Assessment of the Australian Road System

Report

This Report provides an assessment of the status of the Australian Road System and an examination of its future funding requirements. Roads are divided into the categories recognised by Commonwealth road funding legislation: National Highways (16050 kilometres); rural arterials (89600 kilometres); urban arterials (15400 kilometres); local roads (677400 kilometres).

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FOREWORD

This report of a study of the Australian road system comes at a time when current Commonwealth initiatives in land transport are well advanced. The five-year Australian Land Transport Program which began in July 1985, will conclude on 30 June 1990. Although the six-year Australian Bicentennial Road Development program, which began in 1982, was meant to conclude on 31 December 1988, a five-year extension to this program was announced in the 1987 May Economic Statement by the Treasurer. In physical terms, the National Highway system, which is entirely funded by the Commonwealth Government, will be almost fully sealed in the near future. Accordingly, it was perceived that the distribution and level of funds directed to roads by the Commonwealth, might be examined.

In light of these considerations, a study by the Bureau of Transport Economics of the Australian road system was seen as timely and Ministerial terms of reference were given to the Bureau in May 1986.

The report is a self-contained document which describes and brings together the various discrete sub-studies undertaken within each branch of the Bureau. The study was co-ordinated and directed by the Assistant Director of Special Studies Branch. The Bureau reported on previous assessments in 1984 and 1979 and similar reports were prepared by the former Commonwealth Bureau of Roads in 1969, 1973 and 1975.

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Canberra
October 1987

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SUMMARY OF MAIN FINDINGS

This report provides an assessment of the status of the Australian Road System and an examination of its future funding requirements. Roads are divided into the categories recognised by Commonwealth road funding legislation

- National Highways (16 050 kilometres)
- rural arterials (89 600 kilometres)
- urban arterials (15 400 kilometres)
- local roads (677 400 kilometres).

For National Highways and rural arterials, the status assessed is that which is expected to be reached by 1989 (at the conclusion of the current phase of the Australian Bicentennial Road Development Program), and the funding requirements are assessed against a range of economic and technical objectives for the period 1989 to 2000.

The analysis of urban arterial roads is hampered by lack of data and the inherent complexity resulting from the highly interconnected road networks and the close interaction of the networks with adjacent land uses. The analysis of local roads, too, suffers from a lack of detailed data. Because of these difficulties it was not possible to assess the status and determine the funding requirements for urban arterials and for local roads as rigorously as was possible for National Highways and rural arterials.

THE SIGNIFICANCE OF ROAD INFRASTRUCTURE

The significance of roads for Australian land transport is highlighted by a consideration of the distribution of resources devoted to land transport and of the proportion of the land transport task which takes place on roads.

- Road transport accounts for 80 per cent of the resources devoted to land transport.

- Of the resources devoted to road transport, less than 25 per cent is for the provision of road infrastructure.
- Over 97 per cent of passenger travel (person-kilometres) takes place on the roads.
- About half of all freight transport (tonne-kilometres) takes place on roads.
- If low-value, bulk commodities (which dominate rail freight) are excluded, road accounts for over 80 per cent of the remaining, higher-valued, general freight.

ROAD CAPACITY AND TRAFFIC VOLUMES

In general, high capacity (wider) roads are provided to cater for high traffic volumes. On the National Highways and rural arterials, however, a degree of mismatch between road capacity and traffic levels has occurred. Substantial lengths of wide, two lane road have been provided for low traffic volumes while narrower roads carry higher traffic volumes.

FUNDING FOR ALTERNATIVE ROAD OBJECTIVES

Current funding by all levels of Government for National Highways and rural arterials are compared with funding estimated to be required to achieve three alternative objectives:

- preservation of the physical condition of the road system (preservation of the physical asset);
- preservation of the physical condition of the road system and the level of service in the face of traffic growth (preservation of operational performance);
- undertake all economically justified projects (projects with benefit-cost ratios greater than one).

National Highways

Annual expenditure, averaging $490 million[1], has been high in recent years because of the program to seal the entire National Highway system. As this program will be largely complete by 1989, there will be scope to redirect Commonwealth funds to other areas.

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1. Unless otherwise noted, funding levels are in constant 1985-86 prices.

Funding to undertake all economically justified projects is estimated at $390 million per year. This would permit a steady improvement in the operational performance of the system.

Preservation of the current operational performance would require funding of $290 million per year.

The figures quoted are aggregates for the entire National Highway system. However, the situation varies between States and the funding of all economically justified projects would involve a significant redistribution of funds among the States.

Rural arterials

Parts of the rural arterial network provide operational performance, the preservation of which cannot be economically justified for the volumes of traffic they carry. Preservation of current operational performance would require funding of $1 060 million per year.

Funding of only economically justified projects would require $880 million per year and would involve the acceptance of some reduction in operational performance on parts of the rural arterial network. Nevertheless, this would represent an increase over recent funding levels which have been under $800 million per year.

Urban arterials

Current funding of urban arterials appears to be sufficient to preserve operational performance in the short term. However, as three quarters of Australia's population increase is occurring in the capital cities, continuing upgrading and expansion of the urban arterial networks will be necessary and will require increased funding in the longer term.

In addition, the Commonwealth Government has drawn attention to the economic importance of certain urban arterial routes, in particular those making connections to the National Highways and to ports, airports and industrial zones. High returns, and benefits to the economy and to exports may be obtained from upgrading projects on some of these routes. Additional funding may be justified to accelerate such projects.

Local roads

Current funding levels permit a gradual improvement in local road conditions including a growth in their total sealed length.

Absorption of the Commonwealth contribution to local roads into general purpose grants would result in some reduction in funds actually devoted to roads. The impact would be greatest in rural areas.

REDISTRIBUTION OF COMMONWEALTH ROAD FUNDS

Commonwealth road funding of $1 250 million (at current prices) has been foreshadowed for 1987-88. This corresponds to $1 084 million in 1985-86 prices and represents a reduction of 5 per cent on the average for the period 1980-81 to 1984-85. Options for the distribution of these funds were examined under the assumption that State and local governments would continue their own funding at the average for the 1980-81 to 1984-85 period.

The foreshadowed funding level was chosen as a reference case. Funding for National Highways would correspond to that required to undertake all economically justified projects. While this represents a reduction of over $100 million as compared with recent levels, a steady improvement in the National Highway system would be maintained. The balance of Commonwealth funds would be distributed among the rural arterials, urban arterials and local roads in the proportions recommended by the Inquiry into the Distribution of Federal Road Grants (Cameron Report 1986). Funding for rural arterials would be somewhat above recent levels while that for urban arterials would be significantly increased. Funding for local roads would be reduced.

Options with total Commonwealth funding 10 per cent above and below the reference case were also examined. Additional scope for the redistribution of funds is provided by proposals for the extension of the National Highway system.

NATIONAL HIGHWAY EXTENSIONS

The scope for extending the National Highway system by incorporating selected rural and urban arterial routes of national or economic significance was examined. Such extensions would permit the Commonwealth to consolidate its road interests (except for local roads) in an expanded National Highway system for which it assumed full responsibility for funding and choice of objectives. Funding for the additional routes would be covered by the corresponding reduction in the funding needs of the arterial networks. A rationalisation of funding responsibilities would be achieved if the whole of the Commonwealth contributions to the rural and urban arterial networks were redirected to fund National Highway extensions. These limiting cases are illustrated in the options for funding redistribution and the corresponding extent of routes transferred to the National Highways is indicated below. However, a smaller transfer of arterial routes and funding responsibilities is feasible and might be preferred.

Rural extensions

Candidates for rural extensions included:

- routes serving ports, industry and exports;
- routes joining capital cities, major provincial cities and important regional centres;
- routes of defence significance.

The Commonwealth contribution to rural arterials in the reference funding option is $220 million per year. If this sum were directed instead to National Highway extensions, 3750 kilometres of rural routes in the above categories could be funded.

Urban extensions

Urban arterial routes of national and economic significance are primarily

- routes making connections with the termini of existing National Highways
- routes making connections to ports, airports and the principal industrial zones.

Commonwealth funding for urban arterials in the reference funding option is $287 million per year. If redirected to National Highway extensions, all of the scheduled projects in the above categories could be funded.

CHAPTER 1 INTRODUCTION

BACKGROUND

In May 1986 the Minister for Transport directed the Bureau of Transport Economics (BTE) to undertake an assessment of the Australian road system.

In undertaking this study, the present arrangements, responsibilities and funding sources by the three levels of government represent an important consideration. While the study does not enquire if the arrangements should continue, the analysis provided in the report should generally assist in any future decisions concerning this issue. In approximate terms, the Commonwealth Government, State goverments and Local Government Authorities (LGAs) each contribute a third of the total road funding for routine maintenance, rehabilitation works, upgrading and new construction. The responsibilities of each level of government vary across road categories and this matter is discussed in the report.

For the purposes of this analysis, the Australian road system has been considered as comprising four categories: these are National Highways, rural arterials, urban arterials and local roads. This classification is the same as used in past roads studies, and the Terms of Reference have identified tasks to be undertaken in the period to the year 2000 by reference to these road categories.

Although the scope of assessment includes all road categories, the Terms of Reference place emphasis on the evaluation of the National Highway system. Within this road category, three major assessments are sought; they are to determine the continuing costs of road preservation; the costs of upgrading links to National Highway standards where this is economically justified; and the implications of adding major rural or urban road links to the National Highway system, having regard to the importance of such roads. The Terms of Reference, while noting the primary responsibility of State and Territory governments for arterial roads (urban and rural), call for a consideration of issues the Commonwealth Government should take into account in regard to the funding it directs to these road categories. An assessment of the requirements of local roads is also sought.

Although the Terms of Reference emphasise the assessment of National Highways, the Bureau's investigations have been conducted across all four road categories. Nonetheless, it is evident in the report, that the scope and analytical detail is more extensive for National Highways and rural arterials and less comprehensive for urban arterials and local roads.

In undertaking this study, the BTE used data principally made available by all State Road Authorities (SRAs), who also provided assistance with data interpretation. In addition to other published material, a number of agencies made specific submissions to the BTE and, within the scope of the Terms of Reference, this material has been considered.

Some consideration of rail transport has been included in the report, relating primarily, but not exclusively, to those operations where railways provide alternative or competing means of transport to road-based activities. Thus, while the report deals essentially with roads, the total land transport system in Australia has been described broadly with a detailed discussion of the areas of modal competition.

PERSPECTIVE ON ECONOMIC ANALYSIS

In earlier road assessment reports by the BTE and the CBR, an important, but not necessarily dominant, component of the work has been the application of benefit-cost analysis techniques in the assessment process. In this report, that approach is continued, although some further development of thinking on the appropriate application of benefit-cost analysis has occurred.

At the heart of benefit-cost analysis of road projects, is the empirical evidence, that capital works to upgrade a road system will produce direct benefits flowing from decreased vehicle operating costs, and from travel time savings through increased average speeds. Further direct benefits arise from reductions in the frequency and severity of accidents. There is also a range of other indirect benefits, including such factors as social and economic development. Against these benefits must be weighed the cost of upgrading, which usually involves both capital expenditure and variation to routine maintenance and rehabilitation profiles. The incidence of all these factors may vary markedly across road categories. However, benefit-cost analysis of roads could notionally be applied to all categories, from National Highways through to local roads.

As in many economic evaluations, not all of the original elements of benefit have the same intrinsic units of measurement, nor do they all readily correspond with the monetary unit (dollar) which measures capital investment. Consequently, some judgement is required to transform these elements into monetary terms, in order to allow direct comparison between costs and benefits.

The main items of resource costs and direct benefits associated with benefit-cost analysis of road projects are set out in Table 1.1. The three directly measurable elements of benefit are usually referred to jointly as road user benefits.

While the derivation of a suitable transform value for the value of time depends on, *inter alia*, trip purpose, there is general, but by no means universal, acceptance of the values to be used for non-work and work trip purposes; nor, for that matter, is it agreed that small travel time savings should be valued at the same rate as large time savings. Similarly, the value of human life may be inferred variously by reference to lost past and future earnings as well as foregone family and community contributions. Clearly, there are further assumptions which must be made to facilitate any analysis, but the foregoing provides the essential nature of the road project assessment process.

All elements of benefit apply to the various road categories, but the distribution varies considerably among categories. Table 1.2 illustrates this point and also includes benefits from 'other' sources. Other sources of benefits are generally regarded as indirect benefits and, for example, include reductions in dust, noise and losses of production. In addition, the benefits attributable to increased numbers of trips generated by improved roads were treated as indirect benefits in the past road studies represented in Table 1.2. In the present study, indirect benefits have not been estimated. However, growth in traffic activity has been estimated, including generated traffic.

It is clear from Table 1.2 that there is a considerable variation in the distribution of benefits from upgrading urban and rural arterial roads. To a large extent, this is a result of the prevailing traffic conditions. Rural arterials are generally characterised by high speeds and low traffic volumes, whereas average urban arterial speeds are in the range of 30-60 kilometres per hour, and roads are subject to high traffic flows and motorists may experience significant delay. This benefit distribution information, however, gives no indication as to the relative level of overall benefits likely to be associated with improvements in the various road categories. Generally, for a given

TABLE 1.1 DIRECTLY MEASURABLE COST AND BENEFIT SOURCES OF ROAD IMPROVEMENT PROJECTS

Item	*Cost or benefit*	*Intrinsic unit of measurement*	*Transformed unit of measurement*	*Transform required*[a]
Capital investment and maintenance	Cost	Concrete, steel, bitumen, machinery, labour, etc	$	None
Vehicle operation	Benefit[b]	Oil, petrol, tyres, wear and tear, capital replacement	$	None
Vehicle occupant time	Benefit[b]	Person minutes	$	Value of time in $ per minute
Accident	Benefit[b]	Value of human life and suffering and vehicle repairs	$	Human life in $ per fatality, etc

a. To convert to monetary units.
b. Obtained as the differential improvement associated with project.

Source BTE estimates.

TABLE 1.2 DISTRIBUTION OF ROAD BENEFITS ASSOCIATED WITH TYPICAL PROJECTS

(per cent)

Road Category	*Vehicle operation*	*Occupant time*	*Accidents*	*Other*	*Total*
Rural arterial[a]	39-41	30-38	3-4	19-26	100
Urban arterial	22-38	50-59	10-16	2-3	100
Urban local	b	b	100		100
Rural local	c	c	c	c	100

a. Including National Highways.
b. Benefits not normally imputed for this characteristic.
c. Benefit distribution lies between that of rural arterial and urban local roads.

Source Derived from Commonwealth Bureau of Roads (1973, 1975).

degree of improvement, the relative level of benefits could be expected to be related to the mean daily traffic volume for each category of road, which is indicated (in ratio terms) in Table 1.3.

The information on traffic volume ratios is useful in illustrating the relative intensity of the transport effort performed on urban arterials, which is some eight times higher than for the next most trafficked category. Also, at first sight, it may appear that, because traffic on urban local roads is about twice that on rural arterials, the ratio of benefits would be similarly related. This is not so, because improvements in travel speed are not usually an objective, nor are they generally achieved, in urban local road projects. Little is known about the benefit distribution on urban local roads, but it is generally considered to be distributed among accident and 'other' improvements. The overall level of direct benefits on urban local roads is probably much less than would be inferred from the amount of traffic they carry. This does not necessarily imply, however, that the economic performance of such roads would be low, because construction costs of local roads are generally much lower than for arterial roads.

There is a similar lack of knowledge concerning rural local roads, although it is likely that motorist behaviour on these roads more closely approximates that on rural arterials, because the length of many rural road local links is substantial. In a defacto sense, therefore, these roads have many of the characteristics of arterial

TABLE 1.3 AVERAGE TRAFFIC VOLUME RELATIVE TO RURAL LOCAL ROADS

Road category	*Volume ratio*
Urban arterial	200
National Highway	25
Urban local	18
Rural arterial	9
Rural local	1

Source Derived from BTE (1984d).

roads (in particular, travel speeds can be high). In other words, the benefit distribution of rural local road improvement could be similar to that of rural arterials, but may also have the attributes of urban local roads. On average, because traffic levels on rural local roads are one-ninth of those on rural arterials, the level of benefits from similar upgradings will be correspondingly low, and it is difficult to make out a case for funding rural local roads on benefit-cost grounds alone. However, in reality, the funding of the local roads category (urban and rural) absorbed about 43 per cent of all roads expenditure in 1984-85. It would appear, that other investment criteria modify the economic argument for local road improvements.

In the foregoing, the benefits obtained from improving the road system have been discussed without any reference to the relationship between transport and land use. The transport-land use interaction is commonly held to represent a small effect when considering rural arterial projects. The benefits of upgrading are, therefore, measured as though they were confined to the actual users of, or activities immediately adjacent to, the road link under consideration. Only a small portion of the estimated traffic growth would be related to the interaction effects.

In the urban context, the transport-land use interaction is much stronger and the transport and land use effects extend further than both on, and immediately adjacent to, a particular road link which has been upgraded. A proper consideration of urban arterial projects should include spatial, network and temporal effects of transport changes. In particular, the interaction between transport and land use introduces a compounding effect, whereby transport upgradings may induce land use changes (or intensification of use) which in turn stimulate further changes in transport demand.

The methodological principles for analysing rural and urban arterial projects are essentially the same; nevertheless, it can be seen that the process is much simpler for rural projects, where only the characteristics of a particular project need be addressed. For urban projects, the urban transport network and land use should be jointly considered, necessitating the assembly of a great deal of information.

From the above dicussion it is concluded that current benefit-cost analysis techniques provide satisfactory procedures for assessing the merits of programs in the National Highway and rural arterial roads categories, but are somewhat less satisfactory for urban arterial road analysis, unless this is carried out by considering the upgrading project within the context of the urban road network. The procedures generally do not lend themselves to assessment of local roads.

Private and commercial benefits

Table 1.2 shows that vehicle operating costs and occupants' time, collectively dominate road user benefits on both rural and urban arterial roads, although 'other' benefits represent a significant component of total benefits for rural arterial projects. In urban areas, where vehicle occupants' time savings account for between 50 and 60 per cent of all benefits, commercial vehicle activity alone makes up more than three-quarters of this component (Commonwealth Bureau of Roads 1975). Based on Table 1.2 and the estimates contained in Commonwealth Bureau of Roads (1975), commercial vehicle time savings thus account for between 40 and 45 per cent of all benefits arising from urban projects. For rural arterial projects, vehicle occupants' time savings are considerably lower, being in the range of about 30 to 40 per cent of all benefits. Again, commercial vehicle activity makes up about three-quarters of this saving, or 20 to 30 per cent of all benefits.

Information concerning the distribution of vehicle operating cost savings has not been presented in past roads studies, but in the present study, it has been determined that for National Highways and rural arterials, commercial vehicle activity represents approximately one-third of this source of benefits. On this basis, reduced operating costs of commercial vehicles account for 13 per cent of all benefits arising from rural projects. In summary, overall commercial vehicle activity is estimated to account for between 33 and 43 per cent of all benefits for National Highways and rural arterials.

In the case of urban arterials, and assuming that vehicle operating costs are similarly distributed, commercial vehicle activity is estimated to account for between 48 and 57 per cent of all benefits to this road category. It can also be seen that, although commercial vehicle numbers are considerably exceeded by private passenger cars, commercial vehicle benefits constitute about one-half of total benefits in the case of urban arterials and about a third for National Highways and rural arterials.

The estimates presented depend critically on the values attributed to time savings on work and non-work trips. In this study, the values chosen are consistent with the most recent estimates.

ROAD CLASSIFICATION

The current *Australian Land Transport (Financial Assistance) Act 1985* uses a four-category classification system, providing funds separately for National Highways and developmental roads[1], urban arterial roads, rural arterial roads, and local roads. Funds for interstate rail capital works may be provided from the National Highways or rural arterial roads categories. In dealing with funding legislation at the national level, it is necessary to consider road categories as detailed in the legislation.

Each State has its own system for road classification, as indicated in Table 1.4. The classifications have been developed over a period of time to meet the particular legal and operational requirements in each State and are only partially comparable between States. They are used fairly extensively in the documentation of road-related matters, but they are not suitable for comparative analysis. For this reason, the National Association of Australian State Road Authorities (NAASRA) developed a Functional Classification System for roads which has been generally adopted for analysis purposes (BTE 1979, 9).

The NAASRA functional classes of roads number one to nine. Classes 1 to 5 apply to rural roads and are, respectively, arterial, sub-arterial, collector, local and special. Classes 6 to 9 apply to urban roads and are, respectively, arterial, sub-arterial, local and special.

Since an important application of the results of the BTE study could relate to the allocation of Commonwealth funds, this consideration, together with a requirement for a classification system sufficiently disaggregated for detailed analysis, led to the Commonwealth and

1. Referred to henceforth as National Highways.

TABLE 1.4 STATE ROAD CLASSIFICATIONS

NSW	*Vic*	*Qld*	*SA*[a]	*WA*	*Tas*	*NT*
Freeways	Freeways					
State highways	State highways	Highways	State highways	State highways	Highways	
Trunk roads						
Main roads	Main roads	Main roads	Main roads	Main roads	Main roads	Main roads
Development roads[c]		Development roads[c]			Development roads[c]	
Tourist roads	Tourist roads				Tourist roads	
	Forest roads					
Secondary roads		Secondary roads	District roads	Secondary roads	Secondary roads[b]	Secondary roads
						Local roads

TABLE 1.4 (Cont.) STATE ROAD CLASSIFICATIONS

NSW	*Vic*	*Qld*	*SA*[a]	*WA*	*Tas*	*NT*
Unclassified roads	Unclassified roads			Unclassified roads		Other roads
		Urban arterial roads				
		Urban subarterial roads				

a. South Australia has no State road classification system, but uses categories shown for practical purposes.
b. The roads are grouped as Subsidiary roads.
c. Development roads as classified in New South Wales, Queensland and Tasmania are not the same as the Commonwealth category of Developmental Roads used in some legislation.

Source BTE (1984c).

NAASRA functional classifications being combined and consolidated. For the purposes of discussion within this report, roads are generally categorised as:

- National Highways;
- rural arterial roads, comprising NAASRA Classes 1, 2 and 3;
- urban arterial roads, comprising NAASRA Classes 6 and 7;
- rural local roads, comprising NAASRA Classes 4 and 5; and
- urban local roads, comprising NAASRA Classes 8 and 9.

Special roads, or NAASRA Classes 5 and 9, are subsumed in other categories. For some parts of the analysis and discussion local roads were further divided into rural (Class 4) and urban (Class 8).

Commonwealth control over programs and projects was extended a little under the ALTP Act 1985, compared with the *Road Grants Act 1981* which it replaced. Approval of project details only was required for national roads under the 1981 Act; it may now also be required for full arterial road programs. However, there are agreed principles for the allocation of funds to the States for local roads as in the earlier legislation, and approval can be given under the new Act for capital works on interstate railways, for land transport research and for road safety. The ALTP is financed by a share of the fuel excise, indexed to the consumer Price Index (CPI).

The ABRD program is funded directly from a two cents per litre surcharge on motor spirit and automotive distillate. These fuels are predominantly used by motor vehicles operating on public roads. Railways, however, also use automotive distillate and pay all Commonwealth fuel excises.

ABRD funds are restricted to construction projects. The definition of construction includes upgrading and rehabilitation of roads, as well as some re-sealing (see Chapter 5). Projects may be for all categories of roads and for urban public transport, where it will reduce traffic on the urban arterial raod system. The principles formulated for the allocation of road funds to local government are approved by the Commonwealth Government.

STRUCTURE OF THE REPORT

Chapter 2 provides an overview of the land transport system in Australia. In essence, this amounts to a discussion of the two principal modes road and rail. The description of the respective roles of the modes sets the report in context. The remainder of the report deals exclusively with the Australian road system.

In Chapter 3, the historical development of the Australian road system is discussed, with particular emphasis on developments in the last 25 years. Current aggregate statistics of the system are provided, followed by forecasts of travel, vehicle numbers and other relevant parameters to the year 2000. Chapter 4 provides an historical perspective to road financing in recent years.

Chapters 5, 6 and 7 deal with National Highways and rural arterials, urban arterials and local roads, respectively. National Highways and rural arterials have been dealt with together for a number of reasons, including their joint inclusion in the inventory data base, similarities in function, method of analysis and because certain rural arterials have been considered for possible addition to the National Highway system.

In Chapter 8, the scope for alternative distributions of Commonwealth Government road funds among road categories is considered. The bases for this consideration are the analytical results obtained and future funding levels which might pertain in the analysis period (to the year 2000).

CHAPTER 2 LAND TRANSPORT IN AUSTRALIA

Road and rail transport provide a wide variety of transport services which satisfy both the travel and freight movement demands of the community. For passenger travel, the main vehicles used include buses, trains and trams in urban areas, coaches for regional and long distance travel, regional and interstate passenger trains and passenger cars. Freight movements are accommodated in bulk and non-bulk freight trains, with payloads up to 15 000 tonnes, and an extensive range of commercial road vehicles which operate in urban and non-urban areas, with payloads ranging predominantly from one-half to 25 tonnes.

The ownership of transport enterprises is distributed between the public and private sectors, although, with the exception of privately owned railways, the infrastructure is usually under the jurisdiction of the Commonwealth and State governments.

LAND TRANSPORT PROVISION

Table 2.1, is based on the most recent information available from input-output tables for 1980-81 (ABS 1987).

TABLE 2.1 ANNUAL COST OF PROVISION OF LAND TRANSPORT: AUSTRALIA, 1980-81 (CURRENT PRICES)

Type of provision	*($ million)*	*(per cent)*
Road and bridge construction	3 099	18
Road transport services	6 033	35
Private transport	5 026	29
Railways infrastructure and operations	3 087	18
Total	17 245	(100.0)

Sources Derived from ABS (1987). BTE estimates.

The amounts shown, which can only be regarded as indicative, include resources used for upkeep of infrastructure and replacement of vehicle fleets. Resources allocated to private transport amount to 29 per cent of total annual investment in land transport and exceed the expenditure on road and bridge construction. The distribution of resources between the road and rail modes is 82 per cent and 18 per cent, respectively, emphasising the dominant role of road transportation in Australia.

LAND TRANSPORT ACTIVITY

Aggregate measures of passenger travel and freight transport activity are, respectively, passenger-kilometres and tonne-kilometres and are shown in Table 2.2 for the two surface transport modes.

Table 2.2 shows that the freight task is nearly identical for both modes, whereas road transport carries about 36 times as much passenger traffic as rail. These statistics are useful strategically; they are of little assistance, on their own, however, in understanding the specific component tasks of these two modes.

The component tasks considered in this report have been confined to those where road and rail services compete by providing alternative means of satisfying a transport demand. This approach removes from consideration the freight task of non-government railways which amounted to 28 400 million tonne-kilometres in 1984-85, and the bulk

TABLE 2.2 LAND TRANSPORT ACTIVITY: AUSTRALIA, 1984-85[a]

Mode	*Passenger (million kilometres)*	*Freight (million tonne-kilometres)*
Road[b]	217 000	74 300
	(97.4)	(50.3)
Rail	5 900	73 400
	(2.6)	(49.7)
Total	222 900	147 700
	(100.0)	(100.0)

a. Car and truck data for year ending 30 September 1984; passenger train, bus and coach data for 1983-84.
b. Includes bus, tram, coach and car travel.

Sources ABS (1986a, 1986b). BTE (1986b, 1985a) and estimates.

freight task[1] performed by government railways, which is estimated at 35 400 million tonne-kilometres. The remaining rail freight task on government railways is 9600 million tonne-kilometres and characterised as general freight. The road freight task is comprised of 25 100 million tonne-kilometres in urban areas, with the balance of 49 200 million tonne-kilometres in non-urban areas. It is estimated that 25 per cent of the non-urban road freight task consist of bulk shipments, leaving 37 000 million tonne-kilometres competing with rail. The urban task is largely the domain of commercial road vehicles, since rail freight in urban areas is negligible.

Table 2.3 summarises the competitive land transport task in Australia. It must be noted that the table, by definition, excludes 87 per cent of the rail freight task, but only 50 per cent of the road freight task, highlighting the dominance of rail in the regulated bulk freight market. However, in the carriage of general freight, where road and rail do compete, road operators have captured almost 80 per cent of the market.

Table 2.3 also shows the dominance of the private car in urban and non-urban passenger transport (excluding travel on foot and by bicycle) accounting for 95.5 and 93.2 per cent of this activity, respectively. Urban passenger activity is nearly three times that of the non-urban component.

The overview of land transport in Australia presented in Tables 2.2 and 2.3, reveals the pervasive role played by roads, on which 97 per cent of all passenger activity and 50 per cent of all freight activity is undertaken. In the following sections, some further analysis of these competing transport services is provided.

URBAN PASSENGER TRAVEL

Table 2.3 shows that rail and road-based urban public transport services (including trams) enjoy approximately the same share of patronage, although their combined services cater for only 4.5 per cent of total urban passenger activity, averaged throughout the day. Public transport services generally operate to their full capacity only in peak periods and account for a high proportion of work trips to and from the central business areas of capital cities.

The provision of public transport has historically been planned as a radial service emanating from the core of cities. While some changes

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1. Minerals (principally coal), grains, limestone, cement and petroleum products, but including a minority of non-bulk freight such as agricultural products, iron and steel and timber.

TABLE 2.3 LAND TRANSPORT ACTIVITY: AUSTRALIA, SELECTED TASKS, 1984-85

	Urban passenger activity	*Non-urban passenger activity*	*Non-urban general goods freight activity (million tonne-kilometres)*
	(million passenger-kilometres)		
Road			
Bus and tram	3 400 (2.1)	..	..
Coach	..	2 000 (3.4)	..
Passenger car	155 000 (95.5)	55 000 (93.2)	..
Commercial vehicle	..	..	37 000 (79.4)
Rail			
Passenger	3 900 (2.4)	2 000 (3.4)	..
Freight	..	..	9 600 (20.6)

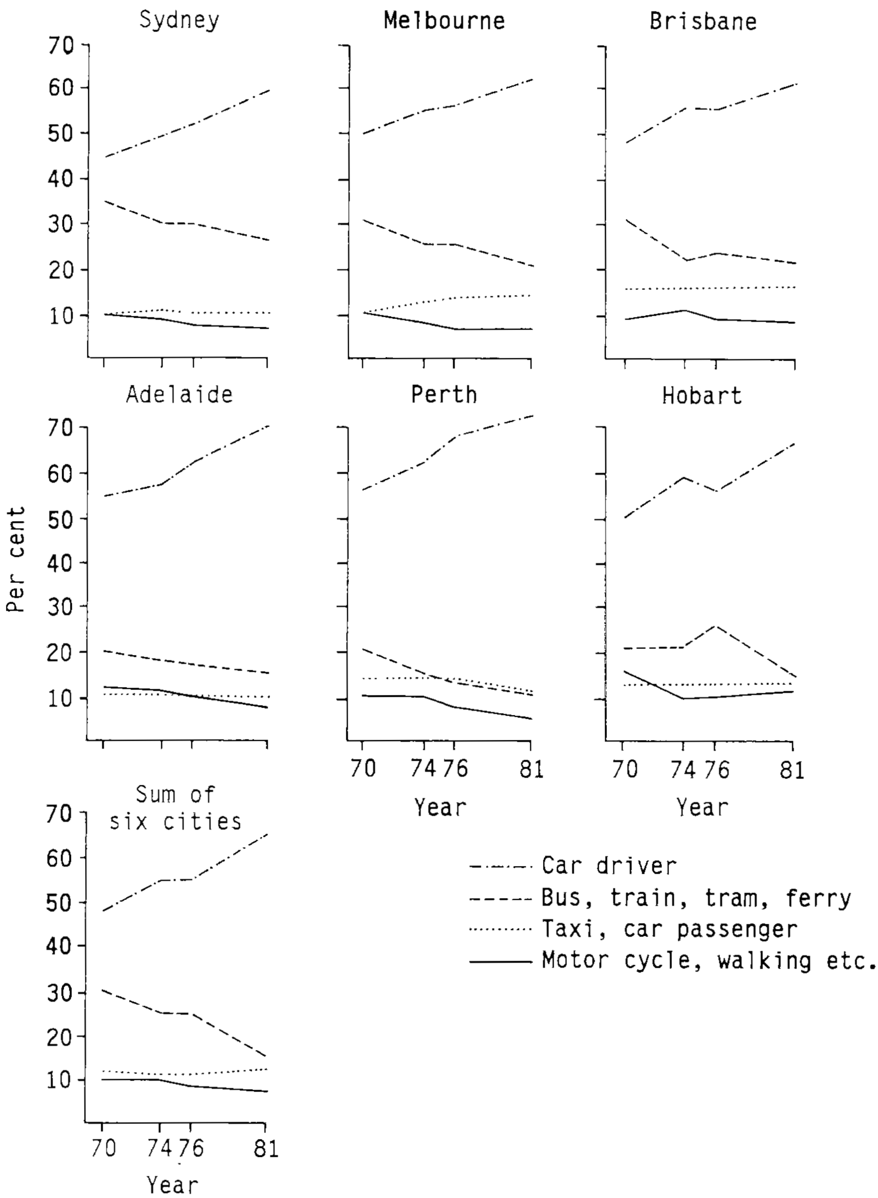
.. Not applicable.

Note Figures in parentheses are percentages of column total.

Source BTE estimates.

to this basic philosophy have been introduced, such as ring services and cross-town services, the principal orientation of services is still a radial one. As the inner areas of cities, notably those of the State capitals, have continued to grow and remain the most highly concentrated employment zones, the radial public transport services have supported and have been supported by this core employment. Figure 2.1 shows the combined trend of modal patronage in the period 1970 to 1981 for journey to work trips in the State capital cities. The information in Figure 2.1 cannot be compared directly with Table 2.3; nonetheless, the relatively small and declining share for public transport shown in Figure 2.1, is supported by the statistics in Table 2.3.

On the basis of the cost of provision only, bus travel is economically preferable to the more expensive travel by car. In fact, however,



Source BTE (1984).

Figure 2.1 Percentage of work trips by mode, 1970 to 1981

user preference is decidedly in favour of car travel, primarily based on time savings and general convenience. Table 2.4 compares some elements of the synthesised financial costs of car and bus travel for the commuter journey. Although these costs are based on a per passenger-kilometre basis, they cannot be interpreted as marginal costs, which for both modes would strictly approach zero. Rather, the costs serve to illustrate the effect of a small change in modal split, where either an increase in bus or car would arise.

This comparison does not take into account vehicle capital costs, nor other fixed costs of operation. Annualised fixed costs for buses, including driver costs, typically range from 1.3 to 2.6 cents per passenger-kilometre, depending on the bus loading level. If these fixed costs were added to the variable bus operating costs shown in Table 2.4, the combined costs would still be less than the operating costs of a passenger car, even with the exclusion of the cost of car parking. Although taxis provide a significant service in all capital cities and many provincial cities, they have not been considered here, but their cost structure would considerably exceed that indicated for passenger cars.

Recent operating cost figures for urban rail services are not available. However, Consumer Price Index (CPI) adjusted costs based

TABLE 2.4 FINANCIAL COSTS FOR ADDITIONAL PASSENGERS: CAR AND BUS, 1984-85

(cents per passenger-kilometre)

		Bus[b]	
Cost component	*Car*[a]	*full*	*half full*
Fuel, oil	3.4	0.4	0.9
Tyres	0.5	0.1	0.1
Maintenance	2.3	0.3	0.6
Total	6.2	0.8	1.6

a. Holden Camira SL, average 1.5 occupants.
b. Seating capacity, 44 passengers.

Note Way maintenance costs are assumed to be negligible.

Source BTE estimates.

on a 1980 study (R. Travers Morgan 1980a) suggest that repair, maintenance and way costs of an additional 56 passenger trailer car in a suburban train are comparable to the direct operating costs of a bus. Annualised capital costs for railway carriages, however, are generally considerably higher than for buses.

The foregoing analysis is relatively simplistic, but it does demonstrate that any endeavour to arrive at some insights into the nature of the investment of funds in urban roads and urban public transport, through scrutiny of the respective resource costs, is not particularly helpful. The comparison of resource costs alone is incomplete, because it ignores effects such as reduced traffic congestion brought about by the modal transfer from car to bus and rail travel. In the final analysis, the balance of provision of urban public transport and private travel does not appear amenable to rigorous determination. Inevitably, the decision on whether to increase road space or expand public transport comes down to analysis within a particular corridor.

The statistics on urban public transport would indicate a relatively small and declining role; in reality, public transport performs a vital task in Australia's capital cities, especially in peak periods. In recognition of this, the ABRD program allows up to 25 per cent of Commonwealth urban arterial grants to be allocated to public transport projects. The evidence suggests that, in most capital cities, this upper limit is being reached, as shown in Table 2.5.

TABLE 2.5 THE PROPORTION OF ABRD URBAN ARTERIAL ROAD FUNDS SPENT ON URBAN PUBLIC TRANSPORT, 1982-83 TO 1985-86
(per cent)

State	*1982-83*	*1983-84*	*1984-85*	*1985-86*
New South Wales	0.0	14.7	25.7	23.0
Victoria	0.0	21.2	15.7	24.2
Queensland	26.5	31.6	22.7	25.0
Western Australia	0.0	14.0	11.5	14.4
South Australia	0.0	0.0	16.7	20.2
Tasmania	0.0	0.0	25.5	24.9
Northern Territory	0.0	0.0	0.0	0.0
Australia	8.2	17.7	19.8	22.3

Source Commonwealth Department of Transport (1984, 1985, 1986).

It could be inferred from the figures in Table 2.5 that authorities have imputed excess benefits for selected public transport projects over competing urban arterial road projects.[2]

RURAL PASSENGER TRAVEL

Table 2.3 shows that the private car is as predominant in non-urban passenger travel as it is in urban areas. Despite this dominance, however, public transport modes also perform a valuable service in rural areas and the following discussion centres on coach and rail passenger travel. The trends in long distance passenger journeys undertaken in Australia are presented in Table 2.6.

It is interesting to note that in 1983-84, the number of passenger coach journeys was two and a half times greater than rail journeys for interstate travel; for intrastate travel, the ratio was reversed in rail's favour by a factor of over six. This is indicative in part, at least, of State transport regulations which constrain intrastate coach operations. The figures in Table 2.6 reflect major increases in coach passenger journeys, particularly on interstate routes, to the possible detriment of interstate rail. However, intrastate rail passenger journeys have also increased significantly, reflecting a consolidation of services, such as the introduction of inter-urban services.

Table 2.7 shows the synthesized cost per passenger for car, coach and train travel for a selected inter-capital city trip. On an operating cost level, coach travel is found to be the most fuel efficient of its land-based alternatives and is the least capital-intensive when measured on a seat per kilometre basis. Motor car operations generally incur high capital costs and are the least fuel efficient. Trains have relatively high labour, capital and maintenance costs, which, cumulatively, make them the most costly travel alternative for passengers under the assumed conditions. For shorter train journeys, however, when sleeping accomodation is not required, the costs shown in Table 2.7 would be reduced considerably; where passenger utilisation is high, costs would be reduced still further.

A large component of the cost of car travel is the fixed costs of car

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2. From discussions with public transport authorities, it would appear that application of funds to urban public transport projects has more to do with limiting debt servicing costs, than the intrinsic economic performance of the public transport project.

TABLE 2.6 COACH AND RAIL LONG DISTANCE PASSENGER JOURNEYS: AUSTRALIA, 1979-80 TO 1983-84

	No. of journeys ('000)		*Per cent change*	
	1979-80	*1983-84*	*Total*	*Per annum*
Rail				
Interstate	780	680	-12.8	-3.2
Intrastate	8 555	10 850	+26.8	+6.7
Total	9 335	11 530	+23.5	+5.9
Road coach				
Interstate	1 100	1 750	+59.1	+14.8
Intrastate	1 250	1 750	+40.0	+10.0
Total	2 350	3 500	+48.9	+12.2

Source BTE (1985a).

ownership. If this component is assumed not to be avoidable (that is, the car would continue to be owned), then the car travel costs shown in Table 2.7 would be reduced by approximately $80, making the cost of car travel similar to that of coach travel. Similarly, if car utilisation were doubled to four occupants, the costs per passenger would be half of that estimated.

In the case of travel between Sydney and Melbourne, the 1984-85 long-run avoidable operating costs (excluding capital construction costs of the transport infrastructure) are estimated to be 11.9 cents per passenger-kilometre for car, 3.0 cents for coach and 16.3 cents for train.

The rural passenger task, in isolation, resolves itself quite clearly from the resource allocation point of view. Long distance coach travel requires fewer resources per passenger-kilometre than either rail or car travel.

NON-URBAN GENERAL FREIGHT MOVEMENTS

Table 2.3 showed that the shares of non-urban general freight movements for road and rail were about 80 per cent and 20 per cent,

TABLE 2.7 LONG-RUN AVOIDABLE OPERATING COSTS: SYDNEY-MELBOURNE PASSENGER TRANSPORT, 1984-85 (CURRENT PRICES)
($ per passenger)

	Line-haul mode[a]		
Task component	*Car*[b]	*Coach*[c]	*Train*[d]
Urban (taxi)[f]	..	5	5
Terminal	..	2	2
Line-haul	103	18	143
Way (maintenance)	3	2	6
Total	106	27	156

a. Based on various assumptions about capital cost, utilisation, and so on.
b. Based on two occupants.
c. 75 per cent load factor.
d. Costs based on overnight Indian-Pacific standard.
f. This item has been included, although it is strictly not a cost to the operator, but rather a fare incurred directly by the passenger(s).
.. Not applicable.

Source BTE estimates.

representing 37 000 and 9600 million tonne-kilometres, respectively. General freight constitutes container traffic, freight forwarding agents' traffic, Full-Car-Load (FCL), Less-than-Car-Load (LCL) traffic and motor vehicles. The approximate rates of growth of these road-rail competitive traffics in non-urban areas are shown in Table 2.8.

This table, based on the estimated railway task in 1984-85, shows considerably higher rates of growth for general road freight traffic than for rail. It should be noted, that the period 1981-82 to 1984-85 includes a fall of over 10 per cent in general freight tonnes in 1982-83, during an economic decline (Australian Railway Research and Development Organisation 1985). In 1984-85, the main inter-capital city corridor rail movements accounted for over 70 per cent of the total general rail freight task. Table 2.9 shows the road-rail modal splits for the main corridors.

Tables 2.8 and 2.9 provide some interesting insights into the respective roles of road and rail in the carriage of general freight. Rail's performance is heavily dependent on inter-capital freight

TABLE 2.8 NON-URBAN GENERAL FREIGHT LAND TRANSPORT TASK BY MODE: AUSTRALIA, 1981-82 TO 1984-85
(millions)

			Per cent change	
Mode	*1981-82*	*1984-85*	*Total*	*Per annum*
Tonnes carried (millions)				
Road	na	na		
Rail	14.5	14.7	+1.4	+0.5
Tonne-kilometres (millions)				
Road	28 700	35 500	+23.7	+7.9
Rail	9 400	9 600	+ 2.1	+0.7

na Not available.

Sources Australian Railway Research and Development Organisation (1984). BTE estimates.

TABLE 2.9 INTER-CAPITAL CITY GENERAL FREIGHT LAND TRANSPORT TASK BY MODE, 1984-85

	Total freight[a] *(million tonne-kilometres)*		*Ratio of road to rail*	*Distance (kilometres)*	
Corridor	*Road*	*Rail*		*Road*	*Rail*
Sydney-Melbourne	2 644	1 137	2.3	889	959
Sydney-Brisbane	1 142	1 186	1.0	1 031	986
Sydney-Adelaide	1 007	940	1.1	1 475	1 683
Melbourne-Adelaide	819	1 040	0.8	747	775
Adelaide-Perth	878	2 617	0.3	2 720	2 645
Total	6 490	6 920	0.9[b]	..	..

a. Both ways.
b. Average for corridors.
.. Not applicable.

Source BTE estimates.

movements. The actual level of movements by road closely matches that of rail for inter-capital activity but only accounts for 6490 million tonne-kilometres out of a total of 35 500 million tonne-kilometres. In other words, about 80 per cent of road's general freight task is associated with other than inter-capital city movements. This indicates a spatially pervasive role for road transport, in contrast to the predominantly inter-capital city role for rail.

Generally, the ratios of road to rail traffic, presented in Table 2.9, indicate an increasing advantage for rail with increasing line haul length, although the Sydney-Melbourne corridor is an exception. A number of reasons can be put forward to explain this anomaly, ranging from rate structures to the quality of the road linking the capitals. The actual reasons are likely to be complex and interrelated, with perhaps considerable dependence on the nature of the general freight activity on this corridor.

A comparison of synthesised long-run avoidable operating costs for road and rail (that is, costs excluding capital construction costs of roads, railways and terminals) indicates that, on the Sydney-Melbourne corridor, carriage by road is cheaper for packages up to 15 kilograms, with road costs being only a third of rail costs. However, road and rail costs are about equal for LCL consignments of 1.5 tonnes, while for FCL traffic, rail costs are about half of road transport costs. The cost synthesis approach indicates that a large proportion of total cost is incurred at terminals. For small package consignments, terminal costs are the dominant component and line-haul costs are relatively small. As the size of the consignment increases, line-haul costs increase as a proportion of total costs. Road has intrinsically higher line-haul costs than rail for any load, as well as higher way maintenance costs. The comparative costs for the FCL task are shown in Table 2.10.

For FCL movements, road and rail costs are equal for line-hauls of around 100 kilometres. Australian Railway Research and Development Organisation studies have shown that the road-rail price competitive range for forwarder traffics is between 350 and 650 kilometres, with the inclusion of overheads and some jointly incurred costs (for instance, Australian Railway Research and Development Organisation 1985, 44). Rail is far more fuel efficient than road, with rail fuel costs per twenty-foot equivalent unit (teu) approximately one fifth those of trucks.

Given these observations about apparent cost advantages to rail for certain types of traffic, it appears paradoxical that rail does not

TABLE 2.10 SYNTHESISED LONG-RUN AVOIDABLE OPERATING COSTS: SYDNEY-MELBOURNE FULL-CAR-LOAD TASK, 1984-85 (CURRENT PRICES)
($ per teu)

	Line-haul mode	
Task Component	*Road*	*Rail*
Urban (truck)	..	96
Terminal		
departure	..	27
arrival	..	26
Line-haul	719	325
Maintenance of way	125	28
Total	844	502

.. Not applicable.

Source BTE estimates.

enjoy a higher modal share. Track and/or rolling stock capacity do not seem to impose limitations on performance, but perceived quality of service deficiencies have been cited for the railways, and references have been made to customer perceptions of unreliability and service delays, damage to consignments and periodic industrial disputes (R. Travers Morgan 1980b, Australian Railway Research and Development Organisation 1985).

CHAPTER 3 PAST AND CURRENT STATE OF THE ROAD SYSTEM AND TRAVEL FORECASTS

The length of the Australian road system is currently estimated to be approximately 800 000 kilometres. However, of this amount, some 634 000 kilometres or almost 80 per cent are defined as rural local roads and this road category carries less than 10 per cent of all vehicle travel. The remaining 166 000 kilometres, representing all other road categories, carry over 90 per cent of vehicle traffic.

During the last 20 years the total length of the Australian road system has changed very little. Even when compared with the length in 1933, the change has been quite modest. However, over the last 10 years the estimate of road length has been revised downwards to account for previously included roads which do not constitute trafficable ways. Table 3.1 provides some broad measures of road travel in Australia in approximately the same period. It may seem paradoxical that total travel has grown by over 800 per cent since 1929-30, whereas road length has increased by only 15 per cent. The explanation lies in the profound change in the quality of the road system and the significant increase in capacity through sealing, pavement widening and carriageway duplication on the most heavily used 20 per cent of the system.

Table 3.1 also includes details of the related changes in vehicle population and use, compared with Australia's population. Most noteworthy is the gradual stabilisation of the average annual usage of vehicles, with the figure remaining essentially constant at about 16 000 kilometres per annum since 1969-70. Overall, total vehicle kilometres of travel (vkt) have grown at the same rate as vehicle numbers, representing a 4.3 per cent per annum growth rate since 1971-72.

ROAD STATUS

The total length of road by State category and seal is shown in Table 3.2. Figure 3.1 represents this information diagrammatically and indicates the extent of sealed roads by category. The diagram

TABLE 3.1 MEASURES OF ROAD TRAVEL: AUSTRALIA, SELECTED YEARS

Year	Population[a] (millions)	Motor vehicles[a] (millions)	Persons per motor vehicle	Total vehicle-kilometres of travel (millions)	Average distance (kilometres)	
					per vehicle	per person
1929-30	6.46	0.65	9.94	na	na	na
1949-50	8.07	1.31	6.16	17 012	13 000	2 100
1959-60	10.20	2.75	3.71	35 783	13 000	3 500
1964-65	11.28	3.63	3.11	53 399	14 700	4 730
1969-70	12.40	4.68	2.65	75 855	16 200	6 110
1971-72	12.91	5.18	2.49	85 580	16 500	6 630
1981-82	15.05	7.86	1.92	126 800	16 130	8 430
Average annual growth rate (per cent)						
1949-50 to 1959-60	2.4	7.7	-4.9	7.7	0.0	5.2
1959-60 to 1971-72	2.0	5.4	3.3	7.5	2.0	5.4
1971-72 to 1981-82	1.5	4.3	2.6	4.0	0.2	2.4

a. As at 31 December.
na Not available.

Source Derived from ABS (1985d). Commonwealth Bureau of Roads (1973).

TABLE 3.2 PROJECTED ROAD LENGTH: AUSTRALIA, 1989

(kilometres)

State or Territory	Road category: National Highway		Rural arterial		Rural local		Urban arterial		Urban local		Total	
	All	*Sealed*	*All*	*Sealed*	*All*	*Sealed*	*All*	*Sealed*	*All*	*Sealed*	*All*	*Sealed*
NSW	1 345	1 345	27 708	19 687	150 000	36 400	4 492	4 492	12 000	11 000	195 545	72 924
Vic	698	697	14 382	14 084	129 400	36 500	3 518	3 518	12 000	11 000	159 998	65 799
Qld	3 933	3 933	17 952	15 794	130 800	22 000	2 448	2 448	8 000	7 000	163 133	51 175
SA	2 456	2 456	8 491	7 776	83 200	5 100	2 509	2 509	5 000	4 500	101 656	22 341
WA	4 647	4 571	16 080	12 040	112 800	15 800	1 120	1 120	4 000	3 800	138 647	37 335
Tas	319	319	2 371	2 161	12 900	4 000	529	529	1 000	900	17 119	7 900
NT	2 656	2 656	2 620	1 316	14 700	800	480	480	500	500	20 959	5 776
ACT	0	0	121	121	400	200	289	289	700	700	1 510	1 310
Total	16 054	15 977	89 725	72 979	634 200	120 800	15 385	15 385	43 200	39 400	798 567	264 420

Note Owing to rounding, figures may not add to totals.

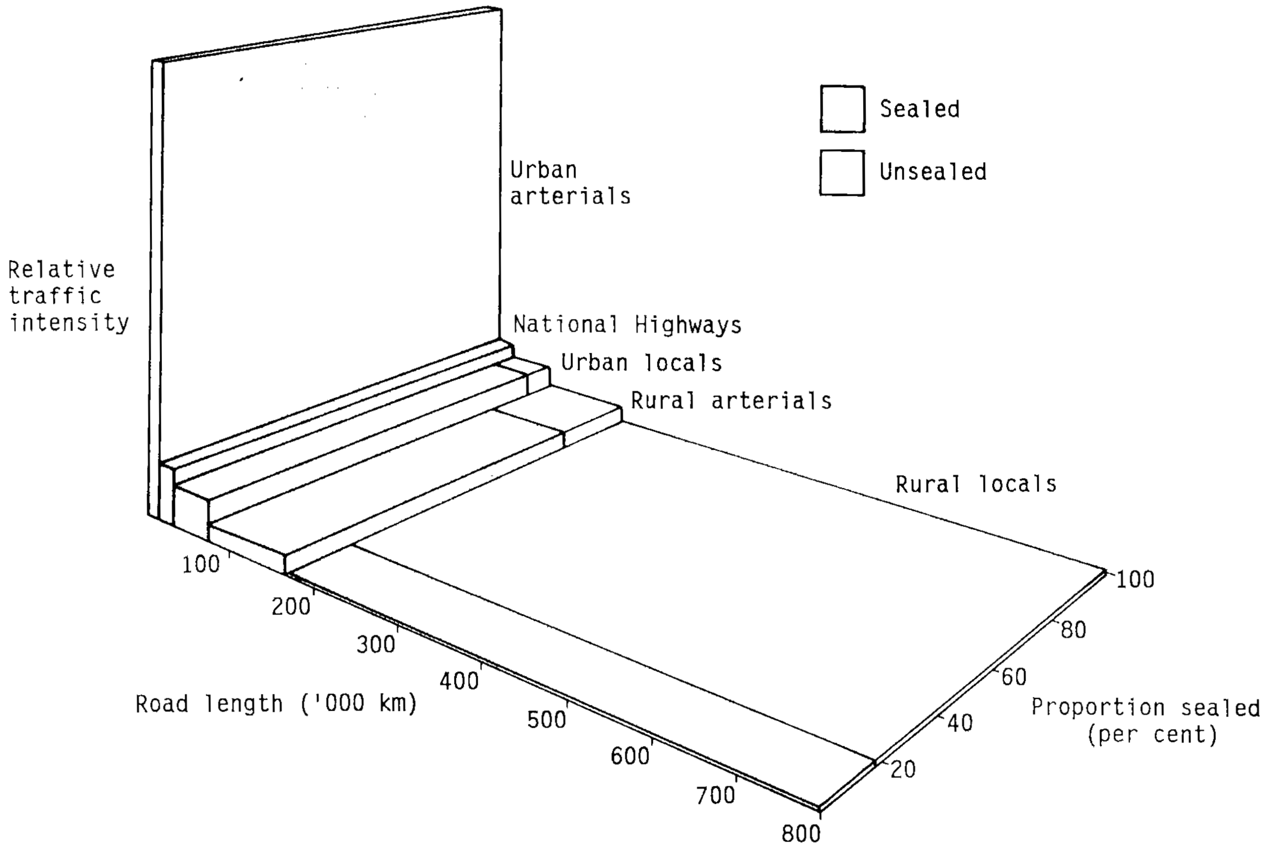
Source BTE (1984d) and projections.

illustrates the dominance of the system by rural local roads and, in addition, shows that less than 20 per cent of the length of roads in this category are sealed. It is evident that sealing is almost complete for National Highways, urban arterials, and urban local roads. Rural arterials are 81 per cent sealed. These observations in themselves indicate that one measure of quality of the road, that is, the sealed proportion of the principally used road categories, is approaching completion.

