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Before and after opening of the M4 Motorway from Mays Hill to Prospect

Sydney case studies in induced traffic growth

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Working Paper

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The original version of this data set and commentary was completed in May 1997 and presented in two parts. These were:

1. Road traffic data for western Sydney sector arterials: Great Western Highway and M4 Motorway 1985 – 1995

2. Rail ticketing data and passenger journey estimates for the Western Sydney Rail Line 1985 – 1995

These have now been combined and are presented here as part of an ongoing series of case studies in induced traffic growth from the Sydney Metropolitan Region.

In the first, report which focussed on road traffic volumes, an error was made. The location points of road traffic counting stations were incorrect. Although this error does not affect the general conclusions, details of some of the analysis presented in this version are different to that presented in the original papers listed above. Some data additions have also been made, and so the accompanying commentary has been expanded.

Acknowledgements

During the collation of this data Mr Barry Armstrong from the NSW Roads & Traffic Authority provided invaluable information on road data collection methods as well as problems with data integrity. Mr Malcolm Emerson assisted with many small and unplanned—on my part—data checks. Mr Bernie Chellingworth from the RTA's Blacktown office also provided data on opening dates for sections of the M4 and access to studies of the motorway before and after its opening. Mr Mathew Wilson and Mr Ray Daltry explained the development and thinking behind the identification of screenlines used by the RTA for traffic modelling and monitoring programs. I am very grateful to all these people for their help and very sound advice.

Assistance and data from staff at StateRail has also been greatly appreciated. In particular, advice from Mr Ian Kearns and Mr David Enever of StateRail's Planning and Finance section was critical. Data had to be extracted from CityRail archives. Mr Adrian Lewis took great care when doing this, pointing out inconsistencies where they occurred. His attention to detail has eliminated many potential errors and any that remain are my own.

My colleague Dr Felix Laube also went to considerable trouble to obtain data for service frequencies on the line. Without this data the analysis would have been greatly lacking. Dr Glen Searle, Dr Stuart White and Mr Peter Mills gave careful consideration to the text and suggested several improvements, all of which have been adopted.

Thanks are also due to Mr William Craig for his knowledge of when the timetables *went bad*, dates of rail improvements and general observations of transit service levels from a user perspective.

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Executive Summary

This paper examines before and after conditions surrounding the opening of the Mays Hill to Prospect section of the M4 Motorway in Sydney's west. The aim of the examination has been to identify any possible traces of induced traffic growth, or increases in travel generated as a direct response to the increase in road capacity. Other causes for traffic volume increases have been progressively ruled out, leaving a residual that could be induced traffic growth.

Results show a large increase in road traffic volumes that ocurred immediately after opening of the M4 Motorway section from Mays Hill to Prospect. These are summarised as follows:

- Combined road traffic on the Great Western Highway and M4 at Prospect grew from an average of just under 80,000 vehicle movements per day in 1991 to just under 100,000 in 1992 (see p.16), an average increase of just under 20,000 per day.
- Road traffic shifts from the Great Western Hwy to the M4, depending on the point of examination, were in the order of 5,000 to 50,500 vehicles on average per day, (see p.17).
- Road traffic on these two roads had been growing at a rate between four and three per cent, or by around 3,000 to 2,000 vehicles per day on average per year, prior to the May 1992 opening (see p.15). In the year after opening, road traffic grew by 24 per cent (see p.32), leaving around 17,000 vehicles on average per day above previous growth trends.
- Road traffic shifts from other arterial roads to the M4 were difficult to estimate (see .p18). A volume of just over 7,000 was estimated from available data (see p.19) leaving just over 10,000 vehicle movements on average per day above expected growth trends.
- An estimated 7,000 or so passenger journeys on average per day appear to have shifted from the rail network to the road network in the year after opening (see p.24) leaving a residual volume of about 3,000 vehicles on average per day.
- While additional trips and passenger journeys may have shifted from roads where traffic volumes were not be measured, or bus services that run parallel to the motorway, it would be unrealistic to suppose that these would be on a scale necessary to make up the remaining 3,000 vehicle trips per day that cannot be accounted for. This residual volume is most likely new trips in the form of traffic redistribution or induced traffic growth (see pp.27).

Problems involving boundary conditions and data parity were incurred when undertaking this analysis. Where volumes have been extrapolated from other trends, conservative estimates have been used in the sense that higher volumes have been used so that the residual volume that might be induced traffic growth is lower. More could be learnt from analysis of fluctuations in daily traffic volumes so that the period over which changes occurred would be identified. This would help to rule out other possible causes such as population changes, which generally take more than a few months to bring about significant changes.

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Abbreviations

AADPJ	Annual Average Daily Passenger Journeys
AADT	Annual Average Daily Traffic
AWT	Average Weekday Traffic
CBD	Central Business District
GWH	Great Western Highway
HMSO	Her Majesty's Service Offic
HV	Heavy Vehicle
RTA	Roads & Traffic Authority
SACTRA	Standing Advisory Committee on Trunk Route Assessment
VKT	Vehicle Kilometres Travelled
WSRL	Western Sydney Rail Line

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Before and after opening of the M4 motorway from Mays Hill to Prospect

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Introduction

The aim of this paper is to provide an overview of the changes in road traffic movements that took place after the opening of the last section of the M4 Motorway from Mays Hill to Prospect in Sydney's west. In particular, this empirical analysis aims to gauge the extent and calibre of any additional road traffic generated in response to the quicker travel times made possible by the increase in capacity. This effect is often referred to as *induced traffic growth* — a sharp increase in traffic volumes that occurs immediately after road network capacity is expanded and congestion reduced. This increase in traffic continues until congestion levels return and travel times begin to rise again, stopping further growth.

The existence of induced traffic growth has been a point of concern in transport studies for some time. Interest was heightened during the 1980s and 90s when many new urban motorway projects were opened both in Australia and overseas. In the UK, public concern over the effects of the M25 ring-road in London prompted the British Government to commission a special study into the issue of induced traffic growth. This was undertaken by SACTRA — the Standing Advisory Committee on Trunk Route Assessment. That report, entitled *Trunk roads and the generation of traffic* was a landmark study and remains one of the most authoritative sources of information on the subject (SACTRA, 1994).

SACTRA found that induced traffic growth is real and ocurs extensively, reaffirming the views put forward by seminal writers on the subject (Thompson, 1977 and Smeed, 1964). Similar findings to these have been articulated in Australian Government inquiries (see Kirby, 1980).

Despite a rich and extensive array of case studies for European Union and North American cities, there are few equivalents for Australian cities. Luk and Chung (1997) point to this gap in the literature, providing a Melbourne case study. Problems with data parity and boundary conditions were encountered in their analysis. They found no evidence of induced traffic growth. There is one other case study by Mewton (1997), which provides a more extensive analysis of before and after conditions of the Sydney Harbour Tunnel and Gore Hill Freeway. With more extensive data, fewer problems with data parity and fewer holes in the the boundary conditions, Mewton did find evidence of induced traffic growth. He also found that by including these effects, the benefit cost ratio for the project changed. Benefits were outweighed by costs that included external costs such as congestion and loss of public transport patronage.

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In many debates over whether or not induced traffic growth is a real phenomenon, problems with the nature of empirical testing are often cited as a reason for disregarding the phenomenon and its implications (SACTRA, 1994, p.29). This case study does not review the debate over the existence of induced traffic growth, nor does it specify the mechanism within urban systems that causes the behavioural response that gives rise to the increase in vehicle use. This is canvassed in other working papers that form part of this series (see Zeibots, 2003). This case study systematically looks at possible explanations for the large increase in volumes. The full extent of the increase is established, business-as-usual growth is estimated and subtracted, traffic reassignment from other routes is identified and subtracted, volumes from mode shifting are calculated and so on, resulting in a residual.

While the case examined here is unable to quantify with complete certainty the extent of additional traffic movements, it does reveal a residual volume of traffic that cannot be reasonably accounted for. It also shows that large shifts from rail to road use followed in the wake of the motorway section opening. This provides an explanation for some of the increase, but not all. Even with optimistic estimates for traffic movements from other routes and business-as-usual growth, it is not possible to confidently account for all the increase that can be seen. In light of this, the remaining volume is most likely to be new trips, or induced traffic growth, generated by the increase in capacity.

1. The structure of the Sydney transport network and identification of boundary conditions

The Sydney metropolitan area radiates from the Central Business District along a series of radial road and rail trunk routes. A complex network of sub-arterial and local collector roads facilitates traffic moving from local residential neighbourhoods to the main trunk routes. Like spokes on a wheel the trunk routes distinguish each of Sydney's geographical sectors.

Figure 1 shows the Sydney regional trunk route system as laid out in the County of Cumberland Scheme in the early 1950s. The Scheme was Sydney's first legislated plan and was dominated by a proposed series of radial motorways. These are shown in red.

The motorways were at the top of the proposed road hierarchy, their purpose being to provide access for longer distance and regional movements. While the metropolitan area was already served by several radial trunk roads, these did not have restricted access and so were subject to delays at intersections and traffic lights. The motorways planned under the County of Cumberland Scheme aimed to avoid such delays, providing a high speed, high capacity network that would allow traffic to move easily over longer distances once it had joined the motorway network. The geometry of the County of Cumberland Scheme laid the foundation for road and motorway development from that time to the present day.

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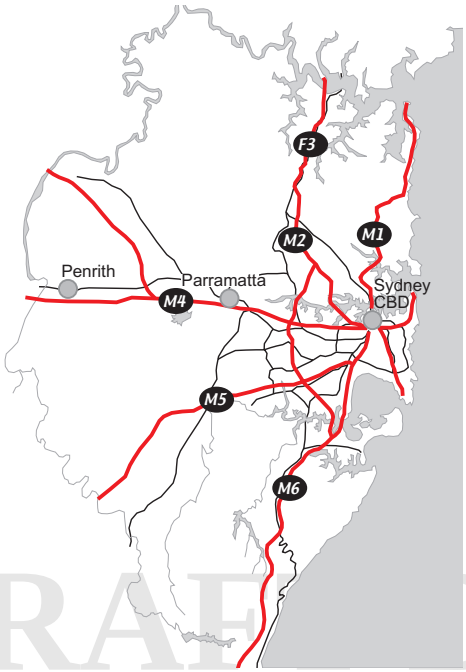
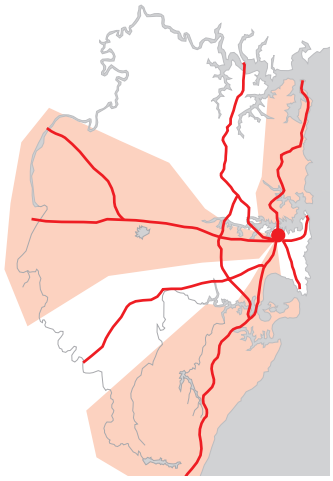
Understanding the motorway network structure and how movement takes place along it is important when establishing boundary conditions for the purposes of this kind of analysis. Boundary conditions identify the partition in a system that distinguishes inputs from outputs. This is an important part of any empirical analysis. In this case the aim is to assess the amount of traffic moving through the system before the capacity increase with those after the increase. It is accepted that the route used to cross the boundary will change for some traffic and a way needs to be found of distinguishing this traffic from new and additional traffic.

In traffic and transport studies, boundary conditions are often set by the location of what traffic engineers call screenlines. A screenline is a conceptual line drawn across a section of the urban system that attempts to capture all traffic movements with the same broad origins and destinations. Where several different routes could be taken for the same trip, a screenline draws a boundary across all of these, thereby accounting for all the traffic moving in and out of the areas on either side.

As shown in the diagram accompanying Figure 1, each motorway is sited in the middle of a geographical sector. Although the rest of the road network is not shown in this diagram, there is a complex network of unrestricted access trunk routes as well as local collector roads. Some of these have a radial alignment and provided access for regional traffic movements before the motorways were built. The

Figure 1 County of Cumberland Scheme trunk route structure plan for Sydney, 1954





Adapted from: Ashton, P. & Waterson, DB. 2000, *Sydney takes shape: a history in maps.* Hema Maps Pty. Ltd., Brisbane, pp.53 and 59.

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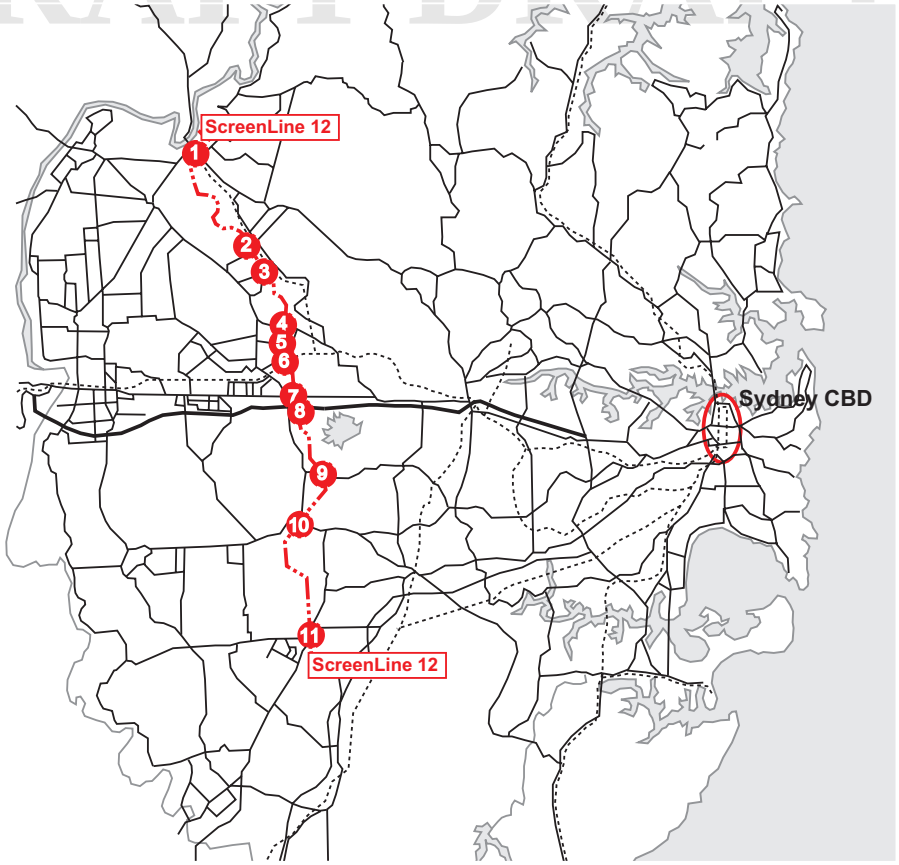
Figure 2 Position of Screenline12



1. Windsor Road (88.046)
2. Garfield Road (88.150)
3. Grange Avenue (71.149)
4. Richmond Road (71.059)
5. Power Street (71.172)
6. Eastern Road (70.067)
7. Great Western Highway (70.001)
8. M4 Motorway (71.002
9. The Horsley Drive (65.140)
10. Elizabeth Drive (64.022)
11. Bringelly Road (64.097)

Legend

- arterial roads
- M4 Motorway
- rail lines
- Screenline12

Source: RTA. 2000, Traffic volume data for Sydey Region 1999, Volume 2. NSW Roads and Traffic Authority, Sydney.

upshot is that there are numerous routes that a traveller could choose to access the same destinations from their point of origin. A screenline therefore needs to cut across the entire sector and all possible routes that could provide access from one side to the other. If not, then the strong possibility remains that much of the increase observed is in fact traffic moving from other routes rather than new traffic. The screenline of particular significance in this study is Screenline12 as shown in Figure 2.

