Traffic Growth in Australian Cities: Causes, Prevention and Cure

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ABSTRACT

This paper looks briefly at the causes of, and outlook for, traffic growth in Australian cities over the next 20 years. Then it looks at the likely negative impacts of this projected traffic growth, including congestion, pollution, noise and accidents. Finally, the paper reviews the range and scope of possible policy measures aimed at ameliorating each of these impacts.

Traffic growth in Australia cities is likely to pose problems in the coming decades. This paper looks briefly at the underlying causes of growth in traffic levels, and then examines how the resulting problems that growth is likely to pose might be tackled.

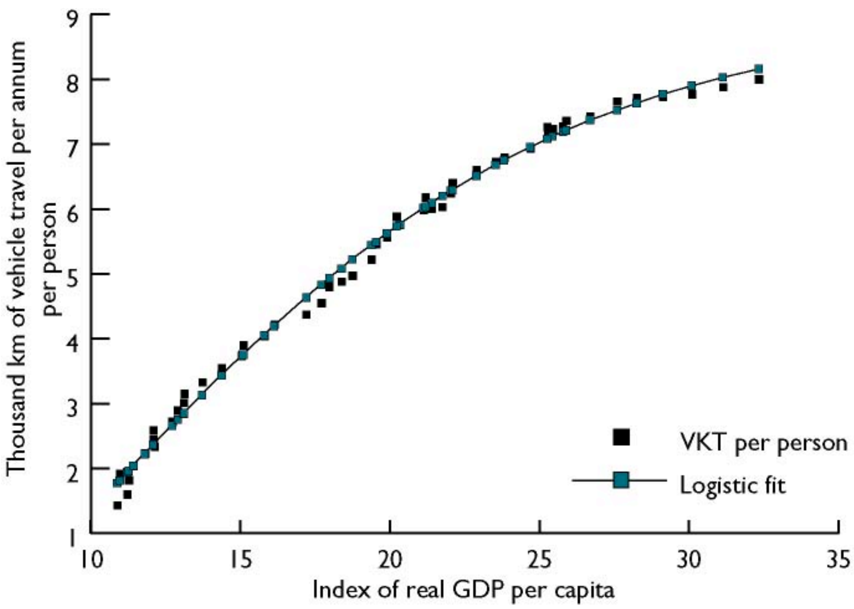
The causes of urban traffic growth vary between types of vehicles. The following sections discuss the causes of growth for cars and commercial vehicles, which together account for the majority of traffic flows in the cities.

1. CAR TRAFFIC GROWTH

A simplifying framework for explaining car traffic (vehicle kilometres travelled or vkt) is the following:

Car traffic = Car travel per person * Population

The advantage of this formulation is that, for Australia, it turns out that car travel per person has a simple relationship to economic activity levels. The trend in per capita car travel (kilometres per person) in Australia has in general been following a logistic (saturating) curve against real per capita income – measured here by real Gross Domestic Product (GDP) per person (see Figure 1).



Source: BTRE (2002a) p.14, interpolated from ABS (2003) and earlier(1965 to 2002).

Figure 1 Per capita historical trend in annual passenger travel versus real Australian income levels

Here, then, we have the basis for understanding the relationship between car traffic and economic development. As incomes per person increase, personal car travel per person also increases, but at a slowing rate over time. In other words, more car travel is attractive as incomes rise, but there reaches a point where further increases in per capita income elicit no further demand for car travel per capita. However, traffic then continues to respond in a one-to-one relationship to population growth (that other component of aggregate economic activity levels).

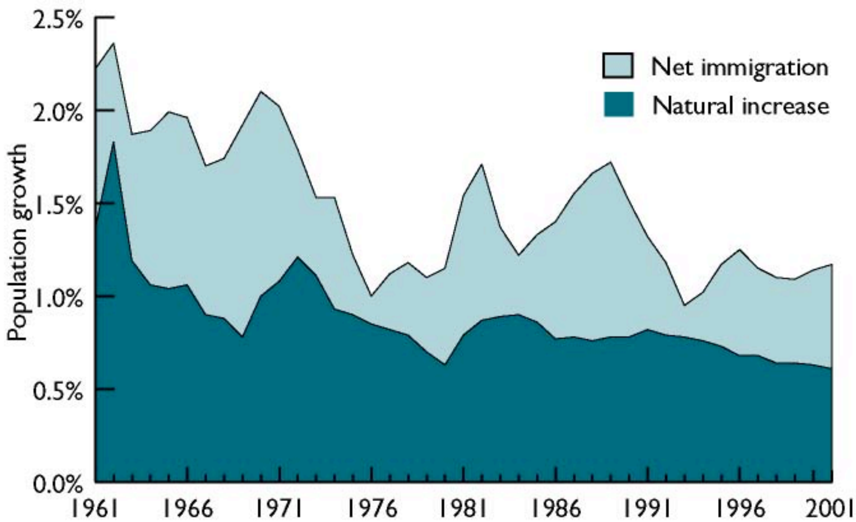
2. CAR TRAFFIC PROJECTIONS FOR AUSTRALIAN CITIES

Once again, our formula for understanding the relationship between car traffic growth and economic growth is: Car traffic = Car travel per person * Population

The assumed base case rate of GDP growth of 2.7 per cent per annum over the 18 years from 2002 to 2020 (Treasury 2002) implies that Australia-wide per capita car travel should level out at around 9000 kilometres per person by 2020 – about a 12% increase on 2002. After 2020, growth from this term in the equation will become insignificant.

There is still the growth in car travel resulting from population growth. The two main sources of population growth are natural increase and immigration. The contribution each has made to population growth over the last 40 years is shown in figure 2 (where the two components have been stacked). The average growth rate of both components has tended to decline over time.

The Australian Bureau of Statistics has previously produced three scenarios for population growth – see www.abs.gov.au for details – projecting national population to be between about 22 million and 24 million people by 2020. The following analysis uses population projections based on the trend to 2020 of the ABS Series III projections (ABS 200l). This assumes a net immigration level of about 70,000 persons per year and a further decline in the rate of natural increase (due to a fairly rapid ageing of the population, coupled with a fairly low fertility rate). The population of Australia is forecast to reach about 22.2 million in 2020 under this scenario.



Source: BTRE (2002a) p.16.

Figure 2 Components of Australian population increase

The ABS population projections are also available for Australia's cities. If we use national car travel per person percentage increases and capital city population projections (BTRE 2003, p 361), Table 1 gives the resulting (unconstrained) car traffic projections. For example, the national percentage projected increase in car travel per person is (8.87-7.94)/7.94*100 = 11.7%. Increasing Sydney's 7.035 thousand vkt per person by that amount gives the projected 2020 level of 7.858 thousand per person. Multiplying this by Sydney's projected 2020 population of 4.999 million gives projected 2020 Sydney car vkt of 39300 Mvkt. It should be noted that the national level of vkt per person is higher than the metro level, but it is assumed the latter will saturate in a like manner to the national total.

