DEPARTMENT OF TRANSPORT AND REGIONAL SERVICES

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IMPROVING TRANSPORT ON THE WARRINGAH PENINSULA: ISSUES AND OPTIONS

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IMPROVING TRANSPORT ON THE WARRINGAH PENINSULA: ISSUES AND OPTIONS

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FOREWORD

At the Warringah Transport Summit on 26 February 2002 convened by the Hon Tony Abbott MP, Member for Warringah, the Deputy Prime Minister and Minister for Transport and Regional Services, the Hon John Anderson MP offered the assistance of the BTRE in analysing the cost and feasibility of options to improve transport in the Warringah Peninsula region of Sydney.

Warringah is an established area of Sydney with more limited transport options than are available to residents of other areas of the city. In this study the BTRE has sought to analyse the key transport issues and to identify potential improvement options in the context of these issues. The study does not provide definitive analysis of any option.

In August 2002, the BTRE released a discussion paper. The BTRE is grateful to the more than 80 individuals and organisations in Sydney who provided comments and suggestions on the paper. The project has also benefited from the knowledge and insights of colleagues in the BTRE and the Department of Transport and Regional Services.

The BTRE appreciates the assistance from Transport NSW, the Transport Data Centre and the State Transit Agency.

The BTRE research team comprised Phil Potterton, Quentin Reynolds and Mark Tonkin. The Institute of Transport Studies (University of Sydney) undertook transport research and modelling. Coffey Geosciences, Hyder Consulting and Dobinson and Associates provided further professional advice.

Tony Slatyer
Executive Director
January 2003

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EXECUTIVE SUMMARY

This report fulfils an offer in February 2002 by the Deputy Prime Minister and Minister for Transport and Regional Services, the Honourable John Anderson MP for the BTRE to analyse the cost and feasibility of transport improvement options in the Warringah Peninsula region of Sydney.

TRANSPORT AND THE REGION

The Warringah region (2001 population 260 721) comprises four local government jurisdictions, Pittwater, Warringah, Manly and Mosman. The region has three road entry and exit points, Spit Bridge, Roseville Bridge and Mona Vale Road, with ferry transport at Manly and Mosman providing additional options in the south of the region.

Local trips, predominantly by car, dominate travel in the region, as elsewhere in Sydney. The public transport share of journeys to work (20 per cent) is below the average for the Sydney region average (23 per cent). Within the Warringah region, however, there is a considerable range in public transport use for the journey to work: above the Sydney average in Mosman (32 per cent) and Manly (29 per cent), suburbs where residential densities are high and generally more favourable to public transport service quality and use and below it in Pittwater (12 per cent) and Warringah (17 per cent). However, the public transport share of the 10 per cent of Warringah region trips in the morning peak that are headed for the Sydney Central Business District (CBD) is slightly higher from Pittwater and Warringah combined (62 per cent) than from Manly (55 per cent) and Mosman (54 per cent).

Morning peak period public transport trips (primarily bus) are shared quite evenly between destinations internal to the peninsula on the one hand and the CBD, the near CBD area (ie including the Eastern Suburbs and Inner Western Sydney) and North Sydney on the other. In contrast, two thirds of morning peak car trips are internal to the peninsula, with the Sydney CBD, the near CBD area, Willoughby/Lane Cove and the 'rest of Sydney', making up the balance in fairly even shares.

MAIN TRANSPORT ISSUES

The Warren Centre's Community Values Study identified traffic congestion as the main traffic and transport concern for Warringah region residents (51 per cent of those surveyed, compared with 42 per cent for Sydney). The closer to the city, the greater the congestion, although Forest Way, in the northern part of the peninsula, is also significantly congested. The slowest car speeds are on Spit and Military roads (average of 21 kilometres per hour, five to eight kilometres per hour slower than inner routes through Chatswood and Willoughby). At weekends particularly, the Spit Bridge, which opens regularly for boat traffic, is a major congestion point.

Secondly, public transport was the focus of 29 per cent of the Warren Centre's survey respondents in the Warringah region, 17 per cent identifying lack of adequate public transport (compared with 12 per cent for Sydney) and 12 per cent indicating the reliability of public transport as their main concern (compared with 11 per cent for Sydney). With no rail service in the region, Warringah region residents have fewer public transport options available to them than many other parts of Sydney. 'East-west' bus services are more limited than 'north-south' services. Bus services also are not independent of congestion on the road system, although bus priority arrangements secure a travel time advantage for bus passengers relative to car passengers over the same route.

Thirdly, the Spit Bridge and Roseville Bridge routes each pass through dense residential inner areas. Conflicts between through and local traffic, which include 'rat-running' through residential streets during peak periods, have adverse consequences for the local transport environment and residential amenity. On the Spit route, where traffic is heaviest, with six traffic lanes to accommodate and less than optimal lane widths, safety is an issue with insufficient space for a Jersey (crash) barrier on the winding Spit Hill. There are also kerbside markings at Spit Junction in the northbound direction, advising pedestrians that large vehicles may 'jump the kerb'.

MAJOR IMPROVEMENT STRATEGIES

These issues suggest that major transport improvement strategies for the region should be screened against the following main objectives:

- reducing road congestion in the Warringah region, including at weekends;
- not increasing traffic congestion in the Sydney region as a consequence of improvements on the peninsula;
- improving public transport; and
- improving the inner Warringah area (Mosman/Cremorne) urban environment, including accessibility, amenity and safety.

With these objectives in view, preferred strategies for further consideration comprise:

- a road tunnel bypass of Spit and Military roads, together with improved local amenity and accessibility on the surface route;
- a high speed public transport service with dedicated right of way separated from the existing road system, which would run from both Brookvale and Manly to North Sydney, the Sydney CBD and possibly Chatswood; and
- improved cross-linking bus services, in particular from Brookvale to Chatswood via Dee Why.

The road tunnel strategy would improve travel times from Manly north and provide a bypass of the Mosman/Cremorne area for through traffic, including trucks and potentially some buses. It would enable surface route changes that favour public transport, local accessibility, urban amenity and improved safety. Bus services could also be reconfigured or expanded, with an increase in the number of 'through' express buses from the Northern Beaches. Planning for such services could include an expansion of park and ride facilities, at Brookvale and other locations.

A higher speed public transport system with a dedicated right of way for the major corridors from Brookvale and Manly to North Sydney and the Sydney CBD could also be investigated, as an additional rather than alternative improvement. This would benefit public transport service reliability and travel times and could be expected to have a small positive impact on traffic congestion and the inner area local transport environment.

Improved public transport cross-links, in particular from the Northern Beaches and Brookvale to the Chatswood bus/rail interchange would also be beneficial, with a small potential impact on congestion.

OPTIONS FOR ANALYSIS

The analysis in this paper focuses on alternative variants of the inner area tunnel bypass strategy. This is the approach with the greatest potential to address traffic congestion in the Warringah region, while also improving inner area amenity and accessibility and having a positive impact on public transport.

The variants of this strategy comprise, firstly, a tolled road tunnel with two lanes in each direction from Burnt Bridge Creek Deviation at Seaforth/Balgowlah to the Warringah Freeway at Cammeray, together with surface road improvements favouring local accessibility in Mosman/Cremorne (option A) and, secondly, by way of comparison, a shorter tolled tunnel from Spit Road to the freeway, joining an improved bridge crossing of Middle

Harbour and an improved Sydney Road intersection at Seaforth, with similar surface road changes (option B).

RESULTS

Institute of Transport Studies (University of Sydney) travel projections, undertaken for the study using the Transport and Environment Strategy Impact Simulator (TRESIS) model, indicate a significant reduction in travel time of around 7 per cent for Warringah region residents from both options[1]. These reductions result from increased road capacity in both directions, together with bypassing of local congestion, traffic signals and associated queues. These savings accrue to travellers on all major routes, not solely those using the tunnel bypass.

The travel projection results underpin a strongly positive project benefit-cost ratio of 5.0:1 for option A and 6.4:1 for option B. The net present value of option A, ie the dollar value 'today' of the project's net benefits that occur over time, expressed as a single lump sum, is $3.8 billion, while that of option B is $3.5 billion. These results mean that the overall benefits of either project alternative to Warringah region residents and other travellers substantially outweigh the overall costs to the general public. The project is economically viable.

At a toll level of $3.50 per trip, the longer tunnel would require a public funding contribution of an estimated $290 million (which could be configured over the development timetable of the project) to be financially viable for a facility owner. This amount would comprise less than 10 per cent of the project's net present value for the community. In contrast, the shorter tunnel-with-bridge option may not require any government funding contribution.

An alternative toll level and structure could improve the financial viability of the project. A variable tolling structure, ie with a premium charged for travel in the peak, would be likely to maximise revenue and minimise any cost to the public sector. It would also help to ensure that the new infrastructure did not add to peak period congestion on the Warringah Freeway, minimising any additional traffic induced by the improved road conditions.

1 Due in part to the large scale and strategic character of the TRESIS model, the modelling of the options did not include surface route changes to improve local accessibility.

INTRODUCTION

At the Warringah Transport Summit on 26 February 2002 convened by the Member for Warringah, the Hon Tony Abbott MP, the Deputy Prime Minister and Minister for Transport and Regional Services, the Hon John Anderson MP offered the assistance of the BTRE in analysing the cost and feasibility of options to improve transport in the Warringah Peninsula region of Sydney.

At this meeting, the NSW Coalition proposed a road tunnel from the peninsula to the expressway at Gore Hill, including a dedicated 24 hour busway.

In addition, the Shore Regional Organisation of Councils (SHOROC) vision statement for transport in the region calls for a high standard, convenient public transport system, in conjunction with a well connected road network, which incorporates an additional crossing of Middle Harbour and alternate routes for urban freight.

APPROACH TO THE STUDY

The BTRE's approach to the study has entailed:

- identifying the transport issues on the basis of available information and consultation with stakeholders;
- identifying options for improvement;
- obtaining limited new information to enable specific options to be analysed;
- undertaking the analysis and identifying issues for further consideration.

STUDY PROCESS

Following initial research and consultation with stakeholders, the BTRE released an issues paper in August 2002, outlining five possible options. On the basis of feedback on this paper, results of a travel time survey and traffic and tunnel engineering advice, BTRE specified two options for modelling and analysis. This report includes the results of this analysis.

In undertaking its initial research, BTRE obtained advice from Dobinson and Associates. The Institute of Transport Studies (ITS), University of Sydney, undertook a survey of travel times on the routes connecting the peninsula with the rest of Sydney (ITS 2002a). ITS also undertook demand modelling of the two tunnel bypass options using the Transport and Environment Strategy Impact Simulator (TRESIS) model of Sydney (ITS 2002b). Coffey Geosciences provided specifications of possible tunnel alignments, together with construction costs (Coffey Geosciences 2002). Hyder Consulting provided some comment on traffic and transport aspects of the identified options.

The BTRE has not independently checked, and does not warrant the accuracy of, this information provided by consultants.

OUTLINE OF THE PAPER

Chapter one provides an overview of the Warringah region, in terms, broadly, of geography, demography and transport.

Chapter two identifies the main transport issues.

Chapter three reviews the advantages and disadvantages of alternative approaches to addressing the main transport issues.

Chapter four sets out alternative strategies in relation to the transport objectives, as suggested by the earlier discussion.

Chapter five describes the two options for detailed analysis, sets out their costs, summarises the analysis and identifies issues for further investigation.

CHAPTER 1 THE WARRINGAH REGION [2]

REGIONAL PROFILE

The Warringah Peninsula is bounded in the south and south-west by Middle Harbour, in the north-west and north by Ku-ring-gai Chase National Park and in the east by the Pacific Ocean.

The Warringah region for this report is a larger area than the Warringah Peninsula and comprises four local government areas (LGA): Pittwater, Warringah, Manly and Mosman. See figure 1.1.

The Australian Bureau of Statistics estimated the population of the Warringah region as 260 721 in 2001 (table 1.1 and figure 1.2). The population of the region grew at 0.8 per cent a year between 1996 and 2001, a substantially faster rate of growth than 1991 to 1996 (0.4 per cent), but less than the Sydney region average of 1.2 per cent per annum from 1991 to 2001. Residents aged 65 years or older account for 14 per cent of the Warringah region population, compared with 11 per cent for the Sydney region.

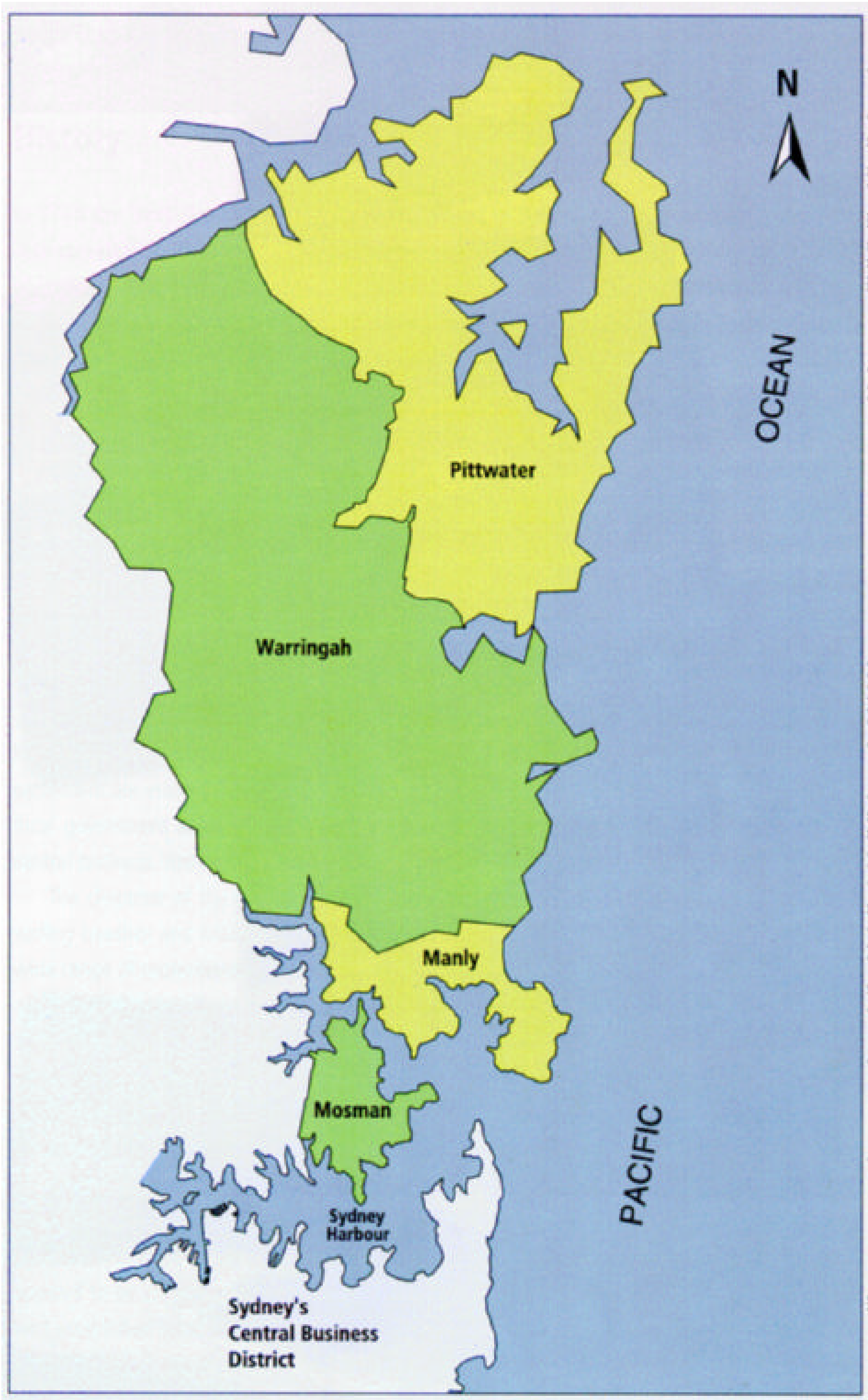
TABLE 1.1 WARRINGAH REGION POPULATION AND DENSITY IN 2001

Council	*Population (2001)*	*Area (km^2)*	*Population density (pers/km^2)*
Pittwater	56 642	91	625
Warringah	136 662	150	914
Manly	39 390	15	2 710
Mosman	28 027	9	3 208
Total	260 721	263	990

Source Australian Bureau of Statistics, Regional Population Growth (3218.0), 25 July 2002.

[2] The first section and, to a lesser extent, the second section of this chapter, are adapted from Sinclair Knight Merz 1996.

