lanes each way north of Hawkesbury River crossing
2004 ⁶	72,900	3,700	72,900	3,700	72,900	3,700	3,700 (2 lanes) south of Hawkesbury River Crossing	3 lanes each way south of Hawkesbury River crossing
2011	84,000	4,000	86,800	4,600	88,100	5,000	5,600 (3 lanes)	Advanced incident management systems
2021	93,700	4,400	96,500	5,000	100,500	5,800	5,600 (3 lanes)	
2026	100,500	4,700	103,700	5,400	112,800	6,200	6,000 (3 lanes plus climbing lanes)	3 lanes each way plus climbing lanes
Beyond 2026								4 lanes each way <i>or</i> demand management <i>or</i> new corridor

1. Assuming rail capacity upgrades to Hawkesbury River by 2011 and to Wyong by 2021.
2. Includes modal shift (rail to road) and induced traffic resulting from new F3-Orbital link.
3. Includes modal share increase to road (compared to Base) and induced road traffic effects (compared to Base).
4. Unstable traffic conditions at capacity, long delays at peaks, holiday periods and during incidents; based on 1860 vehicles per lane.
5. Improvements required, before the year in question, to avoid unstable traffic conditions and long delays (assuming rail investment is made).
6. Assuming current widening works north of the Hawkesbury River crossing are completed by 2004.

Potential Transport Improvement Program for Main Northern Corridor

The traffic analysis summarised in **Table 2-7** provides a technical basis for a transport improvement program over the next 25 years in the main northern transport corridor. This analysis indicates that if investments in rail were not implemented in accordance with *Action for Transport 2010*, road traffic demand on the F3 would increase significantly (both AADT and peak hour volumes). The resulting F3 volumes could have a significant effect on inter-regional traffic performance on the F3 and would result in increasing delays and crashes on the F3 over time. This would be the case with or without a new F3 to Orbital link.

Without significant rail capacity improvements in the corridor, traffic demand management measures would need to be introduced at times of peak period use before 2021, and even with these measures the need for a new road transport corridor would most likely become critical between 2021 and 2026.

2.6 The need for a new F3–Sydney Orbital link and its objectives

The declining traffic operational and safety performance of the interim National Highway from the M2 motorway to the F3 Freeway, as described in this chapter, warrants major improvements for road users, especially along Pennant Hills Road which is used by large numbers of heavy commercial long-distance vehicles. The expected growth in this traffic will put increasing pressure on communities living and working in the corridor, from increasing road crashes, increasing community severance, noise and vehicle emissions.

Given the social, environmental and traffic factors summarised in this chapter, there is an existing need for major improvements to be implemented. The RTA and DOTARS have agreed on objectives for a new F3–Sydney Orbital link to address these factors:

- Planning objectives:
 - 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, and
 - Serve the future growth needs of long-distance transport.
- Project objectives:
 - Provide a high standard link that integrates with the regional transport network
 - Minimise social and environmental impacts during construction and operation
 - Provide opportunities for improved public transport, and
 - Be economically justified and affordable to government.

3

Community consultation process and inputs

3.1 The study's community consultation processes

A comprehensive community involvement program is an integral part of this study.

The program has been designed and managed to afford the broader community the opportunity to make inputs to the study and ensure community requirements, aspirations, preferences and concerns are adequately and appropriately addressed.

The community consultation process is being implemented in accordance with the study's approved *Community/Stakeholder Involvement Plan* of May 2002.

To date, there has been less community interest than anticipated. This most likely reflects the size of the study area, with many diverse communities, and the strategic (rather than "immediate") nature of the project. Some organisations, such as STEP Inc and various Chambers of Commerce, are inclined to address strategic issues and have been active in the consultation process, but the broader community is more likely to respond to identified corridors/routes for which community and individual property impacts can be identified.

It is therefore likely that the most significant community inputs will occur in the final months of the study, once the feasible corridor options have been released for comment.

Consultation objectives

The proposed study program includes a range of activities designed to:

- Engage and inform
- Create awareness
- Elicit meaningful inputs, and
- Share decisions where practicable.

More specifically, the community involvement program aims to:

- Identify community and stakeholder representatives and seek their positive contribution to the process
- Inform the community of the corridor/route selection process and the opportunities for them to be involved
- Provide the community and other stakeholders with adequate opportunities to be involved in and influence the corridor/route selection components
- Effectively manage community and stakeholder expectations concerning their contributions to the process
- Involve the community in the detailed planning, environmental and engineering studies forming parts of the corridor/route selection process, and establish a mutually beneficial two-way flow of information

- Identify community issues and concerns associated with the project and ensure they are effectively communicated within the project team and addressed
- Ensure that all issues raised by the community are considered and addressed in the development of the project
- Achieve satisfactory response times
- Identify measures to mitigate perceived and actual issues that are causing or might cause community concern
- Build on consultation activities undertaken on previous projects
- Inform the community about the link concept and its benefits
- Establish lines of communication with the community that will be able to be effectively carried on from the current study's corridor/route selection process to future environmental assessment, detailed design and construction processes, and
- Facilitate an open and fair process where mutual trust is developed and maintained.

Stakeholders

The community involvement program has included and will continue to include activities to meet the information and participation needs of all target audiences. The stakeholders associated with this project have been grouped as follows:

- Elected members of Federal and State parliaments
- Elected Local Government representatives
- Federal Government organisations
- State Government organisations
- Local Government bodies and organisations
- Advisory and interest groups
- Road transport groups
- Residents within the study area
- Businesses within the study area
- Potentially affected land owners (and, later, the ultimately affected land owners)
- Organisations with significant interests in the project or the area adjoining the proposed corridor(s)/route(s) of the project
- The wider community, including road users, and
- The media.

The estimated population of the study area is 340,000, in approximately 100,000 households.

Consultation activities so far

The community consultation activities undertaken to October 2002 have been to:

- Establish and service a website, a freecall telephone number, a reply paid mail facility and an e-mail link to the project team
- Distribute an initial newsletter to 115,000 households and businesses in and around the study area, between 4 and 10 May 2002, and
- Hold “Information Days” at five locations, to give people information on the study.

These Information Days replaced an originally planned public meeting, with the prior agreement of the RTA and DOTARS. They involved a total of 131 hours of staffed time (91 hours by Sinclair Knight Merz staff and 40 hours by RTA staff), and it is estimated that contact was made with approximately 2,000 people.

- Hold two rounds of “community focus group” meetings.

It was originally anticipated that four focus groups would be required. In practice, with relatively little early community response to the study despite a proactive campaign to contact community groups in the study area, the people nominating for membership have been able to be accommodated in two groups, meeting in Thornleigh and Dural.

3.2 Identification of community issues for consideration in the study

While the number of people who have participated in the consultation process to date has been small, compared to the total population of the study area, there has been considerable commonality in the broad issues raised. It is unlikely that new issues would have arisen from consultations with a broader group, had there been greater community interest in the study during its early phases.

It can be expected, however, that many other issues, including issues more specifically related to individual routes, will be identified once the feasible corridor options being investigated are released for comment.

Key community issues raised so far

The list below indicates the issues raised during the Information Days, in e-mailed, phoned and mailed comments and in the discussions of the community focus group meetings.

- Reduced reliance on road transport and greater investment in the rail system for freight
- Need to ensure there is no damage to National Parks and other bushland/open space and remnant vegetation areas, including Berowra Valley Regional Park (including damage from indirect impacts such as erosion and runoff)
- Need to counter Sydney’s growth (eg. through decentralisation)
- Need to apply sustainable development principles to the study
- Extent and impacts of induced traffic
- Design capacity of the new link
- Overall minimisation of environmental impacts
- Need for the link to provide early traffic relief on both Pennant Hills Road and the Pacific Highway south of Pearce’s Corner
- Whether the road will be tolled, and the cost of tolls to users
- Getting more freight on rail rather than road
- Need for detailed origin/destination data and traffic model verification

- Fragmentation of communities
- Unforeseen local traffic consequences
- Minimisation of impacts on flora and fauna at both regional and local levels
- Location and treatment of tunnel ventilation stacks and emissions
- Concerns about Pennant Hills Road (upgrading as National Highway link, widening, safety)
- Effects on future land uses
- Need for greater public transport expenditure
- Fire and safety in tunnels
- Local traffic impacts at Wahroonga
- Location of on/off ramps
- Minimisation of effects on the built environment, including resumption of houses and impacts on property values
- Comprehensiveness of study
- Concern that some trucks won't/can't use tunnels
- The study criteria that ruled out the B2/B3 route in earlier studies should be applied again in the current study
- No surface solution in Lane Cove Park (B2/B3)
- Need for a fair distribution of outer suburban and country/interstate traffic, and
- Dedicated truck lane and cycling lanes as part of any link

Corridor options suggested by the community

Between April and July, link options suggested by the community included:

- Northern access using the Putty Road
- Corridors bypassing Hornsby
- Corridors avoiding the Dural/Galston/Arcadia area
- Corridors through built environments in preference to corridors through unbuilt areas, in order to preserve the bushland and greenbelt
- Corridors to provide access to western Sydney where future growth will occur
- Corridors which would also relieve traffic on roads in eastern and central Sydney, including the Pacific Highway, with the study measuring this relief for each option
- Special heavy vehicle ring roads for “through” traffic around the suburban area
- Dean Park to Mount Colah via Galston Gorge
- An extension of the Sydney Orbital from Dean Park through Rouse Hill, Dural and Berowra, with a new crossing of the Hawkesbury River between Jolls Bridge and Mount White

- A corridor from Liverpool to Blacktown, Kellyville and Mt Colah
- An old railway route west of Range Road, off the M2, crossing the Hawkesbury River at Wisemans Ferry and joining the F3 at the Peats Ridge exit
- A new high level bridge over the Hawkesbury River
- A new northern end of the Sydney Orbital joining the F3 north of Berowra, to avoid the congestion at Wahroonga
- A corridor directly north-west from the Quakers Hill area to join the F3 around Mt White, possibly following part of the route of the gas/oil pipelines and tunnelling under the Hawkesbury River
- A new six-lane freeway from Kariong to the M2 (tunnelling through Wahroonga to the M2) and then to Dean Park
- A north/south national highway from the Old Windsor Road/Sydney Orbital interchange through Kellyville, Dural and Galston and linking with the F3 at Ku-ring-gai Chase Road
- A tunnel following the Pennant Hills Road ridge, with exhaust stacks at the Dartford Road tip, Pioneer Ave, Lilla Road, the 132 kV electricity transmission tower, Thompsons Corner and Copeland Road
- A highway west of Hornsby, ultimately linking to the Cumberland Highway
- A Y-link junction with the M2, with one link for south-western bound traffic and the other for south-east/city-bound traffic
- A new corridor from the F5 to Narellan, Bringelly, Luddenham and Kingswood, then north generally along The Northern Road to Windsor and Cattai Road and Wisemans Ferry Road to Maroota, and then across the Hawkesbury River to Lower Mangrove, Mangrove Mountain and Yarramalong before joining the F3 at Wyong.

Most of these options have been reviewed, and many of the concepts are reflected in the corridor options that have been developed by the study team (as listed in Section 5 of this report) and have been subsequently investigated (as described in Section 6).

The ideas warranting further considerations, and others received during the course of the study, will be addressed as part of the continuing investigations.

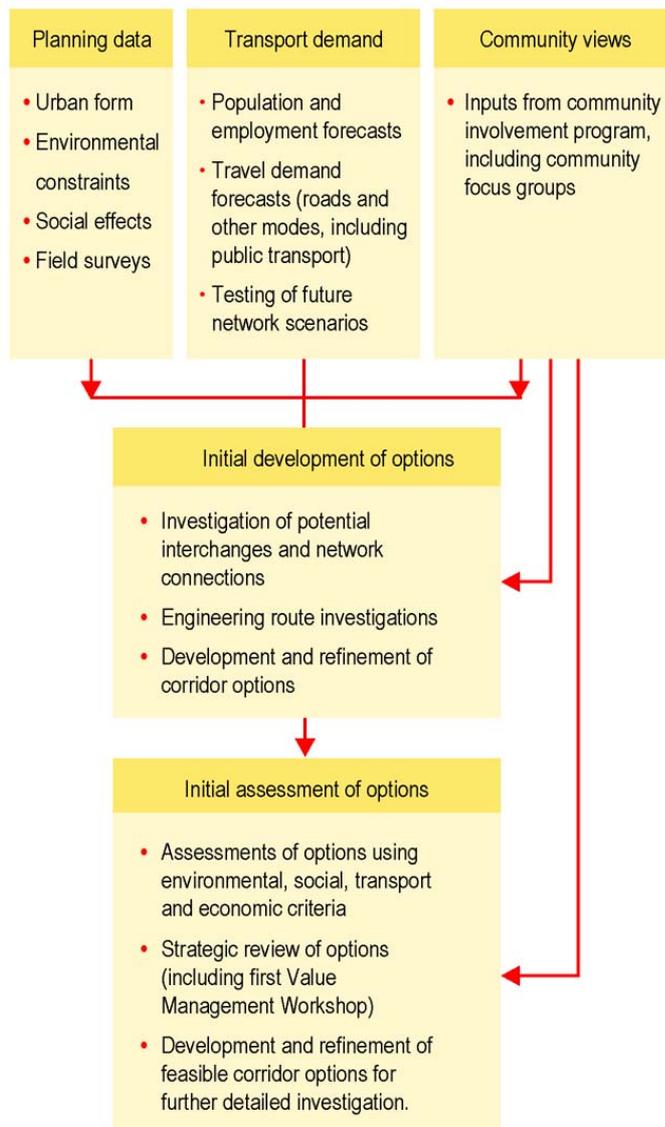
4

The process of corridor option development

4.1 Development process

The processes used by the study team in developing a “long list” of options for potential new National Highway corridors between the F3 and the Sydney Orbital are summarised in **Figure 4.1**.

Figure 4.1: Overview of the study’s processes for developing and assessing corridor options



This section summarises the factors considered in these development processes concerning:

- Land use opportunities and constraints (Section 4.2)
- Economic and regional development (Section 4.3)
- Urban design, landscape and visual assessments (Section 4.4)
- Social and environmental impacts (Section 4.5), and
- Engineering feasibility (Section 4.6).

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

- Land availability, both existing and further land uses and extent of urban land development
- Engineering design standards
- 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 described earlier.

Once the feasible locations of a new link connection to the F3 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 4-1**.

Information was gathered on the potential constraints to the positioning of a new transport link. These constraints included existing residential areas, urban growth areas, industrial/business zoned land, parks and reserves and physical landforms. These constraints were incorporated on a digital map of the study area. The study team was then able to assess how broad corridor options fitted and to identify a “best fit” to the identified link interchange options, given the various physical, social and environmental constraints to their positioning.

4.2 Land-use considerations

Land use across the northern Sydney metropolitan area has been a major factor in the identification of potential 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 determine the travel demand to particular locations, including the number and type of vehicles used. Different land uses also create traffic flow variability throughout the day and over longer time scales.

In addition, and just as importantly, the direct impacts of the project on land use, and subsequently economic, social and environmental impacts, have the potential to be significant, and must therefore be considered in the development of corridor options.

Table 4-1: Criteria used to develop and assess corridor options

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

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

- 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 on a local level.

As a major regional, state and national transport link, it also has the potential to be a major influence on patterns of land use growth and change in the northern Sydney area.

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.

Planning NSW is currently focussing mainly on residential development in its planning for urban release areas. However, it has been recognised in this study that a new corridor could significantly increase accessibility to major industrial and employment areas, particularly those developing in western Sydney (see Section 2.2).

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

In addition, consideration has been given to the potential to rezone land close to the corridor(s) for industrial or other production-related land uses. The availability of land suitable for large-scale industrial or employment-related development has therefore been another factor in the identification of corridor options.

Opportunities to do this 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

Figure 4.2 illustrates some of the types of land use constraints within the study area.

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 likely to be 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 therefore generally not be viewed favourably by other government agencies, the development industry or the community.

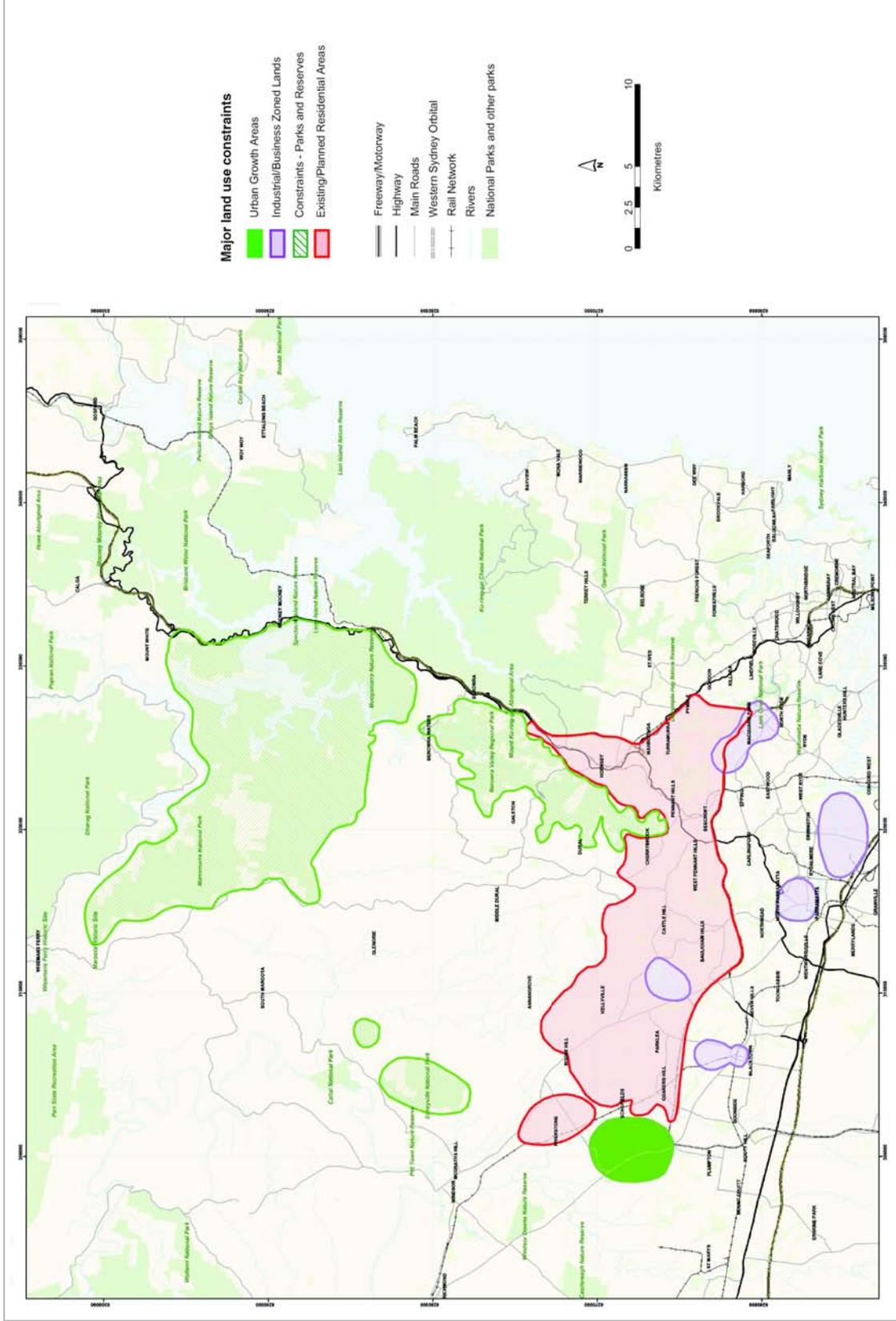
Land that is already zoned for urban purposes, or is in the advanced stages of planning (ie. with draft LEPs or local environmental studies underway), has therefore generally been considered a constraint on the project.

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 — have been and 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.

Figure 4.2: Land use constraints in the study area



Consideration of tunnelling options has therefore been given 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 have therefore been favoured in these areas as well.

Summary

The land-use opportunities and constraints that have primarily influenced the identification of corridor options have included:

- The directness of accessibility to growing or existing industrial and employment zones (i.e. areas identified in *Shaping our Cities* or state/regional planning instruments)
- The potential to integrate with the planning of new urban release areas, through access to/from new residential population growth areas and integration with business or industrial zoned land to minimise local amenity impacts and provide direct access
- The avoidance of impacts on existing urban areas or areas in advanced stages of planning, particularly residential areas, and
- The avoidance of impacts on national parks, nature reserves, regional reserves and land zoned for environment protection purposes.

4.3 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 to destinations throughout 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 Western Sydney Orbital 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 Freeway to the west of Gosford and there would be no significant difference between them in regional development terms.

4.4 Urban design, landscape and visual assessment considerations

Consideration of urban and regional design within route selection has been an important component of the route assessment process. The key issues and objectives of this assessment are to:

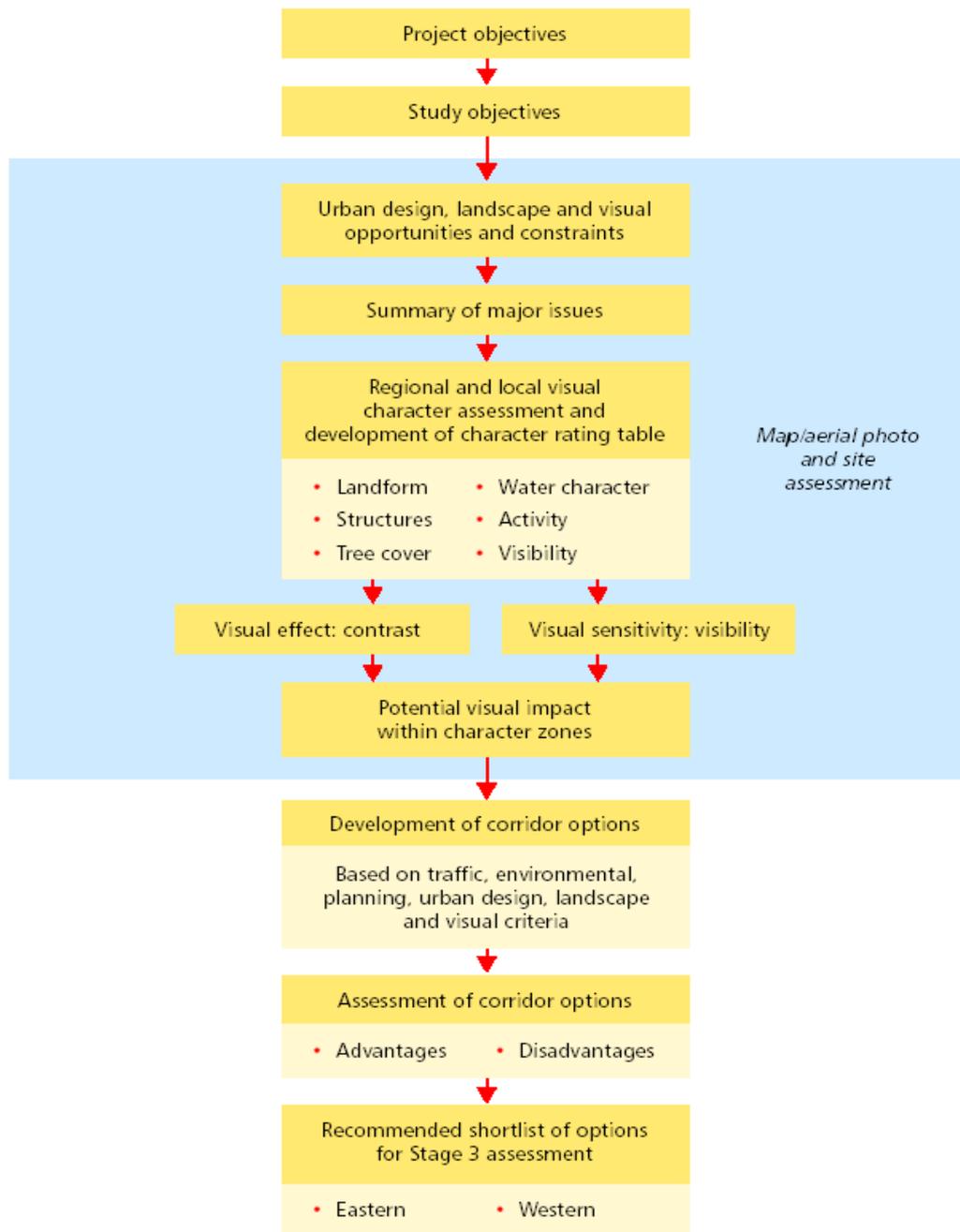
- Protect the existing built, natural, scenic and heritage values of the region
- Fit into Sydney's planned growth areas and recognise the development potential of the corridor
- Enhance land values within the corridor wherever possible
- Minimise community severance
- Improve community access including 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 4.3**, has involved:

- Agreement on project and study objectives by the study team
- 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 4.4 maps the character zones and land form constraints that have been used to develop (and later to assess) the corridor options during the preliminary stages of the study.