Urban arterials are estimated to account for 46 per cent of vkt; National Highways carry some 9 per cent and rural arterials a further 19 per cent. Traffic intensity is shown in Figure 3.1 by the height of the segments which represent the various road categories, illustrating clearly the dominant role performed by urban arterial roads. Thus, not only does this road category account for almost half of all vkt, but the traffic intensity (vehicles per day (vpd)) is some eight times greater than for the next highest road category (National Highways).

National Highway System

The set of roads comprising this category is shown in Figure 3.2, while Figure 3.3 depicts the state of the National Highway system which is expected to exist in June 1989. The latter diagram shows the distribution of road length by traffic volume and road type for the National Highway system. The commonwealth specifies uniform design and construction standards for new work on National Highways. Existing sections which have not been upgraded since the declaration of the National Highway system in 1974 may not, therefore, meet the new standards. In Figure 3.3 the seal width standard of seven metres per two lane carriageway (3.5 metres per lane) is used to specify the road types. As would be expected, dual carriageways (four lanes) are provided primarily for high traffic volumes and, as most of these have been constructed since 1974, there are very few substandard four lane roads remaining. By constrast, there is a substantial proportion of substandard two lane road still in existence (46 per cent of total length). It should be emphasised that the fact that a road does not meet the specified width standard does not necessarily mean that it provides inadequate service. The majority of the substandard two lane National Highway caters for traffic volumes of fewer than 1000 vehicles per day, at which level a narrower seal may be perfectly adequate. However, a small proportion of this substandard two lane National Highway is carrying many thousands of vehicles per day - and will consequently have a high upgrading priority.



Source Prepared by BTE

Figure 3.1 Traffic intensity, proportion sealed and length of Australian roads, 1989

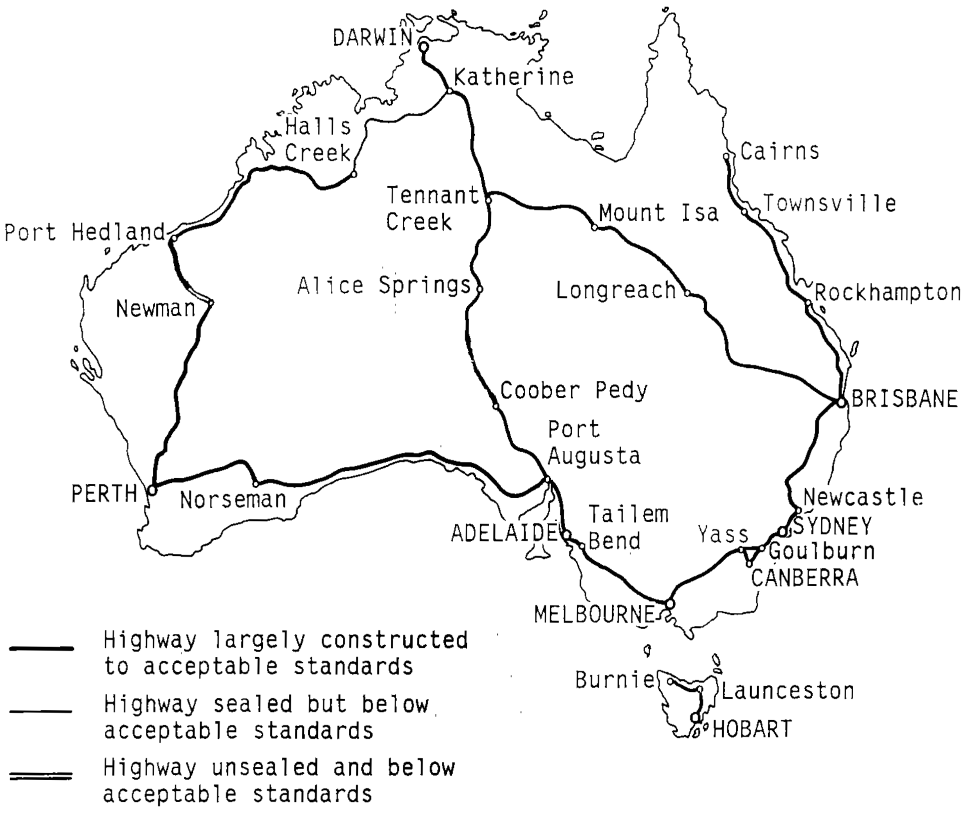
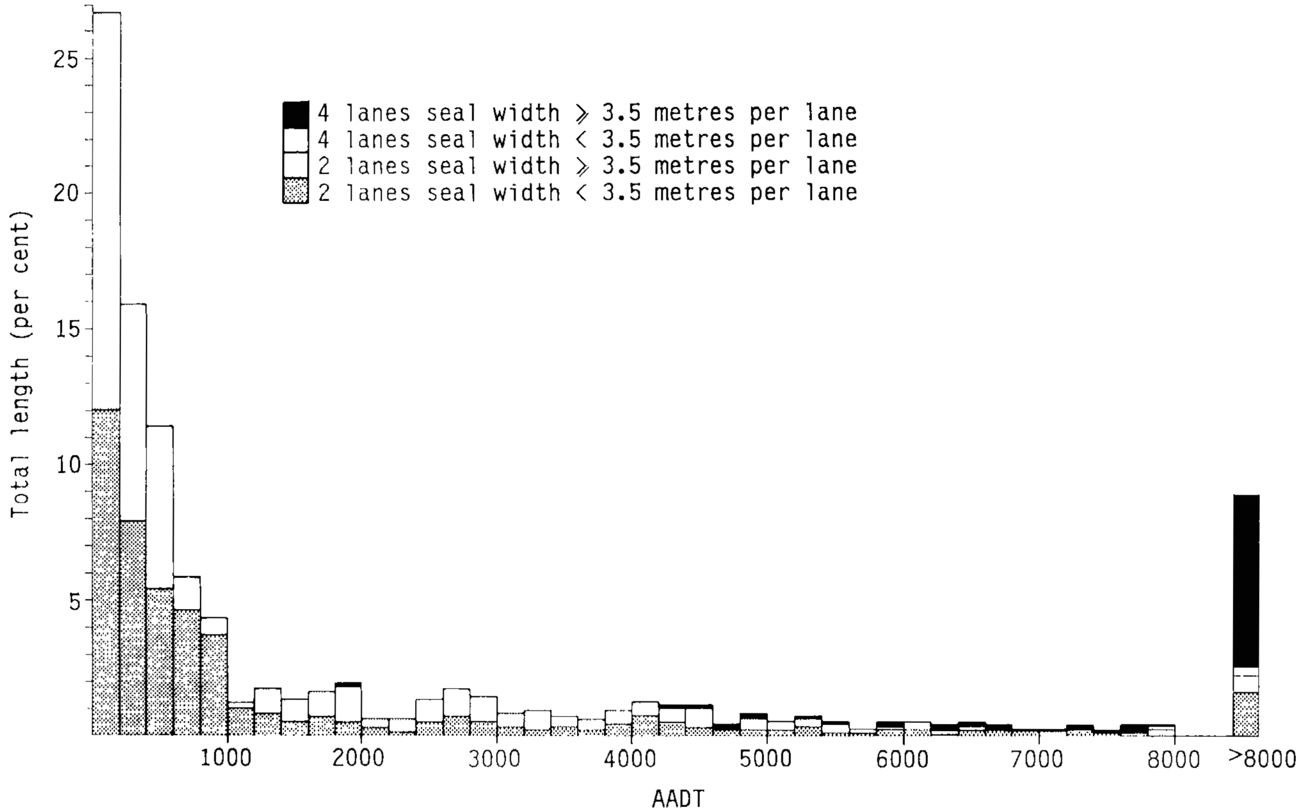


Figure 3.2 The National Highway: condition expected at June 1989

Table 3.3 presents some examples of mismatch between road capacity and traffic volume. The table shows that 379 kilometres of National Highway appears to have capacity significantly in excess of traffic level. This amount is comprised of 260 kilometres of two lane road of above minimum standard but carrying fewer than 100 vpd, and a further 119 kilometres of dual carriageway carrying fewer than 5000 vpd. These lengths are quite small and they represent only 2.7 per cent and 9.2 per in their respective categories.

Rural Arterial Roads

The set of roads comprising this category cannot be as easily depicted as the National Highway system, but some idea of their coverage is provided in Table 3.4, which shows the relationship between rural arterial road length and the area of each State, as well as its population.



Sources National Association of Australian State Road Authorities (1985). BTE projections.

Figure 3.3 Projected distribution of National Highway length by traffic and road type, 1989

TABLE 3.3 PROJECTED NATIONAL HIGHWAY ROAD LENGTH: SELECTED TRAFFIC VOLUMES, 1989

(kilometres)

State or Territory	*Total length*	*Narrow two lane carriageway >500 vpd*	*Wide two lane carriageway <100 vpd*	*Wide two lane carriageway >3000 vpd*	*Dual carriageway <5000 vpd*
NSW	1 346	479	0	127	37
		(3.0)	(0.0)	(0.8)	(0.2)
Vic	698	44	0	138	43
		(0.3)	(0.0)	(0.9)	(0.3)
Qld	3 933	1 209	100	498	23
		(7.5)	(0.6)	(3.1)	(0.1)
SA	2 456	940	160	242	1
		(5.8)	(1.0)	(1.5)	(0.0)
WA	4 646	970	219	7	1
		(6.0)	(1.4)	(0.0)	(0.0)
Tas	319	47	0	129	1
		(0.3)	(0.0)	(0.8)	(0.0)
NT	2 656	101	23	0	12
		(0.6)	(0.1)	(0.0)	(0.1)
ACT	0	0	0	0	0
		(0.0)	0.0	(0.0)	(0.0)
Australia	16 054	3 790	260	1 141	119
		(23.6)	(1.6)	(7.1)	(0.7)

Note Figures in parentheses are percentages of total length in the State or Territory.

Source BTE projections.

The table reveals that Victoria, New South Wales and Tasmania are similar in terms of persons per kilometre and land area per kilometre of rural arterial road, although, even within this group, Victoria stands out as having the most intense settlement and rural arterial coverage. The remaining States and Territories exhibit wide variation in these attributes but, overall, are considerably less populated than the first group.

Figure 3.4 shows the expected road distribution by traffic and road type length as at June 1989. Table 3.5 provides details by State, where road capacity does not reasonably correspond with traffic

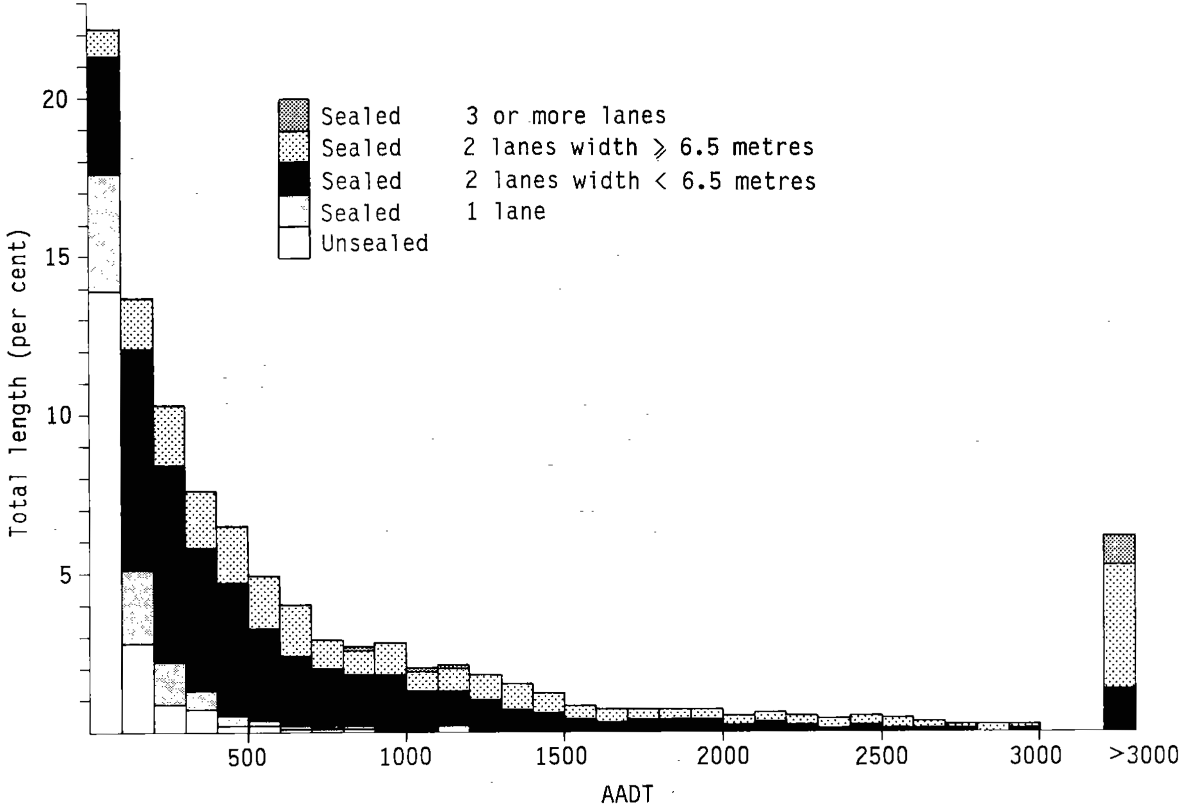
TABLE 3.4 RURAL ARTERIAL ROAD LENGTH COMPARED TO STATE POPULATION AND AREA, 1984

State	*Persons per kilometre of road*	*Area (square kilometre per kilometre of road)*
New South Wales	180	26.7
Victoria	265	14.8
Queensland	130	89.5
South Australia	130	94.6
Western Australia	84	154.0
Tasmania	168	26.1
Northern Territory	45	434.3
Australian Capital Territory	2446	24.0
Australia	160	24.0

Source ABS (1986d).

levels. In particular, the length of unsealed roads carrying traffic volumes greater than 100 vpd is 4305 kilometres and, of this length, 3585 kilometres are in New South Wales. Australia-wide, unsealed arterial roads carrying more than 100 vpd represent almost 26 per cent of the length of unsealed arterial roads; in New South Wales, the comparable proportion rises to 46 per cent.

The length of wide two lane rural arterials carrying fewer than 1000 vpd is also important. In all, 13 024 kilometres, representing 14.5 per cent of the entire rural arterial category, are in this class, as shown in Table 3.5. This indicates possible over-provision of road capacity relative to traffic level. It is understood that the opportunity to vary road standards, particularly sealed widths, with traffic volume on single two lane carriageways poses difficulties, but the analysis suggests, at least superficially, that there may be scope for improving the relationship between road provision standard and traffic volume. To some extent, the less than ideal relationship between traffic volume and carriageway width is illustrated in Figure 3.4, which shows the wide scatter of single road types across a substantial traffic volume range.



Sources National Association of Australian State Road Authorities (1985). BTE projections.

Figure 3.4 Projected distribution of rural arterial length by traffic and road type, 1989

TABLE 3.5 PROJECTED RURAL ARTERIAL ROAD LENGTH: SELECTED TRAFFIC VOLUMES, 1989

(kilometres)

State or Territory	*Total length*	*Unsealed >100 vpd*	*Sealed width >6.5 m (two or more lanes) <1000 vpd*
NSW	27 708	3 585	3 829
		(12.9)	(13.8)
Vic	14 382	111	3 574
		(0.8)	(24.8)
Qld	17 953	36	722
		(0.2)	(4.0)
SA	8 491	263	1 159
		(3.1)	(13.6)
WA	16 080	71	3 702
		(0.4)	(23.0)
Tas	2 371	137	33
		(5.8)	(1.4)
NT	2 620	102	5
		(3.9)	(0.2)
ACT	121	0	na
		(0.0)	
Australia	89 726	4 305	13 024
		(4.8)	(14.5)

na Not available.

Note Figures in parentheses are percentages of total length in State or Territory.

Source BTE projections.

Urban arterial roads

Figure 3.1 clearly illustrates the dominant role of urban arterial roads. As a group, they are characterised by high capacity links, carrying large traffic volumes over relatively short distances at speeds considerably lower than National Highways or rural arterial roads. Although the average number of lanes per link for urban arterials and freeways exceeds that of rural arterials, across the five largest capital cities the divided four lane arterials and freeways carried 45 per cent of urban traffic, while constituting only

27 per cent of the total urban arterial road length (National Association of Australian State Road Authorities 1984a). On average, the volume of urban arterial traffic was more than twice as high on divided arterials and freeways than on undivided roads and this ratio is unlikely to have changed in recent years.

Local roads

Table 3.2 shows that local roads comprise 85 per cent of the total road length in Australia. Their primary function is to provide access to properties, businesses and farms and they serve to link all landuses with the arterial road system. While local roads can be regarded as a single road category because of functional similarity, in many respects it is useful to distinguish between rural and urban local roads.

Rural local roads are by far the largest road sub-category and have the greatest diversity of pavement conditions, ranging from formed earth to sealed carriageways. They are also the lowest trafficked sub-category (see Figure 3.1), but this does not diminish their importance because, in general, most primary produce requiring transport must first make use of rural local roads.

Urban local roads as a sub-category comprise only 11 per cent of local road length, but it was estimated in 1981 (National Association of Australian State Road Authorities 1984b), that 53 per cent of all local road travel was performed on them. More than 90 per cent of urban local roads are sealed and, hence, this group has less variable pavement conditions than its rural counterpart.

Urban locals receive much greater investment per kilometre of length than rural local roads. This can partly be explained by the provision of, for example, kerb and guttering, stormwater drainage, traffic management facilities and by the fact, that the level of traffic is, on average, 18 times higher on urban than rural local roads. In addition, the spillover of urban arterial traffic is a problem of serious dimensions in many capital cities. This phenomenon is not confined solely to urban areas; however, while there are examples in rural areas of unacceptably high traffic volumes on local roads, they are much less frequent than in urban areas.

Recent traffic statistics, especially those relating to high traffic volumes on local roads, are not available but it was estimated in 1981 (National Association of Australian State Road Authorities 1984b), that over 20 per cent of urban local roads carried in excess of 1000 vpd and 9 per cent in excess of 2500 vpd. From earlier information, it would appear that the problem of high traffic volumes on urban local roads is increasing, although in recent years the management of traffic in urban precincts is receiving much greater attention. The solution to such problems revolves around the reconciliation of overall traffic system efficiency for travellers and environmental protection for residents.

ROAD USAGE FORECASTS

The forecasts prepared for this study are intended to aid decision-making on government road investments. Forecasts concentrate on vehicle numbers and vkt for each class of vehicle, to the year 2000. The method of forecasting is similar to that used for earlier roads studies which, in the case of passenger vehicles and rigid trucks, relies on simple forecasting techniques involving estimates of population, number of vehicles per head and average distance travelled per vehicle to yield total vkt. Because of the different situation with articulated trucks, tonne-kilometres were first forecast, and truck numbers and vkt derived on the basis of consistent assumptions concerning average loads and average distance travelled per truck. Details of the forecasting methodology are provided in BTE (1987b).

Factors affecting road usage

Roads are used for both private and commercial purposes. The major private use is by passenger cars. The use of passenger cars in preference to other forms of transport is a prominent feature of Australian society. The demand for this form of transport is affected by three principal factors: population, income and, to a lesser extent, vehicle price. Operating costs do not appear to have a significant influence on demand. Production costs, technology, taxation, safety regulations and exchange rate changes are important factors affecting the supply of road vehicles.

The demand for commercial vehicles for freight transport is affected principally by economic activity, although price and operating costs are also important. Competition is provided mainly by the railways in the non-urban general freight sector; competition from sea and air transport is minimal. The high service quality provided by road transport has allowed an increase in its share of the market over the years which has been maintained despite recent relative price increases in the road transport industry.

Past trends in road usage

The methods used to forecast vehicle usage to the year 2000 depend heavily on past trends. Table 3.6 shows that there has been a

TABLE 3.6 ANNUAL RATES OF GROWTH PASSENGER CARS ON REGISTER, POPULATION, AND CARS PER CAPITA: AUSTRALIA, 1965, 1975 AND 1985

(per cent)

Year ending 30 June	*Cars*	*Population*	*Cars per capita*
1965	8.8	2.0	6.7
1975	5.5	1.2	4.2
1985	3.1	1.2	1.8

Source ABS (1986c).

continuing decline in the annual rate of growth of passenger car numbers, a parallel decline in population growth and a consequent drop in the growth of cars per capita since 1965. Nonetheless, the absolute number of cars continues to increase. The declining rate of increase forms the basis of the forecasts for the period 1985 to 2000.

In contrast, Table 3.7 shows that rates of growth of light commercial vehicles and rigid trucks have not shown any discernible trend, remaining fairly constant over the period 1972 to 1985 at rates of between 4.4 and 5.8 per cent. The growth rate of the articulated truck fleet has declined, however, in the same period. Nevertheless, these rates of growth have been above the rate of increase in economic activity, mainly because of the increase in the distance over which freight is being transported. This is evident from the greater rate of increase of tonne-kilometres performed, as compared with tonnes consigned (BTE 1984a).

Structural changes in the composition of output, differential rates of growth of sectors of the economy, changes in modal share of transport, changed production techniques, and different locational patterns of production and consumption can cause demand for commercial vehicles to grow at disproportionate rates compared to overall economic activity. It is difficult to see why this should persist in the long run. It is considered that, in the absence of other influences, the increase in numbers of commercial vehicles should tend towards the rate of increase in economic activity.

Forecasts of vehicle usage

Between 1976 and 1985, the proportion of travel undertaken in urban and non-urban areas by different classes of vehicles did not change very much and no marked change is expected to the year 2000.

Passenger cars and station wagons

A rate of increase in per capita ownership of passenger vehicles of 2 per cent per annum has been adopted for the period 1985 to 1990, 1.5 per cent for 1990 to 1995, and 1 per cent per annum for 1995 to 2000. Although this trend could be reversed if there were a substantial increase in the rate of growth of household disposable income, such an increase is not expected to occur. As shown in Table 3.8, the number of passenger cars and station wagons is projected to increase from eight million to 10 million between 1990 and 2000.

TABLE 3.7 ANNUAL RATES OF GROWTH IN NUMBERS OF COMMERCIAL VEHICLES ON REGISTER: BY TYPE OF VEHICLE, AUSTRALIA, 1972 TO 1976 AND 1977 TO 1985

(per cent)

Years	*Light commercial vehicles*	*Rigid trucks*	*Articulated trucks*
1972 to 76	4.8	5.8	6.0
1977 to 85	4.9	4.4	3.0

Source BTE estimates.

TABLE 3.8 PROJECTED NUMBER OF PASSENGER CARS AND STATION WAGONS: AUSTRALIA, 1990, 1995 AND 2000

('000)

As at 30 June	*Vehicle numbers*
1990	8 030
1995	9 190
2000	10 180

Source BTE projections.

Annual average distance travelled by passenger cars and station wagons between 1971 and 1985 shows no clear trend, and has changed little over five ABS Surveys of Motor Vehicle Usage (SMVU) (ABS 1986a). The annual average has remained between 14 500 and 16 500 kilometres, depending upon State of registration. The projected figures are presented in Table 3.9.

Table 3.10 shows the projected total travel for this vehicle group, derived from the values presented in Tables 3.8 and 3.9.

TABLE 3.9 ESTIMATES OF ANNUAL AVERAGE CAR TRAVEL BY STATE, 1985 TO 2000
(kilometres)

State or Territory	*Vehicle-kilometres travelled*
New South Wales and Australian Capital Territory	15 500
Victoria	15 800
Queensland	15 500
South Australia and Northern Territory	15 100
Western Australia	16 000
Tasmania	14 300

Source BTE projections.

TABLE 3.10 PROJECTED TOTAL TRAVEL BY PASSENGER CARS AND STATION WAGONS: AUSTRALIA, 1990, 1995 AND 2000
(million)

Year ending 30 June	*Vehicle-kilometres travelled*
1990	125 000
1995	143 000
2000	158 000

Source BTE projections.

Commercial vehicles
Four vehicle classes make up the commercial vehicle group: these are light commercials, rigid trucks, articulated trucks, and buses and other truck-type vehicles. Analysis of this group is complicated by changing definitions and classification of commercial vehicles, as well as by changes in other factors affecting road usage.

In projecting the numbers of commercial vehicles and their road usage, it has been assumed that the factors responsible for increasing the average distance travelled by freight and for maintaining commercial vehicle growth rates at levels well above the rate of increase of total economic activity, are likely to be of decreasing importance, and that rates of growth will tend to move closer to rates of increase in economic activity.

The general assumption concerning the rate of growth in economic activity which underlies the forecasts is that it will remain at a fairly low level, similar to that which has been experienced in the past 10 to 15 years. This assumption accords with forecasts prepared by both the National Institute for Economic and Industry Research (1986) and BIS-Shrapnel (1986). Concerning modal share, it is likely that the scope for entry by road transport into the long distance freight market will decrease with time. In addition, if structural change occurs in favour of manufacturing, output could be expected to be less transport-intensive. Projections for this study have, therefore, assumed that past growth rates in numbers of commercial vehicles will continue for the period 1985 to 1990, and will decrease slightly for 1990 to 1995 and 1995 to 2000.

Light commercials
The annual average growth rate in vehicle numbers in this class over the period 1972 to 1985 has been just under 5 per cent per annum. This is projected to decline progressively to 3.3 per cent per annum in the period 1995 to 2000. Average travel per vehicle has changed little over the last five SMVUS and the average of these survey results is projected for the forecast period. Tables 3.11 and 3.12 show vehicle numbers and overall travel in the forecast period.

Rigid trucks
The annual average growth rate in vehicle numbers in this class during the period 1972 to 1985 has declined from 5.8 per cent per annum to 4.4 per cent. This is projected to decline progressively to 3.0 per cent per annum in the period 1995 to 2000. Average annual travel by rigid trucks has shown some tendency to increase but, for the forecast period, fixed values have been adopted, although these vary by State.

TABLE 3.11 PROJECTED NUMBER OF LIGHT COMMERCIAL VEHICLES, 1990, 1995 AND 2000
('000)

As at 30 June	*Vehicle numbers*
1990	1 480
1995	1 800
2000	2 120

Source BTE projections.

TABLE 3.12 PROJECTED TRAVEL BY LIGHT COMMERCIAL VEHICLES, 1990, 1995 AND 2000
(million)

Year ending 30 June	*Vehicle-kilometres travelled*
1990	25 000
1995	30 000
2000	36 000

Source BTE projections.

Tables 3.13 and 3.14 show vehicle numbers and overall travel in the forecast period.

Articulated trucks

Projections for articulated trucks are the most difficult to prepare. The future number of vehicles will be influenced by a variety of market, regulatory and other factors. In addition, tonne-kilometres performed have been growing substantially faster than tonnes carried, partly because road freight has increased its share of the longer distance services at the expense of rail and sea carriers.

The major elements and their values, which form the basis for the forecasts of vehicle numbers and travel, are set out in Table 3.15.

TABLE 3.13 PROJECTED NUMBER OF RIGID TRUCKS, 1990, 1995 AND 2000
('000)

As at 30 June	*Vehicle numbers*
1990	660
1995	790
2000	920

Source BTE projections.

TABLE 3.14 PROJECTED TRAVEL BY RIGID TRUCKS, 1990, 1995 AND 2000
(million)

Year ending 30 June	*Vehicle-kilometres travelled*
1990	11 900
1995	14 300
2000	16 600

Source BTE projections.

TABLE 3.15 PROJECTED VALUES USED TO FORECAST ARTICULATED VEHICLE ACTIVITY, ANNUAL INCREASES[a]
(per cent)

Period	*Tonne-kilometres*	*Average distance travelled*	*Average weight carried*	*Number of vehicles*	*Vehicle-kilometres travelled*
1985 to 1990	8.1	2.0	3.0	3.1	5.1
1990 to 1995	7.1	2.0	2.5	2.5	4.5
1995 to 2000	6.1	2.0	2.0	2.1	4.1

a. Values for vehicle numbers, tonne-kilometres and vkt are derived from the sum of State totals.

Source BTE projections.

Tables 3.16, 3.17 and 3.18 have been derived from Table 3.15.

TABLE 3.16 PROJECTED NUMBER OF ARTICULATED TRUCKS, 1990, 1995 AND 2000

As at 30 June	*Vehicle numbers*
1990	58 900
1995	66 800
2000	74 100

Source BTE projections.

TABLE 3.17 PROJECTED TRAVEL BY ARTICULATED TRUCKS, 1990, 1995 AND 2000
(million)

Year ending 30 June	*Vehicle-kilometres travelled*
1990	4 700
1995	5 900
2000	7 200

Source BTE projections.

TABLE 3.18 PROJECTED TONNE-KILOMETRES PERFORMED BY ARTICULATED TRUCKS, 1990, 1995 AND 2000
(million)

Year ending 30 June	*Tonne-kilometres performed*
1990	79 000
1995	111 000
2000	150 000

Source BTE projections.

Buses and other truck-type vehicles
These categories have been subject to substantial classification changes which render past trends of limited value for forecasts. In addition, changes in regulation of the bus industry would affect future growth and complicate projections.

Rates of growth in bus numbers are assumed to decline from 6 per cent to 4 per cent per annum over the period, as the impact of increasing use of micro-buses lessens, and because of slowing rates of growth in population. Average vkt is based on the 1979 survey of bus usage, with some adjustment to allow for the large increase in micro-buses in New South Wales. Tables 3.19 and 3.20 show vehicle numbers and overall travel in the forecast period. A rate of increase of 4 per cent per annum has been adopted for other truck-type vehicles, and projections of distance travelled are based on distance travelled by this class in 1985.

Reliability of forecasts

The projections obtained from the foregoing analysis have been compared with the in-built travel forecasts contained in the NAASRA Data Bank (NDB) National Association of Australian State Road Authorities (1985). While full comparisons could not be made, because the NDB covers travel only on National Highways and rural arterials, the comparisons that were feasible showed acceptable correspondence.

Overall, the forecasts indicate reasonably close agreement with more recent historical trends, which have been characterised by steady rather than dramatic rates of growth.

TABLE 3.19 PROJECTED NUMBERS OF BUSES AND OTHER TRUCK-TYPE VEHICLES, 1990, 1995 AND 2000

As at 30 June	*Buses*	*Other truck-type vehicles*
1990	102 900	56 600
1995	131 300	66 100
2000	159 700	77 300

Source BTE projections.

TABLE 3.20 PROJECTED VEHICLE-KILOMETRES TRAVELLED BY BUSES AND OTHER TRUCK-TYPE VEHICLES, 1990, 1995 AND 2000
(million)

Year ending 30 June	*Buses*	*Other truck-type vehicles*
1990	2 700	700
1995	2 400	810
2000	4 100	950

Source BTE projections.

CHAPTER 4 ROAD FINANCING

Recent developments in road financing at each of the three levels of government in Australia are discussed in detail in BTE (1987a) and earlier issues, and BTE (1984b). It is appropriate to consider sources of funds for roads and expenditure of those funds separately, since in all but a few cases there is no absolute nexus between revenue raised from road use and road expenditure in the budgets of the three levels of government. In fact, the revenue from road user taxes applied to roadworks is often a matter of discretion. In practice, a range of sources of revenue is available, and can be periodically adjusted by approaches ranging from indexation and periodic reviews of charges, to basic changes in the proportions of revenue allocated to roads.

In general, governments have traditionally tended to make separate decisions on the level of road expenditure and on the level and form of revenue to be raised (either from road users or general revenue sources).

COMMONWEALTH ROAD FINANCING LEGISLATIVE ARRANGEMENTS

A detailed analysis of the legislative arrangements under which Commonwealth grants are provided to the States for roadworks was provided in BTE (1984b). This section concentrates on changes since then, particularly the introduction of the ALTP in July 1985. The arrangements prior to that date are summarised in Appendix I, which provides more details of financing arrangements.

The *Australian Land Transport (Financial Assistance) Act 1985* established the ALTP from 1 July 1985 and replaced the *Roads Grants Act 1981.* The ALTP is funded by a hypothecated fuel excise, using a trust fund similar to that of the ABRD program. A major difference, however, is that the level of fuel excise hypothecated to the ALTP trust fund is indexed with other excise, whereas that hypothecated to the ABRD trust fund is fixed at two cents per litre for the life of the program. In effect, this means that the respective indexation increases are not hypothecated to the ABRD fund, but they are to the ALTP fund.

Another change from the *Roads Grants Act 1981* is the number of road categories eligible for funding. The two arterial road categories (urban and rural) which were amalgamated under the Act have been split again under the ALTP, as they are in the ABRD program. In addition, up to 20 per cent of the allocations to rural and urban arterial roads may be spent on routine road maintenance and minor resealing, making this the first Act since 1974 which allows Commonwealth funds for arterial roads to be spent on such works.

Other activities eligible for funding under the ALTP, but not the ABRD program, include:

- approved capital expenditure on mainline railways;
- expenditure on land transport research; and
- expenditure by an approved road safety organisation on road safety activities.

Expenditure on mainline railway projects is dependent on agreements between railway managements and unions to improve operating practices and efficiency. In practice, funding for these projects will be limited to the extent of fuel excise payments made by railways to the ALTP trust fund.

ALTP National Highway project approval procedures are similar to those under both the ABRD program and the *Roads Grants Act 1981*. However, the requirement to submit details of a program of works for arterial roads for approval, which was waived under the *Roads Grants Act 1980*, has been reintroduced under the ALTP. Provision is made for either program or project approval of works on arterial roads at the Minister's discretion.

Funding approval procedures for local roads are similar to those under the *Roads Grants Act 1981*. By and large, allocation of most of the funds to local government authorities is determined by a formula for each State. The ABRD program has additional administrative requirements dealing with local road funding, similar to those for other road categories (such as individual projects approval and signposting). The allocation formulae are discussed in more detail in Chapter 7.

There are no requirements under the new legislation for the States to spend a certain amount of their own funds in order to qualify for

Commonwealth grants. This was also the case with the Roads Grants Acts. The ABRD program, on the other hand, contains matching expenditure requirements, in that the States are required to maintain their own level of road expenditure. This is because the ABRD program was conceived essentially as an additional source of funds over and above the existing funds available for roadworks at the time. The objective of providing additional funds would have been defeated if existing funding levels (outside the ABRD program) were not maintained.

The question of matching requirements for road funding has a long and vexed history. The Commonwealth has generally been concerned to ensure that its programs did not simply allow the States to divert funds from roadworks. Indeed, the various legislative arrangements since 1969 reflect several changes in Commonwealth Government policy to encourage the States to increase road expenditure effort. Project and program approval procedures have alternately been relaxed and tightened, and expenditure matching requirements have been abolished and reinstated. The number of road categories has been reduced and expanded, the urban/rural split has been abolished and revised. For instance, the arrangements under the ABRD program and *Roads Grants Act 1981* are different in several important aspects. These changes in approach probably reflect more than anything the success of the States in circumventing constraints imposed by the Commonwealth, because of the inherent flexibility in funding arrangements and the broad nature of overall Commonwealth objectives.

ROAD PRICING

One of the major features of the ALT Program and the ABRD Program is their funding through an hypothecated fuel excise. In recent years there has been a growing reliance on fuel excise revenue, by Federal and State governments, for both the funding of roads and for general revenue purposes. All States, except Queensland, levy a fuel tax through various business (fuel) franchise schemes. The States still maintain their traditional forms of charges and taxes on road users, such as vehicle registration fees, drivers' licence fees and specific charges such as number plate fees and permit fees. However, these have been diminishing in importance.

As a consequence of the increasing reliance on fuel excise, a common complaint is that motorists are paying more for the use of roads than the current level of road expenditure. On the other hand, it has been claimed that operators of heavy vehicles may not be paying enough to cover the damage these vehicles cause to road pavements, or contribute a share of the costs of providing and improving the road system. The reasons for the latter position is that, although heavy trucks cause considerably more damage to roads than lighter vehicles, they do not use a correspondingly greater amount of fuel.

The Bureau and others have suggested that one way of overcoming this problem may be to structure registration charges for heavy vehicles to more closely reflect the cost of road damage they cause (see, for example, BTE 1985b). It has also been suggested that the States could follow the New Zealand example of using distance measuring devices, hubodometers, to assess annual charges for heavy vehicles. Such a provision has been included in the Federal interstate vehicle registration scheme introduced in 1986. This is seen as preferable, from an equity viewpoint, to greater reliance on fuel excise revenue for funding roadworks. A scheme that more closely related charges to the costs of road use would generally be consistent with economic efficiency principles.

SOURCES OF FINANCE

From 1959 to the introduction of the ABRD program in 1982-83, all Commonwealth road grants were funded from consolidated revenue or the loan fund. The ABRD program reintroduced the tying or hypothecation of a share of fuel excise to roads expenditure. The program provided for the earmarking of first, one cent per litre in 1982-83 and, thereafter, two cents per litre, to a special trust fund to be used to provide additional road grants to the States. The ALTP, which began in 1985-86, is also funded by a fuel excise levy. Currently, approximately six cents a litre is hypothecated, out of a total of around 20 cents a litre of Commonwealth fuel excise. Despite reintroduction of hypothecation, the ratio of road grants to total fuel excise is currently far below the peak levels reached during the period from 1950 to 1980, and is the lowest on record (see Table 4.1).

The States, on the other hand, have until recently hypothecated the great bulk of revenue from taxes on road users to roadworks. Traditionally, the main sources of revenue for roadworks were vehicle registration charges. More recently, various forms of State fuel franchise fees, levied in all States except Queensland (and also the Territories), have become an important source of revenue for roadworks. They have also become a source of general budget revenue, since the share of fuel tax directed to roadworks has been progressively reduced in most States. In New South Wales, for example, only receipts from the tax on automotive distillate are hypothecated to roadworks, while the much larger receipts from motor spirit rates are retained in consolidated revenue. At the same time,

TABLE 4.1 COMMONWEALTH ROAD GRANTS AS A PERCENTAGE OF FUEL TAX REVENUE, 1926-27 TO 1986-87 (CONSTANT 1984-85 PRICES)

Year/Legislation	*Average revenue* ($ million)	*Average payments* ($ million)	*Payments/ revenue (per cent)*
1926-27 to 1930-31	9.2	6.5	70
1931-32 to 1936-37	22.3	7.9	36
1937-38 to 1946-47	34.1	10.5	31
1947-48 to 1949-50	84.8	24.2	29
1950-51 to 1953-54	114.9	48.9	43
1954-55 to 1958-59	157.5	101.3	64
1959-60 to 1963-64	236.5	166.6	70
1964-65 to 1968-69	407.2	247.9	61
1969-70 to 1973-74	774.4	413.9	53
1974-75 to 1976-77	1 248.7	687.1	55
1977-78 to 1979-80	1 399.6	844.1	60
1980-81 to 1984-85	1 545.6	1 042.7	67
1985-86	2 527.7	1 174.7	46
1986-87	4 669.9e	1 107.7e	24e

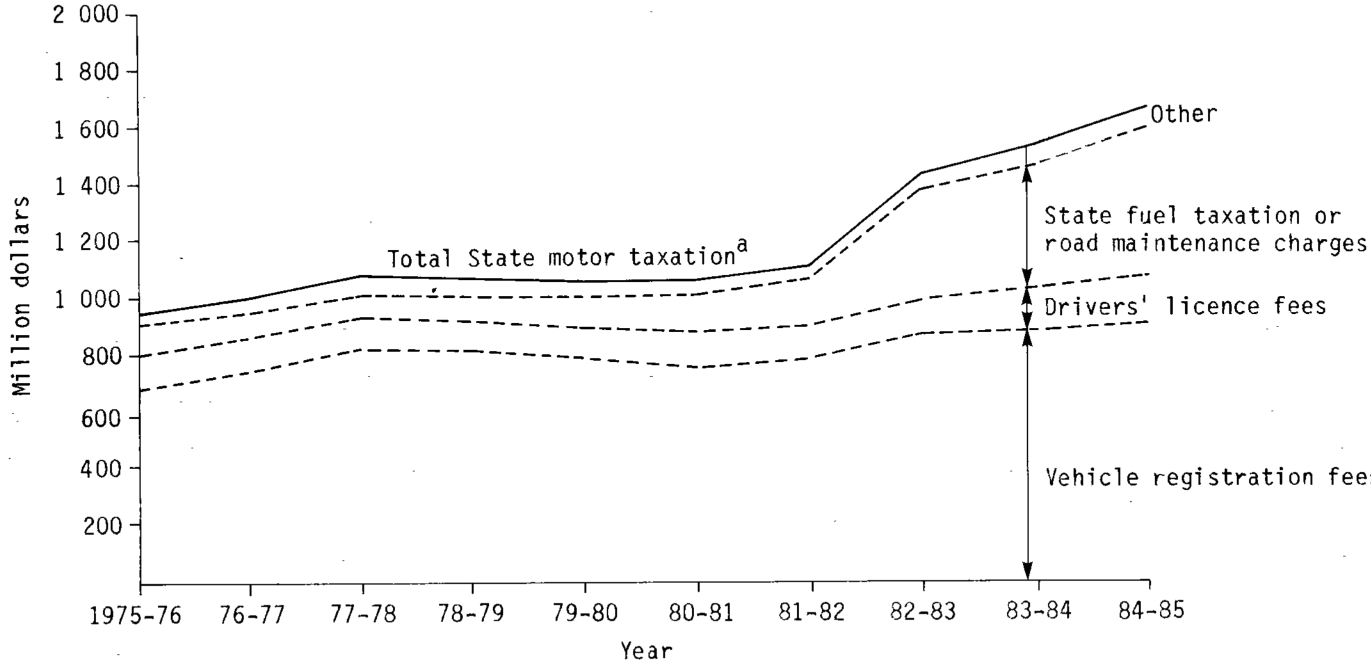
e Estimated.

Note Price deflators used were ABS Implicit Price Deflator of Gross Domestic Product for revenues and the BTE Road Construction Price Index (overall activity) for road payments.

Sources ABS (1985a). BTE (1982, 1986c, 1987a). Commonwealth of Australia (1986).

the New South Wales Government has been financing a significant element of its road program from borrowings. Movements in the various items of State road revenue over the decade to 1984-85 are shown in Figure 4.1.

Local Government Authorities (LGAs) impose no specific road user charges apart from parking fees and, in some cases, charges on operators of road vehicles or operators of businesses (such as quarrying, private housing or other property development) associated with significant heavy road vehicle traffic. In addition to specific road grants and reimbursements from the Commonwealth, States and private developers, local government road expenditures are funded from general revenues, such as loans and tax sharing grants from the Commonwealth.



a. Figures are gross receipts from which collection costs must be subtracted to obtain net motor taxation receipts.

Source BTE (1987a).

Figure 4.1 State motor taxation, 1975-76 to 1984-85 (constant 1984-85 prices)

ROAD EXPENDITURE LEVELS

Figures 4.2 and 4.3 show movements in the level of total road expenditure over the last 25 years by level of government, measured against a number of broad criteria of demand for road use. Total road expenditure by each level of government rose steadily during the 1960s. Commonwealth expenditure reached a peak in 1972-73, declining steadily thereafter, until the introduction of the ABRD program. Commonwealth expenditure in 1983-84 almost reached the level of the earlier peak.

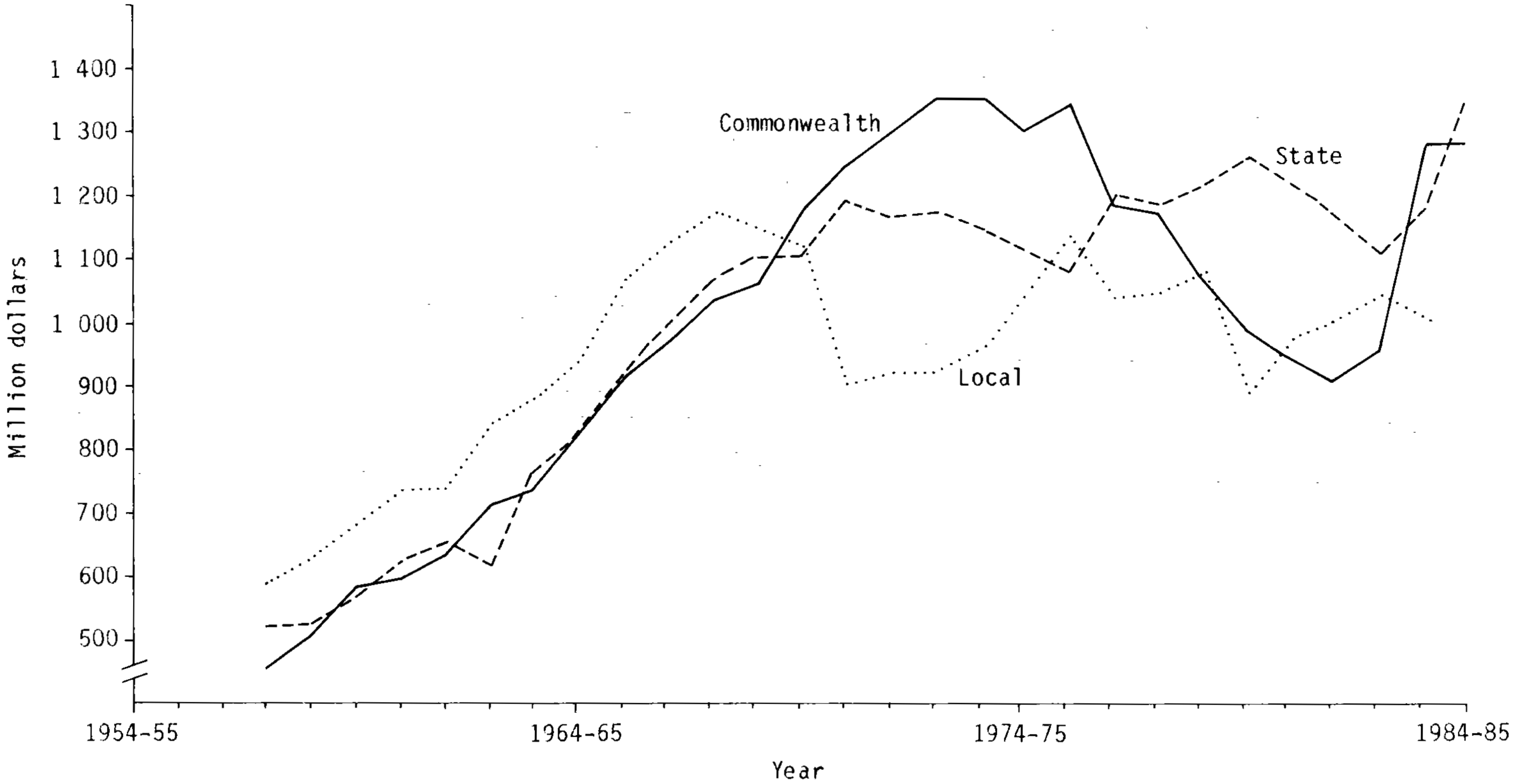
State road expenditure declined after 1970-71, but increased again after reaching a low point in 1975-76. Peak expenditure occurred in 1978-79. The subsequent decline was arrested in 1983-84. Local government road expenditure reached a peak in 1967-68 and declined significantly in the following two years. Expenditure increased subsequently, reaching a peak in 1975-76, partly as a result of the Commonwealth Regional Employment Development (RED) scheme that year. Since then, local government road expenditure has fluctuated around the 1976-77 level.

Total road expenditure by the three levels of government rose steadily from the 1950s, reaching a peak in 1975-76. There was only a slight decline until 1982-83, when the ABRD program helped to boost total road expenditure in 1983-84 to a little below the 1975-76 level. While total expenditure has increased significantly since the late 1950s and has almost kept pace with movements in unit road costs since 1975-76, it has not increased in line with the growth in motor vehicle numbers, nor with the growth in motor vehicle traffic. Road expenditure per capita grew until the mid-1960s; it fell steadily after that until the ABRD program was introduced in 1982-83.

The decline in road expenditure relative to traffic levels does not necessarily signify that the road system is deteriorating or becoming more congested. There may be economies of scale in road building and much of the road system was constructed with a large amount of excess capacity. However, there is some level of expenditure which is required simply to preserve the system at the current standard and cope with expected increases in traffic. In addition, the large increases in heavy vehicle traffic over the last 20 years will have reduced the life of at least some sections of the road network. These issues are discussed further in the following chapters.

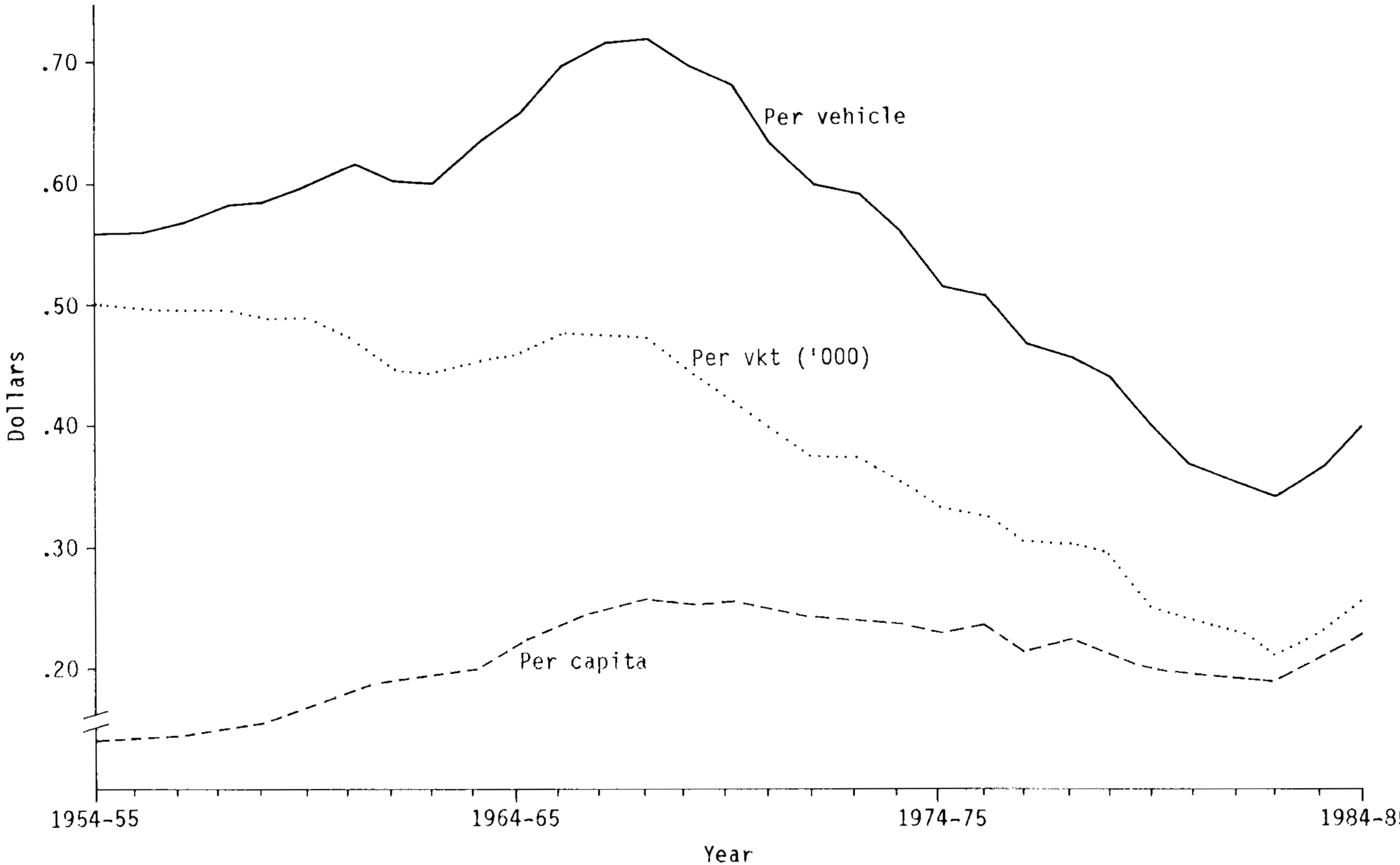
Comparison with other developed countries

Appendix II contains a comparison of road expenditure measured against



Sources BTE (1986d, 1987a).