Screenline12 attempts to capture regional, or longer distance, traffic movements from the outer edge of the western sector to the key centres of Parramatta and the CBD in the east. To do this it has to cross a large area. It is just on 40 kilometres in length. The reason it covers such a long distance — around 20 kilometres either side of the M4 Motorway — is because vehicle movements may very well have been attracted from distant routes as motorists took advantage of quicker travel times. This possibility needs to be included in the analysis. Screenline12 was identified by technical staff at the NSW Roads & Traffic Authority (RTA) where it is used to assist in traffic monitoring programs and modelling tasks (Wilson, 2003). Figure 2 shows the position of screenline12 and lists the eleven roads that cross it.

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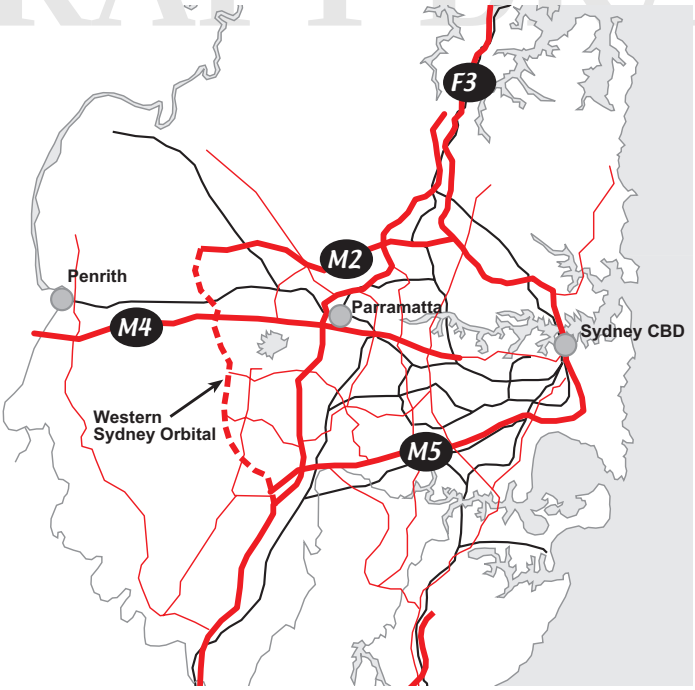
Figure 3 The Sydney Orbital, 2000



Source: TransportNSW. 1998, *Action for Transport 2010*, p.30.

Before moving forward with the analysis it is important to acknowledge that while construction of several of the County of Cumberland Scheme motorways has taken place, the configuration was altered in some parts after 1990. This occurred in response to criticism that radial motorways funnel traffic into the central city. It was believed the motorways should direct traffic around congested centres instead. A new concept called *The Sydney Orbital* was developed in response to this criticism. This is shown in Figure 3. This comprised the Cumberland motorway network with additions to the M2 and a Western Sydney Orbital. This was meant to take traffic around the city — the demographic centre being Parramatta. Given that the city's operational centre is still the CBD in the east, which attracts more traffic than Parramatta, the network still functions as a radial network and so screenlines are configured to capture these movement formations.

Regrettably, comprehensive time series data were not collected at all these points during the study period from 1985–1995. As will be shown, the most dramatic changes to traffic volumes occurred on the Great Western Highway and M4 Motorway. Data for these points is relatively complete, so to begin, these primary trunk routes that sit at the centre of the western sector and which accomodate the greatest traffic volumes, will be considered.

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Figure 4 Sequence of section constructions for the M4 Motorway

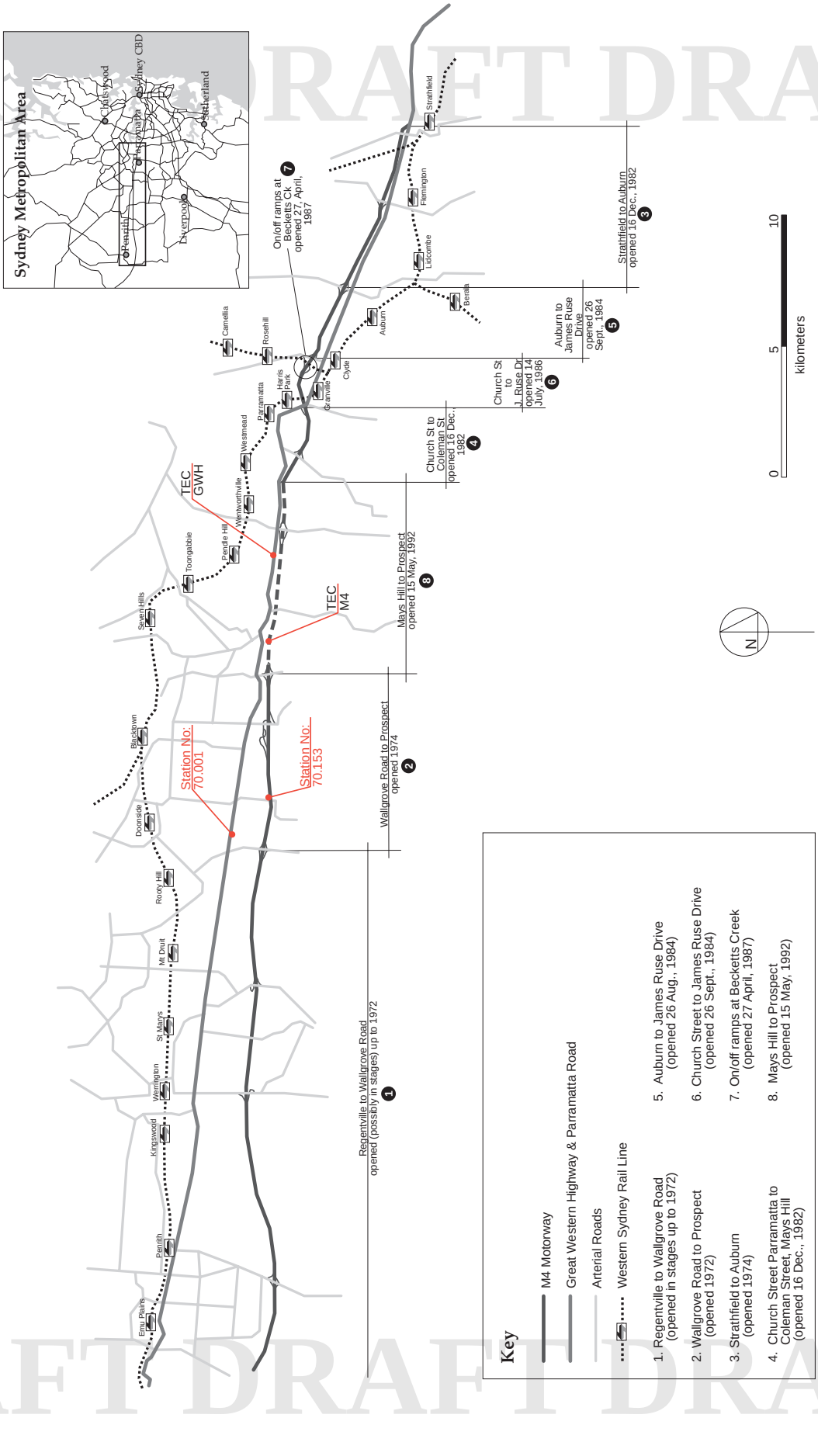

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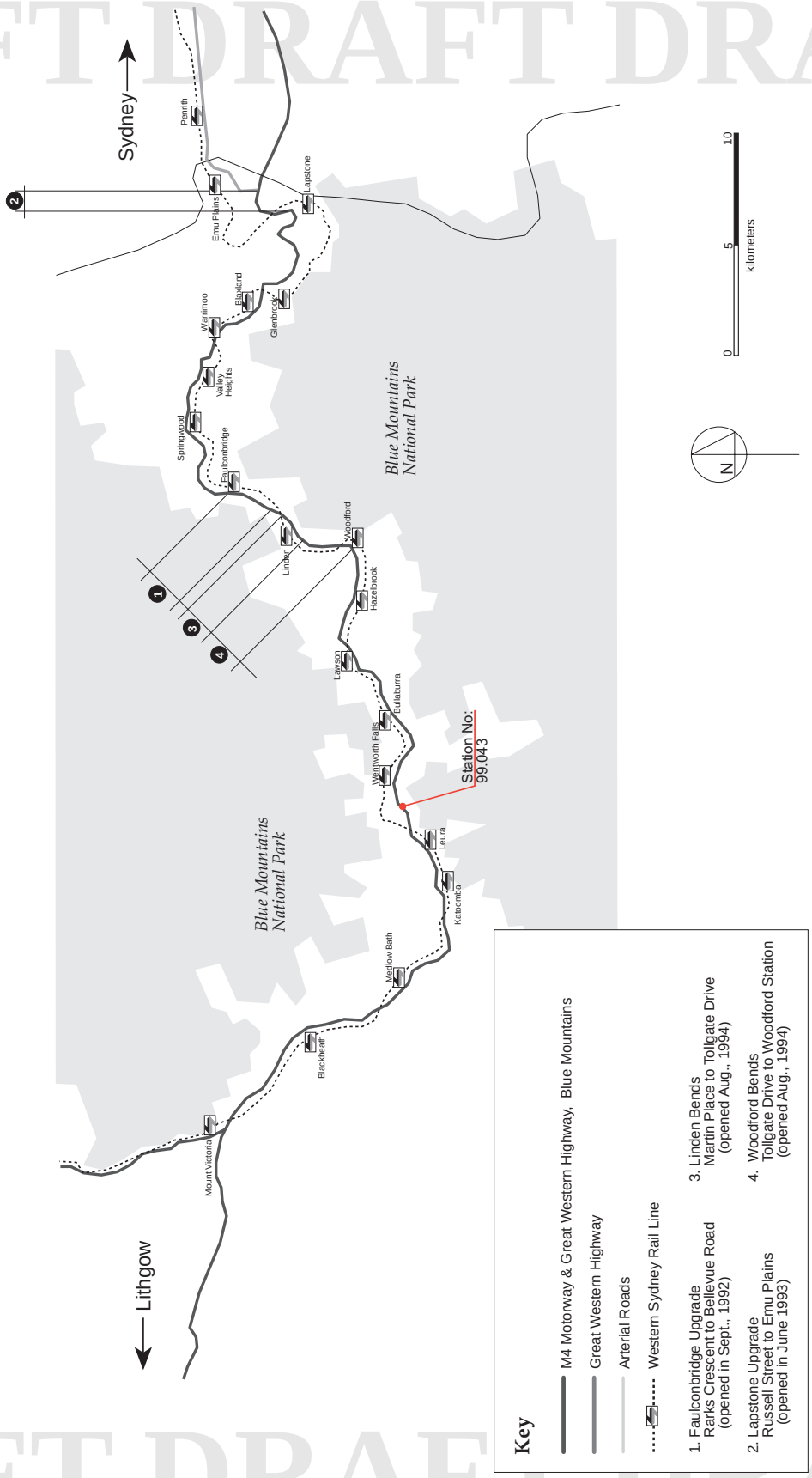
Figure 5 Sequence of capacity changes on the Great Western Highway in the Lower and Upper Blue Mountains



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2. Road data for the Great Western Highway and M4 motorway 1985 – 1995

Three trunk routes dominate the western sector of Sydney. These comprise one unrestricted access carriageway, starting in the east at Parramatta Road which dog-legs onto Church Street at Parramatta before joining the Great Western Highway (GWH); the M4 Motorway, which is a restricted access carriageway in the form of a tollway, an; the Western Sydney Rail Line (WSRL). Together these trunk routes provide for long distance commuting along the western axis of the Sydney conurbation and Blue Mountains region. They are shown in Figures 4 and 5.

Parramatta Road and the GWH have a six lane capacity in most Sydney metropolitan sections. Throughout the Blue Mountains, the GWH is a mix of two and four lane sections. The M4 is a tolled motorway. Prior to the opening of the section from Mays Hill to Prospect, the M4 operated as a freeway. After this last section was opened to traffic, vehicles passing through toll gates west of Strathfield paid a $1.50 toll in both directions. Until 1995 the motorway had a capacity of four lanes. In the late 1990s it was expanded to six lanes. The effects of these increases in capacity are not analysed here.

As can be seen in Figure 4, the M4 motorway has been built in stages, beginning in 1972. The last section between Mays Hill and Prospect was opened to traffic on 15 May 1992.

The data used to monitor changes in road traffic volumes were obtained from the RTA which has a regular traffic monitoring program that records volumes at around 2,000 points in the Sydney Metropolitan network. Of these, some 140 are permanent counting sites (see notes on road data and different data types on p.30).

Figure 4 also shows the position of permanent counting stations No.s 70.001 and 71.002 (previously 70.153). These sites are located on Screenline12.

Data were also obtained from a report commissioned by the RTA and undertaken by TEC Consulting. Pneumatic tube counters were used by TEC to obtain data. The locations of these temporary sites are indicated in Figure 4 as TEC:GWH and TEC:M4.

The primary difference between data collected at each of the sites is that RTA data comprise Annual Average Daily Traffic (AADT) counts which include data for weekdays and weekends, whereas data collected by TEC are for average weekday traffic only. The value for AADT is generally lower than for Average Weekday Traffic (AWT).