Figure 4.3: Overview of the study's processes for taking account of urban design considerations



4.5 Social and Environmental Considerations

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

More details on the assessment of link options can be found in Working Paper No.5 Social and Environmental Studies Report.

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 north from Berowra lookout

A review of available information on the aquatic biota and habitats of the various waterways has 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.



Looking south from Berowra lookout

Of the fish and macroinvertebrate species recorded in the Hawkesbury/ Nepean River system, Macquarie Perch (*Macquaria australasica*) and the Adams Emerald Dragonfly (*Archaeophya adamsi*) are listed as vulnerable under the NSW Fisheries Management Act 1994. None of the remaining fauna or flora species known to occur in the Hawkesbury/Nepean River system is listed or currently under consideration for listing under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 or the NSW Fisheries Management Act. Further, within the Hawkesbury/Nepean catchment the Macquarie Perch is considered to be predominantly confined to the upper reaches, outside the study area.

A “high level” assessment of hydraulics has concluded that if the link were 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 routes 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 have been identified, described and mapped as part of the provision of biological inputs to the corridor options assessment, refinement and selection process. The major biophysical constraints in the study area are summarised in **Figure 4.5**.

There are a number of National Parks, Nature Reserves and Council Bushland Reserves within the immediate study area. These reserves are listed in **Table 4-2**.

Table 4-2: Conservation reserves in the study area

Marramarra National Park	11,760 ha
Dharug National Park	14,850 ha
Popran National Park	3,970 ha
Cattai National Park	420 ha
Scheyville National Park	920 ha
Lane Cove National Park	600 ha
Rouse Hill Regional Park	45 ha
Berowra Valley Regional Park	3,870 ha
Muogamarra Nature Reserve	2,270 ha

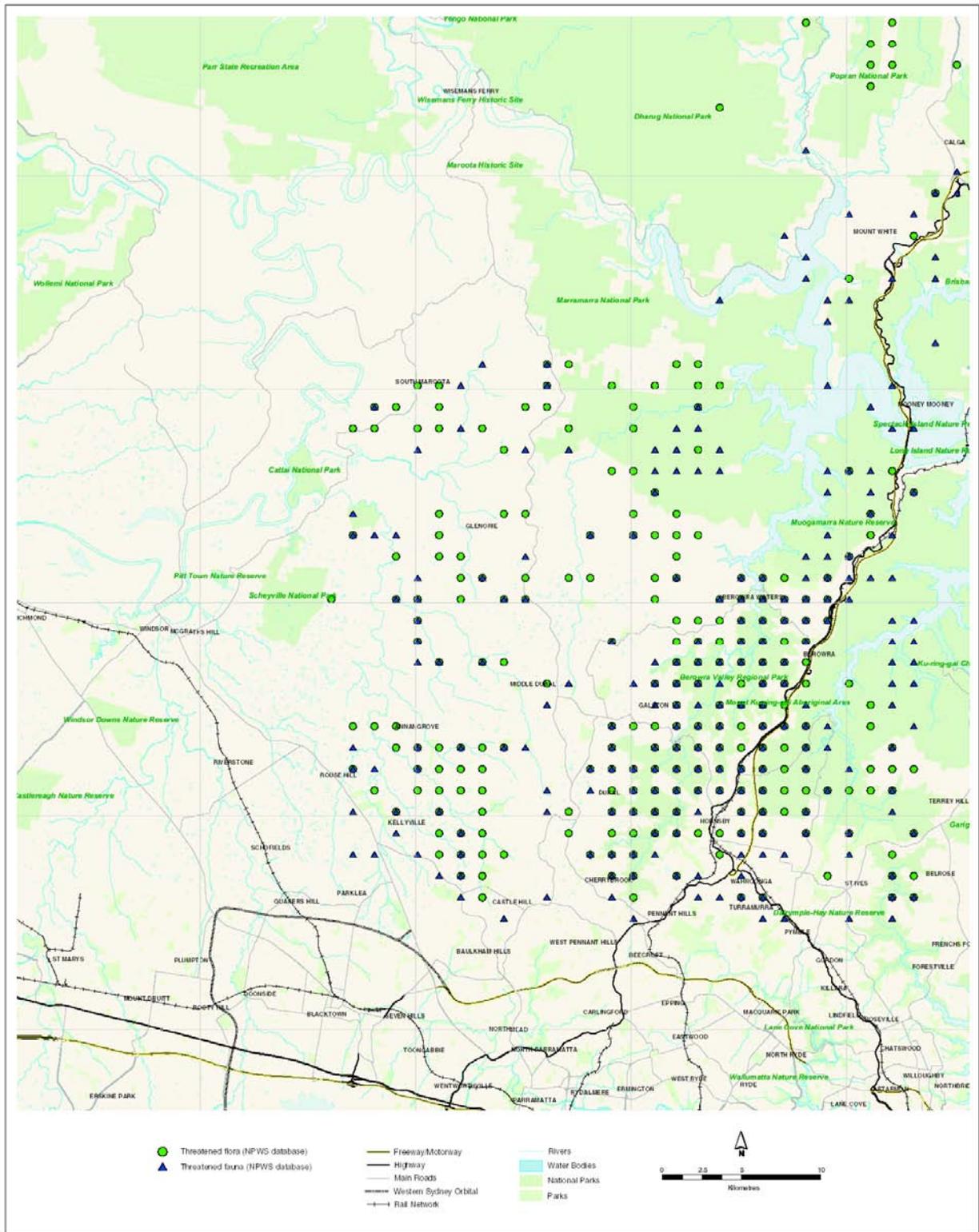
In addition, there are several larger National Parks, such as Ku-ring-gai Chase National Park and Brisbane Water National Park in the broader study area, although they would not be directly affected by most of the corridor options considered.

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.

A review of significant wetlands throughout the Sydney Basin has shown there are no internationally significant wetland (RAMSAR) sites within the study area. However, there are two wetlands of national importance, listed on the Directory of Important Wetlands as Longneck Lagoon (Wetland No 83) and Pitt Town Lagoon (Wetland No 87), immediately west of the study area.

Although no significant wetlands are found within the study area, bird species listed under the provisions of the China Australia Migratory Bird Agreement and the Japan Australia Migratory Bird Agreement might still be found in the area. Indeed, habitat for these species, which are commonly encountered within the Sydney Basin bioregion, is well represented in the study area and they would be expected to occur in fresh and salt-water environments such as permanent and ephemeral wetlands, local creeks and large river systems such as the Hawkesbury River. The agreement enforced by these treaties is adequate management and protection of both these species and their habitat.

Figure 4.5: An example of biophysical constraints (endangered flora and fauna) in the study area



A review of existing databases and other information has produced a total of 36 threatened flora species previously recorded in the study area (from 1800 to 2002), including 15 species listed on Schedule 1 (Endangered) and 21 species on Schedule 2 (Vulnerable) of the NSW Threatened Species Conservation Act 1995. Of these species, 29 are also listed as nationally threatened under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999.



Looking north across the Hawkesbury River from the end of the Canoelands Road firetrail



Looking south across the Hawkesbury River from the end of the Wendoree Park firetrail

A total of 52 threatened fauna species have been previously recorded from the study area: 16 species of mammals, three species of frogs, one species of reptile, 31 species of birds and one species of land snail. From this list 13 species are listed on Schedule 1 (Endangered) and 39 species are listed on Schedule 2 (Vulnerable) of the Threatened Species Conservation Act and nine are also listed as nationally threatened under the Environment Protection and Biodiversity Conservation Act.

Several significant vegetation communities listed on Schedule 1 Part 3 (Endangered Ecological Community) of the Threatened Species Conservation Act occur within the Sydney Basin bioregion. Of these, portions of

nine endangered ecological communities have been identified in the study area. One significant fauna population (Gang Gang Cockatoo) listed on Schedule 1 Part 2 (Endangered Population) of the Threatened Species Conservation Act, has been identified within the study area. It is found in an area bounded by Beecroft/ Cheltenham in the west, Epping/North Epping in the south, Turrumurra/South Turrumurra in the east and Thornleigh/Wahroonga in the north. This population encompasses but is not restricted to parts of Pennant Hills Park and Lane Cove National Park.

Indigenous heritage

Investigations of the locations of known Aboriginal sites and areas of cultural significance are currently being undertaken. Until site data details are available, only preliminary comments of a general nature can be made, based on the study team's knowledge of known site types and distribution patterns within the Hawkesbury sandstone and Cumberland Plain landform units.

The study area falls within the Deerubbin, Metropolitan and Darkinjung Local Aboriginal Land Council Areas.

The Deerubbin LALC is in the south-western corner of the study area. Other Aboriginal groups identified by the National Parks and Wildlife Service as having an interest in this area include the Darug Tribal Aboriginal Corporation and the Darug Custodian Aboriginal Corporation.

The Metropolitan LALC area extends north from Sydney Harbour to the Hawkesbury River, and all areas within the study area north of the Hawkesbury River are within the Darkinjung LALC area.

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 are currently being mapped from data supplied by the National Native Title Tribunal.

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

Non-indigenous heritage

Investigations of the locations of known non-indigenous heritage sites have 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. These sites are currently being mapped.

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.

It is anticipated from a review of the sites listed in the heritage registers that unrecorded heritage items may include original road alignments, National Parks, Flora and Fauna Reserves, remnants of early settlement (farm buildings, archaeological sites, wells, fencing, remnant orchards, mining, etc), isolated burials, wharf remnants on the Hawkesbury River and ferry crossing points.

Related Social Issues

A preliminary overview of social issues for the study area has 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.

This overview has enabled the potential range of social constraints to be identified early in the study.

The overview was developed before obtaining feedback from the community, and will therefore be supplemented and refined, as additional information becomes available.

Social issues associated with any proposal generally relate to the impact of the proposal on the lives of individuals or communities and/or its effects on their homes or properties.

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, Baukham 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, Baukham Hills, Castle Hill, Hornsby and Mount Ku-ring-gai, and there are heavy industrial areas at Thornleigh and Hornsby.

More detailed assessment of likely social effects from the link options can be found in Working Paper No.5 Social and Environmental Studies Report.

Climate and air quality

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

One objective for all transport projects is to improve air quality or at least to minimise air quality impacts, and it will be important during the study to consider the changes in air quality that may occur with the project.

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 in the number of vehicles on surface roads.

For more information on air quality assessments refer to Working Paper No.5.

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.

During the following stages of the study, road traffic noise will be modelled for the various “shortlisted” options (see Chapter 6) and the numbers of residents affected will be estimated from the most recent census data. The study will then identify “noise hot-spots” where barriers or other mitigation measures would most likely be required. Noise surveys may also be undertaken at broadly representative locations, if this is necessary to clarify the assessment.

4.6 Engineering considerations

Engineering design process

Integration of constraints/opportunities

Use was made of a Geographical 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 a strategic assessment of the key land use, social and environmental factors within the study area.

Identification of possible interchange locations

Another of the engineering design starting points in developing options has been the identification of feasible interchange locations or “nodes” for access to and from the F3 and the Sydney Orbital.

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 possibilities 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 these possibilities are discussed further below.

It has also been assumed that a number of intermediate interchanges could be located along the various corridor options to provide local access to the link. Possible interchange locations identified to date have 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.

Linking interchange locations

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

These preliminary links were conceptualised, primarily to provide coverage of the study area, to avoid duplication of the existing major routes and to address the project objectives, especially the needs to relieve Pennant Hills Road and cater for the growth of inter-regional traffic.

Refinement of corridors

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 the factors summarised in Sections 4.2 to 4.4 above.

A number of discussions have been held with DOTARS and the RTA to review and revise possible concepts.

The corridor options developed through this process have been represented by their centrelines, but are much wider, so as to allow for optimisation during design.

Many of the options have sub-options allowing for different horizontal and vertical alignments, including tunnels and bridges rather than cuts and fills.

Design criteria

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 have been adopted, as outlined below.

Rural freeway

The specific requirements for rural and semi-rural areas are as follows:

- Minimum 110 km/h horizontal alignments
- Minimum 110 km/h vertical alignments
- Dual carriageway with two or three 3.5 metre lanes, a 2.0 metre left shoulder and a 1.0 metre right shoulder (carriageway widths may vary in long tunnels)
- A 10 metre depressed median, and
- Through carriageways to provide for cyclists where appropriate with an increased left shoulder of 3.0 metres.

Urban freeway

The specific requirements of an urban freeway are as follows:

- Minimum 80 km/h horizontal alignments
- Minimum 80 km/h vertical alignments
- Dual carriageway with two or three 3.5 metre lanes and a 2.5 metre left shoulder and a 0.5 metre right shoulder
- A 6.0 metre wide median including a median barrier with full access control and separation of through and local traffic (vehicular and pedestrian), and
- Through carriageways to provide for cyclists where appropriate with an increased left shoulder of 3.0 metres.

Tunnels

The specific requirements for tunnels are as follows:

- Minimum 80 km/h horizontal alignments
- Minimum 80 km/h vertical alignments
- Provision of breakdown bays
- Fire control access
- Mobile telephone coverage through tunnels
- Dual carriageway with three 4.0 metre lanes in inner urban situations
- Dual carriageway with two 4.0 metre lanes in outer urban situations
- Provision for emergency pedestrian egress behind appropriate barriers, and
- Cyclists and pedestrians will not be permitted to use tunnels.

Additional criteria

In addition to the project-specific requirements of the brief, the following additional criteria have been adopted during the development of the long list options:

- A maximum batter height of 40 metres has been adopted. Where the terrain requires batters higher than these, a tunnel or bridge design has been used.
- No surface crossings have been allowed through National Park areas. Tunnels and bridges have been used in these locations.
- Tunnels have generally been used through urban areas. The location of any ventilation stacks that may be required have not been considered at this stage.
- Where applicable, links have been shown along existing arterial and collector road corridors.
- Interchanges have been provided at major road crossings.
- Locations of crossings of the Link (overpass or underpass) have been based on a review of the surrounding local road network.

Access to the Sydney Orbital and the F3

A pre-concept level of design investigation has been carried out on a number of the potential major intersections along the Sydney Orbital and the F3.

While the design speed for ramps should ideally be at least 80 km/h, this may have to be reduced at any M2/Sydney Orbital connection at the M2 tunnel, Windsor Road, Sunnyholt Road and Dean Park.

All intersections investigated would be able to be constructed.

The M2/Sydney Orbital connection options

M2 toll booths at Macquarie Park

The features of an interchange at this location 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.



The Lane Cove River valley and National Park near Busaco Road, Marsfield, just north of the M2 Motorway's toll plaza

M2 tunnel near Beecroft Road

The layout of an interchange at this location would face a number of constraints, including:

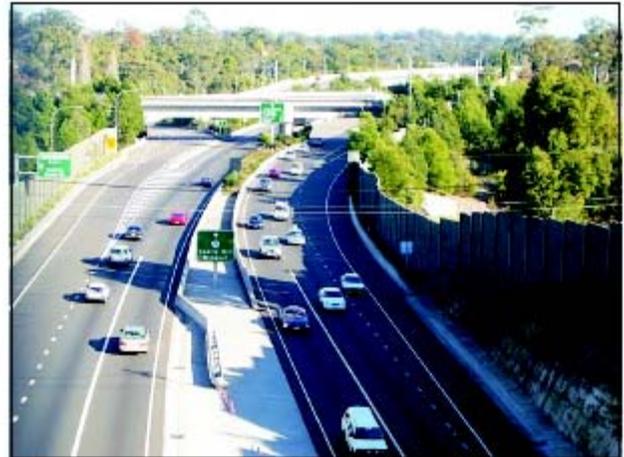
- The Main North railway line, which passes over the M2 between the tunnel and Beecroft Road
- The Epping bus interchange and associated busways
- Terrys and Devlins Creeks
- The Beecroft Road bridge and interchange
- The new Parramatta Rail Link, now under construction, and
- The proposed future North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

The features of an interchange at the M2 tunnel would include:

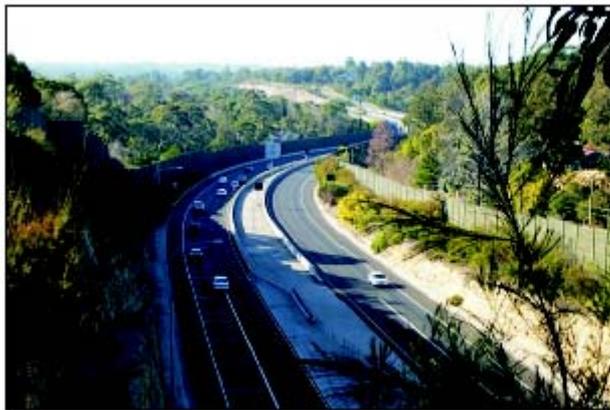
- No direct connection with Beecroft Road, and
- East-bound and west-bound ramps on either side of the M2 tunnel.



The eastern portals of the M2 tunnels



Looking west from above the M2 tunnels to the Main North Rail line bridge and Beecroft Road



Looking east from above the M2 tunnels towards the Terrys Creek bridge



Looking west along the M2 bridge across Terrys Creek just east of the M2 tunnels

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 features of an interchange at this location would include connections to and from Pennant Hills Road, south of the M2.



Looking west from the Pennant Hills Road bridge over the M2



Looking west along the M2 to the Pennant Hills Road bridge

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 constraints 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.



Looking west along the M2 towards the Windsor Road bridge. The central busway lanes will be extended west of this interchange

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.

The F3 connection possibilities

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 Pearce's Corner.

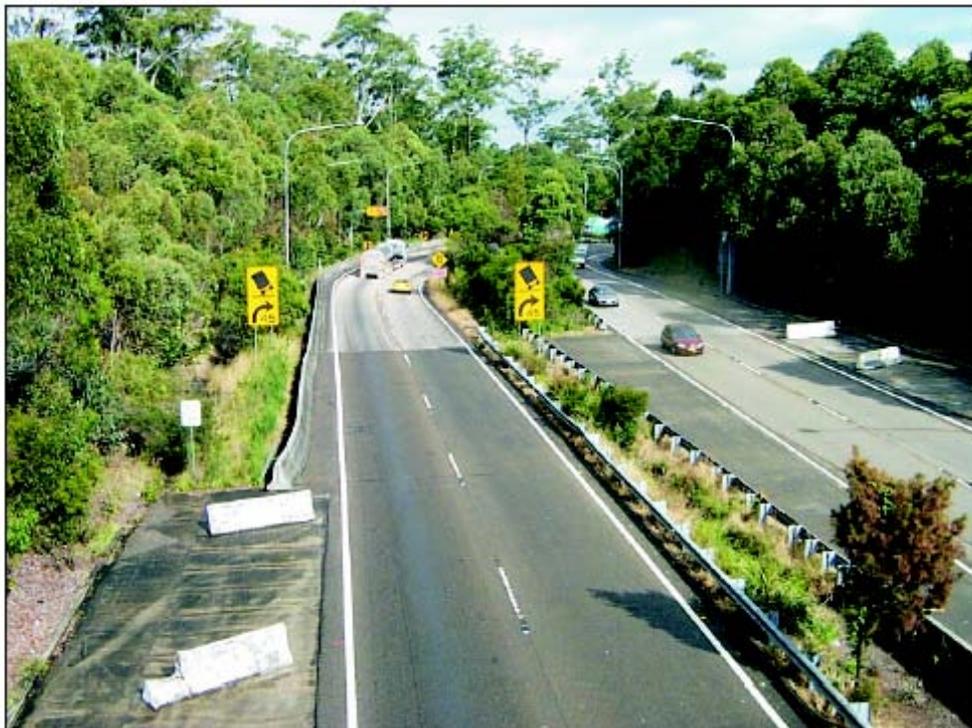
Other F3 interchanges

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 west along the Pacific Highway from its bridge over the F3 towards its junction with Pennant Hills Road at Pearce's Corner



Looking south along the F3 from the Pacific Highway bridge at Wahroonga. The F3 joins Pennant Hills Road just around the corner.



Looking north along the F3 from the Pacific Highway bridge. The northbound ramp from the highway joins in the distance.



Looking east along the Pacific Highway from its bridge over the southernmost section of the F3 freeway.



The junction between the F3 and Pennant Hills Road, looking south along Pennant Hills Road, just south of Pearces Corner



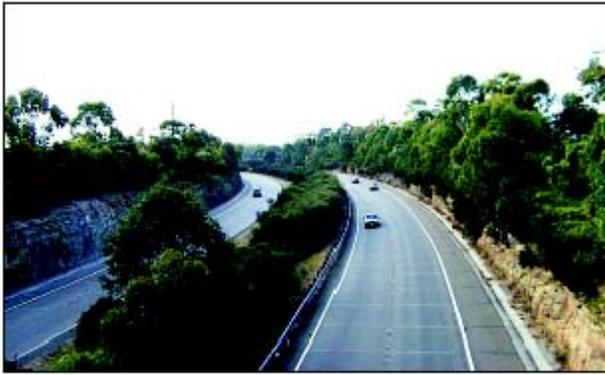
Looking east onto the southern end of the F3 freeway at its junction with Pennant Hills Road.



Looking north along the F3 from the Ku-ring-gai Chase Road bridge at Asquith.



Looking south along the F3 from the Ku-ring-gai Chase Road bridge at Asquith.



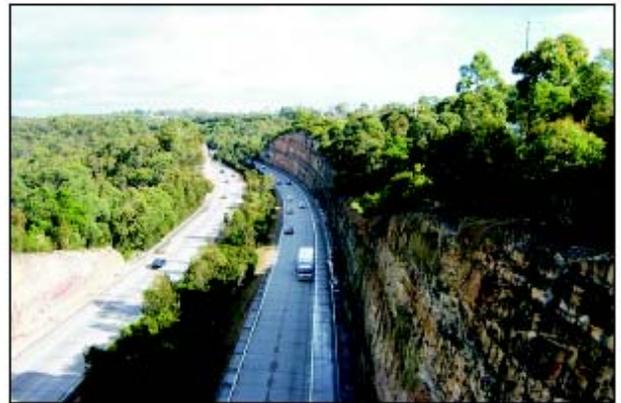
Looking north along the F3 from the Church Street bridge at Mt Ku-ring-gai.



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.