Figure 4.2 Road expenditure in Australia by level of government, 1954-55 to 1984-85 (constant 1984-85 prices)



Sources BTE (1986d, 1987a) and estimates. ABS (1985d, 1986a,c).

Figure 4.3 Road expenditure per vehicle, per capita and per 10 000 vehicle-kilometres travelled in Australia, 1954-55 to 1984-85 (constant 1984-85 prices)

various demographic, economic and road-related variables for Australia and five other developed countries. As would be expected, expenditure per kilometre of road is relatively low in Australia, given its large area and low population density. Expenditure per vehicle and as a percentage of Gross Domestic Product is, however, relatively high. Overall, Australia compares favourably with other developed countries in roads expenditure.

Recent trends in road expenditure

The latest year for which detailed data on road expenditure by all three levels of government are available is 1984-85. In this section, information is generally presented for the decade 1975-76 to 1984-85.

Commonwealth road expenditure

Commonwealth road expenditure declined steadily from 1975-76 to 1981-82, but increased in 1982-83 and 1983-84 with the introduction of the ABRD program. The ABRD program is funded by a fixed two cents per litre excise on fuel, but it is expected that total road expenditure under this program will decline in real terms until its termination in December 1988.[1] Although the ALTP is indexed against the CPI and its predecessor, the *Roads Grants Act 1981*, also contained annual increases in funds, total Commonwealth road expenditure in fact fell slightly in real terms (measured against the BTE Road Construction Price Index) in 1984-85 and fell again in 1985-86. Funds available under the ALTP for 1986-87 were cut in the 1986 Commonwealth Budget and some expenditure initially earmarked under the ABRD program for 1986-87 has already been deferred. In real terms, it is expected that Commonwealth road expenditure in 1986-87 will be about 14 per cent below the 1983-84 peak.

Funding for the ALTP is to be cut from the levels that would have applied had the Program been indexed as originally planned. At this stage, total Commonwealth grants under both programs will be held at nominal levels from 1987-88 to 1989-90, similar to those in 1985-86 and 1986-87. This implies a significant decline in real terms from 1983-84 to 1989-90.

The distribution of Commonwealth grants among the States altered very little over the decade to 1984-85 (see Appendix I). Some minor alterations to the overall pattern occurred with the beginning of the

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1. In his Economic Statement in May 1987, the Commonwealth Treasurer announced that the ABRD fuel excise was to be continued for a further five years after 1988-89 on the same basis as at present.

ABRD program, as some States were unable to spend their full entitlement in 1982-83 and funds were carried over to be spent in 1983-84. Tasmania's share has fluctuated as a result of special grants for the rebuilding of the Tasman Bridge and construction of the second Hobart bridge. Apart from these anomalies, the grants to the States under the various Roads Grants Acts have been increased annually on a strict pro rata basis since 1977-78 (with the Northern Territory being included in the legislation from 1979-80). The distribution of grants available to the States under the ABRD program has been almost identical to that under the *Roads Grants Act 1981* and the current ALTP.

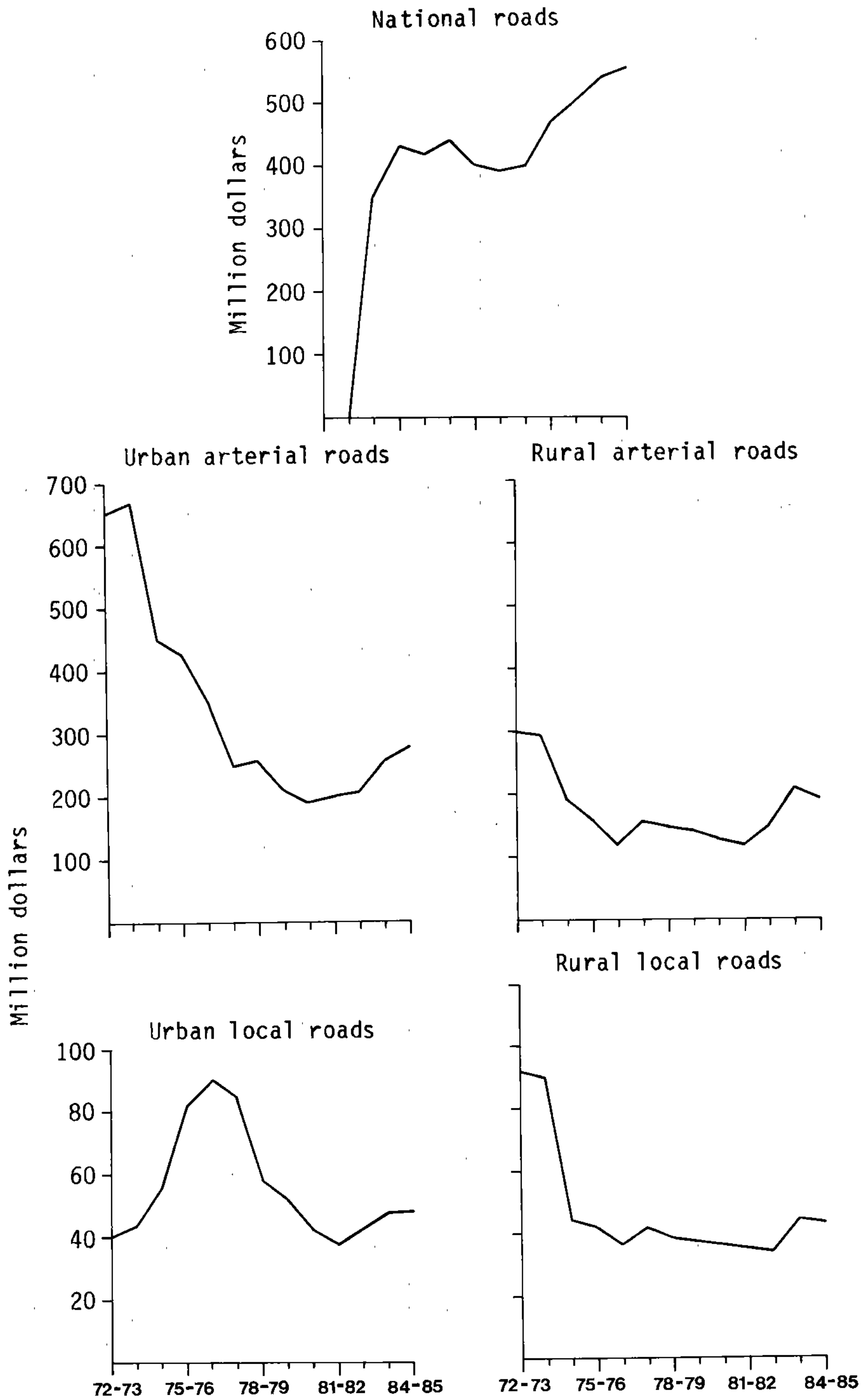
The distribution of roads expenditure among road categories, on the other hand, has altered significantly over the decade, particularly since 1974-75, when the National Highway system was established. The main changes since 1974 have been:

- The *Roads Grants Act 1974 and National Roads Act 1974* involved introduction of the category of National Highways and of funding for urban local roads. There were consequent cuts in the share of funding to urban and rural arterial roads and rural local roads.
- The *States Grants (Roads) Act 1977* involved a cut in funds to urban arterial roads and an increase in the share of funds to rural arterial and rural local roads.
- The *Australian Bicentennial Road Development Trust Fund Act 1982* involved a cut in the share of funds to local roads and an increase in the share for arterial roads.
- The *Australian Land Transport (Financial Assistance) Act 1985* resulted in only slight changes in category shares from previous Roads Grants Acts, and small amounts were made available for new categories including mainline railways, road safety and land transport research.

The effects of these changes are shown in Figure 4.4.

The Cameron Report

Changes to both the allocation of Commonwealth roads grants among States and the distribution between road categories of funds for roads other than national roads, were recommended in the Report of the Inquiry into the Distribution of Federal Road Grants (Cameron Report 1986). The Commonwealth Government has accepted the Inquiry's recommendation to distribute grants on the basis of the principles of 'effort neutrality', provision of funding for both restoration and upgrading purposes and a periodic review of the data sources supporting the indicators chosen by the Inquiry and the weighting



Source BTE (1987a).

Figure 4.4 Commonwealth road expenditure by category, 1972-73 to 1984-85 (constant 1984-85 prices)

applied to those indicators in the light of Commonwealth objectives. The Government also endorsed the Inquiry's recommendations for the continued allocation of ALTP funds for the three years from 1 July 1987.

Broadly, the Committee recommended that allocations to arterial and local roads should be based on a set of indicators. The implications of this recommendation is that the share of funds to arterial roads would increase at the expense of local roads, with the largest relative increase going to New South Wales, followed by South Australia and Victoria; the other States would receive a lower share of funding than at present.

State road expenditure
There has been no clear pattern to State road expenditure since the early 1970s. Overall expenditure rose from a low point in 1975-76 to a peak in 1978-79. A gradual decline from that date was arrested in 1983-84. Total State road expenditure in 1983-84 was at a similar level to that in 1974-75. However, this overall pattern was not generally reflected in individual States, and the State peak corresponded to the 1978-79 national peak only in Tasmania. Table 4.2 shows the movement in State road expenditure over the decade to 1983-84.

The increase in State road expenditure from 1975-76 to 1978-79 largely compensated for the decline in Commonwealth grants; after that date, however, both declined.

Local government road expenditure
Local government expenditure reached a peak in 1975-76, with the assistance of the RED scheme, and has fluctuated since then. In 1983-84, total local government expenditure was about 3 per cent below the 1975-76 figure. The pattern among the States has been mixed, with expenditure in some States falling over the decade while that in other States increased. This is shown in Table 4.3.

Relative road expenditure effort

There is a wide variation in the level of effort that State and local government road funding represents. Appendix I includes details of State road expenditure per motor vehicle and local government road expenditure per capita.

State road expenditure per vehicle varies markedly. The Northern Territory spends more per vehicle than any of the other States, with South Australia's effort being the lowest. The effort of all States

TABLE 4.2 STATE ROAD EXPENDITURE BY STATE GOVERNMENT, 1975-76 TO 1984-85 (CONSTANT 1984-85 PRICES)
($ million)

Year	*NSW*	*Vic*	*Qld*	*WA*	*SA*	*Tas*	*NT*	*Total*
1975-76	422.8	306.9	160.2	88.9	78.1	31.6	..	1 088.5
1976-77	412.6	312.7	205.3	113.2	100.6	55.9	..	1 200.3
1977-78	489.3	334.4	198.6	111.3	88.7	57.1	..	1 279.4
1978-79	464.7	305.7	199.1	129.1	94.7	60.1	69.6	1 323.0
1979-80	478.5	273.7	192.5	136.8	80.3	54.2	52.2	1 268.2
1980-81	479.1	252.4	189.1	125.4	79.1	49.6	48.5	1 223.2
1981-82	418.2	258.4	220.9	113.5	70.0	45.1	48.1	1 174.2
1982-83	382.1	253.9	199.6	119.0	73.6	47.3	35.2	1 110.7
1983-84	414.9	298.5	191.1	109.7	74.9	57.7	30.1	1 176.9
1984-85	495.0	304.0	248.0	120.0	81.0	61.0	33.0	1 342.0

.. Not applicable.

Note Price deflator used was the BTE Road Construction Price Index (Oveall Activity).

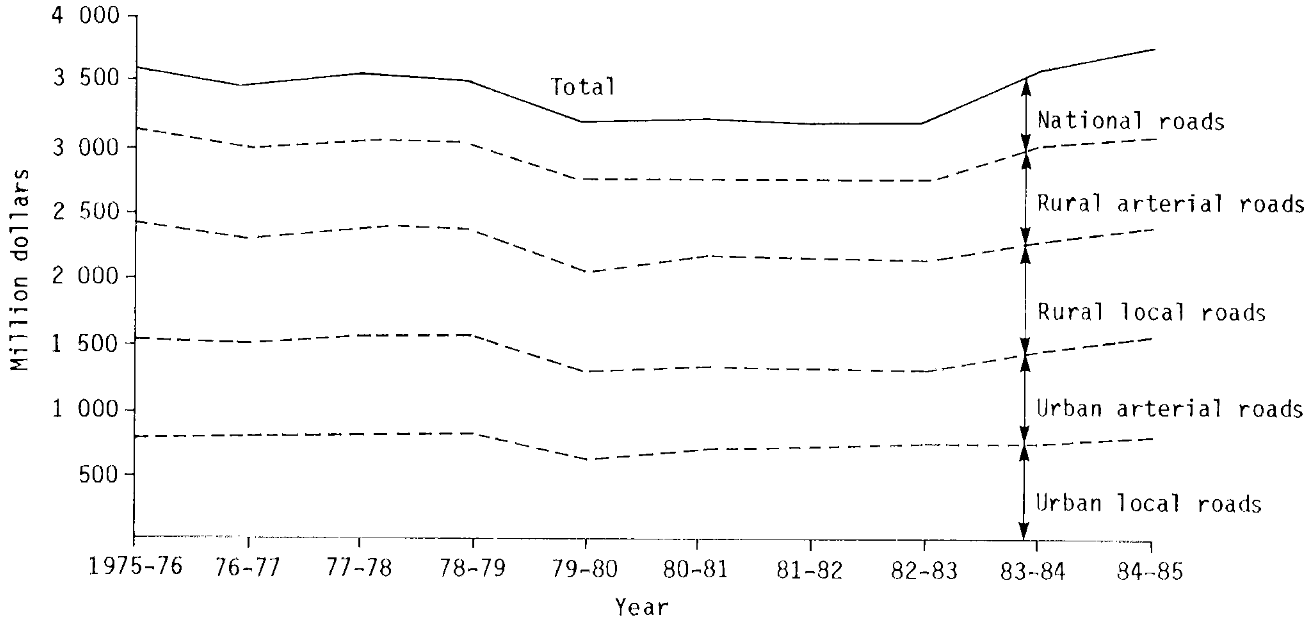
Source BTE (1986c, 1987a).

except Tasmania fell over the period 1975-76 to 1984-85, and that of Tasmania declined from a peak in 1976-77.

Local government road expenditure effort per capita also does not show a consistent pattern over the period. In most States it has fluctuated. Comparisons among the States are made difficult by the existence of unincorporated areas (controlled and financed by State rather than local governments) in New South Wales, South Australia and the Northern Territory. However, local government road expenditure in New South Wales and Queensland has been consistently above that in Victoria, South Australia and Western Australia, while the Tasmanian effort has declined significantly in recent years.

Category trends

Despite the decline in Commonwealth road funding in real terms from 1975-76 to 1982-83, National Highway expenditure, which is fully funded by the Commonwealth, remained fairly constant (see Figure 4.5). It received a large boost, along with other categories, under the ABRD program, particularly in 1983-84 when the ABRD levy was raised from one cent per litre to two cents per litre.



Note Expenditure on planning and research is not included.

Source BTE (1987a).

Figure 4.5 Australia: total road expenditure by category, 1975-76 to 1984-85, (constant 1984-85 prices)

TABLE 4.3 LOCAL GOVERNMENT ROAD EXPENDITURE BY STATE, 1975-76 TO 1984-85 (CONSTANT 1984-85 PRICES)
($ million)

Year	*NSW*	*Vic*	*Qld*	*WA*	*SA*	*Tas*	*NT*	*Total*
1975-76	560.7	204.4	195.3	72.9	66.9	36.7	4.3	1 141.2
1976-77	467.3	219.2	167.3	75.0	70.7	35.2	5.7	1 040.4
1977-78	493.5	209.4	162.9	76.4	79.6	36.9	5.6	1 064.3
1978-79	501.8	215.2	159.2	85.1	78.6	38.0	1.2	1 079.1
1979-80	301.2[a]	222.4	179.8	68.2	71.5	31.2	3.3	877.6[a]
1980-81	405.3	241.8	175.7	64.3	71.7	27.3	1.1	987.2
1981-82	447.7	224.9	179.6	71.6	71.4	25.9	3.4	1 024.5
1982-83	433.4	246.0	190.7	71.0	79.8	25.4	5.2	1 051.5
1983-84	405.7	244.7	206.6	64.0	71.7	26.2	5.1	1 024.0
1984-85	431.0	245.9	223.3	76.3	79.2	26.0	3.8	1 085.5

a. The local government road expenditure figure for New South Wales for 1979-80 is believed to underestimate actual expenditure. For further explanation see BTE (1987a).

Note Price deflator used was the BTE Road Construction Price Index (Overall Activity).

Source BTE (1986c, 1987a).

The major category to decline has been urban arterial roads. Funding for this category was cut considerably in the Commonwealth's 1977-78 road grants legislation. The States initially responded by transferring their own funds from other categories to urban arterial roads. However, this practice began to decline in 1979-80. The introduction of the ABRD program has only partly restored funding to this category. The level of expenditure on urban arterial roads in 1983-84 was 95 per cent of that in 1975-76, having risen from 73 per cent in 1982-83.

The funding of rural arterial roads also declined until 1982-83, but this category had already received an effective boost in 1974-75, when some of these roads were declared as National Highways and were then eligible for 100 per cent funding by the Commonwealth.

Expenditure on urban local roads fluctuated over the period. A peak was reached in 1977-78, with 1983-84 expenditure being about 98 per cent of this peak expenditure. The dip in expenditure shown for 1979-80 is believed to be a statistical error in the New South Wales local government road expenditure figures, which were taken from the ABS Standardised Local Government Finance Statistics (SLGFS).

Expenditure on rural local roads has also varied over the decade, but only to a small degree. Expenditure in 1984-85 was only 2 per cent below that in 1975-76, although it had fallen a little lower for most of the period. (A similar reservation, as for urban local roads concerning the 1979-80 rural local roads expenditure figure, applies.

Overall, the pattern of allocations has altered little over the period, except for the decline in expenditure on urban arterial roads.

THE REACTION OF STATE AND LOCAL GOVERNMENT TO CHANGES IN COMMONWEALTH ROAD FUNDING

In the above discussion it was noted, that since the early 1970s, there have been significant changes in the pattern of Commonwealth road grants, both in the total level of grants and their distribution among road categories. Over the same period, there were few restrictions on State and local government authorities to prevent them from counteracting the Commonwealth changes if they so desired. There were, for example, no category quotas (as the CBR had urged), requiring a minimum level of expenditure in each road category. The Commonwealth Minister, at the time of the introduction of the *National Roads Act 1974,* did make a suggestion, however, that the States should devote more of their funds to rural local roads, since the Commonwealth had accepted full funding responsibility for those roads classified as National Highways (Australia, House of Representatives 1974).

There was little change in the direction of State allocations to road categories in 1974-75, except for a drop in funding for urban local roads. This category had been receiving large percentage increases in funding from the Commonwealth, so the State withdrawal of funds could be seen as a response which largely reduced the impact of the Commonwealth increases. Funding for rural arterial roads remained high from 1974-75 to 1976-77, despite the Commonwealth's major funding effort on National Highways. The category which suffered a real decline in funding during this period was urban arterial roads while State funding of rural local roads increased significantly.

The change of Commonwealth Government in 1975 saw a shifting emphasis in road funding. The next roads legislation, in 1977-78, contained an increase in funding for rural roads but a large drop for urban arterial roads. The States initially responded to these moves with shifts in funding in the opposite direction. However, over the next five years the direction of State funding was reversed. The share of Commonwealth funds directed to all categories remained the same over this period.

The ABRD program led to increases in Commonwealth funding for all categories in 1982-83 and 1983-84. State expenditure declined in 1982-83 but increased in 1983-84. Under the ABRD legislation the States were required to maintain at least the real amount of their road expenditure at a base level for the duration of the program. Accordingly, the decline in State road funding after 1978-79 was probably arrested by the expenditure requirement clause in the ABRD legislation. It appears that the States have responded to changes in the pattern of Commonwealth road expenditure and have on occasions changed the allocation of their funds among categories in ways which in effect countered Commonwealth policies.

The level of local government road expenditure has been largely unaffected by that of the Commonwealth or the States. While Commonwealth expenditure declined from 1975-76 until 1982-83, local government road expenditure fluctuated over the period. The peak in 1975-76 was largely due to Commonwealth grants under the RED scheme, as most of these grants appear to have been spent on roadworks. On the other hand, the increase in Commonwealth tax sharing grants appears to have had little overall impact on local government road expenditure over the period since 1975-76.

THE IMPORTANCE OF ROADS EXPENDITURE IN GOVERNMENT BUDGETS

The discussion of the previous two sections has examined Commonwealth road expenditure patterns in relation to the level and pattern of State and local government road expenditure. In general, these levels of government appear to take into consideration Commonwealth road expenditure before setting their own road expenditure priorities. However, Commonwealth road expenditure is clearly not the only determinant of State and local government road expenditure. Their expenditure must be guided also by their other budgetary priorities. In addition, at the State government level, separate decisions have to be made about the level of revenue to be raised from road users and the level of that revenue which should be devoted to road expenditure.

Decisions on the revenue to be raised from road users have to be guided by various public finance and taxation considerations. Governments are mindful of the total level of taxation levied and must balance this against what are a limited number of taxation measures and a very wide range of expenditure areas to be funded. Thus, roads cannot be considered in isolation since increases in road user taxation may limit the ability to raise funds from other sources.

The following paragraphs examine the importance of roads in the budgets of the three levels of government and how roads have fared in the light of the major increase in expenditure demands on all levels of government. The discussion focuses on the decade since 1975-76. Comment on earlier years is contained in BTE (1984b).

Commonwealth Government

The period since 1975-76 has been marked by calls from the Commonwealth Government for restraint in budget expenditure. However, over the ten years from 1975-76 to 1984-85, total Commonwealth budget outlays, as shown in the Budget Statements, grew by approximately 30 per cent in real terms (Commonwealth of Australia 1986). Commonwealth road expenditure, on the other hand, declined until 1982-83 when the ABRD program was introduced. The decline, as a percentage of Commonwealth budget outlays, was from 2.40 in 1975-76 to 1.74 in 1981-82, but was followed by an increase to 2.13 per cent in 1983-84. Since then it has declined again to just over 2 per cent (see Appendix I).

Most of the increase in budget outlays over the period has gone to defence, social security and welfare and economic services. Strong growth also occurred in expenditure on general public services and general purpose grants to the States and local government see Appendix I). The only decline occurred in the area of transport and communication. Some of this was due to removal 'off budget' of the Australian Postal Commission and the Australian Telecommunications Commission. Nevertheless, transport expenditure (including that on roads) declined in real terms over the period and now represents a smaller share of total budget outlays than formerly.

The growth in general revenue (tax sharing) grants to the States over the period was a major element of the Commonwealth Government's late 1970s federalism policy. Along with the growth of these grants went a decline in specific purpose grants (including road grants) to the States. The restraint exercised on total budget outlays from 1975-76 on was relaxed somewhat in 1981-82 and the following years. The main areas to benefit from this relaxation were not specific purpose grants but tax sharing grants and social security and welfare. Subsequent relaxation led to health, social security and tax sharing grants receiving most of the budget increases. The two most recent budgets basically held all expenditures fairly constant, although transport and communication expenditure fell significantly.

State governments

While Commonwealth road grants fell from 1975-76 to 1981-82 and again after the introduction of the Bicentennial program, tax sharing grants to the States increased significantly. These grants represent a large proportion of total State government revenue. However, none of these grants have been explicitly directed by the States to roadworks. (State government budget outlays are summarised in Appendix I.)

The major growth areas in State expenditure have been health, welfare and other social services. These are areas which received financial attention under Commonwealth programs in the 1970s, and the States have extended those programs and have continued to fund them. The largest percentage increase, however, has been in public utilities, particularly electricity generation plants. Transport expenditure has also grown, but this largely reflects increasing deficits for rail and urban public transport. Road expenditure as a percentage of State budget outlays has declined significantly since 1975-76.

Local government

The main sources of local government revenue are shown in Appendix I. Commonwealth general purpose (tax sharing) and specific purpose grants form a large share of total local government revenue. Rates account for the bulk of local government revenue sources, with borrowings providing a small share (although borrowings have declined significantly in recent years).

As with the States and the Commonwealth Government, health and and other social services have received the largest increase in local government expenditure since 1975-76. Expenditure on roads has remained fairly constant as a percentage of total local government budget outlays. From this, it would appear that the large increase in tax sharing grants from the Commonwealth to local government after 1979-80 were spent on the whole range of expenditure functions. A proportion, similar to that from other untied funds such as rates and borrowings, was probably spent on roads, although it is not possible to identify separately the final allocation of particular sources of untied revenue. This issue is discussed further in Chapter 7.

All governments

Overall, it appears that all three levels of government have adopted similar expenditure policies since 1975-76. The main areas of expenditure increases for all three levels of government have been social security and welfare and what has been described by the National Inquiry into Local Government Finance (NILGF) (Self 1985) as 'people services'. There has been less emphasis on capital infrastructure, including roads.

CHAPTER 5 NATIONAL HIGHWAYS AND RURAL ARTERIAL ROADS

This chapter presents the expenditure implications for Australia's major rural road system. This system encompasses the classifications 'National Highways' and 'rural arterials'[1] as declared by the Commonwealth Government, excluding roads in the Australian Capital Territory.

The emphasis of the analyses presented here is on road expenditure (restoration and upgrading) which can be justified in economic terms in a reasonably strict sense. Restoration works are deemed to include routine maintenance and rehabilitation activities. Other considerations reflecting equity, regional development and social factors are not included as part of the formal analytical framework, but are noted as influences which can modify results based solely on economic considerations. Road expenditure is analysed for the period 1989 to 2000.

The chapter provides information on:

- the status of the rural arterial and National Highway systems expected to be achieved by 1989,[2] at the conclusion of the existing ABRD program;
- the expenditure required to preserve the roads asset at the level to be achieved by 1989, using surface condition and level of service, respectively, as criteria;
- determination of expenditure levels for road construction (that is, rehabilitation and upgrading) based on minimum levels of economic justification;
- the effect of changes to existing road funding in terms of how the distribution of such funds for roads programs may change, based on economic criteria; and

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1. Rural arterials refer to the rural arterial roads declared by the Commonwealth Government, excluding the National Highway system.
2. Years 1989 and 2000 refer to the end of June, respectively, unless otherwise indicated.

- the implications of including certain rural arterial routes in an extended National Highway system and the expenditure that would be required to restore and upgrade the extensions.

Supporting details of expenditure and road status are presented in Appendixes III and IV.

STATUS AT 1989

Two different approaches have been adopted in assessing the status of the system at the conclusion of the ABRD program in 1989. In the case of the National Highway system, for which the Commonwealth Government has funding responsibility, projected works programs of the States as supplied to Commonwealth authorities, have been used to update the road inventory to 1989. Comparable information is not available on a consistent basis in the various States for rural arterials. Hence, a model was used to synthesise the 1989 inventory for this class of road (see Appendix IV).

National Highways

Physical and operational conditions

Figure 3.2 shows the National Highway system in Australia. This system was defined in 1974 by the Commonwealth Government, and it committed itself to taking full responsibility for the funding of both construction and maintenance of National Highways, which link 68 per cent of Australia's population.

Using the various roadworks programs drawn up by individual States for their respective National Highways, and combining this information with actual National Highway inventory information, the status of the system in 1989 has been projected. In 1989, National Highways will comprise approximately 2 per cent of the total length of roads in Australia and 13 per cent of the length of all arterial roads (including National Highways).

The proportion of total Australian road travel (measured in terms of vkt) taking place on National Highways in 1989 is estimated to be approximately 10 per cent. This represents about 30 per cent of total road travel in rural areas of Australia. Nearly four-fifths of all travel on National Highways occurs in the three eastern seaboard States.

Table 5.1 shows the length of National Highways in various seal width categories together with characteristics of traffic and road roughness for each State. Roads are classed as 'one lane' where the seal width is 4.5 metres or less. The roughness rating is measured by the NAASRA Roughness Meter (NRM).

The level of service ratings, ranging from 1.0 to 5.0, are based on the scale of A to F presented in the Highway Capacity Manual (HCM) (Transportation Research Board 1985). Traffic conditions, signified by numerical scale ranges, are:

- 1.0 to 2.0 - Unstable operating conditions. Overtaking is generally impossible and queues of slow moving or stationary vehicles occur.
- 2.0 to 3.0 - Speed and manoeuvreability are severely restricted. Traffic flow tends to lose stability at the lower end of the range.
- 3.0 to 4.0 - The ability to select speed and to manoeuvre is usually affected by other vehicles.
- 4.0 to 5.0 - Traffic flow is generally unrestricted, but the effect of other vehicles is evident at the lower end of this range.

Two average values of the roughness and level of service characteristics are shown. The first is based on weightings by vkt and gives more emphasis to those parts of the road system with higher levels of traffic. The second average is calculated solely from carriageway length and gives no additional significance to areas of high traffic levels. Further details of level of service and roughness ratings are contained in Appendix IV.

The separate data given for each State in Table 5.1 illustrate the wide range of road conditions which will prevail in 1989 on National Highways. The most noteworthy features among the States are:

- the absence of one lane roads in New South Wales, Victoria, South Australia and Tasmania;
- the existence of a small section of unsealed road in Western Australia;
- the relatively high mean roughness rating on Queensland National Highways; and
- the relatively low mean level of service for users of National Highways in New South Wales.

Intercity links

The lengths and usage of the intercity links of the National Highway system are summarised in Table 5.2. The main features are:

- the relatively high proportion of the Sydney-Melbourne link which is divided, and the high mean traffic flow on this link;

TABLE 5.1 PROJECTED STATUS OF NATIONAL HIGHWAYS, 1989

	Length (kilometres)						Mean level of service[b] based on weighting by		Mean roughness[c] based on weighting by	
		Sealed				Mean traffic flow[a]				
State	*Unsealed*	*One lane*	*Multi lane*	*Divided*	*Total*	*(aadt)*	*vkt*	*Length*	*vkt*	*Length*
NSW	0.0	0.0	859.8	485.7	1 345.5	11 545	3.3	3.8	76.3	80.9
Vic	0.0	0.0	331.6	366.2	697.8	7 141	4.8	4.8	68.0	69.1
Qld	0.0	26.3	3 669.5	236.8	3 932.5	3 324	3.8	4.4	82.2	95.5
SA	0.0	0.0	2 325.7	130.5	2 456.2	1 769	4.3	4.7	51.2	50.2
WA	75.7	272.8	4 289.5	8.6	4 646.5	500	4.6	4.9	73.6	67.0
Tas	0.0	0.0	277.5	41.8	319.3	5 433	4.1	4.3	63.2	65.9
NT	0.0	380.6	2 252.7	22.4	2 655.8	247	5.0	5.0	73.7	75.6
Australia	75.7	679.8	14 006.3	1 292.0	16 053.7	2 657	3.8	4.6	73.9	74.2

a. Vehicle kilometres divided by route length.
b. Level of service is measured on a scale of 1.0 to 5.0. See text for details.
c. Measured in NRM counts. For general purposes, a roughness count of less than 100 is good and a count of 140 or more is poor (National Association of Australian State Road Authorities 1984a). See Appendix IV for details.

Notes 1. Owing to rounding, figures may not add to totals.
2. Status as at 30th June, 1989.

Source BTE projections.

TABLE 5.2 PROJECTED NATIONAL HIGHWAY STATUS: INTERCITY LINKS, 1989

	Length (kilometres)						*Mean level of service[b] based on weighting by*		*Mean roughness[c] based on weighting by*	
		Sealed				*Mean traffic flow[a]*				
Link	*Unsealed*	*One lane*	*Multi lane*	*Divided*	*Total*	*(aadt)*	*vkt*	*Length*	*vkt*	*Length*
Sydney-Melbourne	0.0	0.0	220.3	585.9	806.3	11 696	4.0	4.5	73.8	71.7
Melbourne-Adelaide	0.0	0.0	506.6	194.0	700.6	5 564	4.3	4.5	62.6	65.2
Adelaide-Perth	0.0	0.0	2 626.1	43.4	2 669.4	1 425	4.5	4.7	62.4	67.3
Port Augusta-Darwin	0.0	0.0	2 652.8	22.4	2 675.2	269	5.0	5.0	65.9	60.8
Perth-Katherine	75.7	653.5	2 965.1	.9	3 695.2	280	4.6	4.9	71.9	67.2
Brisbane-Tennant Creek	0.0	26.3	2 313.6	91.4	2 431.3	1 159	4.2	4.8	89.5	98.7
Sydney-Brisbane	0.0	0.0	802.7	144.5	947.2	9 325	3.0	3.5	73.4	83.2
Hobart-Burnie	0.0	0.0	277.5	41.8	319.3	5 433	4.1	4.3	63.2	65.9
ACT border-Goulburn	0.0	0.0	31.3	34.9	66.2	10 819	3.1	3.8	98.7	93.0

TABLE 5.2 (Cont.) PROJECTED NATIONAL HIGHWAY STATUS: INTERCITY LINKS, 1989

	Length (kilometres)						*Mean level of service[b] based on weighting by*		*Mean roughness[c] based on weighting by*	
		Sealed				*Mean traffic flow[a]*				
Link	*Unsealed*	*One lane*	*Multi lane*	*Divided*	*Total*	*(aadt)*	*vkt*	*Length*	*vkt*	*Length*
ACT border-Yass	0.0	0.0	36.9	0.0	36.9	6 485	3.2	3.2	106.7	109.0
Brisbane-Cairns	0.0	0.0	1 573.4	132.7	1 706.1	5 523	3.7	4.0	79.0	85.4
Australia	75.7	679.8	14 006.3	1 292.0	16 053.7	2 657	3.8	4.6	73.9	74.2

a. Vehicle-kilometres divided by route length.
b. Level of service is measured on a scale of 1.0 to 5.0. See text for details.
c. Measured in NRM counts. For general purposes, a roughness count of less than 100 is good and a count of 140 or more is poor (National Association of Australian State Road Authorities 1984a). See Appendix IV for details.

Notes 1. Owing to rounding, figures may not add to totals.
2. Status as at 30th June, 1989.

Source BTE projections.

- the relatively low level of service on the links from the Hume Highway to the Australian Capital Territory and on the Sydney-Brisbane link;
- the relatively high mean roughness rating on the Brisbane-Tennant Creek link and the Federal Highway (Australian Capital Territory border - Goulburn link); and
- the existence of an unsealed section on the Perth-Katherine link.

Changes from 1981 to 1989

By 1989, the overall standard of the system is expected to have improved substantially over the conditions existing in 1981 (BTE 1984a). The principal changes since 1981 will be:

- National Highways will be sealed by 1989 in all States except Western Australia, where 76 kilometres will remain unsealed;
- the length of divided road will have increased by 705 kilometres or 120 per cent. The largest increase of any State will be 274 kilometres in New South Wales, an increase of 129 per cent over the eight year period;
- a reduction in the length of the Port Augusta-Darwin link of approximately 150 kilometres; and
- the length of National Highways in the various width classifications will show a general increase in road capacity in all States.

In addition, travel on National Highways will have increased by 50 per cent between 1981 and 1989.

The growth in vehicle travel to 1989 will not necessarily be accompanied by an increase in the number of casualty[3] or fatal accidents. BTE (1984d) reported that fatal accident numbers and fatal accident rates (per unit of vehicle travel) had generally declined over the period 1975 to 1981. Data for the period 1981 to 1984 display a similar drop in fatal accident numbers and rates. Casualty accident numbers and rates over the period 1980 to 1984 (1985 for South Australia and Tasmania) also indicate a general downward trend. However, no attempt has been made to assess whether this trend may continue to 1989 or beyond.

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3. Injuries requiring hospitalisation.

Achievement of design standards

The projected state of development of National Highways in 1989 was compared with the design standards for construction as laid down by the Commonwealth Department of Transport (1982), as a basis for estimation of the approximate cost of improving those parts of the road system not yet constructed to these standards. To simplify the process, the design standards considered were confined to the seal widths specified in the Department's minimum design standards, and the divided road requirements in the Department's notified standards.

Such a comparison should not be used as a guide to the need for improvement, since road conditions lower than these design standards could be quite adequate for the traffic conditions prevailing at 1989. Design standards are used primarily as a guide for redesign when restoration becomes necessary as a result of road deterioration, for upgrading of road geometrics, or for new routes.

Where road sections will not have been constructed to the design standards by 1989, the cost of improvement was assessed. This cost is given for each intercity link in Appendix III. For Australia, a total expenditure of approximately $3100m would be required by 1989 to upgrade the system to the specified seal width and divided road standards, excluding the cost of bridges and rehabilitation of structurally deficient pavements. This latter estimate is developed independently of the analyses presented later in this chapter, and cannot be related to them since different situations are considered in each case.

Rural arterial roads

Physical and operational conditions

Rural arterial roads amount to some 90 000 kilometres or approximately 11 per cent of the total length of roads in Australia. It is estimated that nearly 35 per cent of total Australian road travel in 1989 (measured in vkt), will occur on rural arterial roads.

Due to the unavailability of State advance roadworks programs for the rural arterial system, an alternative approach to that used for National Highways for the projection of the 1989 status was required. This status was synthesised using the algorithms on which the subsequent budget analysis of the rural arterial road system was based. The approach is explained in Appendix IV.

The principal characteristics of rural arterial roads are shown in Table 5.3. They are:

- the relatively high proportion of unsealed road lengths in New South Wales, Western Australia and the Northern Territory compared with other States;
- the relatively high proportion of one lane sealed roads in Queensland and the Northern Territory compared with the proportions in other States;
- the relatively high mean roughness levels in each State compared with National Highways; and
- the relatively high mean level of service compared with National Highways in most States.

In 1989, the length of sealed rural arterial roads will amount to approximately 73 000 kilometres, representing 81 per cent of the total length of rural arterial roads. This proportion can be compared with the sealed proportions of 78 per cent in 1981 and 71 per cent in 1972.

PRESERVATION OF THE ASSET

The construction of a new road, or the upgrading of an existing one, affects the expenditure required in the future to preserve the asset. Any road system deteriorates over time as a result of both the pavement and surface wear caused by the vehicle traffic it sustains, and normal weathering. One measure of this deterioration is the NRM count, which corresponds to an indication of the roughness of the road surface. Furthermore, as traffic levels grow on a road system, congestion effects can become apparent in the form of slower average vehicle speeds, increased accident rates and peak-time queueing. In this way, the 'level of service' of the road deteriorates, resulting in increased travel time and road user costs.

The term preservation can be interpreted in several ways. In its narrowest technical sense, it can refer to activities such as linemarking, pothole repair, resealing or resheeting, but exclude all types of construction. This type of activity is subsequently referred to as routine maintenance. In a broader sense, road preservation can refer to any work aimed at returning a road to its original structural condition. Preservation in this sense would involve rehabilitation[4] work (subsequently referred to as preservation of the physical asset).

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4. Rehabilitation is construction work carried out on the existing alignment to return the pavement to its design strength, with negligible upgrading of geometric standards.

TABLE 5.3 PROJECTED STATUS OF RURAL ARTERIAL ROADS, 1989

	Length (kilometres)					*Mean*	*Mean level of service*[b] *based on weighting by*		*Mean roughness*[c] *based on weighting by*	
		Sealed				*Mean traffic flow*[a]				
State	*Unsealed*	*One lane*	*Multi lane*	*Divided*	*Total*	*(aadt)*	*vkt*	*Length*	*vkt*	*Length*
NSW	8 021.2	235.8	19 086.2	365.0	27 708.1	979	4.3	4.7	94.6	114.5
Vic	298.0	229.3	13 576.4	277.9	14 381.8	1 213	4.5	4.7	73.6	86.5
Qld	2 157.5	4 587.5	11 063.4	144.4	17 952.8	807	4.2	4.7	90.2	108.2
SA	715.2	40.5	7 643.0	92.6	8 491.1	934	4.6	4.8	80.4	85.9
WA	4 040.0	1 739.0	10 252.3	48.6	16 079.8	505	4.6	4.9	67.3	89.7
Tas	210.2	27.2	2 109.6	23.7	2 370.7	1 004	4.5	4.6	76.0	92.7
NT	1 304.3	1 130.1	185.4	0.0	2 619.7	43	5.0	5.0	76.4	106.0
Australia	16 746.4	7 989.3	63 916.3	952.1	89 604.1	866	4.4	4.7	84.2	100.8

a. Vehicle-kilometres divided by route length.
b. Level of service is measured on a scale of 1.0 to 5.0. See text for details.
c. Measured in NRM counts. For general purposes, a roughness count of less than 100 is good and a count of 140 or more is poor (National Association of Australian State Road Authorities 1984a). See Appendix IV for details.

Notes 1. Owing to rounding, figures may not add to totals.
2. Status as at 30th June, 1989.

Source BTE projections.

In an even broader sense, preservation can refer to the roadworks necessary to maintain the level of service provided by a road. Such roadworks would include the rehabilitation activities referred to above, together with any upgrading of the road needed to counteract the effect of increased traffic volumes on level of service (subsequently referred to as preservation of operational performance).

The material in this section addresses road preservation in each of these three senses, that is:

- routine maintenance;
- preservation of the physical asset; and
- preservation of operational performance.

Routine maintenance

Table 5.4 shows the projected levels of expenditure on routine maintenance between 1989 and 2000, for both National Highways and rural arterial roads. In some ways, the annual requirement for routine maintenance is fairly regular. For example, tasks such as drainage clearance and line marking need to be carried out regularly, regardless of the condition of the pavement. However, the requirement for other routine maintenance tasks such as resheeting and resealing can be reduced to some extent by a concerted program of road rehabilitation and/or upgrading, such as that occurring on National Highways during the 1980s. On the other hand, if there is relatively little expenditure on rehabilitation and upgrading over a number of years, the eventual requirement for routine maintenance can increase.

The figures presented in Table 5.4 were derived by assuming that the level of maintenance expenditure in 1983-84 (BTE 1986a) would continue in real terms until the year 2000.

Preservation of the physical asset

One way of assessing the physical condition of roads is to consider their mean roughness level. Roads become rougher over time because of the passage of vehicles and to a lesser extent, the weathering process. Routine maintenance activities are intended to delay the effects of these factors. However, when a pavement nears the end of its economic life, it is necessary to rehabilitate the pavement. Preservation of the physical asset, that is, without upgrading of geometric standards, is achieved by pavement rehabilitation.

Appendix IV contains details for modelling pavement deterioration, routine maintenance and rehabilitation requirements, and their combined effects on road roughness.

TABLE 5.4 PROJECTED EXPENDITURE ON ROUTINE MAINTENANCE, 1989 TO 2000 (CONSTANT 1985-86 PRICES)
(*$ million*)

	National Highways		*Rural arterial roads*	
State	*Per year*	*Total for period 1989 to 2000*	*Per year*	*Total for period 1989 to 2000*
NSW	19.5	214.5	115.2	1 267.2
Vic	9.7	106.7	55.5	610.5
Qld	32.3	355.3	86.0	946.0
SA	7.2	79.2	31.9	350.9
WA	19.3	212.3	35.9	394.9
Tas	2.4	26.4	9.1	100.1
NT	6.9	75.9	2.9	31.9
Australia	97.3	1 070.3	336.5	3 701.5

Note Owing to rounding, figures may not add to totals.

Source BTE projections.

Table 5.5 shows the rehabilitation expenditure[5] that would be required during the period 1989 to 2000 to preserve the mean roughness in each State at the 1989 level.

The rehabilitation projects required to maintain the mean roughness level of a road system have been evaluated in terms of their economic merit. This has been expressed as a benefit-cost ratio (bcr) for each of the particular projects to be undertaken. Each project undertaken on a section of the road system has a cost associated with it, but also confers benefits on the traffic using the road. In the main, these benefits comprise reduced vehicle operating costs, savings in travel time and reduced accident costs. To provide an overall indication of the economic worth of total expenditure on the system, the average bcr of the individual projects was calculated. The

5. The analytical process used for this estimation allows for routine maintenance in its narrower technical sense, such as resheeting to reduce roughness. However, the cost of this maintenance is not included in the estimates in Table 5.5.

methodology for the selection of projects on the basis of bcr is outlined in Appendix IV.

National Highways

As shown in Table 5.5, the mean bcr of works required to rehabilitate National Highways to preserve their mean roughness level is above unity for all States except Western Australia, and is relatively high in New South Wales. On this economic basis, there could be a case for increasing the mean standard of the pavement condition in States other than Western Australia, since the resulting benefits would exceed the costs.

At the expenditure levels required to preserve mean roughness, further analysis indicates that there could be a marginal decline in mean level of service of the National Highway system due to projected traffic growth as illustrated by the mean level of service data given in Appendix III.

TABLE 5.5 PROJECTED EXPENDITURE REQUIRED TO PRESERVE THE PHYSICAL ASSET, 1989 TO 2000 (CONSTANT 1985-86 PRICES)

	National Highways			*Rural arterial roads*		
State	*($m)*	*(per cent)*	*mean bcr*	*($m)*	*(per cent)*	*mean bcr*
NSW	233.3	17.4	6.7	2 132.4	37.1	1.4
Vic	97.6	7.3	3.6	1 165.9	20.3	1.0
Qld	413.7	30.8	2.1	963.6	16.8	1.1
SA	193.5	14.4	1.1	617.2	10.7	0.9
WA	155.1	11.5	0.8	518.0	9.0	0.7
Tas	63.0	4.7	1.9	235.0	4.1	0.8
NT	187.6	14.0	2.3	112.3	2.0	0.8
Australia	1 343.9	100.0	2.8	5 744.5	100.0	1.1

Notes 1. Expenditure for rehabilitation of pavements to preserve mean roughness level. Expenditure for routine maintenance and bridges is excluded.
2. Owing to rounding, figures may not add to totals.

Source BTE projections.

Rural arterial roads
Table 5.5 shows that an expenditure of approximately $5745 million is required to preserve the mean roughness of rural arterial roads during the period 1989 to 2000. In view of the low mean bcrs for this work, there appears to be a case for the postponement of some rehabilitation work on rural arterials on economic grounds in all States except New South Wales. Based on the status of the rural arterial system in 1989, projected synthetically, the mean bcrs of projects required to rehabilitate these roads are lower in all States than the mean bcrs for corresponding projects on National Highways.

Analysis not reported in Table 5.5 also indicates that at the expenditure levels needed for rehabilitation over the period 1989 to 2000, there could be a marginal decline in level of service on the rural arterial road system in all States due to traffic growth (see Appendix III).

Preservation of operational performance

The operational performance of a road, as perceived by a road user, encompasses both the roughness of the road and the level of service provided by the road. Road roughness can affect vehicle operating costs, user comfort and convenience. The level of service provided to road users reflects the level of congestion on the road and the ability of users to maintain a particular travel speed. For example, a road with a low level of service is very congested, providing stop-start travel; a high level implies that vehicles can travel freely without delays. It also follows, that the level of service provided by a road may deteriorate over time due to a growth in traffic.

The road expenditure figures shown in Table 5.6 reflect funding levels that would be required to preserve the mean level of service, as well as the mean roughness of National Highways and rural arterials during the period 1989 to 2000. Both rehabilitation and upgrading projects are required under this criterion (see Appendix IV).

National Highways
A comparison of Tables 5.5 and 5.6 shows that the expenditure required to preserve the operational performance of National Highways is some 36 per cent higher than the expenditure required for rehabilitation alone. The mean bcrs of projects on National Highways exceeds unity in all States except Western Australia. Queensland requires the highest proportion of funds (nearly 32 per cent), a similar proportion to that, when only rehabilitation expenditure is considered.

TABLE 5.6 PROJECTED EXPENDITURE REQUIRED TO PRESERVE OPERATIONAL PERFORMANCE, 1989 TO 2000 (CONSTANT 1985-86 PRICES)

	National Highways			*Rural arterial roads*		
State	*($m)*	*(per cent)*	*mean bcr*	*($m)*	*(per cent)*	*mean bcr*
NSW	336.6	18.4	5.4	2 489.0	36.7	1.3
Vic	122.4	6.7	2.9	1 319.1	19.4	1.0
Qld	576.4	31.5	2.1	1 163.2	17.1	1.0
SA	237.6	13.0	1.3	729.5	10.7	0.9
WA	195.1	10.7	0.8	680.2	10.0	0.7
Tas	78.9	4.3	1.9	275.5	4.1	0.7
NT	281.8	15.4	1.5	131.3	1.9	0.9
Australia	1 828.8	100.0	2.4	6 787.7	100.0	1.0

Notes 1. Expenditure includes both upgrading to preserve mean level of service, and rehabilitation to preserve mean roughness level. Excludes expenditure for routine maintenance and bridges.
2. Owing to rounding, figures may not add to totals.

Source BTE projections.

Rural arterial roads
From Tables 5.5 and 5.6 it can be seen that the expenditure needed to preserve the operational performance of rural arterial roads over the period 1989 to 2000, is 18 per cent higher than the amount needed for rehabilitation alone. However, on grounds of benefit-cost analysis alone, much of the work required to preserve the mean level of service should not be carried out, as indicated by the mean bcr values shown in Table 5.6. This implies, that an appreciable proportion of the rural arterial road system provides a level of service which cannot be justified in strictly economic terms by the amount of traffic which it carries, although there may be sufficient other (non-economic) considerations to justify this level.

ECONOMIC IMPLICATIONS OF ROAD PROJECTS

The analysis presented in the previous section referred to the preservation of the current National Highway and rural arterial systems at their 1989 levels, in terms of two different criteria.

This section presents the results of an analysis in which each part of the major rural road system is considered solely in terms of the economic merits of projects (rehabilitation or upgrading), which might be undertaken on that part over the period 1989 to 2000. Again, bcr values are used to measure the economic merit of a road project.

Construction expenditure estimates presented in this section reflect the cost of undertaking all projects with a bcr greater than or equal to a specified *minimum*. It should be noted, however, that economic worth is not the only criterion for determining the desirability or otherwise of undertaking roadworks by using public funds. Factors such as equity and national importance are often also taken into account in the final decision.

National Highways

Table 5.7 illustrates the relationship between the minimum allowable bcr of projects and the resulting level of expenditure on National Highways, that would ensue if these rehabilitation and upgrading projects were undertaken during the period 1989 to 2000. If the minimum bcr were increased from 1.0 to 2.0 (that is, all projects undertaken have a bcr of at least 2.0), the expenditure on all National Highways between these years would fall by 48 per cent from $2794 million to $1450 million, in 1985-86 prices.

Projects in New South Wales and Queensland would generate the greatest expenditure levels in the range of bcrs examined, although a significant level of expenditure in Queensland would be on projects of relatively low economic worth. Nevertheless, even at a minimum bcr of 3.0, the corresponding expenditure in Queensland would be substantially greater than in the other States, again with the exception of New South Wales. Overall, assuming that projects with bcrs greater than or equal to unity are undertaken, the analysis indicates that the mean roughness (based on weighting by vkt) of the National Highway system would decrease marginally. The mean level of service (based on weighting by vkt), however, would increase quite substantially in all States (see Appendix III).

In order to examine further the financial and physical characteristics of future construction projects on the National Highway system, projects with an economic worth yielding a bcr of at least unity are considered in more detail in the following discussion.

The mean bcr of projects with a minimum bcr of unity on New South Wales National Highways is estimated to be 2.66. This figure is significantly higher than the 1.08 for Western Australia and the range

TABLE 5.7 RELATIONSHIP BETWEEN MINIMUM ALLOWABLE BENEFIT-COST RATIO AND RESULTING LEVEL OF EXPENDITURE: NATIONAL HIGHWAYS, 1989 TO 2000 (CONSTANT 1985-86 PRICES)
($ million)

	Minimum allowable bcr				*Projected expenditure*
State	*0.5*	*1.0*	*2.0*	*3.0*	*1989 to 2000*[a]
NSW	1 386.5	1 063.8	722.7	503.9	1 363.5
	(31.1)	(38.1)	(49.8)	(56.9)	(36.0)
Vic	283.4	223.8	115.1	84.4	638.9
	(6.4)	(8.0)	(7.9)	(9.5)	(16.9)
Qld	1 656.5	829.6	348.4	155.8	712.2
	(37.2)	(29.7)	(24.0)	(17.6)	(18.8)
SA	309.6	162.9	56.5	29.8	364.8
	(6.9)	(5.8)	(3.9)	(3.4)	(9.6)
WA	182.5	122.0	27.2	6.4	382.9
	(4.1)	(4.4)	(1.9)	(0.7)	(10.1)
Tas	294.9	170.8	51.0	20.1	136.0
	(6.6)	(6.1)	(3.5)	(2.3)	(3.6)
NT	343.4	221.6	129.0	84.9	188.6
	(7.7)	(7.9)	(8.9)	(9.6)	(5.0)
Australia	4 456.8	2 794.4	1 449.9	885.2	3 786.9
	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)

a. Projected expenditure based on historical levels from all sources, including ABRD funds and ALTP funds, both being maintained in real terms as detailed in Table 5.9.