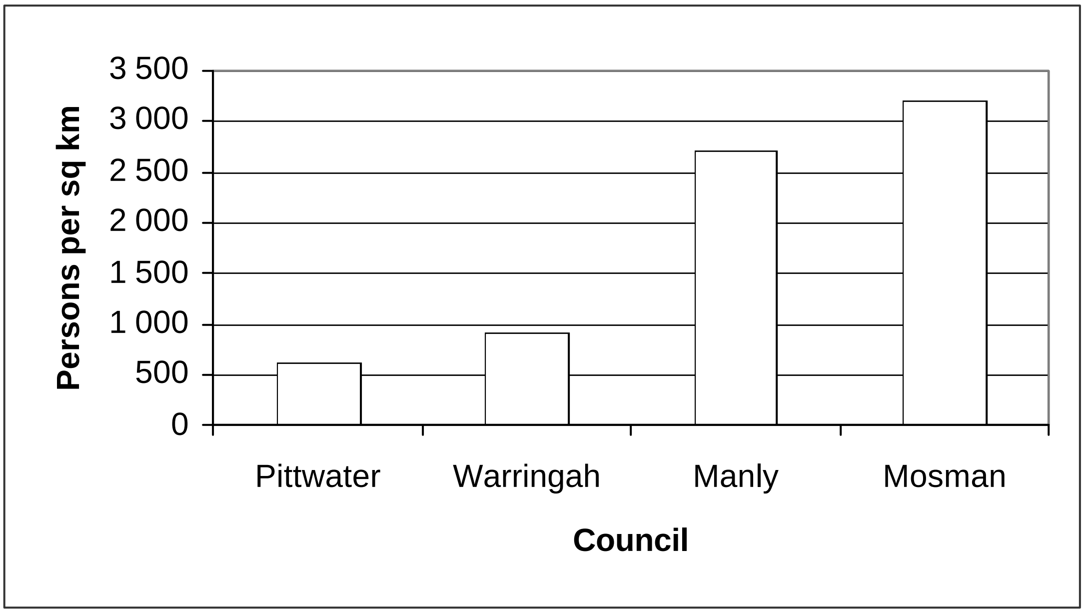
FIGURE 1.1 WARRINGAH REGION COUNCILS



Source SHOROC

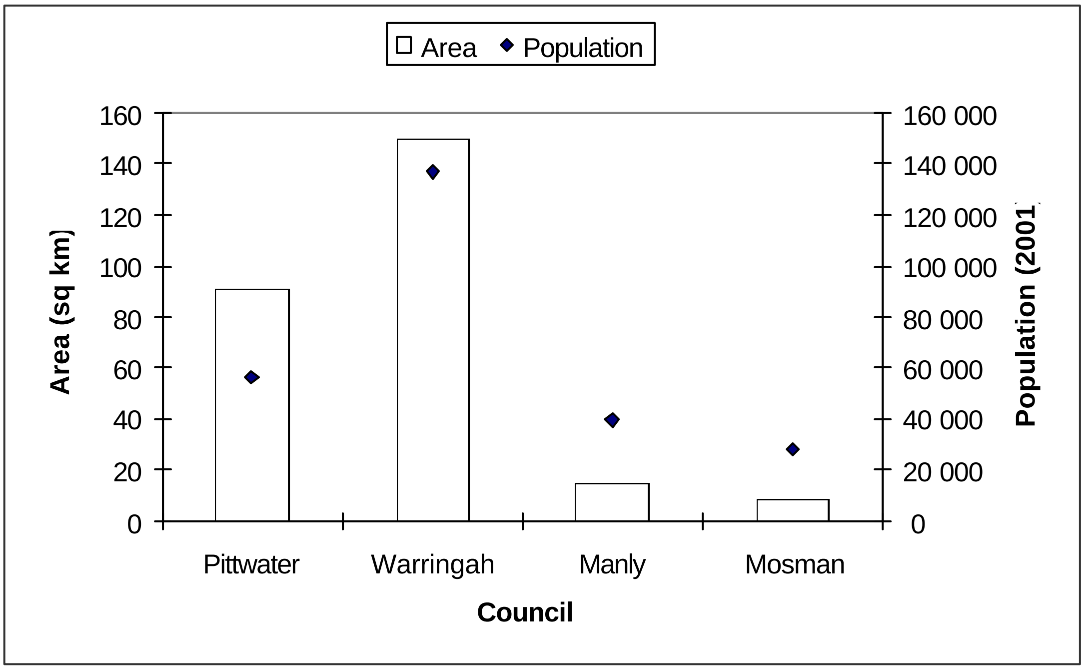
Residential amenity is in general very high, with an abundance of bushland and beach (the region contains roughly half of Sydney's ocean beaches). The average residential density is quite low (990 persons per square kilometre) and development is dispersed. However, as figure 1.3 shows, there are substantially higher densities in Mosman (3 208 persons per square kilometre) and Manly (2 710 persons per square kilometre) and there are also higher density pockets further along the coast, for example at Dee Why and Narrabeen. Table 1.2 gives comparable populations and densities for other areas in Sydney.

FIGURE 1.2 WARRINGAH POPULATION AND LAND AREA



Source Australian Bureau of Statistics, Regional Population Growth (3218.0), 25 July 2002.

FIGURE 1.3 WARRINGAH REGION POPULATION DENSITIES BY COUNCIL



Source Australian Bureau of Statistics, Regional Population Growth (3218.0), 25 July 2002.

TABLE 1.2 SYDNEY POPULATIONS AND DENSITIES IN 2001 [a]

Region	*Population (2001)*	*Area (km^2)*	*Population density (pers/km^2)*
Warringah region	260 721	263	990
North, except Warringah region	361 885	304	1 190
North-west	317 820	3 500	91
West	818 377	4 986	164
South-west	757 405	3 554	213
South	434 055	401	1 082
Central	848 010	217	3 911
Total [b]	3 857 660	10 460	369

a. Using the regions used by Larcombe and Meyer, 2001.

b. Total is the Sydney Statistical Division, excluding Gosford-Wyong SSD.

Source Australian Bureau of Statistics, Regional Population Growth (3218.0), 25 July 2002.

The area is characterised by relatively high incomes. Median individual annual income in 2001 was between $26 000 and $31 148 in Pittwater and Warringah, between $31 200 and $36 348 in Manly and between $36 400 and $41 548 in Mosman. All areas are above the Sydney Statistical Division average of between $20 800 and $25 948 (ABS 2002).

The biggest activity centre is Manly. Other centres exist at Brookvale, Dee Why, Narrabeen, Mona Vale and lesser locations. Brookvale has the largest retail centre (Warringah Mall) and is well served by public transport as it lies on the trunk corridor to the city.

TRANSPORT OVERVIEW

Land access to the Warringah Peninsula is constrained. There are only three road entry or exit points—Spit Bridge in the south, Roseville Bridge mid-way and Mona Vale Road in the north. Road options to and from the Manly area are limited to the Spit Bridge route. Ferry transport at Manly and Mosman provides an additional entry and exit point in the south of the region. There is no rail transport link. See figure 1.4.

With the level of commuting traffic and a limited number of roads, congestion at peak times is high. This not only reduces mobility for Warringah residents (car users and pedestrians) but causes noise and localised air pollution in the most congested areas—North Sydney, Mosman and, to a lesser extent, Willoughby.

FIGURE 1.4 WARRINGAH REGION MAJOR ROADS

As elsewhere in Sydney, a significant proportion of Warringah residents work outside the region. Forty-four per cent of workers in the northern region[3] of Sydney (which includes the Warringah suburbs) work outside the region.[4]

Warringah is also a major attractor of visitor trips from elsewhere in Sydney, to some extent for employment and especially for tourism and recreation. At weekends, the inflow and outflow of visitors causes significant congestion.

Car ownership is relatively low in the (higher average income) inner area–areas with greater access to public transport–and relatively high in the (lower average income) northern part of the peninsula. The percentage of households with no motor vehicle, motorbike or motor scooter in 2001 was 4.3 per cent in Pittwater and 7.3 per cent in Warringah. In contrast, the Sydney average of 10.1 per cent was slightly exceeded in Mosman (10.2 per cent) and Manly (11.1 per cent).

Public transport services

Buses provide surface public transport in the region. Most are operated as part of the Sydney Buses network (the State Transit Authority). Network structure consists of a trunk route between the Harbour Bridge and Spit Bridge along Military Road (around 800 buses a day). Here many services merge in a high-frequency bus corridor (ie transit lane for buses and cars with three or more) given priority at peak times over other traffic; and a fan-like pattern north of Spit Bridge as routes break from the trunk corridor and spread out to serve local communities.

Forest Coach Lines, a private operator, operates services over the Roseville Bridge (around 250 buses a day), with services that reach to Mona Vale, Narrabeen and Brookvale to connect with Chatswood and the Sydney CBD.

By water, there is also a fast and frequent ferry service between Manly and the City (Circular Quay), offering the choice of fast premium-priced services by Jetcat or the slower cheaper conventional ferries. It serves commuter and visitor markets. For commuters, it is used mainly by those who work within walking distance of Circular Quay.

There is no rail transport, although a rail link from Chatswood to Dee Why is planned for after 2010 (NSW Government 1998).

3 The northern region also includes Hunters Hill, Ku-ring-gai, Lane Cove, Ryde, Willoughby and part of Hornsby. See Larcombe and Meyer (2001).

4 This compares with a range from 22 per cent of workers in the central region to 58 per cent in the north-western region of Sydney. See Larcombe and Meyer (2001).

Travel patterns and mode shares

Twenty per cent of journeys to work from the Warringah region make use of public transport, compared with a Sydney Statistical Division (SD) average of 23 per cent (ABS 1996 Census). The range is from 12 per cent of trips in Pittwater to 32 per cent in Mosman (see table 1.3).

TABLE 1.3 SHARES OF JOURNEYS TO WORK MAKING USE OF PUBLIC TRANSPORT

Pittwater	*Warringah*	*Manly*	*Mosman*	*Warringah region*	*Average for Sydney SD*
12%	17%	29%	32%	20%	23%

Source ABS 1996 Census.

Looking at all trips within and from the peninsula in the morning peak period (ie including non-work trips):

- fifteen per cent (15 800) of trips from Pittwater and Warringah combined are by public transport;
- sixty-nine per cent of trips (71 100) from Pittwater and Warringah combined are internal to these areas and of these only 8 per cent (5 900) are by public transport;
- sixty-two per cent of trips (4 800) from these locations to the Sydney CBD are by public transport, a higher percentage than from the more residentially dense suburbs of Manly and Mosman[5];
- twenty-three per cent of trips (4 300) from Manly are by public transport;
- fifty-seven per cent of trips (10 700) from Manly are internal to the peninsula and an estimated 7 per cent (800) of these internal trips are by public transport[6];
- twenty-one per cent of trips (4 200) from Mosman/Cremorne[7] are by public transport; and
- thirty-one per cent of trips (6 300) from Mosman/Cremorne are internal to the peninsula and an estimated 5 per cent (300) of these are by public transport[8].

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5 Other factors which might help explain this contrast include higher average incomes and shorter trip distances in Manly and Mosman relative to the areas to the north. Both of these factors would favour car travel.

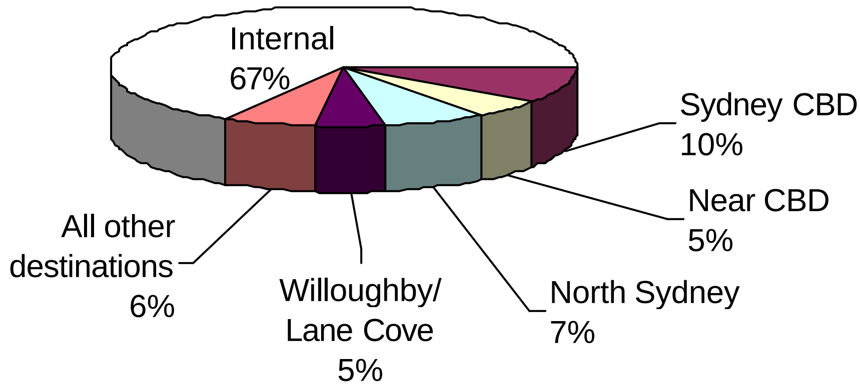
6 The Transport Data Centre (TDC) advises that this estimate may be unreliable, due to small sample size.

7 In the Transport Data Centre data, parts of North Sydney Council area (generally Cremorne) were added to the Mosman area. See Appendix I.

8 See note 4 above.

See figure 1.5 and table 1.4 for other details.

FIGURE 1.5 DESTINATIONS OF MORNING PEAK TRIPS BEGINNING IN WARRINGAH REGION



Note Internal includes Pittwater, Warringah, Manly and Mosman/Cremorne.

Source BTRE analysis of NSW Department of Transport, Transport Data Centre, 2000 Household Travel Survey.

TABLE 1.4 WARRINGAH REGION TRIPS – MORNING PEAK

Morning peak	*From Pittwater/Warringah*		*From Manly*		*From Mosman/Cremorne*	
7.00 to 9.00	*Trips*[a]	*By PT*	*Trips*[a]	*By PT*	*Trips*[a]	*By PT*
Internal	77 300	9%	10 700	7%[b]	6 300	5%[b]
To Sydney CBD	7 700	62%	2 500	55%	3 700	54%
To North Sydney	2 600	74%	2 500	37%[b]	5 100	0%[b]
To Near CBD	2 800	53%	1 100	45%[b]	3 400	39%
To Willoughby/ Lane Cove	4 500	11%[b]	900	41%[b]	1 200	36%[b]
All other destinations	7 600	3%[b]	900	41%[b]	500	37%[b]
All destinations	102 500	15%	18 900	23%	20 100	21%

a. Rounded to nearest hundred.

b. TDC warn that small numbers in their estimates based on survey data are unreliable.

Source BTRE analysis of NSW Department of Transport, Transport Data Centre, 2000 Household Travel Survey.

Public transport provides a much smaller proportion of trips on an all day basis, ie 7 per cent from Pittwater and Warringah, 9 per cent from Manly and 11 per cent from Mosman / Cremorne (see table 1.5).

The largest external destination for trips from the peninsula is the Sydney CBD (13 900 trips in the morning peak). Public transport is used for 58 per cent of these trips, compared with an average of 69 per cent for morning peak trips from elsewhere in the Sydney region to the CBD. North Sydney and ‘near CBD’[9] are the next largest destinations (10 200 and 7 300 trips respectively). Together, these three destinations comprise 22 per cent of all morning peak period trips originating in the Warringah region. See table 1.6 and figure 1.6.

TABLE 1.5 WARRINGAH REGION TRIPS – ALL DAY

All Day	*From Pittwater/Warringah*		*From Manly*		*From Mosman/Cremorne*	
	Trips[a]	*By PT*	*Trips[a]*	*By PT*	*Trips[a]*	*By PT*
Internal	559 100	5%	112 500	4%[b]	95 100	4%[b]
To Sydney CBD	14 300	58%	5 500	75%	8 700	54%
To North Sydney	8 800	34%	5 000	18%[b]	22 800	2%[b]
To Near CBD	13 900	37%	5 900	22%[b]	10 700	30%
To Willoughby/ Lane Cove	13 100	6%[b]	2 600	24%[b]	6 100	37%[b]
All other destinations	41 400	4%[b]	6 000	10%[b]	10 600	27%[b]
All destinations	650 700	7%	137 500	9%	154 000	11%

a. Rounded to nearest hundred.

b. TDC warn that small numbers in their estimates based on survey data are unreliable.

Source BTRE analysis of NSW Department of Transport, Transport Data Centre, 2000 Household Travel Survey.

TABLE 1.6 WARRINGAH REGION MORNING PEAK TRIPS BY PUBLIC TRANSPORT – SHARE OF DESTINATION

Morning peak 7.00 to 9.00	*Trips from region*	*Public Transport[a]*	*Bus*	*Ferry*	*Train[b]*
Internal	94 300	8%	8%	0%	0%
To Sydney CBD	13 900	58%	42%	14%	3%
To North Sydney	10 200	28%	24%	0%	4%
To Near CBD[c]	7 300	45%	19%	9%	17%
To Willoughby/Lane Cove	6 500	20%	20%	0%	0%
All other destinations	9 000	8%	2%	4%	2%
All destinations	141 300	17%	13%	2%	2%

a. Individual modes may not add to public transport total share due to rounding.

b. For trips with multiple modes, the hierarchy is (high to low): ferry, train, bus, car driver, car passenger, other. So a bus then ferry trip, or a ferry then train trip, will both be recorded as ferry. Similarly a car passenger then train trip, or a bus then train trip will both be recorded as train. Obviously, all train trips from the peninsula involve at least one other mode.

c. Eastern Suburbs, Inner Western Sydney and Inner Sydney SSDs except Sydney-Inner SLA. A complete description of data sets used is in Appendix I.

Source BTRE analysis of NSW Department of Transport, Transport Data Centre, 2000 Household Travel Survey.