5

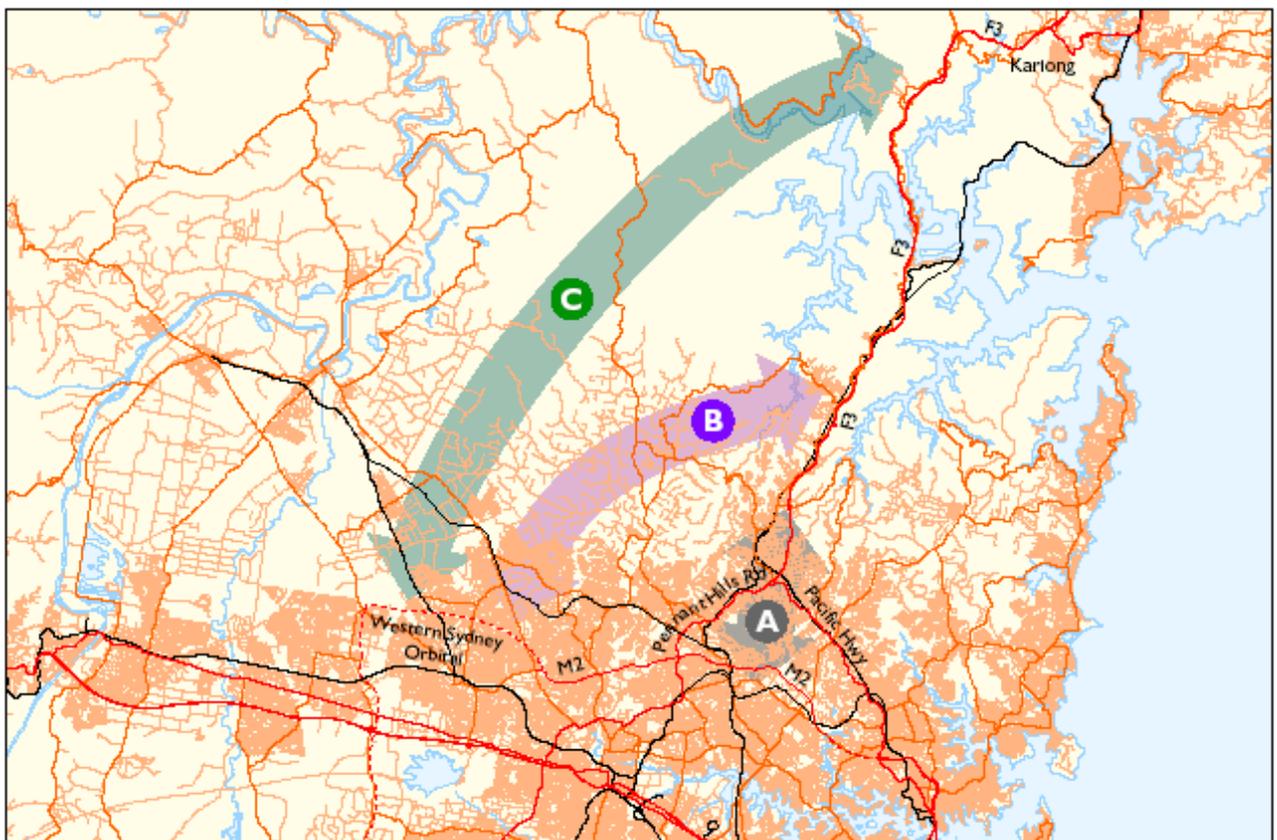
The corridor options investigated

5.1 Grouping of 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.

17 broad corridor options were identified. For the purposes of strategic comparisons, they were able to be 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 5.1**.

Figure 5.1: Broad corridor types



Type A are the more easterly options, mostly in tunnel, which would connect the F3 at Wahroonga to the M2 Motorway.

Type B are the central options that would connect the Sydney Orbital between Pennant Hills Road and Dean Park and/or connect to the F3 north of Hornsby but south of the Hawkesbury River.

Type C are the western options, which would connect the Sydney Orbital between Pennant Hills Road and Dean Park with the F3 north of the Hawkesbury River and would necessitate a new crossing of the Hawkesbury River.

The corridor Type A options are an extension of the F3 corridor south to the M2 and they rely on the F3 corridor as the major transport corridor into Sydney from the north.

The corridor Type B options bypass the M2 and the developed areas of Hornsby. As with Type A, the corridor Type B options would rely on the F3 corridor as the major transport link into Sydney from the north.

The Type C options would also act as a second major corridor into Sydney, and provide additional capacity including a new crossing of the Hawkesbury River, providing an alternative route choice and greater user flexibility and benefits at times of traffic incident and bush fires when compared with Types A and B.

The long list of corridor options developed for assessment, shown in **Figure 5.2**, were as follows.:

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

Western Sydney Orbital at Quakers Hill Parkway, Quakers Hill to F3 at Mt Colah

11

Western 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 Railway Line

15

Western Sydney Orbital at Dean Park to F3 north of Mt Ku-ring-gai

17

Western Sydney Orbital at Norwest Boulevard at Kings Langley to F3 north of Mt Ku-ring-gai.

Type C

8

Western Sydney Orbital at Quakers Hill Parkway, Quakers Hill to F3 at Mt White via Dural

9

M2 at Windsor Road to F3 at Mt White

10

Western Sydney Orbital at Dean Park to F3 at Mt White via Riverstone

12

Western Sydney Orbital at Sunnyholt Road to F3 at Mt White

16

Western Sydney Orbital at Dean Park to F3 at Mt White via Annangrove

As the assessments summarised in Chapter 6 of this report later showed⁶ the grouping of corridors turned out to reflect some quite fundamental differences in the abilities of the groups of options to provide short to medium-term relief to Pennant Hills Road and longer-term opportunities for Sydney's growth.

5.2 The 'base case'

The "base case" for this study is defined as the situation without the development of a new F3 to Sydney Orbital link.

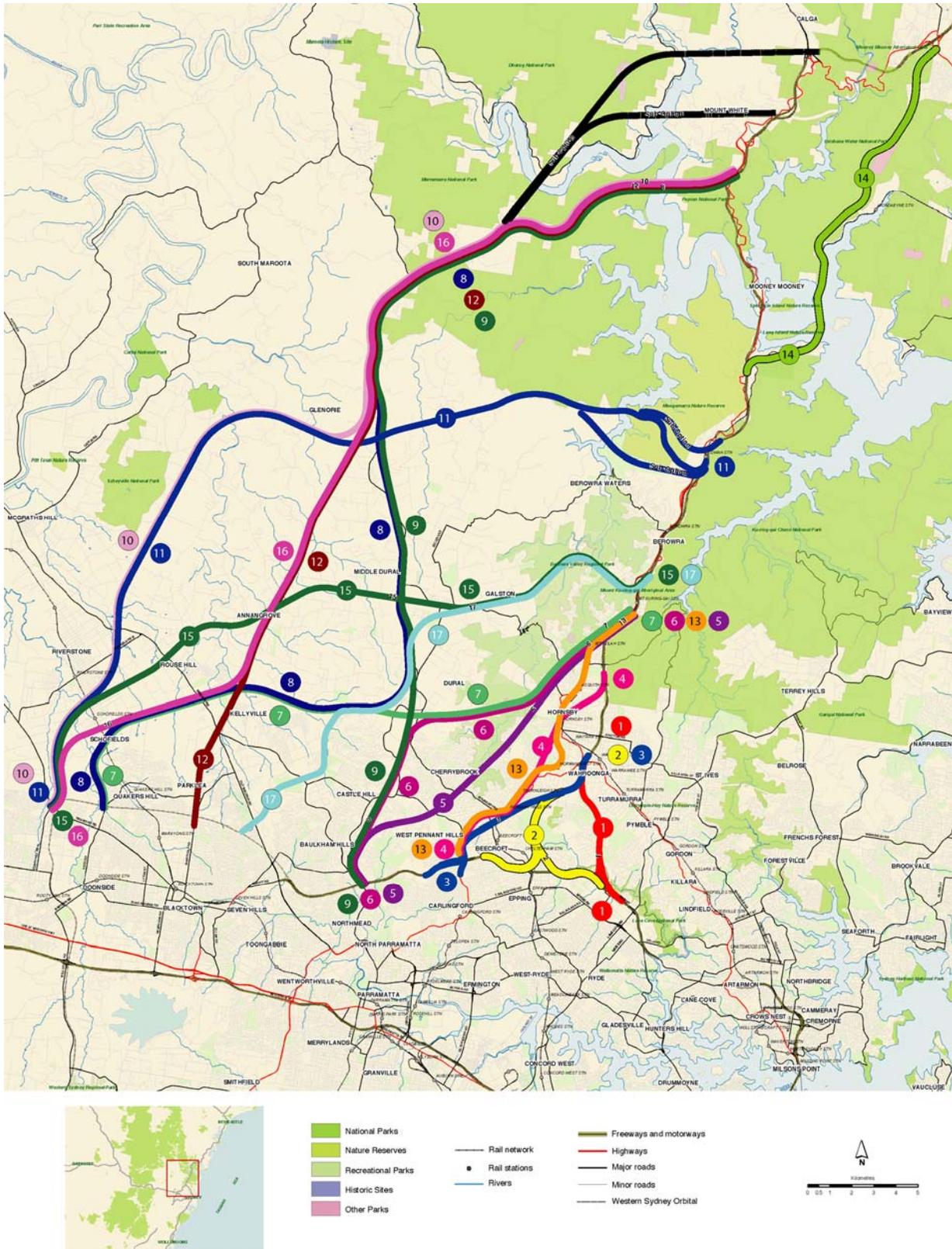
The "base case" assumes:

- The western section of the Sydney Orbital (linking the M5 to the M2, and scheduled for completion by 2007) will form part of the 2011 base road network
- All other road improvements assumed by the RTA for network modelling purposes in response to growth in demand will proceed, and in particular:
 - The 2011 base road network will 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 will again include six lanes on the M2 east of Abbott 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 will be in operation by 2011, and the section of the Main North railway line between the Central Coast and Hornsby will also be upgraded by 2011 as described in Section 2.3.

At this stage, the "base case" is assumed not to involve minor capital or operating expenditures on roads in the existing corridor. This simplification has been adopted because of the strategic nature of the economic evaluation and the order of accuracy of the capital cost estimates for the development options.

⁶ With the exception of Option 13, which the assessments found not to be feasible to construct, and Option 14, which would not itself provide an F3-Sydney Orbital link.

Figure 5.2: The corridor options developed and assessed during the preliminary stages of this study



5.3 Type A corridor options

Option 1: M2 at Macquarie Park to F3 at Wahroonga

This option (**Figure 5.3**) would have a southern connection to the M2 motorway at Marsfield, immediately to the east and west of the existing tollbooths, and a northern connection to the F3 freeway at Wahroonga.

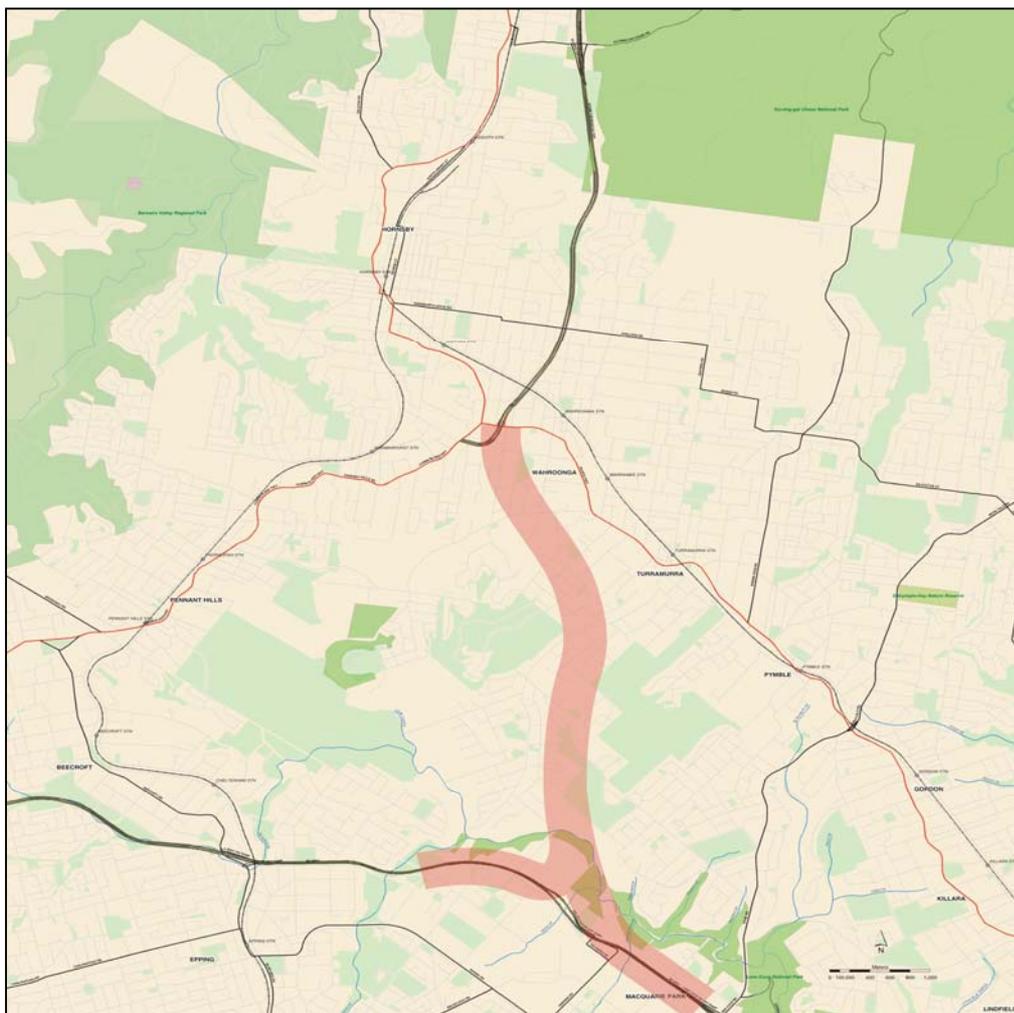
The corridor alignment concept includes and provides for:

- Approximately 6.5 km of the route in dual two or three-lane tunnels, under the Macquarie Park sporting fields, Kissing Point Road, Comenarra Parkway, Twin Creeks Reserve, Lucinda Avenue South and Exeter Road, and
- Major waterway crossings at Lane Cove River and Mitchell and Coups Creeks.

There would be steep grades of 6% for about 0.6 km between the M2 and the Lane Cove River and 4.5% for approximately 2.5 km approaching the F3.

If the Lane Cove River were crossed by a bridge, the grade between the M2 and the Lane Cove River would be reduced to approximately 3%.

Figure 5.3: Option 1 - M2 at Macquarie Park to F3 at Wahroonga



Option 2: M2 at North Epping to F3 at Wahroonga

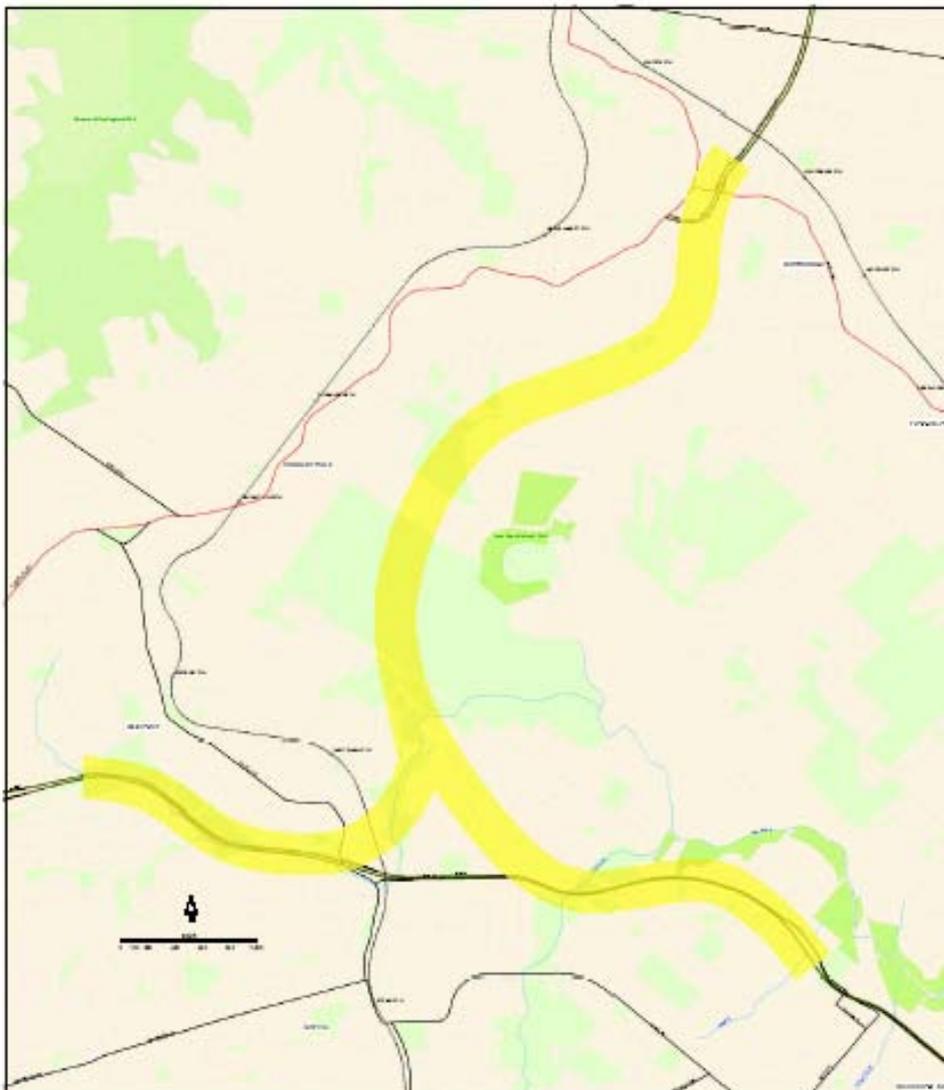
This option (**Figure 5.4**) would have dual southern connections to the M2 motorway, on either side of the existing M2 tunnel at Terrys Creek to the east and Beecroft Road to the west, and a northern connection to the F3 freeway at Wahroonga.

The corridor alignment concept includes and provides for:

- A 6.5 km long dual two-lane or three-lane tunnel alignment between North Epping and Wahroonga, a 2.5 km long dual tunnel eastern connection with the M2 and a 2 km long dual tunnel western connection with the M2
- Tunnelling under North Epping, Devlins Creek Valley, Pennant Hills Park, Lane Cove National Park, Sydney Adventist Hospital, Coups Creek Valley and Exeter Road, and
- Major waterway crossings at Devlins Creek, Lane Cove River and Coups Creek.

The steepest grades would be a 1km long section at 5% and a 3km section at 4.5%.

Figure 5.4: Option 2 - M2 at North Epping to F3 at Wahroonga



Option 3: M2 at Pennant Hills Road to F3 at Wahroonga

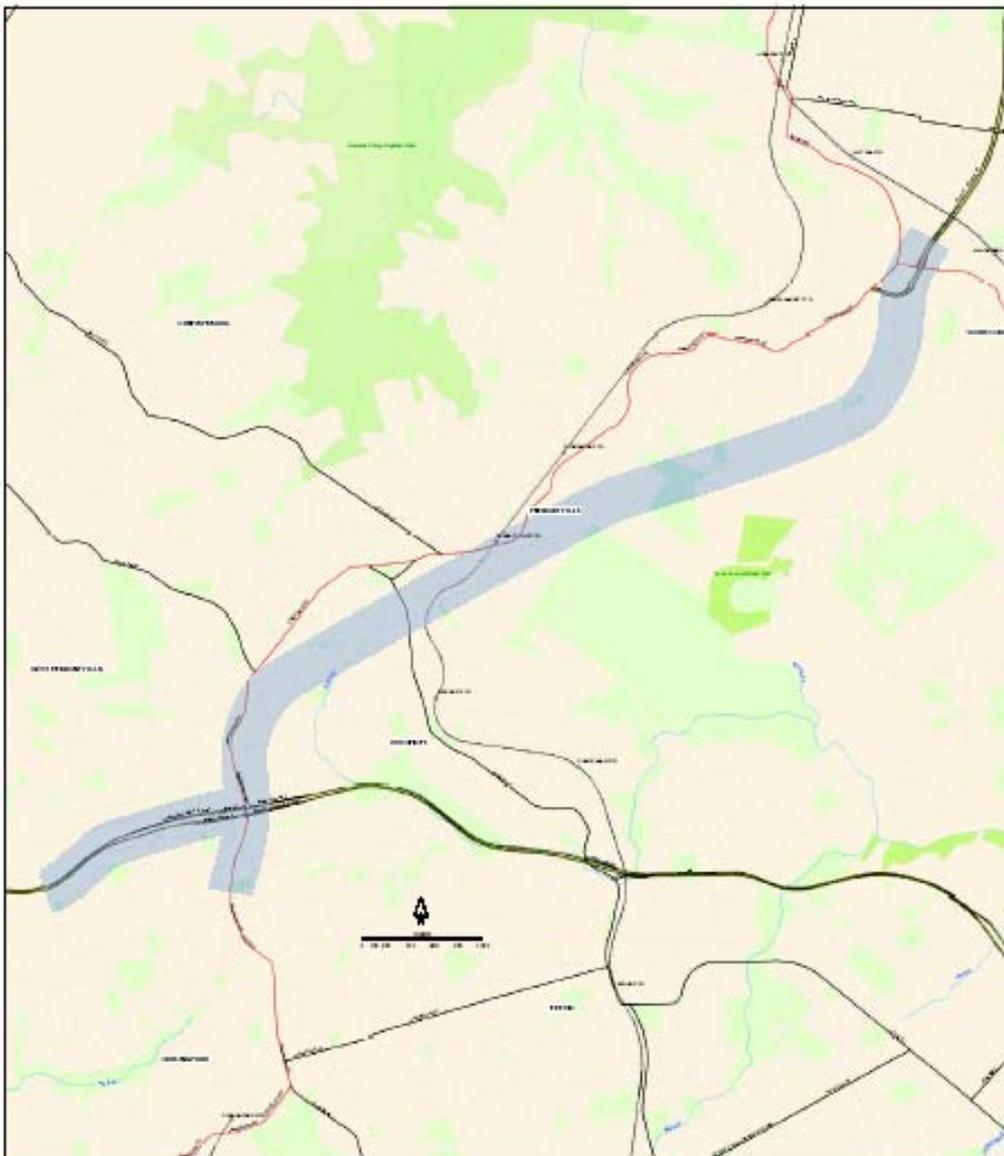
This option (**Figure 5.5**) would have a southern connection to the M2 motorway at Pennant Hills Road and a northern connection to the F3 freeway at Wahroonga, and there could be an intermediate interchange at Boundary Road/Beecroft Road in Pennant Hills.

The corridor alignment concept includes:

- Approximately 8 km of the route being in dual two-lane or three-lane tunnels
- Tunnelling close to Pennant Hills Road (Pennant Hills), the Main North railway and a connection to the F3 at Pearce's corner, and
- No major waterway crossings.

The maximum grade would be 1.5%, and the average tunnel depth would be approximately 25 metres.