Table 1: Car Traffic Projections for Australian Cities

City	**2002**			**2020**			**Percent**
	Car	Popul (a)	Car (b)	Car (c)	Popul (a)	Car	**change**
	VKT/	(000)	VKT(m)	VKT/	(000)	VKT(m)	**2002-**
	Person			Person			**2020**
	(000)			(000)			
Sydney	7.035	4207.5	29,600	7.858	4999.0	39300	+33%
Melbourne	8.089	3556.8	28,770	9.035	4058.4	36700	+28%
Brisbane	6.903	1681.8	11,610	7.711	2188.0	16,900	+46%
Adelaide	7.474	1111.9	8,310	8.348	1170.4	9,800	+18%
Perth	7.163	1430.9	10,250	8.001	1798.1	14,400	+41%
Hobart	7.155	193.0	1,381	7.992	187.7	1500	+9%
Darwin	6.041	93.2	563	6.748	127.2	860	+53%
Canberra	8.962	318.0	2,850	10.011	354.9	3,550	+25%
Metro	7.412	12,593	93,334	8.279	14,884	123,200	+33%
Rest Aust	8.886	7,026	62436	9,994	7,885	78,800	+26%
Total Aust.	7.94	19619	155,770	8.87	22769	202,000	+30%

(a) BTRE(2003) p320-321
(b) BTRE(2003) pp.3-30
(c) The Australia level per cent increase from 7.94 to near saturation at 8.87 is assumed to apply to each city. At the level of the 8 capitals, the increase from car travel per person is 12%, and from population 18.5%. The overall increase in Australia Metro car traffic is then (1.12 * 1.185-1.0)*100 or about 33% in 18 years.

The average increase in car traffic in Australian capital cities is projected to be on the order of 33% (close to the Sydney and Melbourne levels of growth, with the highest growth is in Brisbane, because of its high population growth). Even with a proportion of this growth occurring at the city fringes, this still implies substantial increases in the (unconstrained) level of car traffic on our current city networks.

3. TRUCK TRAFFIC GROWTH

The basis mechanism generating truck traffic is as follows:

Truck Traffic (vkt) = Road Freight Task / Average Load per Truck

In other words the number of truck kilometres is performed in order to carry out the freight task in each city. The number of vehicles travelling is determined by the average load.

In fact, in order to understand the relationship further, it is better to think of truck traffic as the product of numbers of vehicles times the yearly average km they each perform.

The influences of the economy and technological shifts can then be illustrated as below:

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  TRUCK TRAFFIC (vkt)
Number of * average kms  =  Road Freight Task (tkm) / Average Load per
Vehicles       per vehicle                                          Truck(t)
 ^   ^   ^    ^                            ^ (+)           ^ (+)           ^ (+)         ^ (+)
 !   !   !    !                            !               !               !             !
 !   !   !    !                            !               !               !             !
 !   !   !    !                        Economic        Falls in      Technical     Shift to
 !   !   !    !-----(+) --------------development      freight <-(+)- change        larger
 !   !   !-----(+)----------------------------------------  rates  <-(+)-------!---------  truck
 !   !-----(-)--------------------------------------------------------------------!            types
 !-----(-)------------------------------------------------------------------------------------!
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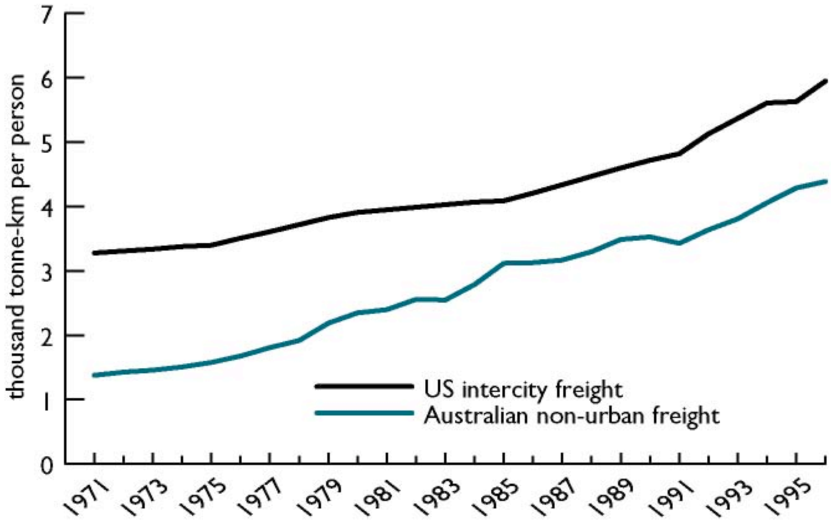
Figure 3 Causes of truck traffic growth

The main influence of economic development is through increases in the freight task. In Gargett (2004), freight task growth was found to react greater than proportionally to the growth rate of the economy - about 1.21 times economic growth. While this relationship cannot continue indefinitely, there are no signs yet of saturation in Australian truck freight use per person (as there are in car travel per person). Similarly, there are no signs of saturation in current levels of United States truck freight per person, and American levels of road freight per person are already much higher than those in Australia (see figure 4).



Source: BTRE (2002a) p. 20.

Figure 4 Comparison of Australian non-urban per capita road freight and US intercity per capita road freight

The other influence on the aggregate demand for freight transport is the real freight rate. Real road freight rates in Australia have fallen dramatically since 1965, mainly driven by the progressive introduction of larger articulated vehicles, but also by technological change which has made possible lighter vehicles, improved terminal efficiencies, etc. Real road freight rates fell 45 per cent from 1965 to 1990, and then another 3 per cent in the 1990s (BTRE 2002b). In Gargett (2004) a one per cent fall in real road freight rates was found to cause a 0.89 per cent increase in the freight task.

The other influence of technological change is direct. For example, the same weight-reducing technological change that lowers freight rates also makes possible direct increases in average loads.

However, the main influence on average loads has been the continuing shift to the larger articulated vehicles. This directly increases average load and thus has a negative effect on the number of vehicles on the road, and thus truck traffic.

Overall, then, the effects of economic development and its associated technical change can be summarised as follows:

(1) as the economy grows, the road freight task grows even quicker.

(2) the shift to larger vehicles makes possible larger loads and therefore less traffic (albeit composed of larger vehicles), but at the same time makes possible lower real freight rates which causes additional demand for freight transport.

(3) general technological change has a similar “double-edged” effect on truck traffic.

A methodology for deriving detailed forecasts of commercial traffic in Australian cities has been presented in an earlier paper (Gargett and Cosgrove 2004).

