APPENDIX 2

M5 EAST EXPANSION TRAFFIC MODELING REPORT
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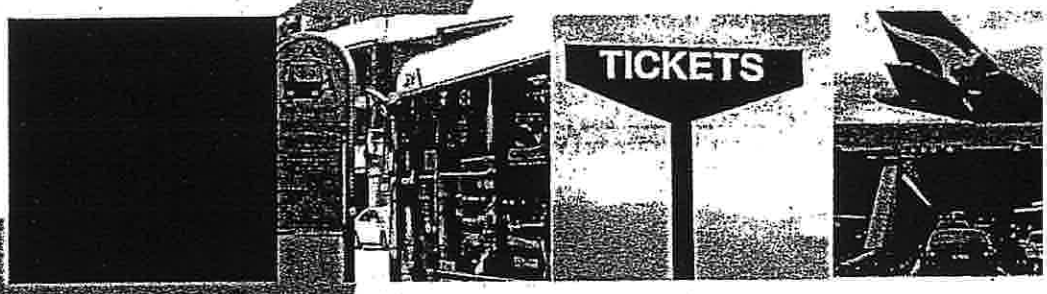
M5 East Expansion
Traffic Modelling Report

Draft



Roads and Traffic Authority, NSW

Halcrow MWT

Roads and Traffic Authority, NSW

M5 East Expansion

Traffic Modelling Report

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1 Introduction

The Roads and Traffic Authority, NSW commissioned Halcrow MWT to undertake traffic modelling of various options for the expansion of the M5 East Motorway in southern Sydney.

Scenario development and analysis resulted in the development of a preferred option. This is a 4 lanes eastbound, 3 lanes westbound arrangement.

This option was then further developed and analysed. The results of this analysis are presented in this report.

Section 2 of this report provides background information on the M5 East.

Information on the inputs to the modelling process are outlined in Section 3.

The calibration and validation of the base model is outlined in Section 4.

Land use and forecasting assumptions are discussed in Section 5.

Option definition and development is described in Section 6 and the results of the modelling are outlined in Section 7.

Section 8 provides results and conclusions.

2 Background

2.1 *M5 and M5 East*

The M5 East connects the M5 Motorway and King Georges Road at Beverly Hills with General Homes Drive at Kyeemagh. It is 10km in length and combines surface road and tunnel. The main M5 East Tunnel comprises twin 4km 2 lane tunnels between Bexley Road, Earlwood and Marsh Street, Arncliffe. A further 550m tunnel passes under the Cooks River and on General Holmes Drive another cut and cover tunnel passes under the Sydney Airport runway. The main tunnel has a clearance of 4.6m with the other a clearance of 4.4m. The speed limit in the M5 East main tunnel is 80km/hr and at surface 90km/hr. The tunnel has a steep grade of about 8% at the western end which is an issue for heavy vehicles. There is one ventilation stack to exhaust air from the main tunnel located in a near by industrial area in Turrella. A ventilation tunnel forms a third tube which lies below the two traffic tunnels.

The M5 East was opened to traffic in December 2001 and operates toll free. The M5 East forms part of the Sydney Orbital and plays an important role in connecting Sydney's south west with Sydney Airport, Port Botany and the Sydney CBD. Further, it forms part of the National Auslink Network linking Sydney and Melbourne. Since its opening, daily traffic on the M5 East has significantly exceeded forecasts. Weekday traffic is routinely above 100,000 vehicles per day compared to 69,000 vehicles per day forecast for 2011 in the Supplementary M5 East EIS (1996). Approximately 8% of this traffic comprises heavy vehicles.

The Sydney Metropolitan Strategy (p. 172 and p. 192) identifies the need to plan, assess and evaluate proposals to improve road connections between Port Botany and Western Sydney. Increasing the capacity of the M5/M5 East Motorway and/or an easterly extension of the M4 Motorway are identified as potential options. Similarly, the NSW Government's recent review (p. 14) of the Freight Industry Advisory Board's Report recommends that planning for additional truck capacity in the M5 and M4 corridors should proceed.

The NSW Premier subsequently announced in May 2008 that the NSW Government would contribute $20 million, adding to the Federal Government's commitment of $25 million, to investigating the viability of the two projects, one of these being the M5 East Duplication. This work is due to commence in 2008/9.

2.2 *Main Tunnel Capacity*

The capacity of the M5 East's eastbound and westbound carriageways is affected by the proportion of heavy trucks using each and their ability to negotiate the relatively steep grades in them. In this regard the westbound tunnel has steeper grades (8%)and is more likely to have heavy laden trucks (carrying full import containers from the port) than the

east bound tunnel (which is used by a significant number of trucks returning empty containers to the port).

Figures 2.1 and 2.2 provide a plots of total vehicles and passenger car equivalents (PCU's) centred using each tunnel over a 24 hour period. The counts are from 2004 but the capacities as reflected by peak usage have not changed. These show that the capacity of each tunnel is up to 4,400 PCU's. However in terms of actual vehicles the capacity of the eastbound tunnel is about 4,000 vehicles per hour whereas that of the westbound is only about 3,300 vehicles per hour.

The difference is attributable to the steeper up grade and higher proportion of laden trucks in the westbound direction resulting in a heavy truck to passenger car unit equivalence of 6. For the eastbound tunnel the equivalence is only 3.

The implications of this imbalance for the M5 East are that in any improvement scheme it is more important to give relief to westbound traffic than to eastbound traffic although both directions would obviously benefit from having more capacity.