Notes 1. Construction expenditure (excluding bridges), 1989 to 2000.
2. Owing to rounding, figures may not add to totals.
3. Figures in parentheses are percentages.

Source BTE projections.

of 1.33 to 1.50 for all other States. In general terms, these mean bcrs reflect the mean traffic flows for National Highways shown in Table 5.1.

Comparison of the calculated expenditures in Table 5.7 with the expenditures projected for the period 1989 to 2000 (based on projection of historical expenditure), shows that, overall, the expenditure during the 1990s on National Highway projects with a minimum bcr of unity would be less than the projected level. However, on the basis of solely economic criteria, the distribution of this expenditure among individual States would be significantly different. Queensland National Highways would require construction expenditure 16 per cent greater than the amount projected, while the corresponding figures for Tasmania would be 27 per cent and for the Northern Territory, 17 per cent greater. The other States would require construction expenditure below that indicated by the historical expenditure projection.

These significant differences in the distribution of National Highway construction expenditure do not necessarily indicate that the funding distribution which occurred during the 1980s was, or is, inappropriate. The economic analysis undertaken in this study relates to the requirements of the road system as it will exist in the 1990s. Hence, it might be expected that the relatively large amounts of money spent on construction works on the Victorian National Highways during the 1980s would result in a lower requirement for these works during the 1990s. In fact, Table 5.7 indicates that purely economic considerations would suggest a reduced level of funding in the 1990s, relative to the projected funding, for all States except Queensland, Tasmania and the Northern Territory. Increasing the required economic worth of road projects further to yield a minimum bcr of 2.0, would reduce the corresponding expenditure below the projected level in all States.

During the 1990s, approximately 62 per cent of construction expenditure on National Highways, producing a minimum bcr of unity, would be spent on projects to upgrade the standard of the road. The other 38 per cent would be spent on the rehabilitation of roads to their existing standard. Over 66 per cent of upgrading expenditure involves replacing single carriageway roads with four lane divided roads, while a further 26 per cent relates to the construction of six and eight lane divided roads. Only a few per cent of the upgrading expenditure involves the sealing or widening of single carriageway roads.

The projected status of the National Highway system in the year 2000, based on the above expenditure, is summarised in Appendix III. The major change in comparison with its status in 1989 is an additional 943 kilometres of divided road. Approximately 10 per cent of the route length of the National Highways will have been subject to upgrading between 1989 and 2000.

Rural arterial roads

Table 5.8 indicates how total construction expenditure on rural arterial roads decreases as the minimum allowable bcr of construction projects increases. If the minimum bcr were increased from 1.0 to 2.0, the expenditure on all rural arterial roads between 1989 and 2000 would fall by nearly 72 per cent from $5091 million to $1449 million.

The total construction expenditure at a minimum project bcr of unity ($5091 million) is substantially below the construction expenditure shown previously as being required to maintain the physical asset ($5744 million), or to maintain the mean level of operational performance ($6788 million). This indicates that the mean standard of Australia's rural arterial roads, on the basis of economic criteria alone, is somewhat high for the level of traffic usage.[6] This situation prevails in all States except New South Wales, where the expenditure required to maintain the physical asset is slightly lower ($2132 million) than that for a minimum project bcr of unity ($2389 million).

At a minimum project bcr of unity, the mean bcr of projects undertaken on the rural arterial system is 1.13, varying from 1.05 in Western Australia to 1.35 in the Northern Territory. The mean bcr of 1.13 is substantially lower than the corresponding mean of 1.91 for National Highways. Details of expenditure by project type are given in Appendix III for each minimum bcr.

According to projections, approximately 51 per cent of the expenditure at a minimum bcr of unity would be spent on rehabilitation projects, with the remainder on upgrading projects. The majority of the upgrading expenditure relates to the duplication of sealed roads although, as was the case for National Highways, those projects involving the widening of duplicated roads generate particularly high bcrs.

Table 5.8 also shows that the construction expenditure during the

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6. The previous analysis indicated that many of the projects that need to be undertaken to preserve the rural arterial asset, according to set criteria, would have very low bcrs. Hence, from an economic efficiency stance, it would not be appropriate to preserve these parts of the road system at their 1989 standard. The analysis discussed here supports this conclusion, since only those projects which are individually economically efficient (bcr of at least unity), are considered and these generate less expenditure in total.

TABLE 5.8 RELATIONSHIP BETWEEN MINIMUM ALLOWABLE BENEFIT-COST RATIO AND RESULTING LEVEL OF EXPENDITURE: RURAL ARTERIALS, 1989 TO 2000 (CONSTANT 1985-86 PRICES)
($ million)

	Minimum allowable bcr				*Projected expenditure*
State	*0.5*	*1.0*	*2.0*	*3.0*	*1989 to 2000*[a]
NSW	4 350.3	2 388.7	887.5	261.5	1 518.6
	(42.9)	(46.9)	(61.3)	(69.3)	(35.1)
Vic	1 874.1	1 076.9	341.2	80.1	925.3
	(18.5)	(21.2)	(23.6)	(21.2)	(21.4)
Qld	1 866.9	831.6	98.5	15.0	951.4
	(18.4)	(16.3)	(6.8)	(4.0)	(22.0)
SA	927.9	349.5	35.3	1.2	270.3
	(9.2)	(6.9)	(2.4)	(0.3)	(6.3)
WA	661.4	287.4	58.9	10.1	431.2
	(6.5)	(5.6)	(4.1)	(2.7)	(10.0)
Tas	348.2	102.7	3.3	0.0	201.3
	(3.4)	(2.0)	(0.2)	(0.0)	(4.7)
NT	104.4	54.5	23.8	9.7	25.2
	(1.0)	(1.1)	(1.6)	(2.6)	(0.6)
Australia	10 133.1	5 091.2	1 448.5	377.6	4 323.3
	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)

a. Projected expenditure based on historical levels, including maintenance of both ALTP and ABRD funds in real terms.

Notes 1. Construction expenditure (excluding bridges), 1989 to 2000.
2. Owing to rounding, figures may not add to totals.
3. Figures in parentheses are percentages.

Source BTE projections.

1990s, derived from a minimum project bcr of unity, would be greater than the projected construction expenditure in the same period. However, the distribution among the States would be quite different, with Queensland, Western Australia and Tasmania spending some estimated 13, 33 and 49 per cent less, respectively, than indicated by 1989 to 2000 expenditures projected from a historical basis. The other States would spend more, in some cases, such as New South Wales, by substantial amounts.

The status of the rural arterial system resulting in year 2000 from the undertaking of projects with a minimum bcr of unity, is shown in Appendix III. The major change from 1989 would be an additional 1500 kilometres of divided road.

FUNDING SCENARIOS

Although the thrust of the analysis in this chapter is on expenditures for roadworks, based on their economic merit, and the projected status of the major rural road networks that results from this expenditure, it is also of interest to examine the implication of assumed funding scenarios in terms of road status and economic return on expenditure. The previous roads study (BTE 1984c) devoted considerable attention to this aspect, and it is not intended to repeat that analysis in the same depth here.

In the first instance, two funding scenarios are postulated and examined as follows:

- upper level - involves funding at the level of the current ALTP and ABRD program in real terms to the year 2000, assuming a constant annual expenditure; and
- lower level - involves funding only at the level of the ALTP in real terms to the year 2000, assuming a constant annual expenditure.

The implications of these funding scenarios are discussed below in terms of the average bcr of those road projects undertaken in an economically efficient way. Separate funding scenario components were determined for National Highways and for rural arterial roads in each State, as shown in Table 5.9. Appendix IV describes how projects were scheduled under the funding scenarios.

Tables 5.7 and 5.9 show that, for Australia as a whole, the upper funding level for National Highways ($3787 million) is much higher, than the estimated expenditure which would be incurred on projects with a minimum bcr of unity ($2794 million). However, this does not apply to the individual States of Queensland and Tasmania and the Northern Territory.

The lower funding level shown in Table 5.9 for National Highways is somewhat below the above figure, although, in this case, the funding levels shown for Victoria, South Australia and Western Australia are appreciably higher than the corresponding amounts shown in Table 5.7 for a minimum bcr of unity.

TABLE 5.9 ROAD FUNDING SCENARIOS: EXPENDITURES, 1989 TO 2000 (CONSTANT 1985-86 PRICES)
($ million)

	National Highways		*Rural arterial roads*	
State	*Upper*[a]	*Lower*[b]	*Upper*[a]	*Lower*[b]
NSW	1 363.5	826.1	1 518.6	1 270.5
Vic	638.9	411.4	925.3	713.9
Qld	712.2	425.7	951.4	830.5
SA	364.8	276.1	270.2	211.7
WA	382.9	213.4	431.2	345.4
Tas	136.0	96.8	201.3	168.3
NT	188.6	121.0	25.2	11.5
Australia	3 786.9	2 370.5	4 323.2	3 551.8

a. Continuation of real funding of ALTP and ABRD program to the year 2000.
b. Continuation of real funding of ALTP only.

Notes 1. Construction expenditure (excluding bridges) over the period 1989 to 2000.
2. Owing to rounding, figures may not add to totals.

Source BTE projections.

It is of interest to note that, to achieve complete expenditure on Victorian National Highways under the two scenarios, the specified funds would have to be devoted to projects with very low levels of economic returns. Up to 33 per cent of the budget under the upper funding scenario and 3 per cent under the lower funding scenario would fall into this category. Because of their extremely low bcrs, projects in Victoria, which would generate the above levels of expenditure, were not analysed. The status of the Victorian National Highways in the year 2000, shown in Appendix III, therefore, does not reflect construction of these very uneconomic projects.

The overall lower funding level for rural arterial roads ($3552 million) shown in Table 5.9, is substantially lower than that generated from the costs of projects with bcrs greater than or equal to unity ($5091 million, see Table 5.8). This difference is largely accounted for by the differences in the components for New South Wales, Victoria and South Australia. A similar picture emerges for the upper funding scenario relating to rural arterials.

Figures 5.1 and 5.2 illustrate the variation of the mean bcrs of projects undertaken on National Highways over the period 1989 to 2000, based on the two scenarios described above. For both budget levels, the mean bcrs of projects undertaken starts at a high level in 1989, but decrease very rapidly towards the year 2000. This pattern indicates that the allocation of expenditure prior to 1989 was either insufficient to enable construction of projects of high bcrs, or was not allocated to some projects of high bcrs for other reasons. This pattern is far more pronounced in New South Wales than in the other States. At the upper funding level, the mean bcrs of projects in the Northern Territory, Tasmania and Queensland will exceed unity in 2000, while the mean project bcrs in the other States will be substantially less. At the lower funding level, mean project bcrs in 2000 tend to be greater than at the higher funding level, since projects of higher economic merit will remain outstanding.

Figures 5.3 and 5.4 illustrate the mean bcrs of projects on rural arterials for each year at both funding levels. These diagrams show that projects in States other than the Northern Territory and Tasmania have declining mean bcrs to the year 2000. Unlike the mean bcrs for National Highways, however, there is no rapid decline over time.[7] Projects in States other than Tasmania and Western Australia have mean bcrs above 1.0 at the year 2000. The lower funding level shows the same trends as the upper funding level, although the decline in mean bcrs over time is not as great. At the funding levels assumed, rural arterial projects, generally, have a higher mean bcr than National Highways in all States except the Northern Territory.

The projected status of the National Highway and rural arterial road systems in the year 2000, based on these two funding scenarios, is shown in Appendix III.

OVERVIEW OF THE ECONOMIC ANALYSES

The evaluation of expenditure described in the previous sections deals separately with three aspects:

- maintenance of the assets and of operational performance levels;

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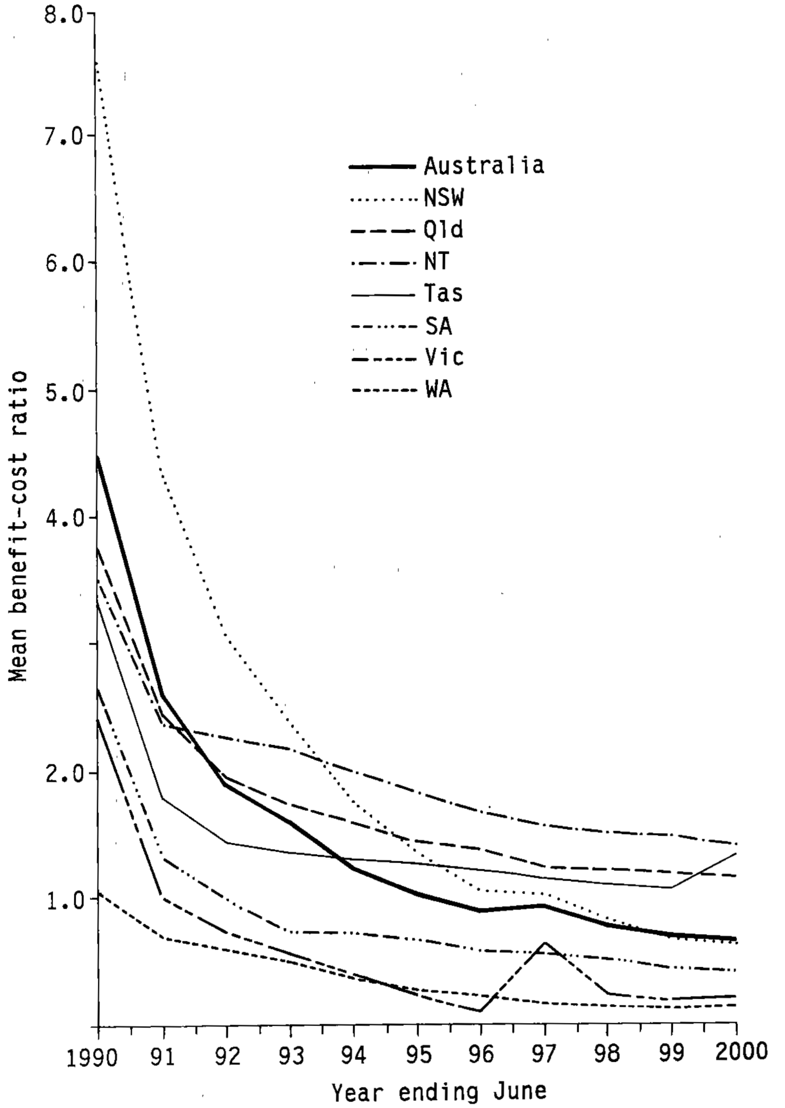
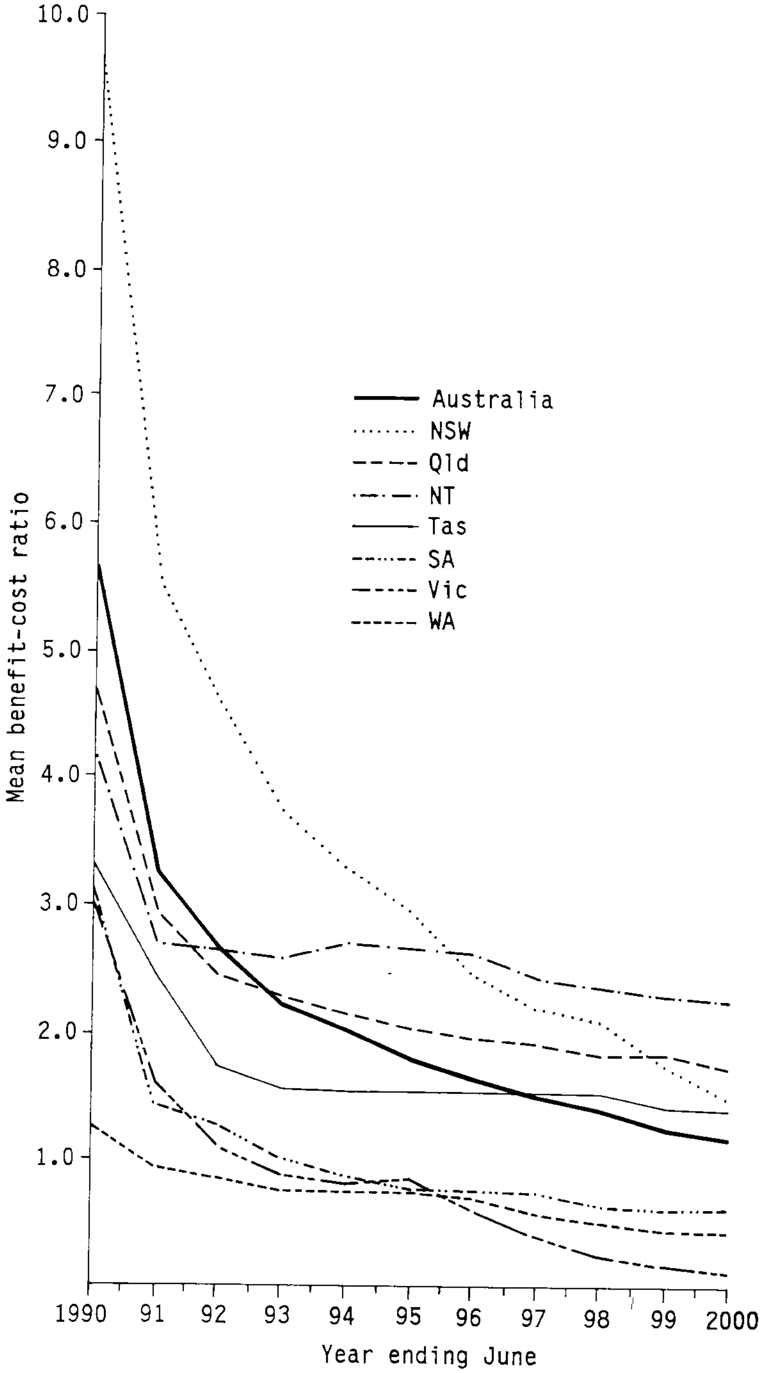
7. However, it should again be noted that the status of the rural arterial system in the base year 1989 was synthesised, whereas the corresponding status for National Highways was derived from projected works programs. The synthesis can be expected to have produced a more economically optimal system than will be achieved in practice (that is, average bcrs of additional projects will be lower).



Source BTE projections.

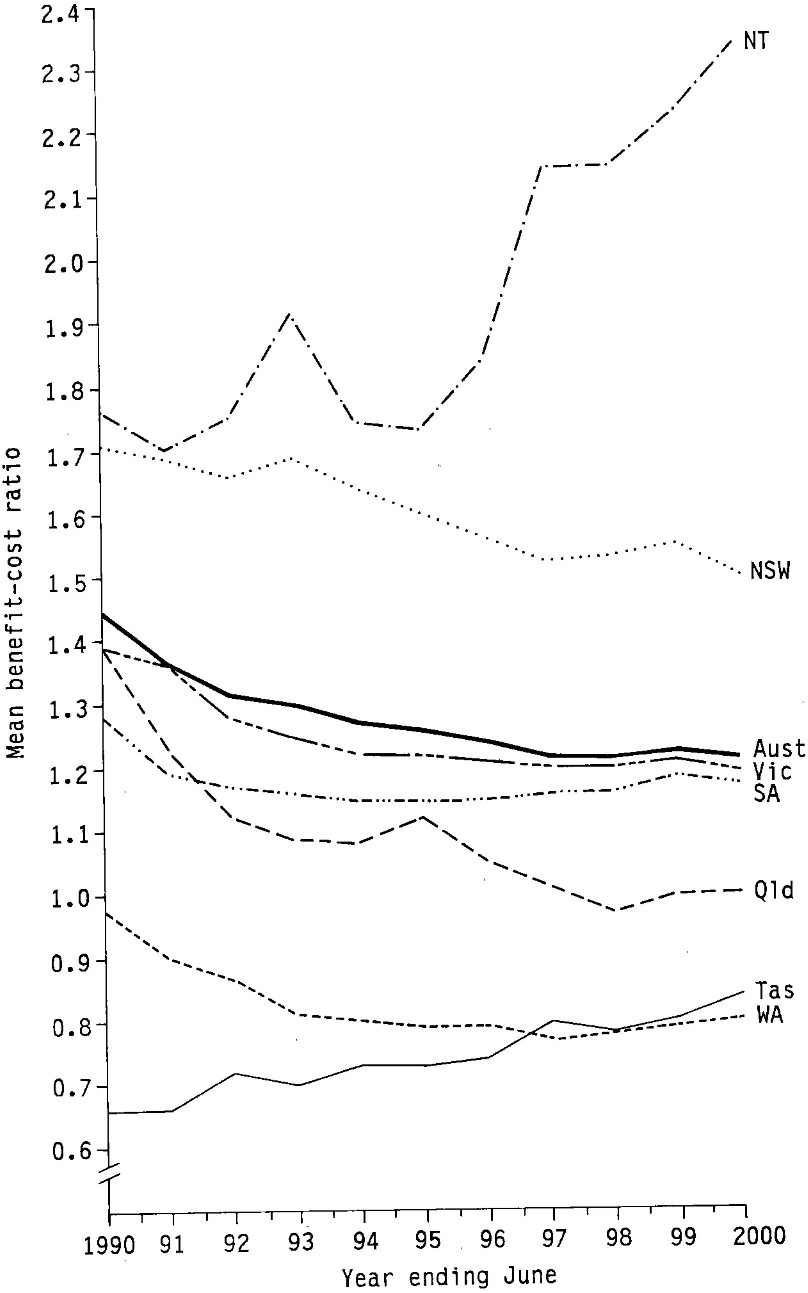
Figure 5.1 Mean benefit-cost ratio of projects: National Highways, upper funding level, 1989 to 2000

- economic worth of investment in roads; and
- funding scenarios based on hypothetical levels with and without the ABRD component of road expenditure (designated as 'upper' and 'lower', respectively).



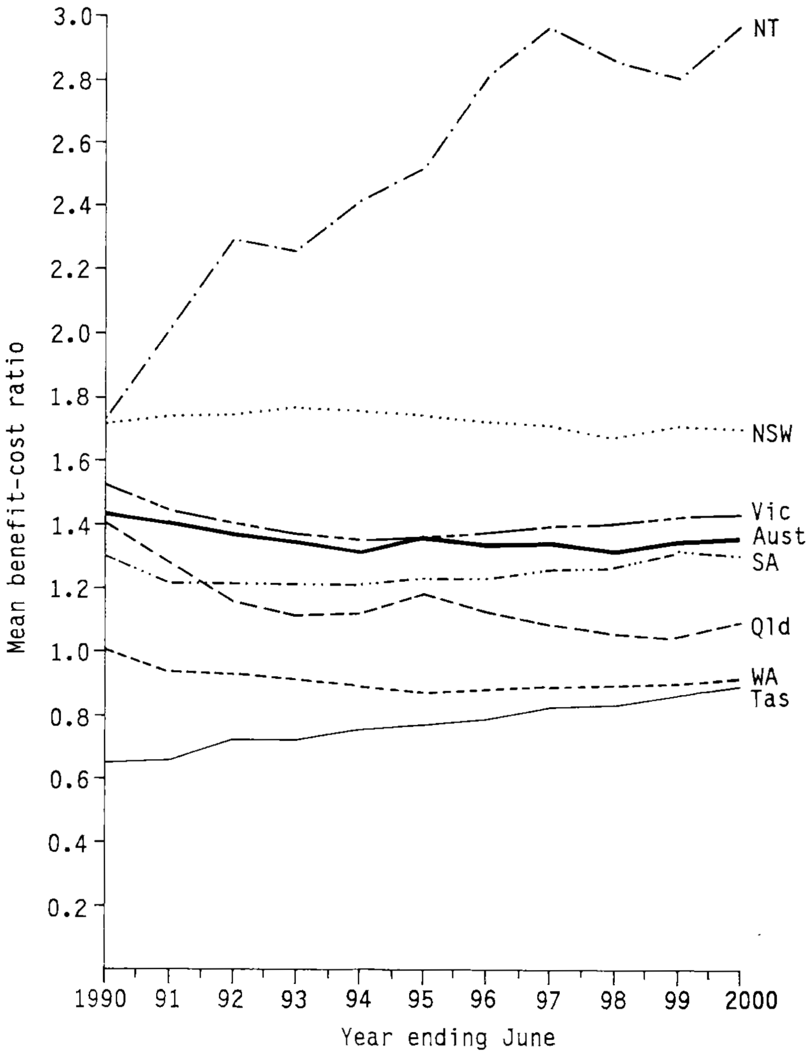
Source BTE projections.

Figure 5.2 Mean benefit-cost ratio of projects: National Highways, lower funding level, 1989 to 2000



Source BTE projections.

Figure 5.3 Mean benefit-cost ratio of projects: rural arterials, upper funding levels, 1989 to 2000



Source BTE projections.

Figure 5.4 Mean benefit-cost ratio of projects: rural arterials, lower funding level, 1989 to 2000

The principal results of the analysis of these aspects, which are summarised in Table 5.10, are brought together in the following discussion. Details of the method used to estimate total expenditure (including routine maintenance and bridge expenditure) are given in Appendix IV.

TABLE 5.10 ECONOMIC EVALUATION SUMMARY: AUSTRALIA, 1989 TO 2000 (CONSTANT 1985-86 PRICES)

Basis of expenditure	*Expenditure[a] ($ million)* NH	*Expenditure[a] ($ million)* RA	*Mean project bcr* NH	*Mean project bcr* RA	*Minimum project bcr[b]* NH	*Minimum project bcr[b]* RA
Preservation of						
Physical asset[c]	1 344 (2 635)	5 744 (10 433)	2.8	1.1	0.5	0.2
operational Performance[d]	1 829 (3 202)	6 788 (11 624)	2.4	1.0	0.2	0.3
Minimum bcr						
0.5	4 457 (6 245)	10 133 (15 425)	1.3	0.7	0.5	0.5
1.0	2 794 (4 307)	5 091 (9 685)	1.9	1.1	1.0	1.0
2.0	1 450 (2 761)	1 448 (5 540)	3.0	2.1	2.0	2.0
3.0	885 (2 119)	378 (4 316)	4.1	3.1	3.0	3.0
Funding scenarios						
Upper	3 787 (5 435)	4 323 (8 802)	1.6	1.3	0.1	0.8
Lower	2 371 (3 798)	3 552 (7 922)	2.3	1.4	0.4	0.8

a. Construction expenditure (excluding bridges) over the period 1989 to 2000. Figures in parenthesis are total expenditures which result when estimates for routine maintenance and bridge construction are included. Neither of these, however, has been included in the economic evaluations. Details of the bridge expenditure estimation process are given in Appendix IV.
b. Minimum bcr of projects in the last year of the analysis period 1989 to 2000.
c. Rehabilitation expenditure required to maintain mean roughness level.
d. Includes upgrading expenditure to maintain mean level of service, and rehabilitation expenditure to maintain mean roughness level.

Notes 1. NH denotes National Highways.
2. RA denotes rural arterials.

Source BTE projections.

Table 5.10 indicates the relatively low expenditures required to maintain the asset and the operational performance level of National Highways, compared with corresponding expenditure levels on rural arterials and compared with current expenditure levels, as illustrated by the funding scenarios. As noted previously, very low minimum bcrs of projects required to preserve the rural arterial asset suggest that part of this road system has been developed to a standard which is in excess of requirements in economic terms.[8] These parts of the system will continue to require rehabilitation, however, if the mean roughness and level of service of the rural arterial system as a whole are to be strictly maintained at the projected 1989 level. The analysis indicates, that the level of required expenditure is very sensitive to the assessment criteria used and that substantial reductions in required expenditure would occur, even if the system were to be preserved to a slightly higher mean roughness or a slightly lower level of service.

The amounts required to preserve the physical asset and, hence, also to preserve operational performance on rural arterials, could be reduced by the postponement of all rehabilitation work with a low bcr. This, however, would result in a gradual decrease in the general condition of the road system, as indicated by its average roughness level. Similarly, upgrading work could be postponed until it becomes more economically warranted, but the general level of service would decline.

The following discussion relates to road projects with a minimum economic worth, as measured by their bcrs of unity. Table 5.10 shows that the mean bcr of projects carried out on National Highways, satisfying this criterion, is substantially higher than the bcr of similar projects carried out on rural arterial roads. The resulting construction expenditure levels for rural arterial road projects exceed the higher funding scenario discussed previously. Because of the approach taken to projecting the 1989 status of the rural arterial system, synthesised from earlier inventories, this estimate of expenditure may be somewhat conservative.

The various analyses on rural arterials summarised in Table 5.10, reflect a substantial range of construction expenditures, from $3500 million to $10 000 million. Examination of the mean bcrs in Table 5.10 indicates that a number of projects have bcrs close to unity. The implication is that a wide range of total expenditure could be economically justifiable, but there are relatively few rural arterial road projects which individually would produce large economic returns.

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8. This statement also applies to the National Highway system to a degree as indicated by the marginal bcrs, but the resulting expenditures are substantially lower and the mean project bcrs are substantially higher than for rural arterials.

As discussed earlier in this chapter, the economic evaluation process used for this analysis did not embrace expenditure on bridges or routine maintenance. However, to augment the results of the various analyses summarised in Table 5.10, the estimated associated bridge and maintenance costs have been added to the expenditures derived from the evaluation process and these totals are given in parentheses in Table 5.10.

The discussion above refers to the rural arterial and National Highway picture for Australia as a whole. The comparisons may vary from State to State. Previous tables in the chapter provide information on a State basis and allow certain State by State comparisons to be made.

It must be noted that using the results to extrapolate outcomes is not appropriate and, in particular, that incremental bcrs obtained would not be realistic. This arises as a result of the time-dependent nature of the road projects which are generated under each set of analysis criteria. Thus, different streams of projects are scheduled in each case, creating different time profiles of benefits and costs.

EXTENDED NATIONAL HIGHWAY SYSTEM

The *National Roads Act 1974* established a set of National Highways for which the Commonwealth Government assumed complete funding responsibility. The Commonwealth Government accepts continuing responsibility for the preservation and construction of the National Highway system to standards which it sets. National Highways currently account for some 2 per cent of Australia's total road length and comprise essentially the same roads which were selected in 1974, although some route relocations have occurred.

The National Highway system was established because it was difficult for the States to assemble the large resources to construct long segments of main arterial roads joining major centres (Australia, House of Representatives 1974). The assumption of financial responsibility for this road system by the Commonwealth meant that consistent objectives for the construction of these roads could be set, eliminating concern that the development of components of the system would be subject to the different priorities of individual States.

Since 1974, the National Highway network has been upgraded at an increasing rate, particularly in recent years under the ABRD program. There have also been developments in land use and traffic patterns since the original delineation of the National Highway system. These circumstances suggest that extensions of the National Highway system could be appropriate. Also, it is timely to examine the funding and expenditure implications of incorporating additional major rural roads into the National Highways system because of the imminent conclusion of current Commonwealth funding programs. Such roads would then become eligible for complete Commonwealth funding and be subject to Commonwealth design standards.

In the following analysis, possible extended National Highway systems are developed to illustrate the scope for extension within a reasonable range of expenditure levels. The sequence of this analysis consists of:

- consideration of possible Commonwealth objectives applicable to extended systems;
- formulation of strategies to reflect the importance of network extensions for the achievement of Commonwealth objectives;
- development of a quantitative basis for ranking of individual routes (candidates) for inclusion in an extended system; and
- presentation of illustrative options for an extended system.

Objectives for extended systems

The selection and analysis of routes suitable as National Highways should be consistent with some defined national objectives for an extended system. The following objectives have been selected for the purposes of illustration:

- to provide a network of roads between the capital cities and the more important regional centres as a basic infrastructure for the movement of traffic engaged in industry and commerce and, particularly, for traffic contributing to export earnings; and
- to preserve and develop the network to standards consistent with the level of usage by all vehicle categories, providing for efficient, reliable and safe travel and preservation of the environment, given both present and projected future traffic conditions.

Strategies for extending the system

One area of roads policy in which the Commonwealth Government has traditionally indicated an interest, concerns roads of 'national significance'. As noted previously, the current National Highway system is regarded in this way. The term 'national significance' in this context represents an abstract concept. Given current Commonwealth economic objectives, roads which directly affect

Australia's trade competitiveness, or increase the efficiency of Australian industry or which facilitate new industry and so on, could be considered to have national significance. Such roads are possible candidates in any extension which might be considered to the current National Highway system. In more specific terms, options for extensions to the National Highway system include:

- extending the system to embrace routes contributing significantly to export earnings;
- connecting major ports and industrial centres to the system;
- providing alternative routes to supplement the capacity of components of the system, particularly, routes which bypass large cities;
- providing links from the more important regional centres to the capital cities and major provincial cities;
- providing links between those capital cities not already directly connected; and
- providing additional links along corridors serving principal defence strategies or major defence interests.

Consideration of these options resulted in the identification of approximately 90 additional rural routes, totalling some 23 000 kilometres in length. The identified routes consist of existing roads, most of which are rural arterial roads. Routes extending into capital cities were generally defined by end points at the inner urban boundaries. Connections to the urban network within the inner urban boundaries are considered separately in Chapter 6.

No consideration was given to the suitability of the general location of the route to serve a particular area or function. The appropriate location of a route requires detailed investigations which are not appropriate for present purposes.

In order that possible extended systems could be related to an appropriate range of funding levels, it was necessary to apply a system for ranking the routes comprising the extensions, according to some measure of their significance. Given the difficulty of establishing the relative importance of different national objectives for the road system, an appropriate quantitative proxy for the significance of a particular route was required to facilitate this ranking.

Ranking of individual routes

The most appropriate measure of relative significance of a route is the level of usage which is made of it for the purposes of meeting national objectives. Details of usage were analysed for a range of vehicle types for individual sections of possible extension routes.

After testing the general effects of various parameters on the ranking of routes, the mean heavy vehicle aadt of the route was adopted as the primary indicator of the significance of a route in the current exercise. Heavy vehicles tend to be used for transporting goods and commodities having economic value. Hence, of the indicators readily available, this indicator relates most closely to some measure of a road's contribution to economic performance.

In order to introduce a further dimension, however, another indicator was devised to reflect the direct economic merit of spending funds on a road as well as its overall economic contribution. This indicator was based on a composite of total aadt, heavy vehicle aadt, and mean route bcr.[9] The last of these introduces this additional dimension into consideration. The ranking of routes according to the composite indicator[10] provided a length and expenditure relationship of almost identical general characteristics to that derived by the ranking based solely on heavy vehicle aadt.

Figure 5.5 shows the cumulative length and cumulative total expenditure which illustrates the implications of an extended National Highway system, based on the ranking of routes according to mean heavy vehicle aadt. Additional routes contribute to the total network length in order of decreasing heavy vehicle aadt. The annual expenditure is averaged over the period 1989 to 2000, and refers to the cost of rehabilitation and upgrading projects having a bcr of unity or above. It also includes the estimated costs of associated bridge works and routine maintenance.

Figure 5.5 also illustrates the relationship between expenditure and cumulative length for some specific classes of routes, which have

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9. Potential improvements to each road section were considered for the period 1989 to 2000. The costs of construction and the benefits to all vehicle classes were used to calculate the bcr of individual projects. The bcrs of the projects on sections were averaged to determine a route bcr.
10. Routes were ranked for the three indicators (heavy vehicle aadt, total aadt and mean route bcr) individually and these respective ranks were then summed to provide the composite indicator.

prime functions corresponding to particular strategies for extension of the National Highway system. Routes having important roles satisfying more than one strategy are included in each of the appropriate groups. The relationship illustrated for 'all routes' includes the routes in the functional groups, together with some additional routes of minor export significance.

Options for an extended system

For illustrative purposes, some summary characteristics of extensions to the National Highway system are given in Table 5.11 for two hypothetical expenditure levels. These expenditure levels are notional amounts spanning a range which may embrace the more realistic options for the funding of extensions to the system. To put these expenditure levels into some perspective, it may be noted that the projected annual expenditure level of $100 million for extensions, together with the annual expenditure of $390 million for the existing system, correspond approximately to the annual expenditure on the existing system by the Commonwealth Government in recent years. The annual expenditure level of $300 million for extensions, together with

TABLE 5.11 CHARACTERISTICS OF ILLUSTRATIVE EXTENSIONS TO THE NATIONAL HIGHWAY SYSTEM, 1989

Annual expenditure[a] ($million)	*Length (kilometres)*	*Per cent length sealed*	*Per cent length divided*	*Mean traffic flow[b] (aadt)*	
				All vehicles	*Heavy trucks*
100	1 407	100.0	38.7	9 204	1 292
300	6 715	100.0	14.2	4 359	628
(392)	(16 054)	(99.5)	(8.0)	(2 657)	(381)

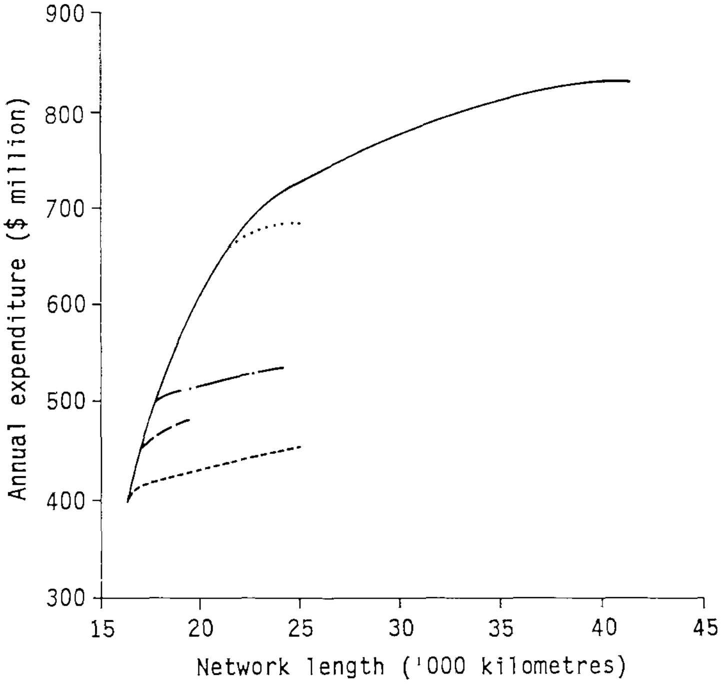
a. Average expenditure for the period 1989 to 2000 for road construction projects having a bcr of at least unity, plus routine maintenance and bridge expenditure.
b. Vehicle kilometres divided by route length.

Note Corresponding data for the existing National Highway system are given in parentheses.

Source BTE projections.

the annual expenditure of $390 million for the existing system, amounts to the approximate level of expenditure by the Commonwealth Government in recent years on National Highways and rural arterial roads combined.

Based on this analysis, the majority of the length of the extensions at both the upper and lower expenditure levels are located in the east of Australia, particularly on the south and south-eastern seaboards and the more densely populated areas. As funding levels increase, the adopted method of route ranking implies that additional coastal and inland routes can be incorporated, but these continue to be



——— All extensions
········· Links joining capital cities, major provincial cities and important regional centres
—·—· Routes of major defence interest
— — Routes serving ports, industry and exports
------- Alternative routes, including city by-passes

Source BTE projections.

Figure 5.5 Extended National Highway system: annual expenditure and length

concentrated on the capital cities and regional population centres in the east.

Figure 5.5 can be used to estimate the approximate length of the extended system which would incur particular expenditure levels according to the analysis criteria noted previously. Without a detailed assessment of vehicle loadings and other characteristics for individual routes, the specific contribution to national objectives of each route cannot be assessed fully, and the ranking of routes for the purposes of this analysis should be regarded as indicative only.

CHAPTER 6 ASSESSMENT OF URBAN ARTERIAL ROADS

GROWTH OF CAPITAL CITIES

From the outset of European settlement in Australia, most of the present capital cities were, and still remain, the dominant locations of population. In Table 6.1 the population of capital cities since 1921 is shown. In all but one case, Darwin, the capital city population as a proportion of State population has increased steadily over the period 1921 to 1984. Moreover, between 1961 and 1984, the non-capital city population has increased by only 1.2 million compared with a capital city population growth of 3.8 million. Thus, in the last 25 years, population growth in the capital cities has accounted

TABLE 6.1 POPULATION OF CAPITAL CITIES AND AS A PROPORTION OF STATE POPULATION, SELECTED YEARS
(million persons)

City	*1921*		*1961*		*1984*	
Sydney	0.90	(43)	2.18	(56)	3.36	(62)
Melbourne	0.77	(50)	1.91	(65)	2.89	(71)
Brisbane	0.21	(28)	0.62	(41)	1.15	(46)
Adelaide	0.26	(52)	0.59	(61)	0.98	(72)
Perth	0.15	(47)	0.42	(56)	0.98	(71)
Hobart	0.05	(24)	0.16	(33)	0.18	(40)
Darwin	0.001	(36)	0.01	(28)	0.07	(48)
Canberra	0.002	(80)	0.06	(96)	0.26	(99)
All capital cities	2.34	(43)	5.95	(57)	9.86	(63)
Australia	5.91		10.55		15.56	

Note Figures in parentheses are capital city populations as a percentage of State population.

Source ABS (1986d).

for more than three quarters of the entire population increase. At present, 63 per cent of Australia's population reside in the capital cities.

ROADS PROVISION IN CAPITAL CITIES

Figure 3.1 illustrates the high intensity of traffic activity on urban arterial roads compared to all other road categories and Table 6.2 shows the average daily travel on urban arterials in State capital cities.

The capital cities, and to a lesser extent the larger provincial cities of Australia, have reached levels of sophistication for handling traffic which greatly exceed their capability of 20 years ago. The progressive development of road networks and associated infrastructure has probably varied somewhat among cities; nevertheless, there has been general similarity in the progression through several identifiable stages.

As cities developed throughout this century, in particular since World War II, the general aim of authorities was not only to keep pace with the growth in travel demand but, simultaneously, to improve the quality of service. The most obvious means pursued in the early 1950s was to adopt road-widening programs. Initially, road pavements were widened within existing road reservations, with subsequent and additional travel demands being accommodated by widening of these reservations. (The Adelaide metropolitan road widening scheme is a

TABLE 6.2 URBAN ARTERIAL ROAD USAGE IN AUSTRALIAN CAPITAL CITIES, 1981

City	*Vehicles per day per lane*
Sydney	21 500
Melbourne	18 200
Brisbane	16 500
Adelaide	16 900
Perth	13 900
Hobart	12 500

Source National Association of Australian State Road Authorities (1984a).

good example of the latter.) Programs such as these have been continuing for many years in the capital cities and can be expected to continue, particularly in outer developing areas, into the foreseeable future.

Pavement widening was often associated with traffic signal installation and pavement flaring at intersections, in order to match mid-block capacity with that of the signalised intersection. These combined measures gave further substantial improvements to road system capacity and service quality. The programs were supplemented by co-ordinated traffic signals and clearways to handle additional traffic growth. More recently, area traffic control achieved through sophisticated area-wide traffic signal co-ordination has been introduced and progressively refined in some cities.

At present, Australian capital cities exhibit various stages of arterial network evolution. The measures described have yielded system improvements which enabled travel demand to be satisfied at a sustained or improved level of service. Inevitably, however, once these increases have been fully applied, the scope to extend network capacity is likely to become increasingly limited, especially in the inner areas of larger cities.

Freeway construction is one way of increasing road network capacity. In areas of high land and property values, a road widening program is unlikely to be preferred indefinitely because the costs of provision, particularly for land and services relocation, outweigh the benefits gained through marginal road widening. While freeways are very costly, both in terms of construction and alignment acquisition, their capacity to cater for high vehicle flows has been repeatedly demonstrated. It can be argued, therefore, that in the appropriate circumstances, freeway-type construction (including high capacity limited access arterial roads) in built-up areas is a cost-effective solution, particularly when the other measures have been exhausted.

For all that, freeway construction has not always found favour in the community (see, for instance, Bulletin (1971, 1974) and Hurst (1977)). Nevertheless, the evidence is that the freeway construction rate has been maintained over the last 15 years, as shown in Table 6.3. Not all of the freeway construction has occurred in inner city locations; a substantial proportion has been provided in the outer areas of urban statistical divisions.

Inner urban development

A future expansion of freeway-type links, which continues historical

TABLE 6.3 GROWTH OF URBAN FREEWAYS, SELECTED YEARS
(kilometres)

State	*1972*	*1977*	*1984*
New South Wales	43	116	142
Victoria	55	84	116
Queensland	0	18	29
South Australia	0	0	0
Western Australia	6	8	20
Tasmania	0	0	0
Northern Territory	0	0	0
Australian Capital Territory	0	0	15
Total	98	216	322

Sources BTE (1984c). State Road Authorities' annual reports, 1984-85.

construction rates, would generally have profound impact within the upgraded region or transport corridor, although it is unlikely to have a significant effect on the overall travel performance of present arterial networks. It would seem, therefore, that a prevailing characteristic of surface transport systems in the inner areas of Australian capital cities is their emerging stabilisation of capacity. This stabilisation in the inner areas would appear to be a feature of most capital cities of Australia, offset by new high-capacity links which rectify serious localised capacity deficiencies. Thus, further additions to the road capacity in the inner areas of capital cities, in the short term, seem likely to be provided predominantly as new, high-capacity, access-controlled (or, at least, partially access-controlled), facilities. These facilities will be very costly when expressed on a cost per kilometre basis, but their traffic-handling capabilities will make them cost-effective. Other means of adding to road capacity, such as widening of road reservations, are less likely to be favoured in built-up areas for the reasons previously cited.

The relationship between urban arterial roads and local roads must also be considered. Traffic control measures to reduce through-traffic from local roads and move it back onto arterial roads should bring about significant localised traffic improvements, together with improvements in the amenity of residential precincts by reinforcing a hierarchical road system. Major improvements to the arterial road system, involving increased capacity and access control, will also be necessary to achieve the desired outcome.

In summary, the road system of the inner areas of capital cities is likely to remain essentially stabilised at about its present capacity into the foreseeable future. The provision of further high capacity links will provide significant, but primarily localised, improvements at traffic bottlenecks. The consequent level of traffic service in these inner areas will, at best, be preserved, but road system quality should become more homogeneous throughout the network.

Outer urban development

While the inner, built-up areas of cities are envisaged as becoming characterised by stabilised transport systems, the general peripheral expansion of cities will necessitate the provision of additional capacity, principally by the upgrading of existing routes and, to a lesser extent, by the construction of new links. For example, in the three divisions of the New South Wales Department of Main Roads, which approximately comprise the County of Cumberland, the forward estimate of expenditure for the period 1986-87 to 1989-90 indicates that, in the two outer divisions (Blacktown and Parramatta), 76 per cent of division's funds are planned to be applied to upgrading existing roads and 24 per cent to new routes and bridges. In the inner division of Sydney the pattern is reversed, with 47 per cent of funds planned to be applied to upgrading existing routes and 53 per cent of funds planned to be applied to (relatively expensive) new routes and bridges (New South Wales Department of Main Roads, pers. comm. 1986).

Past road layouts in the older, inner areas, which have resulted in the use of local roads by arterial traffic, should be largely avoided in outer areas. Hence, a well defined road hierarchy, based on current traffic and town planning principles, should ensure that the amenity of residential precincts is preserved from the outset in the developing outer urban areas.

URBAN ARTERIAL ROAD FUNDING CONSIDERATIONS

From the foregoing discussion it might be inferred that, in the fully built-up areas of capital cities, future funding needs for arterial roads will be primarily to preserve the asset in perpetuity. In one sense, the argument that stabilisation of the road system has occurred in the inner areas of cities can lead to that conclusion, but the requirement to achieve, spatially, a road system with a uniform level of service, will still necessitate new capital works to rectify specific bottlenecks in these built-up areas and to improve accessibility. On present indications, a slight decline in level of service would appear likely in the foreseeable future. Most SRAs would have planned, at least tentatively, long term road systems to improve present traffic service levels significantly. If, in the longer term, the communities of these cities demand greater convenience of mobility, these demands could be satisfied through an accelerated road construction and upgrading program. However, the costs to improve substantially the level of service will be high, as measured against current levels of investment.

In the outer urban areas where development is still proceeding, capital works will represent a significant part of total expenditure. Indeed, as 75 per cent of Australia's population growth is occuring in capital cities, and outer areas are predominantly satisfying that growth, there will be a continuing need to expand and upgrade the arterial road network in these areas.

A recent simulation analysis of Sydney's traffic, carried out by the Department of Main Roads, New South Wales examined the impact of major road improvement valued in excess of $2000 million. The improvements were targeted at relieving existing congestion and providing capacity on corridors needed for the growth and development of the city. Without the proposed investments, morning peak speeds on the road network were predicted to be nearly halved, with model average speeds falling from the present 35 to 19 kilometres per hour at about the 15 year horizon. With investment, the average speeds did not deteriorate, but at the 15 year horizon were about 10 per cent higher than at present. The model also predicted that the immediate impact of making that investment now would be to improve average speeds from only 35 to 39 kilometres per hour. This shows just how difficult it is to improve performance across an established extensive network, but improvement in selected corridors to accomodate traffic growth can be made and in such corridors the level of service would be raised (New South Wales Department of Main Roads, pers. comm. 1986). The study did not measure the shortening of the peak periods or improvements in mean network speeds off-peak, but, undoubtedly, these would have provided significant traffic benefits.

While the foregoing example is not representative of all capital cities, it, nonetheless, indicates that improvements to urban arterial network performance of even modest proportions is likely to require large capital expenditures. In the context of total community expenditure on transport, including ownership cost of vehicles, the indicative capital expenditure on the urban arterial network is small, but, as a proportion of the total funds available to the roads sector, the amount is substantial. For example, each year, Sydney motorists spend approximately $700-800 million on fuel alone.

The National Association of Australian State Road Authorities (1984a) analysed four categories of cities, the categorisation being based on population size. Categories 1 and 2 comprised Sydney, Melbourne, Brisbane, Adelaide and Perth, a group considered sufficiently representative for the discussion which follows.

Two levels of future expenditure were considered. The first, described as F100, approximated the level of expenditure in 1980-81, while F150 was 50 per cent higher than the F100 level. At the F100 expenditure level, 29 per cent of funds were allocated to recurrent expenditure, with the balance allocated to minor and major upgrading works. The distribution of these funds between inner and outer urban areas was not presented by NAASRA, but the continuing peripheral growth of capital cities could be expected to have absorbed a substantial proportion of funds to accomodate the expansion and upgrading of arterial road networks.

The analysis by NAASRA of peak travel speeds in 1981 and those which would arise in 1991 under different funding levels, is contained in Table 6.4.

The table shows the relatively small peak-hour travel speed changes over a wide funding range. These results are consistent with the example cited earlier for Sydney and they indicate that considerable funding increases would be necessary to bring about substantial improvements in peak period travel speeds. While Table 6.4 shows that

TABLE 6.4 PEAK PERIOD TRAVEL SPEEDS, CATEGORY 1 AND 2 CITIES

Year	*Funding level*	*Representative peak period travel speed (kilometres per hour)*
1981	Existing	41
1991	F50	38
1991	F100	40
1991	F150	42

Source National Association of Australian State Road Authorities (1984a).

actual travel speeds in the peak period are relatively insensitive to the level of road investment, the effect of this investment on the duration of peak periods is not revealed. Generally, an increase in road network capacity results in a decreased duration of the peak period and, subsequently, in improved (more regular and faster) off-peak traffic flows when a large proportion of commercial travel occurs. There may also be other unquantifiable benefits to business such as better timetabling of operations and possible reductions in commercial vehicle fleets. Land use and travel demand changes, which would probably follow road network improvements, are also involved and developments would need to be tailored to maximise community benefits from these.

In peak periods, which largely influence the provision level of road network capacity, the principal mechanism for achieving equilibrium between transport supply and demand is traffic congestion. In the absence of an explicit pricing mechanism for road usage in peak periods, which most city authorities throughout the world are reluctant to pursue, attempts to improve service quality through one-off road system improvements without appropriate land use controls, seem unlikely to succeed.

Road expenditure distribution

Table 6.5 presents expenditure distribution details on capital city urban arterial roads in 1980-81.

More recent and comprehensive data are not available, but the values presented have been compared with more recent if limited data and, for the purpose of discussion, are still considered to be applicable. From Table 6.5, it is evident that 27 per cent of funds were applied to roadworks identified as routine maintenance and rehabilitation, while a further 40 per cent was spent on network additions and associated land acquisition. The balance, representing 33 per cent of funds, was spent on minor and major improvements to the existing network. The National Association of Australian State Road Authorities (1984a) indicated that a substantial proportion of minor improvement works was associated with rehabilitation of older pavements; to a lesser extent, asset rehabilitation also formed part of major improvement projects, such as road widening. This leads to the general conclusion that funding requirements to restore the road asset currently lie between 27-60 per cent.