4. TRAFFIC FORECASTS FOR AUSTRALIAN CITIES

Using these methodologies for cars and commercial vehicles, as well as others adopted for the small amounts of bus and motorcycle traffic, forecasts have been made of traffic growth in each Australian capital city. These are presented in Tables 3 through 11 at the end of this paper. Variations in city growth rates (eg the high growth in Brisbane, Perth and Darwin, and the low growth in Hobart) are due mainly to variations in projected population growth.

However, the average Metro growth in traffic is 40-plus per cent over the 18 years from 2002 to 2020. Table 1 summarises the unconstrained projections for the 8 capital cities combined. (It should be noted that there might be several reasons for traffic growth to be constrained below these forecasts, not the least of which is increasing levels of congestion).

Cars continue to be the largest component of the traffic stream. Their growth of 33 per cent is, as we have seen, composed of 12% growth coming from the effect of rising income levels on per person travel, and the rest from the projected increase in population of the 8 capital cities. Buses and motorcycles continue to be a small part of the traffic stream. Articulated trucks grow quickly, but their numbers are small.

However, LCVs are projected to be a substantial and an extremely quickly growing part of the traffic stream. It is essentially their projected growth that substantially lifts the growth in total Metro traffic to 41% vs the 33% for cars.

5. DEALING WITH THE IMPACTS OF TRAFFIC GROWTH

Growth is always a double-edged sword. It brings its advantages in increased incomes and increases in personal mobility for a growing population.

However, within the confines of the semi-constrained networks that our cities represent, growth of the size outlined above also brings its share of potentially negative outcomes. The rest of this paper looks at the nature and size some of these likely impacts, and at what can be done in the way of preventative or curative measures to try to deal with these, while retaining the benefits that growth brings.

6. NEGATIVE IMPACTS OF TRAFFIC GROWTH

First and foremost is increasing congestion. If one assumes a 40-plus per cent increase in traffic, less perhaps 20 per cent for possible increases in capacity (see Prevention Measures discussion below), then the outlook is for an increase of 20-plus per cent in the volume to capacity ratios in our cities from 2002 to 2020. This will lead to substantial increases in congestion delays.

Increases in pollution are perhaps the next potential negative impact that springs to mind. But here, measures are possible and indeed already in train, that should cancel the effect of traffic growth over the years to 2020 for the major pollutant gases (but not their Greenhouse effect).

Noise and accidents are also problems that can be exacerbated by traffic growth. However, as will be seen there are measures possible to offset the potential growth of accidents and of noise levels from our roads.

So what are these measures, and to what extent can they mitigate the problems associated with traffic growth in our cities? We have grouped them under the headings of 'prevention' and 'cure', extending the medical analogy.

Prevention measures are such things as increasing the capacity of the network re congestion, or on-road monitoring re pollution from vehicles.

Curative measures are more in the areas of new vehicle standards, radical technology changes, or pricing solutions.

7. CONGESTION

Preventative measures for congestion focus mainly on attempts to increase the carrying capacity of the city networks.

The building of key freeway links (often including tunnelling) attempts to overcome the through-traffic capacity constraints of the existing city networks. Often these include managed lanes, comprising high occupancy vehicle lanes, toll lanes, etc (see Federal Highway Administration 1999a, Eno Transportation Foundation 2002). Also important can be such things as parking restrictions on arterial roads, and unconventional intersections designed to increase capacity at major intersections (see VicRoads 2004). Unfortunately, networks are just that, and traffic, like water, seeks to equalise delay. Thus lacking pricing, arterial improvements tend to cause traffic to divert to the improved arterials (BTRE 2004, p35). There is an increase in system capacity, but access to it is not restricted to through traffic.

Other capacity-increasing measures can be just as important in their cumulative effect.

A trend to peak spreading in Australian cities has helped to keep the worst effects of congestion at bay. But also important in past decades has been the increasing 'intelligence' built into the system of lights at intersections, allowing what is called dynamic traffic capacity management (see www.scoot.utc.com/facilities.htm). Running off sensors built into the roadway, these traffic control systems include traffic signal coordination, dynamically variable speed limits, variable message signs (allowing, for example, provision of real-time congestion information) , and ramp metering to control access to freeways so as to prevent their flow collapsing (see Federal Highway Administration 1999b). Such in-built intelligence has allowed significant increases in system capacity over past decades. But this, and peak spreading, are basically one-offs, and once they are fully exploited, their ability to cancel out the effects of further traffic growth on congestion is limited.

Other ways to increase capacity are more physical in nature. New technologies are making possible dynamic road markings that can change the lane configurations of roads and intersections appropriate to the time of day (see Philips Lighting 2004). Similarly, reversible lanes (tidal flows) allow capacity to adjust to the needs of the greatest flow. However, with the rise in inner city living, increasingly there are flows out of the city in the morning that are moderating the imbalance. Narrowing lane width is an option on some roads to add an additional lane, as is allowing the use of shoulders on freeways during peak periods (see New Civil Engineer 2002).

Accidents are an important cause of congestion on city roads. It is estimated that 40 to 60 per cent of congestion on freeways is due to 'incidents' (see Institute of Transportation Engineers 1997, p19). The new technologies that allow active traffic management also allow real-time monitoring of roads for incident detection (see Institute of Transportation Engineers 1997, Bowers et al. 1996). Incident management systems can then attempt to minimise the traffic disruption. In addition, various measures can be taken to minimise incidents, including lane controls on exit and entry to freeways, repair of roadside equipment, debris removal, etc. More will be said of this later.

Maintenance also restricts traffic flow. Night-time maintenance is one answer, but there must be consideration of noise problems. Maintenance contracts could also include a cost for traffic delay, providing maintenance managers with an incentive to take traffic delay costs into account.

Increasing congestion will also affect the ability of commercial trucking to make its way around our cities. And truck and light commercial trips will be the fastest growing categories over the next 20 years (although the absolute size increase in car traffic will be larger). Toll truckways and separate truck lanes have been suggested in overseas studies, as ways of ensuring ease of commercial vehicle movement (see Reason Public Policy Institute 2002). However, the economics of traffic separation depends on traffic levels and road space availability, and may not be practical in Australian cities. Another idea is that temporal use of road space by trucks can ease peak congestion (eg increased night-time/weekend use).

Curative measures with regard to congestion hinge mainly on travel demand management, pricing, technology and urban design (see Bureau of Transport and Regional Economics 2002, Chapter 2). Note that all of the so-called 'cures' are only partially so.

Travel demand management by means of trip reduction programs has had some success in reducing travel (see Brog et al 1999, Tisato and Robinson 1999, Victoria Transport Policy Institute, Canada 2004). Similarly, parking controls (eg pricing/reducing parking spaces in congested areas and CBDs) are tools to restrict travel demand in and to these areas. Greater use of transit lanes and High Occupancy Vehicle lanes on freeways and arterials are other avenues for demand management (see Federal Highway Administration 1999a).