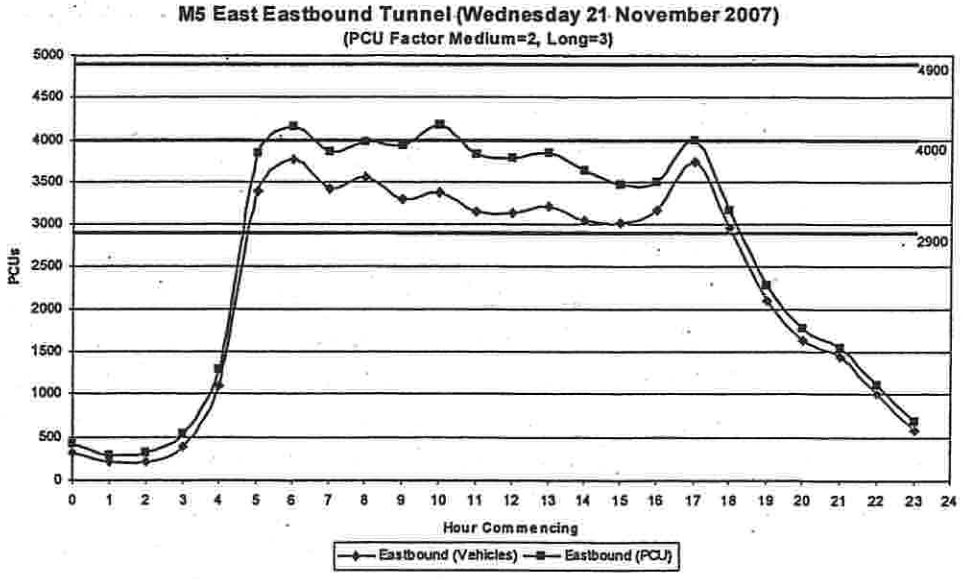


Figure 2.1 – M5 Flows - Eastbound

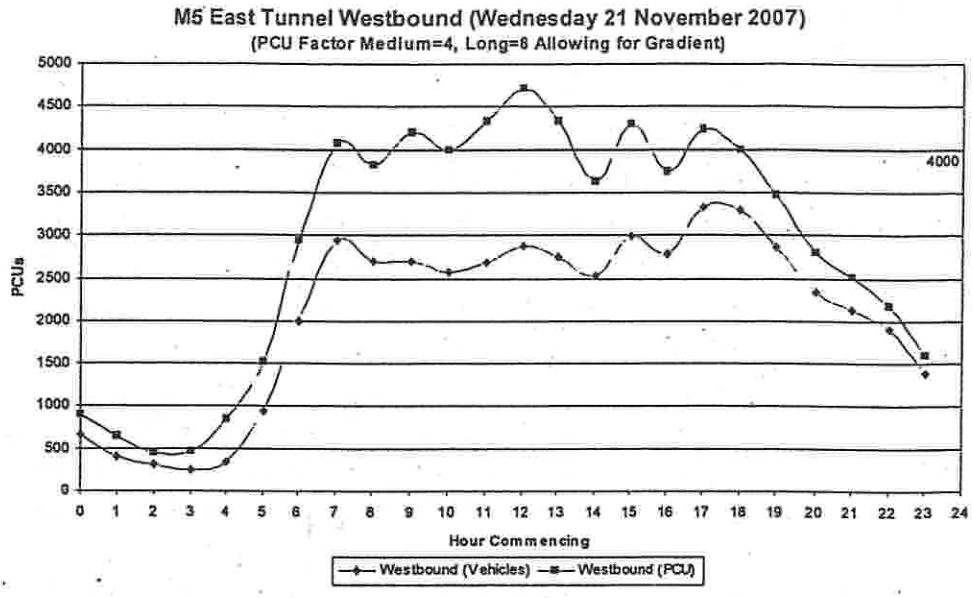


Figure 2.2 – M5 Flows - Westbound

2.3 ***Airport Tunnel and General Holmes Drive Capacity***

General Holmes Drive provides an important link between the M5 East and The Grand Parade to the south and Foreshore Road, Southern Cross Drive and General Holmes Drive to the north.

As well as catering for the confluence of these roads, it also accommodates weaving movements between different arrival and departure points.

Eight traffic lanes are provided in this section of General Holmes Drive which includes the tunnel under the airport north-south runway. During morning peak hours tidal flow operates with five lanes eastbound (northbound) towards the city and Foreshore Road and three lanes westbound (southbound) away from these. The city bound peak flow peaks at around 8,000 vehicles per hour while the outbound (southbound) peaks at about 4,000 vehicles per hour at this time.

At other times it operates with four lanes in each direction and this generally copes with the evening outbound peak which is around 7,000 vehicles per hour. The apparent imbalance between the morning and evening is explained by the duration of the peaks. Morning peak operates over an effective two hour period while the evening has a more sustained period of three hours.

Over an average weekday traffic flows in each direction are about equal. The total weekday flow through the airport tunnel in 2006 was around 150,000 vehicles.

The tidal arrangement works satisfactorily at the moment but peak period queuing especially in the morning peak indicates that the system is at or close to capacity at these times.

Thus any increase in M5 East capacity that directed traffic towards the General Holmes Drive/Airport tunnel section would need to be accompanied by additional or parallel capacity for this section as well.

2.4 *Trend in Daily Traffic Volumes*

Table 2.3 provides records of changes in daily use since the M5 East was opened.

Table 2.3 – M5 East AADT Daily Traffic Volumes (365 Day Average)

Year	Eastbound	Westbound	Total
2002	39,175	35,870	75,045
2003	45,025	40,380	85,905
2004	48,850	42,055	90,905
2005	49,080	44,080	93,160
2006	48,810	43,970	92,780
2007	49,630	46,230	95,860

These records show that traffic volumes on the M5 East quickly grew from opening at the end of 2001 to be over 85,000 vehicles per day within two years. By the end of 2004, the tunnel had reached its nominal capacity of over 90,000 per day (constrained by peak period capacity as discussed in Section 2.2). Since then, the daily volumes have grown fairly much in line with the regional growth rate of about 1.4% per annum.

The volumes in Table 2.3 also indicate the effect of heavy vehicles as discussed in Section 2.2. The westbound flows which are affected by laden heavy vehicles, have consistently been about 10% below the eastbound flows, although this discrepancy reduced in 2007.

It should be noted the Table 2.3 AADT flows are seven day a week averages. As indicated above, the average weekday flows are consistently above 100,000 vehicles two way. In terms of PCU, this represents 130,000 per day. The daily flow profiles provided in Appendix A show that M5 East effectively flows at or near capacity for nearly 12 hours per weekday. Few roads in the Sydney region exhibit this characteristic.

2.5 *M5 and M5 East Surface Capacity Augmentation*

The operator of the M5 Motorway has submitted a proposal to the RTA to increase the number of traffic lanes west of King Georges Road from two lanes to three lanes in each direction (except eastbound between Belmore Road and King Georges Road)[1]. There is width available in the corridor to allow this.

The RTA is still to make a decision on this. However for the purposes of this investigation it has been assumed that this would take place (including the eastbound section between Belmore Road and King Georges Road) before 2016.

[1] If any upgrade were to occur to M5 East, it is assumed that this section would also be upgrade to 3 lanes as provision has already been made for this in the current pavement width.

Widening of the surface section of the M5 East between the western tunnel portal and King Georges Road would require land acquisition and significant changes to the Kingsgrove Road interchange as it is not possible to fit three traffic lanes each way in this section. Notwithstanding, this assessment assumes the widening would be undertaken as part of any capacity augmentation of M5 East.

3 Inputs to the Modelling Process

The Halcrow MWT Strategic Road Model of the Sydney Metropolitan Area is based on two main sources:

- Network – based on network model development by Halcrow MWT over several years, and
- Demands – based on outputs from the Transport Data Centre's Strategic Travel Model (STM)

This section describes the inputs from the STM.

3.1 *The Sydney Travel Model*

The Sydney Travel Model is a four step multi modal model run by the Transport Data Centre. The model is used to test:

- Major infrastructure changes
- Different population/employment growth and distribution scenarios

The STM is under constant development and for the M5 East, the model used STM outputs from September 2007. The primary assumptions in the STM at this time were:

- TPDC Nov 2006 population projections (see Appendix A)
- TPDC Nov 2006 employment forecasts (see Appendix A)
- RTA Oct 2006 Road networks
- Rail itineraries supplied by RailCorp
- TPDC Sep 2004 bus networks
- Macros v1.2 (development version).

At the time of the M5 East model development, the STM was based on the 2001 Census and Journey to Work information. The TDC has recently released updated models based on the 2006 census. These models and their results are currently being evaluated for use in updating the forecasts for the M5 East Expansion. Updated land use forecasts from the Australian Bureau of Statistics have also been recently released. These increase the forecast 2026 population by around 400,000 persons. This increased population will also have an impact on the forecasts for the M5 East Expansion.

The Transport Data Centre have released a summary document explaining the inputs and methodology behind the STM. This is included in Appendix A.

Updated modelling using this new information should be available in February 2009.

4 Model Calibration and Validation

The output trip tables from the STM were input to the Halcrow MWT Strategic Road Model. The section describes the calibration and validation of the Halcrow MWT Strategic Highway Model.

4.1 *Highway Model Calibration*

The Halcrow MWT Sydney Metropolitan Highway Model updates the output vehicle trip matrices from the STM, and through a process of matrix refinement the model is calibrated against traffic counts. Model Calibration screenlines are shown in Figure 4.1.

Figure 4.1 – Sydney Network Calibration Screenlines

The UK Highways Agency defines traffic model calibration and validation criteria in the Design Manual for Roads and Bridges. The Halcrow MWT Highway Model has been calibrated to this criteria as there is no local equivalent. The Highway Agency criteria and the calibration of the Halcrow MWT model is shown in Tables 4.1 and 4.2.