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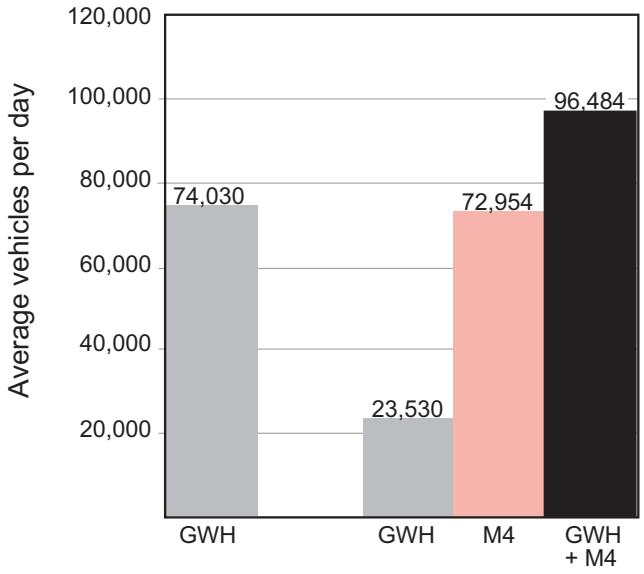
Figure 6 Comparison of before and after Average Weekday Traffic classification counts for sites on the Great Western Highway and M4 Motorway



Location	**Before** (March, 1992) light	rigid	artic.	total	**After** (Aug., 1992) light	rigid	artic.	total
Great Western Highway	69,204	2,720	2,106	74,030	22,862	418	250	23,530
	93%	4%	3%	100%	97%	2%	1%	100%
M4 Motorway	-	-	-	-	68,119	2,648	2,187	72,954
					93%	4%	3%	100%
Total				**74,030**	**90,981**	**3,066**	**2,437**	**96,484**

Source: TEC Consulting. 1992, *Traffic changes associated with new M4 Motorway works*. NSW Roads & Traffic Authority, Table 3.1.

Figure 6 shows before and after average weekday road traffic volumes for the M4 and GWH from the report undertaken by TEC Consulting. These have been disaggregated according to vehicle type. The RTA data, as shown in Appendices I and II, could not be disaggregated in this way.

For the month of March—immediately before opening of the new motorway section—and the month of August—after opening—the data indicate a significant increase in traffic volumes over the two road routes. Average Weekday Traffic (AWT) on the GWH for March was 74,030. After opening of the M4 from Mays Hill to Prospect the AWT on the GWH dropped to 23,530 for August, while the AWT for the

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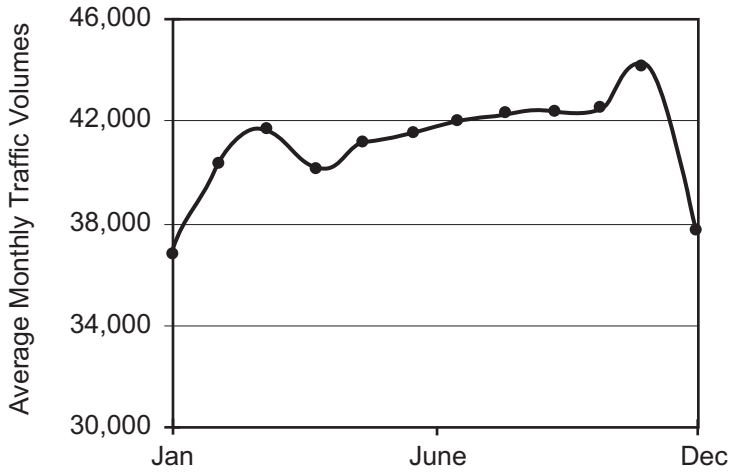
Figure 7 Seasonal fluctuations in traffic volumes on the Great Western Hwy (70.001) 1985



* Note that a broken scale has been used on the x axis.

Source: RTA. 1986, *Traffic volume data for Sydney region 1985*. NSW Roads & Traffic Authority, Sydney.

M4 reached 72,954. Combined, August AWTs for these routes were 96,484. This constitutes an increase of 22,454 vehicle movements on average per day for working weekdays.

By far the greatest increases are in volumes of light traffic, that is, private motor cars, motorcycles and utility vans. These volumes increased by 21,777, or 31 per cent. Rigid and articulated heavy vehicles increased by 346 and 81 respectively, or thirteen and four per cent.

The increases in heavy vehicle traffic are relatively small and quite possibly fall within the bounds of typical fluctuations for this corridor. Figure 7 shows seasonal traffic volume fluctuations typical of this corridor when no changes in capacity took place. As can be seen, volumes during March are lower than those for August but this difference is only in the order of a few thousand vehicle movements. The 'saddle-back' pattern that results can be seen on most roads across the metropolitan network. With respect to light traffic, fluctuations of the magnitude shown in Figure 6 are unusual and fall well outside typical growth rates or seasonal fluctuations.

Figure 8 shows Annual Average Daily Traffic (AADT) volumes for the RTA sites 70.001 and 71.002 for the years 1985 to 1995. Until 1992, combined traffic volumes were increasing from between three and four per cent per year, or from between 2,129 and 2,753. The exact volumes at these sites are

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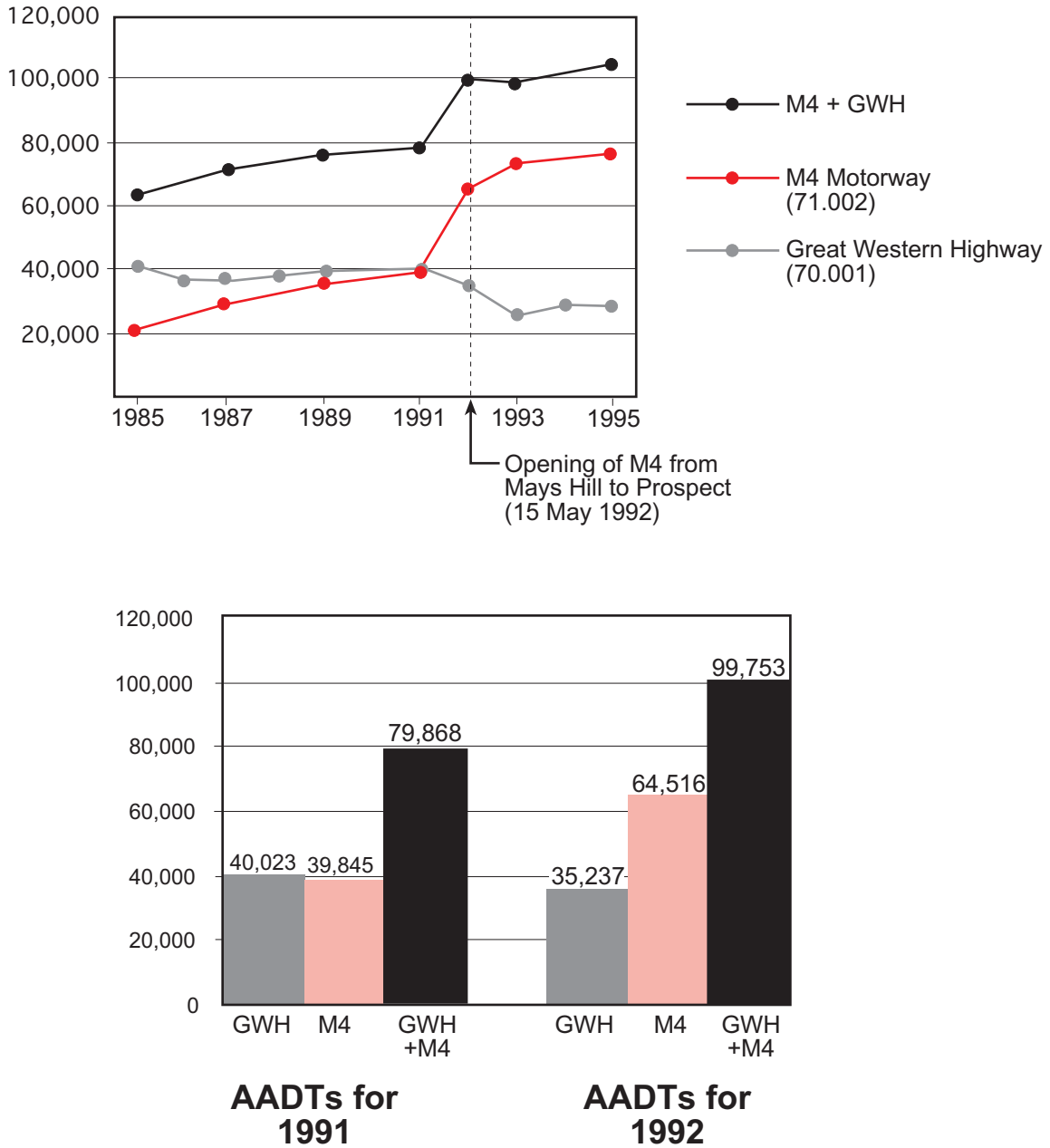
Figure 8 Annual Average Daily Traffic for the M4 Motorway (71.002) and the Great Western Highway (70.001) at Pendle Hill 1985–1995



Source: RTA. 1995, *Traffic volume data for Sydney region 1993*. Roads and Traffic Authority of NSW, and Armstrong, B. 2003, *Personal communication*, 6 January.

shown in Appendix I on page 32. Volumes for the GWH suggest the road had been operating at capacity for some time. Where there had been increases, lane widenings had taken place. A distinct jump in the road traffic volumes for 1992 can be observed. This coincides with the opening of the Mays Hill to Prospect section of the M4.

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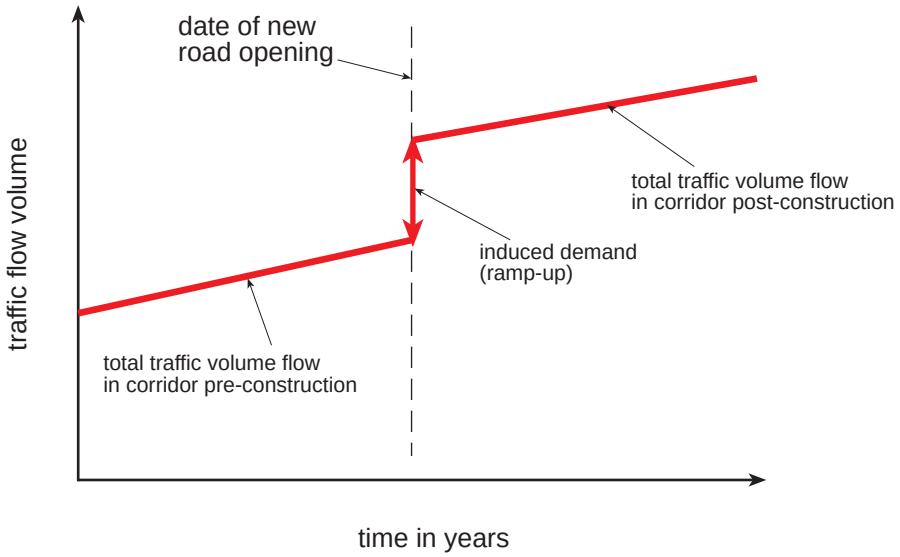
Figure 9 Conceptualisation of induced demand due to road capacity increases



Source: Luk, J. and Chung, E. 1997, *Induced demand and road investment—an initial appraisal.* ARR 299. Australian Road Research Board, Vermont South, p.10.

The distinct jump in the time series data is referred to as *ramp-up*. Figure 9 shows a conceptual outline of this phenomenon as it typically appears on time series graphs of road traffic volumes like that shown in Figure 8. Where the increase occurs, a distinct 'ramp' appears, hence the term ramp-up. The diagram suggests the increase in volumes occur almost instantly. This is not the case. The *ramp-up period* takes many months until growth rates stabilise and reach an equilibrium where the slope of traffic volume increases becomes less steep. Changes in daily traffic volumes would need to be analysed in order to assess the period over which ramp-up took place.

The duration of the ramp-up period is interesting for several reasons, the primary one being that because it takes place over a relatively short period of time, population increases and demographic changes can be ruled out as causes.

A portion of this increase potentially is comprised of *induced traffic growth*. At a glance it is possible to see that large volumes of traffic previously using the GWH, began using the M4 instead. This shift is in the order of 50,500 per weekday on average for the TEC Consulting sites. In the case of the RTA sites identifying the precise scale of the shift is difficult. This is because data for the years prior to

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1992 at site 71.002 were collected via non-permanent or sample counters. As outlined in Appendix I, in addition to only measuring a sample, the data records axle pairs and not vehicle numbers. This means that counts prior to 1992 read higher than they would if they were of the same type as those for site 70.001.

Figure 8 compares AADT figures for 1991 with those for 1992. If counts for site 71.002 are adjusted to account for heavy vehicle traffic, then the difference is 19,885. The adjustment was made by reducing volumes prior to 1991 by 11.25 per cent. This rate was derived using a method described in in Appendix I on pages 30–32. This is based on the heavy vehicle make-up of traffic measured in the TEC data. This is conservative in the sense that the larger the adjustment figure, the greater the reduction in traffic volumes and therefore the larger the volume difference that must be accounted for by either mode shifting or traffic reassignment.

The growth of 19,885 is lower than the 21,777 estimated by the TEC sites. However, it is in the same range and it should also be taken into account that the TEC data are AWT counts whereas the RTA data are AADT counts. This should have the effect of reducing averages and therefore differences. As has been shown, traffic reassignment from the GWH to the M4 is able to account for some of the dramatic increase after opening. The remaining increases need to be accounted for by first examining losses in traffic volumes from the remaining roads in Screenline12.

3. Road data for remaining roads that cross Screenline12 1985–1995

Data for the remaining roads in Screenline12 is patchy and there is the complicating problem of changes to counting station types, and therefore data typology, at the time of the new motorway opening. Adjustments to data had to be made to accommodate this in the same way that they were for station 70.002 on the M4 Motorway.

These adjustments are explained and examined in detail in Appendix II on pages 34–39. It should be stressed that although a simple method has been employed to estimate volumes for those years where data were unavailable, great care has been taken to ensure that estimates are conservative. Table 1 provides a summary of the volume estimates for traffic reassignment from other routes on Screenline12.