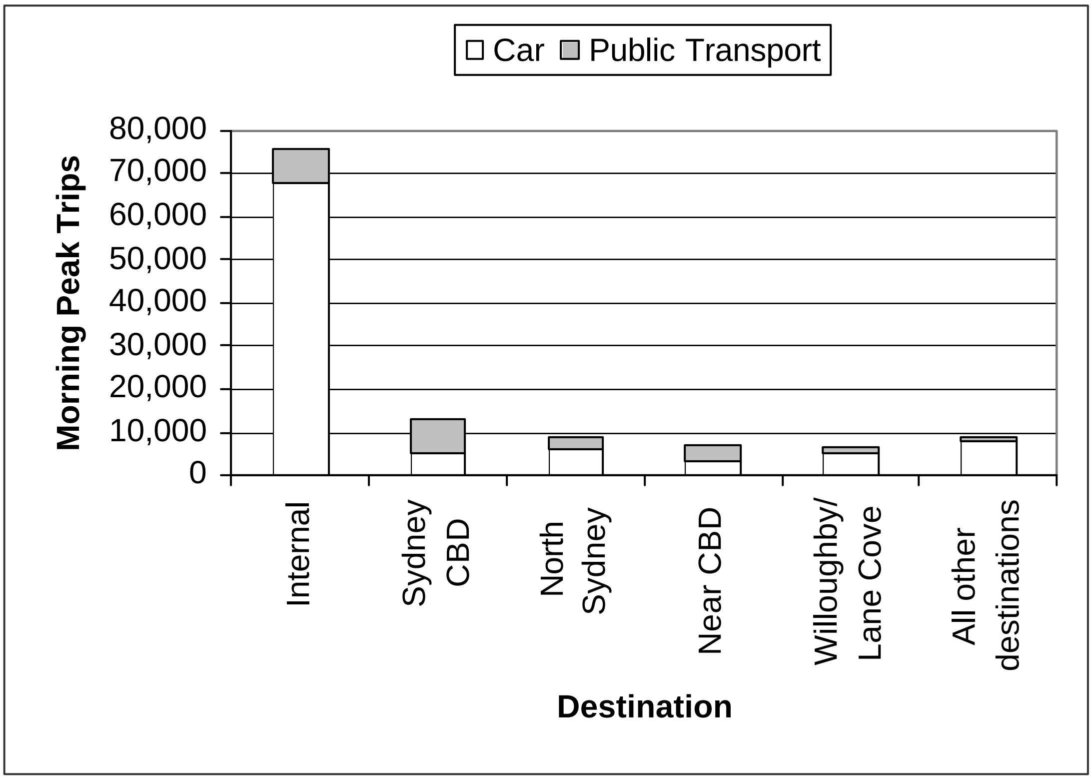
9 Throughout this report, ‘near CBD’ means Eastern Suburbs SSD, Inner Western Sydney SSD, and Inner Sydney SSD except Sydney–Inner SLA.

Travel destinations

Of the 17 per cent of morning peak period trips from the peninsula that are by public transport, 13 per cent are by bus, 2 per cent are by ferry and 2 per cent are by train. Morning peak bus trips are predominantly internal to the peninsula (41 per cent) or headed for the Sydney CBD and North Sydney (45 per cent). There are also more than 1 000 morning peak period bus trips to each of the near CBD and Willoughby / Lane Cove areas.

FIGURE 1.6 CAR AND PUBLIC TRANSPORT TRIPS BEGINNING IN WARRINGAH REGION

Note Internal includes Pittwater, Warringah, Manly and Mosman/Cremorne.



Source BTRE analysis of NSW Department of Transport, Transport Data Centre, 2000 Household Travel Survey.

Destinations for other public transport modes are less evenly spread. More than 80 per cent of ferry trips are to the CBD and near CBD areas, while over 70 per cent of train trips (which in all cases will involve another connecting mode) are to these areas. North Sydney is also a significant destination for train trips. See table 1.7.

Car travel in contrast is predominantly internal to the peninsula (71 per cent), with a very even spread elsewhere in Sydney. This is as expected with the radial route profile of public transport and the suitability of the car for travel to both local and dispersed destinations. However, the volume of car travel to the Sydney CBD, near CBD and North Sydney (14 300 trips) is over half that of the total Warringah region bus passenger market, suggesting scope for public transport to improve its overall share.

TABLE 1.7 WARRINGAH REGION MORNING PEAK TRIPS – SHARE OF MODE

Morning peak 7.00 to 9.00 Destination:	*Mode: Car*[a]		*Bus*		*Ferry*[b]		*Train*[b]	
Internal	67 900	71%	7 800	41%	200	5%	0	0%
To Sydney CBD	5 000	5%	5 800	31%	1 900	62%	400	18%
To North Sydney	5 900	6%	2 500	13%	0	0%	400	17%
To Near CBD	3 400	4%	1 400	7%	600	21%	1 300	58%
To Willoughby/Lane Cove	5 300	6%	1 300	7%	0	0%	0	0%
All other destinations	8 000	8%	200	1%	400	12%	200	8%
All destinations[c]	95 500	100%	19 000	100%	3 100	100%	2 200	100%

a. Individual modes may not add to total due to omission of trips by 'Other' mode and due to rounding.

b. For trips with multiple modes, the hierarchy is (high to low): ferry, train, bus, car driver, car passenger, other. TDC notes that some estimates are based on small numbers surveyed and may be unreliable.

Source BTRE analysis of NSW Department of Transport, Transport Data Centre, 2000 Household Travel Survey.

CHAPTER 2 MAJOR TRANSPORT ISSUES FOR THE REGION

POLICY AND COMMUNITY CONTEXT

Current transport policy and initiatives

The NSW Government's transport strategy for Sydney, *Action for Transport 2010*, lays emphasis on: reducing car dependency; improving public transport and increasing public transport use; improving Sydney's air quality; reducing greenhouse emissions; safeguarding the environment; making freight more competitive; and improving road safety.

The Roads and Traffic Authority is currently upgrading the two lane section of Mona Vale Road above Terrey Hills. This comprises extension of the overtaking lane eastbound from the Ba'hai Temple to east of Lane Cove Road West and provision of a westbound overtaking lane from Ingleside Road to the Ba'hai Temple. The first stage, from the temple to Manor Road, is to be completed in 2002-03. The next stage, from Manor Road to Ingleside Road, is expected to be undertaken, subject to confirmation of funding, in 2003-04.

In August 2002, the NSW Government announced a plan to widen the Spit Bridge, by adding two extra lanes to its western side. In November 2002, it announced a further proposal to reduce weekend bridge openings from 11 to 8 per day and to introduce a weekend afternoon clearway for southbound traffic from the Spit Bridge to Ourimbah Road, Mosman.

In the Warringah region, in recent years the Manly ferries have been progressively refurbished and construction of a new bus/ferry interchange at Manly was completed in August 2000.

Measures to improve bus services between the peninsula and the Sydney CBD have included: T2 lanes; bus and bus transfer improvements at Mona Vale; provision of indented bus bays at selected locations along Military and Spit Roads; annual Easter Show direct routes to Olympic Park; and e-tolling queue reduction. At present, Transport NSW is evaluating the feasibility of providing a park and ride facility at Warringah Rugby Park, Warriewood. In addition, the State Transit Authority is reviewing all of its services in the Manly/Warringah/Pittwater region as part of the 'Better Buses' program, with changes to be introduced in mid-2003.

Ferries aside, the only major new transport infrastructure in the region in the past 50 years have been the Roseville Bridge, which opened in 1966 and the Burnt Bridge Creek deviation, which opened in 1985. Other infrastructure changes have included tidal flow on Military Road at Cremorne.

Planning policy

In respect of new developments, the NSW Department of Urban Affairs and Planning's *Integrating Land Use and Transport Policy Package*, released in September 2001, states that the aim of integrating land use and transport is to ensure that urban structures, building forms, land use locations, development designs, subdivision and street layouts achieve a number of objectives. These include: improving access to housing, jobs and services by walking, cycling and public transport; increasing the choice of available transport; reducing travel demand; supporting efficient and viable public transport services; and providing for efficient movement of freight.

Local government

The transport policy of the SHOROC Regional Organisation of Councils, incorporating Manly, Mosman, Pittwater and Warringah (SHOROC 2002), calls for a high standard, convenient, demand managed public transport system, in conjunction with a well connected road network, which incorporates an additional crossing of Middle Harbour and which is not reliant on significant population increases in the SHOROC region.

The policy seeks to make any major population increase conditional on upgrading of the transport system, noting that the SHOROC Councils stand by the Section 117 Direction from the Minister (1980) which states "any proposal for major increase in residential zoning on Warringah Peninsula should be accompanied by evidence that additional employment opportunities exist or have been created and/or that the capacity of the transport system has been upgraded to cater for the proposal".

Community attitudes

The Warren Centre for Advanced Engineering surveyed attitudes to transport issues in Sydney in 2000 as part of its 'Sustainable Transport in Sustainable Cities' project (Warren Centre 2002a; 2002b). Traffic congestion was identified as the major concern by 42 per cent of Sydney residents. The next three most serious concerns were lack of public transport (12 per cent), reliability of public transport (11 per cent) and train accidents (6 per cent). 64 per cent of those surveyed opted for travel demand management rather than increasing road capacity to manage road congestion.

Attitudes in the Warringah region are similar to those of Sydney residents in general, with a slightly sharper focus on both traffic congestion and public transport. A majority of Warringah region residents (51 per cent) list traffic congestion as their major concern, 17 per cent indicate lack of adequate public transport and 12 per cent nominate reliability of public transport. Five per cent identify train accidents.[10]

When asked whether more toll roads should be built or whether the focus should be on new public transport infrastructure, 71 per cent of both Sydney and Warringah region residents chose the latter.

Many Warringah residents (58 per cent) believe not enough money and resources are being spent on Sydney's roads, compared with 52 per cent of Sydney residents. A large majority of Warringah region residents (88 per cent) consider that, if more money were to be invested in Sydney's roads, it should not be at the expense of public transport, compared with 82 per cent for the rest of Sydney.

Regarding options for funding improved public transport, just over half of Warringah region residents surveyed favoured transferring a portion of the road budget to public transport (compared to 55 per cent for the whole of Sydney). Twenty per cent favoured raising transport fares and tolls (compared with 12 per cent for Sydney) and 16 per cent favoured introducing a special transport levy on Sydney residents and businesses (18 per cent for Sydney). The least preferred option (4 per cent) was transferring the funds to public transport from the health, education and police functions (3 per cent for Sydney)[11].

The survey findings suggest that Warringah region residents generally favour policy approaches to traffic congestion that involve both improved roads and improved public transport.

TRAFFIC CONGESTION

Car travellers and, to a certain extent, bus travellers experience severe congestion travelling within, into and out of the Warringah region, especially though by no means exclusively in the morning peak. During August and September 2002, the Institute of Transport Studies, University of Sydney carried out a travel time and traffic flow survey in the region. The survey vehicles were fitted with Global Positioning System navigation aids and position information was recorded every second during each trip. This and other data were later analysed to determine trip times and speeds for non-transit lane users. Data were collected from nearly 1100 trips over 18 different road segments covering different times of the day. Figure 2.1 shows the 18 segments.

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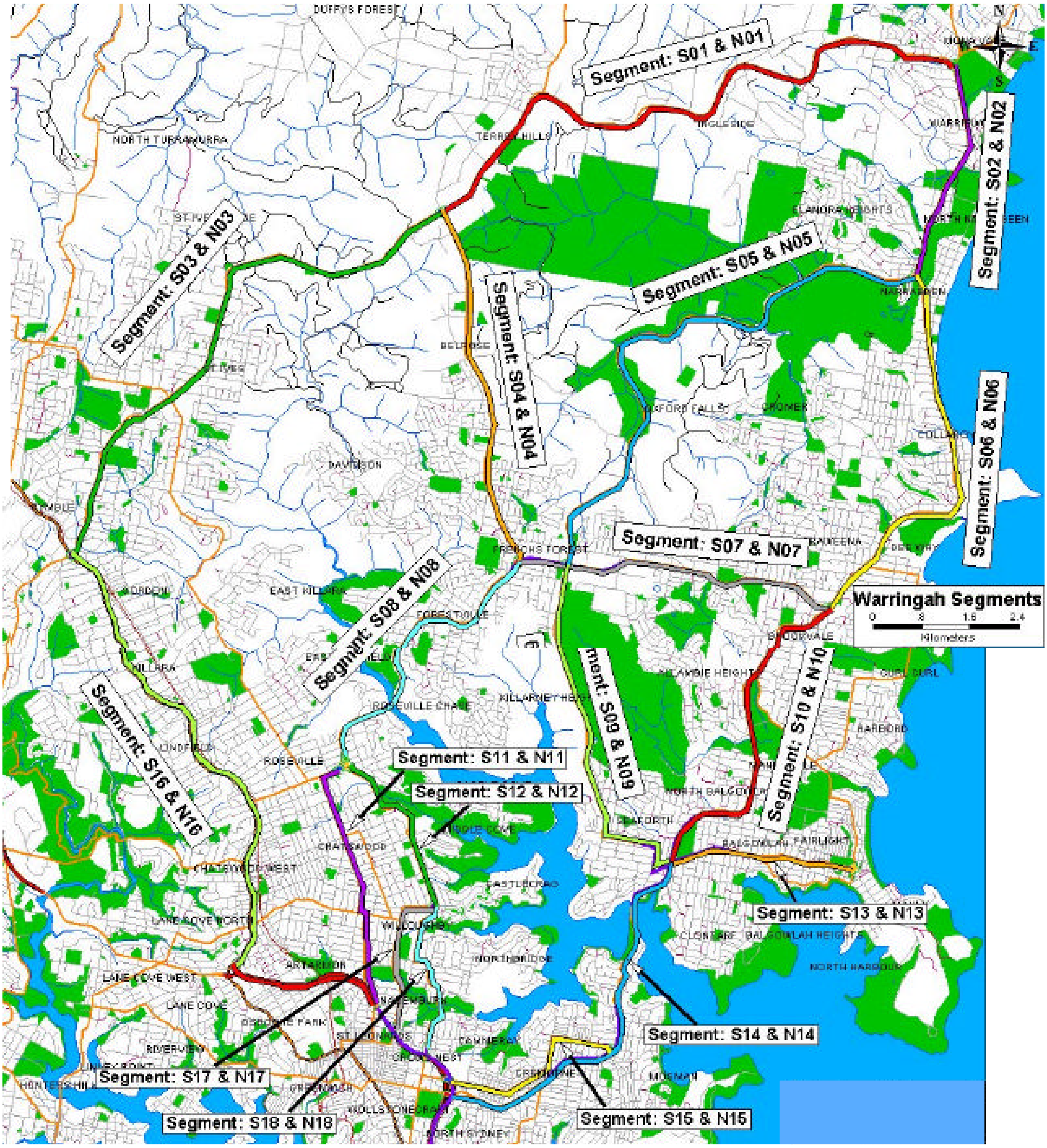
10 Original data used in Warren Centre 2002a.

11 8 per cent of Warringah residents and 12 per cent of Sydney residents did not choose the listed options with some making their own suggestions.

FIGURE 2.1 EIGHTEEN SEGMENTS FOR TRAVEL TIME STUDY



Source ITS 2002a

Speeds

There is evidence to suggest that congested traffic conditions are occurring across much of the day on many arterial roads in the Warringah Peninsula. In many cases, average speeds were not only low during the peak[12] and peak shoulder periods, but also during the medium volume periods such as the middle of the day and weekends. In particular, average speeds were noticeably low on many segments in the lower Northern Beaches area such as segment 3 (Mona Vale Road), segment 6 (Pittwater Road), segment 7 (Warringah Road), segments 5 and 9 (Wakehurst Parkway), segment 10 (Burnt Bridge Creek Deviation), segment 1 (Willoughby Road), segment 13 (Sydney Road), segment 14 (Spit Road/Military Road) and segment 16 (Pacific Highway). The speeds observed on such segments are well below the posted limits at most times of the day, which suggests they are operating at near capacity levels.

The slowest average speed during the morning peak from the 18 road segments surveyed was from the Burnt Bridge Creek deviation and Sydney Road intersection along Manly, Spit and Military Roads. The average speed over the 6.9 kilometre route was 21 kilometres per hour during the morning peak. Generally, average speeds during the morning peak are above the average speed in the northern half of the region, and below the average in the south. The speeds for all segments are shown in table 2.1 below (from ITS 2002a).

Table 2.1 shows the average speeds on each segment, in different directions, during different times of the day, in kilometres per hour. The standard deviation (in parentheses) measures the variability of survey results. Thus on segment one, the mean speed of 51.4 kilometres per hour during the morning peak has a variability[13] of 11.4 kilometres per hour.

Travel times

The travel study aggregated trip times using data from this and other studies, to estimate the average travel time from the intersection of Pittwater and Barrenjoey Roads to the Sydney Harbour Bridge, via five alternative routes. Figure 2.2 shows these north-south alternatives.