Table 4.1 – Model Calibration (AM Peak)

	Criteria	Halcrow MWT Model Result
Assigned hourly flows compared with observed flows		
1. Individual flows within 15% for flows 700-2700vph		
2. Individual flows within 100vph for flows <700vph	>85% of cases	87%
3. Individual flows within 400vph for flows >2700vph		
4. Total screenline flows to be within 5%	All (or nearly all) screenlines	22 of 24 screenlines
5. GEH Statistic		
i) individual flows - GEH <5	>85% of cases	85%
ii) screenline totals - GEH <4	All (or nearly all) screenlines	21 of 24 screenlines

Table 4.2 – Model Calibration (PM Peak)

	Criteria	Halcrow MWT Model Result
Assigned hourly flows compared with observed flows		
1. Individual flows within 15% for flows 700-2700vph		
2. Individual flows within 100vph for flows <700vph	>85% of cases	92%
3. Individual flows within 400vph for flows >2700vph		
4. Total screenline flows to be within 5%	All (or nearly all) screenlines	23 of 24 screenlines
5. GEH Statistic		
i) individual flows - GEH <5	>85% of cases	90%
ii) screenline totals - GEH <4	All (or nearly all) screenlines	22 of 24 screenlines

4.2 *Highway Model Validation*

The Halcrow MWT Model has been validated against travel times. The UK Highways Agency sets travel time validation criteria as shown Tables 4.3 and 4.4.

Table 4.3 – Model Validation (AM Peak)

	Criteria	Halcrow MWT Model Result
Travel times within 15% (or 1 minute if higher)	>85% of routes	86%

Table 4.4 – Model Validation (PM Peak)

	Criteria	Halcrow MWT Model Result
Travel times within 15% (or 1 minute if higher)	>85% of routes	82%

While not meeting the criteria in the PM peak, the model generally validates well against travel times.

The final comparison to determine the validity of the model is a visual comparison of the trip length distribution against the distribution from the STM. This comparison is made is Figures 4.2 and 4.3.

In these figures the "Original" bars represent the trip length distribution from the STM, while the "Adjusted" line shows the final trip length distribution for the calibrated and validated highway model.

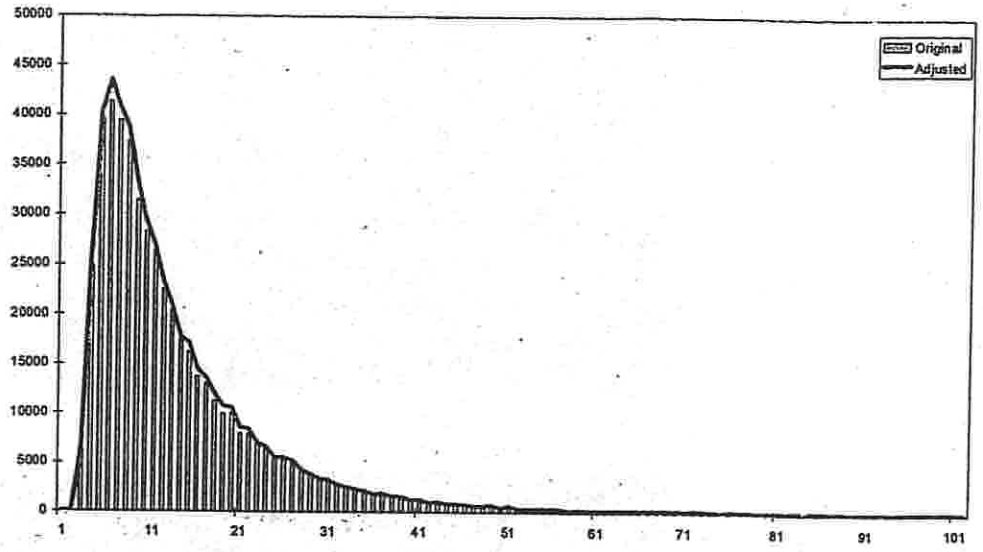


Figure 4.2 – Trip Length Distribution Comparison – AM Peak

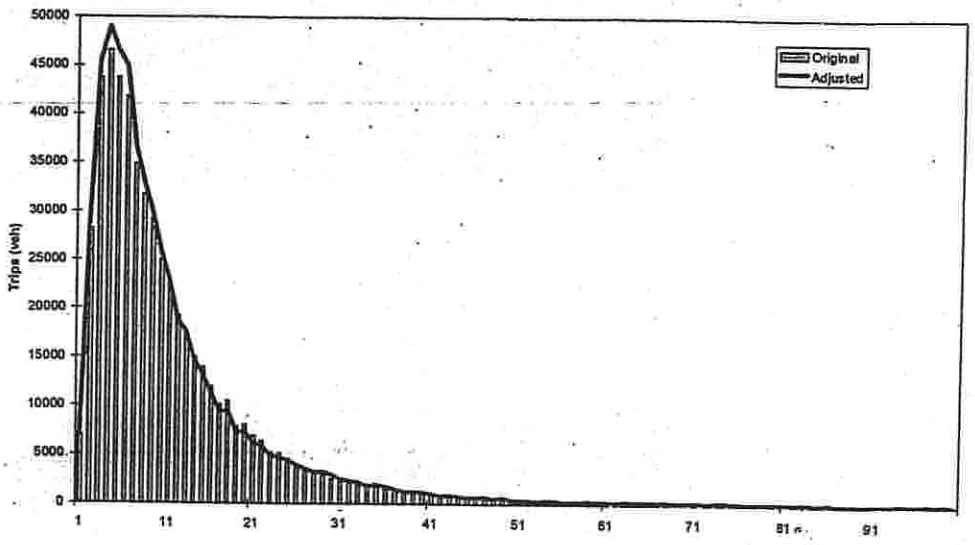


Figure 4.3 – Trip Length Distribution Comparison – PM Peak

The graphs show a good correlation between the STM and Halcrow MWT trip length distributions.

5 Land Use and Forecasting Assumptions

5.1 *Introduction*

Traffic demands in the M5 East corridor will be influenced by continuing population and employment growth in the parts of Sydney on either side of it. They will also be influenced by growth in activity at Sydney Airport and Port Botany.

This growth is discussed below.