The primary roads from which traffic is likely to have shifted are Windsor Road, Richmond Road, Elizabeth Drive and Bringelly Road. The heavy vehicle make-up of traffic on these roads is unknown. In the method devised to calculate the adjustment figure for the M4 data, four figures were calculated in all. The lower of these were eight and five per cent. These were both used to adjust the non-permanent counting station data for the other sites along Screenline12.

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Table 1 Traffic reassignment estimates for remaining roads in Screenline12

Road	AADT volumes between 1992 and 1993	Reassignment Estimate AADT (8 and 5 per cent)	
Windsor Road		▼ 3,316	▼ 3,423
Garfield Road	Cross-regional route discounted from tally	-	-
Grange Avenue	Cross-regional route discounted from tally	-	-
Richmond Road		▼ 1,329	▼ 2,487
Power Street	Cross-regional route discounted from tally	-	-
Eastern Road	Cross-regional route discounted from tally	-	-
The Horsley Drive	No apparent deviation from typical growth patterns, discounted from tally	-	-
Elizabeth Drive	Data unavailable for 1992 and 1993. See notes in Appendix II, pp.34–35	not available	
Bringelly Road		▼ 2,365	▼ 2,442
TOTAL		**▼ 7,010**	**▼ 8,352**

The exception to the problem of patchy data was Eastern Road. At this site, data were available for all years and the station type remained the same. Eastern Road shows a sharp increase in volumes that coincide with the opening of the M4 section from Mays Hill to Prospect.This is because it has a ring-road orientation and functions as a feeder route for traffic to the M4. What is particularly significant about this road is that where the lower conversion estimate was used, an AADT volume is returned that appears to be outside the ceiling capacity for this feeder route. The higher conversion rate of eight per cent returns an AADT volume that is more plausible given later AADT counts. This is outlined in more detail on pages 36–37.

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This provides a check for the adjustment levels used and some guidance as to the veracity of the adjustments made to different data typologies to achieve data parity for comparison purposes. The reason the rate of 11.25 per cent was used to adjust the M4 data and not the other roads on Screenline12 is because heavy vehicle numbers on restricted access carriageways are generally higher than on unrestricted trunk routes or main roads and so the number of axle pairs is higher. Consequently, a lower percentage must be used. The difficulty is that there is no sure way of knowing what these varying rates were at the time of the M4 section opening. The data are more internally consistent if an adjustment rate of eight per cent is used and so the results are more likely to be realistic.

There is also the significant issue that no data are available for Elizabeth Drive during the crucial years of 1992 and 1993. On examination of the time series for the period it appears that Elizabeth Drive had reached its ceiling capacity. If there had been any significant decline in traffic volume numbers on that route, they recovered very quickly and so it is possible that any capacity that was freed up by traffic reassignment from Elizabeth Drive to the M4 Motorway was quickly taken up by new traffic generated in the immediate vicinity of Elizabeth Drive. In effect, this amounts to a form of 'knock-on' induced traffic growth and further reassignment from other routes as the effects cascade through the system after changes on the primary trunk routes where speeds are higher.

Several roads that cross Screenline12 do not have the radial orientation of Windsor Road, Richmond Road, Elizabeth Drive and Bringelly Road. Instead they perform an orbital function and in some cases, like Eastern Road saw an increase in road traffic volumes as they acted as feeders to the motorway. These roads have been discounted from the tally in Table 1 otherwise the analysis would include the double counting of some traffic.

If the large increase of 19,885 AADT has normal growth substracted from it — 2,753 was the highest annual growth rate — then 17,132 AADT remains. If the reassignment estimate of 7,010 from these other roads is taken into account and subtracted, then there is a residual of 10,122. This is still well above what might normally be expected on this route.

There are other possible explanations for the sharp increase. These have to be progressively ruled out and the numbers accounted for so that any residual is potentially new trips that have been generated because of the change in travel times brought about by the additional capacity. The next section outlines what these other possible explanations are.

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4. Explanations for road traffic increases in the wake of capacity additions

There are several forms of system feedback that provide potential explanations for what can be observed in this 'snapshot' view of changes to traffic volumes in western Sydney. These were outlined in some detail in the special report on induced traffic growth carried out by the Standing Advisory Committee on Trunk Route Assessment in the UK (SACTRA, 1994, pp.51–54).

Traffic reassignment refers to traffic that shifts from other routes running parallel to the new route. In this instance no additional trips are being made, but the route choice is changed because the same trip can be made in a shorter period of time. The origin and destination combinations of trips remain the same and there may even be a decrease in the distance between the two so that Vehicle Kilometers Travelled (VKT) is decreased.

Traffic redistribution refers to cases where commuters decide to undertake longer journeys in terms of distance because the increase in capacity has meant that new destinations can be reached within shorter periods of time than previously possible. No additional trips are made but new origin and destination combinations result, where the distance between the two is increased so that Vkt overall increases. Some researchers classify this as a form of induced traffic growth because of the increase in Vkt. The data in this analysis has no way of detecting this.

Mode shifting refer to traffic that shifts from one mode to another, such as from rail to the road network. Once again this occurs as a result of faster travel times on the new route and mode compared to those on the old route and mode. In cases such as the M4, this results in an increase in road vehicle Vkt but a decline in rail passenger kilometres.

Induced trips refers to cases where people undertake new and additional trips. The mechanism that explains this behavioural change is described in other papers in this series.

Other than redistributed and induced trips, the following are a summary of how the additional traffic could be accounted for with no increase in net passenger kilometres because origins and destinations remain the same:

- Reassignment from other roads running in parallel to the GWH and M4
- Mode shifting from bus services
- Mode shifting from rail services

This is where difficulties with data availability and parity, as well as boundary conditions, can be seen.

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In relation to the first possibility, reassignment, there are no data available for parallel streets or possible 'rat runs'.

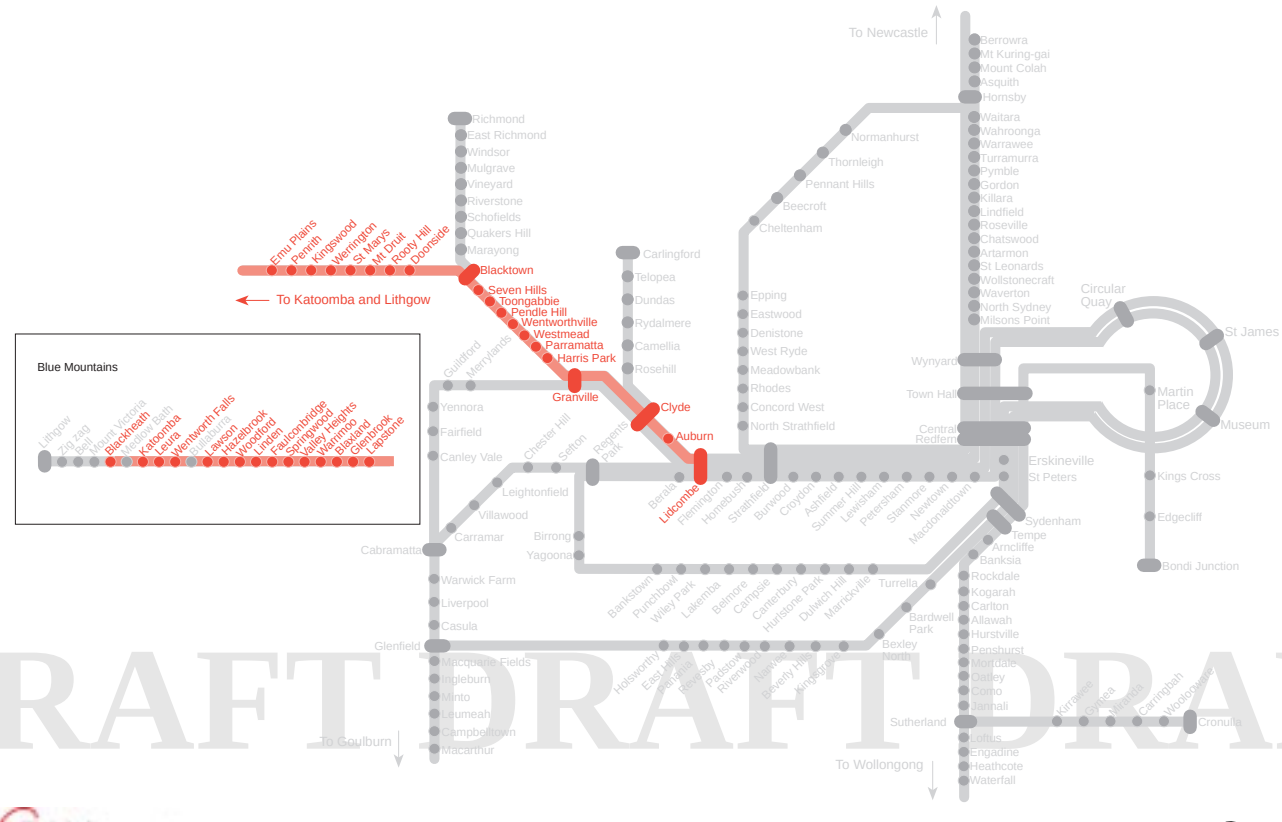
There are no data available for parallel bus services, so mode shifting from bus to private motor vehicle cannot be assessed. Data are available for rail passenger journeys, however.

Mode shifting is a possibility because the other prime trunk route on this axis is the Western Sydney Rail Line. Time series data for passenger journey estimates show a drop in estimated passenger journeys for this line which coincided with the opening of the M4 section from Mays Hill to Prospect.

5. Rail data for the Western Sydney Rail Line 1985–1995

The time series data in this set consist of passenger journey estimates. These have been calculated from records of ticket sales for stations on the WSRL. These have been assembled for the purposes of identifying large changes in rail passenger journeys, or commuter volumes, on the line. Where changes occured during the study period, explanations for significant increases or decreases in rail passenger journeys have been sought.

Figure 10 Rail stations on the Western Sydney Rail Line



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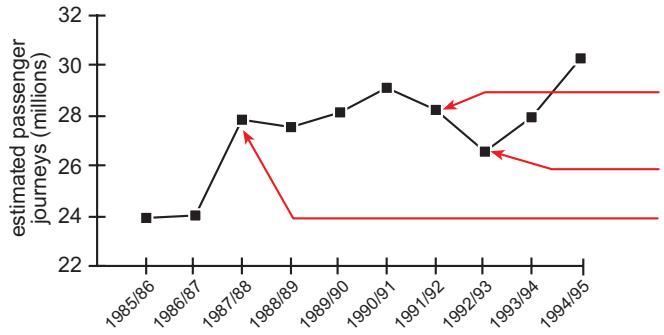
The rail stations for which data have been collated are shown in Figure 10. These stations are: Lidcombe, Auburn, Clyde, Granville, Harris Park, Parramatta, Westmead, Wentworthville, Pendle Hill, Toongabbie, Seven Hills, Blacktown, Doonside, Rooty Hill, Mount Druitt, St Mary's, Werrington, Kingswood, Penrith, Emu Plains, Lapstone, Glenbrook, Blaxland, Warrimoo, Valley Heights, Springwood, Faulconbridge, Woodford, Hazelbrook, Lawson, Wentworth Falls, Leura, Katoomba and Blackheath.

Figure 11 Estimated passenger journeys for the Western Sydney Rail Line 1985–1995

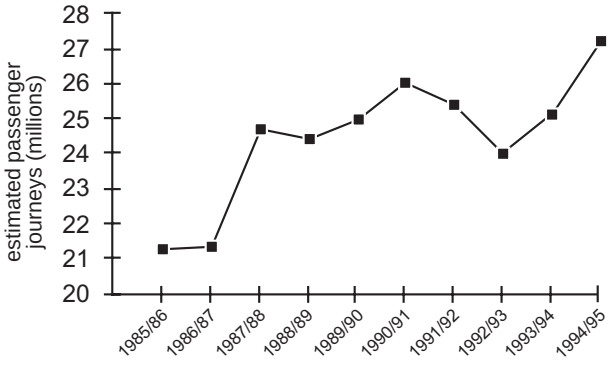


Estimated passenger journeys for stations Lidcombe to Blackheath

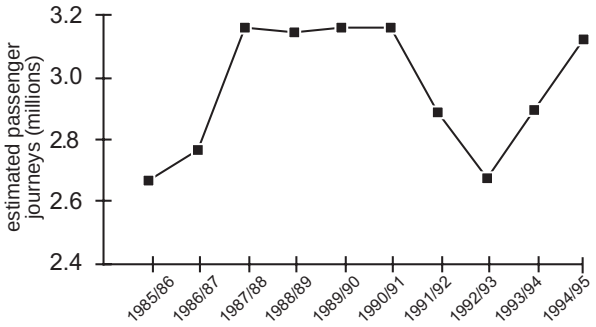
2. Opening of Mays Hill to Prospect section of the M4 Motorway (May 1992)

3. Continuing effects of the M4 opening.

1. Quadruplification of the rail line between Granville and Westmead.



Estimated passenger journeys for metropolitan stations Lidcombe to Penrith



Estimated passenger journeys for Blue Mountains stations Emu Plains to Blackheath

* Note that scales on the y axis alter between plots. Scales have been chosen to highlight more clearly fluctuations in passenger estimates.

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Table 2 Coincidental changes in rail passenger journeys, infrastructure capacities and service levels

Infrastructure Change	Changes in estimated rail passenger journeys	Changes in AADJP*
Quadruplification of rail track between Granville and Westmead 1986/87 to 1987/88	Lidcombe to Blackheath from 24,097,941 to 27,843,422	▲ 10,262
	Lidcombe to Penrith from 21,331,373 to 24,682,012	▲ 9,179
	Emu Plains to Blackheath from 2,766,568 to 3,161,410	▲ 1,081
Opening of the Mays Hill to Prospect section of the M4 Motorway 1990/91, 1991/92 to 1992/93	Lidcombe to Blackheath from 29,180,998 to 26,612,573	▼ 7,038
	Lidcombe to Penrith from 26,018,749 to 23,930,994	▼ 5,720
	Emu Plains to Blackheath from 3,162,249 to 2,681,579	▼ 1,318
Changes to service levels 1993/94 to 1994/95	Lidcombe to Blackheath from 26,612,573 to 30,311,973	▲ 10,135
	Lidcombe to Penrith from 23,930,994 to 27,187,412	▲ 8,921
	Lidcombe to Penrith from 2,681,579 to 3,124,561	▲ 1,214

* Annual Average Daily Passenger Journeys

Figure 11 shows plots of estimated passenger journeys made on the Western Sydney Rail Line between the financial years of 1985/86 and 1994/95. The raw data are tabled in Appendix V. The method used to calculate the Annual Average Daily Passenger Journeys (AADPJ) is outlined in Appendix IV.