Figure 5.5: Option 3 - M2 at Pennant Hills Road to F3 at Wahroonga



Option 4: M2 at Pennant Hills Road to F3 at Asquith

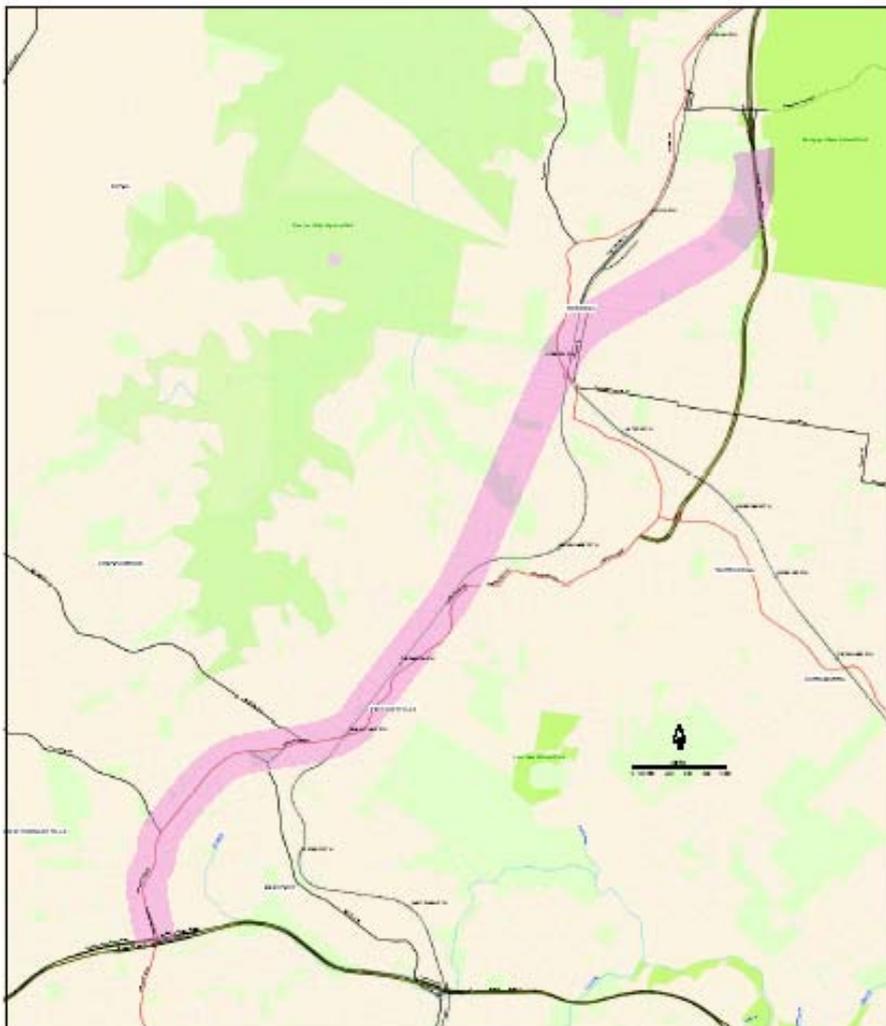
This option (**Figure 5.6**) would have a southern connection to the M2 motorway at Pennant Hills Road and a northern connection to the F3 freeway at Asquith, south of the existing interchange at Ku-ring-gai Chase Road. Intermediate interchanges could be possible at Hornsby (Pacific Highway) and Pennant Hills (Boundary Road/Beecroft Road).

The corridor alignment concept includes and provides for:

- An overall length of 12 km, with approximately 10.7 km of the route being in dual two-lane or three-lane tunnels (or in two shorter tunnelled sections if the alignment could be daylighted at some location, possibly over Waitara Creek)
- Tunnelling under Pennant Hills Road (Pennant Hills), the Main North railway, Dartford Road, Milson Parade, The Rampart, Normanhurst Park, Homewood Avenue, Hall Road, Jersey Street, George Street and Sherbrook Road, and
- A major waterway crossing at Waitara Creek.

Option 4 would require upgrading of most of the M2 and the full length of the F3 to Kariong beyond 2025. Its maximum grade would be 5%, at Hornsby.

Figure 5.6: Option 4 - M2 at Pennant Hills Road to F3 at Asquith



5.4 Type B corridor options

Option 5: M2 at Windsor Road, Baulkham Hills, to F3 at Mt Colah

This option (**Figure 5.7**) would have a southern connection to the M2 motorway at Windsor Road, Baulkham Hills, and a northern connection to the F3 freeway at Mt Colah, south of the existing Church Street overpass.

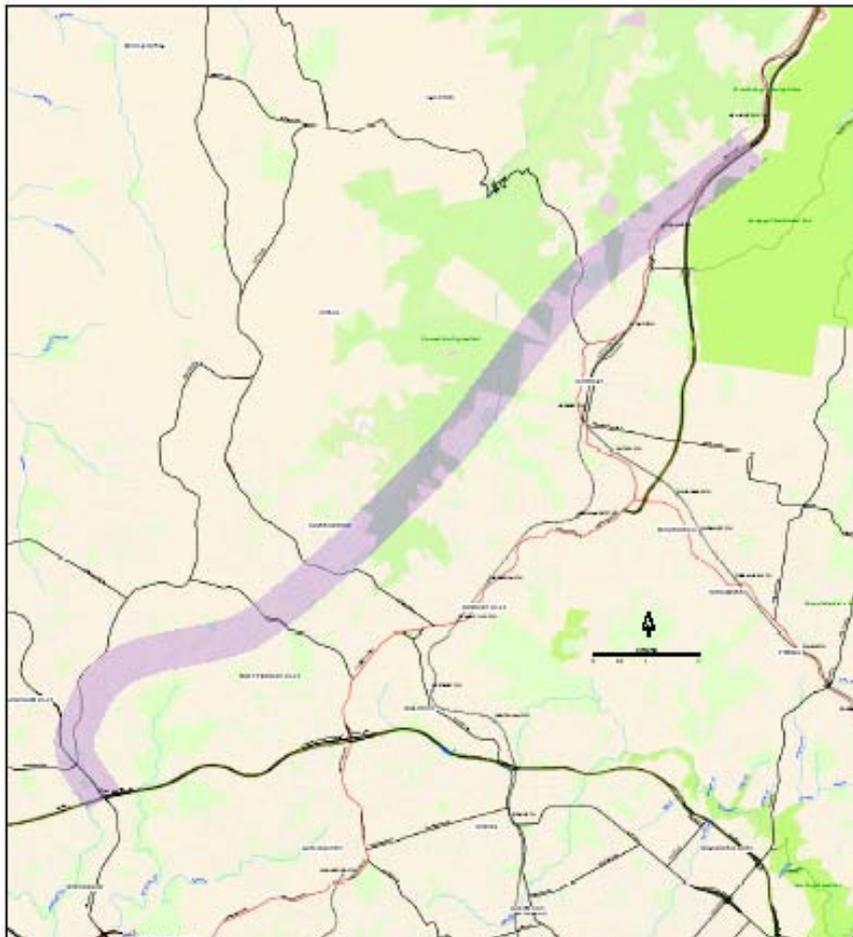
The corridor alignment concept includes and provides for:

- A total length of 19 km
- Approximately 8 km of dual two-lane or three-lane tunnel alignment under Castle Hill, West Pennant Hills and Cherrybrook, followed by 4.7 km of surface road and bridges along the Berowra Creek Valley and across parts of the Berowra Valley Regional Park, followed by another 4.5 km dual tunnel alignment under Mt Colah to the F3 freeway
- Tunnelling under Castle Hill and Cherrybrook in the south and Asquith, Walls Gully and Mt Colah in the north, and
- Major creek crossings at Excelsior Creek (tunnel), Berowra Creek (bridge) and Calga Creek (tunnel).

Its maximum grade would be 3.5% over a 3km distance between Asquith and Mt Colah.

Within this option there could be several possible combinations of tunnels and surface alignments.

Figure 5.7: Option 5 - M2 at Windsor Road, Baulkham Hills, to F3 at Mt Colah



Option 6: M2 at Windsor Road, Baulkham Hills, to F3 at Mt Colah, via Round Corner

This option (**Figure 5.8**) would have a southern connection to the M2 motorway at Windsor Road, Baulkham Hills, and a northern connection to the F3 freeway at Mt Colah, south of the existing Church Street overpass.

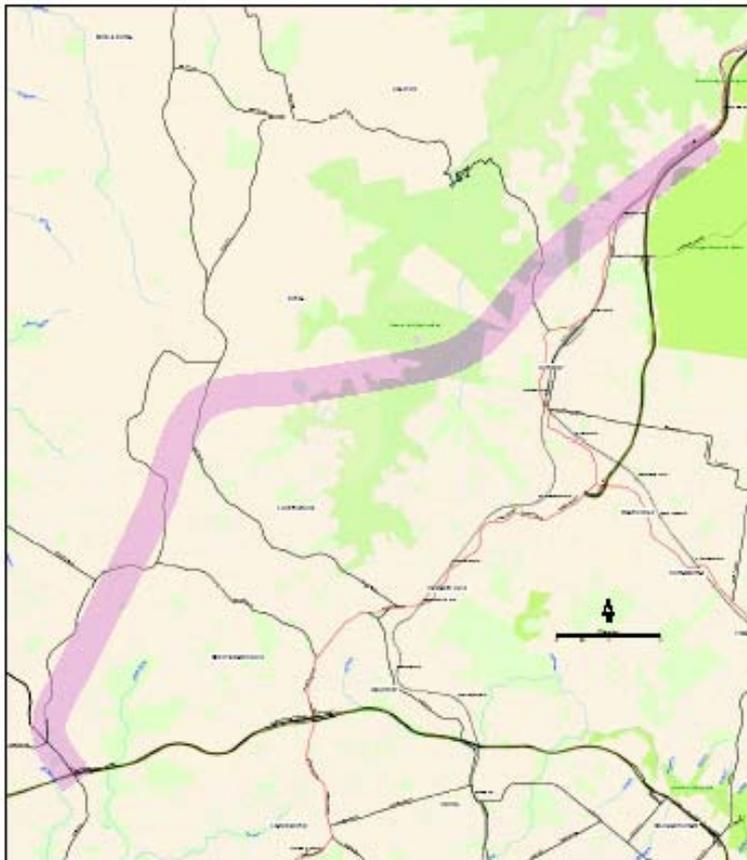
It would follow the line of Windsor Road, Old Northern Road, Hastings Road and New Line Road to Round Corner. From Round Corner, the corridor might follow the alignment of Quarry Road east along Tunks Ridge before crossing Berowra Valley Regional Park and Berowra Creek. The final 6km would follow the same alignment as Option 5 to Mt Colah.

The corridor alignment concept includes and provides for:

- A total length of 20 km
- Approximately 5.5 km of dual two-lane or three-lane tunnel alignment under Windsor Road and Old Northern Road through Baulkham Hills and Castle Hill
- Approximately 8 km of surface road and bridges along Old Northern Road, Hastings Road, New Line Road, Quarry Road and across Berowra Valley Regional Park and Berowra Creek
- A 4.5 km dual tunnel alignment under Asquith, Walls Gully and Mt Colah, and
- Major creek crossings at Georges Creek (bridge), Tunks Creek (bridge), Berowra Creek (bridge) and Calga Creek (tunnel).

Its maximum grades would be 4% over 2 km around Glenhaven and 3.5% over 3 km between Asquith and Mt Colah.

Figure 5.8: Option 6 - M2 at Windsor Road, Baulkham Hills, to F3 at Mt Colah, via Round Corner



Option 7: Western Sydney Orbital at Quakers Hill Parkway, Quakers Hill, to F3 at Mt Colah

This option (**Figure 5.9**) would have a southern connection to the Western Sydney Orbital at Quakers Hill Parkway, Quakers Hill, and a northern connection to the F3 freeway at Mount Colah, south of the Church Street overpass.

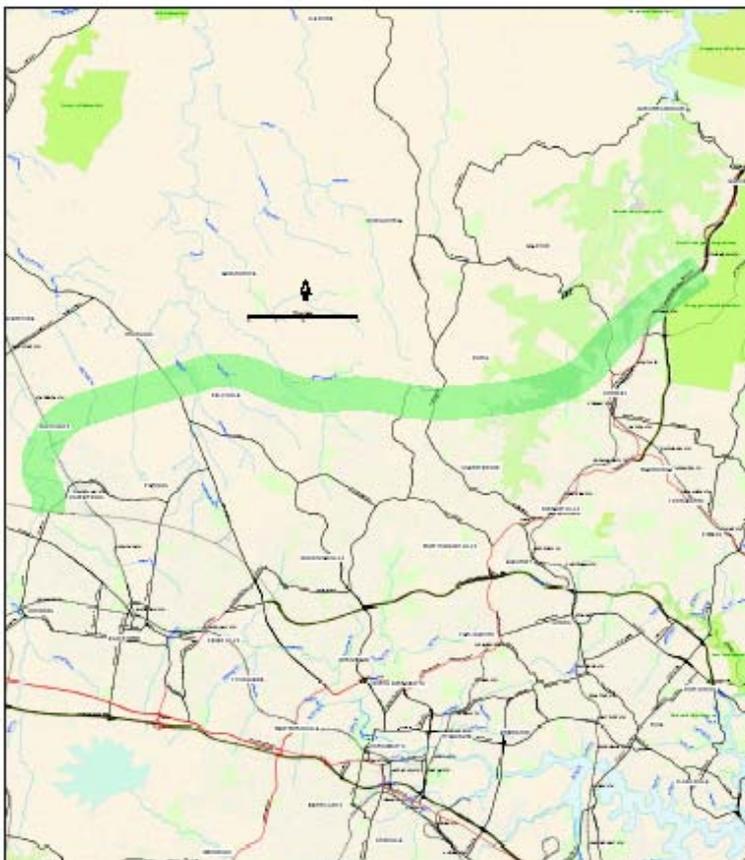
It would head north from the Sydney Orbital at Quakers Hill Parkway before turning east along Schofields Road, through the proposed Mungerie Park development area north-west of Kellyville and then along Glenhaven Road to Round Corner. The alignment would then be the same as Option 6 for the final 10 km from Round Corner to Mt Colah, including a surface alignment along Tunks Ridge and across Berowra Valley Regional Park and Berowra Creek.

The corridor alignment concept includes and provides for:

- A total length of approximately 30 km
- Approximately 23.5 km of surface road and bridges
- 4.5 km of dual two-lane or three-lane tunnel alignment below Asquith, Walls Gully and Mt Colah, and
- Major creek crossings by bridge at Eastern, First Ponds, Second Ponds, Caddies, Smalls, Cattai, Dooral, Georges, Tunks and Berowra Creeks and by tunnel at Calna Creek.

Its maximum grades would be 4% over 2 km around Glenhaven and 3.5 % over 3 km between Asquith and Mt Colah.

Figure 5.9: Option 7 - Western Sydney Orbital at Quakers Hill Parkway, Quakers Hill, to F3 at Mt Colah



Option 11: Western Sydney Orbital at Dean Park to F3 at Berowra, via Riverstone

This option (**Figure 5.10**) would have the same alignment as Option 10 from Dean Park to Glenorie, and would then continue east to the F3, crossing Berowra Creek north of Berowra Waters. The Glenorie–Berowra section can be divided into two distinct subsections:

- From Glenorie to Coba Ridge, across the ranges to the north-east of Glenorie and then along the Coba Ridge fire trail, and
- From Coba Ridge to Berowra, for which the potential alternatives include:
 - A surface road to Berowra Creek, a 400 m bridge across Berowra Creek north of Collingridge Point and a tunnel below the Muogamurra Nature Reserve, and
 - A surface road to Berowra Creek, a 400 m bridge across Berowra Creek at Cunio Point and a surface alignment south of the Muogamurra Nature Reserve.

The corridor alignment concept includes and provides for:

- A total length of approximately 45 km
- Tunnelling under Muogamurra Nature Reserve, if the alignment did not bypass this reserve, and
- Major waterway crossings at Eastern Creek, First Pond Creek, Killarney Chain of Ponds, Cattai Creek, Kellys Creek, Brush Tail Creek and Berowra Creek.

Its maximum grades would be 4% from Berowra Creek to the F3 freeway and 3% through Riverstone and Box Hill.

Figure 5.10: Option 11 - Western Sydney Orbital at Dean Park to F3 at Berowra, via Riverstone



Option 13: M2 at Pennant Hills Road to F3 at Mt Colah via railway line

This option (**Figure 5.11**) was developed and investigated in response to a number of comments from the community regarding possible “double decking” of the railway, south of Hornsby.

The section from the M2 motorway to Normanhurst would involve an M2 connection at Pennant Hills Road and tunnels under Pennant Hills Road, as for Options 3 and 4. From Normanhurst to Mt Colah the new roadway would be on a viaduct over the existing railway.

The length of the alignment would be approximately 15 km.

There would be no major waterway crossings.

The maximum grade would be 3.5%, between Normanhurst and Hornsby.

Engineering feasibility investigations into this option have demonstrated it would be extremely difficult to construct a National Highway above the existing railway given the width requirements of the roadway. Furthermore, the intersections with cross roads would need to be at three levels and would cause severe visual intrusion. For these reasons Option 13 is not regarded as a practical alternative to the other eastern options.

Accordingly, Option 13 has been excluded from further consideration and is not recommended for detailed investigation.

Figure 5.11: Option 13 - M2 at Pennant Hills Road to F3 at Mt Colah via railway line



Option 14: Brooklyn to Somersby via railway line

This option (**Figure 5.12**) would not connect the F3 freeway to the Sydney Orbital, but would simply provide an alternative to future widening of the F3 (beyond six lanes) and/or another new crossing of the Hawkesbury River.

While it would therefore not be able to satisfy the project objectives on its own, it might need to be considered in combination with other options at the later stages of the study.

Option 14 would have a southern connection to the existing F3 freeway at Brooklyn and a northern connection south of Somersby.

The corridor alignment concept includes and provides for:

- An alignment following the Main North railway line from the F3 freeway south of Brooklyn to the Hawkesbury River
- A new bridge across the Hawkesbury River and an alignment along the western bank of Mullet Creek to Wondabyne, and
- A tunnelled alignment under Brisbane Water National Park to the F3 freeway at Somersby or a connection to Gosford.

Option 14 is not considered to be a stand-alone option and has therefore not been taken forward for further analysis.

Figure 5.12: Option 14 - Brooklyn to Somersby via railway line



Option 15: Western Sydney Orbital at Dean Park to F3 north of Mt Ku-ring-gai, via Middle Dural and Galston

This option (**Figure 5.13**) would follow the alignment of Options 10 and 11 north from Dean Park to Schofields before heading north-east to Annangrove and Middle Dural. It then follows east through Galston and across Berowra Creek and Berowra Valley Regional Park to join the F3 freeway just north of Mount Ku-ring-gai.

It would predominantly be a surface alignment.

A possible variant would have its connection to the Western Sydney Orbital at Sunnyholt Road and use the same alignment as Option 12 between the M2 motorway and Annangrove, before heading east to Middle Dural and the F3 freeway.

The Dean Park corridor alignment concept includes and provides for:

- A total length of approximately 34 km
- Tunnelling on either side of the Berowra Creek crossing, and
- Major waterway crossings at Eastern Creek, First Ponds Creek, Second Ponds Creek, Caddies Creek, Cattai Creek, Blue Gum Creek, Scaly Bark Creek, Guppy Creek, O'Haras Creek, Colah Creek, Berowra Creek and Calna Creek.

Its maximum grades would be 4.5% over 1.5 km leading down to Berowra Creek and 3% over 2 km from Berowra Creek to the F3 freeway.

Figure 5.13: Option 15 - Western Sydney Orbital at Dean Park to F3 north of Mt Ku-ring-gai, via Middle Dural and Galston



Option 17: Western Sydney Orbital at Kings Langley to F3 north of Mt Ku-ring-gai, via Round Corner and Galston

This option (**Figure 5.14**) would have a southern connection to the Western Sydney Orbital at Kings Langley, between Old Windsor Road and Norwest Boulevard, and a northern connection to the F3 Freeway north of Mt Ku-ring-gai.

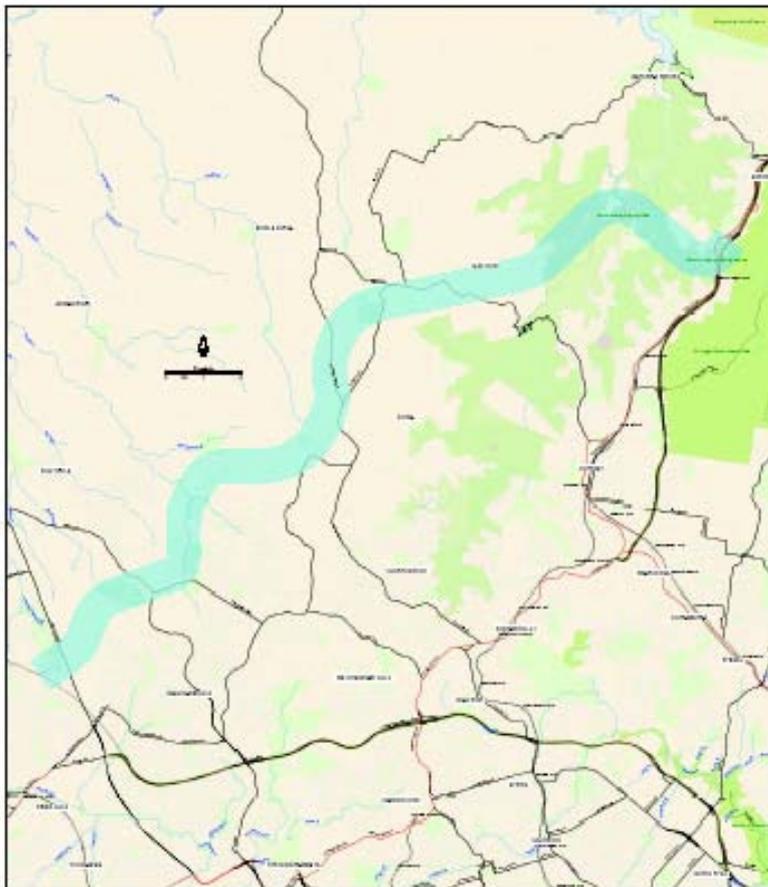
It would initially follow a surface alignment north from the M2 motorway before swinging east onto the alignment of Options 7 and 8 and heading towards Round Corner. It would then head north towards Middle Dural, on the same surface alignment as Option 8, before swinging east again to join the Option 15 alignment through Galston and across Berowra Creek and Berowra Valley Regional Park to join the F3 just north of Mount Ku-ring-gai.

The corridor alignment concept includes and provides for:

- A total length of approximately 23 km
- Tunnelling on either side of the Berowra Creek crossing, and
- Major creek crossings at Strangers Creek, Smalls Creek, Cattai Creek, Dooral Creek, Georges Creek, O'Haras Creek, Colah Creek, Berowra Creek and Calna Creek.

Its maximum grades would be 4.5% over 1.5 km leading down from Galston to Berowra Creek, 3.5% over 2 km through Castle Hill and 3% over 2 km from Berowra Creek to the F3 freeway.

Figure 5.14: Option 17 - Western Sydney Orbital at Kings Langley to F3 north of Mt Ku-ring-gai, via Round Corner and Galston



5.5 Type C corridor options

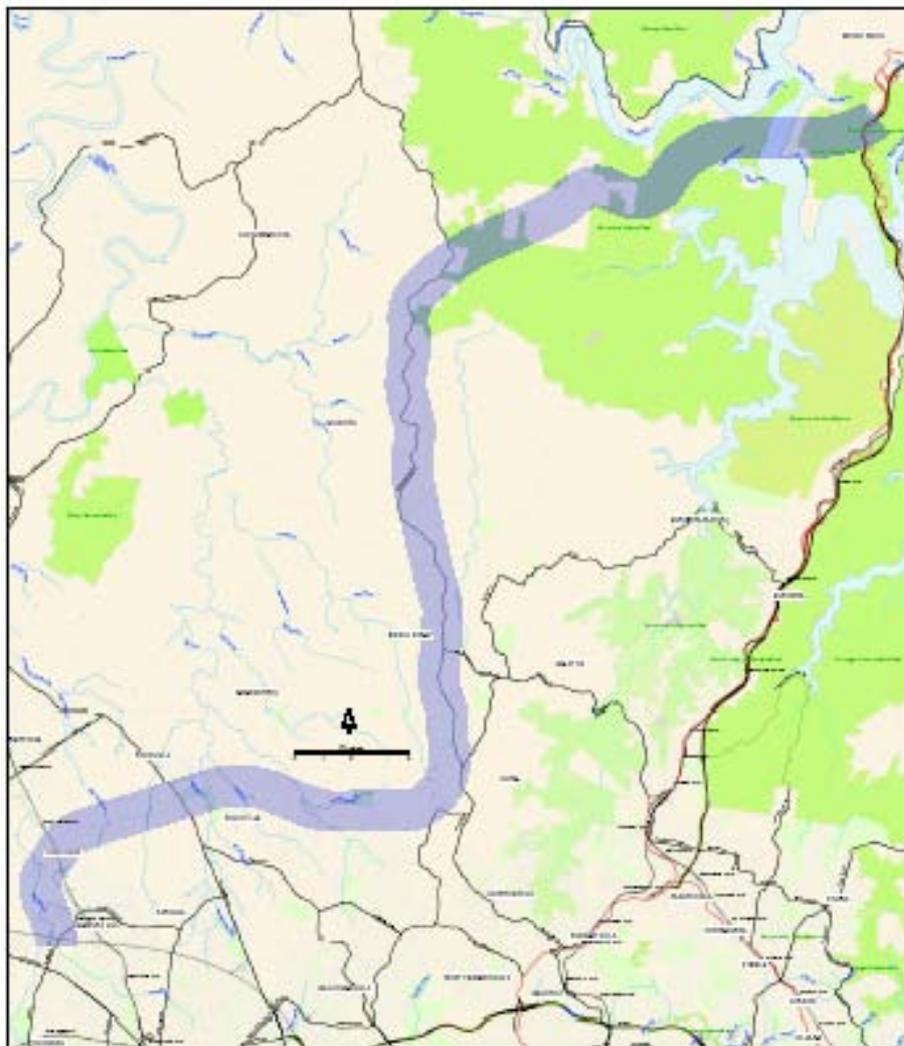
Option 8: Western Sydney Orbital at Quakers Hill Parkway, Quakers Hill, to F3 north of the Hawkesbury, via Dural

The option (**Figure 5.15**) would have a southern connection to the Western Sydney Orbital at Quakers Hill Parkway, Quakers Hill, and a northern connection to the F3 freeway at (or north or south of) Mount White.