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12 Peak and other time periods for the survey were defined in terms of traffic volumes. Peak periods are those morning and afternoon periods where traffic volumes exceed 3 000 vehicles per hour. Shoulder periods, immediately before and after the peak, are those with volumes greater than 2 000 but less than 3 000. Periods of medium volume are those periods (generally other periods during the day up to 7pm) with traffic volumes between 1500 and 2 000. For practicality, weekend measurements between 9am and 7pm were assigned to the medium volume period, although volumes exceed 2 000 at certain times during the day.

13 In a ‘normal’ distribution, 68% of trips would have a trip speed within the range of the average value plus or minus one standard deviation. For segment 1, 68% of trips would have an average speed between 40 and 62.8 km/h (=51.4 +/- 11.4). However, trip speeds will not be ‘normally’ distributed—the distribution will be biased or skewed to one side. Nevertheless, the standard deviation is the best available measure for variability.

TABLE 2.1 AVERAGE SURVEY SPEEDS ON SEGMENTS

Stratum	Segment 1	
	West	East
Peak	51.4 (11.4)	56.7 (6.7)
Shoulder	54.1 (6.5)	61.2 (3.4)
Medium	57.6 (8.2)	58.8 (5.4)
Low		

Stratum	Segment 2	
	South	North
Peak	57.7 (9.4)	47.2 (9.5)
Shoulder	59.6 (6.8)	42.6 (3.7)
Medium	46.8 (8.2)	46.4 (10.2)
Low	53.3 (6.5)	47.6 (4.5)

Stratum	Segment 3	
	South	North
Peak	47.4 (4.9)	46.4 (5.8)
Shoulder	53.9 (5.3)	50.6 (8.6)
Medium	53.1 (6.8)	50.7 (5.6)
Low		63.0 (7.3)

Stratum	Segment 4	
	South	North
Peak	37.6 (16.2)	53.3 (5.7)
Shoulder	51.9 (3.8)	53.2 (4.7)
Medium	49.5 (4.1)	49.4 (6.5)
Low	45.2	56.0 (6.5)

Stratum	Segment 5	
	South	North
Peak	56.3 (6.0)	64.5 (4.6)
Shoulder	61.9 (7.7)	64.5 (3.4)
Medium	57.8 (7.1)	64.6 (3.3)
Low	62.8 (4.9)	68.8 (4.5)

Stratum	Segment 6	
	South	North
Peak	44.5 (3.8)	41.0 (1.8)
Shoulder	42.7 (5.8)	38.3 (4.5)
Medium	40.0 (3.8)	42.1 (3.8)
Low	51.2 (4.3)	49.4 (5.8)

Stratum	Segment 7	
	West	East
Peak	27.4 (2.8)	35.8 (4.2)
Shoulder	38.9 (9.0)	46.3 (8.5)
Medium	40.4 (8.2)	41.2 (4.3)
Low	40.6	

Stratum	Segment 8	
	South	North
Peak	39.2 (7.8)	49.5 (5.0)
Shoulder	59.4 (5.1)	51.5 (5.9)
Medium	53.8 (9.8)	50.6 (6.5)
Low	61.8 (7.6)	55.1 (7.7)

Stratum	Segment 9	
	South	North
Peak	45.7 (10.3)	46.0 (6.9)
Shoulder	46.4 (7.1)	41.6 (5.0)
Medium	49.3 (5.5)	45.5 (6.8)
Low		44.7 (5.2)

Stratum	Segment 10	
	South	North
Peak	28.3 (8.0)	34.3 (7.2)
Shoulder	35.8 (4.0)	30.8 (9.3)
Medium	38.3 (5.9)	34.0 (4.8)
Low	46.5 (11.5)	48.4 (11.4)

Stratum	Segment 11	
	South	North
Peak	25.1 (8.1)	25.6 (7.0)
Shoulder	34.6 (3.7)	27.8 (6.4)
Medium	37.0 (5.2)	32.9 (9.0)
Low	41.0 (8.1)	38.3 (3.6)

Stratum	Segment 12	
	South	North
Peak	29.9 (8.5)	36.3 (7.9)
Shoulder	45.6 (5.4)	45.4 (8.9)
Medium	41.2 (6.1)	40.4 (8.3)
Low	62.8	48.9 (6.9)

Stratum	Segment 13	
	West	East
Peak	32.6 (10.3)	41.1 (5.2)
Shoulder	31.4 (5.8)	38.0 (5.1)
Medium	33.5 (4.9)	36.0 (5.2)
Low	40.1 (4.6)	33.3 (9.5)

Stratum	Segment 14	
	South	North
Peak	21.2 (4.5)	34.3 (5.6)
Shoulder	32.2 (8.3)	36.3 (6.6)
Medium	31.6 (5.3)	36.8 (5.4)
Low	37.5 (3.8)	45.7 (8.9)

Stratum	Segment 15	
	West	North
Peak	33.9 (2.8)	28.4 (4.4)
Shoulder	36.3 (2.6)	34.4 (4.8)
Medium	30.3 (5.2)	31.1 (3.8)
Low	31.9	29.3

Stratum	Segment 16	
	South	North
Peak	23.8 (4.8)	33.8 (5.1)
Shoulder	31.6 (6.0)	33.4 (8.0)
Medium	35.0 (3.5)	34.9 (1.1)
Low	37.8	37.9 (5.4)

Stratum	Segment 17	
	South	North
Peak	24.8 (4.7)	35.6 (5.6)
Shoulder	41.4 (5.2)	43.3 (6.6)
Medium	39.5 (6.1)	45.8 (4.3)
Low	44.2	49.9 (7.2)

Stratum	Segment 18	
	South	North
Peak	33.7 (7.6)	34.8 (5.7)
Shoulder	39.0 (3.6)	37.5 (7.6)
Medium	36.6 (4.4)	32.8 (4.8)
Low	45.0 (14.5)	41.9 (4.7)

During the morning peak, the best travel time (48 minutes) was estimated for Route 2 (Wakehurst Parkway, The Spit then either Military or Ourimbah Roads, at a total distance to the Sydney Harbour Bridge of around 30 kilometres). Next was Route 1 (52 minutes along Pittwater Road, Condamine Street then Spit Bridge), then either Route 3 (54 minutes along Forest Way, Roseville Bridge and then either Willoughby Road, Brook Street or Miller Street to access the Warringah Freeway) or Route 5 (55 minutes along Pittwater Road, Warringah Road then the Roseville Bridge options).

The longest southbound trip time at any time of day was via the Mona Vale Road, Pacific Highway and Gore Hill Freeway route, Route 4 (nearly 59 minutes in the morning peak). The meandering Route 5 was generally the next slowest.

Of routes 1, 2 and 3 and during off-peak times, what might seem like the main road route (Route 1) never provided the quickest trip. The survey results indicated that using Route 2 or Route 3 would always have saved a few minutes.

It is clear from the relatively small differences in estimated trip times that, in congested areas, drivers continually search alternatives. Indeed, for this reason the travel time differentials reported here may themselves prove short-lived. As commuters discover the quickest route and adjust their habits accordingly, trip times on all of the often-used routes will tend to converge (and have the same ‘generalised cost’ in economic terms). The less-used routes will have longer trip times, or higher generalised cost.

Intersections

The travel study also analysed three major intersections, Wakehurst Parkway / Warringah Road, Burnt Bridge Creek Deviation / Sydney Road / Manly Road and Spit Road / Military Road at Spit Junction.

The intersection of Wakehurst Parkway and Warringah Road was shown to be heavily utilised at all times of day (table 2.2). Even in the low volume periods before 6am and after 7pm, average speeds, for a two kilometre route length one kilometre each side of the intersection, did not exceed 50 kilometres per hour in the westbound direction. This was well below the posted limit of 70 kilometres per hour.

At the Sydney Road intersection, peak southbound traffic on Burnt Bridge Creek Deviation was shown to be relatively unimpeded[14], with an average travel time of less than three minutes for the two kilometre road section stretching a kilometre either side of this intersection (table 2.3). However, the average travel time in the northbound peak was around eight minutes.

14 Travel time and speed estimates for the Burnt Bridge Creek Deviation / Sydney Road intersection may be unreliable, due to the small number of run counts.

FIGURE 2.2 NORTH-SOUTH TRAVERSE ROUTES

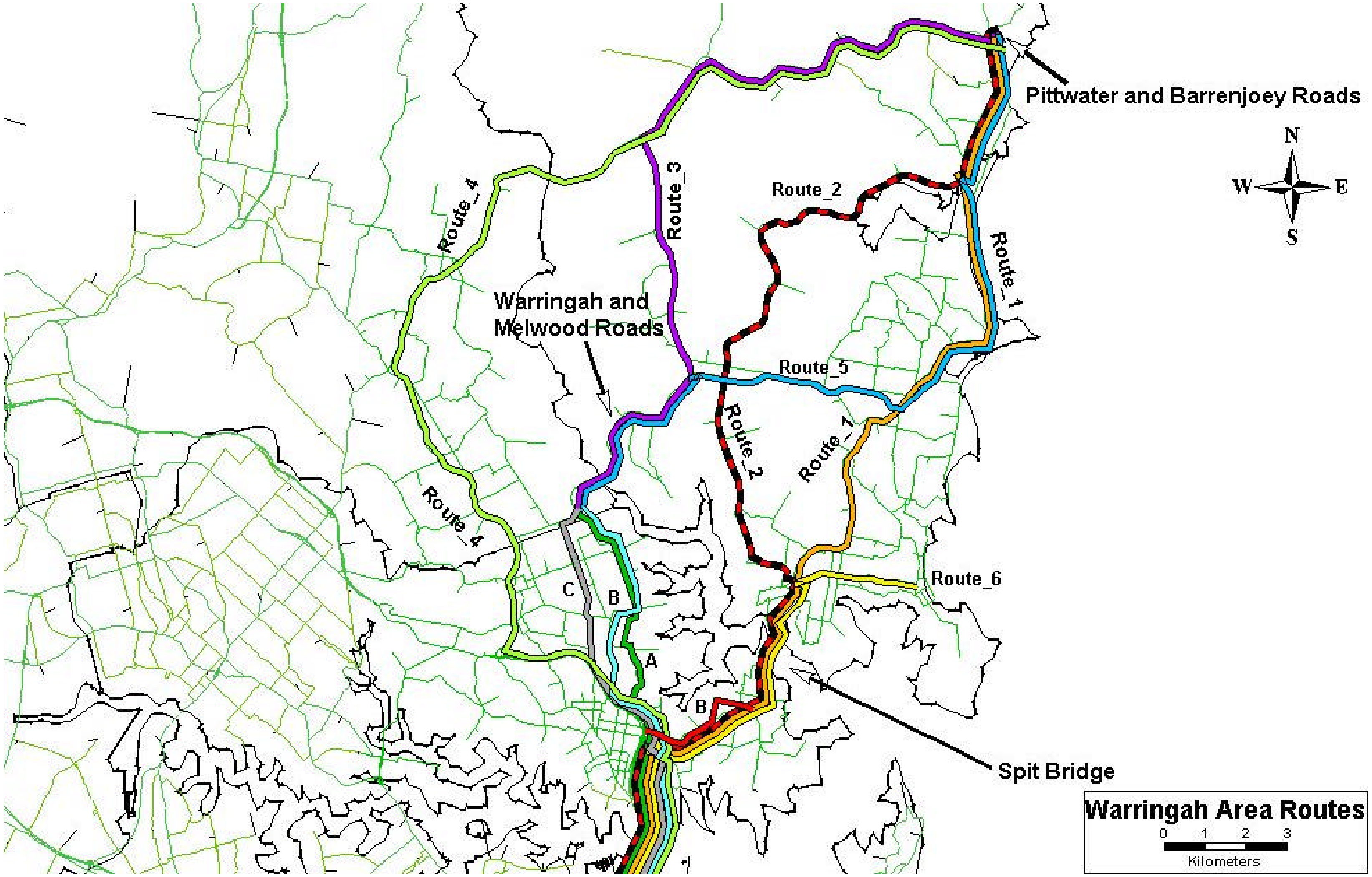

TABLE 2.2 TRAVEL TIME AND SPEED – WARRINGAH ROAD AND WAKEHURST PARKWAY INTERSECTION

Average time/speed	*West*	*East*
Peak	3.96	5.68
	32.77	22.45
Shoulder Peak	2.65	3.04
	48.70	40.36
Medium Volume	3.47	3.33
	36.04	38.55
Low Volume	2.47	2.32
	48.85	55.95

Note Travel time from 1 km before to 1 km after the intersection in minutes (average speed in km/h shown shaded).

TABLE 2.3 TRAVEL TIME AND SPEED – MANLY ROAD, BURNT BRIDGE CREEK DEVIATION AND SYDNEY ROAD INTERSECTION

Average time/speed	*Burnt Creek Bridge Dev'n*		*Sydney Road (Seaforth)*		*Sydney Road (Manly)*	
	South	*North*	*South*	*North*	*South*	*North*
Peak	2.23	7.67	7.89	2.41	6.39	2.74
	55.10	22.25	19.17	47.35	22.2	44.90
Shoulder Peak	2.19	3.17	3.67	2.52	4.45	3.62
	55.83	40.55	36.20	45.20	28.9	35.07

Note Travel time from 1 km before to 1 km after the intersection in minutes (average speed in km/h shown shaded). Estimates may be unreliable due to the small number of run counts.

In contrast, peak southbound travel from Sydney Road (ie from the Wakehurst Parkway and Frenchs Forest Road) was slow, with a travel time for the two kilometre road section of around eight minutes, while peak northbound travel was relatively unimpeded. Peak southbound travel on Sydney Road from Manly is also quite slow, with an average travel time of over six minutes.

Travel speeds through the Spit Junction intersection are similar to the prevailing speeds for the Spit and Military road segment as a whole at all times of day (table 2.4).

Reliability

A recognised consequence of congestion is that trip times become unreliable. This applies to public transport users also, to the extent that buses use general traffic lanes rather than bus priority lanes, or to the extent that road crashes and other incidents impede traffic flow in the bus lane.

TABLE 2.4 TRAVEL TIME AND SPEED – SPIT JUNCTION

Average time/speed	*South*	*North*
Peak	5.60	3.90
	23.37	33.56
Shoulder Peak	4.24	3.60
	31.39	34.46
Medium Volume	4.57	3.52
	28.16	35.83
Low Volume	3.30	2.78
	37.25	45.75

Note Travel time from 1 km before to 1 km after the intersection in minutes (average speed in km/h shown shaded).

While the concept is well understood, there is no universally recognised measure. However, the standard deviation of trip times and speeds (see 'Speeds' above) can be used to give an indication of reliability. Table 2.5 draws from the data in table 2.1 to show which are the least reliable segments.

TABLE 2.5 THE MOST UNRELIABLE SEGMENTS

Morning Peak	*Afternoon peak*
S04 - Forest Way (43%)	N11 - Willoughby Road, Penshurst Street, Boundary Road (27%)
S11 - Boundary Road, Penshurst St, Willoughby Road (32%)	N12 - Eastern Valley Way from Edinburgh Road to Boundary Road (22%)
W13 - Sydney Road from Belgrave Street to the intersection of Burnt Bridge Creek deviation and Manly Rd (32%)	N10 - The Burnt Bridge Creek deviation, Condamine Street, and Pittwater Road to the intersection with Warringah Road (21%)
S12 - Eastern Valley Way from Boundary Road to Edinburgh Road (28%)	N02 - Pittwater Road from Wakehurst Parkway to Barrenjoey Road (20%)
S10 - Pittwater Road from the intersection with Warringah Road, along Condamine Street to the intersection of Burnt Bridge Creek deviation and Sydney Road (28%)	N14 - Military, Spit and Manly Roads (to the intersection of Sydney Rd and Burnt Bridge Creek deviation) (16%)

Source Calculated from table 2.1. As a rough guide, the average trip time will be exceeded by the percentage figure (in brackets) about once per week. For example, a 40% figure would suggest that a trip which on average takes 10 minutes, will take at least 14 minutes (10 minutes plus 40%) about once per week.

The most reliable peak period travel times recorded by the survey were when travelling west on[15] Ourimbah Road to Ernest Street during the morning peak; travelling north-east on the Wakehurst Parkway from Warringah Road to Pittwater Road in the afternoon peak; and travelling on Pittwater Road between Wakehurst Parkway and Warringah Road during either peak.

15 The variability of times to queue and enter the intersection at the start of these segments is not included in this analysis.

Weekend road congestion

In contrast to weekdays, traffic in Warringah is more evenly balanced in each direction on Saturdays, Sundays and public holidays, with leisure traffic predominating. The Spit Bridge, which has a capacity of only two lanes in each direction and opens hourly at weekends for boat traffic, is a significant choke point. (On weekdays, the capacity constraint is somewhat overcome through a tidal flow arrangement in the peak direction and no bridge openings during peak periods).