Congestion pricing is a way of facing motorists with the reality of the costs of their travel decisions (Transportation Research Board 1994).

Bray (2002) makes the argument that 'current decision-making on the extent of road use is constrained by:

- limitations of current government charges (current fixed charges need to be converted to a payment that varies with car use and is perceived)
- under-perception by drivers of the financial cost of motoring (perceived cost of car use being about half to three-quarters of the actual cost); and

- a failure by motorists to recognise the travel time externality they cause (when their presence increases congestion and thus adds to the travel time of other road users).'

However, Bray also states that 'two issues appear to be central to the future of road pricing:

- whether roads should continue to be treated as a social good or treated instead as an economic good; and
- the willingness of the community to accept that pricing can lead to better travel decisions and their willingness to be subject to such pricing.'

If roads are to continue to be a social good, there is no criterion for supply other than to try to fulfil all potential demand (the high cost of additional road capacity in urban areas making this a difficult task). However, as Bray observes, 'While transport professionals may see the sub-optimality of this situation, the community at large appears to generally accept it.'

With regard to the willingness of the community to accept pricing of roads, while much work has been done on road pricing, it seems it has not been consolidated and presented in a way that is meaningful to the community. On the other hand, the increasing number of toll roads in Melbourne and Sydney, along with the fairly wide spread of the in-vehicle, on-road, and compliance components of the charging systems associated with these, has brought to the average motorist in these cities a first-hand familiarity with road pricing that was absent only a decade ago. In addition, there are even more powerful technologies being introduced in new vehicle models that would do away with the necessity of road-side infrastructure, and allow charging for use of roads at a very fine segment level (see Europa ITS 2002).

In summary, road pricing as a partial cure for increasing congestion is increasingly possible (on technical and familiarity grounds), but may not be seen by the public as desirable until the problems get much worse, and pricing's benefits are more widely understood and its costs are made socially acceptable.

With regard to pricing, extending the reach, and improving the speed, convenience and capacity of public transport, are essential adjuncts to pricing strategies (see Roads and Traffic Authority NSW (1991). But as BTRE (1999) points out, 'Even if the share of the urban public transport system were doubled, private road vehicles would still constitute 86 per cent of the (passenger transport) task. In other words, to be effective in addressing congestion and the environmental effects from traffic, policies designed to affect city transport must target road travel directly' (see also Cox 2001, Gerondeau 1997, Goodwin 1997, Stopher 2004).

Other curative measures for congestion are so-called smart cars with a very small road footprint (see www.thesmart.co.uk), separation sensing which might safely allow closer spacing, or more futuristic, a system which would take control of the vehicle over the nominated trip.

Finally, there is the nature of the city itself. In the long run, many aspects of urban design impact positively or negatively on congestion. Decisions on major infrastructure items can have large local impacts. For example in Melbourne, the siting of the wholesale food markets recently will have effects on traffic flows for decades to come. Similarly, the decision to dredge Port Phillip Bay for access for larger ships of greater depth has many implications for city traffic. Although it is possible that the trend to larger ships might in future simply mean wider not deeper ships, there is the option that these be accommodated in the long-run at Westernport – again with major implications for accommodating transport links and for city traffic. As an example, Vancouver has moved its port facilities to the south of the city, and there are significant volumes of truck traffic and industry that shifts locations and patterns as a result.

The other major impact of urban design is on car traffic. There have been several recent Australian reviews of this work (see Queensland Transport 2002 and Westermark 1998). Again, decisions in this area have decade-long effects on traffic and on congestion (see Stopher 2004 on current patterns of urban sprawl and urban densification).

8. POLLUTION

Preventative measures here focus on ensuring the on-road pollution performance of the existing fleet. This is an important issue. A Queensland random inspection program found that 'Generally, leaded fuel (older) cars were not well maintained with 47% rating Poor. While unleaded fuel (newer) cars were better maintained, 24% still obtained a Poor rating.' (Queensland Transport 1999, p1).

There are three levels of enforcement possible. The first is to combine random (road-side detection) or annual testing with a program to tune the worst-offending vehicles. The second level is to require all vehicles over 7 years to undergo regular maintenance. The third is to require an annual emissions inspection and maintenance of all vehicles.

Table 2 below sets out the approximate reductions in Carbon Monoxide (CO) and Hydrocarbons (HC) from the three levels, drawn from an Australian study (FORS 1996) and the review of a Canadian emissions inspection and maintenance program (Stewart et al 2001). It can be seen that in the case of urban pollution from existing motor vehicles, a city can have as much pollution as it is not prepared to pay to avoid.

Table 2: The Emissions Reductions from Three Levels of Anti-Pollution Measures

	% reduction in CO	**% reduction in HC**
Gross polluters serviced	13%	6%
All vehicles serviced	25%	13%
All vehicles, emission I&M program	48%	53%

But as the FORS study pointed out, 'Cost-effective policies for pollution control will rely on a carefully balanced combination of new car standards and workable in-service maintenance programs. Neither approach alone will deliver the goods.'

Thus, *curative policies* vis a vis urban vehicle pollution are focussed on new car and commercial vehicle standards. In this regard, there is good news, for in the next 20 years it appears that increasingly stringent emissions standards for new vehicles will result in most transport emission levels falling in absolute terms in our cities, even in the absence of in-service maintenance programs. A recent BTRE study has found that in the 8 capital 'Metro' area, CO emissions by motor vehicles should fall from 2 ½ mt in 2000 to 1 ½ mt by 2020. Most other pollutants are set for similar orders of magnitude reductions due to new vehicle standards (BTRE 2003).

Thus it can be seen that the projected traffic growth in our cities is in no way necessarily linked to increases in pollution from motor vehicles. Quite the contrary, there is enormous scope for using both new car standards and workable in-service maintenance programs to substantially reduce pollution, even in the face of traffic growth.

9. NOISE

The problem of noise is quite unique among the negative effects of motor vehicle traffic, in that it is heavily a perceptual problem. It has been established by studies that the perception of noise problems is closely linked to the worst 3 instances of noise per hour. As such, noise as a problem relates heavily to the 'worst offending vehicles' phenomenon.

Preventative measures are therefore heavily based on detecting and remedying the worst offending vehicles, either with annual noise tests, or with random or automatic roadside testing/detection.

Curative measures include noise standards for new vehicle designs, and complementary legislation and enforcement prohibiting the sale/installation of noise-enhancing equipment. Many of the worst offending vehicles are motorcycles and trucks, and these vehicle categories warrant specific attention. For example, the European 'quiet truck' concept could be considered (see Noise Management July 2002), as could improved noise standards for motorcycles.

Recent advances in 'quiet road' technology have also made it possible to design roads to eliminate a fair degree of the background hum from traffic on a road (see Ashphalt Institute 2004). Finally there are the standard noise barrier techniques.