The conceptual corridor alignment can be divided into four distinct sections:

- From the Western Sydney Orbital at Quakers Hill Parkway, Quakers Hill, to Round Corner, generally along the existing alignments of Schofields Road and Glenhaven Road (as under Option 7)
- From Round Corner via Dural and Middle Dural to Glenorie, generally along the alignment of Old Northern Road
- From Glenorie to Canoelands, generally along the alignment of Old Northern Road through Forest Glen and then along Canoelands Road, with a tunnel connection below Marramarra National Park, and

Figure 5.15: Option 8 - Western Sydney Orbital at Quakers Hill Parkway, Quakers Hill, to F3 north of the Hawkesbury, via Dural



- From Canoelands to the F3 freeway at (or north or south of) Mount White, for which the potential alternatives include:
 - A dual two-lane or three-lane tunnel connection below the Marramarra National Park from the surface road at Canoelands to Paddys Bight on the Hawkesbury River, followed by a 1 km bridge over the Hawkesbury River, followed by either a dual tunnel under the Dharug National Park or a surface road along approximately the same route as Wisemans Ferry Road to Spencer, followed an 800 m bridge over Mangrove Creek to Wendoree Park, followed by a 5 km surface alignment to Mt White
 - Variants on the last surface section north of Wendoree Park, joining the F3 freeway further to the north around Calga or possibly around Kariong, in the latter case with a new Mooney Creek crossing, and
 - A 6.5 km dual tunnel under the Marramarra National Park from the surface road at Canoelands to just north of Big Jims Point. The route then follows a 1.1km bridge across the Hawkesbury River, followed by a 2.5 km dual tunnel alignment to the F3 freeway approximately 1 km north of Lily Hill.

The Mount White corridor alignment concept includes and provides for:

- A total length of approximately 54 km
- Tunnelled alignments under Marramarra National Park and between the Hawkesbury River and the F3 freeway, and
- Major waterway crossings at Eastern Creek, First Ponds Creek, Second Ponds Creek, Caddies Creek, Smalls Creek, Cattai Creek, Dooral Creek, Georges Creek, O'Haras Creek, Glenorie Creek, Layburys Creek, Hawkesbury River, Cohens Creek, Allens Creek, Breakfast Creek and Mangrove Creek.

Its maximum grades would be 4.5% over 4 km at Mount White and 4% from Canoelands to the Hawkesbury River.

Option 9: M2 at Windsor Road to F3 north of the Hawkesbury, via Dural

This option (**Figure 5.16**) would have a southern connection to the M2 motorway at Windsor Road, Baulkham Hills, and a northern connection to the F3 freeway at (or north or south of) Mount White.

From the M2 motorway at Windsor Road to Round Corner the alignment would be the same as Option 6, following Old Northern Road, Hastings Road and New Line Road, including approximately 5.5 km of dual tunnel alignment under Windsor Road and Old Northern Road through Baulkham Hills and Castle Hill.

From Round Corner to the F3 freeway the alignment would be the same as for this section of Option 8.

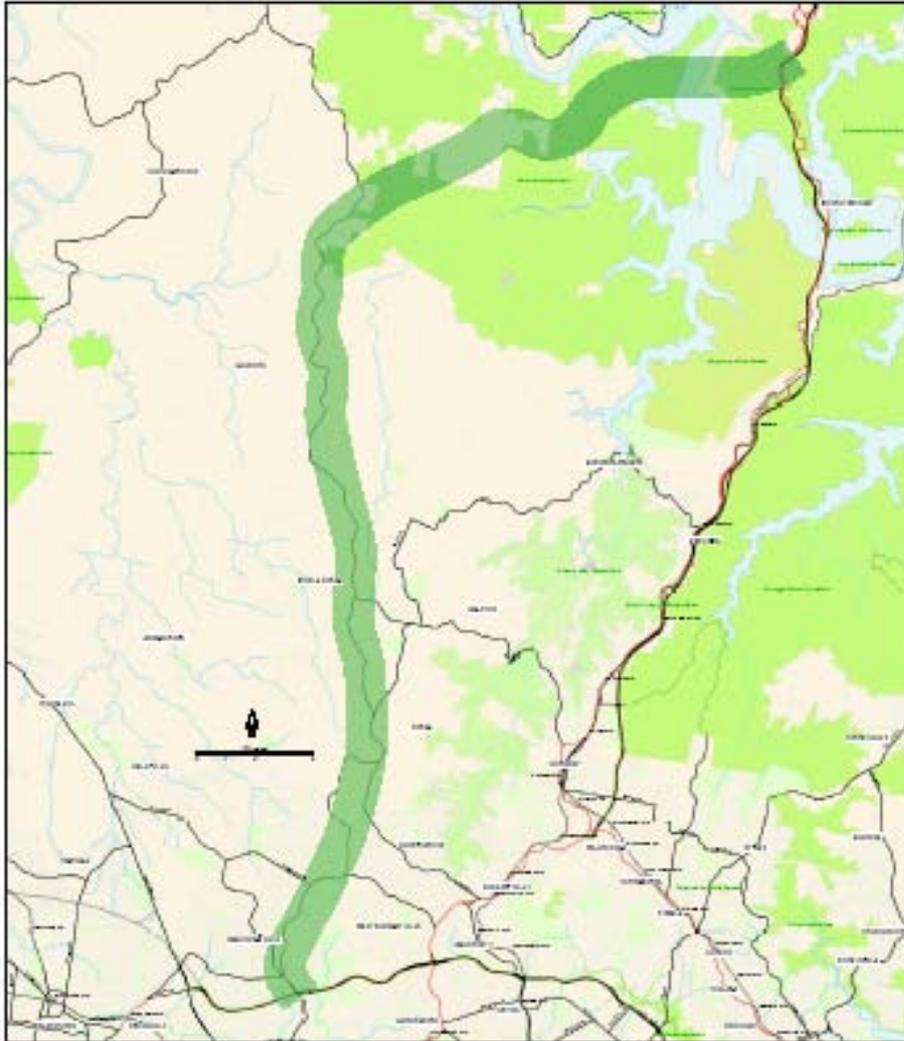
Option 9 therefore includes the alternative alignment sub-options applying for the southern part of Option 6 and northern part of Option 8.

The corridor alignment concept includes and provides for:

- A total length of 46 km (Mount White variant)
- Tunnelled alignments under Castle Hill and Marramarra National Park and between the Hawkesbury River and the F3 freeway, and
- Major creek crossings at Georges Creek, O'Haras Creek, Glenorie Creek, Layburys Creek, Hawkesbury River, Cohens Creek, Allens Creek, Breakfast Creek and Mangrove Creek.

Its maximum grades would be 4.5% over 4 km at Mount White and 4% from Canoelands to the Hawkesbury River.

Figure 5.16: Option 9 - M2 at Windsor Road to F3 north of the Hawkesbury, via Dural



Option 10: Western Sydney Orbital at Dean Park to F3 north of the Hawkesbury, via Riverstone

This option (**Figure 5.17**) would have a southern connection to the Western Sydney Orbital at Dean Park and a northern connection to the F3 freeway at (or north or south of) Mount White.

Its conceptual corridor alignment can be divided into four distinct sections:

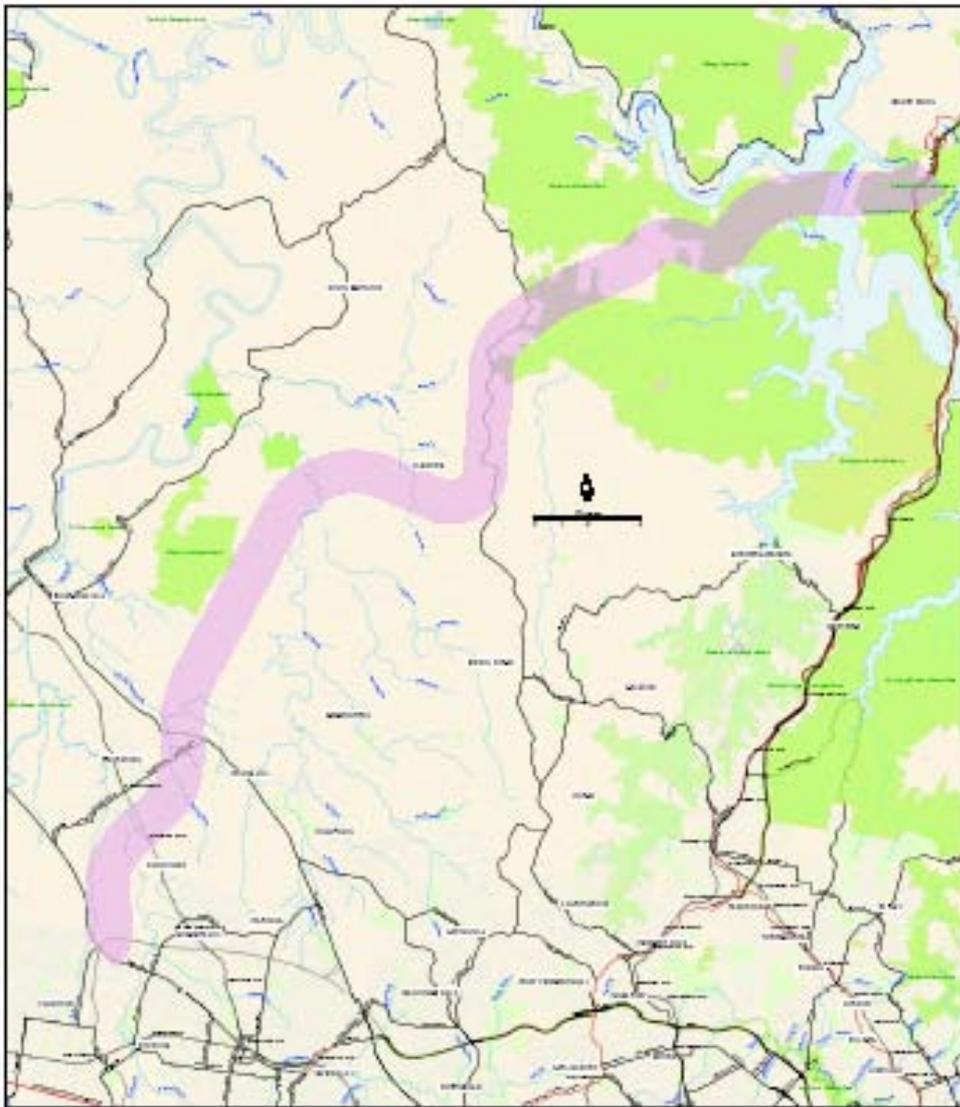
- From the Western Sydney Orbital at Dean Park north to Schofields, northwest of Schofields station
- From Schofields to Glenorie via a surface alignment initially heading north past Riverstone to Boundary Road, through Box Hill and Maraylya, and then swinging east, generally along the western part of Cattai Ridge Road at Kenthurst, to Glenorie.
- From Glenorie to Canoelands, using the same alignment as this section of Options 8 and 9, and
- From Canoelands to the F3 freeway, again as for this section of Options 8 and 9, including their alternative alignments and F3 connections.

The corridor alignment concept includes and provides for:

- A total length of 51 km (Mount White variant)
- Tunnelled alignments under Marramarra National Park and between the Hawkesbury River and the F3 freeway, and
- Major waterway crossings at Eastern Creek, First Pond Creek, Killarney Chain of Ponds, Cattai Creek, Kellys Creek, Brush Tail Creek, Layburys Creek, Hawkesbury River, Cohens Creek, Allens Creek, Breakfast Creek and Mangrove Creek.

Its maximum grades would be 4.5% over 4 km at Mount White, 4% from Canoelands to the Hawkesbury River and 3% through Riverstone and Box Hill.

Figure 5.17: Option 10 - Western Sydney Orbital at Dean Park to F3 north of the Hawkesbury, via Riverstone



Option 12: Western Sydney Orbital at Sunnyholt Road, Acacia Gardens, to F3 north of the Hawkesbury, via Annangrove

This option (**Figure 5.18**) would have a southern connection to the Sydney Orbital at Sunnyholt Road and a northern connection to the F3 freeway at (or north or south of) Mount White.

Its conceptual corridor alignment can be divided into three distinct sections:

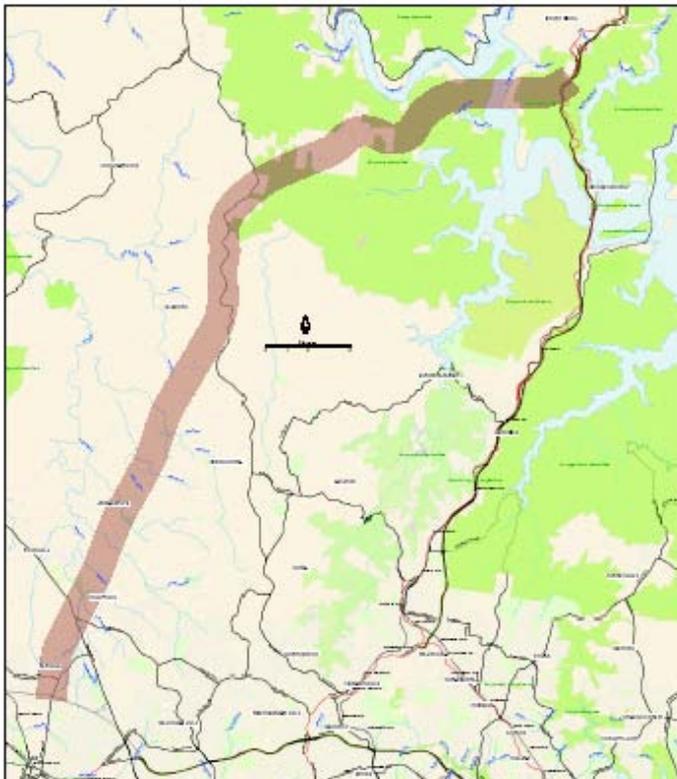
- From the Western Sydney Orbital at Sunnyholt Road, Acacia Gardens, to Glenorie, via a surface alignment north through Stanhope Gardens and Annangrove
- From Glenorie to Canoelands, using the same alignment as this section of Options 8, 9 and 10, and
- From Canoelands to the F3 freeway, again as for this section of Options 8, 9 and 10, including their alternative alignments and F3 connections.

The corridor alignment concept includes and provides for:

- A total length of approximately 44 km (Mount White variant)
- Tunnelled alignments under Marramarra National Park and between the Hawkesbury River and the F3 freeway, and
- Major waterway crossings at Kellys Creek, O'Haras Creek, Scaly Dark Creek, Blue Gum Creek, Cattai Creek, Caddies Creek, Strangers Creek, Layburys Creek, Hawkesbury River, Cohens Creek, Allens Creek, Breakfast Creek and Mangrove Creek.

The maximum grades would be 4.5% over 4 km at Mount White and 4% from Canoelands to the Hawkesbury River.

Figure 5.18: Option 12 - Western Sydney Orbital at Sunnyholt Road, Acacia Gardens, to F3 north of the Hawkesbury, via Annangrove



Option 16: Western Sydney Orbital at Dean Park to F3 north of the Hawkesbury, via Annangrove

This option (**Figure 5.19**) would have a southern connection to the Western Sydney Orbital at Dean Park and a northern connection to the F3 freeway at (or north or south of) Mount White.

It would initially follow the alignment of Options 10, 11 and 15 north from Dean Park, before swinging east to join the alignment of Options 7 and 8 just east of Schofields. It would then follow the alignment of Options 7 and 8 to the future Mungerie Park development area north of Kellyville., where it would swing north and follow the alignment of Option 12 to Annangrove and Glenorie and then the alignment of Options 8, 9, 10 and 12 across the Hawkesbury and on to the F3 freeway.

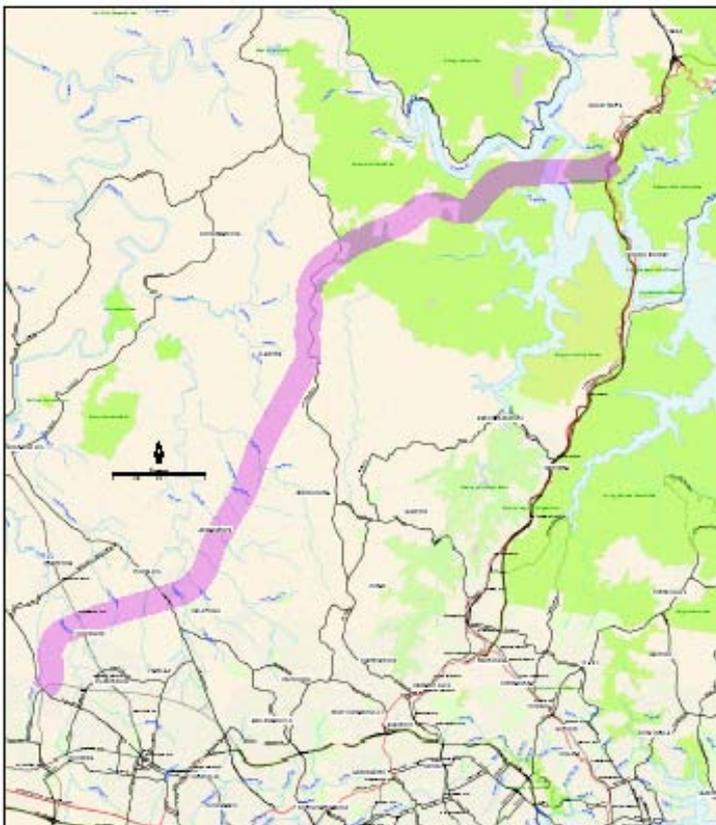
Option 16 therefore includes the alternative alignment sub-options applying for the northern part of Options 8, 9, 10 and 12.

The corridor alignment concept includes and provides for:

- A total length of approximately 46 km (Mount White variant)
- Tunnelled alignments under Marramarra National Park and between the Hawkesbury River and the F3 freeway, and
- Major waterway crossings at Eastern Creek, First Ponds Creek, Second Ponds Creek, Caddies Creek, Strangers Creek, Layburys Creek, Hawkesbury River, Cohens Creek, Allens Creek, Breakfast Creek and Mangrove Creek.

Its maximum grades would be 4.5% over 4 km at Mount White and 4% from Canoelands to the Hawkesbury River.

Figure 5.19: Option 16 - Western Sydney Orbital at Dean Park to F3 north of the Hawkesbury, via Annangrove



5.6 Estimates of properties affected by each option

A strategic analysis was carried out to determine the indicative number of properties that each of the options would cross or pass under. The assessment framework included:

- 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. No distinction was made between surface and tunnelled alignments.
- The analysis did 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.
- No analysis was made to determine the number of properties that would be adjacent to the routes, without being crossed.

The results of the analysis are shown in **Table 5-1**.

Table 5-1: Indicative number of properties crossed or passed under, wholly or partly, by each of the preliminary options. (other than Option 14, which has been excluded from further analysis)

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

Notes:

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

5.7 Construction cost estimates

Comparative strategic cost estimates were prepared for each option as shown in **Table 5-2**. Preliminary long sections for each corridor option were prepared for this purpose, based on the nominal centrelines of the corridors.

Table 5-2: Indicative construction cost estimates for the preliminary corridor options. (other than Option 14, which has been excluded from further analysis)

Option	Surface ⁽²⁾ (\$ million)	Tunnel (\$ million)	Major bridges ⁽³⁾ (\$ million)*	Property acquisition ⁽⁴⁾ (\$ million)	Planning & Design Costs (\$ million)	Total length ⁽⁵⁾ (km)	Total cost (\$ billion) (\$2002)	Average cost per km (\$ million/km)
Type A corridor options								
1	\$24	\$1,100	\$0	\$10	\$81	7	\$1.1–1.3	\$190
2	\$42	\$1,500	\$0	\$10	\$110	8	\$1.6–1.9	\$190
3	\$33	\$1,600	\$0	\$10	\$120	9	\$1.7–2.0	\$180
4	\$120	\$1,900	\$0	\$15	\$150	11	\$2.1–2.4	\$180
						Range	\$1.1–2.4	\$180–190
Type B corridor options								
5	\$180	\$2,600	\$0	\$60	\$190	19	\$3.0–3.3	\$170
6	\$530	\$1,700	\$0	\$210	\$130	20	\$2.6–2.9	\$130
7	\$850	\$650	\$270	\$420	\$69	30	\$2.3–2.6	\$78
11	\$1,000	\$630	\$68	\$390	\$53	45	\$2.1–2.4	\$46
13	\$0	\$1,400	\$900	\$10	\$210	15	\$2.5–2.8	\$200
15	\$920	\$130	\$160	\$500	\$50	34	\$1.8–2.1	\$53
17	\$580	\$130	\$160	\$560	\$50	26	\$1.5–1.8	\$69
						Range	\$1.5–3.3	\$46–170
Type C corridor options								
8	\$1,000	\$760	\$350	\$800	\$84	54	\$2.7–3.3	\$51
9	\$630	\$1,800	\$350	\$620	\$160	46	\$3.6–3.9	\$75
10	\$850	\$920	\$350	\$450	\$96	51	\$2.7–3.0	\$50
12	\$980	\$950	\$350	\$520	\$99	44	\$2.9–3.2	\$61
16	\$1,100	\$950	\$350	\$310	\$99	48	\$2.8–3.1	\$62
						Range	\$2.7–3.9	\$50–75

Notes:

1. The analysis was based on information prepared for risk 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. Other bridges are included within the *Strategic Roadworks Manager* estimate.
4. Broad estimates only based on unit rates.
5. Excludes the length of access ramps.

No allowance has been made in the strategic estimates for the possible costs associated with the upgrades of the F3 Freeway or M2 Motorway that may be required earlier to cater for demand created by the construction of this link.

Cost estimates have 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) have been based on three-lane dual tunnels.

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, tunnels or bridges would generally be used.

At this strategic level of analysis cost estimates for the long list options were prepared based on Benchmark Software's *Strategic Roadworks Manager* program. This program has been designed to undertake strategic cost estimates of rural roads projects. In order to adapt the results for the urban conditions relating to this project, the costing of property acquisitions and tunnels was undertaken separately.

The *Strategic Roadworks Manager* cost estimates were cross-checked using a broad estimate of \$40 million per kilometre. The estimates from the program were generally thought to be low, compared to recent urban construction examples. These estimates were adjusted to allow for urban conditions such as confinement of the work space available, increased traffic control and greater control required for possible pollutants. Discussions were held with the Estimating Group of the RTA's Project Management Office to agree on appropriate construction rates.

The *Strategic Roadworks Manager* program does not include tunnels, so a different approach was taken to estimate driven tunnel costs. For tunnels, the following base costs were used:

- \$120 million per km for twin three-lane inner urban tunnels
- \$100 million per km for twin two-lane inner urban tunnels, and
- \$60 million per km for twin outer urban two-lane tunnels.