The announced plan to widen the Spit Bridge and to reduce weekend bridge openings and introduce a weekend afternoon clearway for southbound traffic (see current 'Transport policy and initiatives' above) would help reduce weekend congestion, particularly in the northbound direction. In the southbound direction, Spit Junction, where traffic merges from Balmoral, Clifton Gardens and the Taronga Zoo, would remain a congestion point.

There is also significant weekend congestion around Warringah Mall at Brookvale.

SAFETY

Motor vehicle accidents throughout the region were suggested as a significant issue. From the accident statistics made available by councils, it would appear that the Roads and Traffic Authority and councils have been steadily improving the situation, particularly in Mosman and Manly (see table 2.6).

TABLE 2.6 NUMBER, TYPE OF ACCIDENTS FOR WARRINGAH REGION COUNCILS, 2001

	LOCAL GOVERNMENT AREA			
TYPE OF ACCIDENT	*Mosman*	*Manly*	*Pittwater*	*Warringah*
Car accident	149	204	292	862
Light truck accident	27	20	46	122
Heavy truck accident	3	4	9	33
Heavy rigid truck accident	1	4	6	23
Articulated truck accident	2	0	3	10
Bus accident	4	3	7	16
Emergency vehicle accident	1	0	3	3
Motorcycle accident	15	14	11	38
Pedal cycle accident	2	14	9	41
Pedestrian accident	19	24	19	36
ALL TYPES OF ACCIDENTS	160	223	312	917
Reduction between 1996 and 2001	22.7%	20.4%	1.3%	4.6%

Note The type of accident categories are not mutually exclusive and cannot be added.

Source RTA accident statistics

Absence of passing lanes on the current two lane section of Mona Vale Road above Terrey Hills is reported as both slowing speeds and contributing to accidents, a situation aggravated by growing heavy vehicle traffic. This section of the road is currently being upgraded (see 'transport policy and initiatives' above).

Mosman Municipal Council reports that, with lane widths on Spit and Military roads 700 millimetres less than standard and with growing truck traffic (in particular, to and from the Ingleside area), there are frequent accidents and incidents involving cars, buses and trucks on this route, particularly on Spit Hill. In addition, the winding Spit Road has no Jersey (crash) barrier and there are also kerbside markings at Spit Junction, in effect to advise pedestrians that large vehicles may 'jump the kerb'.

LOCAL URBAN TRANSPORT ENVIRONMENT

The Spit Bridge route and the Roseville Bridge route each pass through dense residential inner areas (centring on Mosman/Cremorne and Northbridge/Willoughby respectively). Both areas are characterised by conflicts between the needs of through traffic and of local traffic and pedestrians, with adverse consequences for the local transport environment and urban and residential amenity (see also 'Safety' above).

In both areas, access to and from local roads has been restricted to give priority to through traffic, by banning right turns at various intersections during the peak. On the Spit Bridge route, in particular, 'rat running' through residential streets, to avoid contact with the main road system, is widespread, from Manly south. However, in order to relieve pressure on the main route, a temporary right hand turn lane actually permits entry to the residential area of Beauty Point, only between 7am and 9am.

Parking arrangements necessarily reflect a compromise between the interests of through traffic on the one hand and residents, businesses and shoppers on the other. There are clearways during the morning and afternoon peaks and the NSW Government has proposed a weekend afternoon clearway in the southbound direction.

IMPROVING PUBLIC TRANSPORT

In contrast to many areas of Sydney, Warringah residents do not have the option of travelling by fixed rail (unless travelling by another mode first), or by other public transport with a dedicated right-of-way. Other things being equal, a dedicated right of way will maximise both service reliability and the travel time advantage of public over private transport for the same route, while also allowing public transport operators to optimise service frequency.

Bus priority arrangements on the existing road system secure some travel time advantage for bus passengers relative to car travellers over the same route. In the Manly to Sydney CBD corridor, for example, comparison of bus timetable and the above car survey information suggests this advantage is about 10 minutes. Buses, however, are, like cars, subject to both road intersection delays and traffic incidents, particularly on non-prioritised parts of the routes. Schedule reliability on the Warringah Peninsula, is also constrained, particularly on weekday mornings, by congestion in the contra-peak direction. This affects buses returning in the northbound direction for a further run. The congestion results from the tidal flow arrangements on both the Sydney Harbour Bridge and the Spit Bridge, which constrains road capacity in the contra-flow direction[16]. The announced widening of Spit Bridge will alleviate this situation.

The existence and quality of bus priority arrangements also affects the service frequencies that public transport operators find viable. Forest Coach Lines, the operator on the Roseville Bridge route, has claimed that the absence of bus priority arrangements is a barrier to improving service frequency on this route (Forest Coach Lines, pers.comm.).

While residential and employment densities favour provision of good radial public transport services to and from the Sydney CBD, the quality of cross-linking public transport services is less even. State Transit provides services between Dee Why and Chatswood via Forestville but there is no service between these locations via Brookvale.

16 In 2002, the State Transit Authority added eight minutes for buses travelling from the Sydney CBD to Dee Why in the contra-peak direction, due to capacity restrictions on the Sydney Harbour Bridge, Military Road and Spit Bridge (State Transit pers.comm).

CHAPTER 3 ADDRESSING THE ISSUES

This chapter discusses different ways of addressing the key transport issues for the Warringah Peninsula of traffic congestion, the inner area transport and urban environment and improved public transport.

HOW TO ADDRESS TRAFFIC CONGESTION IN THE REGION?

In principle, traffic congestion in any urban location can be addressed by: increasing road capacity; or by reducing the demand for road use during congested periods; or by the two in combination.

Increasing road capacity

With area-wide congestion on major routes during the peak periods, incremental capacity increases in a particular location (for example, a grade separated intersection) are likely to have limited overall impact on traffic flow and travel times. In general, the main impact of such increases would be to relocate the congestion to a point nearer the city in the morning peak (and away from it in the afternoon peak).

A recent study analysing 30 intersections (mostly in the Warringah Council area but including others in neighbouring council areas) found that seven intersections during the morning peak and 11 intersections during the afternoon peak were either operating at capacity with excessive delays, or that they are unsatisfactory and require improvement (Transport and Traffic Planning Associates 2001).

The potential problem of relocated congestion is important also in considering the impact of potential larger improvements in the Warringah region (for example, a new tunnelled road connection from north of the Spit to the Warringah Freeway) on the wider Sydney network, particularly Inner Sydney and Lower Northern Sydney. Cars using such a connection will reach the Warringah Freeway more quickly than currently. While traffic leaving the Warringah region has multiple destinations (see table 1.4), this may add to congestion on the approaches to the Sydney Harbour Bridge. Secondly, in the absence of specific restraints or incentives, the improved road conditions will induce some additional car trips that Warringah region residents and others currently do not make (or which they make by other modes or at different times of day) because of the level of congestion[17]. This is of particular concern in a constrained urban environment where there is finite scope to continue to increase capacity, or where such increases can only be achieved through major change to existing land uses.

The implications of this are, firstly, that limited or location-specific capacity increases in the region are, in the main, only worth considering in conjunction with larger capacity increases that can ensure that traffic remains reasonably free-flowing. Secondly, it is important that demand for any major capacity increase is managed so that congestion elsewhere in the Sydney region does not become worse.

Demand management and road congestion

It follows that tolling of major new capacity increases can be effective in encouraging the efficient use of a new facility and in minimising induced travel demand (as well as funding or helping fund the new facility). Sydney residents are accustomed to tolling of new facilities.

An issue with pricing of new capacity is that the price may be greater than the cost of using the facility at particular times of day. For example, the costs of using an uncongested road tunnel around midnight on a weekday may be no more than the tunnel operating costs. A toll that is higher than this might deter some who would otherwise use the tunnel, with a resulting loss of efficiency in economic terms. This can be addressed by reducing the toll in low demand periods. A second issue is that pricing new capacity, while existing capacity can be used free of charge, carries the risk that traffic will increase on alternative routes, again with a loss of efficiency in the overall road network. Pricing also entails some administrative costs for users and facility owners.

These are issues that go to the form pricing should take, including whether it should be applied say on a facility-by-facility basis or more broadly.

A number of other approaches to reducing the demand for car travel can be adopted, including: personalised travel planning or 'travel blending' to combine trips or move more to public transport; better facilities for non-motorised alternative modes; increasing the cost of parking; and, for the longer term, better integrated land use planning, so that co-location of employment, residential, shopping and recreational uses can limit the need for travel. A

17 For a useful discussion of induced travel, see Noland 2000.

discussion of the effectiveness of these measures is beyond the scope of this paper. However, evidence suggests their individual impact on overall travel patterns is generally quite limited (BTRE 2002a).

Can improved public transport significantly address road congestion?

The main way in which improvements to public transport can alleviate road congestion is by attracting car users, so freeing up road space.

The evidence suggests, however, that it is very difficult to attract car travellers to an improved public transport service in sufficient number to make significant inroads into road congestion (BTRE 2002a). In pricing terms, the cross elasticity of car demand with respect to bus and train fares appears to be less than 0.10. That is, a ten per cent decrease in fares would be expected to lead to slightly less than a one per cent reduction in car travel (see IPART 1996 and Luk and Hepburn 1993). Generally similar estimates of demand responsiveness apply to improvements in service such as reductions in travel time[18].

Many factors underlie this limited responsiveness of travel behaviour. For travel between today's dispersed residential and employment locations—realities that are themselves the result of growing incomes and falling car ownership costs—car travel can offer a more attractive combination of travel time, convenience, reliability, personal safety and cost, even in quite congested road conditions. Inner urban densification, as has occurred in Sydney and other cities over the past decade and which may be favourable to public transport, is an important counter-trend. However, it has not yet been of a magnitude to reverse the general separation and dispersal of home and work locations (and may indeed increase local traffic congestion). In addition, general trends in the labour force, towards more flexible work hours and the increasing workforce participation of women have contributed to the increase in 'multi-stop' and multi-purpose travel behaviour, favouring the car.

Public transport is typically an attractive option—and hence achieves significant mode share—in travel from more densely settled residential locations to central city work locations, where employment densities are high (albeit declining in percentage share terms)[19] and parking is highly priced. Conversely, public transport is a less attractive option for travel between locations where the prevailing route densities do not permit point to point service and where car parking is cheaper.

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18 Dodgson (1985) estimated service cross-elasticities that were higher for rail than for bus in Melbourne and Brisbane, lower in Adelaide and Perth and the same in Sydney, at 0.0098.

19 In Sydney, the CBD share of employment has declined to less than nine per cent of the regional total (Cox 2001).

In the Warringah region, as noted in chapter 1, the public transport mode share of peak period trips from Pittwater and Warringah combined to the Sydney CBD is higher than from Manly or Mosman, despite the higher residential densities of the latter locations. Pittwater and Warringah residents comprise nearly three quarters of the population of the Warringah region. Thus the potential reduction in traffic congestion if, for illustrative purposes, there was an increase in the morning peak Sydney CBD public transport mode share from Pittwater/Warringah, Manly and Mosman/Cremorne to the Sydney region average of 70 per cent of trips is somewhat limited. It would yield about 1 300 fewer car travellers, translating to 1 000 fewer cars, or about half the hourly capacity of one vehicle lane. An increased public transport mode share to other central locations (see table 3.1) could add to this total. All in all, the result would probably be a relatively small but—if achieved cost-effectively—beneficial impact on traffic congestion.

TABLE 3.1 MORNING PEAK TRIPS FROM THE REGION

Morning peak	*From Pittwater/Warringah*		*From Manly*		*From Mosman/Cremorne*	
7.00 to 9.00	By car[a]	By PT[b]	By car[a]	By PT	By car[a]	By PT
INTERNAL To the region	57 300	6 900 (9%)	7 400	800 (7%)[d]	3 200	300 (5%)[d]
CENTRAL To Sydney CBD	2 900	4 800 (62%)	1 200	1 400 (55%)	900	2 000 (54%)
To North Sydney	700	2 000 (74%)	1 600	900 (37%)[d]	3 700	0 (0%)[d]
To Near CBD	1 000	1 500 (53%)	600	500 (45%)[d]	1 800	1 400 (39%)
CENTRAL Total	4 600	8 200 (63%)	3 400	2 800 (46%)	6 400	3 300 (27%)
To Willoughby/ Lane Cove	4 000	500 (11%)[d]	500	400 (41%)[d]	800	400 (36%)[d]
All other destinations	7 400	200 (3%)[d]	300	400 (41%)[d]	300	200 (37%)[d]
ALL DESTINATIONS	73 300	15 800 (15%)	11 600	4 300 (23%)	10 600	4 200 (21%)

a. Trips as car driver, plus as car passenger. All numbers are rounded to the nearest hundred.

b. Trips by public transport, as a percentage of all trips, are shown in brackets.

c. The Peninsula includes Pittwater, Warringah, Manly and Mosman/Cremorne.

d. TDC notes that some estimates are based on small numbers surveyed and may be unreliable.

What about road congestion at weekends?

With Spit Bridge a major source of congestion at weekends, due to regular bridge openings and a lane capacity below that of the approach roads, a full solution requires an uninterrupted all day crossing of Middle Harbour. In turn, this implies either a new higher level bridge over the Spit, a road tunnel, or a permanent closing of the existing bridge. The latter would involve a loss of amenity for Middle Harbour yacht owners. Compensation to install collapsible masts or establish new moorings down-stream from the bridge might be investigated as a possible approach to address this problem. Any solution that did not adequately accommodate the needs of boat traffic would alter the particular character of the area.

As indicated in chapter 2, the announced widening of Spit Bridge will aid the situation, particularly in the northbound direction.

Where should any major new road capacity be sited?

New tunnelled road capacity could be sited either in the south of the region at the Spit, through the Mosman inner area to the Warringah Freeway, or in the centre of the region, from the Roseville Bridge through Willoughby and Northbridge.

Annual average daily traffic is slightly heavier over the Spit route and average travel speeds are lower[20] indicating that road congestion is also worse on the Spit route. In addition, there are a number of intersection congestion points between the intersection of Warringah Road and the Wakehurst Parkway and the Roseville Bridge. This suggests it would be difficult to channel additional traffic through this route, without first increasing road capacity at these intersections. This would entail disruption to existing land uses. In contrast, there is only one intersection (Sydney Road / Manly Road / Burnt Bridge Creek Deviation intersection at Seaforth), where eight southbound lanes converge to three, that would require improving on the Spit route. The Roseville route is also less centrally located in the Warringah region and would not provide a new route option for the Manly area. By the same token, increased capacity on the Roseville route would have a lesser effect in reducing weekend congestion on and around Spit Bridge.

With its lesser effect on congestion south of the Spit, capacity improvements on the Roseville Bridge route would not be as effective in improving accessibility for local traffic and safety in the Mosman area.

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20 According to RTA 1999 traffic data, there were 68 000 vehicles per day on Warringah Road just south of Melwood Avenue, and 69 000 vehicles per day on Spit Bridge. Average speeds on Spit and Military Road were measured at 21 kilometres per hour in the southbound peak and 34 kilometres per hour in the northbound peak. Southbound peak average speeds of 25 kilometres per hour were measured through Willoughby and 36 kilometres per hour in the northbound peak. See Table 2.1.

IMPROVING THE INNER AREA URBAN ENVIRONMENT

A tunnelled bypass of Spit and Military roads from Middle Harbour to the Warringah Freeway is likely to be the most effective approach to improve the local urban environment in the Mosman area.

A road tunnel bypass would allow local accessibility needs to be prioritised ahead of the needs of through traffic. This implies restoring access that in recent years has been restricted to and from adjoining roads and altering traffic light phasing. It would also allow road and pedestrian safety to be prioritised: through reducing the number of lanes on both Spit Road and Military Road (by a total of one, or by one in each direction), increasing lane widths and thereby also overcoming the risk of large vehicles 'jumping the kerb'; and by establishing a Jersey (crash barrier) on Spit Hill.

A key concern with any new tunnel would be the control and disposal of tunnel exhaust emissions, including the location of ventilation equipment and the treatment of emission contents. Optimal design and location of these facilities would need to be carefully evaluated.

IMPROVING PUBLIC TRANSPORT

Many public transport service improvements are largely independent of physical infrastructure considerations. Initiatives such as integrated ticketing across public transport modes, more direct routes and improved information systems all have an important role to play in improving service for existing users and attracting new patrons.

In terms of infrastructure options in the Warringah region, an expansion of bus priority arrangements would, in principle, deliver better service to public transport users. However, unless bus densities are already large enough to occupy a full traffic lane (with or without accompanying high occupancy vehicle traffic), introduction of bus priority arrangements is likely to aggravate traffic congestion. This would be counter-productive. There also appears to be little scope in the Warringah region for the alternative approach of expanding surface road capacity to accommodate a new bus priority lane.

Improving cross-linking bus services

Subject to assessment of viability, services across the Warringah region would be improved if bus services from Brookvale to Chatswood via Dee Why were established. See also 'Opportunities for public transport from a new road tunnel' below.