10. ACCIDENTS

Accidents have already been mentioned as an important contributor to congestion, but the reduction in associated road trauma is an objective in its own right.

Various *preventative measures* can be taken to minimise accidents, including lane controls on exit and entry to freeways, repair of roadside equipment, debris removal, removal of roadside distractions, etc.

However, the major types of accidents are rear-end. Thus preventative measures aimed at headway maintenance can be important for reducing incidents. For example, vehicle spacing indicators can produce a surprising reduction in incidents at specific locations– by affecting driver behaviour.

The severity of an accident determines not only degree of trauma, but also the duration of the incident and its effect on congestion. Severity in turn is related to speed, and so speed management measures can reduce both the trauma and congestion effects resulting from accidents.

In addition, Black Spot programs can specifically design solutions for chronic accident locations.

There are several more technological solutions, such as ABS brakes, separation sensing, etc. But it has been found that the beneficial effects of theses are often offset by increased risk-taking that rises to adjust for so-called safer vehicles and roads.

Of the possible *curative measures,* the most important have to do with the 'worst offending vehicle/driver phenomenon. It has been shown in a UK study that 2% of drivers were responsible for 20% of collisions (see Center for Mathematics and Statistics 2003). In Victoria, it has been shown that 2% of accidents involve unregistered vehicles. A variety of enforcement and penalty pricing mechanisms that would remove offending drivers from the road, or effectively change their behaviour through pricing, other penalties or retraining, could have a significant impact on the accident problem.

Other curative measures with regard to road accident trauma have to do with crash standards and equipment for new vehicles that make serious injury less likely. In more futuristic versions, there could be equipment that would block mobile phone use within vehicles, would not allow the engine to be started if alcohol was detected, etc.

SUMMARY

The mathematics of traffic growth in Australian cities is fairly simple. From 2002 to 2020, there should be a 12% increase in car traffic from increasing car use per person, and a further 18% increase due to population growth. Thus car traffic overall should increase around 33% over the period. When you add to this, high growth in Light Commercial Vehicle traffic (and in the much smaller heavy vehicle traffic), traffic in Australian cities should grow by more than 40% over the 18 years.

While greater mobility brings benefits to individuals, it is also likely to have many negative impacts, including increased congestion costs and upward pressure, in the absence of regulatory, behavioural or other change, on pollution, accidents and noise.

This paper has reviewed some possible policy responses to increases in traffic on city roads. With 2 out of every 3 Australians living in the capital cities, urban traffic and how we deal with it has important implications for Australian quality of life.

TABLE 3 Base case projections of metropolitan vehicle kilometres travelled by type of vehicle, 1990-2020 (billion kilometres)

Year	Cars	Light Commercial Vehicles	Articulated trucks	Rigid and other trucks	Buses	Motor cycles	Total
1990	73.43	12.20	0.69	4.13	0.59	0.84	91.88
1991	73.84	11.56	0.64	3.89	0.60	0.79	91.33
1992	75.07	11.67	0.67	3.80	0.60	0.78	92.60
1993	76.98	12.46	0.70	3.75	0.59.	0.77	95.26
1994	78.56	12.65	.75	3.77	0.62	0.76	97.11
1995	81.96	13.29	0.81	3.90	0.64	0.75	101.35
1996	84.30	14.49	0.86	3.89	0.66	0.78	104.98
1997	85.21	14.89	0.91	3.87	0.69	0.78	106.35
1998	86.92	15.22	0.94	3.79	0.72	0.78	108.38
1999	89.21	16.03	1.01	3.82	0.74	0.78	111.60
2000	91.24	15.88	1.02	3.73	0.79	0.79	113.44
2001	91.21	16.85	1.03	3.76	0.78	0.78	114.43
2002	93.33	17.79	1.08	3.90	0.79	0.79	117.70
2003	96.78	18.53	1.10	3.91	0.81	0.81	121.94
2004	100.12	19.26	1.14	3.99	0.82	0.82	126.15
2005	103.14	20.12	1.19	4.00	0.83	0.82	130.10
2006	104.91	20.79	1.24	4.05	0.84	0.83	132.67
2007	106.67	21.60	1.30	4.12	0.85	0.84	135.38
2008	108.40	22.32	1.36	4.17	0.86	0.84	137.95
2009	110.04	23.06	1.42	4.22	0.88	0.85	140.47
2010	111.63	23.95	1.49	4.29	0.90	0.86	143.11
2011	113.07	24.72	1.55	4.33	0.91	0.86	145.44
2012	114.46	25.52	1.61	4.38	0.92	0.87	147.76
2013	115.78	26.34	1.68	4.42	0.93	0.87	150.02
2014	117.05	27.18	1.75	4.46	0.94	0.88	152.26
2015	118.28	28.05	1.82	4.50	0.95	0.89	154.49
2016	119.44	28.94	1.90	4.53	0.97	0.89	156.67
2017	120.58	30.01	1.98	4.59	0.99	0.90	159.05
2018	121.68	30.95	2.06	4.63	1.00	0.90	161.22
2019	122.74	31.93	2.15	4.66	1.01	0.91	163.39
2020	123.77	32.93	2.23	4.69	1.03	0.91	165.56
Change 2002 to 2020	33%	85%	106%	20%	30%	14%	41%

Note: 'Metropolitan' results refer to all activity within the greater metropolitan areas of the 8 State and Territory capital cities

Sources: BRTRE (2003, p5)

TABLE 4 Base case projections of vehicle kilometres travelled by type of vehicle for Sydney, 1990-2020

(billion kilometres)

Year	*Cars*	*Light Commercial Vehicles*	*Articulated trucks*	*Rigid and other trucks*	*Buses*	*Motor cycles*	*Total*
1990	23.49	4.44	0.22	1.54	0.189	0.294	30.17
1991	23.66	4.20	0.21	1.45	0.190	0.278	29.99
1992	23.87	4.24	0.22	1.42	0.192	0.274	30.21
1993	24.48	4.53	0.22	1.40	0.188	0.270	31.09
1994	24.98	4.59	0.24	1.41	0.197	0.266	31.68
1995	26.06	4.81	0.26	1.45	0.202	0.262	33.05
1996	26.80	5.24	0.28	1.44	0.209	0.271	34.23
1997	27.13	5.38	0.29	1.44	0.219	0.271	34.73
1998	27.45	5.49	0.30	1.41	0.228	0.270	35.15
1999	28.05	5.79	0.32	1.42	0.236	0.270	36.09
2000	28.93	5.73	0.33	1.38	0.250	0.273	36.90
2001	28.92	6.09	0.33	1.40	0.247	0.275	37.26
2002	29.60	6.43	0.35	1.45	0.250	0.277	38.35
2003	30.70	6.69	0.35	1.45	0.257	0.279	39.74
2004	31.78	6.96	0.37	1.48	0.260	0.282	41.12
2005	32.75	7.27	0.38	1.48	0.264	0.284	42.43
2006	33.32	7.52	0.40	1.50	0.268	0.286	43.29
2007	33.90	7.81	0.42	1.53	0.271	0.288	44.21
2008	34.46	8.07	0.44	1.55	0.275	0.290	45.08
2009	35.00	8.34	0.46	1.57	0.278	0.292	45.94
2010	35.52	8.67	0.48	1.59	0.285	0.294	46.84
2011	36.00	8.95	0.50	1.61	0.289	0.296	47.64
2012	36.46	9.24	0.52	1.63	0.292	0.298	48.43
2013	36.90	9.54	0.54	1.64	0.296	0.299	49.21
2014	37.32	9.85	0.56	1.66	0.300	0.301	49.99
2015	37.73	10.17	0.59	1.67	0.304	0.303	50.76
2016	38.12	10.49	0.61	1.69	0.307	0.305	51.52
2017	38.50	10.88	0.64	1.71	0.314	0.306	52.36
2018	38.87	11.23	0.67	1.72	0.318	0.308	53.12
2019	39.23	11.59	0.69	1.74	0.322	0.309	53.88
2020	39.59	11.95	0.72	1.75	0.327	0.311	54.65