It is not possible to determine accurately the total percentage of funds spent on routine maintenance and restoration works. However, on the assumption that most minor improvements and a small proportion of

TABLE 6.5 DISTRIBUTION OF EXPENDITURE: ARTERIAL ROADS, 1980-81
(per cent)

Work category	
Routine maintenance	16
Rehabilitation	11
Minor improvement	14
Major improvement	19
Network additions	37
Long term acquisition	3
Total	100

Source National Association of Australian State Road Authorities (1984a).

major improvements are, in essence, used in the preservation of the road asset, about 40 per cent might be regarded as a more realistic estimate of the proportion of funds spent on routine maintenance and restoration works. Although this estimate is considerably higher than the value of 27 per cent indicated in Table 6.5, it, nonetheless, indicates that the balance of funds, which amounts to 60 per cent, would have to be spent on road upgrading and network expansion. This latter value indicates considerable growth in the stock of urban arterial roads (but not necessarily route length), and contrasts with a less dynamic situation in the other road categories.

As long as the population growth in capital cities is maintained at current rates, the proportional distribution of urban arterial funds allocated to restoration, upgrading and extension works might be expected to remain essentially the same. However, because of the significant growth rate in road stock implied in the distribution estimate, funding requirements will continue to grow on two counts: an increasing restorative component brought about by a continuing increase in the stock of urban arterial roads, and capital funding of new upgradings and network expansions.

In the context of the earlier discussion of a more or less stabilised road network in the inner and fully built-up areas of capital cities and an expanding outer periphery, the estimated proportional split between restorative and upgrading and expansion works is not inconsistent. It might also be expected that funding of urban arterials would exhibit real increases over time, in order to keep pace with overall increases in traffic activity, unless service quality had declined at the same time.

Table 6.6 sets out expenditure on urban arterial roads over a five year period to 1984-85, the year of most recently available statistics.

On the basis of these figures, the average annual rate of real expenditure increase has been 3.8 per cent, although year-to-year rates show extreme variations, including negative values. Financial year 1983-84 also includes the full effects of the ABRD program which contributes to the considerable increase of about 18 per cent from 1982-83 to 1983-84. In the same five year period, the annual rate of population increase in the capital cities was 1.8 per cent.

NATIONAL HIGHWAYS AND URBAN DISTRIBUTORS

The National Highway system represents a sub-set of rural arterial roads which were declared a discrete road category in 1974. In the 1973 Report on Roads in Australia, the CBR articulated five objectives for the establishment of a national roads system, which may be regarded as national objectives. They were to:

- encourage and contribute, to a major extent, to trade and commerce, overseas and among the States;
- assist industry located in major centres of population to be complementary to industry located in neighbouring major centres;
- reduce, significantly, transport costs of the products of rural and/or secondary industry, between points of production and points of export or consumption;
- provide for long distance movement associated with recreation and tourism; and
- improve movement between defence production centres, defence supply and storage locations, and defence establishments generally (Commonwealth Bureau of Roads 1973).

The present National Highway system provides a linkage between capital cities on mainland Australia and, in doing so, services more than two-thirds of Australia's population. The National Highway system generally terminates at specified locations near the urban boundaries of capital cities. There is no physical discontinuity at these locations between the National Highway and urban arterial network, but neither can it be said that in all cases the connection between the two road categories achieves optimum traffic distributions.

TABLE 6.6 EXPENDITURE ON URBAN ARTERIAL ROADS FROM ALL SOURCES, 1980-81 TO 1984-85 (CONSTANT 1985-1986 PRICES)
($ million)

Year	
1980-81	670.6
1981-82	602.1
1982-83	599.4
1983-84	708.8
1984-85	779.1

Source BTE (1987a).

In the context of the five performance objectives cited for National Highways, the view has been put that these objectives would be enhanced by a more efficient distribution system emanating from the urban termini of intercity National Highway links. More specifically, direct urban connections to the urban termini of National Highways should increase intercity mobility and regional or hinterland access to capital cities, by providing efficient distribution from the termini to and within the urban environment. Additionally, efficient connections could be made to particular destinations such as ports, airports and major industrial zones.

The assumption underlying the provision of such distributors is, that improved transport linkages between specified activities generate intrinsically higher benefits than projects which serve the urban community at large. The data necessary to test this viewpoint are not available, but, in one sense, the argument comes down to the conclusion that the valuation of private travel (and, in particular, the private value of time) can be somewhat discounted and that the benefits arising from commercial travel should be more highly valued. Alternatively, if particular types of projects exhibit superior economic performance over other project types where no weighting is given to commercial vehicle activity, then the higher performing projects would normally be selected.

In the following section, the view that urban arterial roads, acting as distributors for National Higways, would achieve greater benefits than other types of urban projects, is examined.

ANALYSIS OF URBAN DISTRIBUTORS

For each capital city, with the exception of Darwin and Canberra, a set of urban projects was identified and grouped under the following categories. Type A projects were those distributor road links emanating from the termini of National Highways. Type B projects were those distributors providing direct linkages with major transport facilities such as ports, airports and principal industrial zones. Type C projects were other arterial road projects not specifically associated with National Highways, representing a general type of urban project. In the analysis of these projects, no weighting was given to any traffic type; in other words, private travel savings were not diminished in value from that normally ascribed, nor were commercial travel savings adjusted upwards.

In all, 42 projects were considered and Table 6.7 shows their aggregate characteristics. It is important to stress that Table 6.7 represents a sample of projects and does not include all major urban projects which might be implemented over the next 10 to 12 years. When the projects, comprising Table 6.7, were matched against long term road planning schemes in capital cities, it was evident that considerable additional works are envisaged by SRAs. For example, the Roads 2000 plan prepared for Sydney by the Department of Main Roads illustrates a comprehensive orbital road network, some links of which are included in Table 6.7. Similar matching was carried out for other capital cities where sufficient detail of future road schemes was available. On the basis of this analysis and from discussions with officers in various SRAs, it would appear that total major urban project expenditure of between two and three times the total amount shown in Table 6.7 could arise (New South Wales Department of Main Roads, pers. comm. 1986). In this event, the total major project expenditure between 1989 and 2000, would more likely be between $3000 and $4000 million, equivalent to an average annual expenditure rate of $270 to $360 million, in constant 1985-86 prices.

Table 6.7 may be compared with available data for the period 1984-85 to 1988-89, which show an average annual expenditure rate on major urban projects to be $320 million and within the range estimate of $270 to $360 million, annually, for the expanded set of projects in types A, B and C.

The annual expenditure rates projected for category A, B and C projects do not include the recurring costs of restoration works. On the assumption that most of the projects identified represent new road links, or extensive upgrading of an existing road, restoration costs

TABLE 6.7 URBAN ARTERIAL ROAD PROJECT CHARACTERISTICS (CONSTANT 1985-86 PRICES)

($ million)

	Project type			
	A	*B*	*C*	*Total*
Number of projects	11	18	13	42
Estimated tota cost	357	641	398	1 396

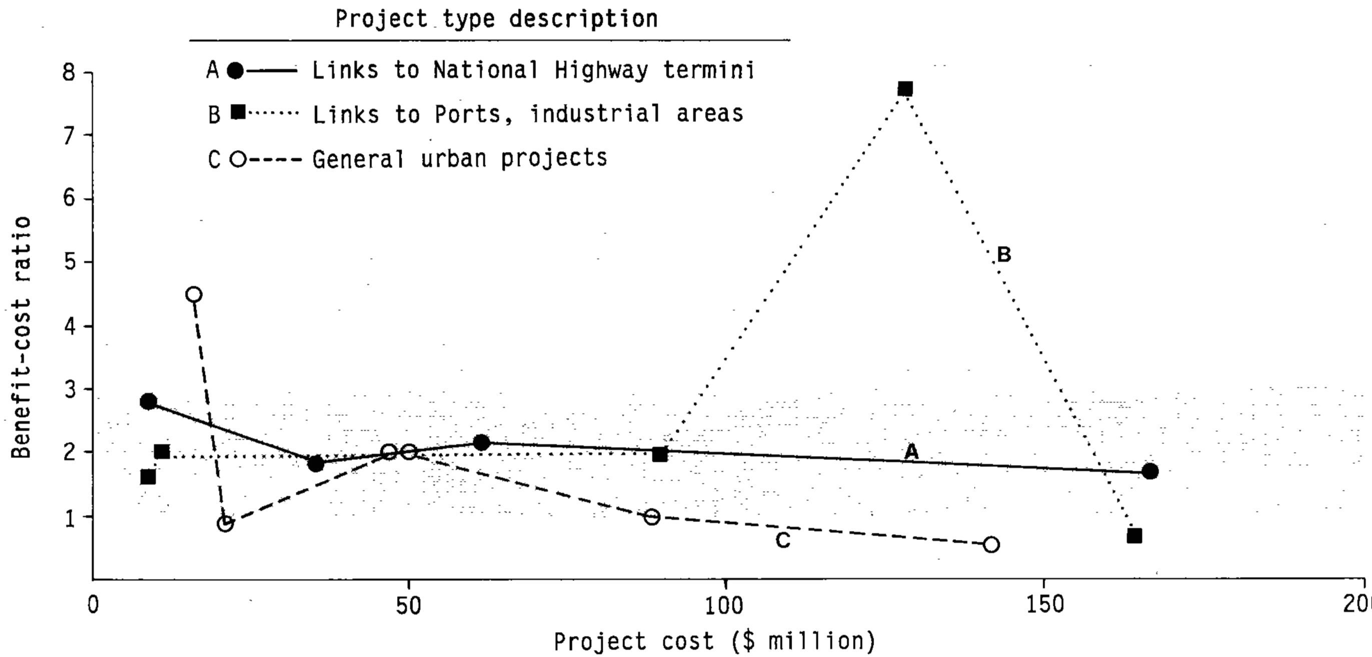
Sources BTE (1987a). Denis Johnston (1987).

would be low in the first three or four years after construction. It is likely, however, that restoration works would arise about seven to ten years after construction and would start to become significant beyond the analysis period.

Analysis of project types A, B and C

Individual project costs, for which the results of economic analysis were available, ranged from $4.9 million to $167 million and bcrs generally varied within the range of 1.0 to 3.0. The time scale of projects was confined to a period of about 10 years, which lies within the timeframe of this study. It must be emphasised that, in many instances, project details were far from precise. In particular, traffic composition details identifying the proportion and type of commercial vehicle activity appear to have been inferred on the basis of general traffic activity in the urban area at large, and do not appear to have been uniquely determined for each project. It might have been expected that project types A and B (that is, National Highway termini links and links to ports and airports) would have had higher commercial vehicle activity than type C (general urban arterial projects), but the data provided did not support this expectation. The relevance of this observation is that commercial vehicle activity is quite sensitive to economic performance because vehicle operating cost and time savings are considerably higher for a commercial vehicle than for a private car. Because the reported commercial vehicle content essentially does not vary across the project types A, B and C, any comparison ignores likely real differences in the level of commercial vehicle activity among categories.

Precise performance details on all projects could not be determined, but for those that were available, Figure 6.1 compares bcr with



Source Denis Johnston and Associates (1987).

Figure 6.1 Relationship between project costs and benefit-cost ratio for selected urban road projects

project cost. Two tentative observations can be drawn from these results. First, economic performance remains essentially independent of project cost, for the set of projects examined. Second, project types A and B do exhibit a somewhat higher economic performance than projects of type C and this effect is more marked at higher project costs. The respective average bcrs of project types A, B and C are 1.8, 3.2 and 1.2, although from Figure 6.1 it can be seen that one particularly high performing type B project is largely responsible for the high average value of 3.2.

In summary, projects associated with links to National Highway termini (type A) and links to ports, airports and principal industrial zones (type B), have economic advantages over general urban projects (type C). If, as suggested earlier, the commercial vehicle activity is higher than reported on project types A and B, then the economic performance of the project categories would also be correspondingly higher. In addition, if a further weighting were made to account for transport activities which encourage and contribute to trade and commerce overseas and among States, then project types A and B would probably be enhanced still further.

Finally, while no functional plans have been included in this report to identify project alignment details, it is evident that the linking of discrete projects is likely to achieve greater benefits than those obtained from individual projects. In particular, the linking of type A and B projects would appear to offer the best scope for further improvements in economic performance.

OTHER URBAN PROJECTS

In a less comprehensive way, the BTE has identified other urban projects which have not been dealt with in the foregoing discussion. These potential projects occur outside capital cities and correspond generally to project types A and B. The projects represent new links or upgradings of existing links to major regional ports and industrial complexes. The links would provide improved access from major rural arterial roads and National Highways to the type of destinations conforming with project types A and B. As planning for some of these projects is at an early stage, overall cost estimates are accordingly very imprecise and economic evaluation has not been undertaken. It is estimated however, that total capital cost of all projects identified in this, group would be in the vicinity of $60 to $90 million, equivalent to an average annual expenditure rate of $6 to $8 million, in constant 1985-86 prices. Seen in this light, this group of projects would entail relatively small outlays, compared to projects in capital cities.

In the course of the study, the BTE has received representations concerning the importance of roads for tourist purposes. While the phenomenon of tourist activity could be said to apply to all road categories, comprehensive data, which would enable specific analysis to identify high priority tourist routes, were not available. Moreover, rural arterial and National Highway traffic forecasts incorporate all trip purposes, including tourist traffic. Where tourist traffic is significant, this would be reflected in the overall traffic estimates, although short seasonal effects would be averaged over a full year. Access from capital cities to tourist locations beyond the metropolitan area, was cited by one council as a possible impediment to those tourists who have only limited time and wish to spend only one day in making a round trip. It is difficult to generalise about such trips, but it might be expected that they would approximately coincide with peak period traffic activity. However, these tourist trips would be outbound in the morning and inbound in the evening, more or less opposite to the prevailing commuter traffic flow.

It seems more likely that any capacity restrictions for the tourist traffic described would relate to limitations of the local road system rather than the arterial road system, in terms of both traffic capacity and structural capacity (arising from coach operations). Nevertheless, it is appropriate to note that a good road system should help to impress tourists and give rise to an improved reputation for Australia as a tourist destination for overseas visitors.

FUTURE FUNDING OF URBAN ARTERIAL ROADS

The complexity of the urban situation makes it difficult to relate total funding requirements to alternative objectives in the precise way which was possible for National Highways and rural arterials. Nevertheless, the examination of a sample of urban arterial projects reported above, estimated to represent about a third of the value of likely future projects arising in the analysis period, has made it possible to deduce approximate future funding requirements for this road category.

Table 6.7 gives the total cost of the projects examined as $1396 million. As this represents approximately only one-third of expenditure on upgrading projects planned for the period 1989 to 2000, the total requirements for this period would be about $4200 million. It was also shown that upgrading works accounted for about 60 per cent of total expenditure on urban arterials. Total funding requirements for the period, including necessary rehabilitation, therefore, amount to $7000 million or an average over the 11 year analysis period of

$635 million per year (in 1985-86 prices). This amount is made up of $380 million per year for upgrading and new construction and $255 million for restoration works. Funding of other (non-capital city) urban projects was estimated to be $6 to $8 million per year, and with restoration works, would amount in total to about $10 million per year. Total funding for urban projects is therefore estimated to be $645 million per year throughout the analysis period.

It should be noted, that this is the level of funding required for upgrading to be undertaken according to current schedules. However, if, as has been discussed, projects of type A and B are considered to be of special relevance to national objectives, and if the Commonwealth desired to accelerate these projects, an increased funding rate might be required in the early years.

CHAPTER 7 ASSESSMENT OF LOCAL ROADS

The main functions of local roads are either to provide access to properties abutting the roads in urban as well as rural areas, or to provide almost exclusively for one activity or use, such as recreation, tourism or logging operations. There is, however, a rather wide grey area between the strict definitions of arterial and local roads. Many local roads have come to serve arterial or through traffic, particularly in urban areas where arterial road traffic has spilled over onto local roads. In rural areas, local roads may also be very long, perhaps even joining a number of population centres, and serving through traffic. These are important definitional problems, because local roads are defined in Commonwealth road grants legislation as those which are not declared as national or arterial roads. Despite the lack of precise definition, however, local roads are an important part of the road network and of the economic infrastructure. Indeed, from the viewpoint of the Commonwealth Government, local roads are required to serve both everyday use by the community and as infrastructure support for national development.

In general, therefore, local roads are perceived to fulfil a variety of roles, depending on the requirements of users and the policies of the different levels of government. Use of local roads may change over time, depending on the demands for local community services and industrial restructuring.

THE COMMONWEALTH GOVERNMENT'S ROLE IN LOCAL ROAD FUNDING

The Self Report (1985) regarded the Commonwealth Government's involvement in the provision of local roads as being limited to those cases where there is a well defined 'national interest' or where, due to risk or cost, some experimentation and development may not be taken up at a local level. For instance, provision of infrastructure for overseas trade, interstate commerce or through traffic, might be judged more important at the Commonwealth level than the local or State level.

Currently, Commonwealth Government involvement in local road planning is by tied grants, presumably aiming to ensure that certain national objectives for local roads are being met. However, at this point it is not clear what these objectives are and whether they have a significant bearing on actual investment in local roads.

Fiscal imbalance (that is, the relative imbalance between revenue sources and expenditure responsibilities of the three levels of government), is one reason given for Commonwealth funding support for local government. Yet, given the extent and the heterogeneous nature of the local road system and the range of expectations from users and governments of what the system should achieve, it is difficult to assess the appropriateness of the current funding arrangements for the distribution of Commonwealth grants for local roads.[1] Nevertheless, it is possible to estimate the impact of Commonwealth funding on the performance of the local roads system and to outline likely future performance levels and funding requirements.

CURRENT PERFORMANCE

Table 3.2 sets out sealed and overall length statistics by State for both urban and rural local roads in Australia. Local roads make up almost 85 per cent of the total road network length, comprised of a 79.4 per cent rural component and 5.4 percent urban component. In addition, there are about 23 000 bridges on local roads, and estimates from the NAASRA Roads Study (NRS) (National Association of Australian State Road Authorities 1984a) indicate that about 85 per cent of these are located in rural areas.

Performance levels

Data of the type available for National Highways and rural arterials, which enabled detailed analyses, were not available for local roads. As a consequence, alternative measures of assessment were selected, based on the qualitative concept of performance and encompassing the notions of serviceability and accessibility. Three performance indicators are used: surface type, particularly seal length; road capacity; and accident rates.

These indicators are not exhaustive and other criteria may also be important, but they represent, in a general sense, a measure of the Commonwealth Government's stated aims in relation to the development of the entire road system. These very broad aims are to make road travel easier, safer, cheaper and quicker. In particular, the selected indicators are judged to show a sufficiently adequate measure

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1. Commonwealth grants for local roads are discussed in detail in BTE (1984b).

of performance if the road is wide enough for the traffic levels it carries; if the gradient and alignment standard permit safe use; and if the road is smooth enough to allow for reasonably comfortable and safe travel.

These factors vary in importance between rural and urban areas. Accordingly, most of the analysis presented in the chapter distinguishes between urban and rural areas and, where possible, between local authorities in different Harris categories.[2]

Road surface

The most relevant of the available performance indicators is surface type, a useful, albeit subjective, measure of serviceability. Objective surface type data indicate that the serviceability of the system is adequate across a large range of local government area types.

Community expectations for particular road surface types may vary between urban and rural areas. Significantly, much of the sealing of local roads in rural areas cannot be justified on the basis of objective quality of service provisions as laid down by the National Association of Australian State Road Authorities (1984a,b). Examples of the sealing of low volume local roads occur frequently in the rural areas of the Northern Territory, Western Australia and Queensland.

Road capacity

Traffic growth over the period 1979 to 1985, estimated from the SMVU (ABS 1986a) was 4.8 per cent in urban areas and 3.5 per cent in rural areas, including interstate travel. Excluding interstate travel, which would be predominantly on arterial roads, traffic growth in rural areas was only about 3.0 per cent. While the SMVU does not differentiate between travel on the different road categories within the urban and rural environments, it can be said that both travel and the length of sealed local roads are increasing, although perhaps at different rates. There is evidence to suggest, however, that some urban local roads have traditionally been constructed to a standard which encourages higher traffic volumes than are desirable in

2. The Harris categories, which are referred to throughout this chapter, are a means of classifying local authorities by their degree of urbanisation. The classification is based on the population of the urban centres associated with the authority. The classifications run from 1 to 8 in decreasing order of urbanisation. Numbers 1 to 3 are regarded as urban local authorities and 4 to 8 are regarded as rural local authorities (see Harris 1975).

residential streets (1500 vpd). Local councils expect this problem to increase, although it is being recognised and addressed in some areas.

In order to resolve the conflict between traffic and amenity on residential streets, Local Area Traffic Management (LATM) schemes have been introduced in many Australian cities with varying degress of success. Such measures usually involve the establishment of road hierarchies and the designation of certain areas as local traffic precincts to be protected from through traffic. Apart from attempting to control traffic volumes, LATM schemes also address problems such as commuter parking and speeding on residential streets and related safety aspects.

Urban subdivision road design criteria have undergone radical changes in recent times to avoid the problems outlined above. Typical of current thinking are the standards recommended by Comerford (1986), which aim to eliminate through traffic from residential areas, as well as to reduce vehicle speeds by minimising carriageway widths and the lengths of straights. The solution to the existing problem, however, does not lie so much with increased investment in local roads as with better investment in urban arterial roads and with an overall strategic plan to rationalise road use, including pricing.

Rural local roads have two main capacity requirements. Capacity, in terms of the numbers of vehicles which can use the road over a given period, is generally not a problem on rural local roads. For most of these roads, the basic width will provide sufficient geometric capacity. Capacity in terms of pavement strength, however, is often insufficient, especially where rural local roads are subject to heavy loading. This problem is addressed later in this chapter.

Accidents

The collection and analysis of accident statistics by road category at a national level has occurred only recently in Australia, but they do not include any assessment of exposure, thereby preventing the estimation of accident rates per vkt on different road classes.

Andreassend (1983) analysed all accidents in the Melbourne metropolitan area in 1981 by type of accident and road category. The report shows that some accidents occur mainly on one particular class of road; in particular, bicycle accidents occur most frequently on local roads, although the definition of local roads used is narrower than that used throughout this chapter.

The Federal Office of Road Safety has also tabulated road fatalities by crash type and road category for Australia as a whole for the years

1981 to 1983. Although the data are for fatal crashes only and also do not include any assessment of exposure, they show that about 10 per cent of crashes occured on urban local roads, 11 per cent on rural local roads, 31 per cent on urban arterials, and 48 per cent on rural arterials.

CURRENT FUNDING LEVELS AND ARRANGEMENTS

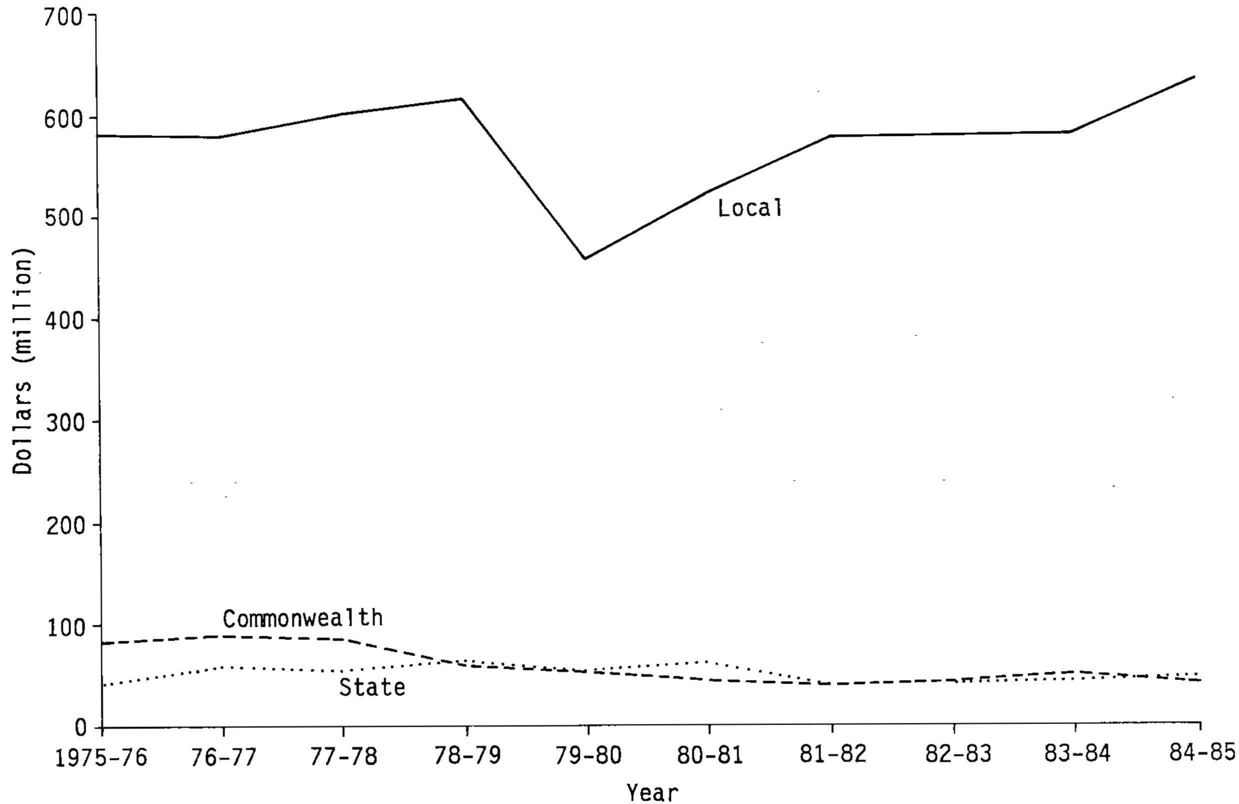
Details of current expenditure on urban and rural local roads by level of government for the period 1975-76 to 1984-85, are contained in BTE (1987a). This information is summarised in Figures 7.1 and 7.2. The dip in local government expenditure in 1979-80 for both urban and rural local roads is believed to be due to an underestimate in the SLGFS data series (ABS 1985c).

The figures demonstrate that Commonwealth and State funding of rural local roads is substantial, but that these two levels of government spend little on urban local roads. In fact, as is noted in BTE (1987a), some of the urban local road expenditure shown for local government is really expenditure on State declared roads. It is likely that this expenditure exceeds State expenditure on urban local roads. Thus, urban councils are on balance net contributors to State road expenditure.

Currently, local authorities have two sources of Commonwealth funds which can be spent on roads: general purpose grants and specific road grants. From 1976-77 on, general purpose grants have been distributed as Personal Income Tax Sharing grants which were replaced in 1986 by a new system of financial assistance grants. Specific road grants come under the ALTP and the ABRD program. Funds under the ALTP are distributed to local authorities within a given State, according to a formula or schedule developed in each State by State and local governments, and approved by the Minister. The funds may be spent on construction or maintenance. ABRD funds are distributed according to the same formula or schedule as ALTP funds, but can only be used for construction projects proposed by the authorities.

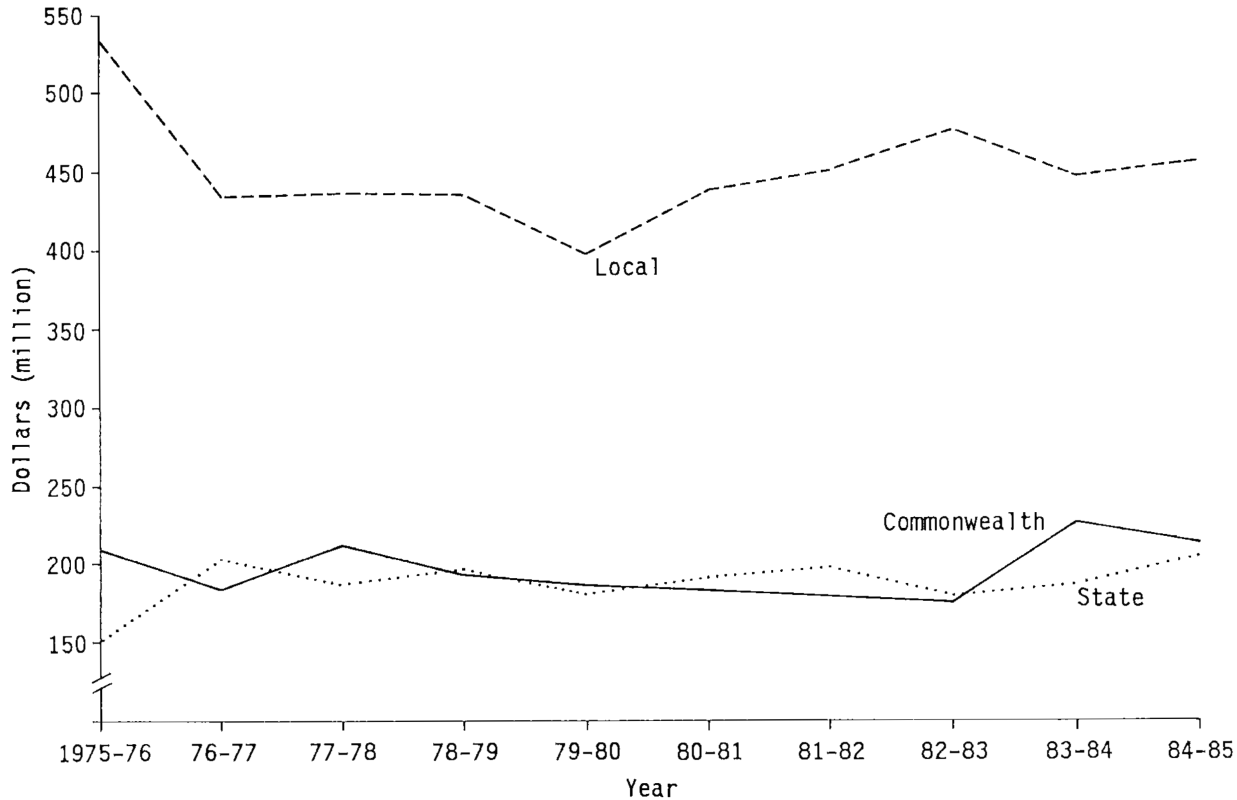
ASSESSMENT OF FUTURE PERFORMANCE AND FUNDING LEVELS

Given the range of factors affecting the future performance of local roads, its assessment is open to interpretation and becomes a question of judgment. The relative importance of the various indicators of performance is also a matter for individual judgment. Ultimately, any assessment of an appropriate level of performance must be balanced against available funds and alternative applications of those funds.



Source BTE (1987a).

Figure 7.1 Urban local road expenditure by level of government, 1975-76 to 1984-85 (constant 1984-85 prices)



Source BTE (1987a).

Figure 7.2 Rural local road expenditure by level of government, 1975-76 to 1984-85 (constant 1984-85 prices)

In the absence of objective functions which define the desired level of performance for local roads, the method employed in this chapter is to consider a range of performance and associated funding levels. The performance/funding levels examined are not presented as specific options, but rather to indicate the range within which alternatives exist.

Performance levels

Four levels of future performance are considered. The first two define the upper and lower bounds of the range of funding levels. The lower bound corresponds to maintaining the current level of serviceability. The upper bound represents an improvement in performance to some defined minimum standard. The third and fourth performance levels are defined as those reached under two levels of funding, namely, continuation of the current level of funding and withdrawal of direct Commonwealth funding of local roads in favour of other arrangements.

The first performance level is virtually equivalent to the current performance level. The second performance level is defined here as an increase in the proportion of local roads that are sealed and is analysed subjectively as a doubling in the rate of sealing of local roads. The third and fourth levels of performance are assessed by reference to estimates of future stocks of roads of various surface types as a function of the overall level of local road funding. In the case of the withdrawal of Commonwealth funding, the absorption of road grants into general financial assistance grants has been considered.

Indicators of future performance

The available information relating road stock to surface type, rates of sealing and funding levels, is scarce. However, some rough estimates can be made of the expected change in road stock with changes in the overall level of funding, at least up to 1991, using the results of the National Association of Australian State Road Authorities (1984b) study of local roads and other sources. This study estimated the 1991 stock of roads of various types given the stock in 1981, under three different levels of funding. These assumptions were funding at the 1981 level, and funding at levels 25 per cent above and below the 1981 level. Separate estimates were made for each State, road category and geographical area, and are generally supported by a recent BTE telephone survey of shire council engineers, regarding local authority road lengths and sealing rates.

The use of the NAASRA estimates introduces some inconsistency because the assumed distribution of funds between States and road categories is different from the current pattern. This unavoidable inconsistency, however, is not expected to affect significantly the reliability of the assessments, given that other assumptions about the way funds are distributed among construction, upgrading and maintenance, are valid.

Levels of funding

Estimates were made of the 'average' cost per kilometre of preserving current serviceability given traffic growth assumptions. This was done by taking a number of estimates made by council engineers of the cost per kilometre of restoring their local roads. The estimates were made in submissions to an Australian Council of Local Government Associations' (ACLGA) survey of local authority infrastructure. In this context, restoration included routine maintenance and rehabilitation work. Using restorative cost relativities outlined in the Cameron Report (1986) and road lengths by surface type, the estimates were extrapolated to give a range of the cost of restoring the entire local road network (see Table 7.1).

The reliability of the estimates produced under this approach depends on the validity of applying an average figure across the board. Additionally, there is the problem that there is not a uniform understanding of what are the best ways to improve serviceability or accessibility; for example, by increasing the proportion of sealed roads or improving amenity functions?

The estimates presented in Table 7.1 show that 56 to 83 per cent of current expenditure is required to keep local roads preserved overall. Taking traffic growth into account, the range of estimates of rehabilitation cost in 1988-89 is $930 to $1330 million, and in 1993-94 is $1050 to $1450 million. These data suggest that an additional $20 million is required each year to preserve the local road system due solely to traffic growth, including the increased loading of heavy vehicles.

Preserving existing levels of serviceability

Preserving existing levels of serviceability and accessibility will depend on traffic growth and changes in the relative importance of the main performance indicators. It is anticipated that local road performance would, at least, be generally preserved at current levels.

Within this context, the rate of growth in seal would be almost zero and the proportion of local roads that were sealed by the year 2000

TABLE 7.1 ESTIMATED RANGE OF TOTAL ANNUAL COST OF RESTORATION OF LOCAL ROADS (CONSTANT 1985-86 PRICES)
($ million)

Surface type	*Urban*			*Rural*			*Total*		
	lower	*average*	*upper*	*lower*	*average*	*upper*	*lower*	*average*	*upper*
Sealed	258	311	377	255	308	373	513	619	750
Paved	7	9	11	318	384	465	325	393	476
Formed	1	1	1	20	25	30	21	26	31
Unformed	0	0	0	1	2	2	1	2	2
Total	266	321	389	594	719	870	860	1 040	1 259

Source BTE estimates.

would be much the same as it is now. Although most local roads in new developments will be sealed, this would not increase the overall proportions significantly. Local road capacity would also be expected to increase only in line with traffic growth and to a defined limit of traffic capacity. Furthermore, the high profile given to road safety, especially in terms of education, should ensure that this aspect of current performance continues to produce encouraging results.

Increasing serviceability

Three different types of increase in serviceability are identified. The first and most quantifiable supposes that there is an intention to double the rate of sealing from current levels. The second target is to upgrade the capacity of particular local roads to accomodate high levels of heavy vehicle or through traffic using local roads. The third option is to target an improvement in safety performance by higher road design and safety standards. It is probable that an actual increase in serviceability would be achieved by some improvement in any one of these three targets. Even the targetting of a single indicator would have implications for the others.

If road sealing is regarded as the main way to increase serviceability, then the NRS results (National Association of Australian State Road Authorities 1984b) suggest that there will be little improvement with total funding increases of 25 per cent. At this level, only 0.63 per cent of urban roads and 0.44 per cent of rural roads would be sealed per annum.

Using the target of doubling the rate of sealing from current levels as an example, an increase in serviceability is expected to require total funding of nearly $2000 million per annum. This is over $1100 million on rural local roads and nearly $900 million on urban local roads and requires a Commonwealth contribution of over $700 million for all local roads, assuming there is no change in funding from other sources.

Continuation of current level of overall funding

The current performance of the local road network is the result of a gradual improvement in both serviceability and accessibility in past years. This, in turn, is the result of generally sustained overall funding, the development of attitudes and understanding of what is required of local roads and improvements in the use of road funds. Therefore, it is important to recognise that sustaining current overall funding is, of itself, no guarantee for improving performance;

assessing the future performance level requires an appreciation of the other two factors.

The predictions of the NRS imply that for all rural roads, a continuation of 1981 funding levels through to 1991 would lead to the proportion of local road length that is sealed increasing by 0.28 per cent per annum (compared to 0.31 per cent per annum in 1981), the sealed length increasing by 1.5 per cent per annum (compared to 2.0 per cent per annum in 1981) and the sealed length per authority increasing, on average, by 2.6 kilometre per annum (compared to 2.8 kilometre per annum in 1981). However, these are generalised figures which may conceal particular instances where improvements may not result.

Based on NRS estimates of the growth in seal length by the year 2000, if funding were maintained at current levels, nearly 80 per cent of urban local roads and about 19 per cent of rural local roads will be sealed. In sum, just over 26 per cent of the total length of local roads would be sealed.

The BTE survey of rural local authorities provided further data on the lengths of sealed and unsealed local roads, the increase in length of sealed local roads undertaken by the council or by private developers in 1985-86, and the typical annual increase in seal length. The summary in Table 7.2 shows that these figures are in agreement with those derived from the NRS.

Traffic on local roads is expected to continue to grow but should be comfortably accommodated, given the present excess capacity of local roads. Spillover effects from congested arterial roads in metropolitan areas could be solved by a combination of better planning and traffic management, and upgrading of relevant urban arterial roads (BTE 1984c).

Safety performance is expected, at least, to be maintained on a road use-related basis, if not in aggregate terms. Accidents may gradually be reduced by the application of better design features and improved road usage within the current funding framework.

Withdrawal of direct Commonwealth funding of local roads

The change to funding arrangements would be an absorption of specific road funds into general financial assistance grants (with complete discretion by LGAs in their application).

The National Association of Australian State Road Authorities (1984b) suggested that a 25 per cent decline in funds from 1981 levels would,

TABLE 7.2 ESTIMATES OF ANNUAL CHANGE IN LENGTH OF SEALED RURAL LOCAL ROADS

	Annual change as a proportion of		*Annual change per Local Government*
Source and year estimated	*Sealed length (per cent)*	*Total length (per cent)*	*Authority (kilometres)*
NAASRA[a]			
1981	2.0	0.31	2.8
1991[b]	1.5	0.28	2.6
BTE 1985-86	1.9	0.33	2.9

a. The NAASRA categories of rural and sparse rural have been combined.
b. This prediction assumes that expenditure continues at 1981 levels in real terms.

Sources BTE telephone survey. National Association of Australian State Road Authorities (1984b).

by 1991, result in the annual rate of sealing falling to 0.8 per cent of the total length of sealed rural local roads, or 0.13 per cent of the total length of rural local roads. In all cases, figures would be slightly higher for urban areas. However, urban local road serviceability was thought to be highly dependent on changes in the level of arterial road congestion, given the growing problem of arterial spillover in metropolitan areas.

In order to predict the response of local authorities to the absorption of road grants into general purpose grants, the Bureau classified them by State and Harris category, and examined the patterns of revenue and expenditure. It was found that, in general, the more rural the category, the greater the percentage of revenue that came from specific purpose grants and the smaller the percentage that came from rates. An implication of these findings is that rural authorities would be affected more than urban authorities by changes in the level of specific purpose grants.

An examination of these patterns suggests that the absorption of road grants into general financial assistance grants would probably lead to a large reduction in total local government road expenditure (BTE 1984b), resulting from the transfer of funds from rural to urban authorities and the lower propensity of urban authorities to spend on local roads. It is further suggested that the distribution of funds according to existing road grants formulae, but allowing for complete discretion in their use, would also lead to a net, albeit smaller, reduction in total local government road expenditure.

The above analysis does not allow for an accurate prediction of the magnitude of change. An upper limit to the relative magnitude of the reduction, however, could be expected to be the proportion of local government road expenditure from tied sources, because:

- it includes State tied road grants;
- some of the additional general purpose grants would be spent on roads; and
- some rural authorities might devote more of the revenue they raised from rates and charges (39 per cent of total revenue in 1984-85) to road expenditure.

In summary, absorption of Commonwealth grants for local roads into general financial assistance grants would have only a marginal effect on the rate of sealing of roads. If current maintenance levels and construction of new roads were maintained, the level of funding of road improvements would fall by about 12 per cent for rural local roads (from 48 to 42 per cent of total rural road expenditure) and increase by about 11 per cent for urban local roads (from 36 to 40 per cent of total urban road expenditure). The annual rate of road sealing would decrease only slightly to 0.44 per cent per annum of total length for urban local roads, and fall to 0.20 per cent per annum for rural local roads. For all local roads, the rate of seal growth would be about 0.22 per cent per annum. The percentage of the length of roads in rural areas giving poor service, as measured by the NAASRA serviceability criteria, would decrease by 0.10 per cent per annum. At these rates of sealing, the proportion of roads to be sealed will be virtually the same as would be achieved if the current level of overall funding were continued.

FUTURE FUNDING LEVELS AND CONSIDERATIONS

The proposed investment at which the range of performance levels is analysed, is based on a 1984-85 funding level for local roads of $1600m and a Commonwealth contribution of $250m (BTE 1987a). As noted, between $900m and $1200m is required each year for rehabilitation purposes. A further increase of approximately $20m is needed to account for traffic growth.

The assessment of desired performance levels and eventual achievement of these objectives is not simply a case of assessing how much to spend and then spending it. If objectives such as achieving easier, safer, quicker and cheaper travel are defined according to some specified criteria, then the overall levels of investment which might be required to achieve these objectives depend on a range of other factors.

On the user (demand) side, factors such as road user attitudes, safety considerations and on-going development of road design criteria have already been mentioned. On the investment (supply) side, there are several factors which have a bearing on the finances which the Commonwealth Government must make available to ensure that the overall funding level is sufficient for its performance objectives to be achieved. These include:

- distribution of local roads grants;
- State responses to changes in Commonwealth funding;
- LGA responses to changes in Commonwealth funding;
- cost factors; and
- road pricing.

Distribution of local roads grants

The distribution of Commonwealth Government local roads grants among local authorities and States is based on formulae which broadly take into account, *inter alia,* both the population and road lengths of a particular area. The most obvious effect is that funds are being directed to rural roads at the expense of urban roads which carry higher traffic levels, because the inclusion of road length in the formulae outweighs that of population. Rural areas contain only 28 per cent of total population but 88 per cent of total road length. Thus, rural areas receive a weighting of 1.38 compared with urban areas, where population and road length are equally weighted. In addition, in Victoria and Tasmania, road length is weighted above 50 per cent, and in New South Wales, rural roads receive a much greater share of funds than do urban roads.

Table 7.3 shows that the more rural authorities (small town and country councils) have increased their own road expenditure at a much faster rate than the overall average since 1981-82. This confirms that roadworks are a relatively more important priority for them than for other local authorities.

Over the same period, the growth in specific purpose payments for roads to these authorities grew by 13.6 per cent, compared with 11.8 per cent for all authorities.

TABLE 7.3 GROWTH IN LOCAL GOVERNMENT AUTHORITY REAL ROAD EXPENDITURE: IN TOTAL AND FROM OWN SOURCES, BY HARRIS CATEGORY, 1981-82 TO 1984-85

(per cent)

Harris category	*Growth in road expenditure from own sources*	*Growth in total road expenditure*
Urban		
Metropolitan	4.7	4.2
Large city	6.1	12.2
Medium city	21.0	17.3
Rural		
Small city	14.5	15.8
Large town	8.0	11.8
Medium town	14.8	14.5
Small town	15.5	14.8
Country	17.8	14.8
All authorities	10.0	10.7

Sources ABS (1985c). BTE estimates.

State responses

Tables 7.4 and 7.5 indicate relative State efforts in funding local roads in 1984-85. It is clear that, on the basis of relative funding at the State level, local roads are not a major priority, except in the Northern Territory, which is legally responsible for most of its local roads. The Northern Territory and Queensland appear to have a higher priority for local roads than the national average. New South Wales' low contribution can be explained by the fact that its Government is restricted by legislation to providing funds only for local roads which fall inside the County of Cumberland. The relatively low priority that the other States appear to attach to local roads, suggests that they are unlikely to increase greatly their own funding in response to a fall in Commonwealth funding.

The relative importance of factors influencing the level of State expenditure on local roads cannot be ascertained with certainty. It would appear, on the basis of limited evidence, that the level of State funding of local roads is influenced at least as much by the

TABLE 7.4 STATE ROAD AUTHORITY EXPENDITURE ON LOCAL ROADS AS A PROPORTION OF TOTAL STATE ROAD EXPENDITURE AND TOTAL STATE GOVERNMENT BUDGET EXPENDITURE: BY STATE, 1984-85

State	*Per cent of total State Road Authority expenditure*	*Per cent of total State government expenditure*
New South Wales	5.5	0.3
Victoria	15.2	0.6
Queensland	17.6[a]	1.2
Western Australia	13.7	0.7
South Australia	12.8	0.6
Tasmania	11.5	0.8
Northern Territory	66.5	5.5
Australia	12.4	0.7

a. Includes Treasury loan funds.

Notes 1. State expenditure may include expenditure on local roads in unincorporated areas.
2. Expenditure is from own resources.

Sources BTE (1987a, 1987c).

level of funds available as by local road needs. The priorities in State road funding are clearly towards arterial roads. It is, therefore, unlikely that the States would respond financially to any decrease in Commonwealth funding of local roads, although it is possible that an increase in Commonwealth funding may encourage some States to increase their own expenditure on arterial roads at the expense of funding of local roads.

Local government responses

Table 7.5 indicates that local authorities have relied heavily on grants from other levels of government to supplement their local roads expenditure. As noted earlier, a reduction in tied road funds is likely to lead to a decline in total expenditure on local roads. No checks are currently made to prevent any substitution of local government road funding by tied grants. From 1979-80 to 1984-85, local government road expenditure from 'own sources' as a percentage of untied revenue has risen overall, but has varied considerably from

TABLE 7.5 PROPORTIONAL EXPENDITURE ON LOCAL ROADS BY LEVEL OF GOVERNMENT AND BY STATE, 1984-85
(per cent)

		State		
State	*Commonwealth Government*	*State Road Authority*	*Other authorities*	*Local government*
New South Wales	12.6	4.5	5.7	77.1
Victoria	14.6	11.9	2.8	70.7
Queensland	14.2	11.8[a]	8.7[b]	65.2
Western Australia	27.7	12.0	0.5	59.7
South Australia	18.6	8.7	3.0	69.7
Tasmania	17.1	8.1	36.7	38.1
Northern Territory	42.2	44.6	0.0	73.1
Total	15.8	9.5	6.4	68.4

a. Includes Treasury road funds.
b. Excludes Treasury road funds.

Notes 1. State expenditure may include expenditure on local roads in unincorporated areas.
2. Expenditure is from own resources.

Sources BTE (1987a).

year-to-year, both among States and between categories of local authorities, indicating some capacity of local authorities to vary their contribution to local road expenditure. Over the same period, untied revenue in real terms has risen, particularly in the more urban authorities.

The process of rationalising local road use and planning will not be helped, if increased restorative costs are met by ratepayers through higher rates. If it is required that local authorities take greater responsibility for local road funding as well as for both planning and the use of these roads, then some change in funding procedures and planning techniques is indicated.

Cost factors
Various factors have acted to increase the cost burden on local authorities of providing a reasonable local road system, particularly in rural areas. In both the BTE survey of rural authorities and the

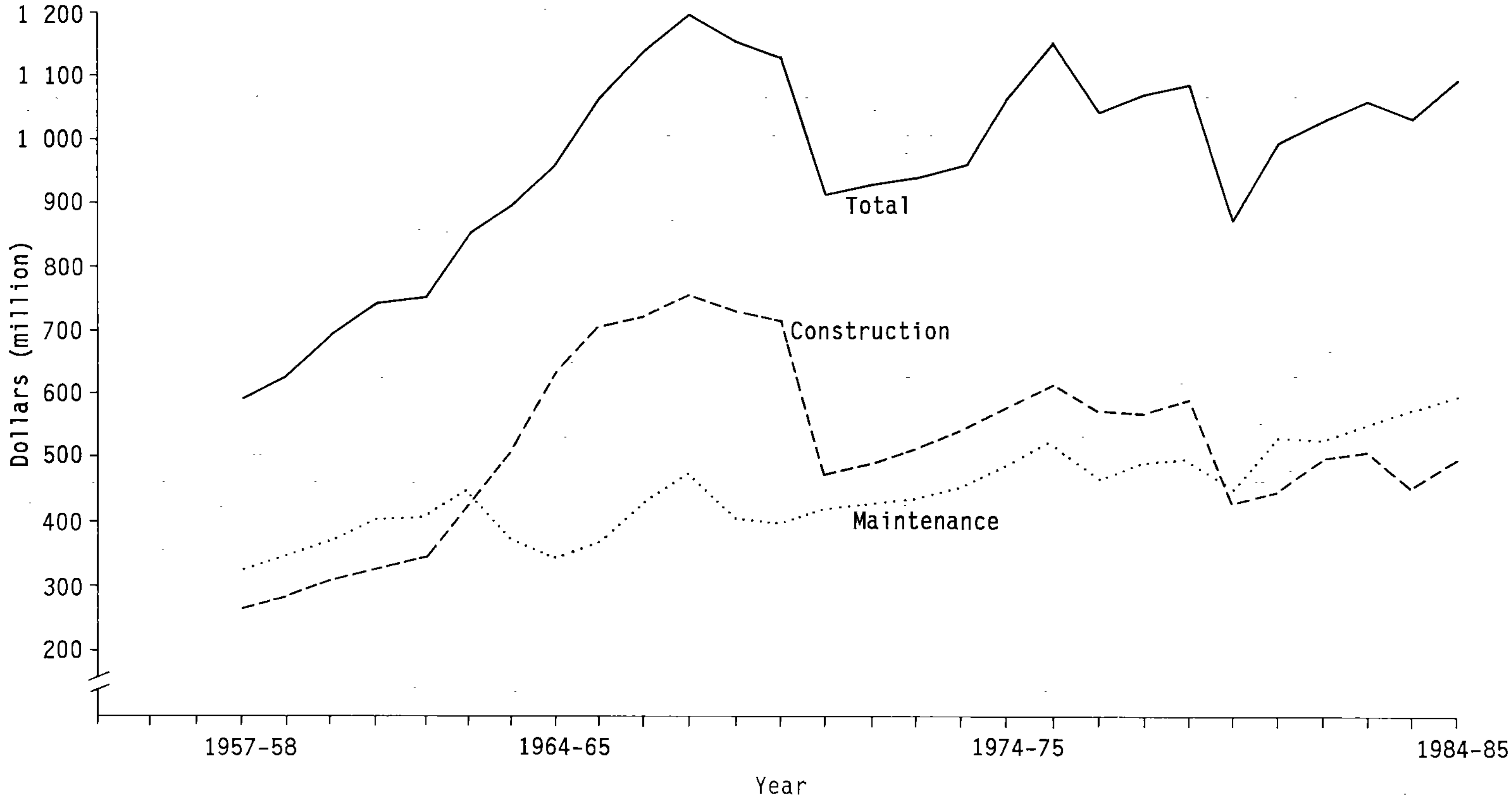
ACLGA survey of infrastructure, many authorities indicated that the serviceability of their local road network was not being preserved and was, in fact, declining. Some of the major factors contributing to this situation appear to be:

- the high levels of local road construction in the 1960s and early 1970s, which encouraged local authorities to design roads to a higher standard than they can maintain today;
- the ABRD scheme which has continued to encourage road construction, albeit at a lower rate than in the 1970s;
- higher than necessary geometric designs;
- lower than adequate pavement designs;
- higher traffic and loading levels than those planned for; and
- materials scarcity and cost.

Figure 7.3 indicates that a peak in total local government road expenditure occurred in 1967-68, while local government road construction expenditure peaked in 1968-69 (excluding routine maintenance and minor resealing). The high level of construction expenditure through the 1960s and early 1970s, has contributed to an increased level of restorative expenditure, as many roads reach the end of their design lives in the late 1980s and the 1990s. The split of local road expenditure between construction and maintenance is currently 55 per cent and 45 per cent respectively. Most of the construction work, however, is restoration of existing roads, with little upgrading or new construction; the percentage applied to construction has declined over recent years (BTE 1987a).

In 1982-83, the ABRD funding program was implemented. Currently, the burden of preservation of a road constructed under the ABRD scheme falls upon LGAs. To the extent that road standards increase under this program, the restoration burden will also increase, especially with the construction of new roads for housing and other developments. These roads are often constructed by private developers, but LGAs become responsible for their restoration.