The \$100 million per km for twin two-lane inner urban tunnels is based on recent road tunnel projects in Sydney. This allows for:

- Tunnelling in sandstone, suitable for both road headers and tunnel boring machines
- Entry and exit tunnels, and
- Mechanical and electrical services.

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.

The estimated rate for major bridges was \$3,500 per square metre, in line with recent experience on some construction projects. Discussions with RTA's Estimating Group suggest this rate may be a little high, but it was adopted on the basis of the expected difficulty with construction of bridges such as the Hawkesbury River crossing, where the water depth is up to 60 metres.

The property acquisition costs were developed as follows:

- The properties counted were those within a 100 metre wide corridor centred on the option alignment, for the surface alignments only.

- Properties were counted as full acquisitions, regardless of whether the corridor passed right through or just took a strip. This was discussed with the RTA's Estimating Group, who agreed this would be appropriate. Should the acquisition costs be developed on a square metre rate, a corridor width of 150 metres was suggested.
- For surface roads through regional park areas, an allowance of \$500 per square metre was made.

In order to develop the project cost, an allowance was included for professional costs, including planning, design, project management and administration.

An allowance for service relocations was also included in the *Strategic Roadworks Manager* estimates.

The *Strategic Roadworks Manager* includes a 50% contingency in the totals calculated. The costs for the tunnels and major bridges have similarly been increased by a 50% contingency over the rates quoted above. The property costs include a 30% contingency, as recommended by RTA. These contingencies allow for:

- Unknowns in the project scope
- Variations in the quantities (such as increased length due to connections at either end of the link or modifications to the alignments), and
- Variations in the rates.

The estimates using this method must be seen as indicative only for the purpose of comparison between options. The cost estimates related to a standard Design and Construct (D&C) method of delivery.

6

Assessment and short-listing of corridors for further investigation

The assessment is described under the following headings:

- i) Options assessment framework;
- ii) Preliminary assessment of options against link objectives using the results fo the preliminary technical studies;
- iii) Overall assessment of Types A, B and C;
- iv) Assessment of the Type A (eastern) options; and
- v) Assessment of the Type B and Type C options and identification of options for further investigation outside this Study

6.1 Options assessment framework

Figure 6.1 summarises the overall processes that have been used in this study to develop and assess the long-list of corridor options described in Chapter 5 of this report and to identify a short-list of feasible route options for further, more detailed investigation.

The preliminary assessment framework has been designed to compare route options on the basis of a wide range of factors, including strategic, transport, environmental, social and economic parameters.

The key steps in the identification and recommendation of the options to be taken forward for more detailed analysis have been:

- 1) An initial assessment of all the options against the overall project objectives, primarily in order to group the options with similar characteristics and performances against these objectives.
- 2) A more detailed assessment of all the options in terms of a wide range of criteria, covering:
 - Traffic and transport issues
 - Strategic urban and regional development issues
 - Engineering feasibility
 - Social and environmental impacts
 - Urban design and landscape requirements, and
 - Economic costs, benefits and affordability.
- 3) An initial identification of the issues associated with the various options that are likely to be of greatest importance or concern to a range of community and stakeholder groups. This is primarily to assess whether

these issues might affect the selection of the 'short list' of options for more detailed analysis and also to help ensure that the key issues will be adequately addressed in the following investigations.

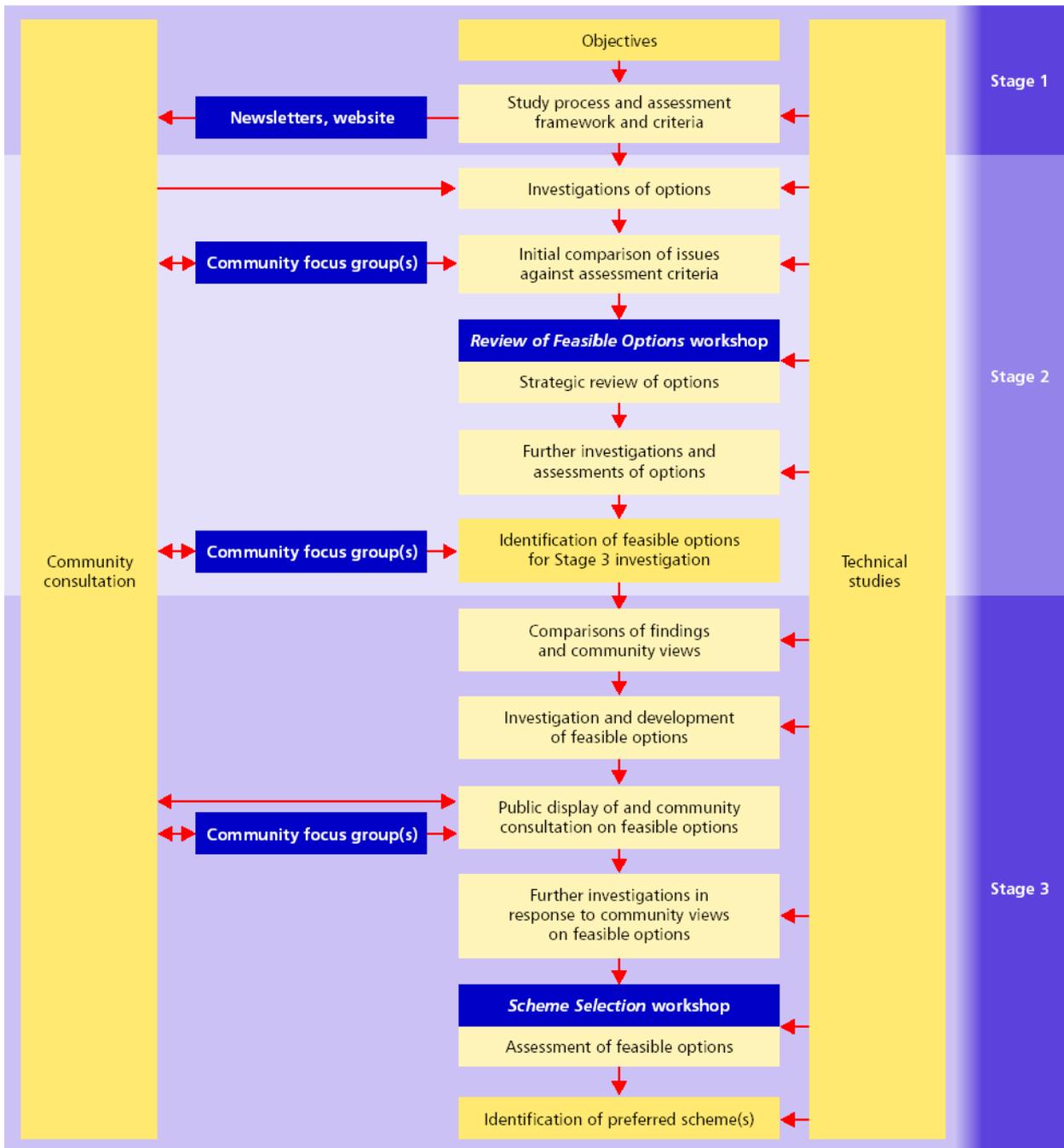
An assessment under the following community groups have been taken into account:

- 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
- Governments 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 the commencement of 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 and DOTARS, the SKM project team and the first round of the community focus group meetings.

This process has led to some amendments to the initial conclusions reached during the workshop, as documented below.

The rest of this chapter presents an overview of the option assessment outcomes of the workshop and subsequent investigations by the project team.

Figure 6.1: Option assessment processes and stages



6.2 Preliminary assessment of options against link objectives using the results of the preliminary technical studies

The options presented to the participants in the *Strategic Review of Feasible Options* value management workshop in June were assessed in terms of their strategic performance in meeting the project objectives:

- Provide a high standard transport link that integrates with the regional transport network.
- Improve safety on the National Highway between F3 and the Sydney Orbital and the surrounding road network
- Improve travel reliability and reduces road user costs of long distance commercial and freight vehicles operations between the F3 and the Sydney Orbital
- Alleviate traffic congestion and improves urban amenity along Pennant Hills Road (the existing interim National Highway)
- Minimise social and environmental effects during the link's construction and operation
- Provide opportunities for improvements to public transport
- Take into account growth in the region, particularly as it relates to inter-regional travel needs, and access to major centres of economic activity including Sydney ports.

Table 6-1 summarises a broad assessment of each of the options against the link objectives⁷.

This assessment indicated there are two broad groups of options related to how well options satisfy the link objectives (**Figure 6.2**):

- Type A options (Options 1, 2, 3 and 4), which 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 Sydney and would provide only relatively limited assistance to the future growth in the western part of Sydney.
- Type B and C Options, which, over a longer 20–40 year timeframe, would generally fulfil the objective of the growth of long distance transport needs as Sydney grows. They would not, however, provide traffic relief in the short/medium-term to the interim National Highway corridors, including Pennant Hills Road.

These 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).

⁷ With the exceptions of Option 13, which would not be feasible to construct, and Option 14, which would not itself provide an F3-Sydney Orbital link.

Table 6-1: Strategic assessment of the generally best-performing options against new link objectives

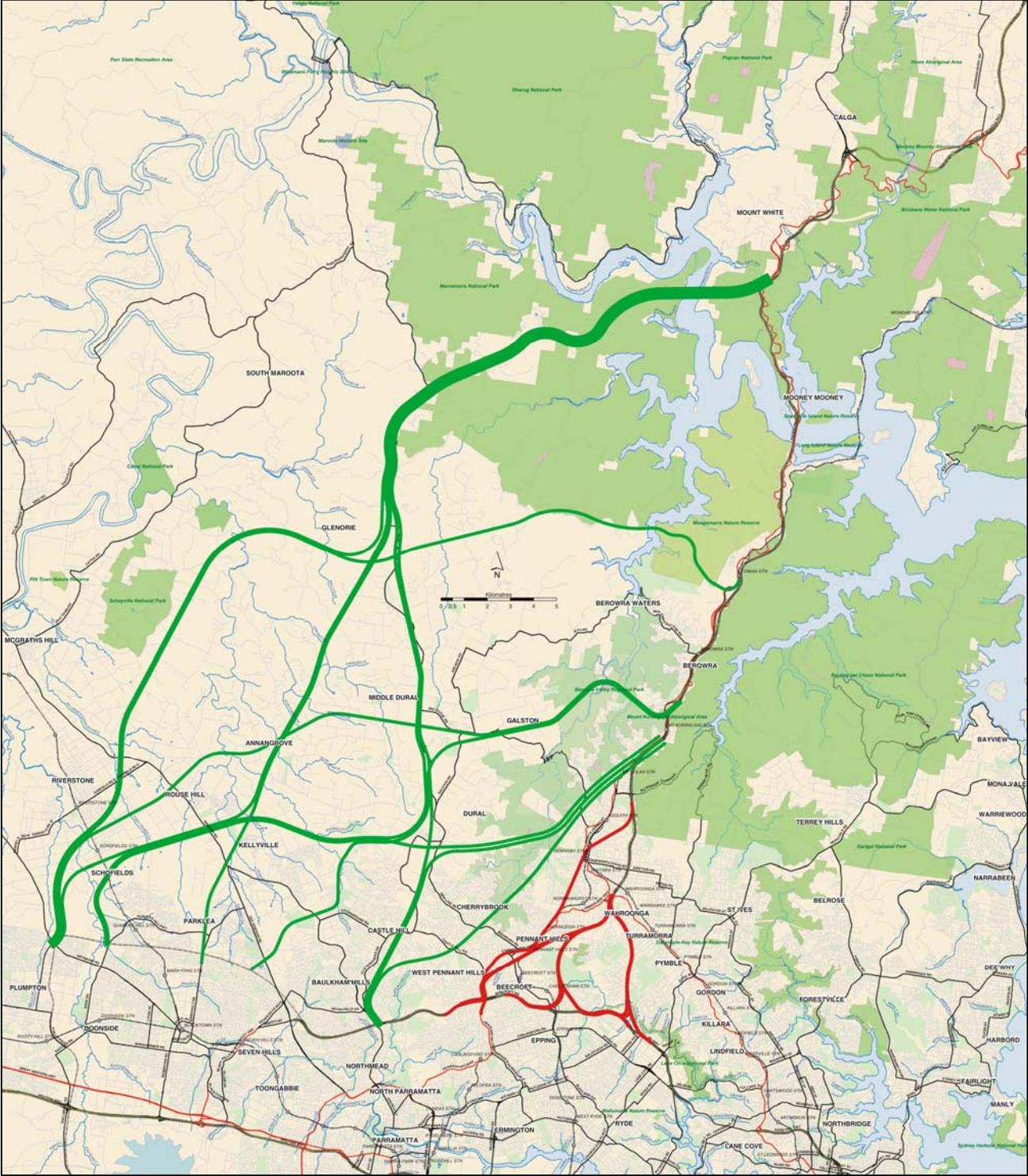
Project objectives	Assessment timeframe	Type A (eastern) options	Type B options (using existing F3 Hawkesbury River crossing)	Type C options (with new Hawkesbury River crossing(s))
Improved F3 to Sydney Orbital connection linked to regional network	Over next 10–20 years	✓	✓	✓
	Longer term, beyond 2021	✓	✓	✓
Improved safety on the existing National Highway and surrounding corridor	Over next 10–20 years	✓	x	x
	Longer term, beyond 2021	✓	x	x
Improve travel reliability and reduce costs of inter-regional commercial movements on the Interim National Highway	Over next 10–20 years	✓	x	x
	Longer term, beyond 2021	✓	✓	✓
Reduce arterial road congestion and improve urban amenity, especially along Pennant Hills Road	Over next 10–20 years	✓	x	x
	Longer term, beyond 2021	✓	✓	✓
Minimise social and environmental effects of a new link	Over next 10–20 years	✓	x	x
	Longer term, beyond 2021	✓	✓	✓
Provide opportunities to improve public transport along the Interim National Highway	Over next 10–20 years	✓	x	x
	Longer term, beyond 2021	✓	x	x
Meet inter-regional commercial transport needs, including improved access to Sydney ports	Over next 10–20 years	✓	x	x
	Longer term, beyond 2021	✓	✓	✓

Notes:

✓ denotes achievement or substantial achievement

x denotes expected lack of achievement

Figure 6.2: The Type A (generally short to medium term) and Types B and C (longer term) groupings of options



6.3 Overall Assessment of Types A, B and C

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.
- *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 over the timeframe of this study.
 - *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 WSO 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.
 - *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 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.

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 6-2**.

Table 6-2: Network Travel Costs and Benefits – Comparison of Type A and Type C

	% Change in network costs compared with Base Case ⁽¹⁾	
	Vehicle Hours	Vehicle Kilometres
Type A ⁽²⁾	-2.3	+0.4
Type C ⁽³⁾	-0.8	+0.3

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 6.3 illustrates typical traffic volumes on a Type C link in 2021 at the Hawkesbury River crossing⁸. It also shows typical traffic relief to Pennant Hills Road, Pacific Highway and Ryde Road from the Type C corridor.

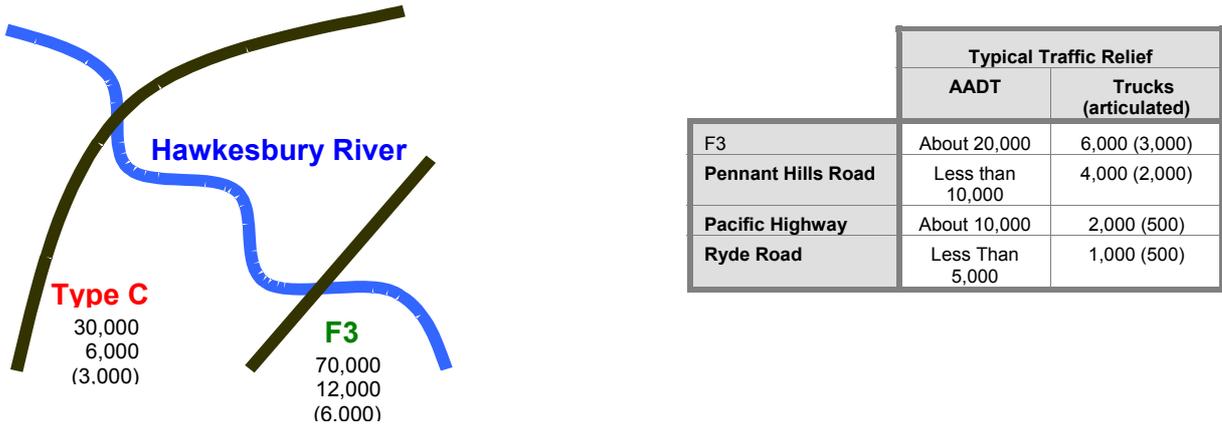
Of the typical 30,000 vehicles per day using Type C in 2021, about 20% would be heavy vehicles and about 5,000 vehicles would be re-distributed to/from western Sydney from the rest of the network including from the Central Coast.

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 6.3**. The traffic relief from Type A would be higher. (Refer to **Table 6-3**)

Figure 6.3 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 6.3: Typical Average Daily Traffic Relief on the Interim National Highway and arterial roads from Type C



⁸ 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 6-3** summarises the traffic analysis based on the outputs of the transport model developed for the purpose of this study.

Table 6-3: Transport assessment results, comparing the effects of Type A, B and C corridors

Transport Improvements	Measure	Corridor assessment			Comment
		Type A	Type B	Type C	
Traffic volumes on new link	Annual average daily traffic (AADT) in 2021 (untolled)	70–105,000	30–50,000	30–50,000	
Traffic congestion relief to Pennant Hills Road (existing National Highway corridor)	AADT in 2021 (untolled)	20–40,000	2,000-12,000	4,000-10,000	
Daily truck relief to interim National Highway ⁽¹⁾	Truck AADT	4,000-11,000	Up to 3,000	Up to 2,000	
Road safety changes on existing National Highway corridor	Savings in fatal and serious crashes per year ⁽²⁾	10–15	5–10	Less than 5	Based on current crash rates
Opportunity to improve public transport	Potential for re-allocation of road space on Pennant Hills road for buses	High	Medium	Low	Type A offers opportunities to improve bus running times along Pennant Hills Road. Type C offers greater benefits for buses using the F3.
Improved access to ports and centres of economic activity for long distance freight movement	Savings in travel time to major freight centres	Significant (to/from eastern Sydney and Port Botany)	Some (to/from western Sydney)	Some (to/from western Sydney)	Type A options offer a more direct route to Sydney ports.

Notes:

- (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.

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 6-4**. 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 6-4: Summary of Social Effects of Corridor Types

Social Criteria	Corridor Type		
	A	B	C
Potential adverse changes to the character of communities	Low	Medium-high	Medium-high
Change in severance, traffic emissions including noise impact along Pennant Hills Road	Significant improvement	Some improvement	No noticeable change
Number of properties affected:-			
•Directly on the surface ⁽¹⁾	20-130	80-450	300-600
•Indirectly ⁽²⁾	350-600	10-1400	10-700
Acceptability of urban design character changes ⁽³⁾	High	Medium	Low

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. Overall, Type A options would also have the lowest adverse social impact in the study area.

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 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 Marramarra 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 **Figure 6.5**. Overall, Type A options would have less environmental impact than Types B and C.

Table 6-5: A Summary of Environmental Impacts of Corridor Types

Environmental Criteria	Corridor Type		
	A	B	C
Impact on Bushland/National Parks	Low	High ⁽¹⁾	High
Potential Impact on threatened fauna species	Low	Medium	Medium
Effect on Water Quality ⁽²⁾	Low	Medium	Medium
Effect on Air Quality ⁽³⁾	Improve most	Improve slightly	Improve slightly
Impacts on character landscape ⁽⁴⁾	Low	Medium	High
Heritage effects – probable impact on known sites	Low	Medium-high	High

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.

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 6-6**.

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 \$15 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 6-6: Economic Performance of Types A, B and C Corridors

Economic Criteria	Corridor Type ⁽¹⁾		
	A	B	C
Capital Cost Estimate (\$million)	1,500 to 2,200	1,600 to 3,400	2,700 to 3,600
Operational Cost Estimate (\$million)	7 to 10 per year	6 to 15 per year	12 to 16 per year
Benefit Cost ratio	1.2 to 1.4	0.1 to 0.4	0.1 to 0.3
Support regional development	Yes	Yes	Yes

(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.

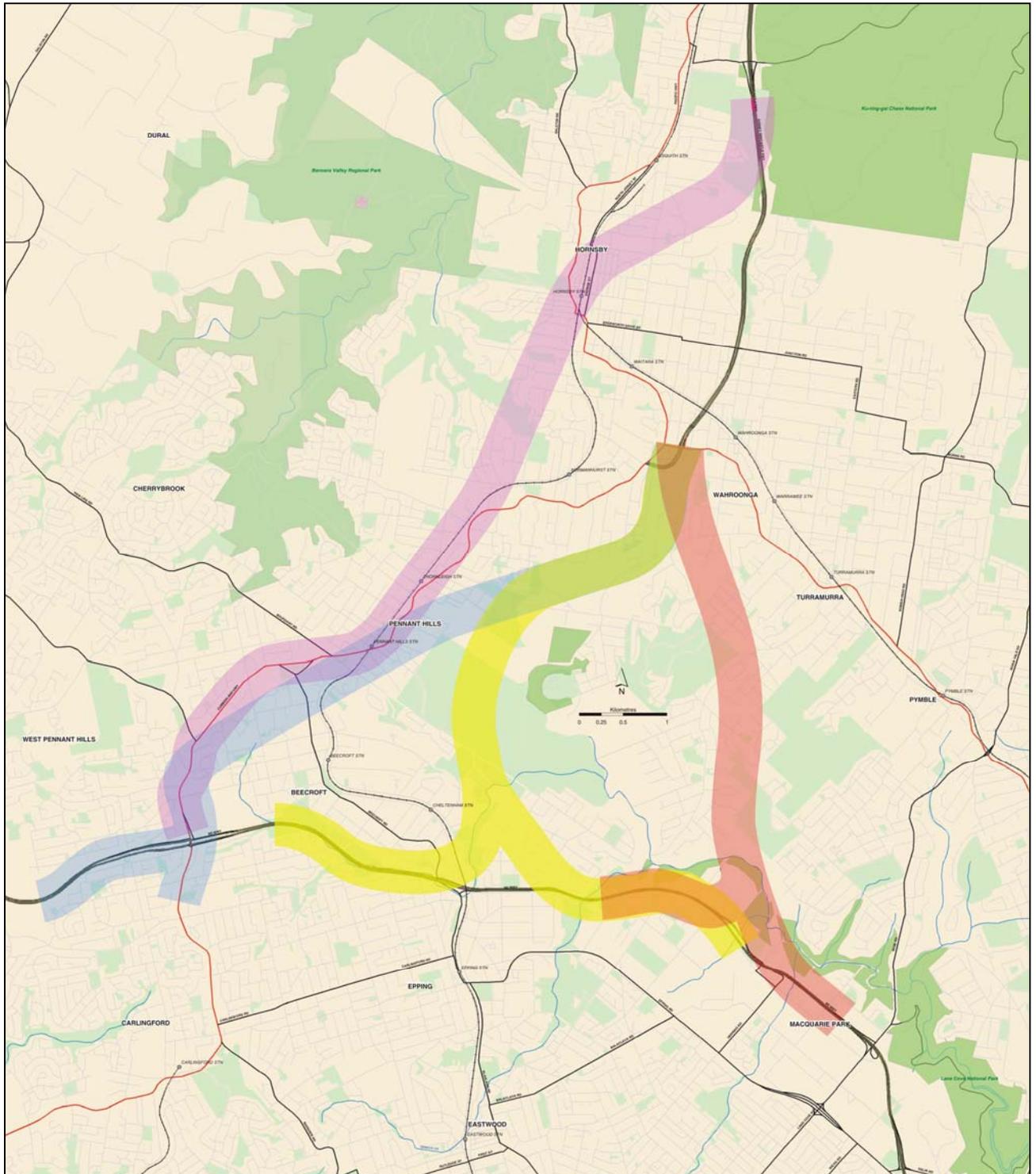
Overall Type A corridor options would have the best economic performance, against both project and National Highway economic objectives. Type A options would be easier for government to fund than Types B and C

6.4 Assessment of the Type A (eastern) options

Figure 6.4 shows the routes of the four eastern corridor options considered in the preliminary assessments (Options 1, 2, 3 and 4):

In the following assessment tables a rank of 1 is judged to be the highest, ie. best satisfying the criteria. The rankings are based on the results of technical studies within each area of investigation.