Source: BTRE 2003 p9

TABLE 5 Base case projections of vehicle kilometres travelled by type of vehicle for Melbourne, 1990-2020

(billion kilometres)

Year	*Cars*	*Light Commercial Vehicles*	*Articulated trucks*	*Rigid and other trucks*	*Buses*	*Motor cycles*	*Total*
1990	22.57	2.80	0.20	1.18	0.136	0.192	27.07
1991	22.62	2.65	0.19	1.11	0.137	0.181	26.89
1992	22.89	2.67	0.20	1.08	0.137	0.178	27.14
1993	23.49	2.83	0.20	1.06	0.134	0.174	27.90
1994	23.99	2.87	0.22	1.07	0.140	0.171	28.45
1995	25.04	3.00	0.24	1.10	0.143	0.168	29.68
1996	25.78	3.25	0.25	1.09	0.148	0.173	30.69
1997	26.06	3.34	0.26	1.08	0.154	0.173	31.07
1998	26.82	3.41	0.27	1.06	0.161	0.173	31.90
1999	27.59	3.59	0.29	1.07	0.167	0.173	32.88
2000	28.09	3.56	0.29	1.04	0.177	0.174	33.34
2001	28.10	3.78	0.30	1.05	0.174	0.176	33.58
2002	28.77	4.00	0.31	1.09	0.177	0.178	34.53
2003	29.80	4.16	0.32	1.09	0.181	0.179	35.73
2004	30.79	4.33	0.33	1.11	0.183	0.181	36.92
2005	31.68	4.52	0.34	1.12	0.185	0.182	38.03
2006	32.19	4.67	0.36	1.13	0.188	0.183	38.72
2007	32.69	4.85	0.38	1.15	0.190	0.185	39.44
2008	33.19	5.01	0.39	1.16	0.192	0.186	40.13
2009	33.66	5.17	0.41	1.18	0.194	0.188	40.80
2010	34.11	5.37	0.43	1.20	0.198	0.189	41.49
2011	34.51	5.54	0.45	1.21	0.200	0.190	42.10
2012	34.90	5.72	0.46	1.22	0.202	0.191	42.70
2013	35.26	5.90	0.48	1.23	0.204	0.193	43.27
2014	35.60	6.09	0.50	1.24	0.206	0.194	43.84
2015	35.94	6.28	0.52	1.25	0.208	0.195	44.40
2016	36.25	6.48	0.54	1.26	0.210	0.196	44.94
2017	36.55	6.72	0.57	1.28	0.215	0.197	45.53
2018	36.84	6.93	0.59	1.29	0.217	0.198	46.06
2019	37.12	7.14	0.62	1.30	0.219	0.199	46.59
2020	37.39	7.36	0.64	1.31	0.222	0.200	47.12

Sources: BTRE 2003 p12

TABLE 6 Base case projections of vehicle kilometres travelled by type of vehicle for Brisbane, 1990-2020

(billion kilometres)

Year	*Cars*	*Light Commercial Vehicles*	*Articulated trucks*	*Rigid and other trucks*	*Buses*	*Motor cycles*	*Total*
1990	9.04	1.65	0.09	0.49	0.085	0.163	11.51
1991	9.12	1.56	0.08	0.46	0.086	0.156	11.47
1992	9.38	1.59	0.09	0.46	0.088	0.156	11.76
1993	9.59	1.71	0.09	0.46	0.088	0.156	12.10
1994	9.78	1.75	0.10	0.46	0.093	0.156	12.34
1995	10.19	1.86	0.11	0.48	0.096	0.156	12.90
1996	10.47	2.05	0.12	0.49	0.100	0.163	13.39
1997	10.57	2.12	0.12	0.49	0.105	0.164	13.56
1998	10.76	2.17	0.13	0.48	0.111	0.165	13.82
1999	11.21	2.30	0.14	0.48	0.114	0.165	14.41
2000	11.29	2.28	0.14	0.47	0.122	0.167	14.47
2001	11.31	2.42	0.14	0.48	0.120	0.169	14.65
2002	11.61	2.56	0.15	0.50	0.123	0.172	15.12
2003	12.10	2.68	0.15	0.50	0.126	0.174	15.73
2004	12.57	2.79	0.16	0.51	0.129	0.176	16.34
2005	13.01	2.92	0.17	0.51	0.131	0.178	16.92
2006	13.29	3.03	0.18	0.52	0.134	0.180	17.33
2007	13.57	3.16	0.18	0.53	0.136	0.183	17.76
2008	13.85	3.27	0.19	0.54	0.139	0.185	18.17
2009	14.11	3.39	0.20	0.55	0.142	0.187	18.58
2010	14.38	3.53	0.21	0.56	0.146	0.189	19.01
2011	14.62	3.65	0.22	0.57	0.148	0.191	19.40
2012	14.86	3.78	0.23	0.57	0.151	0.193	19.79
2013	15.09	3.91	0.24	0.58	0.154	0.195	20.17
2014	15.32	4.05	0.25	0.59	0.156	0.197	20.55
2015	15.54	4.19	0.26	0.59	0.159	0.199	20.94
2016	15.75	4.33	0.27	0.60	0.162	0.201	21.31
2017	15.96	4.50	0.29	0.61	0.166	0.203	21.72
2018	16.16	4.65	0.30	0.61	0.169	0.205	22.11
2019	16.37	4.81	0.31	0.62	0.172	0.207	22.49
2020	16.56	4.97	0.33	0.63	0.175	0.209	22.87

Sources: BTRE 2003 p15

TABLE 7 Base case projections of vehicle kilometres travelled by type of vehicle for Adelaide, 1990-2020