The traffic levels at which roads are sealed are determined independently by LGAs. However, the geometric design of many local roads has often been far in excess of basic requirements and many local roads are wider and better aligned than traffic levels justify. While this excess adds nothing to trafficability and, perhaps, little to safety, it increases the restoration burden significantly if the higher standard is to be maintained. On this basis, there would appear to be a good case for a review of Pavement Management Systems that apply to local roads.



Sources BTE (1986d, 1987a).

Figure 7.3 Local government road expenditure, 1957-58 to 1984-85 (constant 1984-85 prices)

On the other hand, while the roads may be over-designed geometrically, pavements have often been under-designed for the subsequent use made of them. Frequently, this is due to a lack of regard for the full life-cycle cost of pavements, perhaps because the local authority is constrained by budget limitations to minimising the expenditure of road construction costs in the current budget period, rather than to address the on-going restoration requirements. This is particularly a danger where developers are only responsible for initial road construction and not on-going routine maintenance. Adding to this problem are traffic levels and vehicle loading increases. Roads designed for one set of local limits are often used by vehicles which are overloaded.

Another problem faced by many councils is that road costs increase at a greater rate than the CPI to which ALTP grants are tied. For example, the BTE road construction price index rose at a faster rate than the CPI from 1975-76 to 1984-85 (on average around two per cent higher per annum). Additionally, in many areas, road building material supplies have been depleted to the point where suitable supplies are not available locally. Consequently, roads may be restored and upgraded with lower grade materials which wear out more quickly, or high grade materials must be transported at ever increasing cost from distant sources.

The solution to these problems relies on a proper assessment of the costs and benefits of local road projects. In addition, given that local roads are a valuable asset, their costs should be included on council balance sheets, and depreciated in an appropriate manner. This would highlight the importance of life-cycle costs and help to identify the most efficient restoration and upgrading strategies to maintain the value of the local roads asset.

Road pricing

Appropriate pricing of local road use might assist in the efficient management of road resources and tend to rationalise road use, as well as provide an additional source of revenue. It was noted in Chapter 4, that the current system of road user charges does not ensure that all road users, in particular operators of heavy vehicles, pay even the avoidable cost of their use of the roads.

Some pricing mechanisms on local roads are currently in place. For instance, in Tasmania, State legislation allows LGAs to charge export logging operators (woodchip and pulpwood companies) 0.9 cents per cubic metre per kilometre for log trucks travelling on local roads.

This charge may soon be increased subject to State government approval. Woodchip companies also restore some roads themselves, but, overall only a small portion of the estimated increase in road restoration costs due to use by heavy trucks is actually recovered.

At the local government level, the administrative difficulties in establishing and enforcing a pricing mechanism for local roads may be prohibitive.

CHAPTER 8 THE SCOPE FOR COMMONWEALTH GOVERNMENT ROAD FUNDING DISTRIBUTION

The analysis of the four road categories which comprise the Australian road system has been undertaken on the basis of total funding provided by the three levels of government. The funding provided by the Commonwealth is unique, in that allocations are made to all four road categories, whereas State and local governments' contributions are generally restricted to arterial (urban and rural) and local roads, respectively. Although each level of government can, and has, varied the level of funding it provides for roadworks, it can be seen that the Commonwealth has the opportunity not only to vary the level of funding, but also the distribution of those funds among all road categories. State governments have less opportunity to vary their road funding distribution, while local governments distribute road funds predominantly to local roads.

FUNDING OPTIONS

In the discussion which follows, options for variations to the level and distribution (among the road categories) of Commonwealth road funds are considered. The distribution of funds among the States is not taken into account in considering proposals to extend the National Highways. The analysis does not address the question of State and local government responses to funding variations. It is assumed that these governments would continue the level and pattern of road expenditure represented by the average over the last five years for which data are available. Table 8.1 shows this average annual road expenditure by road category and level of government.

Total expenditure by State and local governments amounted to $2384 million and this level of expenditure and its distribution among the road categories is assumed to be maintained, *except* that the State contribution of $37 million to National Highways is redirected to rural arterials to provide a State contribution of $586 million to that category.

Variation to Commonwealth funding levels

The Commonwealth Government has foreshadowed total Commonwealth road expenditure in 1987-88 of $1250 million in current prices. This corresponds to $1084 million in 1985-86 prices and has been adopted as the reference level for Commonwealth funding in the considerations below. In order to provide some insight into the consequences of variations, options for Commonwealth road funding 10 per cent above and below the reference level are also considered. Table 8.2 presents the three funding levels in both 1987-88 and 1985-86 prices.

TABLE 8.1 AVERAGE ANNUAL ROAD EXPENDITURE: 1980-81 TO 1984-85 (CONSTANT 1985-86 PRICES)

($ million)

Level of government	*National Highways*	*Rural arterials*	*Urban arterials*	*Local roads*	*Total*
Commonwealth	489	175	227	250	1 141
State	37	549	431	255	1 272
Local	-	-	6	1 106	1 112
Total	526	724	664	1 611	3 525

Source BTE (1986a).

TABLE 8.2 OPTIONS FOR TOTAL COMMONWEALTH GOVERNMENT ROAD FUNDING, 1989 TO 2000

($ million)

Option	*1987-88 prices*	*1985-86 prices*
Funding foreshadowed for 1987-88 (reference level)	1 250	1 084
Reference level + 10 per cent	1 375	1 192
Reference level - 10 per cent	1 125	975

Note Conversion uses road construction price index (BTE, 1986c).

Possible allocations of funds among the road categories are given in Table 8.3 for the three options of Table 8.2. Option 1 involves Commonwealth funding at the reference level ($1084 million) while Options 2 and 3 illustrate variations of 10 per cent respectively above and below the reference level. As noted previously, State and local government funding is assumed to be the same in all options. In each option, funding for the (existing) National Highways, for which the Commonwealth accepts full responsibility, has been set so that all projects with positive net benefits (bcr greater than one) could be undertaken. This funding level was determined in Chapter 5 to be $392 million per year. The distribution of the balance of Commonwealth funds among the other road categories could be made in a number of ways depending on the objectives to be pursued. For the purpose of this discussion, the allocation to the rural arterial, urban arterial and local roads has been made, in Options 1, 2 and 3, in the proportions recommended by the Inquiry into the Distribution of Federal Road Grants (Cameron Report, 1986). The objective underlying these recommendations can be described, loosely, as the preservation of operational performance as defined in Chapter 5. The consequences, for each of the road categories, of these funding options are noted below.

National Highways

The funding of all projects with positive net benefits would be markedly less than during the period 1980 to 1985, but would nevertheless be sufficient to provide a steady and significant improvement in the physical conditions and operational performance of the National Highways.

Rural arterials

In all three options, funding of rural arterials would be above the average for the period 1980 to 1985 but below the level required to undertake all projects with positive net benefit. As shown in Chapter 5, the latter, economically justified funding level is below the level required to preserve the physical condition or operational performance on rural arterials. There would, therefore, be some decline in both these measures under each of the options, though at a slower rate than hitherto.

Urban arterials

The examination of urban arterial funding needs in Chapter 6 was not sufficiently detailed to enable the consequences of particular funding levels to be determined with confidence. Total funding under all these options would be above the average for the period 1980 to 1985, though only in Option 2 would it be close to the $779 million reached in 1984-85. The estimates of Chapter 6 suggest that total funding of

$645 million per year would be required in order to undertake the urban projects of type A, B and C scheduled for the period 1989-2000 (as well as necessary maintenance works). These projects could therefore be undertaken under all three options, and might be somewhat accelerated under Options 1 and 2.

Local roads
Commonwealth funding for local roads would be significantly below the average for the period 1980 to 1985 in all three options. However, as the Commonwealth contributes only a small proportion of the total funds devoted to local roads, the relative impact on the total would be reduced. Even under Option 3, total funding would be only six per cent below the 1980 to 1985 average, although the impact would be somewhat greater in rural areas. Despite the reductions, the analysis in Chapter 7 suggests that the funding levels in these options would still permit a gradual increase in the total length of sealed local roads.

Redistribution of Commonwealth road funds

One of the features of the current funding arrangements is that they provide for joint funding responsibility, but make no provision for reaching agreement on joint objectives. In the past, a variety of conditions accompanied Commonwealth road grants but, at present, there are no restrictions on State and local government expenditure from their own resources. The result is that, while the Commonwealth makes substantial contributions to all road categories, it has little influence on the objectives pursued on arterial and local roads. It was, in fact, partly due to these circumstances that the National Highway system was declared in 1974. By accepting essentially full responsibility for the National Highways, the Commonwealth was able to ensure that national objectives were followed on these roads.

The success of the National Highway system has led to suggestions that the pursuit of Commonwealth road objectives might most rapidly be advanced by incorporating the principal urban and rural arterial routes of national and economic significance into an extended National Highway system. The funding needs of such National Highway extensions would be covered by a corresponding reduction in the need for Commonwealth funding to the remaining arterial roads. To a degree, such a redistribution might be seen as simply an administrative change but, in the longer term, its consequences could be profound. The Commonwealth would be able to consolidate its road interests in an extended National Highway system for which it would have full responsibility and full control over the choice of objectives. The

TABLE 8.3 ALTERNATIVE ROAD FUNDING OPTIONS (CONSTANT 1985-86 PRICES)

($ million)

Option	*Funding source*	*National Highways*		*Rural arterials*	*Urban arterials*	*Local roads*	*Total*
		Existing	*Extensions*				
1	Commonwealth	392	0	220	287	185	1 084
	State and local	0	0	586	437	1 361	2 384
	Total	392	0	806	724	1 546	3 468
2	Commonwealth	392	0	255	331	214	1 192
	State and local	0	0	586	437	1 361	2 384
	Total	392	0	841	768	1 575	3 576
3	Commonwealth	392	0	185	242	156	975
	State and local	0	0	586	437	1 361	2 384
	Total	392	0	771	679	1 517	3 359
4	Commonwealth	392	220	0	287	185	1 084
	State and local	0	0	586	437	1 361	2 384
	Total	392	220	586	724	1 546	3 468
5	Commonwealth	392	287	220	0	185	1 084
	State and local	0	0	586	437	1 361	2 384
	Total	392	287	806	437	1 546	3 468
6	Commonwealth	392	507	0	0	185	1 084
	State and local	0	0	586	437	1 361	2 384
	Total	392	507	586	437	1 546	3 468

States, too, would be enabled to pursue their own objectives on the remaining arterial networks freed, wholly or partially, from the obligation to obtain approval for the expenditure of Commonwealth funds.

Options 4, 5 and 6 in Table 8.3 illustrate limiting cases for the transfer of urban and rural arterial routes and funding responsibilities to the National Highway system. The cases are limiting in the sense that the routes transferred would have a total funding requirement (for undertaking all projects with positive net benefit) corresponding to the whole of the Commonwealth contribution to that road category (as assumed in reference Option 1). Clearly, smaller transfers of routes and funding responsibilities could be considered. In Option 4, 3750 kilometres of rural arterials linking capital cities, major provincial cities and important regional centres (see Figure 5.5) would be transferred to the National Highways together with associated funding of $220 million per year. In Option 5, urban artieral routes with funding requirements amounting to $287 million would be transferred to the National Highways. In terms of the analysis in Chapter 6, this would be sufficient to undertaken all the A and B type projects scheduled for the period 1989 to 2000. Option 6 combines Options 4 and 5 and represents a complete withdrawal of the Commowealth from arterial road funding.

It needs to be emphasised that this discussion of possible extensions to the National Highway system is somewhat artificial and should be considered only as illustrative. In the first place, it is based on the reference funding level of Option 1 and the route lengths and funds transferred correspond to the Commonwealth contributions to urban and rural arterials in that option. Clearly, a reference case with a different level and distribution of funding would have led to different results. Secondly, the examples chosen illustrate complete withdrawal of the Commonwealth from arterial road funding. It would, of course, be possible to envisage a partial withdrawal, although only complete wihtdrawal would provide the administrative benefits which would flow from a rationalisation of funding responsibilities. Finally, it should be remembered that the discussion has taken no account of the distribution of funding among the States. Any actual transfers of arterial roads to the National Highway system would, obviously, have to be based on agreement with each of the States concerned.

APPENDIX I ROAD FUNDING, SUPPLEMENTARY INFORMATION

This appendix presents supplementary information to that contained in Chapter 3. Tables are presented showing Commonwealth legislative arrangements covering road funding to the States since 1964; the distribution of Commonwealth road grants among the States since 1975-76; State and local government road expenditure efforts over the decade to 1984-85; road expenditure by the three levels of government as a percentage of budget outlays; details of Commonwealth budget expenditure by function from 1976-77 to 1986-87; State budget outlays from 1976-77 to 1984-85; and local government revenue and budget outlays from 1976-77 to 1984-85.

TABLE I.1 BASIC FEATURES OF COMMONWEALTH ROAD FUNDING LEGISLATION, 1964 TO 1986

	Arrangements				
	Allocation procedures				
Road legislation	*States*	*Category allocations*	*Categories*[a]	*Quotas*	*Program approval procedures*
Commonwealth Aid Roads Act 1964 (1964-65 to (1968-69)	Formula	States free to allocate	Rural roads (c and m) Urban roads (c and m)	None on basic grant. Dollar for dollar on supplementary grant.	None
Commonwealth Aid Roads Act 1969 (1969-70 to 1973-74)	50 per cent previous formula 50 per cent needs as per CBR 1969 report	Guided by 1969 CBR report	Urban arterial roads (c) Rural arterial roads (c) Rural roads other than arterial (c and m)	Base amount set with annual increase based on motor vehicle registrations.	None

TABLE I.1 (Cont.) BASIC FEATURES OF COMMONWEALTH ROAD FUNDING LEGISLATION, 1964 TO 1986

	Arrangements				
	Allocation procedures				
Road legislation	*States*	*Category allocations*	*Categories*[a]	*Quotas*	*Program approval procedures*
Roads Grants Act 1974, National Roads Act 1974 (1974-75 to 1976-77)	Basically needs as per CBR report	Guided by 1973 CBR report, except full funding of national roads and less for other categories	National Highways (c) National Highways (m) Export and major commercial roads (c and m) Rural arterial roads (and development roads) (c) Rural local roads (c and m) Urban arterial roads (c) Urban local roads (c) MITERS[b] Beef roads (c)	Based on 1973 CBR report (mainly motor vehicle registrations)	National roads - projec approval. Urban arterial roads - projec approval but with controls over State expenditure on urban arterial All other road categories - program approval.

TABLE I.1 (Cont.) BASIC FEATURES OF COMMONWEALTH ROAD FUNDING LEGISLATION, 1964 TO 1986

	Arrangements				
	Allocation procedures				
Road legislation	*States*	*Category allocations*	*Categories*[a]	*Quotas*	*Program approval procedures*
States Grants (Roads) Act 1977 (1977-78 to 1979-80)	Basically pro rata increase on 1976-77 (± 4 per cent)	Commonwealth Government's own announced objectives	National Highways (c) National Highways (m) National commerce roads (c) Rural arterial roads (c) Rural local roads (c and m) Urban arterial roads (c) Urban local roads (c) MITERS[b]	Pro rata increase to increase in grants	National roads same as for 1974 Act. Establishment of planning committees as alternative to approval procedures for all categories Alternative program of allocations fo local roads.

TABLE I.1 (Cont.) BASIC FEATURES OF COMMONWEALTH ROAD FUNDING LEGISLATION, 1964 TO 1986

	Arrangements				
	Allocation procedures				
Road legislation	*States*	*Category allocations*	*Categories*[a]	*Quotas*	*Program approval procedures*
Roads Grants Act 1980 (1980-81)	Pro rata increases on 1977 Act	Pro rata increase on 1977 Act, except MITERS[b] grants allocated to national roads	National roads (c and m) Rural arterial roads (c) Urban arterial roads (c) Local roads (c and m)	Based on achieving equal effort per vehicle over six years	Procedures same as those in 1977 Act,[b] with program of allocations only for local roads. Provision for development of formula for local roads.
Roads Grants Act *1981* (1981-82 to 1984-85)	Pro rata increase on *Roads Grants Act 1980*	As for *Roads Grants Act 1980*	National roads (c and m) Arterial roads (c) Local roads (c and m)	Abolished	Abolition of approval procedures for arterial roads

TABLE I.1 (Cont.) BASIC FEATURES OF COMMONWEALTH ROAD FUNDING LEGISLATION, 1964 TO 1986

	Arrangements				
	Allocation procedures				
Road legislation	*States*	*Category allocations*	*Categories*[a]	*Quotas*	*Program approval procedures*
Australian Bicentennial Road Development Trust Fund Act 1982 (1982-83 to Dec 1988)	Pro rata to *Roads Grants Act 1981* except National Highways	Commonwealth Government's own objectives	National roads (c) Rural arterial roads (c) Urban arterial roads (including public transport) (c) Local roads (c)	Annual maintenance in real terms of base amounts (based on average real expenditure over previous five years)	Detailed project approval procedures introduced.

TABLE I.1 (Cont.) BASIC FEATURES OF COMMONWEALTH ROAD FUNDING LEGISLATION, 1964 TO 1986

	Arrangements				
	Allocation procedures				
Road legislation	*States*	*Category allocations*	*Categories*[a]	*Quotas*	*Program approval procedures*
Australian Land Transport (Financial Assistance) Act 1985 (1985-86 to 1989-90)	Pro rata to *Roads Grants Act 1981* except National Highways	Commonwealth Government's own objectives	National roads (c and m) Rural arterial roads (c and m) Urban arterial roads (c and m) Local roads (c and m) Railway projects (c) Land transport research Road safety activities	None	Project or program approval procedures for all categories except local roads. Formulae for local roads.

a. Excluding planning and research.
b. Minor Traffic Engineering and Road Safety.
c. Construction.
m. Maintenance.

Source BTE (1984b). *Australian Land Transport (Financial Assistance) Act 1985.*

TABLE I.2 DISTRIBUTION OF COMMONWEALTH ROAD EXPENDITURE AMONG THE STATES, 1975-76 TO 1984-85

(per cent)

Year	*NSW*	*Vic*	*Qld*	*WA*	*SA*	*Tas*
1975-76	30.6	20.7	20.0	13.2	8.8	6.9
1976-77	30.9	19.8	20.8	12.5	8.4	7.7
1977-78	32.6	20.2	20.7	12.7	8.2	5.7
1978-79	32.4	20.7	21.3	12.6	8.4	4.5
1979-80	32.3	20.7	21.2	12.8	8.4	4.6
1980-81	31.7	20.5	21.1	12.5	8.3	5.8
1981-82	31.5	20.4	20.7	12.4	8.3	6.8
1982-83	30.7	19.9	21.1	12.4	8.4	7.6
1983-84	34.4	19.9	20.9	12.0	8.3	4.3
1984-85	33.1	19.9	21.5	13.1	8.3	4.2

Note The Northern Territory has been excluded from the table since it was included in roads grants legislation only from 1979-80. Its inclusion in the table for this and subsequent years would render the State comparisons meaningless.

Source BTE (1987b).

TABLE I.3 STATE GOVERNMENT ROAD EXPENDITURE PER MOTOR VEHICLE ON REGISTER: BY STATE, 1975-76 TO 1984-85 (CONSTANT 1984-85 PRICES)

($)

Year	*NSW*	*Vic*	*Qld*	*WA*	*SA*	*Tas*	*NT*	*Average*
1975-76	192.5	170.0	158.2	164.0	121.8	157.2	..	169.9
1976-77	182.9	170.3	191.2	173.5	149.7	265.6	..	179.1
1977-78	209.4	173.7	175.3	158.6	130.0	258.7	..	183.0
1978-79	192.3	154.8	168.2	178.7	136.9	258.9	1 386.7	181.9
1979-80	189.3	109.3	152.3	181.9	112.8	234.7	1 039.4	169.3
1980-81	181.7	123.5	138.6	162.6	107.9	206.0	965.9	156.1
1981-82	150.3	119.1	153.3	143.6	89.9	180.5	826.2	141.7
1982-83	141.5	117.8	142.9	157.0	101.3	194.2	606.4	131.3
1983-84	143.5	129.5	124.6	132.2	94.8	225.6	448.9	135.8
1984-85	170.9	119.4	177.5	145.5	97.3	280.8	288.3	152.7

.. Not applicable.

Note Price deflator used was BTE Road Construction Price Index.

Source BTE (1987b).

TABLE I.4 LOCAL GOVERNMENT ROAD EXPENDITURE PER CAPITA: BY STATE, 1975-76 TO 1984-85 (CONSTANT 1984-85 PRICES)
($)

Year	*NSW*	*Vic*	*Qld*	*WA*	*SA*	*Tas*	*NT*	*Average*
1975-76	113.2	53.7	93.5	62.0	52.5	89.3	44.7	82.5
1976-77	93.6	57.3	78.8	62.5	55.2	84.9	55.3	72.2
1977-78	97.9	54.2	75.2	62.4	61.5	88.3	51.3	75.2
1978-79	98.4	55.5	72.0	68.5	60.7	90.8	10.0	75.5
1979-80	58.5[a]	57.0	76.2	53.8	54.8	73.8	27.5	60.7[a]
1980-81	77.5	61.3	75.1	49.6	54.4	64.1	8.3	67.2
1981-82	84.5	56.4	74.4	53.7	53.9	60.5	27.0	68.5
1982-83	80.8	60.9	77.1	52.0	59.5	58.8	38.8	69.5
1983-84	75.0	60.0	82.4	46.3	53.0	59.8	36.6	66.9
1984-85	78.7	59.7	87.7	56.3	56.0	58.8	26.4	70.0

a. The New South Wales local government expenditure figure for 1979-80 is believed to underestimate actual expenditure. For further explanation see BTE (1987a).

Note Price deflator used was BTE Road Construction Price Index.

Source BTE (1987b).

TABLE I.5 COMMONWEALTH, STATE AND LOCAL ROAD EXPENDITURE AS A PERCENTAGE OF BUDGET OUTLAYS,[a] 1975-76 TO 1984-85

	Commonwealth			*State*			*Local*		
Year	*Budget outlay ($m)*	*Road expenditure ($m)*	*Per cent*	*Budget outlay ($m)*	*Road expenditure ($m)*	*Per cent*	*Budget outlay ($m)*	*Road expenditure ($m)*	*Per cent*
1975-76	21 860	524.1	2.40	6 084.6	423.2	6.96	1 470.3	443.8	30.18
1976-77	24 124	552.1	2.29	7 352.0	529.0	7.20	1 624.1	458.6	28.24
1977-78	26 802	567.8	2.12	9 296.4	618.4	6.65	1 808.0	514.3	28.45
1978-79	29 045	559.4	1.93	10 158.6	690.2	6.79	2 020.0	563.3	27.89
1979-80	31 694	608.2	1.92	11 268.9	767.6	6.81	2 262.6	531.2	23.48
1980-81	36 274	670.2	1.85	13 488.0	855.3	6.34	2 531.0	689.9	27.26
1981-82	41 339	718.2	1.74	15 472.5	926.0	5.98	2 965.6	808.3	27.26
1982-83	48 982	862.2	1.76	19 163.8	988.8	5.16	3 284.3	934.0	28.44
1983-84	56 570	1 203.8	2.13	20 360.0	1 110.6	5.45	3 364.9	966.9	28.73
1984-85	63 739	1 280.1	2.01	22 874.0	1 314.3	5.74	3 844.0	1 085.5	28.24

a. Budget outlay, in the case of State and local governments, excludes all grants (specific and general purpose) from other levels of government.

Note Price deflators used were ABS Implicit Price Deflator of Gross National Expenditure, and BTE Road Construction Price Index.

Source BTE (1987b).

TABLE I.6 COMMONWEALTH BUDGET EXPENDITURE BY FUNCTION, 1976-77 TO 1986-87 (CONSTANT 1984-85 PRICES)
($ million)

Area	*1976-77*	*1978-79*	*1980-81*	*1982-83*	*1984-85*	*1986-87*	*Increase 1976-77 to 1986-87 (per cent)*
Defence	4 384.4	4 433.3	4 930.3	5 442.5	5 941.2	6 302.8	43.8
Education	4 339.6	4 296.7	4 084.6	4 326.7	4 518.5	4 423.4	1.9
Health	5 108.1	4 948.4	5 088.1	3 898.1	6 113.5	6 211.0	21.6
Social security and welfare	12 919.3	13 796.8	13 824.6	16 059.9	17 833.3	17 646.0	36.6
Housing, urban and regional development, culture and recreation	2 123.1	1 311.3	1 186.7	1 581.0	2 117.9	2 180.3	2.7
Transport and communication	1 986.9	1 230.5	1 379.2	2 003.3	1 900.4	1 446.7	-27.2
Other economic services	1 229.5	1 610.8	1 937.7	2 267.4	2 574.7	2 147.1	74.6
Total general public services	3 245.3	3 257.9	3 452.9	3 811.2	4 425.7	4 519.5	39.3
Total not allocated to function	13 128.4	14 533.5	14 681.5	16 352.0	18 313.9	18 672.0	42.2
Total outlays	48 464.6	49 419.2	50 565.6	55 742.1	63 739.1	63 548.8	31.1

Note Price deflator used was ABS Implicit Price Deflator of Gross National Expenditure.

Source BTE (1987b).

TABLE I.7 STATE GOVERNMENT EXPENDITURE[a] BY FUNCTION, 1976-77 TO 1984-85 (CONSTANT 1984-85 PRICES)
('000 million)

Year	*Education*	*Health*	*Welfare*	*Housing*	*Utilities*	*Transport*	*Other*	*Total*
1976-77	8.93	5.11	0.27	0.51	2.52	2.47	4.89	24.70
1977-78	8.68	5.10	0.23	0.68	2.66	2.60	5.18	25.13
1978-79	8.59	5.09	0.28	0.51	2.79	2.67	5.25	25.18
1979-80	8.46	4.96	0.26	0.50	2.90	2.63	5.39	25.10
1980-81	8.64	5.15	0.31	0.58	3.33	2.73	5.66	26.40
1981-82	8.87	5.15	0.31	0.54	3.99	3.02	5.85	27.73
1982-83	8.89	4.93	0.38	0.65	4.49	3.50	6.13	28.97
1983-84	9.15	5.35	0.43	0.85	3.77	4.29	6.21	30.05
1984-85	9.32	5.97	0.50	0.95	3.13	3.58	6.52	29.97

a. Expenditure includes that from all sources, including Commonwealth grants.

Notes 1. Excludes the Northern Territory.
2. Owing to rounding, figures may not add to totals.
3. Price deflator used was ABS Implicit Deflator of Gross National Expenditure.

Source BTE (1987b).

TABLE I.8 LOCAL GOVERNMENT REVENUE BY SOURCE, 1975-76 TO 1984-85 (CONSTANT 1984-85 PRICES)
($ million)

Year	*Commonwealth specific purpose grants (direct to local government)*	*Commonwealth general purpose grants*	*Commonwealth grants passed on by States*		*Local sources*	*Total*
			Roads	*Other*		
1975-76	235.1	176.4	166.2	180.4	3 489.4	4 247.5
1976-77	26.6	277.8	172.6	68.8	3 525.0	4 070.8
1977-78	26.2	304.4	215.5	37.9	3 707.9	4 291.9
1978-79	29.9	306.1	211.9	26.1	3 794.5	4 368.5
1979-80	24.4	340.6	201.8	24.0	3 800.3	4 391.1
1980-81	30.2	418.9	197.6	22.6	3 816.9	4 486.2
1981-82	34.8	444.1	184.2	23.8	4 029.2	4 716.1
1982-83	53.4	484.1	175.1	28.3	4 026.9	4 767.8
1983-84	61.1	488.5	216.0	205.3	3 611.6	4 582.5
1984-85	73.6	484.4	210.5	205.5	3 760.6	4 734.6

Notes
1. Excludes the Northern Territory.
2. Owing to rounding, figures may not add to totals.
3. Price deflator used was ABS Implicit Price Deflator of Gross Domestic Product.
4. Figures used from the Department of Local Government and Administrative Services (1985) differ from those obtained from the Commonwealth of Australia (1986).

Source BTE (1987b).

TABLE I.9 LOCAL GOVERNMENT EXPENDITURE BY FUNCTION, 1976-77 TO 1984-85 (CONSTANT 1984-85 PRICES)

($ million)

Year	*General Public Services*	*Health, Education, Welfare, Housing*	*Utilities*	*Transport*	*Other*	*Total*
1976-77	660.6	211.1	766.4	1 292.0	610.7	3 840.9
1977-78	710.0	221.7	738.8	1 301.1	679.0	3 650.7
1978-79	749.0	242.4	720.2	1 310.8	713.1	3 735.7
1979-80	713.3	233.6	783.8	1 220.0	811.2	3 761.8
1980-81	719.2	274.6	780.0	1 236.3	838.0	3 868.2
1981-82	742.1	294.7	857.3	1 238.3	848.4	3 981.0
1982-83	636.6	318.0	839.4	1 257.4	980.0	4 031.6
1983-84	642.0	339.4	778.4	1 332.7	1 008.7	4 101.1
1984-85	650.6	361.4	881.4	1 394.1	1 075.4	4 363.1

a. Expenditure includes that from all sources including grants, reimbursements, and so on, from other levels of government.

Notes
1. Excludes the Northern Territory.
2. Owing to rounding, figures may not add to totals.
2. Price deflator used was ABS Implicit Price Deflator of Gross National Expenditure.
3. There is a discontinuty in ABS treatment of expenditure on street lighting. From 1982-83 it is included in 'Other' rather than in 'Transport', as in earlier years.

Source BTE (1987b).

APPENDIX II COMPARISON OF ROAD EXPENDITURE EFFORT BETWEEN AUSTRALIA AND SELECTED COUNTRIES

The tables presented in this appendix show comparisons between Australia's road expenditure effort and that of a number of selected industrialised countries. Financial data for other countries has been converted to Australian currency at average exchange rates each year, and then to constant 1984-85 price estimates. Unfortunately, due to currency fluctuations during the peiod covered by the data, conversion of data from other countries to estimates in Australian currency will produce some distortions to the patterns of expenditure shown for those countries, whether current price or constant price estimates are adopted. Nevertheless, the tables do provide a rough comparison of road expenditure effort among the countries selected. Note, figures refer to respective financial years.

TABLE II.1 ROAD EXPENDITURE AS A PERCENTAGE OF GROSS DOMESTIC PRODUCT, 1979 TO 1984

(per cent)

Country	*1979*	*1980*	*1981*	*1982*	*1983*	*1984*
Australia	1.75	1.64	1.67	1.63	1.68	1.76
FRG	1.69	1.64	1.52	1.36	1.16	1.12
Great Britain	.97	.98	.99	1.07	1.01	.99
Japan	2.54	2.41	2.27	2.28	2.26	na
New Zealand	1.06	.95	.68	.73	1.07	1.12
USA	1.50	1.50	1.40	1.41	na	1.18

na Not available.
FRG Federal Republic of Germany

Sources ABS (1986b). BTE (1987b). International Road Federation (1985). Organisation of Economic Co-operation and Development (1985).

TABLE II.2 ROAD EXPENDITURE PER KILOMETRE OF ROAD, 1979 TO 1984 (CONSTANT 1984-85 PRICES)
($A '000)

Country	*1979*	*1980*	*1981*	*1982*	*1983*	*1984*
Australia	4.3	3.9	4.0	3.8	3.8	4.4
FRG	48.7	35.6	27.0	24.5	18.3	16.2
Great Britain	21.7	22.3	17.9	18.1	16.1	13.3
Japan	36.7	35.7	30.0	30.2	30.4	na
New Zealand	4.1	3.3	2.2	2.4	3.3	3.0
USA	9.8	8.6	8.4	9.0	na	na

na Not available.
FRG Federal Republic of Germany.

Sources ABS (1986b). BTE (1987b). International Road Federation (1985). Organisation of Economic Co-operation and Development (1985).

TABLE II.3 ROAD EXPENDITURE PER KILOMETRE OF PAVED ROAD, 1979 TO 1984 (CONSTANT 1984-85 PRICES)
($A)

Country	*1979*	*1980*	*1981*	*1982*	*1983*	*1984*
Australia	14.8	13.4	13.3	12.6	12.4	13.7
FRG	56.0	36.0	27.3	24.7	18.5	16.3
Great Britain	22.5	23.1	18.6	18.8	16.5	13.3
Japan	85.6	77.8	62.3	59.6	57.1	na
New Zealand	7.9	6.6	4.3	4.6	6.2	5.7
USA	12.0	10.4	10.1	10.8	na	na

na Not available.
FRG Federal Republic of Germany.

Sources ABS (1986b). BTE (1987b). International Road Federation (1985). Organisation of Economic Co-operation and Development (1985).

TABLE II.4 ROAD EXPENDITURE PER VEHICLE, 1979 TO 1984 (CONSTANT 1984-85 PRICES)

($A)

Country	*1979*	*1980*	*1981*	*1982*	*1983*	*1984*
Australia	488	424	420	384	381	413
FRG	968	698	519	465	340	293
Great Britain	445	447	355	356	311	252
Japan	1 120	1 050	847	818	796	na
New Zealand	251	199	129	137	182	159
USA	403	350	328	351	na	na

na Not available.
FRG Federal Republic of Germany.

Sources ABS (1986b). BTE (1987b). International Road Federation (1985). Organisation of Economic Co-operation and Development (1985).

TABLE II.5 ROAD EXPENDITURE PER CAPITA, 1979 TO 1984 (CONSTANT 1984-85 PRICES)

($A)

Country	*1979*	*1980*	*1981*	*1982*	*1983*	*1984*
Australia	240	214	210	203	203	224
FRG	382	280	212	193	146	129
Great Britain	131	135	108	114	101	129
Japan	349	339	285	285	286	na
New Zealand	121	99	65	70	94	86
USA	274	238	223	240	na	na

na Not available.
FRG Federal Republic of Germany.

Sources ABS (1986b). BTE (1987b). International Road Federation (1985). Organisation of Economic Co-operation and Development (1985).

APPENDIX III NATIONAL HIGHWAYS AND RURAL ARTERIALS, SUPPLEMENTARY INFORMATION

This appendix contains more detailed information to supplement the analyses reported in Chapter 5. Data are grouped under the following headings corresponding to components of Chapter 5:

- status at 1989
- preservation of the asset
- economic implications of road projects
- funding scenarios
- extended National Highway system.

STATUS IN 1989

Tables III.1 and III.2 show the projected physical details of National Highways and usage characteristics respectively, in 1989. Noteable aspects of the information in these tables include:

- the relatively high proportion of National Highways road length in urban areas in New South Wales;
- the New South Wales and Queensland National Highway's content of approximately two-thirds of bridges, while comprising only approximately one-third of road length;
- the relatively large percentage of Queeensland National Highways with a poor surface roughness level;
- the high rate of growth of traffic on Queensland National Highways;
- the high proportion of travel in the three eastern seaboard States, amounting to nearly four-fifths of travel on all National Highways;
- the relatively large percentage of roads with a low level of service in both New South Wales and Queensland, and to lesser extent in Tasmania; and
- the high proportion of heavy vehicle travel on National Highways in the Northern Territory.

TABLE III.1 PROJECTED PHYSICAL STATUS OF NATIONAL HIGHWAYS, 1989

	Length (kilometres)						*Mean roughness[a] based on weighting by*		*Per cent with poor roughness[a] based on weighting by*		
		Sealed									
State	*Unsealed*	*One lane*	*Multi-lane*	*Divided*	*Total*	*Per cent length in urban areas*	*vkt*	*Length*	*vkt*	*Length*	*Number of bridges*
NSW	0.0	0.0	859.8	485.7	1 345.5	17.5	76.3	80.9	8.4	11.8	587
Vic	0.0	0.0	331.6	366.2	697.8	7.2	68.0	69.1	1.3	1.0	186
Qld	0.0	26.3	3 669.5	236.8	3 932.5	3.5	82.2	95.5	6.9	13.3	514
SA	0.0	0.0	2 325.7	130.5	2 456.2	1.7	51.2	50.2	0.0	0.0	83
WA	75.7	272.8	4 289.4	8.6	4 646.5	1.3	73.6	67.0	0.9	0.8	103
Tas	0.0	0.0	277.5	41.8	319.3	3.6	63.2	65.9	0.0	0.0	109
NT	0.0	380.6	2 252.7	22.4	2 655.8	3.5	73.7	75.6	4.0	4.8	75
Australia	75.7	679.7	14 006.0	1 292.0	16 053.7	3.9	73.9	74.2	5.5	5.5	1 657

a. Measured in NAASRA roughness meter counts. For general purposes, a roughness count of less than 100 is good and a count of 140 or more is poor (National Association of Australian State Road Authorities 1984a). See Appendix IV for details.

Notes 1. Status as at 30th June, 1989.
2. Owing to rounding, figures may not add to totals.

Source BTE projections.

TABLE III.2 PROJECTED USAGE OF NATIONAL HIGHWAYS, 1989

	Traffic flow (aadt)				Travel (million vkt)			Mean level of service[a] based on weighting by		Per cent with low level of service[b] based on weighting by	
State	*Mean*[c]	*Maximum*	*Minimum*	*Growth*[d] *rate*	*Heavy vehicles*	*Other vehicles*	*Total*	*vkt*	*Length*	*vkt*	*Length*
NSW	11 545	52 685	1 401	3.6	843.3	4 826.4	5 669.7	3.3	3.8	39.8	25.1
Vic	7 141	32 714	1 195	2.5	281.4	1 537.2	1 818.7	4.8	4.8	0.8	0.5
Qld	3 324	66 533	45	5.4	650.0	4 121.8	4 771.8	3.8	4.4	21.3	6.5
SA	1 769	42 706	127	3.4	216.5	1 369.2	1 585.6	4.3	4.7	9.6	1.0
WA	500	17 851	73	2.9	145.4	702.5	848.0	4.6	4.9	2.9	0.2
Tas	5 433	24 601	2 400	2.6	43.5	589.7	633.2	4.1	4.3	13.4	5.9
NT	247	9 774	41	4.2	53.7	186.1	239.8	5.0	5.0	0.0	0.0
Australia	2 657	66 533	41	3.9	2 233.9	13 332.9	15 566.9	3.8	4.6	22.8	4.6

a. Level of service is measured on a scale of 1.0 to 5.0. See Appendix IV for details.
b. Low level of service is based on values below 3.0.
c. Vehicle kilometres divided by route length.
d. Percentage average annual compound growth 1981 to 1989.

Notes 1. Status as at 30th June, 1989.
2. Owing to rounding, figures may not add to totals.

Source BTE projections.

Table III.3 presents the physical details of the rural arterial system in 1989, while Table III.4 shows its usage characteristics. This information is shown in summary form in Table 5.3. Notable aspects of the rural arterial system rural are:

- the high proportion of unsealed and one lane roads in the Northern Territory;
- the high percentage of the length in New South Wales and Queensland with a poor surface roughness level;
- the high mean traffic growth rate in the Northern Territory;
- the high proportion of heavy vehicle travel in the Northern Territory;and
- the low proportion of length with poor levels of service in the Northern Territory and Western Australia. (A similar situation applies to the National Highways in these t 'o States as shown in Table III.2.)

Achievement of design standards

Table III.5 shows the status of the National Highway system in 1989 in relation to the minimum design standards for road width as prescribed in Department of Transport (1982). Approximately $3100 million of roadworks are required to upgrade National Highways to these design standards (not including expenditure for rehabilitation and bridges). Some 47 per cent of the current length of National Highways is below the design standards for width, with the majority occuring on low traffic volume routes.

PRESERVATION OF THE ASSET

As explained in Chapter 5, three aspects of preservation are considered:

- routine maintenance
- preservation of the physical asset
- preservation of operational performance.

Preservation of the physical asset

National Highways

Table III.6 shows the projected status of National Highways in the year 2000, resulting from preservation of the physical asset at the mean level prevailing in 1989. Table III.7 shows the associated expenditure for each type of construction project. Figure III.1 shows the projected distribution of roughness and level of service by road length in the years 1989 and 2000. Noteworthy features are:

TABLE III.3 PROJECTED PHYSICAL STATUS OF RURAL ARTERIALS, 1989

State	*Length (kilometres)*					*Mean roughness[a] based on weighting by*		*Per cent with poor roughness[a] based on weighting by*		*Number of bridges*
		Sealed								
	Unsealed	*One lane*	*Multi-lane*	*Divided*	*Total*	*vkt*	*Length*	*vkt*	*Length*	
NSW	8 021.2	235.8	19 086.2	365.0	27 708.1	94.6	114.5	9.7	13.1	5 363
Vic	298.0	229.3	13 576.4	277.9	14 381.8	73.6	86.5	1.4	2.7	1 859
Qld	2 157.5	4 587.5	11 063.4	144.4	17 952.8	90.2	108.2	9.5	15.5	1 263
SA	715.2	40.5	7 643.0	92.6	8 491.1	80.4	85.9	5.5	6.3	500
WA	4 040.0	1 739.0	10 252.3	48.6	16 079.8	67.3	89.7	0.6	11.6	652
Tas	210.2	27.2	2 109.6	23.7	2 370.7	76.0	92.7	2.9	7.9	932
NT	1 304.3	1 130.1	185.4	0.0	2 619.7	76.4	106.0	1.5	8.7	3 329
Australia	16 746.4	7 989.3	63 916.3	952.1	89 604.1	84.2	100.8	6.2	10.7	13 898

a. Measured in NAASRA roughness meter counts. For general purposes, a roughness count of less than 100 is good and a count of 140 or more is poor (National Association of Australian State Road Authorities 1984a). See Appendix IV for details.

Notes 1. Status as at 30th June, 1989.
2. Owing to rounding, figures may not add to totals.

Source BTE projections.

TABLE III.4 PROJECTED USAGE OF RURAL ARTERIALS, 1989

	Traffic flow		*Travel (million vkt)*			*Mean level of service[a] based on weighting by*		*Per cent with low level of service based on weighting by*	
State	*Mean[b] (aadt)*	*Growth[c] rate*	*Heavy vehicles*	*Other vehicles*	*Total*	*vkt*	*Length*	*vkt*	*Length*
NSW	979	3.6	1 548.0	8 322.1	9 870.0	4.3	4.7	6.8	0.9
Vic	1 213	1.9	770.3	5 596.0	6 366.3	4.5	4.7	3.1	0.6
Qld	808	4.5	816.9	4 518.8	5 335.7	4.2	4.7	10.1	1.0
SA	934	2.8	274.0	2 620.4	2 894.4	4.6	4.8	1.1	0.2
WA	505	3.3	367.9	2 598.3	2 966.1	4.6	4.9	1.0	0.1
Tas	1 004	2.0	59.6	809.2	868.8	4.5	4.6	0.0	0.0
NT	43	5.1	7.5	33.8	41.3	5.0	5.0	0.0	0.0
Australia	866	3.2	3 844.1	24 498.6	28 342.7	4.4	4.7	5.2	0.3

a. Level of service is measured on a scale of 1.0 to 5.0. See Appendix IV for details.
b. Vehicle kilometres divided by route length.
c. Percentage average annual compound growth rate from 1981 to 1989.

Notes 1. Status as at 30th June, 1989.
2. Owing to rounding, figures may not add to totals.

Source BTE projections.

TABLE III.5 NATIONAL HIGHWAY STATUS: DESIGN STANDARDS[a], 1989

Link	Length (kilometres) Above design standard		At design standard		Below design standard		Total		Cost to raise to design standard[b] ($ million)
Sydney-Melbourne	18.2	(2.3)	589.8	(73.1)	198.3	(24.6)	806.3	(100.0)	320
Melbourne-Adelaide	31.5	(4.5)	620.3	(88.5)	48.8	(7.0)	700.6	(100.0)	20
Adelaide-Perth	9.3	(0.3)	754.7	(28.3)	1 905.4	(71.4)	2 669.4	(100.0)	390
Port Augusta-Darwin	0.0	(0.0)	1 618.6	(60.5)	1 056.6	(39.5)	2 675.2	(100.0)	456
Perth-Katherine	109.9	(3.0)	1 924.1	(52.1)	1 661.3	(45.0)	3 695.2	(100.0)	359
Brisbane-Tennant Creek	6.8	(0.3)	1 000.9	(41.2)	1 423.6	(58.6)	2 431.3	(100.0)	486
Sydney-Brisbane	101.2	(10.7)	346.7	(36.6)	499.3	(52.7)	947.2	(100.0)	495
Hobart-Burnie	32.4	(10.2)	259.6	(81.3)	27.2	(8.5)	319.3	(100.0)	30
ACT border-Goulburn	0.0	(0.0)	26.5	(40.0)	39.7	(60.0)	66.2	(100.0)	76
ACT border-Yass	0.0	(0.0)	0.0	(0.0)	36.9	(100.0)	36.9	(100.0)	71
Brisbane-Cairns	27.3	(1.6)	1 056.5	(61.9)	622.3	(36.5)	1 706.1	(100.0)	388
Australia	336.6	(2.1)	8 197.7	(51.1)	7 519.4	(46.8)	16 053.7	(100.0)	3 091

a. Seal width and divided road standards, only (Department of Transport 1982).
b. Excluding the cost of bridges and of rehabilitating structurally deficient pavements (constant 1985-86 prices).

Notes 1. Figures in brackets represent percentage of length of link.
2. Owing to rounding, figures may not add to totals.

Source BTE projections.

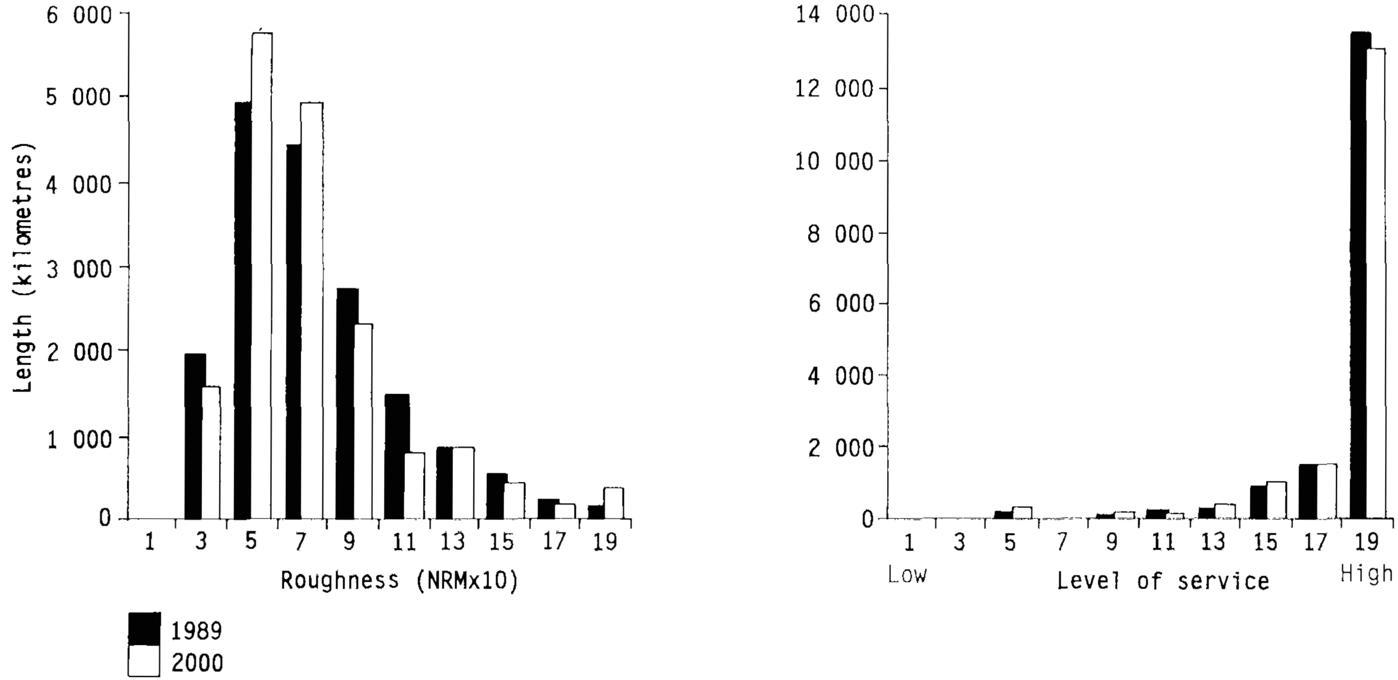
TABLE III.6 PROJECTED STATUS OF NATIONAL HIGHWAYS: PRESERVATION OF THE PHYSICAL ASSET, YEAR 2000

	Length (kilometres)						*Mean level of service*[a] *based on weighting by*		*Mean roughness*[a] *based on weighting by*	
		Sealed				*Mean traffic flow*				
State	*Unsealed*	*One lane*	*Multi lane*	*Divided*	*Total*	*(aadt)*	*vkt*	*Length*	*vkt*	*Length*
NSW	0.0	0.0	859.8	485.7	1 345.5	14 322	3.1	3.7	62.1	80.9
Vic	0.0	0.0	331.6	366.2	697.8	8 666	4.7	4.7	58.4	68.6
Qld	0.0	26.3	3 669.5	236.8	3 932.5	4 196	3.4	4.2	69.8	95.4
SA	0.0	0.0	2 325.7	130.5	2 456.2	2 104	4.3	4.7	41.7	50.1
WA	75.7	272.8	4 289.4	8.6	4 646.5	606	4.5	4.9	58.9	67.0
Tas	0.0	0.0	277.5	41.8	319.3	6 672	3.9	4.2	59.1	65.9
NT	0.0	380.6	2 252.7	22.4	2 655.7	323	5.0	5.0	66.4	75.5
Australia	75.7	679.7	14 006.0	1 291.9	16 053.7	3 288	3.7	4.5	61.9	74.2

a. Level of service is measured on a scale of 1.0 to 5.0. See Appendix IV for details.
b. Measured in NAASRA roughness meter counts. For general purposes, a roughness count of less than 100 is good and a count of 140 or more is poor (National Association of Australian State Road Authorities 1984a). See Appendix IV for details.

Notes 1. Status as at 30th June, 2000 with construction confined to rehabilitation of pavement to preserve the mean 1989 roughness level (based on weighting by carriageway length).
2. Owing to rounding, figures may not add to totals.

Source BTE projections.



Source BTE projections.

Figure III.1 Preservation of the physical asset: change in distribution of roughness and level of service, National Highways, 1989 and 2000

- approximately 30 per cent of total expenditure will be required for divided roads which account for only 8 per cent of the length of National Highways;
- the distribution of roughness between roads of different traffic levels will change substantially between 1989 and 2000, as indicated by the change in mean roughness weighted by vkt; and
- the mean level of service will fall marginally in most States.

Rural arterials

Table III.8 shows the projected status of rural arterials in the year 2000, resulting from preservation of the physical asset at the mean level existing in 1989. Table III.9 presents the associated expenditure for each type of construction project. Figure III.2 illustrates the distribution of roughness and level of service by road length in the years 1989 and 2000. Noteworthy results of this analysis are that:

- nearly 90 per cent of expenditure will occur on sealed undivided roads, which account for 80 per cent of the length of rural arterials;
- the distribution of roughness between roads of different traffic levels will change significantly between 1989 and 2000, and the mean roughness weighted by vkt will be reduced from approximately 84 in 1989 to approximately 67 in 2000; and
- the mean level of service will fall marginally over the period 1989 to 2000.

Preservation of operational performance

National Highways

Table III.10 shows the projected status of National Highways in the year 2000, if the operational performance at the mean level existing in 1989 were maintained. Table III.11 presents the associated expenditure for each type of construction project. Figure III.3 depicts the distribution of roughness and level of service by road length in the years 1989 and 2000. Noteworthy results of this analysis are:

- approximately one third of the 300 kilometres of road upgraded to divided status, will occur in Queensland;
- seventy-six kilometres of road in Western Australia will remain unsealed in the year 2000;

TABLE III.7 EXPENDITURE REQUIRED TO PRESERVE[a] THE PHYSICAL ASSET: PROJECT TYPE, NATIONAL HIGHWAYS, 1989 TO 2000 (CONSTANT 1985-86 PRICES)

($ million)

	Rehabilitation of sealed pavements		
State	*Undivided*	*Divided*	*Total*
New South Wales	88.1	145.2	233.3
Victoria	23.9	73.7	97.6
Queensland	316.7	97.0	413.7
South Australia	133.1	60.4	193.5
Western Australia	149.5	5.6	155.1
Tasmania	49.0	14.0	63.0
Northern Territory	177.8	9.8	187.6
Australia	938.2	405.7	1 343.9

a. Expenditure not required for gravel surfaces.

Notes 1. Expenditure required for rehabilitation of pavements to preserve the mean roughness level (weighted by carriageway length) in each State over the period 1989 to 2000. Expenditure for routine maintenance and bridges is excluded.

2. Owing to rounding, figures may not add to totals.

Source BTE projections.

- almost half of the total expenditure will be spent in Queensland and the Northern Territory; and
- a significant change in the distribution of roughness will occur, although the mean will remain constant.