Figure 6.4: The Type A (eastern) Options 1 (red), 2 (yellow), 3 (blue) and 4 (magenta)



Traffic and transport criteria

At this strategic level of analysis there would be no major differences between the overall performance of the four feasible options in this group in terms of traffic and transport criteria.

Options 3 and 4 have been ranked slightly higher than Options 1 and 2, however, because they would be likely to provide significantly better traffic relief to Pennant Hills Road and equivalent or better performance in terms of road safety, public transport and service to heavy vehicles.

Type A (eastern) options	1	2	3	4
Traffic relief, including:				
• Traffic relief on northern Sydney arterial roads				
• Congestion on the interim National Highway, and	3	3	1	1
• Traffic route/inter connectivity				
Road safety	1	1	1	1
Public transport opportunities	2	2	2	1
Heavy vehicles access to arterial network:				
• Heavy vehicle diversions	3	3	1	1
• Freight opportunities				

Urban and regional development criteria

Option 2 is regarded as marginally the best option in this group. This is in terms of land use and urban development criteria, as it would provide for the most efficient land uses and would provide the most effective access for M2 traffic flows to and from both the east and the west.

Option 4 is not seen as an efficient land use option, as it effectively bypasses an existing freeway-standard road, the southernmost section of the F3. While it would improve local linkages to Hornsby, this is not a primary objective for a National Highway link and local linkages could be improved, if necessary, by other, less expensive means.

Type A (eastern) options	1	2	3	4
Urban and regional development, including:				
• Support for regional, State and national development				
• Access to ports, industrial centres and regional centres	2	1	2	4
• Facilitation of growth in northwestern Sydney and on the Central Coast (both short and long term)				
• Efficiency and acceptability of land use changes				

Engineering feasibility

Option 4 would be more difficult to construct than the tunnel-only options (Options 1, 2 and 3), although Option 1 might need to include a bridge crossing of Lane Cove River if the steep grade of the southern section of a fully tunnelled route were not acceptable.

Type A (eastern) options	1	2	3	4
Engineering feasibility, including:				
• Constructability of tunnels, interchanges, bridges and other surface components	1	1	1	4
• Terrain constraints				
• Impact on existing roads				

Social, environmental and urban design criteria

At this strategic level of assessment, there would be only minor differences between the options in this group in terms of social, environmental and urban design criteria.

Type A (eastern) options	1	2	3	4
Social criteria, including severance, accessibility, property impacts, regional access	1	1	1	1
Environmental criteria, including impacts on vegetation, reserves, fauna, habitat, water quality, heritage, air quality and noise	1	1	1	1
Urban design and landscape criteria, including connectivity, minimisation of land use and landform changes, visual impacts	1	1	1	1

Economic criteria

Option 2 is ranked below other options because of assessed lower user benefits.

Options 1 and 3 would have the best ratios of indicative travel benefits to capital costs.

Option 4 ranks behind Option 3, as it would have a higher project cost for similar travel benefits.

There is little opportunity to stage the Type A options.

Type A (eastern) options	1	2	3	4	
Economics, including:					
• Transport user benefits (preliminary estimates only)	}	2	4	1	2
• Change in vehicle kilometres					
• Ability to stage the project					
Capital Costs	1	2	3	4	

all options have equal rank

Preliminary assessments of likely effects on interest groups and other stakeholders to the Type A options

The interest groups taken into account during the preliminary assessments have been:

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

Only some of the anticipated responses of these various stakeholders have been ranked. Further, the rankings carried out so far should be regarded only as preliminary, as the options will be refined and the results of the on-going community consultations will provide more definitive information on community attitudes as the study progresses.

The rankings reported below have been used primarily to assess whether any particular issues might affect the selection of the “short list” of options for more detailed analysis. They will also be used at the later stages of the study to help ensure the key community issues are adequately addressed.

Travellers

These rankings, based on the traffic and transport criteria rankings summarised above, do not suggest a need to change the earlier ranking of options.

Type A (eastern) options	1	2	3	4
Car users	3	3	1	1
Commercial (light and heavy)	3	3	1	1
Bus and rail users	3	3	2	1
Pedestrians and cyclists	All options have equivalent rank			

Occupiers

Option 4 would have the greatest adverse impacts on residents in terms of properties likely to be affected.

The effects on and likely responses of commercial (office and retail), school, hospital and light agriculture stakeholders are yet to be assessed.

The acceptability of a bridge across Lane Cove River for Option 1, to avoid the steep grades associated with a tunnel under the river, will need to be carefully assessed. It should be noted that the community focus group and several other community consultation inputs have expressed the view that a bridge over the Lane Cove River is not acceptable. (Proposals for a Parramatta Rail Link bridge over this river had to be abandoned in the face of strong local community and environmental group opposition.)

The community is also concerned about impacts on amenity, including air pollution (vent stacks etc) and noise impacts. They want a tunnelled link, but are generally not in favour of additional road tolls.

Type A (eastern) options	1	2	3	4
Residents	2	2	1	4
Industrial	All options have equivalent rank			
Users of open space	3	3	1	2

Stakeholders concerned with the intrinsic values of the study area

In the community consultations to date, strong views have been expressed that options should not go through National Parks or other bushland areas.

Type A (eastern) options	1	2	3	4
National Parks EPA Councils Environment groups (assessed as one group)	If Option 1 involved a tunnel under Lane Cove River, all options would have an equivalent rank.			
	If Option 1 involved a bridge over Lane Cove River, it would rank below the other options for these stakeholders.			

Government agencies

These rankings are based on the transport, economic and regional development criteria rankings summarised above and do not suggest a need to change the selection of options given above.

The impacts on and likely responses of finance, funding and tourism stakeholders are yet to be assessed.

Type A (eastern) options	1	2	3	4
Those concerned with:				
Net community benefit	2	4	1	2
Transport efficiency	1	4	1	2
Regional development	2	1	2	2

Shortlisting of the Type A (eastern) corridor options for further investigation

On the basis of the assessment of the Type A corridor options summarised above,

- Option 4 is assessed as being unnecessary and cost-ineffective when compared to Option 3, as it would provide only similar traffic user benefits but at a significantly greater cost.

The other benefits that might be induced by the additional linkages associated with Option 4, such as increased utilisation of the Hornsby public transport interchanges and faster growth of Hornsby as a commercial centre, are primarily *local* link improvement benefits best addressed through integrated transport planning at the local and State levels.

It is therefore recommended that Option 4 should be excluded from the detailed concept development and investigations. A variant of Option 4, making use of the existing transport corridors (Pennant Hills Road and

Main North Rail Line), without a direct link to Hornsby but with a direct link to the F3 at Wahroonga should be considered further in Stage 3.

Public transport opportunities, including access to the important Hornsby public transport interchanges, should, however, continue to be examined as part of the analysis under the selected Type A tunnel options.

- The performance of Options 1, 2 and 3 is similar across the broad range of assessment criteria considered, and in particular in meeting the key transport objectives of the project.

As no significant reasons have been found for excluding any of these options from further consideration at this stage, it is recommended that Options 1, 2 and 3 should be taken forward for more detailed analyses.

In the case of Option 1, it is recommended that the bridge and tunnel Lane Cove River crossing variants should both be taken forward for assessment.

6.5 Assessment of the Type B and Type C options and identification of options for further investigation outside this Study

Each of the Type B and Type C options (5, 6, 7, 8, 9, 10, 11, 12, 15, 16 and 17), presented at the *Strategic Review of Feasible Options* value management workshop held on 26 June 2002, has been evaluated by the project team using the same assessment framework as for the Type A options.

For ease of reference, **Figure 6.5** shows the routes of all of these Type B and Type C options as they stood at the time of this workshop. (Several of the routes have subsequently been refined.)

In this figure the options are grouped into those options joining the F3 south of the Hawkesbury River (Type B) and therefore reliant on the existing Hawkesbury F3 crossing (Options 5, 6, 7, 11, 15 and 17) and those options involving a new Hawkesbury crossing or crossings (Type C) and joining the F3 north of the Hawkesbury (Options 8, 9, 10, 12 and 16).

An additional type of option discussed at the workshop, an “inland” link between the New England Highway and the Sydney Orbital via (for example) a Putty Road corridor, a Wisemans Ferry/Broke Road corridor or a Peats Ridge/Yarramalong corridor, may be considered further at later stages of the study. A widening of the study’s scope would be required to include an inland route corridor.

Table 6-7 summarises the assessments of these original⁹ options by the workshop participants.

⁹ The term “original” is used here and in the rest of Chapter 6 to distinguish the options presented to the workshop from later refinements of these options and later combinations of the elements options. Options 13 and 14 are not discussed here as they are not considered feasible options (see Chapter 5).

Table 6-7: Summary of assessments of the western options by workshop participants
Note: A number of these “original” options have subsequently required modification.*

Assessment criteria	Type B Options joining the F3 south of the Hawkesbury						Type C Options involving new Hawkesbury River crossing(s)					“Inland” New England Highway–M2 link	
	5	6	7	11	15	17	8	9	10	12	16		
Traffic and transport					★	★	★		★			★	Not yet assessed (an extension of the study would be required if this were to be included)
Urban development						★	★						
Engineering feasibility				★	★	★	★	★					
Social and community		★	★	★	★	★	★	★	★			★	
Environmental	★	★	★										
Economic					★	★			★				
Treasury/Government					★	★	★		★				

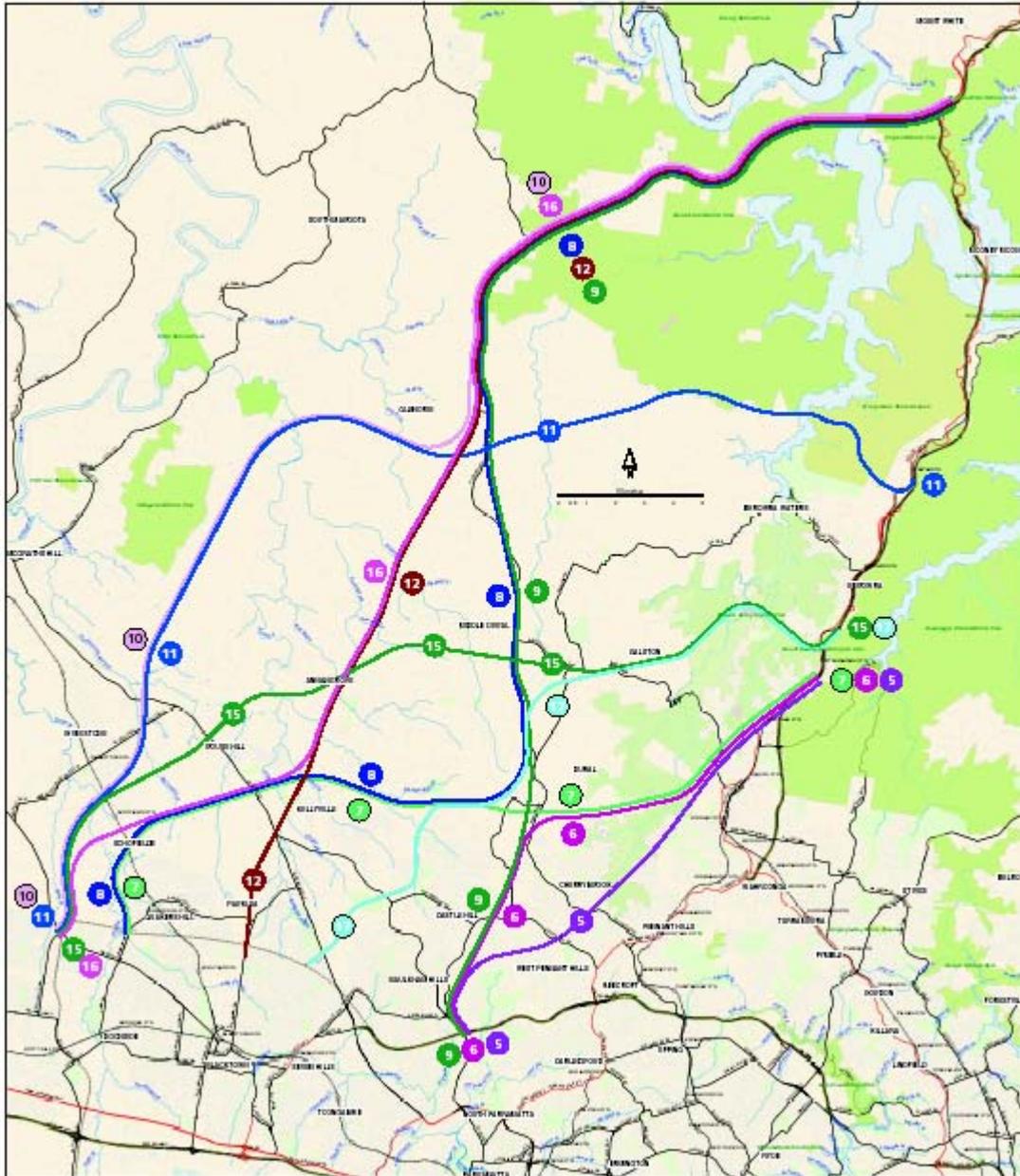
In **Table 6-7**, a ★ sign indicates the option(s) regarded by the workshop participants as likely to have the best performance in terms of the broad criteria listed.

The assessment of the Type B and Type C options has been at a strategic level, examining broad corridors (a kilometre or so wide) rather than specific routes (100 metres wide).

The assessment of the Type B and Type C options has focused on:

- The exclusion of route options which are not considered feasible or practical or which would produce only limited benefits in the long term
- Refining of the broad corridors, particularly in terms of the location of their intersections with the F3 and Sydney Orbital /M2, and
- Ensuring that the options selected adequately reflect the broad strategic corridor options available for the National Highway in the Sydney region.

Figure 6.5: The Type B and Type C Options, as developed for the Strategic Review of Feasible Options value management workshop on 26 June 2002



Feasible connection points to the Sydney Orbital/M2

It is recommended that three of the five locations originally suggested as possibilities for a connection between a Type B or Type C link and the M2/Sydney Orbital should now be excluded from further consideration and investigation.

The connection locations no longer considered practical are:

- A connection at Dean Park (as under the “original” Options 10, 11, 15 and 16), because of environmental (flora and heritage) constraints

- A connection at Sunnyholt Road (Options 12), because of construction constraints on Sunnyholt Road (insufficient road space), and
- A connection at Windsor Road (Options 5, 6 and 9), because of existing traffic flows and the size and complexity of the intersection required.

The two Type B/Type C connection locations recommended for further future consideration are therefore at Quakers Hill Parkway (as under the Options 7 and 8) and at Northwest Boulevard in Kings Langley (as under the Option 17).

The elimination of three of the five originally identified possible connection locations at the southern end of a new western link has led the study team to consider possible combinations of the northernmost and southernmost sections of several of the original options, as discussed below.

Feasible second Hawkesbury crossings and connection points to the F3

For any Type C link involving a new crossing of the Hawkesbury River, such as the Options 8, 9, 10, 12 and 16, more analysis is required on the feasibility and desirability of single or multiple new crossings of the Hawkesbury.

At present, constructability and acceptability considerations suggest a single new crossing would be preferable to a new double crossing.

This suggests the best connection with the F3 might best be at the southernmost of the identified possible connection locations north of the Hawkesbury, about 1 km north of Lily Hill.

It is recommended, however, that alternative river crossings and connections should be also analysed. In particular, as discussed below, an F3 connection at Kariiong or even Somersby, well to the north of Mount White, would assist in relieving longer term traffic congestion on the F3 south of its Wyong, Tuggerah and Gosford connections. It has not yet been established, however, whether corridors leading to such a connection would be feasible with only one crossing or whether two would be required.

Feasible Berowra Valley corridors

The community has expressed strong views against any route along or across the Berowra Valley.

At the 26 June 2002 workshop, the participants concluded that the Option 11 corridors across Berowra Creek just north of Berowra Waters would be most unlikely to ever be acceptable, and that this option should therefore be discarded from further consideration.

A closer inspection of this option has subsequently led to the development of a revised conceptual corridor, slightly to the south of the original routes, crossing Berowra Creek without impinging on Muogamarra Nature Reserve areas.

However, this revised option is similar in nature to the other options crossing the Berowra Valley (Options 6, 7, 15 and 17). Option 5, travelling along the valley, would also face community opposition on environmental grounds. For consistency, the Berowra Valley components of *all* of these options should be either excluded from or included for further investigation; there is no logical basis for excluding the revised Option 11 alone.

Feasibility of long-term relief of F3 capacity constraints

As discussed in Section 2.5 of this report, even with further widening of the F3 within its existing road reserve between Kariiong and Wahoonga, the capacity constraints on the F3 are likely to be evident by around 2026 or earlier, depending investments in capacity improvements to the Main North rail line.

This implies any longer term connection with the F3 should be north of the Hawkesbury River (as under Options 8, 9, 10, 12 and 16) rather than south of the Hawkesbury (as under Options 5, 6, 7, 11, 15 and 17).

It also implies that the F3 connection should be as far north of the Hawkesbury as possible, subject to engineering feasibility, cost and environmental constraints, so as to maximise the capacity relief provided for the congested section of the F3 south of the links between the F3 and Wyong, Tuggerah and Gosford.

Operational and engineering constraints in the Cherrybrook/Castle Hill area

While the construction of Type B or Type C links through the Cherrybrook/ Castle Hill area (as under Options 5, 6 and 9) would be feasible, their operation would load significant volumes of southbound traffic onto roads south of the M2, which are already highly congested.

In addition, significant and expensive lengths of tunnelling would be required to avoid unacceptable impacts on the Cherrybrook and Castle Hill residential areas. There would be limited options for interchange designs at the M2 within the required geometric standards, especially with the proposed extension of the M2 bus lanes west of Windsor Road.

Interest group and other stakeholder issues concerning the Types B and C options

The main stakeholder-specific issues identified in the assessments of the Type B and Type C options are listed below.

Travellers

- A Type B link joining the F3 south of the Hawkesbury would necessitate a more significant upgrading to the F3 than a Type C link joining the F3 north of the Hawkesbury, but would have a greater impact on traffic diversions in the short to medium term than the other western corridors.
- Heavy vehicle diversions and freight routing will be important considerations in developing the Type B and Type C options.
- All the Type B and Type C options offer opportunities for public transport improvements, however there would be limited improvement opportunities on the interim National Highway as a result of the limited traffic relief to Pennant Hills Road.

Occupiers

- A key issue for the Type B and Type C options will be their potentially significant impacts on the large number of existing rural or semi-rural residents and on users of open space in the corridors.
- There is a potential for significant adverse impacts on the character and amenity of the areas traversed.
- In the community consultations to date objections have been raised against the options passing through the Dural and Galston Gorge areas.

Stakeholders concerned with the intrinsic values of the study area

- The principal concerns here are the acceptability of corridors through National Parks (for a link joining the F3 north of the Hawkesbury or an “inland” link) or Regional Parks (for a link joining the F3 south of the Hawkesbury).
- A related concern is the acceptability of a new bridge crossing or crossings of the Hawkesbury River (for a link joining the F3 north of the Hawkesbury or an “inland” link).
- If any part of a National Park were required for the project there would be a need to gain approval through legislation.
- There is a potential for significance impacts on terrestrial environments on sections of most of the western options.
- In the community consultations to date, strong views have been expressed that the link should not go through National Parks, Berowra Valley Regional Park or other bushland areas.

Government

- An issue to be investigated is the likely level of transport user benefits derived from the Type B and Type C options, which would have less user benefits in the short to medium term than the Type A options. Overall, higher benefits would be required to offset the higher capital costs of the Type B and Type C options when compared with the Type A options. While no
- The corridor follows, rather than cuts across, the main waterway in the southern part of Berowra Valley Regional Park, and would be subject to community opposition on environmental grounds
- It would be subject to serious operational and engineering constraints in the Cherrybrook/Castle Hill area, and
- or Type C options, which are more expensive to build. (In contrast, significant interest in the Type A options could be expected, because they are less costly to build and offer greater user benefits and toll revenues.)

Shortlisting of Types B and C options for further investigation outside this Study

On the basis of the study team's analyses of the factors affecting the Type B and Type C options, summarised above, it is recommended that:

- The Option 5 corridor should not be further investigated as part of the further investigations, because:
 - This link would connect with the F3 south of the Hawkesbury, and would therefore provide no long-term capacity relief for the F3 south of Mount White.
 - The corridor follows, rather than cuts across, the main waterway in the southern part of Berowra Valley Regional Park, and would be subject to community opposition on environmental grounds
 - It would be subject to serious operational and engineering constraints in the Cherrybrook/Castle Hill area, and
 - It would necessitate an impractical connection with the M2 at Windsor Road.
- The Option 6 corridor should not be further investigated further because:
 - This link would connect with the F3 south of the Hawkesbury, and would therefore provide no long-term capacity relief for the F3 south of Mount White.
 - It would cut across the Berowra Valley Regional Park
 - It would be subject to serious operational and engineering constraints in the Cherrybrook/Castle Hill area, and
 - It would necessitate an impractical connection with the M2 at Windsor Road.
- The northern section of the Option 7 corridor, between Round Corner and the F3 at Mount Colah, should not be further investigated because:
 - This link would connect with the F3 south of the Hawkesbury, and would therefore provide no long-term capacity relief for the F3 south of Mount White, and
 - It would cut across the Berowra Valley Regional Park.

- The southern section of the Option 9 corridor, between the M2 at Windsor Road and Dural, should not be further investigated because:
 - It would be subject to serious operational and engineering constraints in the Cherrybrook/Castle Hill area, and
 - It would necessitate an impractical connection with the M2.
- The southernmost section of the Option 10 corridor, from the Sydney Orbital at Dean Park to Schofields, should not be further investigated as it would necessitate a connection at Dean Park, which would be impractical because of environmental constraints.
- The northern section of the Option 11 corridor, from Glenorie to the F3 at Cowan, should not be further investigated because:
 - This link would connect with the F3 south of the Hawkesbury, and would therefore provide no long-term capacity relief for the F3 south of Mount White, and
 - Even with the revised alignment across Berowra Waters, avoiding the Muogamarra Nature Reserve, it would be subject to community opposition on environmental grounds.
- The southernmost section of the Option 11 corridor, from the Sydney Orbital at Dean Park to Schofields (using the same route as this section of Option 10), should not be further investigated as it would necessitate a connection at Dean Park, which would be impractical because of environmental constraints.
- The southernmost section of the Option 12 corridor, from the Sydney Orbital at Sunnyholt Road at Parklea to Kellyville, should not be further investigated as it would necessitate a connection at Sunnyholt Road, which would be impractical because of construction constraints.
- The northern section of the Option 15 corridor, from Middle Dural to the F3 at Mt Ku-ring-gai via Galston, should not be further investigated because:
 - This link would connect with the F3 south of the Hawkesbury, and would therefore provide no long-term capacity relief for the F3 south of Mount White, and
 - Its route through the Berowra Valley Regional Park would be subject to community opposition on environmental grounds.
- The southernmost section of the Option 15 corridor, from the Sydney Orbital at Dean Park to Schofields, should not be further investigated, as it would necessitate a connection at Dean Park, which would be impractical because of environmental constraints.
- The southernmost section of the Option 16 corridor, from the Sydney Orbital at Dean Park to Schofields, should not be further investigated, because it too would necessitate an impractical connection at Dean Park.
- The northern section of the Option 17 corridor, from Middle Dural to the F3 at Mt Ku-ring-gai via Galston (using the same route as this section of Option 15), should not be further investigated because:
 - This link would connect with the F3 south of the Hawkesbury, and would therefore provide no long-term capacity relief for the F3 south of Mount White, and
 - Its route through the Berowra Valley Regional Park would be subject to community opposition on environmental grounds.