(billion kilometres)

Year	*Cars*	*Light Commercial Vehicles*	*Articulated trucks*	*Rigid and other trucks*	*Buses*	*Motor cycles*	*Total*
1990	6.50	0.96	0.06	0.28	0.062	0.067	7.92
1991	6.62	0.91	0.05	0.26	0.063	0.063	7.96
1992	6.69	0.91	0.05	0.26	0.063	0.062	8.03
1993	6.86	0.96	0.06	0.25	0.061	0.061	8.25
1994	6.99	0.97	0.06	0.25	0.064	0.060	8.39
1995	7.29	1.01	0.06	0.26	0.065	0.058	8.74
1996	7.49	1.09	0.07	0.25	0.066	0.060	9.03
1997	7.56	1.11	0.07	0.25	0.069	0.059	9.12
1998	7.93	1.13	0.07	0.24	0.071	0.059	9.51
1999	8.00	1.18	0.08	0.24	0.073	0.058	9.63
2000	8.21	1.16	0.08	0.23	0.077	0.059	9.82
2001	8.16	1.22	0.08	0.24	0.075	0.059	9.82
2002	8.31	1.28	0.08	0.24	0.076	0.059	10.05
2003	8.56	1.33	0.08	0.24	0.077	0.059	10.35
2004	8.82	1.38	0.09	0.25	0.078	0.059	10.66
2005	9.04	1.43	0.09	0.25	0.078	0.060	10.94
2006	9.15	1.47	0.09	0.25	0.079	0.060	11.11
2007	9.26	1.53	0.10	0.25	0.079	0.060	11.28
2008	9.37	1.57	0.10	0.25	0.080	0.060	11.43
2009	9.47	1.62	0.10	0.26	0.080	0.060	11.58
2010	9.56	1.67	0.11	0.26	0.082	0.060	11.74
2011	9.64	1.72	0.11	0.26	0.082	0.061	11.87
2012	9.71	1.77	0.12	0.26	0.083	0.061	12.01
2013	9.78	1.82	0.12	0.26	0.083	0.061	12.13
2014	9.85	1.87	0.13	0.26	0.084	0.061	12.25
2015	9.91	1.92	0.13	0.27	0.084	0.061	12.37
2016	9.96	1.98	0.14	0.27	0.084	0.061	12.49
2017	10.01	2.04	0.14	0.27	0.086	0.061	12.62
2018	10.06	2.10	0.15	0.27	0.086	0.061	12.73
2019	10.11	2.16	0.15	0.27	0.087	0.061	12.84
2020	10.15	2.22	0.16	0.27	0.088	0.062	12.95

Sources: BTRE 2003 p18

TABLE 8 Base case projections of vehicle kilometres travelled by type of vehicle for Perth, 1990-2020

(billion kilometres)

Year	*Cars*	*Light Commercial Vehicles*	*Articulated trucks*	*Rigid and other trucks*	*Buses*	*Motor cycles*	*Total*
1990	7.99	1.63	0.09	0.44	0.070	0.068	10.30
1991	8.01	1.55	0.09	0.41	0.071	0.065	10.19
1992	8.24	1.57	0.09	0.40	0.072	0.064	10.44
1993	8.46	1.68	0.10	0.40	0.071	0.063	10.77
1994	8.64	1.72	0.10	0.41	0.075	0.063	11.00
1995	9.02	1.81	0.11	0.42	0.077	0.062	11.50
1996	9.28	1.99	0.12	0.42	0.081	0.065	11.96
1997	9.38	2.05	0.13	0.42	0.085	0.065	12.12
1998	9.46	2.10	0.13	0.41	0.089	0.066	12.27
1999	9.68	2.22	0.14	0.42	0.092	0.066	12.62
2000	9.97	2.20	0.14	0.41	0.097	0.067	12.89
2001	10.00	2.34	0.15	0.41	0.096	0.067	13.06
2002	10.25	2.48	0.15	0.43	0.098	0.068	13.47
2003	10.66	2.58	0.16	0.43	0.101	0.069	14.00
2004	11.06	2.69	0.16	0.44	0.103	0.070	14.52
2005	11.42	2.81	0.17	0.44	0.104	0.071	15.02
2006	11.65	2.91	0.18	0.45	0.106	0.071	15.36
2007	11.88	3.03	0.19	0.46	0.108	0.072	15.72
2008	12.10	3.13	0.19	0.46	0.110	0.073	16.07
2009	12.31	3.24	0.20	0.47	0.112	0.074	16.41
2010	12.52	3.37	0.21	0.48	0.115	0.074	16.77
2011	12.72	3.48	0.22	0.48	0.117	0.075	17.10
2012	12.91	3.60	0.23	0.49	0.118	0.076	17.42
2013	13.09	3.72	0.24	0.49	0.120	0.076	17.74
2014	13.26	3.84	0.25	0.50	0.122	0.077	18.05
2015	13.43	3.97	0.26	0.50	0.124	0.078	18.37
2016	13.60	4.10	0.27	0.51	0.126	0.078	18.68
2017	13.76	4.26	0.28	0.52	0.129	0.079	19.03
2018	13.92	4.40	0.30	0.52	0.131	0.080	19.34
2019	14.07	4.54	0.31	0.52	0.133	0.080	19.66
2020	14.22	4.69	0.32	0.53	0.135	0.081	19.97

Sources: BTRE 2003 p21

TABLE 9 Base case projections of vehicle kilometres travelled by type of vehicle for Hobart, 1990-2020

(billion kilometres)

Year	*Cars*	*Light Commercial Vehicles*	*Articulated trucks*	*Rigid and other trucks*	*Buses*	*Motor cycles*	*Total*
1990	1.130	0.186	0.011	0.095	0.017	0.011	1.450
1991	1.107	0.176	0.010	0.089	0.017	0.010	1.410
1992	1.147	0.177	0.011	0.087	0.017	0.010	1.449
1993	1.178	0.188	0.011	0.085	0.017	0.010	1.489
1994	1.203	0.189	0.012	0.085	0.018	0.009	1.517
1995	1.257	0.198	0.013	0.087	0.018	0.009	1.581
1996	1.293	0.214	0.014	0.087	0.018	0.009	1.636
1997	1.308	0.217	0.014	0.086	0.019	0.009	1.653
1998	1.283	0.218	0.014	0.084	0.019	0.009	1.629
1999	1.347	0.226	0.015	0.084	0.020	0.009	1.700
2000	1.389	0.220	0.015	0.082	0.021	0.009	1.735
2001	1.367	0.230	0.015	0.082	0.020	0.009	1.723
2002	1.381	0.239	0.016	0.085	0.020	0.009	1.750
2003	1.414	0.246	0.016	0.085	0.020	0.009	1.790
2004	1.448	0.252	0.016	0.086	0.020	0.009	1.831
2005	1.475	0.259	0.016	0.086	0.020	0.009	1.866
2006	1.484	0.264	0.017	0.086	0.020	0.009	1.880
2007	1.492	0.271	0.017	0.086	0.020	0.009	1.896
2008	1.500	0.276	0.018	0.086	0.020	0.009	1.908
2009	1.506	0.281	0.018	0.086	0.021	0.009	1.920
2010	1.511	0.288	0.019	0.086	0.021	0.008	1.932
2011	1.514	0.293	0.020	0.086	0.021	0.008	1.940
2012	1.515	0.298	0.020	0.085	0.021	0.008	1.947
2013	1.516	0.303	0.021	0.085	0.021	0.008	1.954
2014	1.517	0.308	0.021	0.084	0.021	0.008	1.959
2015	1.515	0.313	0.022	0.084	0.021	0.008	1.963
2016	1.513	0.318	0.022	0.083	0.021	0.008	1.966
2017	1.511	0.325	0.023	0.083	0.021	0.008	1.971
2018	1.507	0.330	0.024	0.082	0.021	0.008	1.972
2019	1.504	0.335	0.024	0.082	0.021	0.008	1.974
2020	1.500	0.340	0.025	0.081	0.021	0.008	1.975