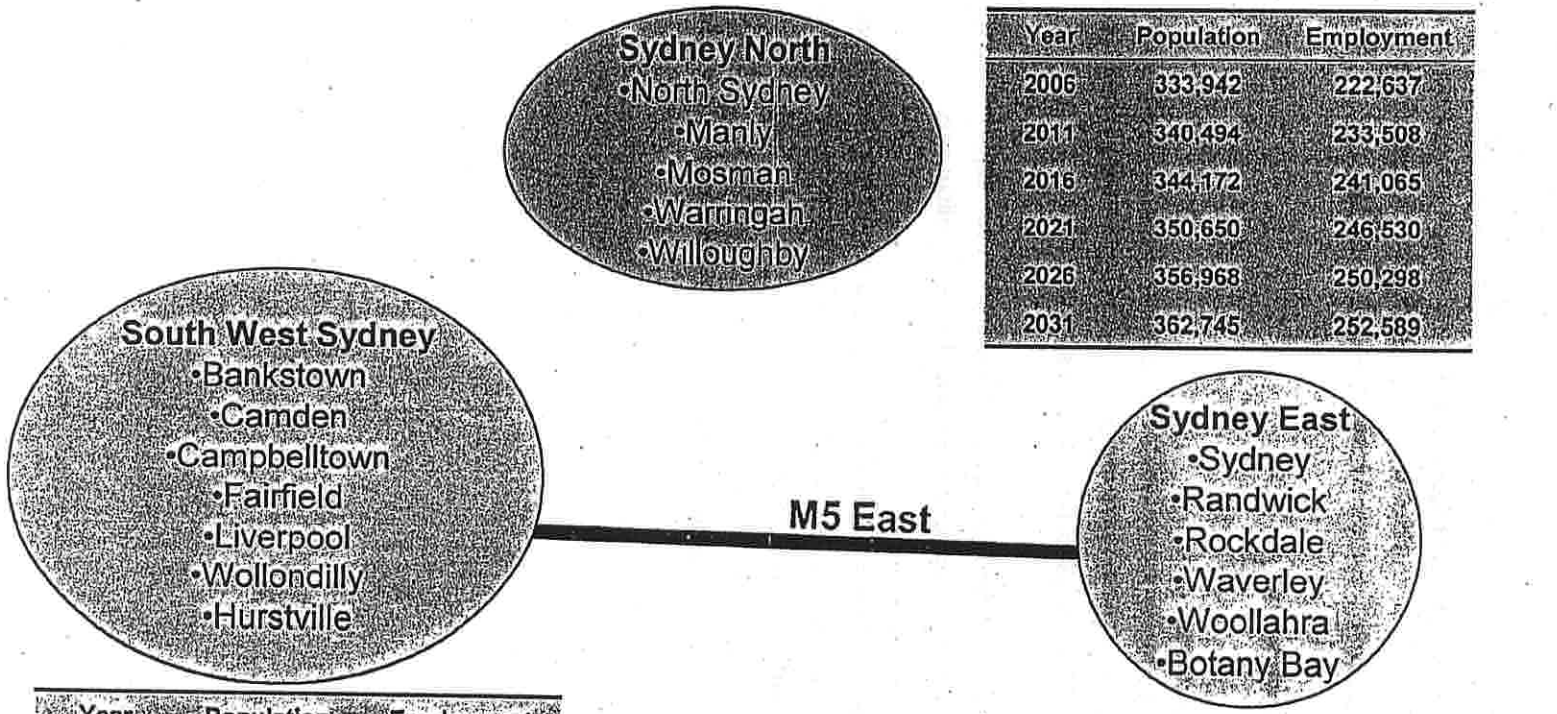
5.2 *Population and Employment*

The Metropolitan Strategy has anticipated that the population of Sydney will grow by about one million to over five million persons by 2031. The number of jobs is expected to increase by 500,000 to 2.5 million over the same time.

The relative locations of the new jobs and homes will have a significant effect on travel demand along different transport corridors in the metropolitan area.

The M5 East corridor caters for travel generally between south western Sydney and eastern Sydney. It also caters for a significant amount of travel between south western Sydney and the north eastern Sydney.

Figure 5.1 indicates forecast growth in employment and population in these three areas.



Year	Population	Employment
2006	333,942	222,637
2011	340,494	233,508
2016	344,172	241,065
2021	350,650	246,530
2026	356,968	250,298
2031	362,745	252,589

Year	Population	Employment
2006	850,370	295,107
2011	900,941	315,506
2016	956,493	330,968
2021	1,019,765	345,561
2026	1,079,792	358,298
2031	1,135,058	368,669

Year	Population	Employment
2006	541,087	586,451
2011	582,926	602,775
2016	612,565	621,829
2021	626,043	636,466
2026	639,492	643,760
2031	652,900	648,181

Source TDC 2007 Land Use Forecasts

Figure 5.1 – Population and Employment Growth

Forecast changes over the 25 years from 2006 to 2031 are as follows.

Table 5.1 – Employment and Population Growth in M5 East Catchment

	Employment (000's)			Population (000's)		
	2006	2031	Change	2006	2031	Change
South West Sydney	295	369	74	850	1,135	285
Sydney East	586	648	62	541	653	112
Sydney North	223	253	30	334	363	29
Total	1,104	1,270	166	1,725	2,151	426

Table 5.1 indicates that between 2006 and 2031 the number of residents linked by the corridor would increase by about 426,000 representing growth of about 25 precent. Similarly the number of jobs linked by the corridor would grow by 166,000 represents growth of about 15 percent.

As mentioned previously, the information outlined above, and the models used for the traffic analysis of the M5 East Expansion are based on results of the 2001 census. The TDC has recently released updated models based on the 2006 census. These models and their results are currently being evaluated for use in updating the forecasts for the M5 East Expansion. Updated land use forecasts from the Australian Bureau of Statistics have also been recently released the increase the forecast 2026 population by around 400,000 persons. Updated traffic models using these figures should be available in February 2009.

The implication of this further growth is likely to be that justification for the upgrading of the M5 East Motorway would most likely be greater than that indicated by the forecasts produced in this analysis.

5.3 Sydney Airport

The model has been updated to include traffic generation based on the Sydney Airport Masterplan 2008. The masterplan assumes an increase in passengers from around 30 million in 2006 to 78.9 million in 2029. During this time mode share to public transport is anticipated to grow by 5%.

Significant commercial and retail developments are also proposed on Sydney Airport Land that adds to total traffic generation.

For this analysis, the combined impacts of passenger growth and other developments has been used to determine traffic generation for Sydney Airport. Tables 5.2 and 5.3 summarise the traffic generation used for Sydney Airport.

Table 5.2 – Sydney Airport Traffic Generation (Average AM Peak Hour)

Year	Total Arrivals	Total Departures	Total Two-Way
2006	4,500	3,500	8,000
2016	7,500	5,600	13,100
2026	9,700	7,300	17,000

Table 5.3 – Sydney Airport Traffic Generation (Average PM Peak Hour)

Year	Total Arrivals	Total Departures	Total Two-Way
2006	2,600	3,500	6,100
2016	4,800	6,600	11,400
2026	7,000	9,400	16,400

The growth in the Average AM Peak Hour between 2006 and 2026 is anticipated to be in the order of 9,000 vehicles, while in the Average PM Peak Hour the growth is around 10,000 vehicles.

5.4 ***Port Botany***

The Port Botany expansion EIS forecasts that container throughput expressed as twenty foot equivalent units (TEU's) will increase as follows.

Table 5.4 – Forecast Port Botany Container Growth

Year	Trade Volume (TEU)
2006	1.25 million
2011	1.75 million
2016	2.5 million
2021	3.2 million

Source: Port Botany Expansion Environmental Impact Statement, Sydney Ports Corporation 2004

Thus over the 15 year forecast period the number of containers handled at the port is expected to increase by about 2 million TEU's or by about 155%.

The port's landside transport strategy seeks to increase the proportion of containers being handled by rail from about 20% to about 40%.

The EIS forecasts that if, as a worst case, only 20% of containers were transported by rail then daily road container transport trips would increase as follows.

Table 5.5 – Forecast Port Botany Truck Movement Growth

Year	Daily (veh/day)	AM Peak (veh/hr)	PM Peak (veh/hr)
2002	2,910		
2006	3,800		
2011	3,750	256	118
2016	5,150	316	144
2021	6,270	376	234

If rail was to carry 40% of containers then truck trips generated in 2021 would reduce to about 4,700 per day. The peak hourly truck volumes would also decrease by 25%. Even under this high rail scenario, truck volumes are expected to nearly double over the next 15 years.

5.5 *Green Square and South Sydney Growth Centre*

The Green Square redevelopment area includes part of the suburbs of Rosebery, Zetland and Alexandria. It is centred on the Green Square railway station midway between the Sydney CBD and the Airport.

A new town centre with major new residential and commercial buildings is proposed adjacent to the railway station.

The area generally falls with Transport Data Centre Zones 75 and 78 to 81. Table 5.6 below provide TDC land use forecasts for the zones along with the forecast morning peak traffic generation

Table 5.6 – Green Square Land Use and Traffic Generation

Year	Residential Population (persons)	Employment (jobs)	AM Peak Hour (veh/hr)		Traffic Generation (two-way)
			Arrival	Departure	
2001	7,646	25,374			
2006	12,983	26,028	5135	2476	7611
2011	16,089	28,050	5601	2813	8415
2016	18,971	29,626	5884	3040	8924
2021	20,580	31,020	6212	3191	9404
2026	22,165	32,330	6670	3365	10,036

Table 5.6 indicates that between 2006 and 2026 there will be significant residential and employment development in the area and this will increase the traffic generation of the area by around 1,600 vehicles per hour in the morning peak.