Opportunities for public transport from a new road tunnel

A road tunnel in the Warringah region would improve public transport service along its length for buses using it, offering reduced trip times and improved reliability.

A tunnel would provide an opportunity for ‘through’ express bus services from the Northern Beaches to North Sydney and the Sydney CBD to be established. Planning for the new services could include an expansion of park and ride facilities, at Brookvale and other locations.

The surface route would remain the appropriate one for most bus services. State Transit Authority data for September 2002 indicate there were 4 500 inbound boardings in the two hour morning peak along Military Road and Spit roads between the Spit and the Warringah Freeway. This represents 25 per cent of all STA inbound boardings from the Brookvale, Mona Vale and North Sydney depots in this time period. There were also additional boardings in the Mosman area on services that then join the main road and carry people along Spit and Military roads. Services of this type could only move to a tunnel environment with the aid of extensive station, escalator and other infrastructure (see also appendix II). The need for convenient interchange between buses is a further constraint on bus operations in a road tunnel.

With reduced congestion as commuter car traffic uses the new tunnel, Spit and Military roads could be improved for public transport. A peak period bus lane in each direction, in contrast to the existing transit and high occupancy vehicle (T3) lane could be established. It is likely this would be justified south of Spit Junction, where bus densities are highest, if not for the whole distance between the Spit and the Warringah Freeway. Alternatively, existing arrangements could be maintained. More indented bus bays would be desirable, where feasible, under either approach, to allow priority to express buses.

Dedicated right of way services

A new public transport service with a dedicated right of way, separate from the existing road system, whether bus transitway or rail-based, would represent a major improvement in quality of service, through improved travel times, reliability and, assuming total patronage increased, better frequencies. As well as attracting some car travellers, there would be, depending on the reach of the new network, significant potential to attract existing public transport users.

In the inner areas at least and possibly further north also, given the constraints on expanding surface road space, any completely new system would need to be underground or elevated[21].

In general, bus-based systems will be considerably less costly than fixed rail systems. However, innovative 'train-like' bus designs, involving a dedicated narrow-lane busway that, with the aid of Intelligent Transport Systems technology, supports buses in both directions (Hensher 2002) may be feasible. Alternatively, a light or 'ultralight' rail solution could be investigated[22].

21 Access to the Sydney Harbour Bridge for a rail-based system might also be considered (Payne 2002).

22 While yet to be used as a public transport system, the Sydney-based Bishop Austrans system is an example of the latter, featuring small (9 person) vehicles operating fully automated on rails with an exclusive right of way. The system is designed to operate with high speed and flexibility over steep gradients and at lower cost than other rail systems (Sinclair Knight Merz 1996). In addition, in the early 1990s, Abigroup, a developer, proposed a VAL people-mover rail system from Brookvale to North Sydney. This system, which operates as a mini-metro in Lille, France, uses rubber tyred wheels and higher volume vehicles than Austrans.

CHAPTER 4 STRATEGIES FOR FURTHER CONSIDERATION

This chapter identifies strategies for further consideration on the basis of likely performance against defined transport improvement objectives.

TRANSPORT IMPROVEMENT OBJECTIVES

On the basis of the issues identified in earlier chapters, four transport improvement objectives can be framed as follows.

- To reduce traffic congestion in the Warringah region, particularly on weekday peak periods and at weekends.
- Not to increase congestion in the rest of Sydney as a consequence of any major improvements in the Warringah region, especially across the Harbour to the CBD.
- To improve public transport services to the Warringah region.
- To enhance amenity and accessibility to inner Warringah (the Mosman area).

CORE STRATEGIES

Three core strategies are identified for further consideration. These are:

- a road tunnel bypass of Spit and Military roads, together with improved local amenity and accessibility on the surface route;
- a new high speed public transport service with dedicated right of way from both Brookvale and Manly to North Sydney, the Sydney CBD and possibly Chatswood; and
- improved cross-linking bus services, in particular from Manly to North Sydney and from Dee Why to Chatswood via Brookvale.

Table 4.1 summarises the ways in which the strategies relate to the four objectives.

Road tunnel bypass

The road tunnel bypass strategy could involve either an under-crossing of Middle Harbour connecting to a tunnel to the Warringah Freeway or, alternatively, an improved bridge crossing of Middle Harbour connecting to a shorter tunnel to the freeway.

TABLE 4.1 TRANSPORT IMPROVEMENT STRATEGIES AGAINST OBJECTIVES

OBJECTIVE *STRATEGY*	*Reduced congestion in Warringah*	*Sydney congestion not increased*	*Improved public transport*	*Improved inner area amenity and accessibility*
Tolled tunnel bypass of Spit and Military Road with improved local accessibility on surface route	Yes	Maybe	Yes	Yes
Dedicated right of way public transport services from Brookvale and Manly	Limited	Yes	Yes	Limited
Improved cross-linking bus services	Limited	Yes	Yes	Limited

Either variant of the strategy should reduce congestion from, in the southbound direction, the approaches to the Spit through to the Warringah Freeway. Whether the tunnel bypass would aggravate traffic congestion in the rest of Sydney would depend largely on the structure and level of the tunnel toll.

The tunnel bypass would provide an opportunity for new express bus services between Northern Beach suburbs and North Sydney and the Sydney CBD. In addition, bus services would benefit from improvement to lane-widths on Spit and Military roads and, depending on the extent of the surface route changes, additional indented bus bays.

Inner urban amenity would be improved through: reduced through traffic, including freight traffic; improved local accessibility, with more roads where right turns onto and from Spit and Military roads are permitted; and improved road and pedestrian safety, with wider lanes and establishment of a Jersey (crash) barrier on Spit Hill.

New dedicated right of way public transport service

A new public transport service on a dedicated right of way would, for the reasons outlined in chapter three, have generally limited impact in reducing traffic congestion in the Warringah region.

A new high speed dedicated right of way service would improve the quality of public transport service and, depending on the extensiveness of the network, would attract significant numbers of existing public transport passengers.

With the problems of the inner Mosman area linked to traffic congestion and the competing claims of through and local traffic, this option would have generally limited benefits for inner area amenity.

Improved cross-linking bus services

Improved cross-linking bus services would similarly have a small impact on traffic congestion. Improved services of this type would, by definition, improve public transport for those users able to benefit.

STRATEGIES FOR FURTHER ANALYSIS

The analysis in chapter 5 focuses on the tunnel bypass strategy, as the one with the greatest potential to reduce traffic congestion in Warringah and improve inner area amenity and accessibility. However, the two public transport strategies also merit further investigation, as complements rather than alternatives to the road tunnel bypass strategy.

CHAPTER 5 ANALYSIS OF ROAD TUNNEL BYPASS OPTIONS

This chapter describes the two road tunnel bypass improvement options identified in chapter 4 in the terms in which they have been developed for costing, demand analysis and economic and financial evaluation purposes. The chapter also identifies key issues for further investigation and summarises the analysis.

OPTION DETAILS

Option A: Road tunnel bypass with surface route accessibility improvements

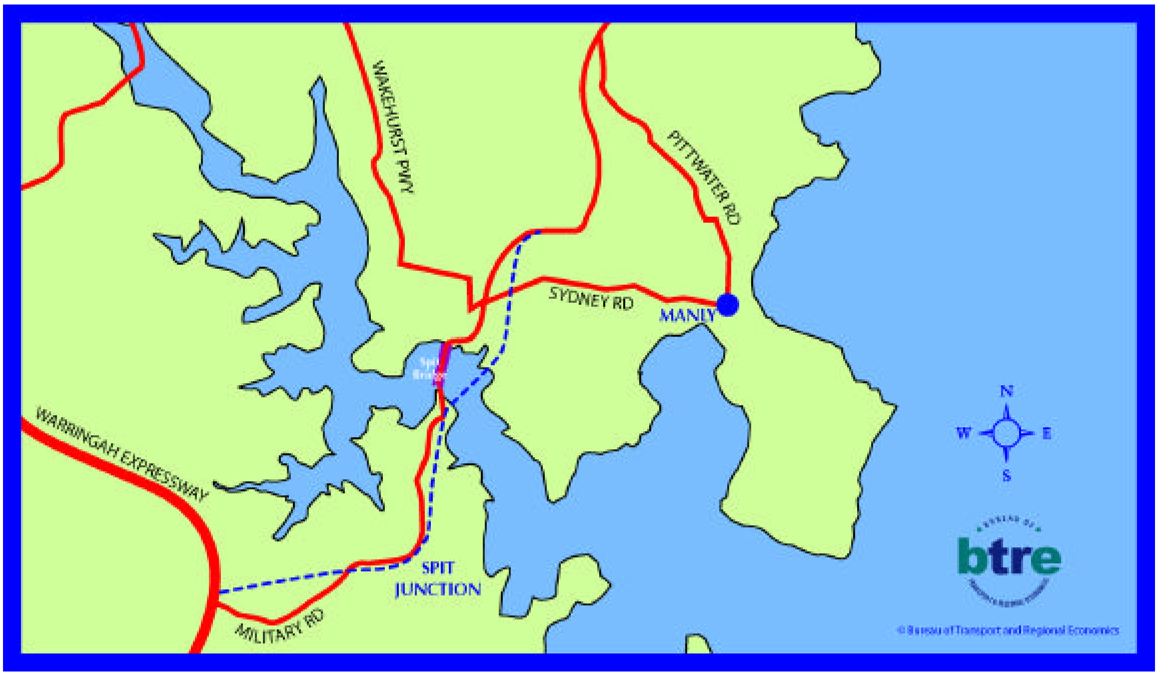
This option comprises two two-lane tunnels, commencing in the southbound direction in the vicinity of Burnt Bridge Creek Deviation and exiting on the Warringah Freeway. Figure 5.1 shows the approximate location.

Land-based rock tunnels from Burnt Bridge Creek Deviation would, for the assumed alignment, connect to an undercrossing of Middle Harbour in the vicinity of Spit Bridge. Here Middle Harbour has up to 20 to 25 metres depth of water and is approximately 400 to 700 metres wide.

The assumed alignment would track the existing Spit and Military road alignment fairly closely to the freeway at Cammeray. This is in order to minimise tunnel lengths and provide an alignment with reasonable curvatures and gradients of less than 3 per cent. The latter would allow trucks and also buses, when using the tunnel, to travel at the tunnel design speed. The total length of the tunnel route, including ramps, would be about 7.6 kilometres.

At the Warringah Freeway, four portals would be required, one each for traffic entering and exiting in both northbound and southbound directions. It is possible there would be insufficient space between Ernest and Falcon streets at Cammeray to accommodate the portals without adopting relatively tight horizontal curvatures and lower traffic speeds. Ramp tunnels for the west side of the Warringah Freeway could dive down at a relatively steep gradient and then turn beneath the carriageways towards the Spit.

FIGURE 5.1 ROAD TUNNEL BYPASS



Surface road works that could be undertaken, subject to the closing of one or alternatively two lanes on Spit and Military roads, include installing a Jersey (crash) barrier on Spit Hill, rearranging lane widths, putting in place indented bus bays where feasible and enhancing Spit and Military roads for local traffic through increasing the access roads where right turns can be made[23].

Express ‘through’ buses would use the tunnel, while other buses would use the existing Spit Bridge and the peak period T3 lane on Spit and Military roads. The existing peak tidal flow arrangements on Spit Bridge would be discontinued.

The option is modelled with a toll of $3.50 per trip[24].

Issues for investigation

Issues beyond the scope of this study and which would need to be addressed include potential impact on marine facilities on the southern side of Spit Bridge, proximity of soft soils and proximity of the Northside Storage Tunnel and the Northern Suburbs Ocean Outfall Sewer.

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23 Due in part to the large-scale and strategic nature of the TRESIS model, surface route changes are not modelled in the analysis.

24 The analysis also includes an untolled scenario (ITS 2002b). Some relevant contrasts with the tolled scenario are discussed in appendix III.

Location of tunnel portals, including consideration of the lane capacity for entering and exiting the Warringah Freeway, would require detailed investigation.

Ventilation requirements are, similarly, a matter for further study. Up to three ventilation emission locations would probably be required, in addition to intakes at the tunnel portals.

Ways of minimising the disruption that tunnel construction would cause to transport, urban amenity and the environment would also need to be investigated, as would the detail of required surface route changes in favour of local accessibility and amenity.

Alternative alignments

The location indicated for the Middle Harbour crossing limits the overall route and channel crossing lengths and also avoids areas with structures or utilities founded on compressible (soft) soils. Other route options further east and further west of Spit Bridge could also be investigated. This could include alignments further inland to the Northbridge peninsula. The latter could entail entry and exit portals to and from the freeway at Naremburn instead of at Cammeray.

Alternative alignments, involving steeper grades and potential climbing lanes, could provide a shorter tunnel length at a higher unit tunnelling cost.

Option B: Shorter road tunnel bypass with bridge and other surface accessibility improvements

For the purpose of the analysis, this option comprises an elevated four-lane road link from a grade-separated Seaforth interchange at Sydney Road joining a higher level four-lane bridge near the existing Spit Bridge. The new bridge would adjoin two-lane tunnels to the Warringah Freeway at Cammeray. The length of the route is 6.6 kilometres, comprising an estimated 5.1 kilometres of tunnel and ramps and 1.5 kilometres for the bridge and road link to the improved Seaforth interchange. Figure 5.2 shows the approximate location.

The configuration of the entry and exit portals at Spit Road would require careful consideration to minimise the extent of land required.

Surface route changes would be as in option A, but could allow for buses to use the new bridge in both directions (entering from and exiting on to Spit Road)[25].

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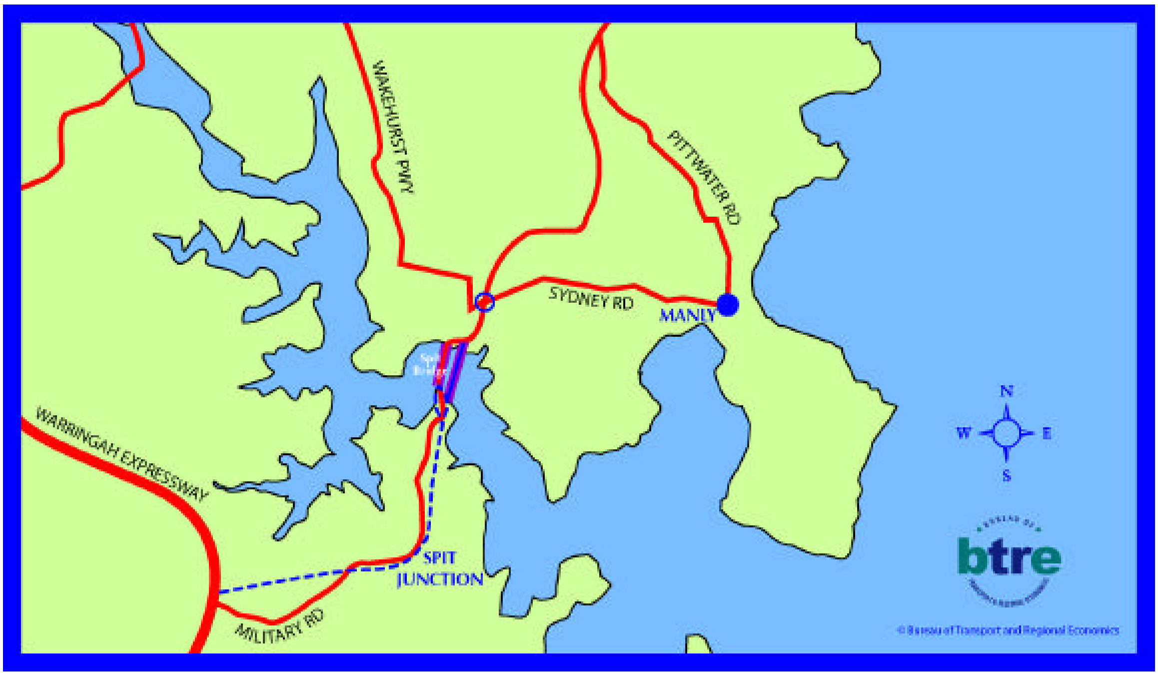
25 As with option A, surface route changes are not modelled in the analysis.

Bridge location and design (see below), portal locations and ventilation arrangements would be matters for further detailed study. It is likely that two ventilation control points would be required, in addition to intakes at the tunnel portals.

The option is modelled with a toll of $3.50 per trip[26].

FIGURE 5.2 SHORTER ROAD TUNNEL BYPASS AND BRIDGE



Alternative bridge concepts

The minimal option for an improved Middle Harbour crossing that is potentially compatible with a Mosman bypass tunnel concept is widening of the existing Spit Bridge to six lanes. The bridge would also be permanently closed to boat traffic. A 24 hour crossing of Middle Harbour is necessary on safety grounds, ensuring that traffic in the tunnel can remain free-flowing. Grade separation for the Seaforth interchange at Sydney Road would also be required.