The Type B and Type C options recommended for further investigation outside this Study are therefore:

- The corridors connecting the Sydney Orbital/M2 at Quakers Hill Parkway (Options 7 and 8) or Norwest Boulevard (Option 17) with the F3 north of the Hawkesbury River (Options 8, 9, 10, 12 and 16).

These corridors, shown in **Figure 6.6**, would combine the various non-excluded sections of Options 7, 8, 9, 10, 11, 12, 15, 16 and 17. The possibilities include:

- A Glenorie–Box Hill–Schofields link (originally part of Options 10 and 11) combined with a Schofields–Quakers Hill Parkway link (originally part of Options 7 and 8)
 - A Glenorie–Annangrove–Kellyville link (part of Options 12 and 16) combined with a Kellyville–Schofields link (part of Options 7, 8 and 16) and a Schofields–Quakers Hill Parkway link (part of Options 7 and 8)
 - A Glenorie–Annangrove link (part of Options 12 and 16) combined with an Annangrove–Rouse Hill–Schofields link (part of Option 15) and a Schofields–Quakers Hill Parkway link (part of Options 7 and 8)
 - A Glenorie–Dural link (part of Options 8 and 9) combined with a Dural–Round Corner link (part of Option 8), a Round Corner–Kellyville link (part of Options 7 and 8), a Kellyville–Schofields link (part of Options 7, 8 and 16) and a Schofields–Quakers Hill Parkway link (part of Options 7 and 8)
 - A Glenorie–Dural link (part of Options 8 and 9) combined with a Dural–Round Corner link (part of Option 8) and a Round Corner–Norwest Boulevard link (part of Option 17)
 - A Glenorie–Middle Dural link (part of Options 8 and 9) combined with a Middle Dural–Annangrove–Rouse Hill–Schofields link (part of Option 15) and a Schofields–Quakers Hill Parkway link (part of Options 7 and 8), and
 - A Glenorie–Middle Dural link (part of Options 8 and 9) combined with a Middle Dural–Annangrove link (part of Option 15), an Annangrove– Kellyville link (part of Options 12 and 16), a Kellyville–Schofields link (part of Options 7, 8 and 16) and a Schofields–Quakers Hill Parkway link (part of Options 7 and 8).
- An “inland” link between the New England Highway and the Sydney Orbital, with the corridors to be examined including:
 - A Putty Road corridor
 - A Wisemans Ferry to Singleton and/or Cessnock corridor, and
 - A Peats Ridge to Singleton and/or Cessnock corridor.

Indicative corridors for the “inland” options are shown in **Figure 6.7**.

Figure 6.6: The Type C options recommended for further investigation, connecting the Sydney Orbital/M2 at Quakers Hill Parkway or Norwest Boulevard with the F3 north of the Hawkesbury River

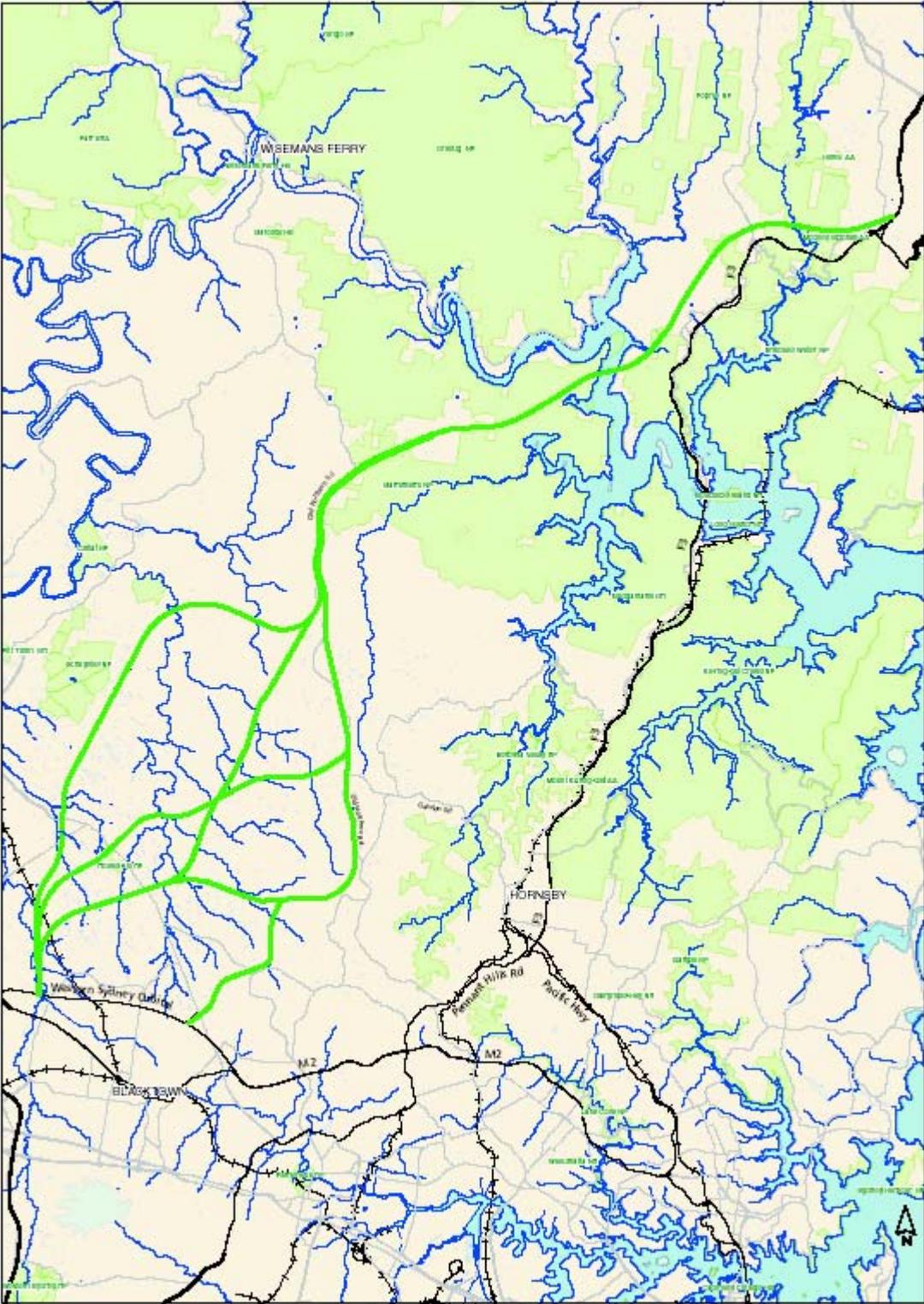
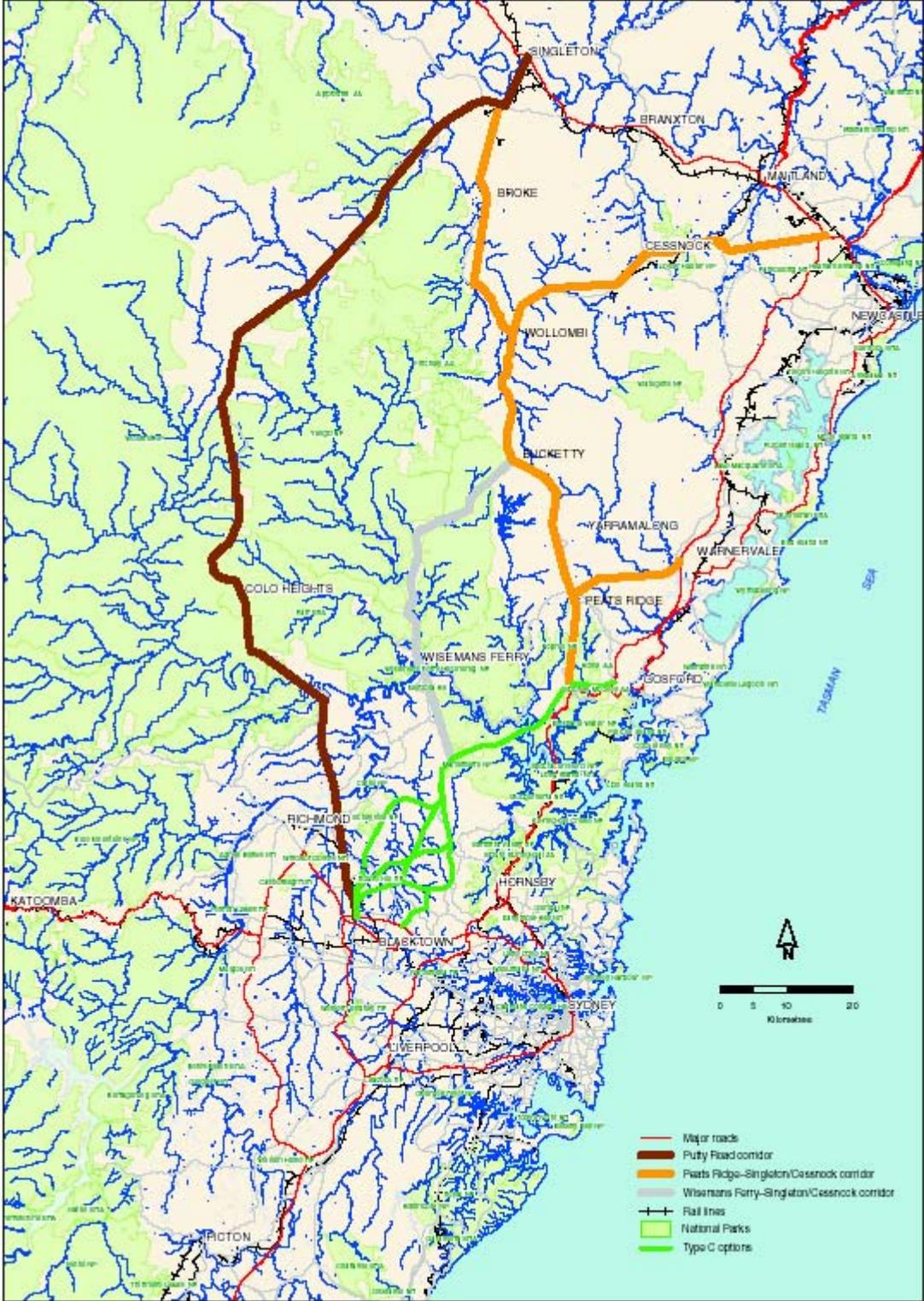


Figure 6.7: The concept of an “inland” longer-term transport link between the New England Highway and the Sydney Orbital is also recommended for further investigation. Potential corridors include Putty Road, Wisemans Ferry and Peats Ridge corridors



7

Conclusions from the preliminary study and recommendations for further investigation

7.1 Preliminary study outcomes

The Type A (eastern) options for further investigation

The study findings indicate that Type A options would best satisfy the transport objectives of a new link including traffic relief to the interim National Highway along Pennant Hills Road. It is likely that at least one of these options would satisfy the new links planning and project objectives within acceptable environmental, social and community standards.

It is recommended that three Type A options should be further investigated (**Figure 7.1**):

- A “Blue option”, from the M2 at Pennant Hills Road to the F3 at Wahroonga
- A “Yellow option”, from the M2 at the M2 tunnel to the F3 at Wahroonga, and
- A “Red option”, from the M2 at Macquarie Park to the F3 at Wahroonga.

It is also suggested that a variation of the Blue option be considered in Stage 3, which has the same interchange locations as the Blue option with a tunnel route alignment more closely following Pennant Hills Road.

The Blue option: M2 at Pennant Hills Road to F3 at Wahroonga

This option would have a southern connection to the M2 motorway at Pennant Hills Road and a northern connection to the F3 freeway at Wahroonga. An intermediate interchange at Boundary Road/Beecroft Road in Pennant Hills should also be investigated.

The current conceptual corridor alignment, shown in **Figure 7.1**, includes and provides for:

- Approximately 8 km of the route being in dual two-lane or three-lane tunnels
- Tunnelling close to Pennant Hills Road in Pennant Hills and under Beecroft Road, the Main North railway and Pennant Hills Road in Normanhurst and a connection to the F3 at Pearce Corner, and
- No major waterway crossings.

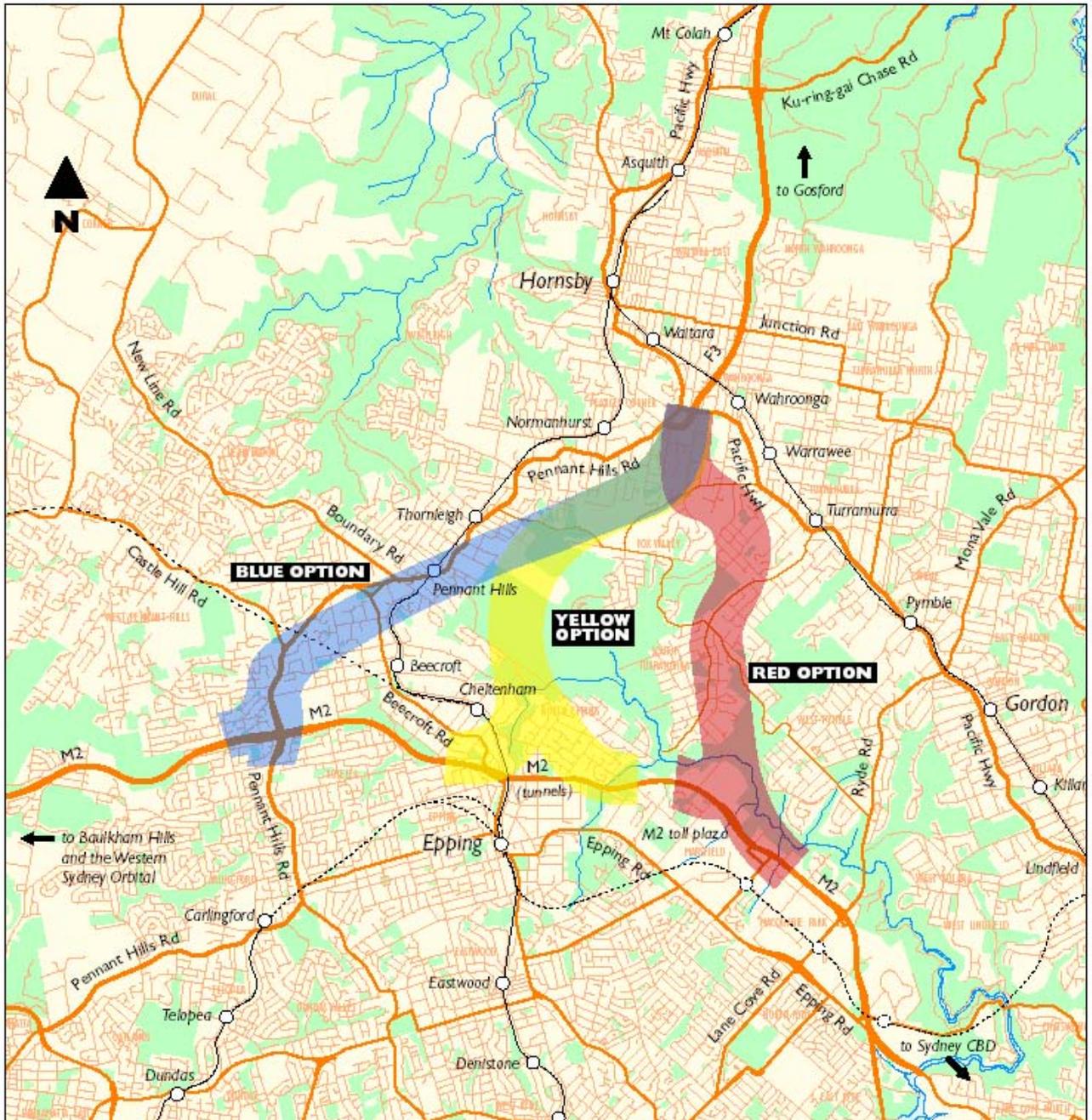
The Yellow option: M2 at North Epping to F3 at Wahroonga

This option would have dual southern connections to the M2 motorway, on either side of the existing M2 tunnel at Terrys Creek to the east and Beecroft Road to the west, and a northern connection to the F3 freeway at Wahroonga.

The current conceptual corridor alignment, shown in *Figure 7.1*, includes and provides for:

- A 2.5 km single lane dual tunnel eastern connection with the M2 and a 2.0 km single lane dual tunnel western connection with the M2, with these tunnels joining a 6.5 km long dual two-lane or three-lane tunnel alignment
- Tunnelling under North Epping, Devlins Creek Valley, Pennant Hills Park, Lane Cove National Park, Sydney Adventist Hospital, Coups Creek Valley and Exeter Road, and

Figure 7.1: The three Type A (eastern) options recommended for further detailed investigation



- Major waterway crossings at Devlins Creek, Lane Cove River and Coups Creek.

The Red option: M2 at Macquarie Park to F3 at Wahroonga

This option would have a southern connection to the M2 motorway at Macquarie Park, immediately to the west of the existing tollbooths, and a northern connection to the F3 freeway at Wahroonga.

The current conceptual corridor alignment, shown in **Figure 7.1**, includes and provides for:

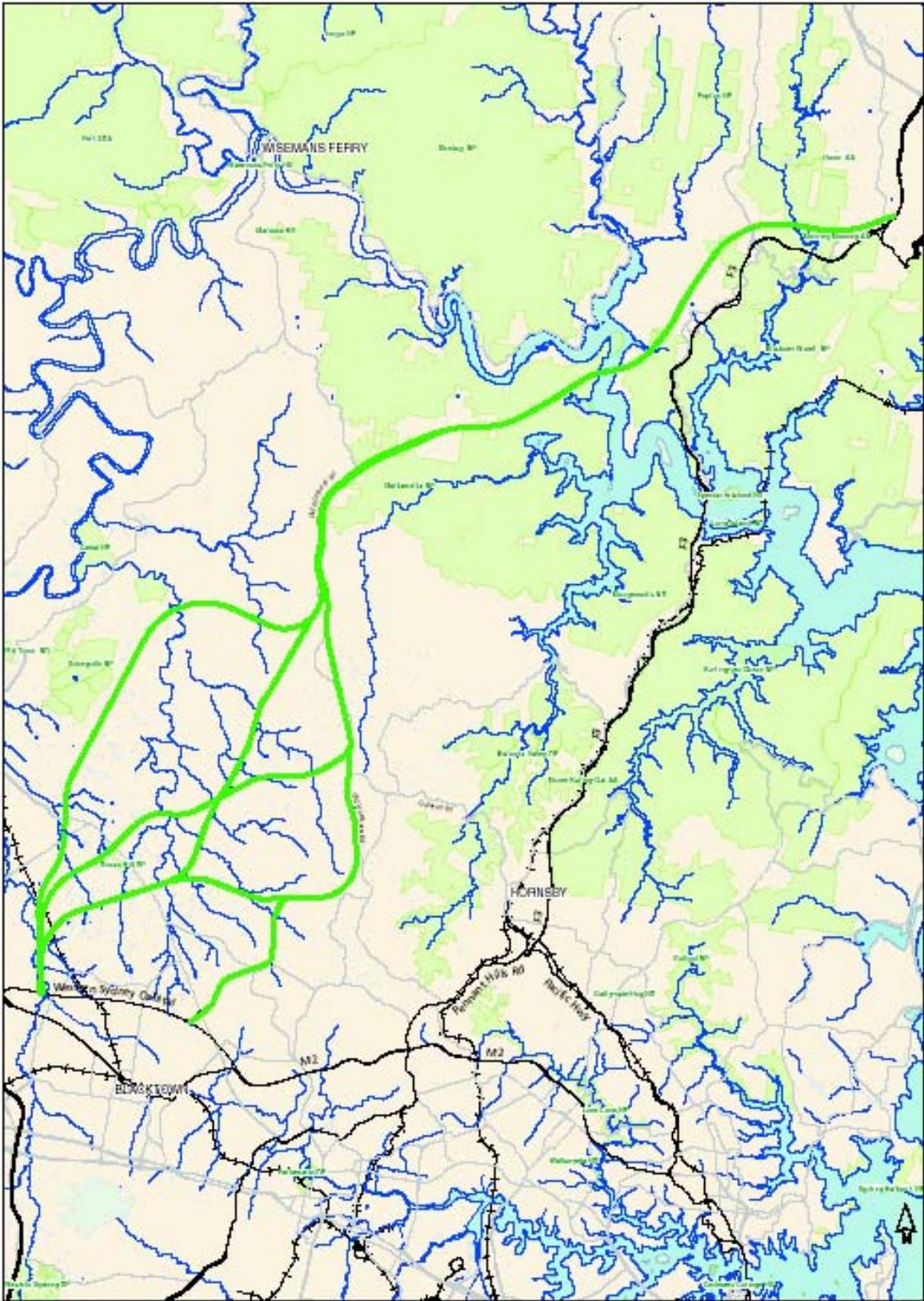
- Approximately 6.5 km of the route being in dual two-lane or three-lane tunnels
- Tunnelling under the Macquarie Park sporting fields, Kissing Point Road, Comenarra Parkway, Twin Creeks Reserve, Lucinda Avenue South and Exeter Road, and
- Major waterway crossings at Lane Cove River, Mitchell Creek and Coups Creek.

An alternative bridge crossing of the Lane Cove River should also be investigated. If this approach were acceptable, it would alleviate steep gradients at the southern end of the link.

The Type C (western) options for further investigation outside this Study (*Figure 7.2*)

On the basis of the investigations undertaken so far and summarised in sections 6.3 and 6.4, the Type C options shown in **Figure 7.2** could also be taken forward for further analysis, in the context of a more holistic study of the future development of metropolitan Sydney.

Figure 7.2: Type C (western) corridor options for further investigation



Investigation into F3 improvements

At the 26 June workshop it was recognised that there was also a need to further investigate the feasibility of access to the F3 north of Kariong, as far north as Wyong, to avoid increasing traffic congestion on the F3 south of Wyong in the future.

The F3 will be widened to six lanes between Kariong and the Hawkesbury River by the end of 2004. Further widening of the F3 and the widening needs of the M2 to accommodate traffic growth as part of the National Highway's needs should be investigated in more detail. The preliminary analysis indicates that by around 2021 the F3 corridor could be subject to demands beyond the capacity of a six-lane freeway, even if programs to upgrade rail infrastructure and services and increase rail's freight and passenger market shares in the corridor are successfully implemented.

Any further study of the need to provide extra capacity in the F3 corridor would need to consider not only the development of Sydney's north west sector and the Central Coast, but also population and employment growth and development patterns and opportunities in Newcastle and the Lower Hunter region. It would also need to consider the long-term strategic options for urban development proposed by Planning NSW and State Development.

7.2 Recommendations for further detailed investigations

It is recommended that the key areas for further study should include:

- The development of concept engineering designs for the three Type A options (Blue, Yellow and Red, shown in **Figure 7.1**), including interchange treatments, typical options for the location of ventilation stacks and cost estimates
- An assessment of the Type A options in terms of their social, environment and economic effects, within the study's agreed assessment framework
- An investigation of the potential to re-allocate road space on Pennant Hills Road for public transport, cyclists and pedestrians
- An investigation of opportunities to move more freight by rail, and the likely social, environmental and economic effects
- An investigation of public transport improvement opportunities in the corridor, including a "public transport only" option
- An investigation of the potential to widen the F3 beyond six lanes in the future, and
- An investigation of tolling regimes, funding scenarios and "Public Private Partnership" opportunities for the National Highway.

The investigations listed above should also examine how governments can invest in integrated transport infrastructure improvements, including rail, as part of the preferred National Highway scheme linking the F3 to the Sydney Orbital.

It is also recommended that a further study to investigate the longer-term (beyond 2021) long-distance transport needs on the eastern coast between Newcastle and Sydney be conducted. Such a study would need to involve State government agencies, including Planning NSW. The preferred National Highway scheme will need to reflect an integrated road/rail approach and incorporate a strategic plan for long-distance and regional transport.