5.6 *Cooks Cove*

The Cooks Cove Development has been added into the traffic model with connections to Marsh Street. It has been assumed that the development is completed by 2016 generating 1950 vehicles in the Average AM Peak Hour and 1500 vehicles in the Average PM Peak Hour (based on the current Cooks Cove Masterplan).

5.7 *Summary of M5 East Corridor Demand*

As an indication of the total market for vehicle travel along the M5 East corridor, peak hour trip table travel demands between the local government areas in the south west and those in the east and north were extracted from the TDC travel model. These are shown on Figure 5.2. The figure shows total traffic and truck volumes for each five year forecast period between 2006 and 2026. In the interest of brevity only morning peak hour volumes are shown. The pattern for evening peak hour and daily travel would be similar.

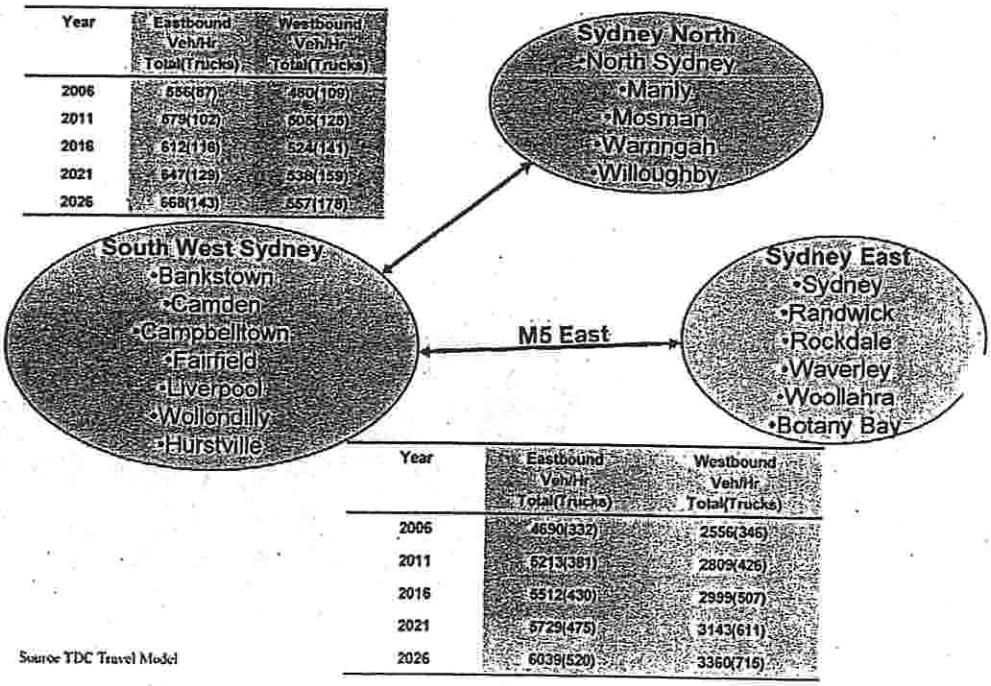


Figure 5.2 – AM Peak Hour Corridor Vehicle Trips

Table 5.7 summarises the potential growth in traffic along the corridor. This reflects all potential demand in the corridor. Obviously not all would travel on the M5 East as for a variety of reasons some would use parallel routes.

Table 5.7 – Growth in Total AM Peak Hour Demand on the M5 East Corridor

Year	Westbound	Eastbound	Two-Way	% Growth on 2006
2006	3,036 (455)	5,246 (419)	8,282 (874)	
2011	3,314 (551)	5,792 (483)	9,106 (1,034)	10%
2016	3,523 (648)	6,124 (546)	9,647 (1,194)	16.5%
2021	3,681 (770)	6,376 (604)	10,057 (1,374)	21.4%
2026	3,917 (893)	6,707 (663)	10,624 (1,556)	28.3%

Note: Figures in brackets are trucks. Figures out of brackets are for all vehicles including trucks.

Table 5.7 indicates that traffic demand in the corridor is forecast to grow by around 28 percent over the 20 year period for which forecasts have been produced. Truck numbers are forecast to grow by nearly 80 percent.

These figures are based on population and employment growth and do not include the passenger traffic growth generated by Sydney Airport.

5.8 *Other Road Projects*

The RTA "List of Road Projects for Modelling Purposes" from September 2008 was used for this analysis. The M4 Extension and F6 have been removed from this project list for the purpose of this analysis.

6 Option Definition and Development

6.1 *Option Definition*

With the new westbound three lane tube being the preferred initial option, further development was undertaken to determine the optimum connections, linkages and tolling for the motorway. In liaison with RTA, five options were determined to require further investigation:

- Option F - M5 East Expansion (4in – 3out) + North-South Link (all tolled)
- Option G - M5 East Expansion (4in – 3out) + North-South Link (all untolled)
- Option H - M5 East Expansion (4in – 3out) (tolled) + North-South Link (untolled)
- Option I - M5 East Expansion (4in – 3out) (tolled)
- Option J - M5 East Expansion (4in – 3out) (untolled)

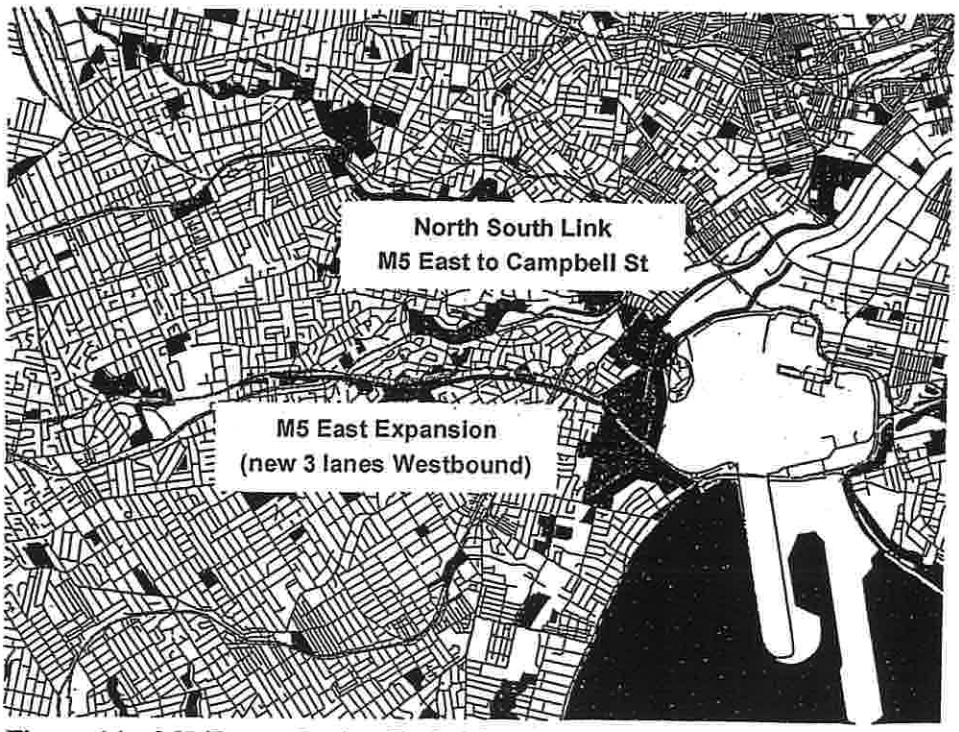


Figure 6.1 – M5 East – Option Definition

6.2 ***M5 East Expansion***

The M5 East Expansion involves the construction of a new three lane westbound tunnel between Marsh Street and Bexley Road.