Passenger journey estimates have also been made for stations Lidcombe to Penrith—classified as *metropolitan stations*—and Emu Plains to Blackheath stations—classified as *Blue Mountains* stations. Plots for these sections are also provided in Figure 11.

As can be seen in Figure 11, there are five financial years in which distinct jumps or changes in passenger journey numbers occurred and these coincide with changes in infrastructure capacities and service levels and consequently relative travel times. The correlation and magnitude of the jumps are summarised in Table 2.

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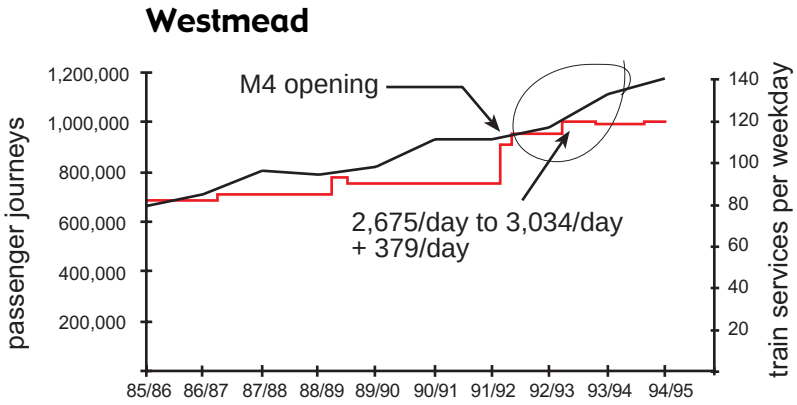
Figure 12 Changes in levels of service and estimated passenger journeys for the Westmead rail station 1985–1995



Over the study period, passenger journeys from Westmead rail station did not decline and service levels steadily increased. During financial years 91/92 to 92/93 service levels increased by 30 per cent and estimated passenger journeys climbed from 976,365 to 1,114,716 or 138,351 (14 per cent). On average, daily trips increased from 2,675 to 3,034 or an average daily increase of 379. This period coincides with the opening of the M4 from Mays Hill to Prospect.

A decline of particular interest occurs between 1990/91 and 1992/93. Passenger journeys declined at both metropolitan and Blue Mountains stations over this period. The decline coincides with the opening of the Mays Hill to Prospect section of the M4 Motorway and so was most likely caused by mode shifting from rail to road. Generally, large swings in passenger volumes only tend to occur when substantial changes are made to rail service travel times, or travel times on an alternate mode.

From the available rail passenger journey data it appears that the decline is in the order of 7,038 AADJP. As with previous data, there are issues of data parity. Whether AADT and AADJP data can be compared with each other is problematic. For example, two or more rail passengers could equate to only one car journey. Changes to the trip rate arising from different ticket types can change resulting AADJP figures.

In addition to the opening of the M4 Motorway section there were changes to rail service levels that also appear to have brought about changes in rail patronage levels. The large increase in patronage between 1986/87 and 1987/88 is greater in magnitude than the decline after opening of the motorway. This increase coincides with the quadruplification of rail track between Granville and Westmead. Some change must have occurred in either an increase in service levels, reducing waiting times, or an increase in travel speed, reducing travel times, to bring about this change in patronage levels. A

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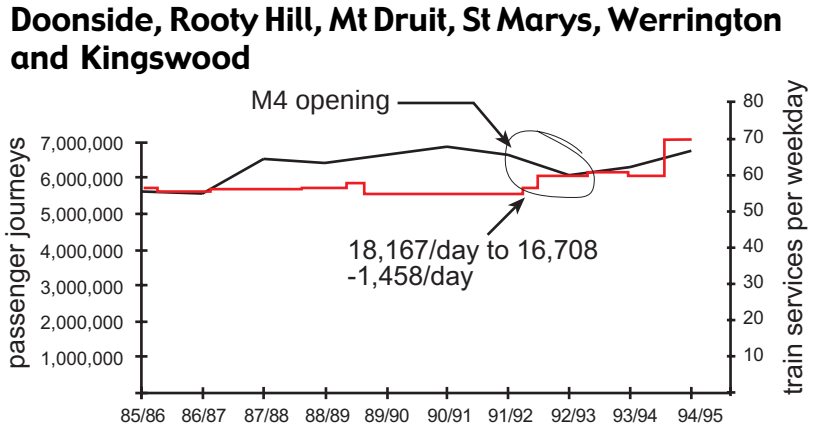
Figure 12 Changes in levels of service and estimated passenger journeys for Doonside to Kingswood rail stations 1985–1995



By contrast, passenger journey estimates for stations from Doonside to Kingswood experienced a distinct drop in patronage, with an estimated 6,630,781 for financial year 91/92 declining to 6,098,561 for 92/93, that is a drop of 532,217. On average, trips declined from 18,167 per day to 16,708 or 1,459. During 91/92, service levels increased by five per day but this did not stop the passenger losses.

change in stopping patterns for services may also have been possible with quadding, in which case, some services may have become significantly faster.

In an effort to assess these effects, timetables for the WSRL were examined over the period 1985–1995. Journey times and stopping patterns have not been examined, but data were collected for changes in service numbers.

There does appear to be some correlation between changes to the number of services and increases in patronage volumes. As can be seen in Figure 12, increases in patronage appear to be preceded by increases in the number of services. Interestingly, the number of services to Westmead increased by 30 per cent during the period that saw the opening of the M4 Motorway section, encouraging patronage growth in the following years. This is the only station that bucks the general trend seen in the aggregate patronage data shown in Figure 11.

By contrast, patronage data for Doonside, Rooty Hill, Mt Druit, St Marys, Werrington and Kingswood show a trend more in keeping with aggregate patterns. Services for these stations all have similar stopping patterns. Westmead is provided with a greater number of scheduled services. In the case of

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the WSRL stations, increases to service levels were made duing the 1991/92 period, but this was not sufficient to ward off the decline in passenger journeys.

The analysis becomes complex at this point. It may be possible that some of the decline on the six stations west of Blacktown comprised people choosing to use other rail stations as their point of access to the rail line. The much greater number of services going to Westmead could cut waiting times for passengers travelling from these local stations to the city. In this way, multiple forms of system feedback are taking place within the networks, owing to multiple changes to travel times for both rail and road travel. This aspect of the system is to a large degree submerged in aggregate passenger volume calculations, however, it highlights the wide range of variables that need to be addressed when identifying what causes volumes to fluctuate as in this case.

In the final tally, where volumes are subtracted from the residual AADT road data, a volume of 3,084 remains.

6. Conclusions

In summary, this analysis found that a large increase in road traffic volumes occurred after opening of the M4 motorway section from Mays Hill to Prospect. The increase could be attributed to:

Difference in AADT volumes between 1992 and 1993	19,885
Expected growth on M4 + GWH	- 2,753
Reassignment from Screenline12	- 7,010
Mode shifting from WSRL	- 7,038
Residual volume	**3,084**

The residual volume of 3,084 could be induced traffic growth, or longer trips encouraged in response to the quicker travel times made possible by the increase in road capacity.

On the basis of the data examined in this overview it is possible to conclude with confidence that:

- Growth in road traffic volumes on the M4 Motorway were well above typical growth rates in the year after opening of the M4 section from Mays Hill to Prospect.
- Road traffic did shift from arterial routes in the surrounding road network to the M4 Motorway. Traffic reassignment alone did not match the apparent growth rates. Where declines occurred, volumes appear to have recovered to previous levels within a short time.
- A large decline in rail passenger journeys took place at the time of the motorway opening indicating a high level of mode shifting from the rail network to the motorway.

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If this examination is viewed as a 'cursory' form of empirical analysis, then the following points could be examined in further detail to provide greater clarity:

- Time series analysis of estimated rail passenger journeys could be undertaken and checks made for synchronisation between drops in rail passenger journeys and increases in road traffic volumes. These could also be checked against general trends on the rail network to gauge the extent of changes due to other causes such as fluctautions in general levels of economic activity.
- Daily road traffic volume data could be examined, thereby revealing more information as to the period over which the ramp-up took place. This could be compared with rail data with the aim of gauging the degree of synchronisation of shifts between the two.
- Data for roads across Screenline12 are more complete for more recent time periods. The M4 Motorway was widened from four to six lanes several years after the opening of the last section. This increase in capacity should have brought about another round of system feedback responses similar to those seen over 1992. It may be possible to detect more given the greater integrity of these data.

In general, on the basis of this analysis, the presence of induced traffic growth cannot be ruled out.

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Appendix I
Notes on road data

Road data were obtained from two sources. Traffic volume counts for months directly before and after opening of the Mays Hill to Prospect section of the M4 Motorway were collected by TEC Consulting as part of a study commissioned by the NSW Roads & Traffic Authority. These were collected via pneumatic tube counters and were able to distinguish different vehicle types from one another on the basis of the number of axles. These counting stations were not on Screenline12. These data are shown on page 14.

The RTA also collects data at numerous points on the Sydney road network as part of its regular traffic monitoring program. There are two different types of counting stations used—permanent and non-permanent. Permanent stations monitor road traffic volumes over all days of the year and record vehicle numbers. Non-permanent stations only record a sample for the year from which an AADT count is extrapolated and the data are counts of axle pairs not vehicle numbers. When estimating a yearly count, seasonal fluctuations and any substantial traffic volume increases recorded at points in the surrounding network are used to generate 'synthetic' data or AADT counts. Where there is a high proportion of articulated heavy vehicles which can have six or more axles, volumes read higher than what they are in terms of actual vehicle numbers.

While data remain in these two different typologies direct comparisons cannot be made.

Conversion of data typologies to permanent station format

A method has had to be developed to convert counts of axle pairs from non-permanent sites to vehicle numbers as counted by permanent sites. There are three variables at play in the composition of heavy vehicle traffic:

1. The percentage of heavy vehicles
2. The type of heavy vehicles and the consequent number of axle pairs
3. Seasonal variations

The only road data identified for which the composition of heavy vehicles are available are the Great Western Hwy and M4 Motorway as shown in the TEC data on page 14.

As can be seen, the heavy vehicle composition of traffic prior to opening of the new motorway section had rigid heavy vehicles as 4 per cent of the traffic stream and articulated heavy vehicles 3 per cent.

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The position of the TEC and RTA counting stations are different. RTA stations are around 7 kilometres west of the TEC sites. This is significant because as traffic moves further west its composition changes

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from a high percentage of local short to medium distance trips made by light vehicles to regional long distance trips. In this way the percentage of articulated heavy vehicles begins to increase and becomes a higher percentage of the overall traffic composition. Heavy vehicles engaged in regional freight movement not only make up a greater percentage of heavy vehicle traffic but also bring increases in the number of axle pairs for those vehicles.

Ausroads has a classification scheme that divides vehicles into 12 different categories.

- Categories 1 and 2 are classified as light vehicles (including cars and motorcycles). These have 2 axles.
- Categories 3, 4 and 5 are classified as rigid heavy vehicles (including buses and rigid trucks). These have 2 to 4 axles.
- Categories 6,7,8 and 9 are classified as articulated heavy vehicles (including semi-trailers). These have 3 to 6 axles.
- Categories 10, 11 and 12 are classified as articulated vehicles with more than one trailer (including B-Doubles and road trains). These have 7 or more axles.

The difficulty posed in this case is that the exact composition of the rigid and articulated heavy vehicle traffic is not known. What is known for this particular route is that it is a key long distance freight route linking Sydney to Lithgow and beyond. This being the case, many of the vehicles classified as articulated heavy vehicles would be semi-trailers (which typically have 6 axles) and not heavy vehicles working on construction for example (which typically have 3 to 4 axles). This route is also a designated B-Double route and so vehicles with up to 10 axles occur in the traffic stream today, although prior to 1992 the number of B-Doubles on urban roads was lower.

This is significant when determining the percentage to reduce counts from non-permanent sites.

To make the conversion, variables were applied to the TEC data with the aim of changing them to a non-permanent data typology. The percentage differences were observed and then used to convert the non-permanent to permanent station data typology. Four conversion methods have been used:

1. **Lower-Eastern**
   - Rigid HVs are 4 per cent of traffic (average axle pairs equal 1.25)
   - Articulated HVs are 3 per cent of traffic (average axle pairs equal 2.5)
2. **Upper-Eastern**
   - Rigid HVs are 4 per cent of traffic (average axle pairs equal 1.5)
   - Articulated HVs are 3 per cent of traffic (average axle pairs equal 3)
3. **Lower-Western**
   - Rigid HVs are 4 per cent of traffic (average axel pairs equal 1.25)

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- Articulated HVs are 3.5 per cent of traffic (average axle pairs equal 2.5)

4. **Upper Western**
   - Rigid HVs are 4 per cent of traffic (average axle pairs equal 1.5)
   - Articulated HVs are 3.5 per cent of traffic (average axle pairs equal 3)

Based on these, four percentages were calculated when converting TEC vehicle number data to axle pair, or non-permanent counting station, data typology. Using an 'Eastern' heavy vehicle percentage component of 4 per cent rigid and 3 per cent articulated heavy vehicles, a lower estimate of 5 per cent and an upper estimate of 8 per cent was calculated. Using a 'Western' heavy vehicle percentage component of 4 per cent rigid and 3.5 per cent articulated heavy vehicles, a lower estimate of 14 per cent and an upper estimate of 18 per cent was calculated.

For the purpose of converting non-permanent station data from the M4 at site 71.002 to permanent station typology data for the period prior to 1991, an average of these 4 has been used. This is 11.25 per cent. This is likely to be conservative given the general observation that heavy vehicle traffic usually comprises around 10 per cent of the entire traffic stream (vehicle numbers) on regional trunk routes like the M4. It should also be noted that the TEC data were collected using pneumatic tube counters. Measuring heavy vehicle composition can be compromised on multi lane roads because vehicles from other lanes can affect the data by confusing the counting mechanism. If only the inside lane is counted and volumes on other lanes estimated from this, then the data may not be entirely accurate. The general tendency is for the readings to be lower than they would be in practice.