A widened bridge would operate on a peak tidal flow basis. In the southbound direction, surface and tunnel traffic would need to be separated. Local congestion here could reduce somewhat the time saving benefits of a tunnel. In the northbound direction, congestion at the tunnel exit would be minimised

26 The analysis also includes an untolled scenario (ITS 2002b). Some relevant contrasts are discussed in appendix III.

with a continuation of the Spit Bridge peak tidal flow arrangement on to Manly Road towards Burnt Bridge Creek Deviation.

Alternatively, a new higher level six lane bridge could replace the existing four lane Spit Bridge on the existing alignment.[27] As with the minimal option, this would achieve an uninterrupted 24 hour crossing, with small disruption to existing land uses and without affecting boat traffic. Its transport impact would be the same as the minimal option. Other bridge configuration options might emerge from further analysis.

COST ESTIMATES

Estimated costs (table 5.1) are based on recent and proposed tunnel construction projects in Sydney (for example, the Northside Storage Tunnel, the M5 East Motorway Tunnel and Lane Cove Tunnel, Gore Hill Freeway). In general, there is a greater degree of certainty regarding costs for the rock tunnel sections, where there is a reasonable amount of precedent experience, than for the crossing of Middle Harbour in non-rock conditions, where the only recent road tunnel example is the Cooks River Crossing on the M5 East Motorway and the older Sydney Harbour Tunnel work.

TABLE 5.1 SUMMARY OF ESTIMATED CONSTRUCTION COSTS

	Option A *$m*	*Option B* *$m*
Land-based rock tunnels	161	107
Middle Harbour bridge	N/A	120
Middle Harbour undercrossing	180	N/A
Sydney Road grade separation	N/A	50
Surface road improvements	30	30
Operational equipment	200	140
Preliminary and contingency cost	217	114
Other items	168	90
TOTAL COST	956	651

Source Coffey Geosciences (2002) and Hyder Consulting (bridge costing).

There is a range of potential alternative methods for a Middle Harbour tunnel crossing, including immersed tube tunnelling, cut and cover tunnelling, driven tunnels and other methods. Specific investigation of methods and costs is required.

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27 An approach involving removing the existing bridge only after a new one has been constructed over its top has been suggested, so that construction would not affect the existing crossing (Manly Daily, 8 November 2002).

Costs of construction may also be reduced through the competitive tendering process.

Costs of tunnel operation include power, communications, lighting, traffic management and control systems, fire alarm systems and ventilation. As this cost information is commercially sensitive, it has not been possible to develop a reliable estimate. A notional cost of 2 per cent per annum of adjusted construction costs is used in the analysis. There is a downward adjustment for the above pro rata costs of the Middle Harbour undercrossing. The resulting annual operating cost estimates are $15.7 million for option A and $13 million for option B.

APPROACH TO THE ANALYSIS

The analysis assesses the economic and financial viability of each option in comparison with the 'do nothing' situation.

The economic evaluation takes the viewpoint of the community as a whole and compares construction and operating costs of a proposed facility with benefits, principally time savings for individuals and vehicle operating cost savings, both expressed in dollar terms and considered over time. The benefits include savings on other routes as well as the improved route. A benefit-cost ratio (BCR) and net present value (NPV), ie the value today of the net benefits that are expected to occur over time, is provided for each option. Not all costs and benefits can be quantified in this way, or at all. Nevertheless, dollar values can be assigned implicitly to them, where they 'tip the balance' between alternatives.

The financial evaluation, in contrast, adopts the perspective of the owner of a tolled facility. Revenues for the improved route (at a toll of $3.50 per vehicle-trip) over time are compared with construction and operating costs, to provide a financial internal rate of return, together with an NPV.

Both evaluations are based on travel demand forecasts provided by the Institute of Transport Studies, University of Sydney (ITS 2002b). The forecasts were undertaken using the TRESIS model, calibrated with data from the ITS 2002 travel time survey (ITS 2002a), results of which are summarised in chapter 2. See Appendix III for a summary of the results of the forecasts and underlying assumptions. The appendix also sets out the specific option parameters that the modelling uses.

ANALYSIS

Travel projection results

The travel forecasts show a small reduction (one per cent) in total Northern Beaches[28] trips in both tolled options, due to some travel being deterred by the new tolls and a slight increase in average trip length. The number of commuting trips is virtually unchanged.

There is a small increase in passenger vehicle kilometres travelled for Northern Beaches residents in both options (half a per cent), indicating, with the improved road conditions, some limited substitution of trips outside the region for local trips.

Total travel time for Northern Beaches residents falls by 10 million hours, or seven per cent, a significant reduction. Total travel time for all trips reduces by 17 million hours (option A) and 16 million hours (option B), a reduction of one per cent at the Sydney region level. These reductions result from increased road capacity in both directions (including in the contra-peak direction on the Spit route), improving traffic flow on all routes, together with bypassing of local congestion, traffic signals and associated queues for tunnel users. These savings are what accrues to travellers on all major routes, not solely those using the tunnel bypass.

Economic evaluation

Table 5.2 shows the summary results from the economic evaluation. Almost all of the quantified benefits of the project arise from time savings on the tunnel bypass route and on other routes in the Warringah region. For option A, the value of these is estimated at $255m in the first year of the project[29], with an average value of in-vehicle travel time of $15.56 per hour (car travellers) and $4.45 (bus passengers). First year benefits total $232m for option B.

These benefits accrue both to tunnel users, estimated at 52 000 (option A) and 50 000 (option B) in the first year and to users of the other routes to and from the Northern Beaches.

At a real discount rate of four per cent, option A has a benefit-cost ratio of 5.0 and a net present value of $3.8 billion. Option B has a benefit cost ratio of 6.4 and a net present value of $3.5 billion. The project is therefore highly

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28 The Northern Beaches zone in the TRESIS model comprises most of the population and area of the Warringah region. See Appendix III.

29 This is notionally 2005. With travel growth projected to increase at about one per cent a year, in line with population and employment growth at this level, first year benefits would be slightly higher if, as could be expected, the project started later than 2005.

economically viable. At an alternative higher discount rate of seven per cent, the project is still highly economically viable: benefit-cost ratios are 3.3 and 4.3 respectively and net present values are each $2.2 billion.

Table 5.3 sets out the sensitivity of the estimated benefit-cost ratio of the project to changes in key outcome parameters, ie construction costs, operating costs and travel time savings. Benefit-cost ratios and net present values are still strongly positive for both options even with 30 per cent increases in construction and operating costs and a comparable reduction in travel time savings[30].

TABLE 5.2 ECONOMIC EVALUATION OF TUNNEL BYPASS OPTIONS

	Option A	*Option B*
KEY ASSUMPTIONS		
Length of life for evaluation purposes (years)	25	25
Warringah population growth (per year)	1%	1%
Real discount rate	4%	4%
Average value of in-vehicle travel time ($ per person hour)	15.56	15.56
Average value of in-vehicle public transport travel time ($ per person hour)	4.45	4.45
Toll ($ per vehicle trip)	3.50	3.50
BENEFITS		
Year one time savings (m hours)	15.6	17.2
Year one time savings ($m)	255	232
COSTS		
Construction ($m)	956	651
Operating ($m per year)	15.7	13.0
BENEFIT-COST OUTCOME		
Benefit-cost ratio	5.0	6.4
Net present value (2002 $m)	3 800	3 500

30 Depending on the extent of the changes, surface route improvements favouring local accessibility over through traffic would reduce the time saving benefits somewhat.

TABLE 5.3 SENSITIVITY OF BENEFIT/COST RATIOS TO ALTERNATIVE OUTCOMES

	Option A		*Option B*	
	BCR	NPV ($m)	BCR	NPV ($m)
Construction costs minus 30%	7.2	4 100	9.2	3 700
Construction costs plus 30%	3.9	3 500	4.9	3 300
Operating costs minus 30%	5.1	3 900	6.5	3 600
Operating costs plus 30%	4.9	3 700	6.3	3 500
Travel time savings minus 30%	3.4	2 200	4.4	2 200
Travel time savings plus 30%	6.6	5 200	8.4	4 800

Unquantified benefits and costs

These results also take no account of a range of other benefits and costs (disbenefits) for the community. These have not been quantified and in some cases are difficult or impossible to quantify.

On the benefit side, these include: improved urban amenity and accessibility in the Mosman area; improved road and pedestrian safety resulting from reduced surface road congestion and surface road improvements; and improvement in air quality due to faster travel times. On the disbenefit side, they include: any visual and other impacts of the tunnel emission location points; any environmental impact on Middle Harbour; and any visual impact causing reduced amenity for residents and others.

Financial evaluation

From a facility owner’s perspective, the key consideration is the financial viability of the project. Benefits that cannot be captured in the tunnel revenue stream are irrelevant from this perspective.

For an owner, the financial outcome can be calculated as the present value of the net after-tax revenue stream, discounted at the after-tax cost of capital, or alternatively as the after-tax financial internal rate of return. The analysis for this paper is a simplified one in not taking account of tax in either the revenue stream or the discount rate.

Table 5.4 sets out key parameters for the financial evaluation. The assumed toll per vehicle trip is $3.50. Tunnel revenue is $66m (option A) and $64m (option B). Construction and operating costs are as in table 5.1. A real discount rate of seven per cent is assumed, to reflect the private sector’s cost of capital which is higher than that of the public sector.

Option A has a financial internal rate of return (FIRR) of 3.5 per cent. The project would require an estimated public funding contribution of $282m to be financially viable. This amount is less than 10 per cent of the estimated net present value of the project for the community of $3.8 billion. The amount of public funding required would also be affected by construction costs that were different from projections, or by toll revenue that is lower or higher than projections.

TABLE 5.4 FINANCIAL EVALUATION OF TUNNEL BYPASS OPTIONS

	Option A	*Option B*
KEY PARAMETERS		
Year one tunnel vehicle trips per day	52 000	50 000
Toll ($/vehicle trip)	3.50	3.50
Revenue ($m)	66	64
Real discount rate	7%	7%
FINANCIAL OUTCOME		
Financial internal rate of return	3.5%	6.9%
Net present value ($m)	- 282	- 4

Option B has a financial internal rate of return of 6.9 per cent, virtually identical to the assumed before-tax cost of capital of seven per cent. This indicates the project is potentially financially viable without a public funding contribution. As with option A, the financial outcome is sensitive to construction costs and / or toll revenue that are different from projections.

Toll level and structure

An alternative toll level and structure could improve the financial viability of the project. A variable toll, with higher peak prices and lower regular prices, may still be attractive to commuters, who comprise about 20 per cent of trips, and would also attract more off-peak trips to the tunnel route. A variable tolling structure of this type would be likely to maximise revenue and minimise any cost to the public sector.

OTHER CONSIDERATIONS

What impact would Warringah Freeway congestion have?

Travel speeds in the tunnel will be lower than the design speed of 80 kilometres per hour if access onto the Warringah Freeway is impeded by congested conditions there. It is possible this could be the situation at the time that the project becomes operational, or subsequently. However, if congestion on the freeway worsens over time, this is likely also to reduce existing travel speeds and times on the surface routes linking Warringah with the centre of Sydney. It is not clear to what extent the projected travel time reductions resulting from a tunnel bypass would change as a consequence.

Would a tunnel bypass cause congestion on the freeway?

The travel analysis does not indicate whether the tolled tunnel bypass scenarios would add to congestion on the Warringah Freeway and across Sydney Harbour. Much of the traffic that leaves Warringah does not travel south over the Harbour Bridge. Less than a third of Northern Beaches trips with destinations outside the zone are headed for zones where the Harbour Bridge can be considered the likely route: ie Inner Sydney, Eastern Suburbs, St George-Sutherland, Canterbury-Bankstown and Inner Western Sydney. The remainder is headed for destinations to the north-west, west and south-west.

It is, however, reasonable to expect that an improvement in travel times resulting from this project would result in some additional trips, as travel that is currently 'suppressed' by congested conditions becomes more attractive. Possible examples include increased commuting (reduced telecommuting or job relocation resulting in a net increase in travel) and relocations of employers and households that also result in a net increase in vehicle kilometres travelled.

In estimating likely induced travel, care is needed to separate this effect from, firstly, other factors that will also tend to increase car travel, such as growth in population, employment and household income and, secondly, travel which is diverted onto the improved route or service from other modes or routes. For this study, some growth in demand from these key drivers and from relocations is already factored in to the travel projections. In addition, because the Warringah Peninsula is not part of a larger corridor, the potential for traffic diversion on to the improved route (and from there southbound on to the Warringah Freeway) should be less than elsewhere.

As well as assisting financial viability, time of day tolling would help to reduce peak period travel to and from Warringah, by providing an incentive to travel at other times. This would help ensure that the new infrastructure did not add to peak period congestion on the Warringah Freeway and the approaches to the Sydney Harbour Bridge, thereby helping to manage any induced traffic.

Public transport outlook

The travel analysis does not take account of the possibility of a reconfiguration or expansion of bus services to maximise the opportunity a tunnel bypass would present. This could involve an increased number of through express buses from Manly and the Northern Beach suburbs. Planning for such services could include an expansion of park and ride facilities at Brookvale and at other locations.

The analysis also does not reflect the opportunity for improved schedule reliability, with reduced congestion in the contra-peak direction for returning buses. This also can have an impact on public transport ridership.

APPENDIX I TRAVEL DATA SET

Origin-Destination travel data between the following 14 regions was requested from the Transport Data Centre of the NSW Department of Transport.

Region	*Description*	*TDC 1996 Zones*
1	Pittwater	Pittwater SLA
2	Warringah North	644, 537, 849, 774
3	Warringah Centre	536, 629, 531, 532, 533
4	Warringah South-east	534, 535, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 786
5	Manly	Manly SLA
6	Mosman-Cremorne	Mosman SLA + 67, 68, 69, 70
7	North Sydney	North Sydney SLA except 67, 68, 69, 70
8	Willoughby-Lane Cove	Willoughby SLA + Lane Cove SLA
9	Ku-ring-gai	Ku-ring-gai SLA
10	North West	Hornsby, Ryde and Hunters Hill SLAs
11	Outer Sydney	Blacktown-Baulkham Hills, Central Western Sydney, Fairfield-Liverpool, StGeorge-Sutherland, and Canterbury-Bankstown SSDs
12	Inner Sydney	Sydney–Inner SLA
13	Near Inner Sydney	Eastern Suburbs SSD, Inner Western Sydney SSD, and Inner Sydney SSD except Sydney–Inner SLA
14	Other	Other regions in Greater Metropolitan Region (GMR) data set. The GMR comprises the Sydney Statistical Division, the Newcastle Statistical Subdivision and the Illawarra Statistical Division.

By six modes – Car Driver, Car Passenger, Bus, Train, Ferry, Other

By six times of day –

1. before 7am
2. 7am-8.59am
3. 9am-2.59pm
4. 3pm-3.59pm
5. 4pm-5.59pm
6. 6pm plus

APPENDIX II CONSULTATION ON THE BTRE ISSUES PAPER

In August 2002, BTRE released an issues paper (BTRE 2002b) for comment. There were over 80 responses, mostly from private individuals, addressing the issues and options the paper outlined and providing suggestions.

GENERAL COMMENTS

Many commented that the proposed options would improve traffic flow in the Warringah region. There were also comments that the issues paper was too oriented towards roadway solutions and that more attention should be given to public transport alternatives.

The SHOROC Transport Steering Committee commented that public transport should be given priority in any option and that the infrastructure question requires investigation. Other issues such as travel demand management and integrated land use and transport planning should be addressed, in conjunction with acquisition of the corridor.

NSROC submitted comments provided by the North Sydney Council. It expressed the view that, without improvements to the public transport system and travel demand management measures, additional road capacity would lead to congestion on the approaches to the Sydney Harbour Bridge. The congestion would be similar to what occurred before the opening of the Harbour Tunnel, with significant volumes filtering on to residential streets. The study should be expanded to include heavy and light rail options, along both the Chatswood to Dee Why route and the Spit route. Others also expressed concern that the BTRE’s options would result in congestion being shifted elsewhere.

The issue of region-wide travel demand management is beyond the scope of this study. However, it is not clear that the comments take full account either of the potential role of a toll in limiting demand and the extent to which car travel from Warringah has destinations other than the Sydney CBD and points south and east of it.

COMMENTS ON OPTIONS

The issues paper proposed the following options:

1) a tunnel from Spit Road to the Warringah Freeway, in conjunction with upgrading of the Seaforth intersections;
2) a tunnel from the Burnt Bridge Creek Deviation at Seaforth/Balgowlah under the Spit and through to the Warringah Freeway;
3) two tunnels, the first from the Burnt Bridge Creek Deviation to the Spit Bridge and the second from Spit Road to the Warringah Freeway, as in option one above;
4) a dedicated busway tunnel under Spit and Military Roads through to the Sydney Harbour Bridge, in combination with options one or three; and
5) other intersection improvements in the region, particularly on the Roseville Bridge route (limited investigation only).