The new tunnel provides two westbound capacity improvements:

- Additional lane westbound, and
- Improved capacity by reducing grade at western portal.

Eastbound the tunnel will provide:

- Two lanes from Bexley Road to Princes Highway, Marsh Street and if constructed, the North-South Link, and
- Two lanes from Bexley Road to Cooks River Tunnel (and onto General Holmes Drive).

6.3 ***North-South Link***

The North-South Link provides a direct connection from the M5 East to the intersection of Campbell Street and Euston Road. This link also provides for a connection to Marsh Street.

The North-South Link provides an alternate route from the M5 East to the South Sydney Growth Centre and also provides potential for integration with Sydney Airport if Airport Drive is to be relocated.

The alignment of the North-South Link also provides for integration with potential future road projects such as the M4 Extension and the F6.

An advantage of the North-South Link would be the provision of additional north-south arterial road capacity to supplement that provided by General Holmes Drive beneath the airport runway.

7 Traffic Modelling Results

Traffic modelling has been undertaken using Halcow MWT's EMME model of the Sydney road network.

The vehicle matrices were developed from 2006 trip tables issues by the Transport Data Centre (TDC) and accord with the Department of Planning land use forecasts. The TDC vehicle matrices are derived from the Sydney Travel Model (STM) which is a four step multi-model run by TDC.

Being a four step model, the STM accounts for changes in mode over time and examines induced demand effects of projects for all modes.

For the purpose of this analysis the "business as usual" STM runs have been used, and no induced demand analysis of the M5 East Expansion has been undertaken. This analysis is normally undertaken during the Environmental Assessment process, and will be undertaken in due course.

Each of the options as described in Section 4 was coded into the models for the purposes of forecasting the changes in traffic volumes on the regional road network. Link traffic volumes modelled for the average morning and evening peak hour for 2006, 2016 and 2026 were considered in the assessment.

Figure 7.1 shows the locations where link volumes are reported. Total volumes captured across the following two screenlines were also examined:

- Screenline 1:
  Forest Road, east of Bexley Road
  Canterbury Road, east of Bexley Road
  Georges River Road, east of Brighton Avenue
  M5E tunnel, east of Bexley
  M5E new tunnel, east of Bexley (for options only)

- Screenline 2:
  General Holmes Drive, east of M5E
  Airport Drive, east of International Terminal

North South Link (for options only)
Princes Highway, north of West Botany Street

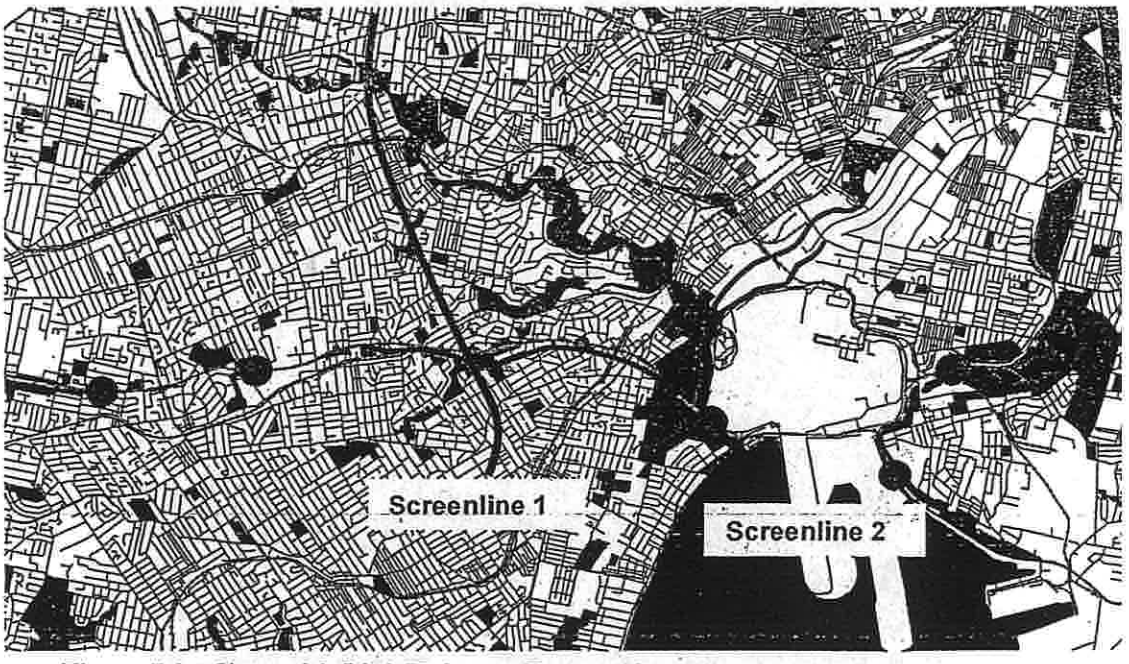


Figure 7.1 – Sites with Link Volumes Reported

Tables 7.1 and 7.2 show the traffic flows for the AM and PM peak periods.

Table 7.1 – Modelled Traffic Flows – 2016

AM			2006	2016					
			Base	Base	Option F	Option G	Option H	Option I	Option J
Eastbound or Northbound									
Screenline 1									
Forest Rd	east of Bexley Rd	EB	1600	1870	1650	1480	1650	1650	1470
M5E - to Cooks River Tunnel	east of Bexley Rd	EB	4190	4540	2750	3450	2670	2930	3530
M5E - to Princes, Marsh and NS Link	east of Bexley Rd	EB			3850	4400	4010	3200	3840
Canterbury Rd	east of Bexley Rd	EB	2040	2270	2110	2020	2090	2240	2190
Georges River Rd	east of Brighton Ave	EB	1540	1720	1620	1590	1610	1680	1650
Screenline 2									
General Homles Dr	east of M5E	EB	8170	9000	8690	8760	8550	9020	9270
Airport Dr	east of International Terminal	EB	2960	3370	3440	3220	3120	3860	3910
NS Link	north of Marsh St	NB			1760	2660	2540		
Princes Hwy	north of West Botany St	NB	3560	3990	3610	3490	3480	4070	4130
Other Links									
M5E	west of King Georges Rd	EB	3320	3780	4890	5070	4890	4840	5000
M5E	east of King Georges Rd	EB	4090	4330	5620	6810	5620	5530	6690
M5E	east of Marsh St	EB	3400	3290	3520	3770	3400	3680	3990
Southern Cross Dr	east of Botany Rd	EB	4540	4780	4730	4710	4690	4830	4870
Foreshore Rd	south of General Homes Dr	EB	1760	2050	1970	2000	1960	2070	2130

[2] Two two-lane tunnels are provided in the eastbound direction under the options. Under the base case a single eastbound tunnel is provided.