The following counts have been used to estimate AADT time series for the Great Western Highway and M4 Motorway throughout the study period. This conversion rate brings about a 'before and after'

	GWH	M4	M4-11.25%	GWH+M4
1983	36920	22680	20129	57049
1984	37757			
1985	41012	23976	21279	62291
1986	36508			
1987	36499	37864	33604	70103
1988	37952			
1989	39641	40527	35968	75609
1990				
1991	40023	44896	39845	79868
1992	35237	64516	64516	99753
1993	26007	73005	73005	99012
1994	28619			
1995	28382			
1996	29685	76460	76460	106145

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* Data in red are raw axle pair counts from non-permanent counting station before upgrade to permanent.

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difference of close to 20,000 vehicles per day which is in alignment with the difference of 22,454 measured at the TEC sites.

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Appendix II
Notes on remaining roads in Screenline12

There are 11 roads in Sydney's west that have points on Screenline12. The following notes outline how AADT figures for each point have been accounted for. As will be discussed, there are problems with data on a range of fronts. Where there are gaps, a quick method has been used to produce estimates. It should be stressed at the outset that there are other, more elaborate ways in which estimates could have been made with a higher degree of reliability, but these would be time consuming. In all cases a conservative approach has been taken, using estimates that produce higher reassignment rates rather than lower.

1. Windsor Road (88.046)

Data for this non-permanent counting station were available for several years over the study period. The percentage of heavy vehicles in the traffic stream for this arterial road is not known. The route does play a regional role, connecting the north-western metropolitan districts of Sydney to rural hinterlands beyond the Hawkesbury River. Given these circumstances, a reasonable proportion of the heavy vehicle traffic is likely to be long distance freight traffic and there is the possibility that long distance commuter and freight traffic travelling from the Blue Mountains to the inner districts of the Sydney metropolitan region could have been reassigned from this route to the Great Western Highway and M4 Motorway.

The relative geometry of the Windsor Road alignment to the M4 and the relative consistency of growth figures prior to 1992, suggests that it is unlikely that significant volumes of short and medium distance trip traffic shifted from this route to the Motorway as was the case with the Great Western Highway. This road acts as a trunk route for traffic moving between the far north-west sector and the inner suburbs of metropolitan Sydney.

	Windsor Road				
	88.046	-5%	growth	-8%	growth
1985	24424	23203		22470	
1986					
1987	25769	28481	1278	23707	1237
1988					
1989	29808	29257	3837	27423	3716
1990					
1991	30797	29257	940	28333	910
1992					
1993	31232	29670	413	28733	400
1994					
1995					
1996	32726	31090	1419	30108	1374

* Data in red are raw axle pair counts from non-permanent counting station.

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The lower conversion rates of 5 and 8 per cent are shown in the table below. The lower, or more conservative value of 5 per cent has been used. As data are only available for every two years and not between the years of 1992 and 1993, the biannual differences have been halved to estimate annual differences.

A simple method has been developed to estimate the traffic volume growth that may have occurred if the M4 Motorway section from Mays Hill to Prospect had not been opened to traffic. The highest growth rate in the years prior to opening estimates an annual increase of 1,918. This being the case, the volume for 1992 should have been 31,175. An annual increase of 1,918 on top of this gives a value of 33,093 which is 3,423 higher than the recorded value of 29,670 AADT.

2. Garfield Road (71.150)

Data for this non-permanent site were only available from 1993, after the Mays Hill to Prospect section of the Motorway was opened. Garfield road is a link road that plays an orbital function between Windsor and Richmond Roads. Any traffic using it, or diverting from it, to access the M4 Motorway would pass over the counting stations at either Windsor or Richmond Road and so fluctuations in traffic volumes at this site have been discounted from the analysis so as to avoid double counting.

3. Grange Avenue (71.149)

Data for this non-permanent site were only recorded for 1993 where an AADT of 3,568 axle pairs were estimated. As with Garfield Road, fluctuations in traffic volumes on Grange Avenue caused by trip reassignment to the M4 Motorway would be picked up at the Richmond Road counting station. In this sense, including changes in traffic fluctuations at either Garfield Road or Grange Avenue opens up the possibility of double counting. Consequently volumes at this site have also been discounted from the analysis.

3. Richmond Road (71.059)

Data parity problems are compounded at this site because up until 1991 it was a non-permanent site that was updated to a permanent site in 1993. Consequently traffic volumes before 1993 listed in red are counts of axle pairs and not vehicles, while later counts are vehicle numbers.

In addition, Richmond Road was widened to a four lane divided carriageway at Glendenning between Owen Street and Hill Road. This increase in capacity was opened to traffic in December 1989 causing traffic volumes to jump steeply for 1989 and 1991 by comparison with previous years. Just as traffic reassignment took place on the M4 in the wake of the capacity increase, it also took place on Richmond Road during this period for the same reasons.

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With these qualifications in mind, if a low heavy vehicle volume is assumed and data adjusted by 5

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per cent, and the biannual rate of growth between 1985 and 1987 is used as indicative of what may have taken place, then volumes for 1992 and 1993 should have been 36,058 and 36,681 respectively. Reassignment would therefore have been in the order of 2,487 vehicles.

	Richmond Road				
	71.059	-5%	growth	-8%	growth
1985	20323	19307		18697	
1986					
1987	21635	20553	1246	19904	1207
1988					
1989	27896	26501	5948	25664	5760
1990					
1991	37301	35435	8935	34317	8653
1992					
1993	34194	34194	-1242	34194	-123
1994					
1995					
1996	34304	34304		34304	

* Data in red are raw axle pair counts from non-permanent counting station.

3. Power Street (71.172)

Data are only available for 1996 and 1999 at this location with AADTs of 12,202 and 13,942 respectively. Power Street is not a regional arterial with a radial geometry like Windsor and Richmond Roads. Like Garfield Road and Grange Avenue, Power Street is a short arterial that functions as an orbital connection between the others. Given its geometry and position within the network, changes on this road are likely to be negligible. Consequently volumes at this site have also been discounted from the analysis.

4. Eastern Road (70.067)

As with other sites, this counting station was upgraded from a non-permanent to a permanent site during the study period. However, the upgrade was installed after 1993 so there is a continuity of data typology over the period that saw the opening of the new section of motorway. As can be seen, the largest increase occurs between 1991 and 1993. Given the location of this site relative to the motorway, the increase in traffic can be explained as additional traffic accessing the motorway.

If the counts from this site were included in an aggregate calculation of fluctuations across Screenline12, double counting would occur. Much of the increase at this site is traffic that would have been using Windsor and Richmond Roads but which has diverted to the M4. It is also interesting to note that AADTs recorded by a permanent counting station after 1994 sit consistently in the high 16,000s. This suggests that the higher adjustment figure of 8 per cent is more likely to reflect traffic composition.

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	Eastern Road				
	70.067	-5%	growth	-8%	growth
1985	10949	10402		10073	
1986					
1987	13378	12709	2308	12308	2235
1988					
1989	14737	14000	1291	13558	1250
1990					
1991	14366	13648	-352	13217	-341
1992					
1993	18375	17456	3809	16905	3688
1994	16924	16924	-532	16924	19
1995	16784	16784	-140	16784	-140
1996	16935	16935	151	16935	151

* Data in red are raw axle pair counts from non-permanent counting station.

If this road were included it would off-set the decline on Richmond Road so that traffic reassignment would be lost in the assessment. It is for this reason that data from this site has been discounted from reassignment calculations.

5. The Horsley Drive (65.140)

Data for this site are only available from 1993 onwards. Counts for 1993 stand at 17,627, increasing to 18,833 in 1996. Other points along The Horsley Drive at 65.097 in the vicinity of the Screenline12 counting station do not show any significant drops between the years of 1991 and 1993. In fact they show an increase.

Other points further to the east of The Horsley Drive do show drops between these years, however it is more feasible to explain these as resulting from reassignment after the opening of the M5 Motorway from Fairford to Beverly Hills in October 1992. The relative geometry of The Horsley Drive at those points relative to the M5 makes reassignment to that motorway more likely. This being the case volumes at this site have been discounted from the analysis.

8. Elizabeth Drive (64.002)

The counting station for this site changed from a non-permanent to a permanent between 1991 and 1994. Data were not collected for 1993. It is unclear as to whether or not this site experienced a decline in traffic volumes after opening of the last section of the M4.

Unlike The Horsley Drive, this trunk road acts as a radial with an alignment that runs consistently from the outer perimeter of the metropolitan area to the center. The Horsley Drive discontinues at Horsley Park.

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	Elizabeth Drive				
	64.022	-5%	growth	-8%	growth
1985	20872	19828		18785	
1986					
1987	19200	18240	-1588	17280	-1505
1988					
1989	20970	19922	1682	18873	1593
1990					
1991	21890	20796	874	19701	828
1992					
1993					
1994	22201	22201		22201	
1995	22005	22005	-196	22005	-196

* Data in red are raw axle pair counts from non-permanent counting station.

Traffic volumes between 1985 and 1991 appear to be reasonably stable, indicating that either this section of Elizabeth Drive had come close to its ceiling capacity or else a pinch point somewhere in the network was restricting continued growth. The volumes for 1994 and 1995 both sit on 22,000 AADT, once again suggesting that the ceiling capacity has been reached.

In the absence of data for 1992 and 1993, it is reasonable to assume that in each of those years an AADT figure in the vicinity of 22,000 would have been achieved. So it is possible and probable that a decline would have occurred in 1992, but volumes in 1993 would have recovered quickly to levels close to the ceiling capacity displayed in the 1994 and 1995 figures. Given the quick apparent recovery rate, it is possible that any capacity that was freed up by traffic reassignment from Elizabeth Drive to the M4 Motorway was quickly taken up by new traffic generated in the immediate vicinity of Elizabeth Drive in response to the quicker travel times possible on that route. In effect this amounts to a form of 'knock-on' induced traffic growth and further reassignment from other routes as the effects cascade down through the system after changes on a primary trunk route.

With these considerations in mind and an absence of data for the crucial years of 1992 and 1993, any attempt to estimate a volume for this route would be highly speculative.

9. Bringelly Road (64.097)

Data have been collected at this non-permanent site throughout the study period. Once again there is the difficulty of having to consider data parity between different counting station types. The heavy vehicle make-up of traffic using this road is not known. There is very little difference in the AADT for 1991 — which was 12,412 — and 1993 — which was 12,348. It is important to keep in mind that this is the southern most road in Sreenline12 and may also have been affected by the opening of the M5

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Motorway from Fairford to Beverly Hills in October 1992.

The lower conversion rates of 5 and 8 per cent are shown in the table. The lower, or more conservative value of 5 per cent has been used. As data are only available for every two years and not between the years of 1992 and 1993, the biannual differences have been halved to estimate annual differences.

As with previous estimations the highest growth rate in the years prior to opening provides an annual increase of 1,191. This being the case, the volume for 1992 should have been 12,982 rather than 11,791. If growth continued to increase at this rate then the AADT for 1993 should have been 14,173 that is 2,442 higher than the recorded rate of 11,731.

	Bringelly Road				
	64.097	**-5%**	**growth**	**-8%**	**growth**
1985	7211	6850		6634	
1986					
1987	8946	8499	1648	8230	1596
1988					
1989	9906	9411	912	9114	883
1990					
1991	12412	11791	2381	11419	2306
1992					
1993	12348	11731	-61	11360	-59
1994					
1995					

* Data in red are raw axle pair counts from non-permanent counting station.

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Appendix III
Notes on the rail data

Data in this set has been obtained from City Rail and consists of the number of tickets sold at each nominated rail station. The data are primarily used for accounting purposes and have been adapted for analysing changes in passenger journey numbers over time.

The City Rail ticket issues data, records ticket sales for 13 accounting periods in each financial year. Data here have been grouped in yearly time periods corresponding to financial years.

The City Rail data also records ticket sales in accordance with their type and price. For example 'return tickets' are sold at concession, full fare and off-peak rates. While the cost of each of these tickets is different, the number of passenger journeys that can be reasonably estimated from each is the same. In the case of a return ticket the number of estimated passenger journeys is 2 irrespective of price.

For the purposes of this data all tickets of the same trip type have been collated as one figure, so that concession rate return tickets and full rate return tickets have both been recorded in the same category. There are five different categories of tickets, each representative of a given number of trips. These are as follows:

- singles .....1 trip
- returns .....2 trips
- weeklys .....10 trips
- monthlys .....37 trips
- quarterlys .....115 trips
- yearlys .....600 trips

Estimates of passenger journeys have been made by simply summing the number of respective ticket types and multiplying them by their trip weighting. Trip weightings used in this collation differ in some cases to those used by City Rail. Singles and returns are the same, however a weekly has a weighting of 10 trips in this collation rather than 11, and a monthly 37 trips rather than 48. Quarterly tickets and yearly tickets vary in the weightings assigned to them by City Rail. It can be expected for example, that a yearly ticket would be used for more than 1000 trips per year if the ticket holder uses rail for trips other than their journey to work. Where a ticket holder is only travelling by rail for their journeys to work they may be expected to make as few as 220 return trips per year after weekends, holiday and sick leave have been accounted for. An estimated 600 trips per year on a yearly ticket is a conservative estimate, but not unrealistic. The same caution has been applied when determining

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weightings for quarterlys and monthlys.

In assigning these weightings a range of values was examined to see whether they would substantially change trends in the time series. This was done without altering trip weightings for singles, returns and weeklys which constitute over 95 per cent of tickets sold. It was found that the degree of variation was minimal and certainly not enough to alter trends. Where weightings were higher differences between years were more discernible as peaks and troughs became more emphasised in the passenger journey estimates.

Area disaggregations

Passenger journey estimates have been calculated in three sets of station groupings. These are as follows:

1. All stations (Lidcombe to Blackheath)
2. Metropolitan stations (Lidcombe to Penrith), east of the Nepean River
3. Blue Mountains stations (Emu Plains to Blackheath), west of the Nepean River

These distinctions have been made for reasons to do with surrounding levels of urbanisation and service levels and also different road developments which affect one area but not the other. The total number of passengers entering at metropolitan stations is also greater than at Blue Mountains stations. This difference is consequently lost in the total aggregate figures.

Ticketing anomalies

For financial years 1985/86 to 1987/88, City Rail did not sell monthly tickets and so a count of 0 ticket sales for the monthly category appears.