Sources: BTRE 2003 p24

TABLE 10 Base case projections of vehicle kilometres travelled by type of vehicle for Darwin, 1990-2020

(billion kilometres)

Year	*Cars*	*Light Commercial Vehicles*	*Articulated trucks*	*Rigid and other trucks*	*Buses*	*Motor cycles*	*Total*
1990	0.395	0.162	0.010	0.049	0.013	0.009	0.637
1991	0.418	0.154	0.009	0.047	0.013	0.008	0.648
1992	0.446	0.155	0.009	0.045	0.013	0.008	0.677
1993	0.455	0.165	0.010	0.045	0.013	0.008	0.695
1994	0.461	0.167	0.010	0.045	0.013	0.008	0.706
1995	0.479	0.176	0.011	0.047	0.014	0.008	0.735
1996	0.490	0.193	0.012	0.047	0.015	0.009	0.766
1997	0.497	0.196	0.013	0.047	0.015	0.009	0.777
1998	0.517	0.198	0.013	0.046	0.016	0.009	0.798
1999	0.526	0.207	0.014	0.046	0.017	0.009	0.819
2000	0.546	0.204	0.014	0.045	0.018	0.009	0.836
2001	0.547	0.215	0.014	0.046	0.018	0.009	0.849
2002	0.563	0.226	0.015	0.048	0.018	0.009	0.878
2003	0.588	0.233	0.015	0.048	0.019	0.009	0.912
2004	0.610	0.240	0.015	0.049	0.019	0.009	0.943
2005	0.630	0.249	0.016	0.049	0.020	0.009	0.973
2006	0.643	0.255	0.016	0.050	0.020	0.009	0.993
2007	0.656	0.262	0.017	0.050	0.021	0.009	1.015
2008	0.669	0.268	0.017	0.050	0.021	0.009	1.035
2009	0.681	0.275	0.018	0.050	0.022	0.009	1.055
2010	0.693	0.283	0.019	0.051	0.022	0.009	1.076
2011	0.705	0.289	0.019	0.051	0.023	0.010	1.096
2012	0.715	0.296	0.020	0.051	0.023	0.010	1.114
2013	0.726	0.302	0.020	0.051	0.024	0.010	1.133
2014	0.736	0.309	0.021	0.051	0.024	0.010	1.151
2015	0.747	0.316	0.022	0.051	0.025	0.010	1.169
2016	0.757	0.323	0.022	0.051	0.025	0.010	1.187
2017	0.767	0.332	0.023	0.051	0.026	0.010	1.209
2018	0.777	0.339	0.024	0.051	0.026	0.010	1.227
2019	0.787	0.346	0.025	0.051	0.027	0.010	1.245
2020	0.797	0.353	0.025	0.050	0.027	0.010	1.263

Sources: BTRE 2003 p27

TABLE 11 Base case projections of vehicle kilometres travelled by type of vehicle for ACT (Canberra), 1990-2020

(billion kilometres)

Year	*Cars*	*Light Commercial Vehicles*	*Articulated trucks*	*Rigid and other trucks*	*Buses*	*Motor cycles*	*Total*
1990	2.316	0.384	0.004	0.059	0.020	0.034	2.818
1991	2.300	0.364	0.004	0.056	0.021	0.033	2.777
1992	2.412	0.367	0.004	0.054	0.021	0.033	2.891
1993	2.472	0.393	0.004	0.054	0.021	0.032	2.975
1994	2.520	0.399	0.004	0.054	0.021	0.032	3.031
1995	2.626	0.421	0.005	0.056	0.022	0.031	3.161
1996	2.698	0.461	0.005	0.057	0.023	0.032	3.276
1997	2.723	0.479	0.005	0.058	0.023	0.032	3.321
1998	2.701	0.494	0.006	0.058	0.024	0.031	3.314
1999	2.804	0.522	0.006	0.059	0.025	0.031	3.447
2000	2.822	0.519	0.006	0.058	0.026	0.032	3.463
2001	2.803	0.552	0.006	0.060	0.026	0.032	3.478
2002	2.850	0.583	0.007	0.062	0.026	0.032	3.560
2003	2.947	0.607	0.007	0.063	0.026	0.032	3.683
2004	3.054	0.629	0.007	0.065	0.027	0.032	3.813
2005	3.136	0.655	0.007	0.066	0.027	0.032	3.923
2006	3.179	0.676	0.008	0.066	0.027	0.032	3.988
2007	3.221	0.700	0.008	0.067	0.028	0.032	4.057
2008	3.262	0.722	0.008	0.068	0.028	0.032	4.119
2009	3.300	0.744	0.009	0.069	0.028	0.032	4.181
2010	3.336	0.770	0.009	0.070	0.029	0.032	4.246
2011	3.367	0.794	0.009	0.070	0.029	0.032	4.302
2012	3.396	0.818	0.010	0.071	0.029	0.032	4.355
2013	3.424	0.842	0.010	0.071	0.030	0.032	4.409
2014	3.449	0.867	0.010	0.072	0.030	0.032	4.460
2015	3.474	0.893	0.011	0.072	0.030	0.032	4.511
2016	3.495	0.919	0.011	0.073	0.030	0.031	4.561
2017	3.517	0.952	0.012	0.074	0.031	0.031	4.617
2018	3.536	0.981	0.012	0.074	0.031	0.031	4.666
2019	3.555	1.010	0.013	0.074	0.031	0.031	4.715
2020	3.573	1.040	0.013	0.075	0.032	0.031	4.764

Note: For simplicity, all VKT within the ACT is assigned to 'metropolitan' travel.

Sources: BTRE 2003 p30

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