AM			2006	2016					
			Base	Base	Option F	Option G	Option H	Option I	Option J
Westbound or Southbound									
Screenline 1									
Forest Rd	east of Bexley Rd	WB	840	1130	1010	770	990	990	740
M5E	east of Bexley Rd	WB	2190	2890	3240	4490	3320	3340	4540
Canterbury Rd	east of Bexley Rd	WB	1260	1440	1400	1300	1370	1420	1350
Georges River Rd	east of Brighton Ave	WB	720	780	770	750	760	770	760
Screenline 2									
General Homes Dr	east of M5E	WB	3450	4600	4680	4820	4510	4600	4920
Airport Dr	east of International Terminal	WB	1320	1750	1830	1530	1460	2080	2140
NS Link	north of Marsh St	SB			340	1480	1270		
Princes Hwy	north of West Botany St	SB	1170	1610	1490	1220	1260	1620	1640
Other Links									
M5E	west of King Georges Rd	WB	2370	3060	3140	3550	3160	3170	3540
M5E	east of King Georges Rd	WB	3000	3360	3350	4700	3390	3440	4710
M5E	east of Marsh St	WB	1910	2490	2790	3060	2610	2600	2960
Southern Cross Dr	east of Botany Rd	WB	3100	3650	3760	3720	3640	3780	3910
Foreshore Rd	south of General Homes Dr	WB	670	1020	1020	1030	1000	1010	1050

PM			2006	2016					
			Base	Base	Option F	Option G	Option H	Option I	Option J
Eastbound or Northbound									
Screenline 1									
Forest Rd	east of Bexley Rd	EB	550	760	940	580	910	930	600
M5E - to Cooks River Tunnel[3]	east of Bexley Rd	EB	3060	3420	1010	1480	930	1060	1830
M5E - to Princes, Marsh and NS Link	east of Bexley Rd	EB			1530	3010	1720	1460	2490
Canterbury Rd	east of Bexley Rd	EB	1240	1380	1430	1260	1400	1460	1330
Georges River Rd	east of Brighton Ave	EB	990	1080	1100	1070	1100	1110	1090
Screenline 2									
General Homes Dr	east of M5E	EB	3550	4370	3910	4100	3740	4000	4510
Airport Dr	east of International Terminal	EB	1030	1730	1640	1480	1400	1800	1810
NS Link	north of Marsh St	NB			440	540	340		
Princes Hwy	north of West Botany St	NB	1760	2060	1860	1650	1560	1970	2060
Other Links									
M5E	west of King Georges Rd	EB	2010	2580	2440	2890	2460	2420	2850
M5E	east of King Georges Rd	EB	3200	3440	2250	4540	2290	2240	4450
M5E	east of Marsh St	EB	2060	2450	2010	2330	1860	2030	2680
Southern Cross Dr	east of Botany Rd	EB	1890	2440	2180	2270	2030	2240	2580
Foreshore Rd	south of General Homes Dr	EB	1000	1200	1160	1190	1160	1160	1200

[3] Two two-lane tunnels are provided in the eastbound direction under the options. Under the base case a single eastbound tunnel is provided.

PM			2006 Base	2016 Base	Option F	Option G	Option H	Option I	Option J
Westbound or Southbound									
Screenline 1									
Forest Rd	east of Bexley Rd	WB	1520	1850	1690	1580	1710	1690	1560
M5E	east of Bexley Rd	WB	3850	4170	5390	6360	5560	5390	6180
Canterbury Rd	east of Bexley Rd	WB	1710	1950	1810	1740	1780	1880	1840
Georges River Rd	east of Brighton Ave	WB	1000	1090	1060	1050	1050	1070	1070
Screenline 2									
General Homes Dr	east of M5E	WB	7380	8540	8070	7840	7750	8220	8340
Airport Dr	east of International Termina	WB	2250	2240	2760	2400	2360	3080	3160
NS Link	north of Marsh St	SB			1040	2700	2490		
Princes Hwy	north of West Botany St	SB	2510	3110	2800	2300	2330	3150	3180
Other Links									
M5E	west of King Georges Rd	WB	3350	4440	4740	4930	4790	4740	4890
M5E	east of King Georges Rd	WB	3990	4300	4970	6020	5060	4990	5980
M5E	east of Marsh St	WB	3600	3800	3620	3470	3320	3570	3690
Southern Cross Dr	east of Botany Rd	WB	4320	4740	4680	4530	4520	4790	4830
Foreshore Rd	south of General Homes Dr	WB	1660	1890	1880	1870	1870	1890	1890

Table 7.2 – Modelled Traffic Flows - 2026

AM			2006	2026					
			Base	Base	Option F	Option G	Option H	Option I	Option J
Eastbound or Northbound									
Screenline 1									
Forest Rd	east of Bexley Rd	EB	1600	2050	1830	1720	1830	1830	1700
M5E - to Cooks River Tunnel	east of Bexley Rd	EB			3180	3680	3150	3250	3720
M5E - to Princes, Marsh and NS Link	east of Bexley Rd	EB	4190	4790					
Canterbury Rd	east of Bexley Rd	EB	4140	4670	4260	3610	4120		
Georges River Rd	east of Bexley Rd	EB	2040	2510	2280	2210	2250	2440	2400
	east of Brighton Ave	EB	1540	1860	1740	1710	1730	1800	1770
Screenline 2									
General Homes Dr	east of M5E	EB	8170	9540	9210	9220	9070	9600	9780
Airport Dr	east of International Terminal	EB	2960	3840	3870	3690	3630	4380	4410
NS Link	north of Marsh St	NB			2040	2900	2790		
Princes Hwy	north of West Botany St	NB	3560	4290	3890	3720	3710	4380	4430
Other Links									
M5E	west of King Georges Rd	EB	3320	3980	5390	5530	5400	5370	5490
M5E	east of King Georges Rd	EB	4090	4480	6120	7150	6130	6010	7030
M5E	east of Marsh St	EB	3400	3440	3710	3950	3620	3840	4170
Southern Cross Dr	east of Botany Rd	EB	4540	5300	5200	5150	5140	5350	5390
Foreshore Rd	south of General Homes Dr	EB	1760	2190	2140	2140	2120	2210	2240

[4] Two two-lane tunnels are provided in the eastbound direction under the options. Under the base case a single eastbound tunnel is provided.

AM			2006	2026				
			Base	Base	Option F	Option G	Option H	Option I	Option J
Westbound or Southbound									
Screenline 1									
Forest Rd	east of Bexley Rd	WB	840	1350	1090	950	1070	1070	920
M5E	east of Bexley Rd	WB	2190	2410	3880	4850	4020	3950	4880
Canterbury Rd	east of Bexley Rd	WB	1260	1580	1470	1390	1450	1500	1450
Georges River Rd	east of Brighton Ave	WB	720	840	810	780	790	820	810
Screenline 2									
General Homes Dr	east of M5E	WB	3450	5170	5220	5220	5060	5240	5420
Airport Dr	east of International Terminal	WB	1320	2200	2120	1900	1790	2470	2590
NS Link	north of Marsh St	SB			770	1830	1680		
Princes Hwy	north of West Botany St	SB	1170	1870	1690	1450	1460	1910	1970
Other Links									
M5E	west of King Georges Rd	WB	2870	3460	3700	4010	3740	3710	4020
M5E	east of King Georges Rd	WB	3000	3450	3980	4970	4050	4030	5020
M5E	east of Marsh St	WB	1910	2630	3110	3200	2960	3040	3240
Southern Cross Dr	east of Botany Rd	WB	3100	4250	4350	4280	4200	4430	4510
Foreshore Rd	south of General Homes Dr	WB	670	1160	1150	1160	1150	1150	1160

PM			2006 Base	2026 Base	Option F	Option G	Option H	Option I	Option J
Eastbound or Northbound									
Screenline 1									
Forest Rd	east of Bexley Rd	EB	550	950	1040	690	1020	1040	1700
M5E - to Cooks River Tunnel	east of Bexley Rd	EB			1290	1830	1220	1340	2180
M5E - to Princes, Marsh and NS Link	east of Bexley Rd	EB	3060	3590	1890	3160	2070	1820	2670
Canterbury Rd	east of Bexley Rd	EB	1240	1460	1490	1330	1460	1510	1390
Georges River Rd	east of Brighton Ave	EB	990	1140	1150	1120	1140	1170	1150
Screenline 2									
General Homles Dr	east of M5E	EB	3550	4920	4530	4750	4360	4640	5120
Airport Dr	east of International Terminal	EB	1030	2240	2000	1890	1820	2330	2340
NS Link	north of Marsh St	NB			720	1730	1520		
Princes Hwy	north of West Botany St	NB	1760	2160	1980	1750	1710	2130	2220
Other Links									
M5E	west of King Georges Rd	EB	2010	2900	2900	3420	2930	2900	3370
M5E	east of King Georges Rd	EB	3200	3620	2890	4960	2910	2890	4910
M5E	east of Marsh St	EB	2060	2670	2420	2850	2290	2440	3130
Southern Cross Dr	east of Botany Rd	EB	1890	3400	3240	3330	3050	3310	3590
Foreshore Rd	south of General Homes Dr	EB	1000	1290	1250	1280	1260	1240	1260

[5] Two two-lane tunnels are provided in the eastbound direction under the options. Under the base case a single eastbound tunnel is provided.