Flexipass tickets were introduced during the 1992/93 financial year. This is a ticket which allows the buyer to nominate the number of days they would like to have on the ticket. Flexipass ticket sales are placed in either one of four categories by City Rail—1st, 2nd, 3rd or 4th quarter. Each of these Flexipass tickets has been incorporated into the counts for one of the categories listed above. These are as follows:

- Flexipass 1st quarter .....monthly
- Flexipass 2nd quarter .....quarterly
- Flexipass 3rd quarter ..... 2 x quarterlys
- Flexipass 4th quarter .....yearly

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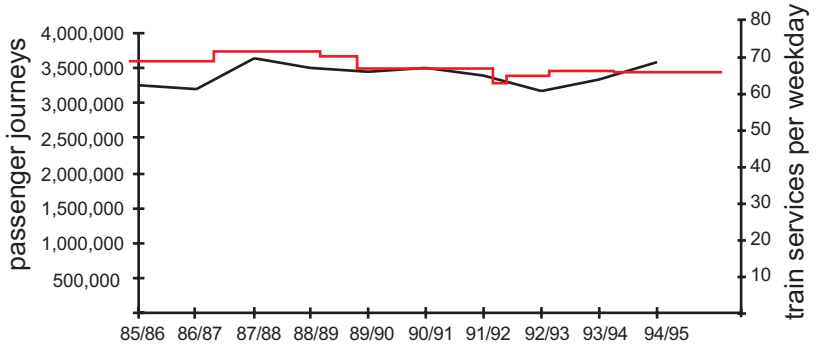
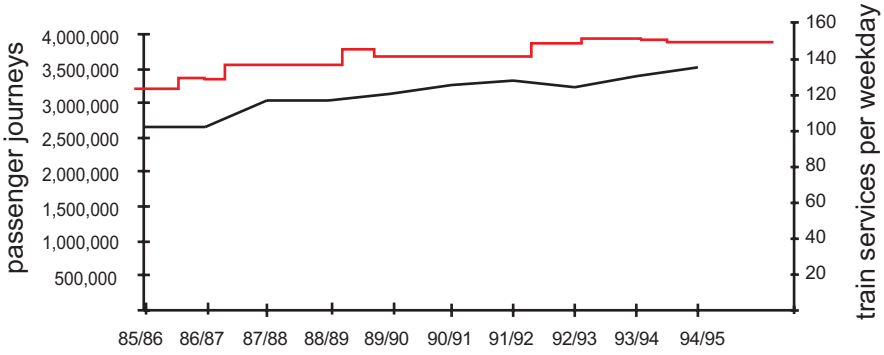
Appendix IV
Notes on changes in levels of service and estimated passenger journeys for stations on the Western Sydney Rail Line 1985-1995

Wentworthville , Pendle Hill, Toongabbie and Seven Hills



Estimated passnger journeys for Wentworthville, Pendle Hill, Toongabbie and Seven Hills fell between financial year 1990/91 and 1992/93 from3,499,588 to 3,174,740. This represents a drop of 892 trips on average per day for the period across the four stations.

Blacktown



Estimated passenger journeys for Blacktown station fell between the financial years of 1991/92 and 1992/93 from 3,318,080 to 3,218,138 or -99,942. The decline represents a drop from 9,115 trips to 8,841 trips on average per day. Services from Blacktown station increased from around 140 to 150 per day during the period over which the M4 section was opened to traffic.

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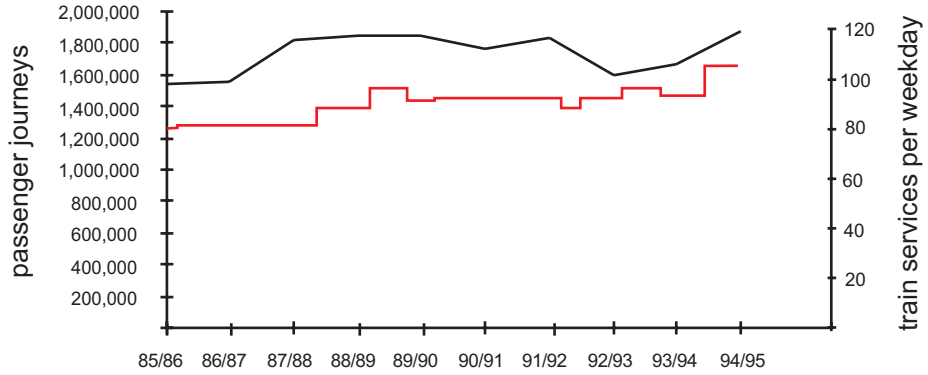
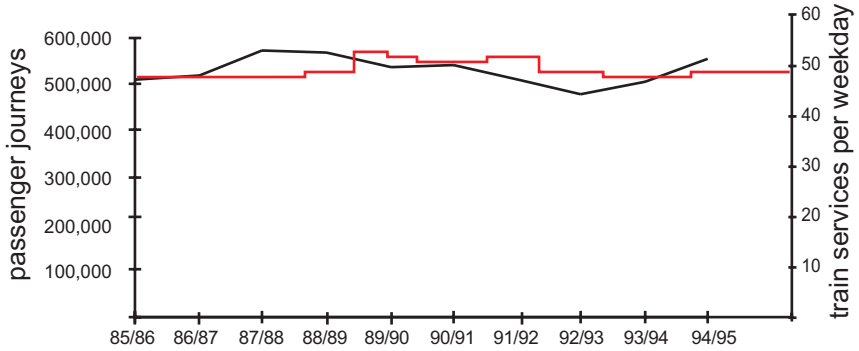
Penrith



Estimated passenger journeys from Penrith also fell between financial year 1991/92 to 1992/93 from 1,823,226 to 1,589,388. The decline of -233,838 represents a loss of 642 passenger journeys per day. While volumes did recover in the following years and service levels rose, it is interesting to note that although service levels were increased in the late 80s, passenger journey numbers remained relatively flat.

Emu Plains



Estimated passenger journeys from Emu Plains fell from 538,957 in financial year 1990/91 to 509,713 in 1992/93. The decline of 62,812 over the two year period represents a drop from 1,481 trips on average per day to 1,308, or -173. Service numbers had declined in the period immediately before opening of the motorway. This decline continued in the two years after opening. There was no substantial increase in service levels during the recovery in numbers during 1995/94 and 1994/95.

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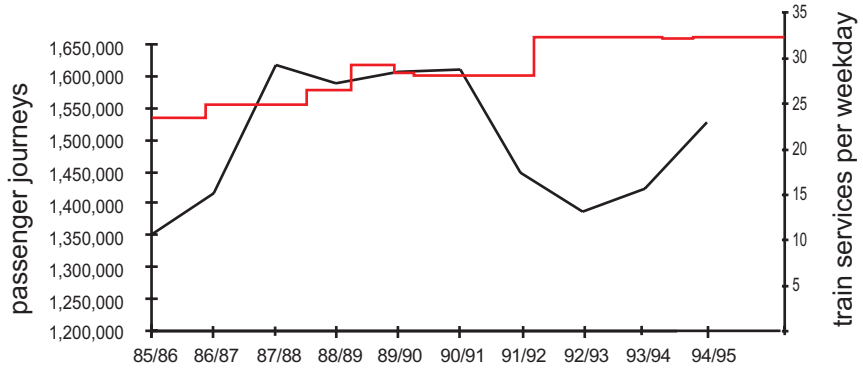
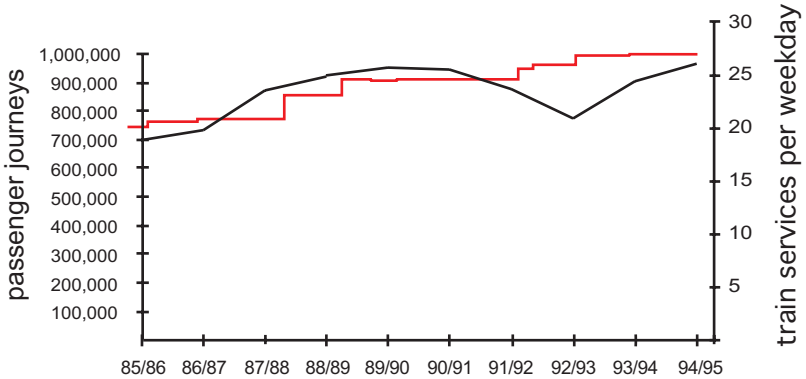
Lapstone, Glenbrook, Blaxland, Warrimoo, Valley Heights and Springwood



Estimates of passenger journeys from all stations between Lapstone and Springwood fell from 1,610,362 in financial year 1990/91 to 1,385,383 in financial year 1992/93, or -224,979. On average trips declined from 4,412 per day to 3,796 or -616. As can be seen there was an increase in service numbers from 28 per day to 33 after the first big fall in passenger journeys. This occurred around the end of 1992, about 6 months after opening of the motorway and may have helped in the recovery of

Faulconbrodge, Woodford, Hazelbrook, Lawson, Wentworth Falls, Leura and Katoomba



Estimated passenger journeys from all stations between Faulconbridge to Katoomba declined from 945,218 in financial year 1990/91 to 775,599 in 1992/93. The decline of -169,619 over the two year period represented a drop from 2,590 trips on average per day to 2,125, or -465. Service numbers were increased slightly by a small number in the period which may have assisted in the recovery of numbers after 1992/93.

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Appendix V
Raw numbers of ticket sales by station and ticket type 1985–1995

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	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95
Lidcombe										
singles	359933	354538	416026	397672	375646	286748	303913	283852	314677	344477
returns	234369	248938	276553	258207	267601	362459	331185	332145	362895	415036
weeklys	58337	57525	63659	66439	79167	79124	68586	62592	62465	64279
monthlys	0	0	0	62	179	396	494	395	1183	376
quarterlys	87	85	84	75	47	59	66	48	20	42
yearlys	11	7	8	11	17	18	16	16	14	17
Auburn										
singles	357871	328084	384643	355325	316912	277699	292786	266429	298929	353987
returns	273887	278752	302185	273936	287626	371863	372722	366859	420307	516916
weeklys	51142	56054	68816	75509	85698	86843	75476	67118	62635	63365
monthlys	0	0	0	90	247	394	488	436	431	370
quarterlys	105	80	60	52	45	38	51	28	15	34
yearlys	11	16	14	13	13	13	14	15	16	11
Clyde										
singles	58956	56201	60435	53277	47546	46774	36949	35738	39680	40362
returns	24998	25239	27113	23476	23428	26702	28661	27212	27963	25790
weeklys	6242	5895	6847	5970	6339	5905	4964	4601	3977	3555
monthlys	0	0	0	0	9	33	52	31	40	20
quarterlys	6	4	3	4	6	5	6	1	0	0
yearlys	3	3	2	2	2	2	4	1	0	0
Granville										
singles	344838	330771	378024	363858	361140	330275	306453	298430	318177	349180
returns	263964	258460	288466	273231	280632	301909	339769	338371	363178	419567
weeklys	47275	50586	56676	59898	63396	68200	60318	54683	51955	55107
monthlys	0	0	0	36	165	254	405	360	473	396
quarterlys	68	72	76	59	55	50	31	24	3	12
yearlys	7	6	6	7	7	8	8	9	7	5
Harris Park										
singles	53562	57390	63274	59874	51656	45935	41619	38152	43288	50303
returns	38106	41984	50159	46553	46431	55566	57505	54328	62320	70958
weeklys	12072	14325	15973	18233	19378	19273	17473	12939	12549	10831
monthlys	0	0	0	36	82	82	83	77	105	122
quarterlys	15	12	13	14	9	15	11	15	0	0
yearlys	2	0	3	4	5	1	3	6	7	3
Parramatta										
singles	738283	723617	894787	881529	852533	730907	816131	789944	929039	1113020
returns	505875	482215	569439	572456	539441	714936	681644	669007	726132	827343
weeklys	108225	112539	141008	141103	149338	147337	136736	137918	130161	136259
monthlys	0	0	0	202	752	1292	1761	1421	1273	976
quarterlys	414	343	326	228	246	191	153	128	36	67
yearlys	45	37	53	60	65	74	64	50	62	66

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	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95
Westmead										
singles	173767	171004	197472	194272	193859	179454	165118	178141	224462	199437
returns	106988	114226	135801	123666	130743	166906	196430	194009	239217	261203
weeklys	25647	29676	32619	33141	34631	39261	35490	38562	39364	43173
monthlys	0	0	0	44	153	268	287	348	305	315
quarterlys	107	99	70	52	53	63	33	34	13	10
yearlys	7	10	9	17	16	19	14	13	9	13
Wentworthville										
singles	103873	100997	114718	116080	106366	101400	100811	99925	113046	101923
returns	109654	108483	122918	115085	122220	132439	130971	123698	143480	156386
weeklys	36366	35545	38168	37083	36635	39157	33438	26292	23069	22867
monthlys	0	0	0	11	110	197	227	192	157	255
quarterlys	90	79	79	56	47	58	68	36	7	18
yearlys	11	7	15	11	23	18	10	10	4	5
Pendle Hill										
singles	89705	92011	109857	110346	107623	101939	95682	83458	98137	93177
returns	92088	88328	106248	101679	109028	106334	117643	115670	137519	155181
weeklys	26765	28715	32993	31695	33255	31500	29355	26415	24139	23426
monthlys	0	0	0	28	59	78	112	102	115	158
quarterlys	129	108	62	35	30	30	28	22	12	11
yearlys	22	23	18	14	18	15	6	6	2	7
Toongabbie										
singles	90283	88035	91823	97777	85711	83365	76047	65883	83653	78589
returns	98524	99062	109044	106180	102008	110673	116050	108925	123048	146980
weeklys	27511	26622	29590	28018	27052	25621	22960	18970	16623	15978
monthlys	0	0	0	35	113	117	194	148	122	103
quarterlys	91	78	66	38	32	21	11	14	2	2
yearlys	14	16	14	19	14	12	8	7	3	2
Seven Hills										
singles	187100	192501	204484	218750	178614	185982	184411	185381	215261	220569
returns	197302	180575	225187	213330	192759	228385	249478	262558	311381	356733
weeklys	77172	77599	88131	83914	82205	80179	74411	72774	70941	77377
monthlys	0	0	0	57	240	473	516	401	616	568
quarterlys	191	145	156	129	109	102	77	54	16	25
yearlys	30	31	38	44	60	39	25	24	14	12
Blacktown										
singles	416837	413617	491358	511690	508254	492061	507842	471445	549882	585375
returns	413334	407581	471118	482606	499271	565963	615914	631521	735907	782974
weeklys	135232	138469	154556	151395	156410	158158	150370	142167	131538	132426
monthlys	0	0	0	84	303	637	825	813	823	786
quarterlys	278	258	201	171	159	138	139	100	24	44
yearlys	48	39	43	55	54	58	47	34	37	27