Rural arterials

Table III.12 shows the projected status of rural arterials in the year 2000 resulting from preservation of the operational performance at the mean level existing in 1989. Table III.13 presents the associated expenditure for each type of construction project. Figure III.4 illustrates the distribution of roughness and level of service by road

TABLE III.8 PROJECTED STATUS OF RURAL ARTERIALS: PRESERVATION OF PHYSICAL ASSET, YEAR 2000

	Length (kilometres)						*Mean level of service[a] based on weighting by*		*Mean roughness[b] based on weighting by*	
		Sealed				*Mean traffic flow*				
State	*Unsealed*	*One lane*	*Multi-lane*	*Divided*	*Total*	*(aadt)*	*vkt*	*Length*	*VKT*	*Length*
NSW	8 021.2	235.8	19 086.2	365.0	27 708.1	1 217	4.1	4.6	70.9	114.5
Vic	298.0	229.3	13 576.4	277.9	14 381.8	1 411	4.4	4.6	56.7	86.5
Qld	2 157.5	4 587.5	11 063.4	144.4	17 952.6	984	4.0	4.7	77.7	108.2
SA	715.2	40.5	7 643.0	92.6	8 491.1	1 081	4.5	4.7	60.1	85.8
WA	4 040.0	1 739.0	10 252.3	48.6	16 079.8	630	4.4	4.8	60.1	89.7
Tas	210.2	27.2	2 109.6	23.7	2 370.7	1 171	4.4	4.6	70.9	92.6
NT	1 304.3	1 130.1	185.4	0.0	2 619.7	60	5.0	5.0	67.6	106.0
Australia	16 746.4	7 989.3	63 916.3	952.1	89 604.1	1 048	4.2	4.7	66.9	100.7

a. Level of service is measured on a scale of 1.0 to 5.0. See Appendix IV for details.

b. Measured in NAASRA roughness meter counts. For general purposes, a roughness count of less than 100 is good and a count of 140 or more is poor (National Association of Australian State Road Authorities 1984a). See Appendix IV for details.

Notes 1. Status as at 30th June, 2000 with construction confined to rehabilitation of pavements to preserve the mean roughness level of 1989 (based on weighting by carriageway length).

2. Owing to rounding, figures may not add to totals.

Source BTE projections.

TABLE III.9 EXPENDITURE REQUIRED TO PRESERVE THE PHYSICAL ASSET: PROJECT TYPE, RURAL ARTERIALS, 1989 TO 2000 (CONSTANT 1985-86 PRICES)

($ million)

State	*Resheeting of gravel pavements*	*Rehabilitation of sealed pavements*		*Total*
		Undivided	*Divided*	
NSW	3.3	1 835.6	293.5	2 132.3
Vic	0.0	1 077.7	88.3	1 165.9
Qld	0.0	899.4	64.2	963.6
SA	0.0	551.5	65.7	617.2
WA	0.0	499.9	18.1	518.0
Tas	0.0	216.4	18.6	235.0
NT	7.6	104.7	0.0	112.3
Australia	10.9	5 185.2	548.4	5 744.4

Notes 1. Expenditure required for the rehabilitation of pavements to preserve mean roughness level (weighted by carriageway length) in each State over the period 1989 to 2000. Expenditure for routine maintenance and bridges is excluded.
2. Owing to rounding, figures may not add to totals.

Source BTE projections.

length in the years 1989 and 2000. Noteworthy results include:

- the length of unsealed and sealed one lane roads will change very little;
- over 1300 kilometres of sealed multilane road will be upgraded to divided road, approximately half being in NSW;
- approximately 70 per cent of the total expenditure will be devoted to rehabilitation; and
- there will be a significant change in the distribution of roughness, with fewer values occurring at the mean, and more values occurring at the extremes of very rough and very smooth.

TABLE III.10 PROJECTED STATUS OF NATIONAL HIGHWAYS: PRESERVATION OF OPERATIONAL PERFORMANCE, YEAR 2000

	Length (kilometres)						*Mean level of service[a] based on weighting by*		*Mean roughness[b] based on weighting by*	
		Sealed				*Mean traffic flow*				
State	*Unsealed*	*One lane*	*Multi-lane*	*Divided*	*Total*	*(aadt)*	*vkt*	*Length*	*vkt*	*Length*
NSW	0.0	0.0	826.8	518.7	1 345.5	14 322	3.4	3.8	72.8	81.2
Vic	0.0	0.0	316.8	381.0	697.8	8 666	4.8	4.7	59.7	69.0
Qld	0.0	26.3	3 577.4	328.9	3 932.5	4 196	4.0	4.3	79.5	95.5
SA	0.0	0.0	2 298.3	157.9	2 456.2	2 104	4.6	4.7	41.7	50.2
WA	75.7	267.5	4 253.1	50.3	4 646.5	606	4.7	4.9	59.2	67.0
Tas	0.0	0.0	265.2	54.1	319.3	6 672	4.1	4.2	64.4	65.9
NT	0.0	323.9	2 242.1	89.5	2 655.7	323	5.0	5.0	66.6	75.6
Australia	75.7	617.7	13 779.7	1 580.4	16 053.7	3 288	4.0	4.6	69.2	74.3

a. Level of service is measured on a scale of 1.0 to 5.0. See Appendix IV for details.
b. Measured in NAASRA roughness meter counts. For general purposes, a roughness count of less than 100 is good and a count of 140 or more is poor (National Association of Australian State Road Authorities 1984a). See Appendix IV for details.

Notes 1. Status as at 30th June, 2000.
2. Owing to rounding, figures may not add to totals.

Source BTE projections.

TABLE III.11 EXPENDITURE REQUIRED TO PRESERVE OPERATIONAL PERFORMANCE: PROJECT TYPE, NATIONAL HIGHWAYS, 1989 TO 2000 (CONSTANT 1985-1986 PRICES)

($ million)

	Rehabilitation[a]			*Upgrading*[b]				
	Sealed							
State	*Undivided*	*Divided*	*Sub-total*	*Widening of sealed pavements*	*Duplication*	*Other*	*Sub-total*	*Total*
NSW	110.6	118.9	229.5	16.8	6.0	84.2	107.1	336.6
Vic	11.3	88.8	100.1	0.0	14.7	7.6	22.3	122.4
Qld	176.9	92.0	269.0	48.9	155.5	103.0	307.4	576.4
SA	125.0	43.9	168.9	0.0	23.1	45.6	68.7	237.6
WA	142.5	5.5	148.0	1.4	45.5	0.2	47.1	195.1
Tas	34.7	30.1	64.8	0.0	13.8	0.3	14.1	78.9
NT	167.3	9.8	177.1	14.6	90.1	0.0	104.7	281.8
Australia	768.3	389.0	1 157.4	81.8	348.8	240.8	671.4	1 828.8

a. Expenditure not required for gravel surfaces.
b. Expenditure for widening of gravel pavements and construction of sealed pavements not required.

Notes 1. Road construction expenditure (excluding bridges) required to preserve the mean level of service in each State over the period 1989 to 2000.
2. Owing to rounding, figures may not add to totals.

Source BTE projections.

TABLE III.12 PROJECTED STATUS OF RURAL ARTERIALS, PRESERVATION OF OPERATIONAL PERFORMANCE, YEAR 2000

	Length (kilometres)						*Mean level of service[a] based on weighting by*		*Mean roughness[b] based on weighting by*	
		Sealed				*Mean traffic flow*				
State	*Unsealed*	*One lane*	*Multi-lane*	*Divided*	*Total*	*(aadt)*	*vkt*	*Length*	*vkt*	*Length*
NSW	8 015.1	204.3	18 546.3	942.5	27 708.1	1 217	4.4	4.7	84.4	114.5
Vic	298.0	209.1	13 413.6	461.0	14 381.8	1 411	4.6	4.6	62.6	86.5
Qld	2 157.5	4 552.5	10 913.1	329.6	17 952.6	984	4.4	4.7	83.2	108.2
SA	715.2	40.5	7 521.7	213.9	8 491.1	1 081	4.6	4.8	61.3	85.8
WA	4 040.0	1 715.8	10 081.8	242.2	16 079.8	630	4.7	4.9	60.0	89.7
Tas	203.5	27.2	2 078.7	61.3	2 370.7	1 171	4.5	4.6	71.8	92.6
NT	1 168.2	1 130.1	321.5	0.0	2 619.7	60	5.0	5.0	62.7	106.0
Australia	16 597.6	7 879.5	62 876.6	2 250.4	89 604.1	1 048	4.5	4.7	74.2	100.8

a. Level of service is measured on a scale of 1.0 (low) to 5.0 (high). See Appendix IV for details.
b. Measured in NAASRA roughness meter counts. For general purposes, a roughness count of less than 100 is good and a count of 140 or more is poor (National Association of Australian State Road Authorities 1984a). See Appendix IV for details.

Notes 1. Status as at 30th June, 2000.
2. Owing to rounding, figures may not add to totals.

Source BTE projections.

TABLE III.13 EXPENDITURE REQUIRED TO PRESERVE OPERATIONAL PERFORMANCE: PROJECT TYPE, RURAL ARTERIALS, 1989 TO 2000 (CONSTANT 1985-1986 PRICES)

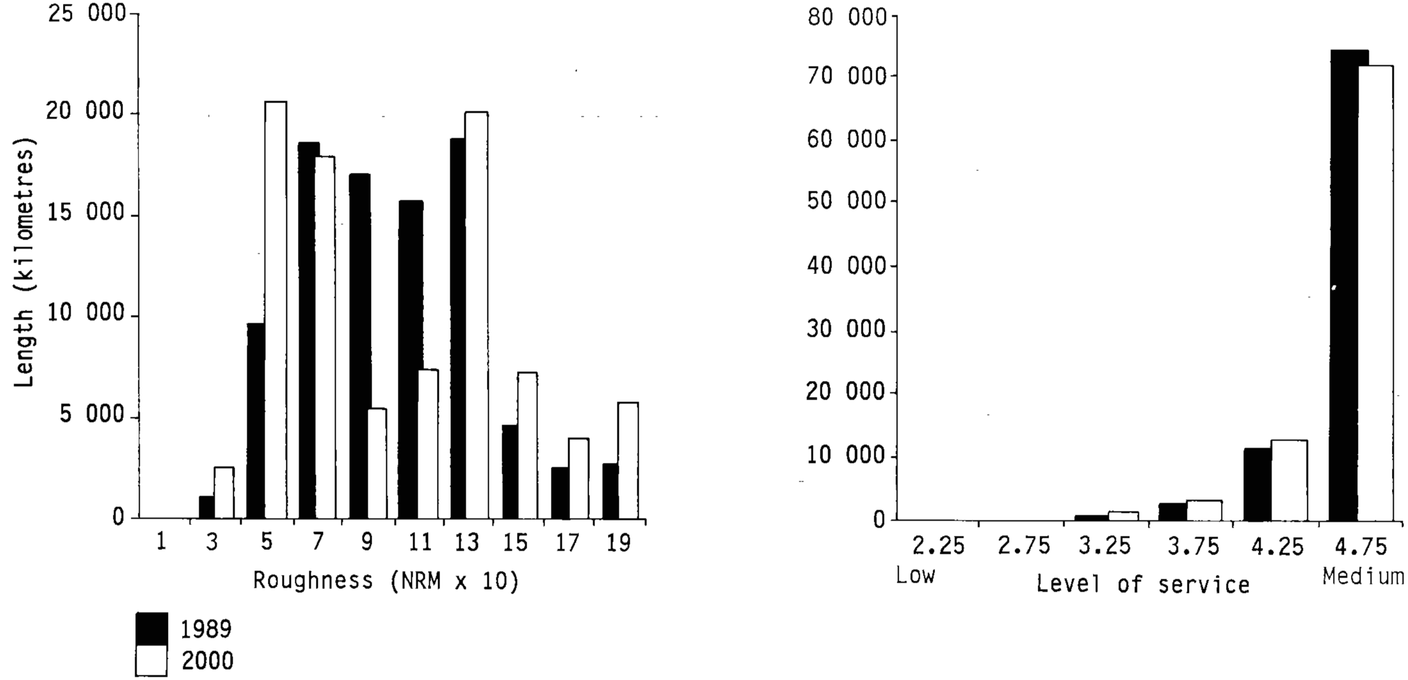
($ million)

	Rehabilitation				*Upgrading*[a]					
		Sealed								
State	*Gravel*	*Undivided*	*Divided*	*Sub-total*	*Construction of new sealed pavement*	*Widening of sealed pavements*	*Duplication*	*Other*	*Sub-total*	*Total*
NSW	0.0	1 313.7	277.9	1 591.6	0.9	220.0	611.1	65.4	897.4	2 489.0
Vic	0.0	991.8	94.1	1 085.9	0.0	23.5	201.4	8.2	233.2	1 319.1
Qld	0.0	618.4	80.2	698.7	0.0	137.1	291.6	35.8	464.5	1 163.2
SA	0.0	481.7	65.4	547.1	0.0	35.8	144.8	1.7	182.4	729.5
WA	0.0	473.7	17.9	491.6	0.0	5.5	182.8	0.3	188.5	680.2
Tas	0.0	190.7	20.9	211.6	1.3	21.7	40.9	0.0	64.0	275.5
NT	2.4	93.9	0.0	96.3	19.6	0.0	0.0	15.4	35.0	131.3
Australia	2.4	4 163.9	556.4	4 722.7	21.8	443.6	1 472.8	126.8	2 064.9	6 787.7

a. Expenditure for widening of gravel pavements not required.

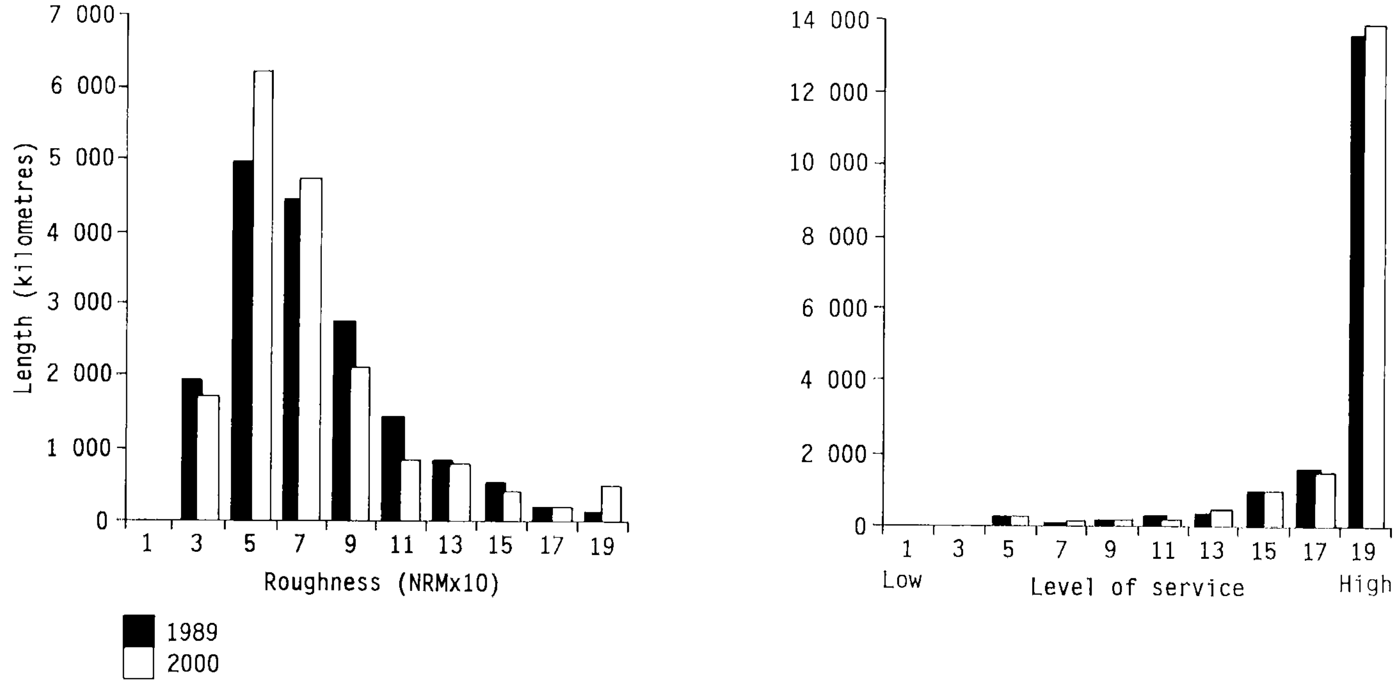
Notes 1. Road construction expenditure (excluding bridges) required to preserve the mean level of service in each State over the period 1989 to 2000.
2. Owing to rounding, figures may not add to totals.

Source BTE projections.



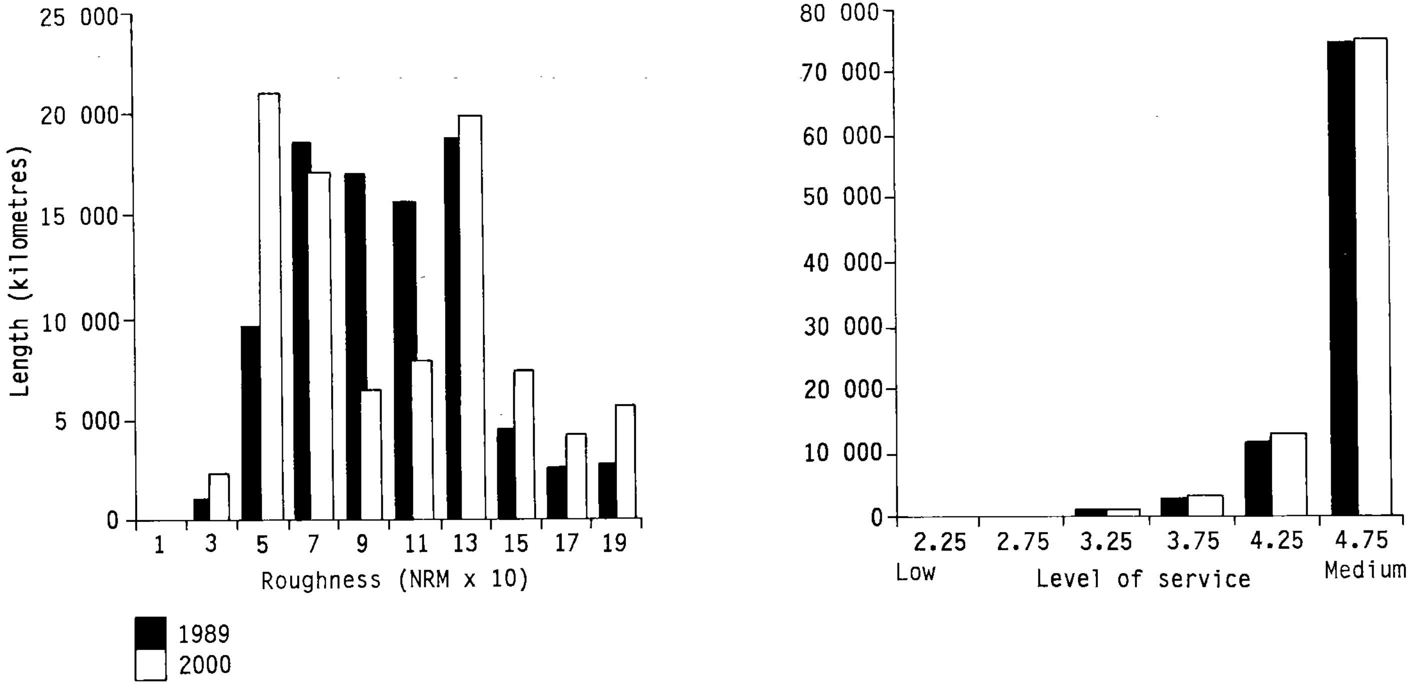
Source BTE projections.

Figure III.2 Preservation of the physical asset: change in distribution of roughness and level of service, rural arterials, 1989 and 2000



Source BTE projections.

Figure III.3 Preservation of operational performance: change in distribution of roughness and level of service, National Highways, 1989 and 2000



Source BTE projections.

Figure III.4 Preservation of operational performance: change in distribution of roughness and level of service, rural arterials, 1989 and 2000

Economic implications of road projects

National Highways

Table III.14 shows the projected status of National Highways in the year 2000 that would result from the construction of projects having various minimum levels of economic worth. Table III.15 presents the associated expenditure for each type of construction project. Figures III.5 and III.6 illustrate the distribution of roughness and level of service by road length in the years 1989 and 2000. Noteworthy features are:

- some 76 kilometres will remain unsealed at the year 2000 under all project bcr constraints;
- there will be no significant change in the length of one lane sealed roads from 1989 to 2000 under all bcr constraints;
- the length of duplication projects under the constraints of a minimum project bcr of 0.5 would be double that under the constraint of a minimum project bcr of 3.0;
- the share of expenditure that would be devoted to upgrading projects would increase as the minimum project bcr increases;
- there would be an increase in the average roughness of National Highways under project bcr contraints of 2.0 or 3.0; and
- there would be an improvement in the level of service under all project bcr constraints.

Rural arterials

Table III.16 shows the projected status of rural aterials in the year 2000, that would result from the construction of projects having various minimum levels of economic worth. Table III.17 presents the associated expenditure for each type of construction project. Figures III.7 and III.8 illustrate the distribution of roughness and level of service, respectively, by road length in the years 1989 and 2000. Noteworthy results of this analysis include:

- the amount of divided road would double by the year 2000 under a minimum project bcr constraint of unity, but the increase would be appreciably less under a minimum project bcr constraint of 3.0;
- the length of unsealed road would be relatively insensitive to the minimum project bcr constraint;
- approximately one-third of all expenditure would be spent on duplication projects under all minimum project bcr constraints;
- the overall construction expenditure would be very sensitive to the minimum project bcr constraint;

- average roughness level would be very sensitive to changes in minimum project bcr constraint; and
- level of service is relatively insensitive to minimum project bcr constraint.

Funding scenarios

National Highways

Tables III.18 and III.19 show the projected status of National Highways in the year 2000 which would result from the construction of sufficient projects to expend both the upper and lower funding levels. Tables III.20 and III.21 present the associated expenditure for each type of construction project. Figures III.9 and III.10 illustrate the distribution of roughness and level of service, respectively, by road length in the years 1989 and 2000. Noteworthy results of this analysis include:

- both scenarios result in significantly more duplicated highways, in 2000, compared to 1989;
- there would be a significant improvement in the mean roughness and level of service for Australia as a whole between 1989 and the year 2000 under the upper funding scenario, but conditions would remain stable under the lower funding scenario;
- National Highways in New South Wales and Victoria show a significant decrease over the period in their mean roughness under both funding scenarios; and
- under both funding scenarios approximately 65 per cent of expenditure would be devoted to upgrading projects.

Rural arterials

Table III.22 and III.23 show the status of rural arterials in the year 2000 for the upper and lower funding scenarios, respectively. Tables III.24 and III.25 represent the corresponding expenditure by project type for the upper and lower funding levels, respectively. Figures III.11 and III.12 illustrate the associated distribution of roughness and level of service, respectively, by road length in the years 1989 and 2000. Noteworthy results of this analysis include the following changes between 1989 and 2000:

- there would be a significant increase in the amount of divided road under both funding scenarios;
- the mean roughness level would increase significantly under both funding scenarios; and
- the distribution of roughness would change appreciably under both funding scenarios, resulting in greater proportions of the length having higher roughness levels by the year 2000.

TABLE III.14 PROJECTED STATUS OF NATIONAL HIGHWAYS UNDER PROJECT BENEFIT-COST RATIO CONSTRAINTS, YEAR 2000

State	*Length (kilometres)*					*Mean traffic flow (aadt)*	*Mean level of service[a] based on weighting by*		*Mean roughness[b] based on weighting by*	
		Sealed								
	Unsealed	*One lane*	*Multi-lane*	*Divided*	*Total*		*vkt*	*Length*	*vkt*	*Length*
				Minimum bcr = 0.5						
NSW	0.0	0.0	204.3	1 141.2	1 345.5	14 322	4.7	4.8	50.0	54.3
Vic	0.0	0.0	207.5	490.3	697.8	8 666	4.9	4.9	48.1	49.1
Qld	0.0	26.3	3 061.9	844.3	3 932.5	4 196	4.6	4.7	66.5	82.3
SA	0.0	0.0	2 213.0	243.2	2 456.2	2 104	4.7	4.8	42.6	50.4
WA	75.7	267.5	4 252.4	51.0	4 646.6	606	4.7	4.9	62.2	70.9
Tas	0.0	0.0	170.4	148.9	319.3	6 672	4.7	4.7	45.9	47.3
NT	0.0	380.6	2 252.5	22.4	2 655.7	323	5.0	5.0	60.6	60.9
Australia	75.7	674.4	12 362.2	2 941.3	16 053.7	3 288	4.7	4.8	54.9	65.3

TABLE III.14 (Cont.) PROJECTED STATUS OF NATIONAL HIGHWAYS UNDER PROJECT BENEFIT-COST RATIO CONSTRAINTS, YEAR 2000

	Length (kilometres)						*Mean level of service[a] based on weighting by*		*Mean roughness[b] based on weighting by*	
		Sealed				*Mean traffic flow*				
State	*Unsealed*	*One lane*	*Multi-lane*	*Divided*	*Total*	*(aadt)*	*vkt*	*Length*	*vkt*	*Length*
				Minimum bcr = 1.0						
NSW	0.0	0.0	369.8	975.7	1 345.5	14 322	4.6	4.7	54.7	64.6
Vic	0.0	0.0	250.7	447.1	697.8	8 666	4.9	4.8	50.3	53.6
Qld	0.0	26.3	3 425.6	480.6	3 932.5	4 196	4.3	4.5	76.4	97.8
SA	0.0	0.0	2 303.3	152.9	2 456.2	2 104	4.6	4.7	49.6	58.5
WA	75.7	267.5	4 261.7	41.6	4 646.6	606	4.7	4.9	70.7	84.0
Tas	0.0	0.0	204.4	114.9	319.3	6 672	4.6	4.6	55.6	59.0
NT	0.0	380.6	2 252.5	22.4	2 655.7	323	5.0	5.0	65.9	70.1
Australia	75.7	674.4	13 068.1	2 235.2	16 053.7	3 288	4.6	4.7	61.6	76.7

TABLE III.14 (Cont.) PROJECTED STATUS OF NATIONAL HIGHWAYS UNDER PROJECT BENEFIT-COST RATIO CONSTRAINTS, YEAR 2000

	Length (kilometres)						Mean level of service[a] based on weighting by		Mean roughness[b] based on weighting by	
		Sealed				Mean traffic flow				
State	*Unsealed*	*One lane*	*Multi-lane*	*Divided*	*Total*	*(aadt)*	*vkt*	*Length*	*vkt*	*Length*
				Minimum project bcr = 2.0						
NSW	0.0	0.0	523.4	822.1	1 345.5	14 322	4.5	4.5	62.9	77.4
Vic	0.0	0.0	326.6	371.2	697.8	8 666	4.8	4.7	60.3	68.9
Qld	0.0	26.3	3 596.5	309.7	3 932.5	4 196	4.0	4.3	89.5	115.1
SA	0.0	0.0	2 321.8	134.4	2 456.2	2 104	4.4	4.7	63.6	71.6
WA	75.7	272.8	4 283.1	14.9	4 646.6	606	4.5	4.9	103.6	103.5
Tas	0.0	0.0	250.4	68.9	319.3	6 672	4.3	4.3	75.5	81.5
NT	0.0	380.6	2 252.5	22.4	2 655.7	323	5.0	5.0	75.2	86.4
Australia	75.7	679.7	13 554.3	1743.6	16 053.7	3 288	4.4	4.7	73.9	93.3

TABLE III.14 (Cont.) PROJECTED STATUS OF NATIONAL HIGHWAYS UNDER PROJECT BENEFIT-COST RATIO CONSTRAINTS, YEAR 2000

	Length (kilometres)						*Mean level of service[a] based on weighting by*		*Mean roughness[b] based on weighting by*	
		Sealed				*Mean traffic flow*				
State	*Unsealed*	*One lane*	*Multi-lane*	*Divided*	*Total*	*(aadt)*	*vkt*	*Length*	*vkt*	*Length*
				Minimum bcr = 3.0						
NSW	0.0	0.0	621.4	724.1	1 345.5	14 322	4.3	4.3	72.1	90.8
Vic	0.0	0.0	327.5	370.3	697.8	8 666	4.7	4.7	66.9	79.0
Qld	0.0	26.3	3 648.3	258.0	3 932.5	4 196	3.8	4.2	97.2	122.1
SA	0.0	0.0	2 322.3	133.9	2 456.2	2 104	4.4	4.7	70.0	74.6
WA	75.7	272.8	4 289.3	8.7	4 646.6	606	4.4	4.9	116.4	107.8
Tas	0.0	0.0	265.2	54.1	319.3	6 672	4.1	4.2	86.5	92.6
NT	0.0	380.6	2 252.5	22.4	2 655.7	323	5.0	5.0	82.6	96.7
Australia	75.7	679.7	13 726.5	1 571.5	16 053.7	3 288	4.2	4.6	82.3	100.6

a. Level of service is measured on a scale of 1.0 to 5.0. See Appendix IV for details.
b. Measured in NAASRA roughness meter counts. For general purposes, a roughness count of less than 100 is good and a count of 140 or more is poor (National Association of Australian State Road Authorities 1984a). See Appendix IV for details.

Notes 1. Status as at 30th June, 2000.
2. Owing to rounding, figures may not add to totals.

Source BTE projections.

TABLE III.15 EXPENDITURE UNDER PROJECT BENEFIT-COST RATIO CONSTRAINTS: PROJECT TYPE, NATIONAL HIGHWAYS, 1989 TO 2000 (CONSTANT 1985-86 PRICES)

($ million)

	Rehabilitation[a]			*Upgrading*[b]				
	Sealed							
State	*Undivided*	*Divided*	*Sub-total*	*Widening of sealed pavements*	*Duplication*	*Other*	*Sub-total*	*Total*
				Minimum bcr = 0.5				
NSW	14.1	309.7	323.8	42.6	718.9	301.2	1 062.6	1 386.5
Vic	30.8	112.5	143.3	0.0	130.5	9.6	140.1	283.4
Qld	269.5	227.2	496.7	103.8	929.6	126.5	1 159.9	1 656.5
SA	121.6	47.6	169.1	0.0	88.6	51.9	140.5	309.6
WA	129.9	4.7	134.7	1.4	46.2	0.2	47.8	182.5
Tas	83.9	92.5	176.4	0.0	118.2	0.3	118.4	294.9
NT	339.8	3.6	343.4	0.0	0.0	0.0	0.0	343.4
Australia	989.6	797.8	1 787.5	147.8	2 032.0	489.5	2 669.3	4 456.8

TABLE III.15 (Cont.) EXPENDITURE UNDER PROJECT BENEFIT-COST RATIO CONSTRAINTS, BY PROJECT TYPE: NATIONAL HIGHWAYS, 1989 TO 2000 (CONSTANT 1985-86 PRICES)

($ million)

	Rehabilitation[a]			*Upgrading*[b]				
	Sealed							
State	*Undivided*	*Divided*	*Sub-total*	*Widening of sealed pavements*	*Duplication*	*Other*	*Sub-total*	*Total*
				Minimum bcr = 1.0				
NSW	6.6	199.1	205.8	39.6	539.9	278.6	858.1	1 063.8
Vic	22.2	107.1	129.3	0.0	84.9	9.6	94.5	223.8
Qld	122.1	105.5	227.5	85.2	397.3	119.6	602.1	829.6
SA	88.0	12.9	100.9	0.0	19.1	42.9	62.0	162.9
WA	80.7	4.2	84.9	1.4	35.4	.2	37.0	121.9
Tas	39.6	49.9	89.5	0.0	81.0	.3	81.3	170.8
NT	219.2	2.3	221.6	0.0	0.0	0.0	0.0	221.6
Australia	578.5	481.0	1 059.5	126.2	1 157.6	451.2	1 735.0	2 794.4

TABLE III.15 (Cont.) EXPENDITURE UNDER PROJECT BENEFIT-COST RATIO CONSTRAINTS: BY PROJECT TYPE, NATIONAL HIGHWAYS, 1989 TO 2000 (CONSTANT 1985-86 PRICES)

($ million)

	Rehabilitation[a]			*Upgrading*[b]				
	Sealed							
State	*Undivided*	*Divided*	*Sub-total*	*Widening of sealed pavements*	*Duplication*	*Other*	*Sub-total*	*Total*
				Minimum bcr = 2.0				
NSW	3.4	83.6	87.0	39.1	347.9	248.7	635.7	722.7
Vic	13.8	89.7	103.5	0.0	4.3	7.4	11.6	115.1
Qld	37.3	50.9	88.2	39.3	123.6	97.4	260.3	348.4
SA	19.2	11.0	30.2	0.0	3.8	22.6	26.4	56.5
WA	19.3	1.0	20.3	0.8	6.0	0.1	6.9	27.2
Tas	9.3	11.9	21.2	0.0	29.6	0.3	29.8	51.0
NT	127.2	1.7	129.0	0.0	0.0	0.0	0.0	129.0
Australia	229.5	249.7	479.2	79.1	515.2	376.4	970.7	1 449.9

TABLE III.15 (Cont.) EXPENDITURE UNDER PROJECT BENEFIT-COST RATIO CONSTRAINTS: BY PROJECT TYPE, NATIONAL HIGHWAYS, 1989 TO 2000 (CONSTANT 1985-86 PRICES)

($ million)

	Rehabilitation[a]			*Upgrading*[b]				
	Sealed							
State	*Undivided*	*Divided*	*Sub-total*	*Widening of sealed pavements*	*Duplication*	*Other*	*Sub-total*	*Total*
				Minimum bcr = 3.0				
NSW	.5	43.7	44.2	34.2	228.0	197.5	459.7	503.9
Vic	8.6	69.8	78.3	0.0	3.2	2.8	6.0	84.4
Qld	9.1	25.2	34.4	12.2	38.6	70.6	121.4	155.8
SA	3.3	6.2	9.5	0.0	3.2	17.1	20.3	29.8
WA	4.8	0.7	5.5	0.8	0.1	0.1	0.9	6.4
Tas	1.6	4.4	5.9	0.0	13.8	.3	14.1	20.0
NT	83.2	1.7	84.9	0.0	0.0	0.0	0.0	84.9
Australia	111.0	151.7	262.7	47.2	286.9	288.4	622.5	885.2

a. No expenditure required on gravel surfaces at these bcr levels.
b. No expenditure required on widening of gravel pavements and construction of new sealed pavements at these bcr levels.

Notes 1. Expenditure on road construction (excluding bridges) for projects having a minimum specified bcr.
2. Owing to rounding, figures may not add to totals.

Source BTE projections.

TABLE III.16 PROJECTED STATUS OF RURAL ARTERIALS UNDER PROJECT BENEFIT-COST RATIO CONSTRAINTS, YEAR 2000

	Length (kilometres)						Mean level of service[a] based on weighting by		Mean roughness[b] based on weighting by	
		Sealed				Mean traffic flow				
State	*Unsealed*	*One lane*	*Multi-lane*	*Divided*	*Total*	*(aadt)*	*vkt*	*Length*	*vkt*	*Length*
					Minimum bcr = 0.5					
NSW	7 721.4	52.2	18 116.5	1 818.1	27 708.1	1 217	4.6	4.7	68.9	101.3
Vic	288.6	137.1	13 106.6	849.4	14 381.8	1 411	4.7	4.7	54.8	76.5
Qld	2 157.5	4 531.3	10 713.0	550.9	17 952.6	984	4.6	4.8	79.0	105.4
SA	715.2	40.5	7 482.0	253.6	8 491.1	1 081	4.7	4.8	56.3	78.2
WA	4 040.0	1 712.7	10 079.0	248.1	16 079.8	630	4.7	4.9	61.7	91.1
Tas	204.7	27.2	2 088.8	50.0	2 370.7	1 171	4.5	4.6	69.5	85.0
NT	1 145.7	1 130.1	344.0	0.0	2 619.7	60	5.0	5.0	70.7	117.3
Australia	16 273.1	7 631.1	61 929.8	3 770.1	89 604.1	1 048	4.6	4.8	65.8	94.2

TABLE III.16 (Cont.) PROJECTED STATUS OF RURAL ARTERIALS UNDER PROJECT BENEFIT-COST RATIO CONSTRAINTS, YEAR 2000

	Length (kilometres)						*Mean level of service[a] based on weighting by*		*Mean roughness[b] based on weighting by*	
		Sealed				*Mean traffic flow*				
State	*Unsealed*	*One lane*	*Multi-lane*	*Divided*	*Total*	*(aadt)*	*vkt*	*Length*	*vkt*	*Length*
Minimum bcr = 1.0										
NSW	8 001.5	173.5	18 285.3	1 247.9	27 708.1	1 217	4.5	4.7	86.5	124.4
Vic	291.4	192.8	13 254.7	642.8	14 381.8	1 411	4.6	4.7	70.0	105.0
Qld	2 157.5	4 553.0	10 923.4	318.8	17 953.6	984	4.4	4.7	92.2	121.5
SA	715.2	40.5	7 602.1	133.4	8 491.1	1 081	4.6	4.8	81.2	103.1
WA	4 040.0	1 732.1	10 158.3	149.5	16 079.8	630	4.6	4.8	77.1	110.5
Tas	210.2	27.2	2 104.0	29.4	2 370.7	1 171	4.4	4.6	87.9	111.4
NT	1 238.0	1 130.1	251.8	0.0	2 619.7	60	5.0	5.0	77.1	124.3
Australia	16 653.7	7 849.7	62 579.6	2 521.7	89 604.1	1 048	4.5	4.7	82.5	115.9

TABLE III.16 (Cont.) PROJECTED STATUS OF RURAL ARTERIALS UNDER PROJECT BENEFIT-COST RATIO CONSTRAINTS, YEAR 2000

	Length (kilometres)						*Mean level of service*[a] *based on weighting by*		*Mean roughness*[b] *based on weighting by*	
		Sealed				*Mean traffic flow*				
State	*Unsealed*	*One lane*	*Multi-lane*	*Divided*	*Total*	*(aadt)*	*vkt*	*Length*	*vkt*	*Length*
Minimum bcr = 2.0										
NSW	8 018.6	234.8	18 713.9	740.9	27 708.1	1 217	4.3	4.7	116.6	147.1
Vic	298.0	217.5	13 475.6	390.6	14 381.8	1 411	4.5	4.7	96.7	129.3
Qld	2 157.5	4 579.1	11 054.5	161.7	17 952.6	984	4.1	4.7	113.0	137.2
SA	715.2	40.5	7 641.1	94.4	8 491.1	1 081	4.5	4.7	110.0	120.2
WA	4 040.0	1 738.4	10 245.5	56.0	16 079.8	630	4.4	4.8	96.3	121.8
Tas	210.2	27.2	1 219.3	23.7	2 370.7	1 171	4.4	4.6	110.8	128.1
NT	1 304.3	1 130.1	185.4	0.0	2 619.7	60	5.0	5.0	85.5	129.0
Australia	16 743.8	7 967.6	63 425.3	1 467.3	89 604.1	1 048	4.3	4.7	108.6	134.2

TABLE III.16 (Cont.) PROJECTED STATUS OF RURAL ARTERIALS UNDER PROJECT BENEFIT-COST RATIO CONSTRAINTS, YEAR 2000

	Length (kilometres)						Mean level of service[a] based on weighting by		Mean roughness[b] based on weighting by	
		Sealed				Mean traffic flow				
State	*Unsealed*	*One lane*	*Multi-lane*	*Divided*	*Total*	*(aadt)*	*vkt*	*Length*	*vkt*	*Length*
					Minimum bcr = 3.0					
NSW	8 021.2	235.8	18 960.1	491.2	27 708.1	1 217	4.2	4.6	141.3	158.2
Vic	298.0	228.6	13 563.3	291.7	14 381.8	1 411	4.4	4.6	111.7	137.8
Qld	2 157.5	4 587.5	11 061.5	146.3	17 952.6	984	4.0	4.7	116.6	138.5
SA	715.2	40.5	7 643.0	92.6	8 491.1	1 081	4.5	4.7	115.5	122.2
WA	4 040.0	1 739.0	10 252.3	48.6	16 079.8	630	4.4	4.8	105.4	125.0
Tas	210.2	27.2	2 109.6	23.7	2 370.7	1 171	4.4	4.6	112.4	128.4
NT	1 304.3	1 130.1	185.4	0.0	2 619.7	60	5.0	5.0	92.5	133.6
Australia	16 746.4	7 988.6	63 775.2	1 094.0	89 604.1	1 048	4.2	4.7	122.9	140.1

a. Level of service is measured on a scale of 1.0 to 5.0. See Appendix IV for details.

b. Measured in NAASRA roughness meter counts. For general purposes, a roughness count of less than 100 is good and a count of 140 or more is poor (National Association of Australian State Road Authorities 1984a). See Appendix IV for details.

Notes 1. Status as at 30th June, 2000.
2. Owing to rounding, figures may not add to totals.

Source BTE projections.

TABLE III.17 EXPENDITURE UNDER BENEFIT-COST RATIO CONSTRAINTS: BY PROJECT TYPE, RURAL ARTERIALS, 1989 TO 2000 (CONSTANT 1985-86 PRICES)

($ million)

State	*Rehabilitation*				*Upgrading*						
	Resheet gravel	*Sealed*		*Sub-Total*	*Widening of gravel pavements*	*Construction of new sealed pavement*	*Widening of sealed pavements*	*Duplication*	*Other*	*Sub-Total*	*Total*
		Undivided	*Divided*								
					Minimum bcr = 0.5						
NSW	0.2	1 507.8	493.0	2 001.0	2.1	46.1	525.1	1 669.8	106.1	2 349.3	4 350.3
Vic	0.0	1 114.6	88.4	1 203.0	0.0	1.6	55.3	602.9	11.2	671.1	1 874.1
Qld	0.0	819.3	167.7	987.0	0.0	0.0	235.0	608.1	36.7	879.8	1 866.9
SA	0.0	623.9	78.6	702.5	0.0	0.0	34.0	191.4	0.0	225.4	927.9
WA	0.0	449.4	17.7	467.1	0.0	0.0	5.7	187.3	1.4	194.4	661.4
Tas	0.0	267.5	29.5	297.0	0.0	1.1	21.7	28.4	0.0	51.2	348.2
NT	2.0	64.6	0.0	66.6	0.0	22.8	0.0	0.0	14.9	37.8	104.4
Australia	2.1	4 847.1	874.9	5 724.1	2.1	71.7	876.9	3 287.9	170.4	4 409.0	10 133.1

TABLE III.17 (Cont.) EXPENDITURE UNDER BENEFIT-COST RATIO CONSTRAINTS: BY PROJECT TYPE, RURAL ARTERIALS, 1989 TO 2000 (CONSTANT 1985-86 PRICES)

($ million)

	Rehabilitation				*Upgrading*						
		Sealed									
State	*Resheet gravel*	*Undivided*	*Divided*	*Sub-total*	*Widening of gravel pavements*	*Construction of new sealed pavement*	*Widening of sealed pavements*	*Duplication*	*Other*	*Sub-total*	*Total*
					Minimum bcr = 1.0						
NSW	0.2	740.2	251.9	992.2	0.0	2.8	347.5	963.4	82.7	1 396.5	2 388.7
Vic	0.0	574.6	55.2	629.8	0.0	1.2	41.0	394.2	10.6	447.0	1 076.9
Qld	0.0	322.3	70.8	393.1	0.0	0.0	129.1	274.7	34.7	438.5	831.6
SA	0.0	243.0	37.7	280.7	0.0	0.0	20.7	48.1	0.0	68.8	349.5
WA	0.0	182.5	9.9	192.5	0.0	0.0	0.7	94.1	0.1	94.9	287.4
Tas	0.0	81.4	11.6	93.0	0.0	0.0	3.5	6.2	0.0	9.6	102.7
NT	0.0	39.6	0.0	39.6	0.0	9.2	0.0	0.0	5.7	14.9	54.5
Australia	0.2	2 183.5	437.2	2 620.9	0.0	13.3	542.5	1 780.7	133.8	2 470.3	5 091.2

TABLE III.17 (Cont.) EXPENDITURE UNDER BENEFIT-COST RATIO CONSTRAINTS: PROJECT TYPE, RURAL ARTERIALS, 1989 TO 2000 (CONSTANT 1985-86 PRICES)

($ million)

	Rehabilitation				*Upgrading*						
		Sealed									
State	*Resheet gravel*	*Undivided*	*Divided*	*Sub-total*	*Widening of gravel pavements*	*Construction of new sealed pavement*	*Widening of sealed pavements*	*Duplication*	*Other*	*Sub-total*	*Total*
					Minimum bcr = 2.0						
NSW	0.0	243.0	69.2	312.2	0.0	0.3	138.3	399.5	37.2	575.3	887.5
Vic	0.0	170.9	27.4	198.3	0.0	0.0	14.3	123.9	4.7	142.9	341.2
Qld	0.0	20.7	14.3	35.0	0.0	0.0	16.3	28.2	19.1	63.5	98.5
SA	0.0	29.1	3.3	32.4	0.0	0.0	1.3	1.6	0.0	2.9	35.3
WA	0.0	48.8	3.7	52.5	0.0	0.0	0.1	6.3	0.0	6.4	58.9
Tas	0.0	0.6	2.7	3.3	0.0	0.0	0.0	0.0	0.0	0.0	3.3
NT	0.0	22.9	0.0	22.9	0.0	0.0	0.0	0.0	0.9	0.9	23.8
Australia	0.0	536.0	120.5	656.5	0.0	0.3	170.2	559.5	61.9	791.9	1 448.5

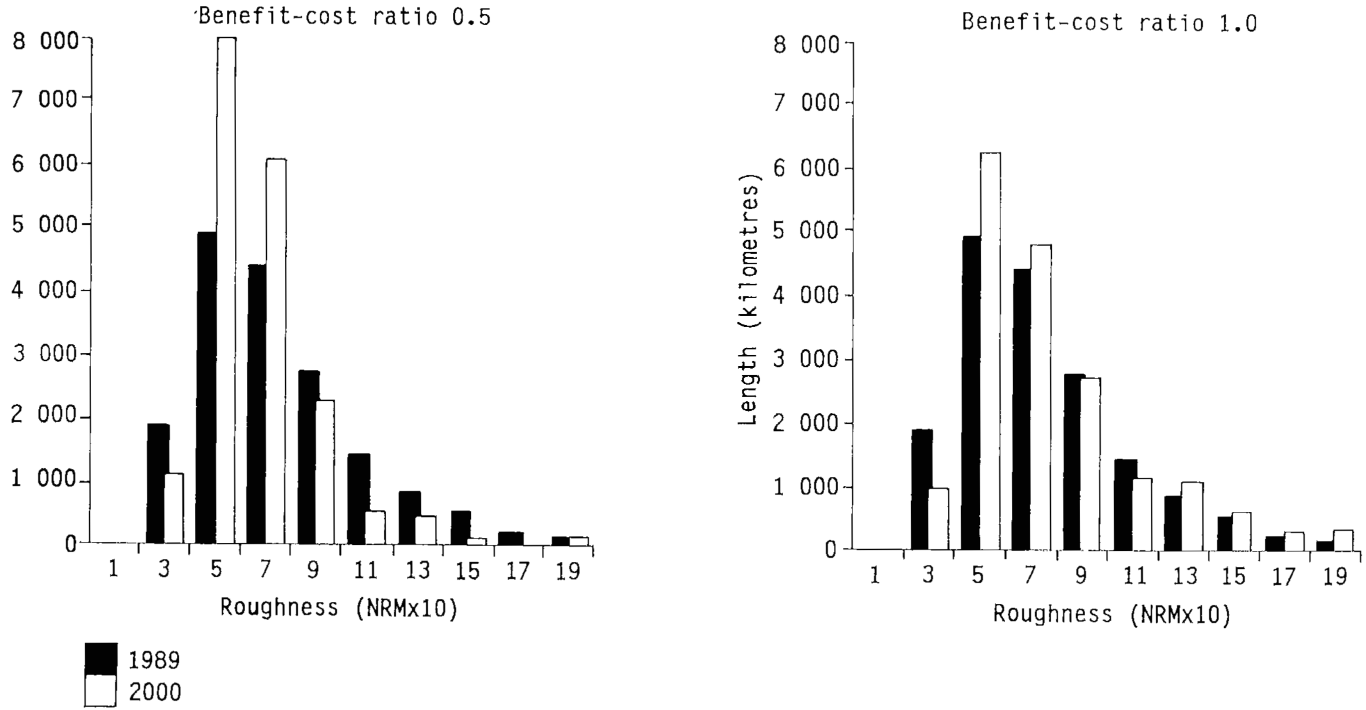
TABLE III.17 (Cont.) EXPENDITURE UNDER BENEFIT-COST RATIO CONSTRAINTS: PROJECT TYPE, RURAL ARTERIALS, 1989 TO 2000 (CONSTANT 1985-86 PRICES)

($ million)

	Rehabilitation				Upgrading						
		Sealed									
State	*Resheet gravel*	*Undivided*	*Divided*	*Sub-total*	*Widening of gravel pavements*	*Construction of new sealed pavement*	*Widening of sealed pavements*	*Duplication*	*Other*	*Sub-total*	*Total*
					Minimum bcr = 3.0						
NSW	0.0	57.3	18.0	75.3	0.0	0.0	43.0	114.5	28.6	186.1	261.5
Vic	0.0	44.9	12.7	57.6	0.0	0.0	6.8	15.3	0.4	22.5	80.1
Qld	0.0	0.8	4.8	5.6	0.0	0.0	0.9	0.0	8.5	9.4	15.0
SA	0.0	1.0	0.0	1.0	0.0	0.0	0.2	0.0	0.0	0.2	1.2
WA	0.0	8.7	1.4	10.0	0.0	0.0	0.0	0.0	0.0	0.0	10.1
Tas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NT	0.0	9.7	0.0	9.7	0.0	0.0	0.0	0.0	0.0	0.0	9.7
Australia	0.0	122.4	36.9	159.3	0.0	0.0	50.9	129.9	37.5	218.3	377.6

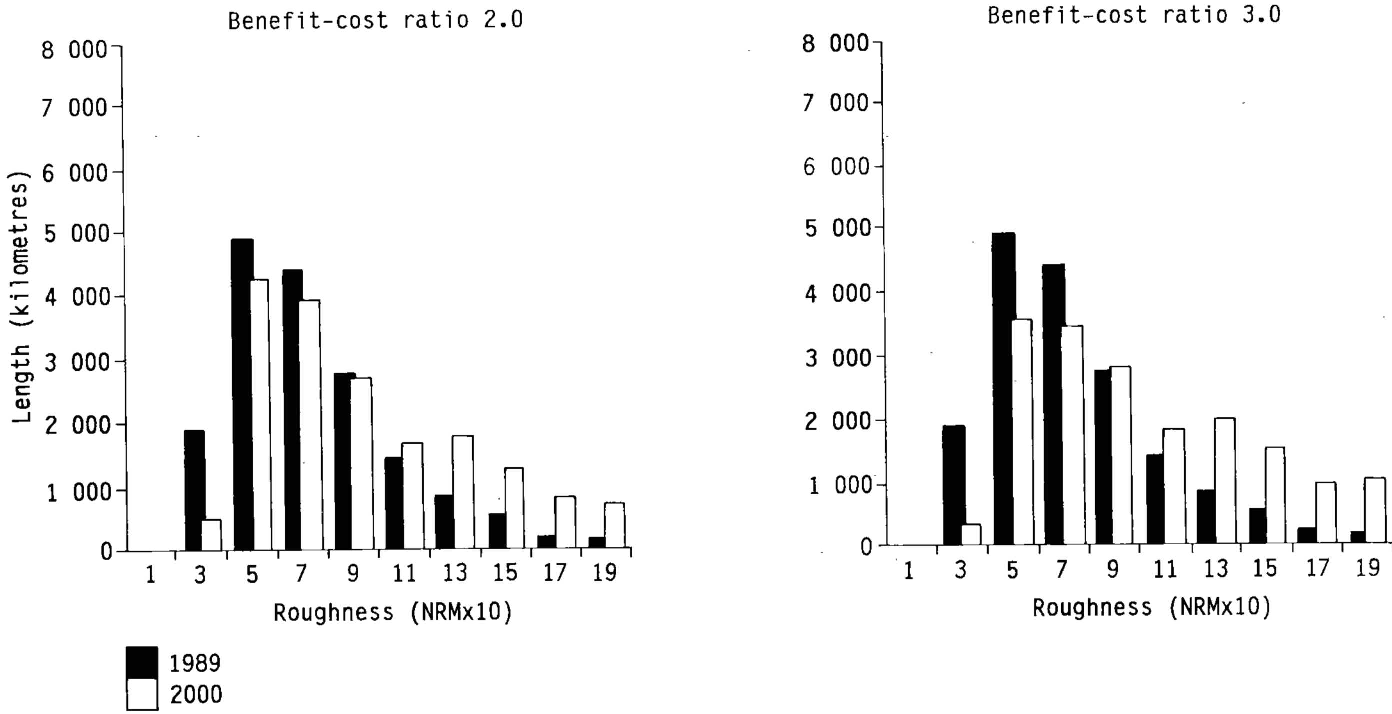
Note Owing to rounding, figures may not add to totals.