PM			2006 Base	2026 Base	Option F	Option G	Option H	Option I	Option J
Westbound or Southbound									
Screenline 1									
Forest Rd	east of Bexley Rd	WB	1520	2150	1950	1850	1940	1940	1810
M5E	east of Bexley Rd	WB	3850	4340	5940	6730	6060	5850	6600
Canterbury Rd	east of Bexley Rd	WB	1710	2110	1970	1910	1940	2030	2020
Georges River Rd	east of Brighton Ave	WB	1000	1140	1110	1110	1090	1130	1140
Screenline 2									
General Homes Dr	east of M5E	WB	7380	9210	8570	8470	8440	8870	8990
Airport Dr	east of International Terminal	WB	2250	2850	3260	2920	2880	3710	3750
NS Link	north of Marsh St	SB			1540	2910	2720		
Princes Hwy	north of West Botany St	SB	2510	3340	2960	2520	2530	3440	3480
Other Links									
M5E	west of King Georges Rd	WB	3350	4980	5290	5430	5290	5300	5420
M5E	east of King Georges Rd	WB	3980	4420	5540	6310	5530	5520	6330
M5E	east of Marsh St	WB	3600	3860	3600	3600	3490	3670	3820
Southern Cross Dr	east of Botany Rd	WB	4320	5250	5210	5100	5110	5350	5360
Foreshore Rd	south of General Homes Dr	WB	1660	2070	2010	2000	2000	2030	2030

7.1 *Tolling Implications*

Tolling of the M5 East and the North-South Link will not only provide a revenue stream for the motorway project, but also reduce the traffic flows on the motorway.

Tolling has been examined using a distance based tolling regime. Tolls where applicable have been applied at 33c/km for cars and 83c/km for heavy vehicles. The toll on the M5 East has been applied between King Georges Road and Marsh Street, and on the entire length of the North South Link.

To obtain daily traffic and the AM and PM peak periods have been expanded using an expansion factor. A factor of 6.25 is an average factor for tolled and untolled roads around the Sydney Metropolitan Area. The current expansion factor for AM and PM to average daily traffic on the M5 East is 7.40. A reduction to 6.25 when the motorway is tolled is considered reasonable at this stage. Further research is required to more accurately determine the tolled expansion factor in this corridor.

The effects of tolling on the M5 East Main Tunnel and the North-South Link are shown in Table 7.3.

Table 7.3 – Daily Traffic Flows

	M5 East Main Tunnel			North South Link		
	2006	2016	2026	2006	2016	2026
	Two-Way	Two-Way	Two Way	Two-Way	Two-Way	Two Way
Base	98,000	107,500	112,000			
Opt F		114,000	131,000		23,000	32,500
Opt G		177,000	190,000		64,000	71,500
Opt H		117,000	136,500		58,000	66,500
Opt I		112,000	127,500			
Opt J		171,000	184,000			

Option F - M5 East Expansion (4in – 3out) + North-South Link (all tolled)
Option G - M5 East Expansion (4in – 3out) + North-South Link (all untolled)
Option H - M5 East Expansion (4in – 3out) (tolled) + North-South Link (untolled)
Option I - M5 East Expansion (4in – 3out) (tolled)
Option J - M5 East Expansion (4in – 3out) (untolled)
AM + PM Expansion factor of 7.40 applied for untolled cases and 6.25 applied for tolled cases

The model is showing a daily toll diversion of approximately 35% for the M5 East Main Tunnel. The North South Link has more available alternative routes and has a significantly higher toll diversion of 65%

7.2 *Network Operation Statistics*

To determine the network effects of the M5 East Expansion, Sydney Network Vehicle Hours of Travel (VHT) and Vehicle Kilometres of Travel (VKT) have been extracted from the Sydney Strategic Highway Model. This statistics are shown in the following Table 7.4.

Table 7.4 – Network Statistics - AM Peak

	2016		2026	
	VHT	VKT	VHT	VKT
Base	250484	7522726	324636	8658395
Opt F	246032	7524858	318875	8658597
Opt G	245060	7536276	318706	8662887
Opt H	245857	7524059	318105	8658475
Opt I	245992	7526466	319745	8659986
Opt J	247186	7534075	320334	8664815

The network statistics by road class are found in Appendix B.

Overall, the M5 East Expansion and the North South Link improve the operation of the road network by reducing travel times by around 2% which is significant over the entire Sydney road network.

7.3 *Network Operation*

The operation of the road network has not been examined in detail however, from the strategic modelling the following conclusions can be drawn:

- The M5 East in its current form will suffer increased congestion over more extended periods into the future (with peak demands exceeding 4,500 vehicles per hour). The capacity of the tunnel in its existing configuration is approximately 4,000 vehicles per hour eastbound and 3,300 vehicles per hour westbound.
- The M5 East expansion improves capacity in the corridor and draws traffic from surrounding roads (peak demand is approximately 8,200 vehicles per hour untolled, with a theoretical capacity of around 8,000 vehicles per hour)
- Under untolled scenarios, the eastbound tunnel to Princes Highway, Marsh Street and the North South Link is over capacity in the 2026 AM peak period (4,650 vehicles per hour), the eastbound tunnel to Cooks River is approaching capacity (3,700 vehicles per hour).
- The westbound tunnel is over capacity in the untolled scenario in the PM peak period for both 2016 (6,350 vehicles per hour) and 2026 (6,750 vehicles

per hour). With toll, the westbound flows are still near capacity by 2026 (6,050 vehicles per hour) where the assumed westbound capacity is 6,000 vehicles per hour.

- The North-South Link assists in diverting traffic from Airport Drive and General Holmes Drive by providing an alternate access to South Sydney. This link also provides network redundancy around the airport precinct.
- In the absence of North-South Link, traffic flows on Airport Drive and General Holmes Drive (3,850 and 9,550 vehicles per hour respectively) would exceed their relevant capacities. These links would require some upgrade if the North-South Link was not constructed.

8 Summary and Conclusions

The M5 East Motorway is currently operating at capacity for many hours throughout the day resulting in significant traffic congestion. This congestion effects private vehicle travel, passenger trips to Sydney Airport and freight transport from Port Botany, Sydney Airport and the South Sydney Growth Centre.

Analysis of the M5 East corridor identified that a new three lane tunnel westbound (allowing for two two-lane tunnels eastbound) would provide additional capacity for both eastbound and westbound traffic.

The additional three lane westbound tunnel would provide more than a proportional increase in capacity by reducing the exit grade at the westbound portal.

The expanded would motorway attract traffic from alternate routes and is forecast to reach capacity by 2026. Tolling the expanded M5 East would provide a revenue stream for the project and generally reduce 2026 flows to within the expanded capacity that the scheme would provide.

The North South Link provides network benefits by diverting traffic from Airport Drive and General Holmes Drive, providing an alternate access to South Sydney. This link also provides network redundancy around the airport precinct. In the absence of the North-South Link General Holmes Drive and Airport Drive are forecast to have demand greater than their capacity leading to significant congestion.