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	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95
Doonside										
singles	68550	62493	76268	70798	67599	66204	65659	64792	82648	81419
returns	67508	66951	77426	70815	72315	90539	92901	96265	120442	131012
weeklys	20077	20464	22870	22718	23571	23122	20302	17845	16059	18954
monthlys	0	0	0	1	42	45	85	64	62	67
quarterlys	38	27	20	19	12	10	16	10	0	0
yearlys	5	5	6	7	4	5	5	8	2	1
Rooty Hill										
singles	56279	58226	68613	68709	69930	70833	69544	68395	91446	98748
returns	62212	64469	74912	71164	80031	94005	99424	105309	130846	144075
weeklys	19025	19580	22434	22285	21930	23575	25197	23523	21650	24978
monthlys	0	0	0	11	21	35	65	103	179	185
quarterlys	20	12	10	13	17	10	12	10	1	2
yearlys	4	7	10	4	10	6	8	2	2	2
Mount Druitt										
singles	246503	247249	290617	302721	298653	297249	295226	278098	330222	325091
returns	315712	313403	368823	346738	374143	420166	438776	446306	523820	595184
weeklys	103037	100975	127546	135455	141595	142526	130815	112684	99736	108020
monthlys	0	0	0	71	436	687	912	871	879	915
quarterlys	88	72	64	70	55	67	68	70	11	10
yearlys	26	21	28	38	44	44	33	30	17	24
St Mary's										
singles	205901	194909	224362	219868	217922	217963	198748	187196	213432	222481
returns	238295	238338	262401	245571	256476	277165	289757	286941	328560	351569
weeklys	107334	107597	125683	126059	127137	126824	112192	93705	84086	83272
monthlys	0	0	0	119	379	587	757	689	657	743
quarterlys	145	101	99	74	51	67	59	48	6	13
yearlys	39	22	31	36	39	32	33	12	9	9
Werrington										
singles	35952	38989	47315	45916	43761	39749	41238	45732	58925	58215
returns	37979	38758	48659	42657	46528	51238	56705	51225	57919	65472
weeklys	21718	23329	25432	25329	28638	27217	24415	21266	19069	19072
monthlys	0	0	0	11	67	149	186	150	138	147
quarterlys	7	2	8	8	7	7	13	16	6	0
yearlys	5	6	3	5	13	10	7	5	6	3
Kingswood										
singles	92127	95605	113975	119454	124202	113190	120727	133045	139393	143894
returns	80051	83390	94005	80231	82088	100715	104501	99697	107797	130645
weeklys	48300	48463	52981	48771	43653	43370	38593	32557	31240	31836
monthlys	0	0	0	5	54	88	103	83	141	143
quarterlys	64	57	31	39	18	27	37	26	4	6
yearlys	12	17	19	16	16	21	12	11	4	5

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	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95
Penrith										
singles	202342	198338	228748	236775	237984	220222	249307	226193	279376	295536
returns	214436	218792	252952	266966	266632	272056	317887	293540	329353	378540
weeklys	86459	88166	103434	102729	100285	93824	88295	73188	69022	75325
monthlys	0	0	0	98	494	569	590	515	583	1133
quarterlys	206	184	141	107	66	69	71	52	15	25
yearlys	37	28	53	57	61	49	42	32	20	26
Emu Plains										
singles	34124	36951	42001	41929	40518	37821	33801	38097	50819	50747
returns	47009	46446	53461	53783	50478	51039	48550	51373	65355	76940
weeklys	34530	35633	39163	38752	35520	36026	33449	29391	29299	33046
monthlys	0	0	0	28	257	249	341	276	267	244
quarterlys	152	121	97	58	59	59	67	52	15	6
yearlys	32	28	33	34	35	38	40	42	27	15
Lapstone										
singles	3759	4006	4047	4024	4136	4254	3526	3772	6134	7488
returns	6079	6603	7905	7393	6192	7541	6035	6181	9099	10973
weeklys	4153	4726	5368	5190	4355	4664	4184	3620	3606	3822
monthlys	0	0	0	5	28	26	38	34	46	37
quarterlys	37	36	43	33	47	37	24	23	1	0
yearlys	5	4	4	0	2	3	3	3	1	4
Glenbrook										
singles	20303	18228	19475	20149	21694	20818	18290	18960	27873	29398
returns	29954	27761	31896	31886	35552	32742	29680	31591	38074	41111
weeklys	13092	13541	15125	15155	15503	14505	14136	12260	12254	13288
monthlys	0	0	0	37	100	200	222	195	181	144
quarterlys	113	111	110	75	81	65	75	57	6	4
yearlys	11	7	15	12	9	11	11	4	5	6
Blaxland										
singles	24470	26541	28615	30099	30527	32075	24561	28333	40814	41571
returns	35020	36127	44702	43660	42280	48028	40656	43419	58492	70313
weeklys	19622	21218	24868	25424	25862	25183	20900	19064	19323	20681
monthlys	0	0	0	79	257	273	366	286	323	305
quarterlys	173	161	127	73	75	83	73	82	8	16
yearlys	33	31	31	25	35	29	29	26	14	18
Warrimoo										
singles	5760	5809	6655	6290	6870	6031	3530	4428	10513	11127
returns	8515	8625	9993	10037	10641	10924	8111	8520	14929	16316
weeklys	5316	5608	5931	6276	6812	6611	5417	4476	3933	4084
monthlys	0	0	0	22	43	44	29	23	35	18
quarterlys	27	28	31	30	18	11	9	11	0	1
yearlys	6	5	6	4	5	6	4	2	2	1

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	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95
Valley Heights										
singles	3113	3553	4107	3947	4097	6330	3150	3440	8211	7654
returns	4419	4228	5127	5124	4898	8591	4005	4392	8474	9398
weeklys	4174	4312	4342	5104	5180	5522	3892	3554	3250	2897
monthlys	0	0	0	5	49	72	68	31	32	14
quarterlys	10	11	8	7	10	7	15	14	0	0
yearlys	1	1	4	3	1	4	1	1	1	0
Springwood										
singles	44938	46796	51316	53763	58169	55104	56158	63128	65434	67833
returns	71608	73871	86470	81913	84182	89761	96550	107106	114100	125559
weeklys	34892	39243	45691	43136	40864	38673	34395	31153	26932	28797
monthlys	0	0	0	90	446	658	770	688	587	565
quarterlys	217	166	128	120	105	90	88	68	26	43
yearlys	41	37	54	57	41	44	39	37	35	22
Faulconbridge										
singles	4060	4097	4901	6071	5631	4627	4119	3352	8248	10338
returns	9758	8998	11085	11273	10980	9445	10165	8693	12863	16805
weeklys	5146	5076	5699	6053	5308	4873	4391	3230	3748	3668
monthlys	0	0	0	40	82	61	57	33	35	25
quarterlys	30	21	12	12	11	20	13	4	1	1
yearlys	2	7	4	6	8	4	5	4	2	1
Woodford										
singles	2991	3000	2690	3525	3902	3931	4055	3985	6855	8510
returns	5119	5729	7088	6576	6294	6245	6353	5216	8280	11285
weeklys	2436	2582	3115	3411	3285	3363	2402	2463	2418	2603
monthlys	0	0	0	1	32	48	61	48	31	5
quarterlys	19	4	3	9	10	8	14	13	0	0
yearlys	4	4	3	3	3	5	3	3	1	1
Hazelbrook										
singles	8041	9087	8390	10333	9813	9693	9611	9733	18432	21156
returns	15488	15618	17128	16536	17222	17877	17713	17180	28401	33161
weeklys	8866	8444	9335	8943	8718	8388	7696	6132	6097	4923
monthlys	0	0	0	7	88	126	137	127	99	73
quarterlys	43	31	14	12	14	16	13	9	7	5
yearlys	15	12	11	6	3	6	6	9	7	4
Lawson										
singles	13266	12239	13564	14571	14280	13281	11745	11773	15409	18666
returns	20338	21355	26271	22311	23772	22631	21270	22499	26966	32419
weeklys	5030	5692	7172	6896	6944	6236	5120	4355	4075	3929
monthlys	0	0	0	30	158	125	124	97	103	99
quarterlys	27	20	17	26	15	17	6	4	1	0
yearlys	1	5	3	5	4	4	7	8	3	2

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	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95
Wentworth Falls										
singles	10638	11013	11435	13846	13888	14397	13564	11960	21397	23182
returns	15879	16177	20722	21862	23977	24411	24399	24295	34321	36772
weeklys	4968	5348	5957	6343	5991	6173	5636	4452	4057	3739
monthlys	0	0	0	9	89	90	55	76	67	60
quarterlys	27	17	7	10	13	1	5	1	2	0
yearlys	5	6	9	4	5	4	4	2	1	1
Leura										
singles	10057	9585	10999	10191	8287	8919	8063	6984	19352	23048
returns	15735	15138	18458	18359	17554	18222	16070	13315	23323	25561
weeklys	3006	2881	2580	3362	3317	3411	2595	1868	1715	2111
monthlys	0	0	0	14	33	39	39	44	24	16
quarterlys	9	2	6	3	3	4	2	4	0	0
yearlys	4	1	2	0	2	2	5	3	1	0
Katoomba										
singles	44618	44295	55193	57074	69511	71260	67794	67007	82213	86728
returns	50020	51340	61084	60450	64991	67426	66322	64113	72260	79440
weeklys	5780	7670	10037	10987	10827	10297	9418	7352	6259	6291
monthlys	0	0	0	27	194	254	261	199	184	160
quarterlys	20	16	22	21	27	27	21	10	1	6
yearlys	3	4	4	4	6	10	8	10	10	11
Blackheath										
singles	10503	9750	11397	13593	12404	11141	10923	8915	18780	21798
returns	13495	14388	17990	18076	17017	16526	15902	13029	21777	24761
weeklys	1759	1819	2024	2102	2153	2026	1604	786	697	715
monthlys	0	0	0	7	45	37	28	22	34	22
quarterlys	4	7	8	18	8	6	6	7	0	0
yearlys	1	2	2	1	1	2	1	0	0	1

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	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95
TOTALS (Lidcombe to Blackheath)										
singles	4123303	4049525	4731584	4714096	4549638	4187631	4241101	4084096	4824157	5185027
returns	3723718	3710348	4282789	4123786	4195431	4881428	5049704	5024508	5788798	6542378
weeklys	1170706	1205917	1395823	1402878	1440952	1436967	1304621	1173955	1097941	1144694
monthlys	0	0	0	1402	5806	8683	10738	9378	10330	9565
quarterlys	3057	2570	2202	1750	1560	1478	1381	1095	259	403
yearlys	503	455	558	584	641	616	525	445	345	325
ESTIMATED PASSENGER JOURNEYS										
	23931154	24097941	27843422	27593972	28128842	29180998	28257840	26612573	28000158	30311973
		166787	3745481	-249450	534870	1052156	-923158	-1645267	1387585	2311815
ESTIMATED PASSENGER JOURNEYS (singles, returns and weeklys)										
	23277799	23529391	27255392	26990448	27350020	28320157	27386719	25872662	27381163	29716723
		251592	3726001	-264944	359572	970137	-933438	-1514057	1508501	2335560
ESTIMATED PASSENGER JOURNEYS (monthlys, quarterlys and yearlys)										
	653355	568550	588030	603524	778822	860841	871121	739911	618995	595250
		-84805	19480	15494	175298	82019	10280	-131210	-120916	-23745
TOTALS (Lidcombe to Penrith)										
singles	3882662	3804575	4456799	4424691	4245911	3887949	3968211	3800229	4423673	4755783
returns	3375282	3357944	3863409	3714547	3779401	4450019	4637923	4603586	5252084	5931564
weeklys	1017936	1042124	1209416	1215744	1260313	1261016	1149386	1039799	970278	1010100
monthlys 0	0	0	1001	3905	6381	8142	7199	8282	7778	
quarterlys 2149	1818	1569	1243	1064	1027	950	736	191	321	
yearlys	339	301	373	420	481	444	359	291	235	238
ESTIMATED PASSENGER JOURNEYS										
	21263121	21331373	24682012	24443207	24963288	26018749	25363821	23930994	25100020	27187412
		68252	3350639	-238805	520081	1055461	-654928	-1432827	1169026	2087392
ESTIMATED PASSENGER JOURNEYS (singles, returns and weeklys)										
	20812586	20941703	24277777	24011225	24407843	25398147	24737917	23405391	24630621	26719911
		129117	3336074	-266552	396618	990304	-660230	-1332526	1225230	2089290
ESTIMATED PASSENGER JOURNEYS (monthlys, quarterlys and yearlys)										
	450535	389670	404235	431982	555445	620602	625904	525603	469399	467501
		-60865	14565	27747	123463	65157	5302	-100301	-56204	-1898

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	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95
TOTALS (Emu Plains to Blackheath)										
singles	**240641**	**244950**	**274785**	**289405**	**303727**	**299682**	**272890**	**283867**	**400484**	**429244**
returns	348436	352404	419380	409239	416030	431409	411781	420922	536714	610814
weeklys	152770	163793	186407	187134	180639	175951	155235	134156	127663	134594
monthlys	0	0	0	401	1901	2302	2596	2179	2048	1787
quarterlys	908	752	633	507	496	451	431	359	68	82
yearlys	164	154	185	164	160	172	166	154	110	87
ESTIMATED PASSENGER JOURNEYS										
	2668033	2766568	3161410	3150765	3165554	3162249	2894019	2681579	2900138	3124561
		98535	394842	-10645	14789	-3305	-268230	-212440	218559	224423
ESTIMATED PASSENGER JOURNEYS (singles, returns and weeklys)										
	2465213	2587688	2977615	2979223	2942177	2922010	2648802	2467271	2750542	2996812
		122475	389927	1608	-37046	-20167	-273208	-181531	283271	246270
ESTIMATED PASSENGER JOURNEYS (monthlys, quarterlys and yearlys)										
	202820	178880	183795	171542	223377	240239	245217	214308	149596	127749
		-23940	4915	-12253	51835	16862	4978	-30909	-64712	-21847

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