Option (1)

It was pointed out that option (1), with a tunnel adjoining an opening bridge subject to occasional failure, could result in traffic congestion in the tunnel for long periods and was potentially unsafe. Managing traffic flow in the tunnel to accommodate scheduled bridge openings would also be complex.

There was also comment that there would be substantial traffic imbalance between the weekday morning and afternoon demands on the tunnel. Given this and the fact that the peninsula is a destination and not a corridor to points beyond, a two lane reversible tunnel was suggested as an alternative to option (1) (and implicitly to option (2) also). However, BTRE investigation showed that the costs of a two lane reversible tunnel would not be significantly less than two two lane tunnels, in view of the requirement to have a second tunnel available for emergency evacuation purposes. The requirement to empty the tunnel before reversing the flow could also raise traffic management and safety concerns.

The SHOROC Transport Steering Committee commented that this option did not comply with its policy and should not be considered further. It did not solve the weekend traffic problem and Spit Bridge would remain a problem. Mosman Municipal Council expressed a similar view.

However, there was also comment that this option would deliver very substantial public and private transport improvements and may have significant cost-benefit advantages, when compared to the other options.

Widening of the Spit Bridge

Option (1) did not provide for a new crossing of Middle Harbour. Although not dependent on it, the option assumed widening of the existing Spit Bridge.

Around 20 respondents expressed opposition to widening of the bridge, on the grounds that it would increase the through traffic flow in the residential areas of Beauty Point and Mosman, adversely affecting safety and residential amenity. In the same vein, several called for elimination of the existing right hand turn from Spit Road into Pearl Bay Road, which is permitted during the morning peak.

There was also comment that the proposal would only have merit if part of a major infrastructure overhaul of the transport route.

Option (2)

More than 20 respondents favoured option (2), particularly as a solution to the problem of the inner area transport environment in and around Mosman.

Option (3)

The SHOROC Transport Steering Committee commented that option (3) did not comply with its policy and should not be considered further. With ten lanes converging to six at Spit Bridge, this would remain a problem. Mosman Municipal Council also opposed consideration of this option.

There was also comment that this option could be considered as a later stage of option (1). In addition, an alternative to a tunnel under Sydney Road could be a shorter ‘cutting’, with side light-controlled access for Seaforth and Balgowlah traffic. This would be shorter, would not require tunnel exhausting and would be less costly. A high level bridge could also link the two improvements, as well as replacing the existing bridge.

Concerns of local residents about the bridge widening aspect of option (1) applied also to this option.

Option (4)

Seven respondents favoured option (4), as a potential solution to excess through traffic in the Mosman area and as an approach with a potentially lower impact on the environment.

One respondent commented that a public transport tunnel under Spit and Military roads with escalators to the surface would be disruptive and would require considerable surface land acquisition. Ventilation problems with a non-electric bus system would also be significant.

The State Transit Authority commented that waiting in tunnels accessed by escalators would not be a safe and welcoming environment for passengers. Extensive and expensive infrastructure would be required to improve amenity and ensure safety. This would reduce the number of stops that could be provided. The State Transit Authority also stated that, contrary to the issues paper's claim, most buses would not use the tunnel, given the stopping patterns of buses from north of Spit Bridge and the large number of local buses in the Mosman area. Interchange between services in the tunnel and on the surface would also need to be addressed.

Option (5)

Option (5) attracted no comments.

OTHER SUGGESTIONS

Permanent closure of Spit Bridge

One respondent proposed consideration of permanent closure of Spit Bridge (ie ending all bridge openings for river traffic), with tour operators and yacht owners to have the option of seeking moorings elsewhere.

Alternative crossings of Middle Harbour

A route alignment involving a tunnel from Burnt Bridge Creek Deviation to Sugarloaf Point, a medium level bridge and a tunnel from Castlecrag to the Gore Hill Freeway at Naremburn was proposed. The new link would have a shorter total distance than option (2).

Tolling of tunnels

The toll for the proposed tunnel could be discounted for vehicles carrying three or more passengers, with all city-bound vehicles carrying three or more passengers to cross the Harbour Bridge toll-free.

Public transport options

Rail options were suggested, including a system from Newport through Dee Why and Forestville to Chatswood. A similar if slightly different proposal was for a Warringah Railway to cross Middle Harbour between the Spit and Sugarloaf Point.

Reinstatement of the eastern rail tracks on the Sydney Harbour Bridge would facilitate rail alternatives.

Other options, including personal rapid transit systems, shuttle buses and community buses, were also proposed.

Public transport service improvements

Public transport should be made more attractive by: replacing substandard older buses; better frequencies and connections; more efficient fare collection; overcoming late running.

Alternative transport modes

Improved bicycle infrastructure on the lower North Shore was proposed, with the harbour bridge cycleway to be extended to North Sydney earlier than proposed in the Bike 2010 plan.

APPENDIX III TRAVEL PROJECTIONS

This appendix summarises the travel demand projections for the two tunnel bypass options (ITS 2002b).

TRESIS

How the model works

The two tunnel based options were analysed using the Institute of Transport Studies' Transport and Environment Impact Simulator (TRESIS) model. TRESIS 1.3 includes four behavioural choice models that affect travel activity. In the order of the assumed decision hierarchy, these are: residential choice and choice of workplace location; choice of commuter mode and departure time for each worker in the household; vehicle choice (type and number of vehicles); and vehicle use. Non-commuting trips are not modelled separately. Instead, the journey to work is expanded up, with a method that uses existing trip data.

To evaluate any strategy, the simulator calculates the choice probabilities and vehicle use predictions that the four behavioural models require. These are calculated for a random sample of 'synthetic households', weighted to reflect incidence in the population. Data specifications are included for the synthetic households, new and used vehicles, the transport network and attributes of residential and employment locations. The calculations are repeated for each synthetic household and then equilibration in the three markets (travel, location and vehicle) is undertaken to arrive at a final set of demand estimates.

In response to a new strategy, adjustments in vehicle, travel and location choices at the household level translate at the aggregate level into a new set of equilibrium levels for traffic congestion, residential densities, total kilometres of travel by vehicles and public transport, fuel consumed and greenhouse gas emissions.

Model zones and Warringah

TRESIS divides the Sydney region into 14 zones. The Warringah region is split between two of these zones, Northern Beaches and Lower Northern Sydney. The Northern Beaches zone, comprising Pittwater and Warringah council areas, makes up over 90 per cent of the geographical area of the Warringah region and has over 70 per cent of the population (see table 1.1).

Set up of the model

Two links connect Northern Beaches with Lower Northern Sydney, Spit Road through Spit Bridge and Warringah Road through Roseville Bridge. (Mona Vale Road is an internal road which also connects to the Hornsby-Ku-ring-gai zone.) Whereas Spit and Military roads have six lanes, the Spit Bridge itself has four lanes. The model applies tidal flow (ie three lanes) for the Spit Bridge link for the morning and afternoon peaks in the southbound and northbound directions respectively.

The Roseville Bridge feeds traffic to both the Lower Northern Sydney and Hornsby-Ku-ring-gai zones. One third of the route capacity (ie one lane) is assigned for the analysis to Lower Northern Sydney and two thirds (two lanes) to Hornsby-Ku-ring-gai, in view, particularly, of heavy traffic volumes on Boundary Road headed for Chatswood. Assumed lane capacities on both the Spit and Roseville routes are 1 810 vehicles per lane per hour.

The tunnel (option A) and the tunnel-with-bridge (option B) are each assumed to have the standard capacity for a high speed road, 2 300 vehicles per hour per lane. Under these options, tidal flow on the surface route would be discontinued. No other changes in favour of local accessibility are made in the model set-up.

DEMAND PARAMETERS

Growth in travel demand is derived from growth in population (one per cent), employment (one per cent) and calibrated by the total number of trips for commuting (to and from work) and all trips. This gives 12.6 million trips of which 2.5 million are commuting (to and from work) trips.

Sydney region population (all zones) is assumed to grow at one per cent per annum, increasing the number of households from 1.44 million to 1.89 million in 2025. Assuming an average of about 2.8 persons per household, population increases from 4.04 million to 5.29 million in 2025.

OPTION PARAMETERS

Key parameters for the two tunnel based-options, as described in chapter 5, are set out in table III.1.

TABLE III.1 KEY PARAMETERS FOR OPTIONS

Parameter	*Option A*	*Option B*
Lengths (km)		
Existing – car	8.3	7.0
Existing – bus	6.0	7.0
Tunnel and ramps	7.6	5.1
Bridge to Seaforth interchange	N/A	1.6
Total assumed length	7.6	6.6
Tunnel length time saving – car [a]		
Existing speed (km/h)	35	35
Existing time (mins)	14.2	12
Assumed speed (km/h)	80	80
Assumed time (mins)	5.7	5
Saving (mins)	8.5	7
Tunnel length time saving – bus [a]		
Existing speed (km/h)	23	23
Existing time (mins)	15.7	18.3
Assumed speed – Seaforth interchange to bridge (km/h)	N/A	80
Assumed speed – Spit and Military roads (km/h)	30	30
Assumed time (mins)	12.0	12.1
Saving (mins)	3.7	6.2
Toll ($ per vehicle trip)	3.50	3.50

a. TRESIS estimates travel times for six different time of day periods. Speeds for both cars and buses vary by time of day. In particular, car travel speeds in the southbound peak are currently considerably lower than 35 kilometres per hour (see table 2.1). Peak time savings from these options relative to the current surface route over the relevant distance will accordingly be significantly greater. In addition, tunnel length time savings shown here should not be construed as the average time saving for all trips between Northern Beaches and Lower Northern Sydney, since this is the outcome of the changed traffic conditions throughout the network.

RESULTS

For each option, tolled and untolled scenarios were modelled. Tables III.2 and III.3 show the results for the tolled scenarios.

TABLE III.2 SUMMARY OF TOLLED SCENARIO RESULTS, NORTHERN BEACHES RESIDENTS TRIPS, 2005

Statistic	*Do Nothing*	*Option A*	*Change*	*Option B*	*Change*
Total trips	807 000	799 200	-7 800	798 900	-8 100
Commuting trips	152 700	152 600	-100	152 700	0
Total travel time (m minutes)	7 555	6 975	-580	7 022	-533
Total annual travel time cost ($m)	1 870	1 728	-142	1 740	-130
Total passenger VKT (m)	2 110	2 117	+7	2 116	+6
Operating costs per vehicle ($/year)	1 209	1 208	-1	1 208	-1
Daily bus trips	59 500	57 100	-2 400	58 100	-1 400
Total user money costs $m)	471	510	+39	509	+38

TABLE III.3 SUMMARY OF TOLLED SCENARIO RESULTS, SYDNEY TRIPS, 2005

Statistic	*Do Nothing*	*Option A*	*Change*	*Option B*	*Change*
Total travel time (m minutes)	119 718	118 685	-1 033	118 780	-938
Total annual travel time cost ($m)	27 099	26 844	-255	26 867	-232
Total passenger VKT (m)	32 994	32 969	-25	32 972	-22
Daily bus trips	753 000	749 300	-3 700	751 300	-1700
Total user money costs ($m)	8 638	8 708	+70	8 707	+69

Transport impact

Total trips originating in or with destinations of Northern Beaches decrease very marginally in the untolled scenarios (around 1 600 trips or 0.2 per cent) and by slightly more in the tolled scenarios (about 8 000 trips, or around one per cent of daily trips). The reduction reflects both a slight increase in average trip length and the deterrence effect of the tolls. The number of commuting trips is virtually unchanged.

There is a slight increase in passenger vehicle kilometres travelled for Northern Beaches residents (half a percent). However the increase in the average trip length (2.7 kilometres) is negligible. At the Sydney region level, there is a minuscule reduction in vehicle kilometres travelled (0.1 per cent).

Travel time for Northern Beaches residents falls by about 10 million hours or seven per cent, a significant reduction (17 million hours in option A and 16 million hours in option B, or one per cent at the Sydney region level – see table III.3). This reflects the bypassing the tunnel provides of numerous traffic signals, with associated stops and queues, on the Spit route (from the Seaforth interchange at Sydney Road southwards) combined with increased capacity, improved traffic flow in the contra-peak direction on the Spit route and improvement to traffic flow on the other routes. Modelled average travel times between zone 13 (Northern Beaches) and zone 11 (Lower Northern Sydney) reduce by more than 40 per cent at all times of day.

Vehicle operating costs are virtually unchanged, with the slightly greater distance travelled offset by lower fuel and operating costs.

With the improved vehicle travel times, bus trips originating in the Northern Beaches decline by 4 per cent (A) and 2.4 per cent (B). Bus trips reduce by less than half a per cent on a whole of Sydney basis.

There are generally small changes in the pattern of travel as a result of the options. The largest absolute change (5 000 to 8 000 trips, or over 1 per cent) is the reduction in internal Northern Beaches trips, reflecting the increased attractiveness of travel outside the region. Since the reduction occurs under both tolled and untolled scenarios, it appears this change reflects a substitution at the margin of fewer longer trips for a larger number of shorter ones. There are also large reductions in the number of trips to Lower Northern Sydney under the tolled scenarios (6 000 to 7 000, or 10 per cent to 12 per cent). In contrast, travel to Lower Northern Sydney increases by 3 000 to 4 000 trips (around 5 per cent) in the untolled scenarios. Other increases of note are to Inner Sydney (1 000 to 2 000 trips under all scenarios, 3 per cent to 4 per cent) and to Inner Western Sydney (600 trips or 10 per cent). See table III.4 (Northern Beaches is zone 13).

TABLE III.4 TRIPS FROM THE NORTHERN BEACHES ZONE TO OTHER ZONES

Zone	*Do Nothing*	*Option A*	*Change*	*Option B*	*Change*
1	39 800	41 500	+1 700	41 300	+1 500
2	8 100	8 700	+ 600	8 600	+ 500
3	8 800	9 300	+ 500	9 200	+ 400
4	7 800	8 100	+ 300	8 100	+ 300
5	6 300	6 600	+ 300	6 600	+ 300
6	4 400	4 500	+ 100	4 500	+ 100
7	6 100	6 800	+ 700	6 800	+ 700
8	12 200	12 600	+ 400	12 500	+ 300
9	6 800	6 800	0	6 800	0
10	11 600	11 700	+ 100	11 600	0
11	65 500	59 300	-6 200	58 600	-6 900
12	30 800	30 600	- 200	30 700	- 100
13	590 100	584 000	-6 100	584 800	-5 300
14	8 800	8 800	0	8 800	0
Total	807 000	799 300	-7 800	798 900	-8 100

Source ITS (2002b). The TDC Household Travel Survey is the source for the ‘Do Nothing’ scenario.

Note Travel zones are: 1. Inner Sydney 2. Eastern Suburbs 3. St.George-Sutherland 4. Canterbury-Bankstown 5. Fairfield-Liverpool 6. OuterSouth Western Sydney 7. Inner Western Sydney 8. Central Western Sydney 9. Outer Western Sydney 10. Blacktown-Baulkham Hills 11. Lower Northern Sydney 12. Hornsby-Ku-ring-gai 13. Northern Beaches 14. Gosford-Wyong.

Toll revenues

Toll revenues increase by about $6m in the untolled scenarios (0.6 per cent), due to increased use of toll roads elsewhere in Sydney and a further $66m (A) and $64m (B) in the tolled scenarios. See table III.5. The difference between the total revenue for the tolled and untolled scenarios can be interpreted as the revenue from the tunnel in each option.

TABLE III.5 TOLL REVENUE, SYDNEY TRIPS, 2005

	Do Nothing	*Option A untolled*	*Option A tolled*	*Change*	*Option B untolled*	*Option B tolled*	*Change*
Total toll revenues ($m)	916 691	922 768	988 721	+65 593	986 443	922 213	+64 230

Socioeconomic impact

The options have a negligible impact on the number of households in the Northern Beaches (increases of 200 to 400, or less than half of one per cent).

The number of workers moving in to the region to live is also small, around 500 or half of one per cent.

There is a slightly greater impact on jobs in the region, with the tunnels apparently making it more attractive for employers to locate in the Northern Beaches. The overall increase is about 2 000 (around two per cent) and there is little difference between the tolled and untolled scenarios.

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ABBREVIATIONS

ABS	Australian Bureau of Statistics
AUSTROADS	Association of Australian State Road Authorities
BCR	Benefit-cost ratio
BTRE	Bureau of Transport and Regional Economics
CBD	Central Business District
GMR	Greater Metropolitan Region
ITS	Institute of Transport Studies, University of Sydney
LGA	Local Government Area
NPV	Net present value
NSROC	North Sydney Regional Organisation of Councils
RTA	Roads and Transport Authority
SD	Statistical Division
SHOROC	Shore Regional Organisation of Councils
SLA	Statistical Local Area
SSD	Statistical Subdivision
STA	State Transit Authority
TDC	Transport Data Centre
TRESIS	Transport and Environment Strategy Impact Simulator