Source BTE projections.



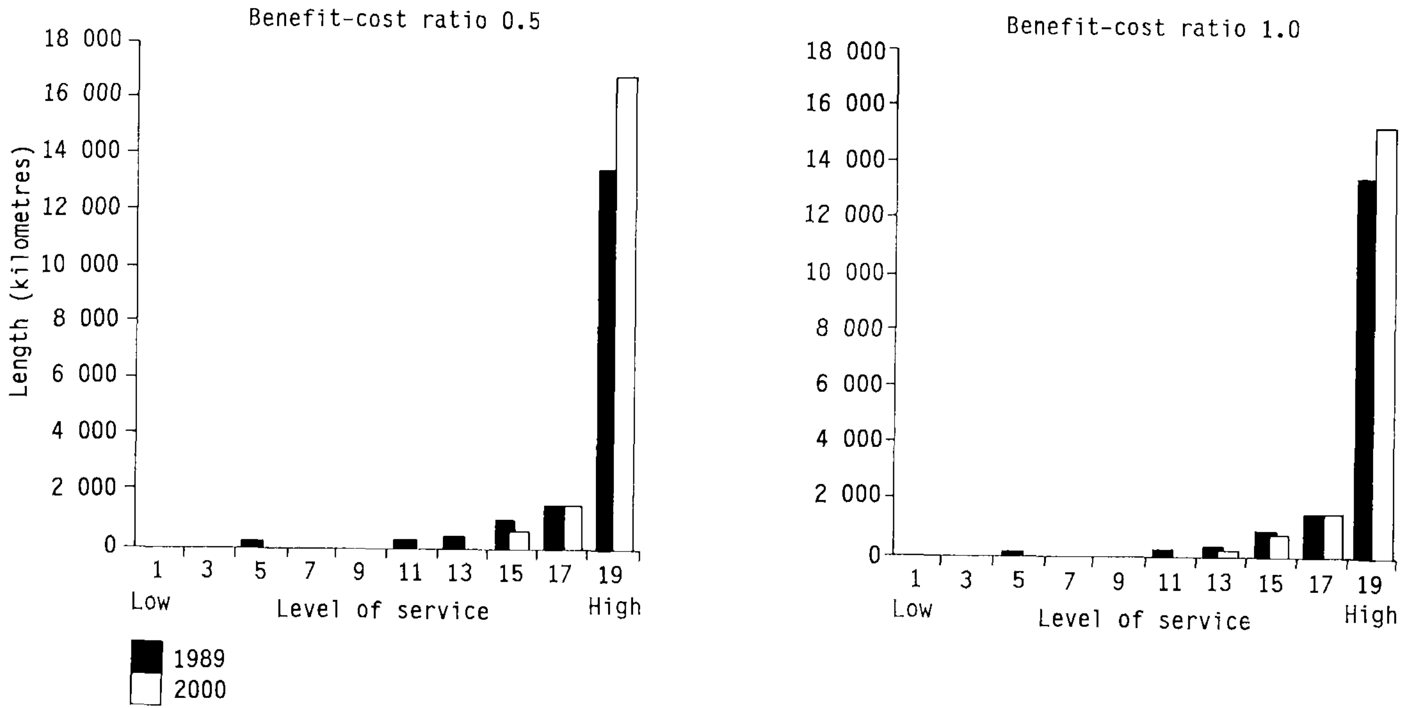
Source BTE projections.

Figure III.5 Length of road by roughness: selected levels of economic justification, National Highways, 1989 and 2000



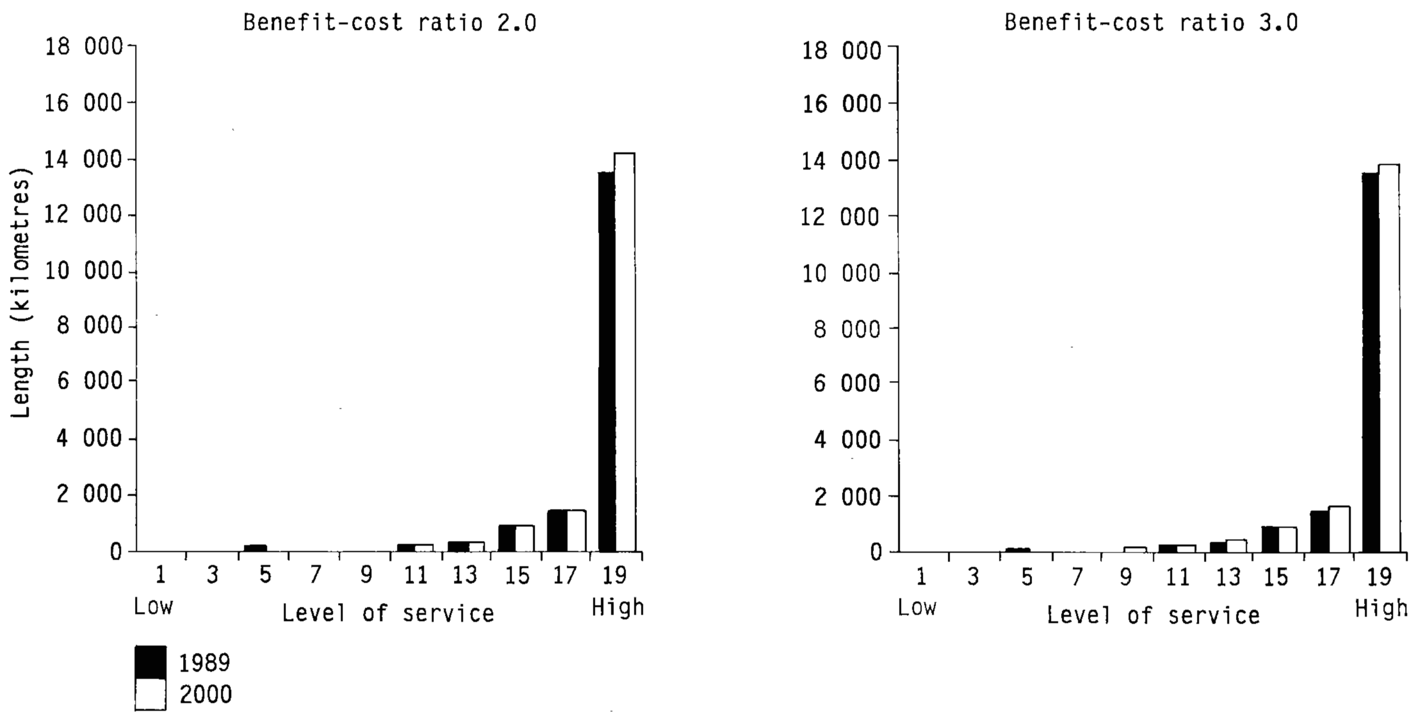
Source BTE projections.

Figure III.5 (Cont.) Length of road by roughness: selected levels of economic justification, National Highways, 1989 and 2000



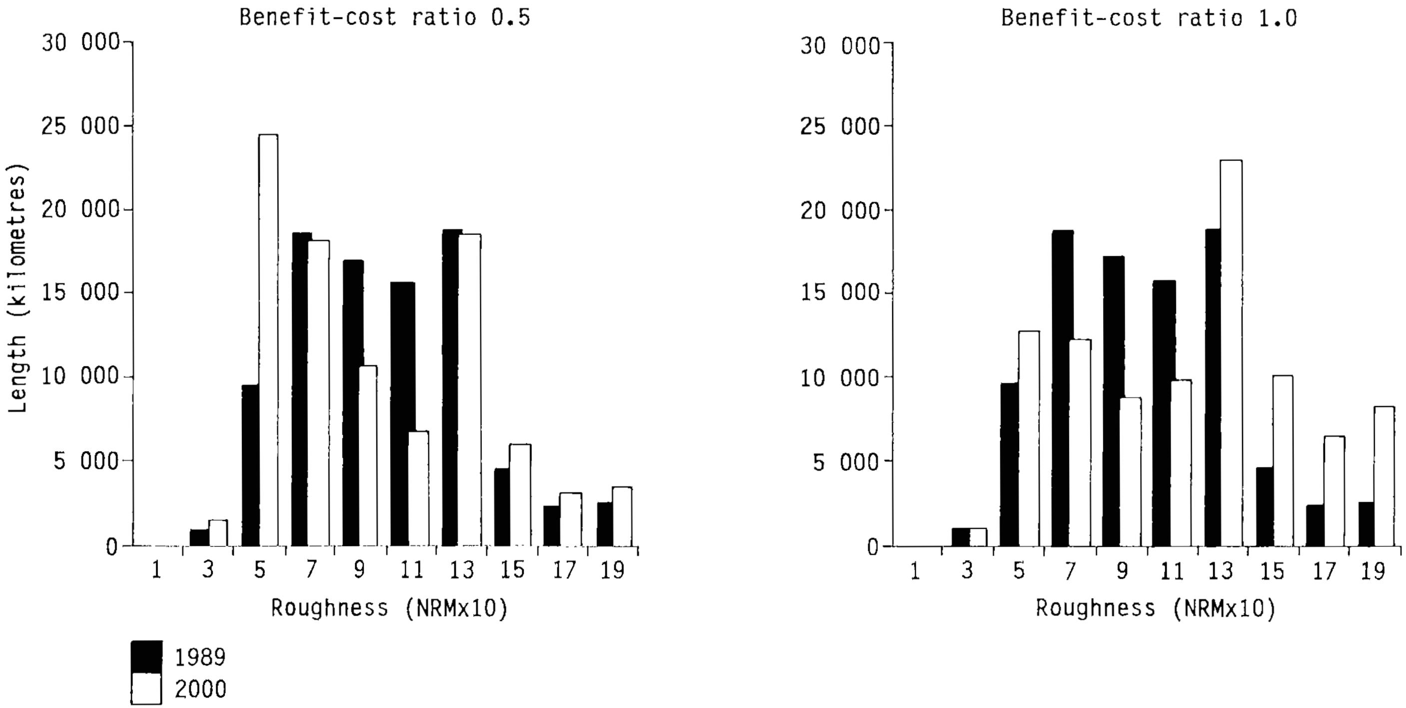
Source BTE projections.

Figure III.6 Length of road by level of service: selected levels of economic justification, National Highways, 1989 and 2000



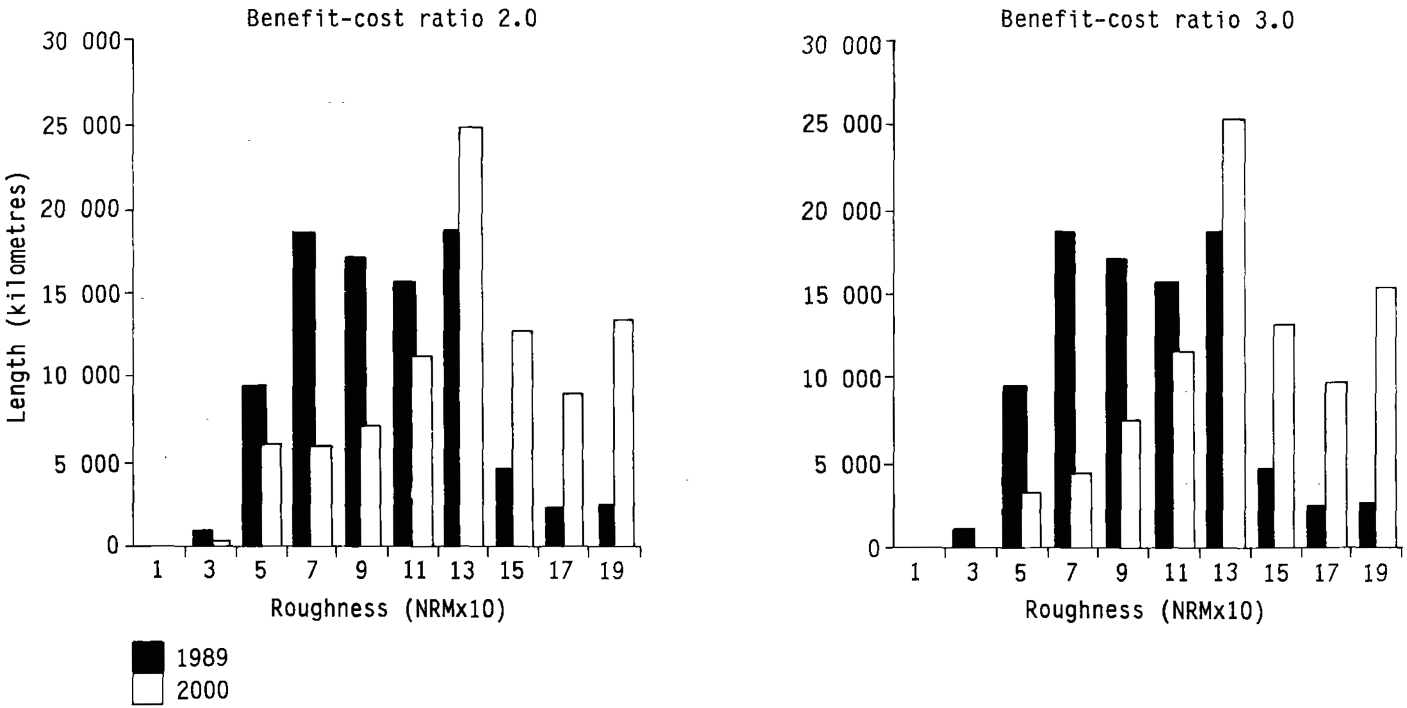
Source BTE projections.

Figure III.6 (Cont.) Length of road by level of service: selected levels of economic justification, National Highways, 1989 and 2000



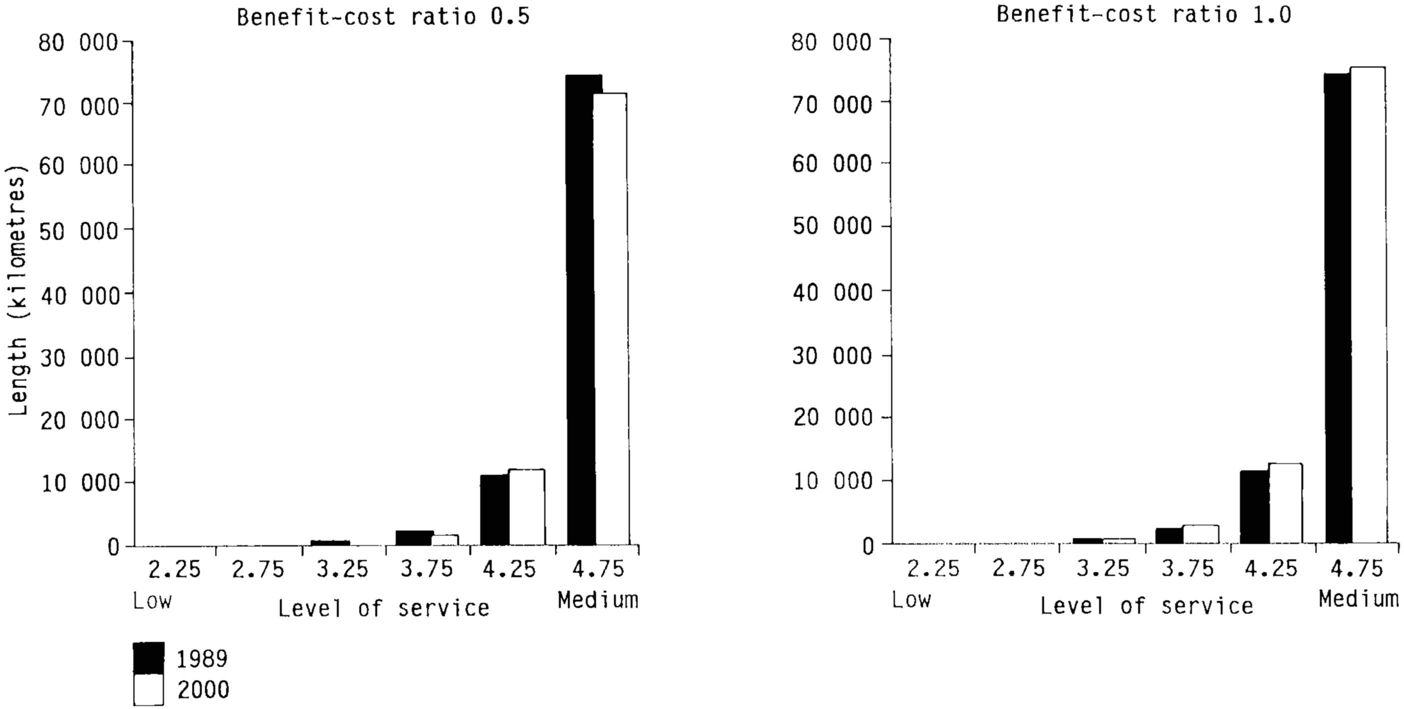
Source BTE projections.

Figure III.7 Length of road by roughness: selected levels of economic justification, rural arterials, 1989 and 2000



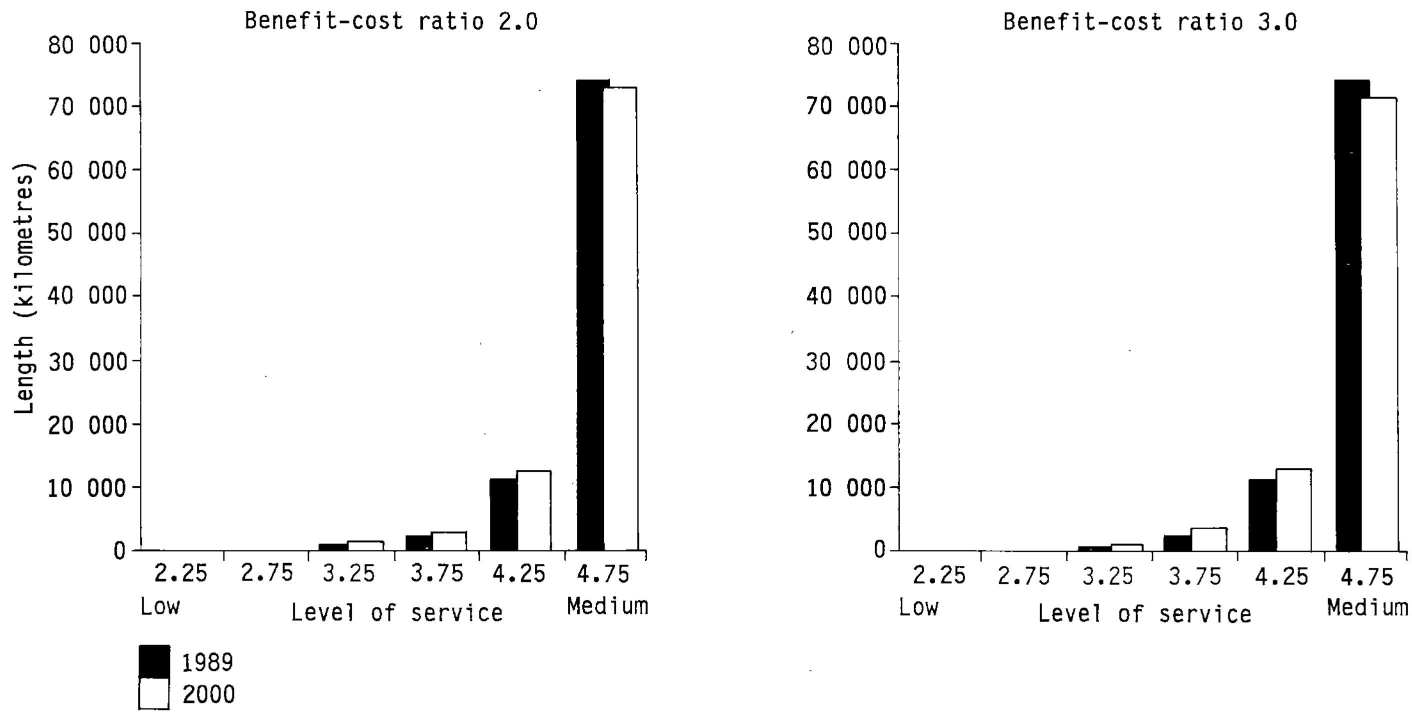
Source BTE projections.

Figure III.7 (Cont.) Length of road by roughness: selected levels of economic justification, rural arterials, 1989 and 2000



Source BTE projections.

Figure III.8 Length of road by level of service: selected levels of economic justification, rural arterials, 1989 and 2000



Source BTE projections.

Figure III.8 (Cont.) Length of road by level of service: selected levels of economic justification, rural arterials, 1989 and 2000

TABLE III.18 PROJECTED STATUS OF NATIONAL HIGHWAYS: UPPER FUNDING SCENARIO, YEAR 2000

	Length (kilometres)						Mean level of service[a] based on weighting by		Mean roughness[b] based on weighting by	
		Sealed				Mean traffic flow				
State	*Unsealed*	*One lane*	*Multi-lane*	*Divided*	*Total*	*(aadt)*	*vkt*	*Length*	*vkt*	*Length*
NSW	0.0	0.0	144.4	1 201.1	1 345.5	14 322	4.7	4.9	49.4	51.9
Vic	0.0	0.0	66.8	631.0	697.8	8 666	5.0	5.0	47.1	47.1
Qld	0.0	26.3	3 471.0	435.2	3 932.5	4 196	4.3	4.4	77.9	100.2
SA	0.0	0.0	2 176.9	279.3	2 456.2	2 104	4.7	4.8	40.1	46.8
WA	75.7	267.0	4 166.8	137.0	4 646.5	606	4.9	4.9	54.7	53.7
Tas	0.0	0.0	221.5	97.8	319.3	6 672	4.6	4.5	58.7	61.7
NT	0.0	380.6	2 252.5	22.4	2 655.7	323	5.0	5.0	67.0	72.9
Australia	75.7	673.9	12 500.0	2 803.9	16 053.7	3 288	4.6	4.8	58.1	65.7

a. Level of service is measured on a scale of 1.0 to 5.0. See Appendix IV for details.
b. Measured in NAASRA roughness meter counts. For general purposes, a roughness count of less than 100 is good and a count of 140 or more is poor (National Association of Australian State Road Authorities 1984a). See Appendix IV for details.

Notes 1. Status as at 30th June, 2000.
2. Owing to rounding, figures may not add to totals.

Source BTE projections.

TABLE III.19 PROJECTED STATUS OF NATIONAL HIGHWAYS: LOWER FUNDING SCENARIO, YEAR 2000

	Length (kilometres)						*Mean level of service[a] based on weighting by*		*Mean roughness[b] based on weighting by*	
		Sealed				*Mean traffic flow*				
State	*Unsealed*	*One lane*	*Multi-lane*	*Divided*	*Total*	*(aadt)*	*vkt*	*Length*	*vkt*	*Length*
NSW	0.0	0.0	466.7	878.8	1 345.5	14 322	4.6	4.6	56.9	68.2
Vic	0.0	0.0	97.9	599.9	697.8	8 666	5.0	5.0	46.5	46.4
Qld	0.0	26.3	3 570.8	335.5	3 932.5	4 196	4.1	4.4	86.1	111.1
SA	0.0	0.0	2 250.6	205.6	2 456.2	2 104	4.7	4.8	41.9	49.9
WA	75.7	267.5	4 245.3	58.1	4 646.5	606	4.7	4.9	58.4	64.5
Tas	0.0	0.0	238.4	80.8	319.3	6 672	4.5	4.4	63.2	65.4
NT	0.0	380.6	2 252.5	22.4	2 655.7	323	5.0	5.0	75.6	87.6
Australia	75.7	674.4	13 122.3	2 181.1	16 053.7	3 288	4.5	4.7	64.0	75.8

a. Level of service is measured on a scale of 1.0 to 5.0. See Appendix IV for details.
b. Measured in NAASRA roughness meter counts. For general purposes, a roughness count of less than 100 is good and a count of 140 or more is poor (National Association of Australian State Road Authorities 1984a). See Appendix IV for details.

Notes 1. Status as at 30th June, 2000.
2. Owing to rounding, figures may not add to totals.

Source BTE projections.

TABLE III.20 EXPENDITURE BY PROJECT TYPE: UPPER FUNDING SCENARIO, NATIONAL HIGHWAYS, 1989 TO 2000 (CONSTANT 1985-86 PRICES)

($ million)

	Rehabilitation[a]			*Upgrading*[b]				
	Sealed							
State	*Undivided*	*Divided*	*Sub-total*	*Widening of sealed pavements*	*Duplication*	*Other*	*Sub-total*	*Total*
NSW	13.7	190.4	204.1	42.7	817.8	298.8	1 159.3	1 363.4
Vic	30.8	114.3	145.0	0.0	272.3	9.5	281.8	426.8
Qld	97.5	81.7	179.2	86.4	330.7	115.9	533.0	712.2
SA	143.3	51.0	194.2	0.0	117.0	53.6	170.5	364.8
WA	223.5	8.3	231.8	3.0	147.9	0.2	151.1	382.9
Tas	33.1	40.9	74.0	0.0	61.7	0.3	62.0	136.0
NT	186.9	1.7	188.6	0.0	0.0	0.0	0.0	188.6
Australia	728.8	488.2	1 217.0	132.1	1 747.4	478.2	2 357.7	3 574.8

a. Expenditure not required for gravel surfaces.
b. Expenditure for widening of gravel pavements and construction of new sealed pavements not required.

Note Due to rounding, figures may not add to totals.

Source BTE projections.

TABLE III.21 EXPENDITURE BY PROJECT TYPE: LOWER FUNDING SCENARIO, NATIONAL HIGHWAYS, 1989-2000 (CONSTANT 1985 TO 86 PRICES)

($ million)

	Rehabilitation[a]			*Upgrading*[b]				
	Sealed							
State	*Undivided*	*Divided*	*Sub-total*	*Widening of sealed pavements*	*Duplication*	*Other*	*Sub-total*	*Total*
NSW	4.3	103.9	108.2	39.1	425.7	253.1	717.9	826.1
Vic	31.9	114.7	146.6	0.0	243.0	8.8	251.8	398.4
Qld	50.6	53.3	103.9	51.0	166.5	104.3	321.8	425.7
SA	123.5	41.4	164.9	0.0	60.3	50.9	111.2	276.1
WA	151.1	5.8	156.9	1.7	54.5	0.2	56.4	213.4
Tas	30.6	23.0	53.6	0.0	42.9	0.3	43.2	96.8
NT	119.3	1.7	121.0	0.0	0.0	0.0	0.0	121.0
Australia	511.3	343.8	855.1	91.8	993.0	417.5	1 502.3	2 357.4

a. Expenditure not required for gravel surfaces.
b. Expenditure not required for widening of gravel pavements and construction of new sealed pavements.

Note Due to rounding, figures may not add to totals.

Source BTE projections.

TABLE III.22 PROJECTED STATUS OF RURAL ARTERIALS: UPPER FUNDING SCENARIO, YEAR 2000

State	Length (kilometres)					Mean traffic flow (aadt)	Mean level of service[a] based on weighting by		Mean roughness[b] based on weighting by	
		Sealed								
	Unsealed	One lane	Multi-lane	Divided	Total		vkt	Length	vkt	Length
NSW	8 015.1	204.3	18 512.1	976.7	27 708.1	1 217	4.4	4.7	100.6	136.1
Vic	298.0	196.1	13 291.1	596.4	14 381.8	1 411	4.6	4.7	74.2	110.1
Qld	2 157.5	4 551.5	10 893.2	350.6	17 952.6	984	4.4	4.7	89.2	118.6
SA	715.2	40.5	7 620.3	115.3	8 491.1	1 081	4.6	4.8	86.4	107.2
WA	4 040.0	1 726.6	10 122.4	190.9	16 079.8	630	4.6	4.9	69.5	103.1
Tas	210.2	27.2	2 090.8	42.5	2 370.7	1 171	4.5	4.6	79.7	100.9
NT	1 304.3	1 130.1	185.4	0.0	2 619.7	60	5.0	5.0	85.7	129.7
Australia	16 740.3	7 876.3	62 715.2	2 272.3	89 604.1	1 048	4.5	4.7	87.3	118.7

a. Level of service is measured on a scale of 1.0 to 5.0. See Appendix IV for details.
b. Measured in NAASRA roughness meter counts. For general purposes, a roughness count of less than 100 is good and a count of 140 or more is poor (National Association of Australian State Road Authorities 1984a). See Appendix IV for details.

Notes 1. Status as at 30th June, 2000.
2. Owing to rounding, figures may not add to totals.

Source BTE projections.

TABLE III.23 PROJECTED STATUS OF RURAL ARTERIALS: LOWER FUNDING SCENARIO, YEAR 2000

	Length (kilometres)						Mean level of service[a] based on weighting by		Mean roughness[b] based on weighting by	
		Sealed				Mean traffic flow				
State	*Unsealed*	*One lane*	*Multi-lane*	*Divided*	*Total*	*(aadt)*	*vkt*	*Length*	*vkt*	*Length*
NSW	8 015.1	213.1	18 593.1	886.9	27 708.1	1 217	4.4	4.7	106.5	140.2
Vic	298.0	202.0	13 350.4	531.2	14 381.8	1 411	4.6	4.7	81.3	117.4
Qld	2 157.5	4 553.0	10 923.4	318.9	17 952.6	984	4.4	4.7	91.5	120.8
SA	715.2	40.5	7 623.6	111.9	8 491.1	1 081	4.5	4.8	91.3	110.5
WA	4 040.0	1 731.4	10 143.8	164.6	16 079.8	630	4.6	4.9	73.8	107.4
Tas	210.2	27.2	2 091.0	42.3	2 370.7	1 171	4.5	4.6	83.8	106.0
NT	1 304.3	1 130.1	185.4	0.0	2 619.7	60	5.0	5.0	93.2	133.4
Australia	16 740.3	7 897.3	62 910.7	2 055.8	89 604.1	1 048	4.5	4.7	92.5	122.9

a. Level of service is measured on a scale of 1.0 to 5.0. See Appendix IV for details.
b. Measured in NAASRA roughness meter counts. For general purposes, a roughness count of less than 100 is good and a count of 140 or more is poor (National Association of Australian State Road Authorities 1984a). See Appendix IV for details.

Notes 1. Status as at 30th June, 2000.
2. Owing to rounding, figures may not add to totals.

Source BTE projections.

TABLE III.24 EXPENDITURE BY PROJECT TYPE: RURAL ARTERIALS, UPPER FUNDING SCENARIO, 1989 TO 2000 (CONSTANT 1985-86 PRICES)

($ million)

	Rehabilitation[a]			*Upgrading*[b]					
State	*Undivided*	*Divided*	*Sub-total*	*Construction of new sealed pavement*	*Widening of sealed pavements*	*Duplication*	*Other*	*Sub-total*	*Total*
NSW	453.2	117.8	571.1	0.8	239.4	641.3	65.9	947.5	1 518.6
Vic	483.0	51.3	534.3	0.0	34.5	346.4	10.2	391.0	925.3
Qld	372.7	73.9	446.5	0.0	147.1	322.5	35.2	504.8	951.4
SA	192.5	31.9	224.4	0.0	18.9	27.0	0.0	45.8	270.2
WA	281.1	12.9	294.0	0.0	2.6	134.1	0.5	137.2	431.2
Tas	154.8	16.9	171.7	0.0	9.2	20.4	0.0	29.5	201.3
NT	24.8	0.0	24.8	0.0	0.0	0.0	0.4	0.4	25.2
Australia	1 962.1	304.7	2 266.8	0.8	451.6	1 491.7	112.2	2 056.3	4 323.1

a. Expenditure not required for gravel surfaces.
b. Expenditure not required for widening of gravel pavements.

Note Owing to rounding, figures may not add to totals.

Source BTE projections.

TABLE III.25 EXPENDITURE BY PROJECT TYPE: RURAL ARTERIALS, LOWER FUNDING SCENARIO, 1989 TO 2000 (CONSTANT 1985-86 PRICES)

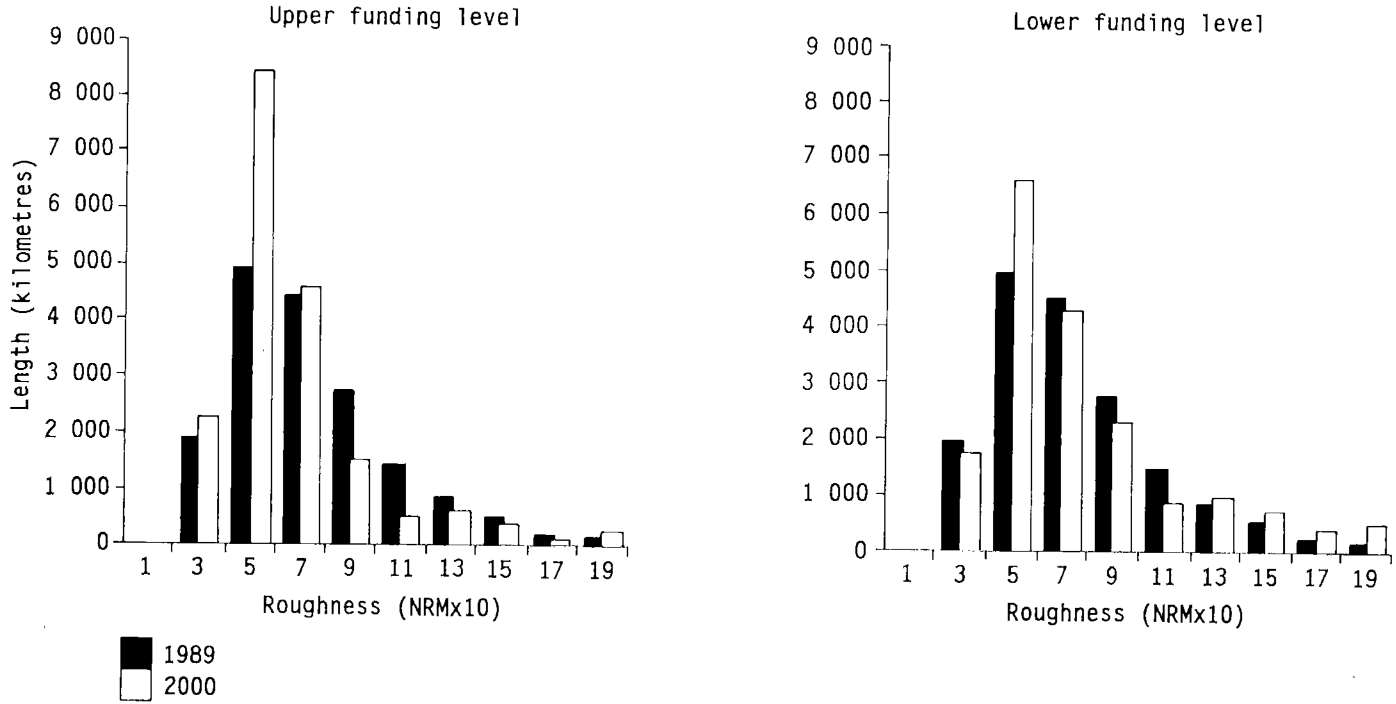
($ million)

	Rehabilitation[a]			*Upgrading*[b]					
State	*Undivided*	*Divided*	*Sub-total*	*Construction of new sealed pavement*	*Widening of sealed pavements*	*Duplication*	*Other*	*Sub-total*	*Total*
NSW	373.2	98.6	471.8	0.8	198.4	539.6	59.8	798.7	1 270.5
Vic	358.2	42.7	400.9	0.0	27.6	276.8	8.6	313.0	713.9
Qld	321.0	68.2	389.2	0.0	131.5	275.1	34.7	441.3	830.5
SA	151.4	24.1	175.5	0.0	13.5	22.8	0.0	36.3	211.7
WA	223.7	11.5	235.2	0.0	1.1	108.9	0.2	110.2	345.4
Tas	127.0	13.3	140.3	0.0	7.8	20.2	0.0	28.0	168.3
NT	11.5	0.0	11.5	0.0	0.0	0.0	0.0	0.0	11.5
Australia	1 566.0	258.4	1 824.4	0.8	379.9	1 243.4	103.3	1 727.4	3 551.8

a. Expenditure not required for gravel surfaces.
b. Expenditure not required for widening of gravel pavements.

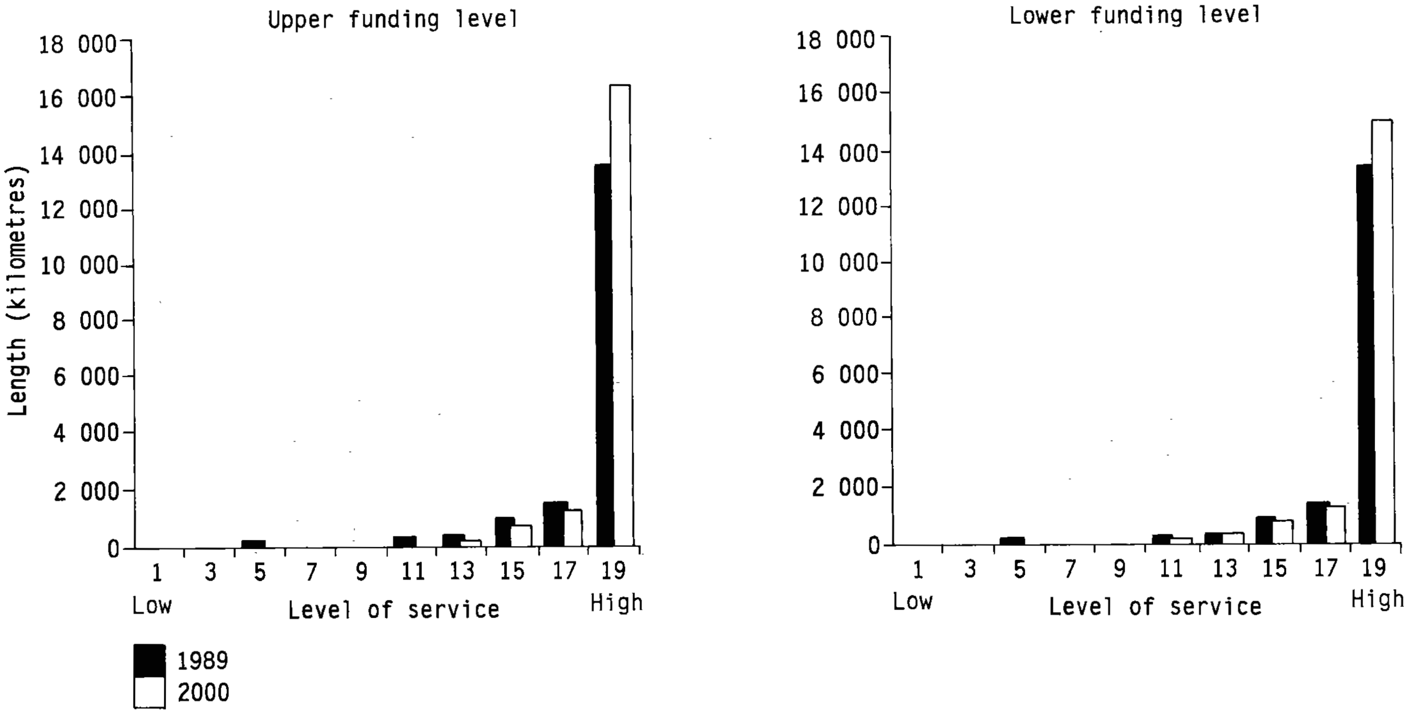
Note Owing to rounding, figures may not add to totals.

Source BTE projections.



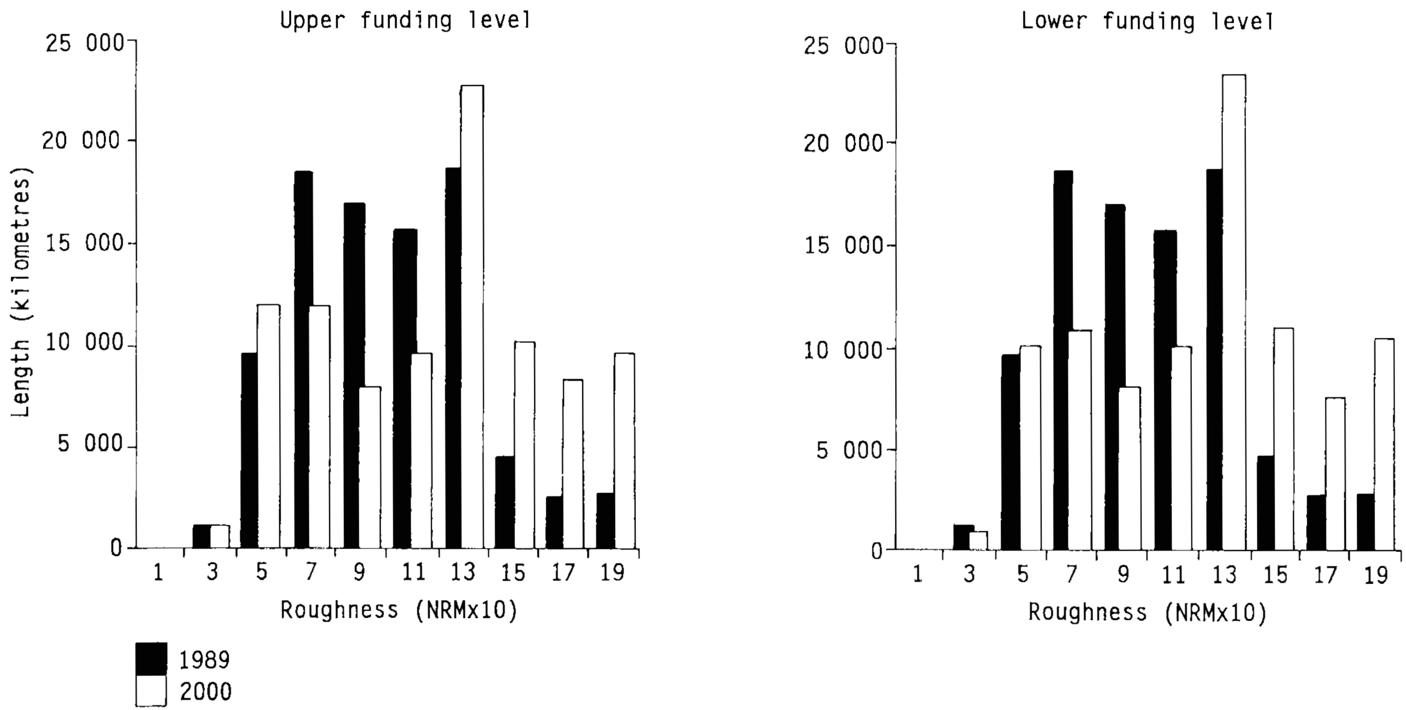
Source BTE projections.

Figure III.9 Length of road by roughness: funding scenarios, National Highways, 1989 and 2000



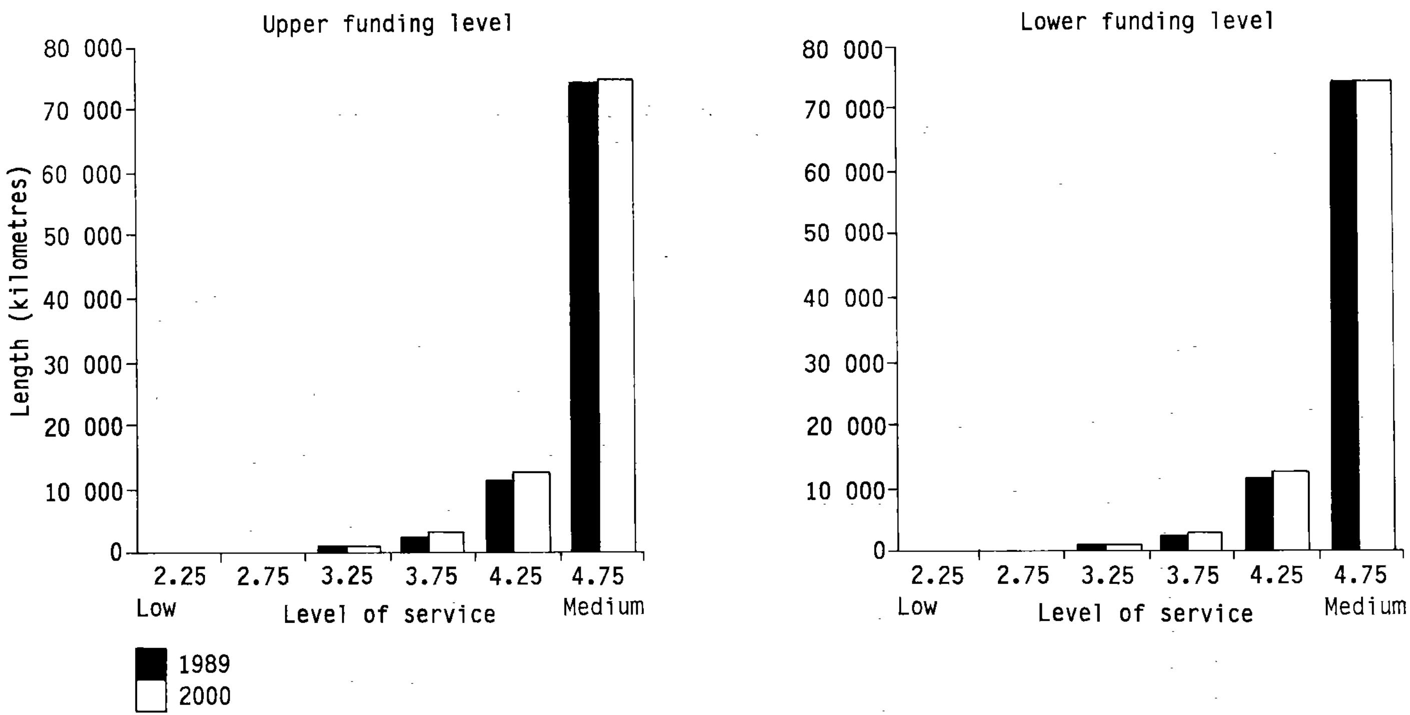
Source BTE projections.

Figure III.10 Length of road by level of service: funding scenarios, National Highways, 1989 and 2000



Source BTE projections.

Figure III.11 Length of road by roughness: funding scenarios, rural arterials, 1989 and 2000



Source BTE projections.

Figure III.12 Length of road by level of service: funding scenarios, rural arterials, 1989 and 2000

APPENDIX IV NATIONAL HIGHWAYS AND RURAL ARTERIALS, EXPLANATORY NOTES

This appendix includes the following information on various procedures and methods used in the preparation of Chapter 5:

- data base formation
- methodology of benefit-cost analysis
- projection of expenditure data.

DATA BASE FORMATION

To analyse rural arterials and National Highways between 1989 and 2000, three road inventory data bases were established:

- National Highways 1989
- rural arterials 1989
- extensions to National Highways 1989.

The information included in these data bases was derived from data supplied by the SRAs in NDB format. The data were sectionised on the basis of determinants used for the Review of Road Vehicle Limits study (National Association of Australian State Road Authorities 1985).

Internal checks were undertaken to verify the accuracy of the information, particularly with regard to road length vkt. Checks were also undertaken of the traffic growth estimates derived from the NDB inventory. Where anomalies were found, the data were corrected except where discussion with the respective SRA indicated that this was unnecessary.

The routes comprising the National Highways and extensions to National Highways were divided into segments. Individual segments were identified both by highway name and segment end points. (For example, Hume Highway, Mittagong to Federal Highway). For each segment, data on the population served by the route was incorporated in the data base.

Updating to 1989 status

Since the nominal currency of the SRA data varied by State from 1981 to 1987, and the analysis period for this study was 1989 to 2000, it was necessary to update all of the data to 1989. For each data base, a slightly different approach was required.

The data for National Highways were manually updated to 1989, using SRA future works programs. This updated information was forwarded to each SRA for comment and corrections were made where necessary. Such a procedure was not practical in the case of rural arterials, since detailed future works programs were not readily available. Instead, the data relating to the rural arterial system at 1989 were 'synthesised' analytically, using the NDB information as a reference base, and generating hypothetical roadworks which would be undertaken in subsequent years up to 1989. These hypothetical projects were derived from actual or projected expenditure levels, under the universal assumption that these expenditures would be incurred on economically efficient projects. The methodology was the same as that used in the major analysis covering the period 1989 to 2000.

The effect of this approach was to produce characteristics of a road system which would be closer to economic optimality than would be the case in practice. Since operational procedures used by SRAs are not accounted for in the methodology, the 1989 status of rural arterials, as developed by this process, is somewhat idealised.

In the updating process, it was necessary to estimate the variation of certain parameters over time. The four prinicipal data items requiring such estimation were:

- traffic flow
- pavement age
- road roughness
- level of service.

Traffic flow

The level of traffic flow is measured as aadt. This is the total number of vehicles passing a given point during a specified year divided by the number of days in the year. Aadt varies from road section to road section. To calculate mean traffic flow for a route, the following relationship was used:

$$\text{Mean aadt} = \frac{\sum(\text{aadt}_s)l_s}{\sum l_s}$$

where $(aadt_s)$ is the aadt of road section s, and l_s is the length of road section s. The summation is undertaken for all sections on the route.

The inventory data for road sections included compound traffic growth rates for future years. From these the mean growth rate was calculated for rural arterials and National Highways. Projections of traffic growth for the rural areas of each State were also calculated using data from the various SMVUS (ABS 1986a; Commonwealth Bureau of Census and Statistics 1965, 1973).

Road section growth rates beyond 1989 were factored where necessary to reflect the relationship between traffic growths for rural arterials and National Highways and the rural area traffic growths calculated from smvus for each State.

Pavement age
Pavement age is based upon the year in which construction work was last carried out on the road to achieve the present structural design standard.

Where pavement age was not included in the inventory of a road section, the other section characteristics were used to impute the age, whilst maintaining its distribution by road length to reflect the pavement age length profiles provided by each SRA.

Road roughness
Road roughness results from the effects of both surface irregularities (due to seal breaks or patches) and deformation of the pavement. Road roughness measurement provides an indication of rideability and vehicle operating cost.

The units adopted to measure roughness are counts (bumps per kilometre) as measured by the NRM (Stevenson 1976). Since roughness counts usually range from 20 to 200 per kilometre, roads with a roughness below 100 counts are rated as being in a 'good' condition while roads with a roughness above 140 counts are rated as having a 'poor' surface condition (National Association of Australian State Road Authorities 1984a).

In order to calculate the average roughness levels over given routes or total networks, the roughness counts of road sections on those routes or networks were weighted both by vkt and carriageway length, respectively. Mean roughness calculated from weighting by vkt is a better indicator of the level of roughness perceived by the average road user, while mean roughness based on weighting by carriageway length is a better indicator of the average surface condition of the road asset.

To assess the level of roughness at 1989 from the roughness at the year of measurement, an annual increase in roughness was made to account for the effect of traffic, and a decrease applied to account for the effect of periodic resealing or re-sheeting. The algorithms contained in NIMPAC (National Association of Australian State Road Authorities 1979) were used for this purpose. Similarly, the procedures of NIMPAC were also applied to impute roughness level when it was missing from the inventory data.

Level of service

Level of service in this study was based on the operational analysis procedures employed in the Highway Capacity Manual (HCM) (Transportation Research Board 1985) and defined as quantitative measure describing operational conditions within a traffic stream, and their perception by motorists and/or passengers. It further describes these conditions in terms of speed and travel time, freedom to manoeuvre, traffic interruptions, comfort and convenience, and safety. Six levels of service are defined, ranging from 'A' (highest) to 'F' (lowest). This discrete scale was converted into a continuous numerical scale ranging from '5' to '1' by regression analyis. In the regression equation, level of service was a function of volume capacity ratio and terrain.

Volume capacity ratio was derived from such factors as lane width, influence of shoulders, terrain, whether in or out of a town and the amount of heavy vehicle traffic, as described in HCM.

For unsealed roads an approximation was developed, based on a proxy seal width of one half of the pavement width for paved roads or one quarter of the formation width for unpaved roads. The number of lanes and traffic conditions were then based on this proxy seal width to calculate level of service.

The mean level of service estimates shown in various tables in Chapter 5, is the average of the individual level of service values of the road sections, weighted either by section length or by section vehicle kilometres of travel.

METHODOLOGY OF BENEFIT-COST ANALYSIS

The analysis involved development of computer based models to simulate road projects in the period 1989 to 2000, and to report the status of the inventory at, and expenditure to, the year 2000.

Models

Three models were developed to simulate road upgrading and rehabilitation projects for an analysis period of 11 years, from July 1989 to June 2000, according to the following criteria, respectively:

- maintenance of the physical asset and operational performance of the road system as at June 1989;
- a specified minimum bcr for projects; and
- a yearly budget.

The economic assessment of road projects was based on their bcrs. For each potential project, the construction cost was calculated and the benefits to road users were determined. Projects synthesised by the models are assumed to occur on the existing road alignment and do not include bridge projects. Allowance was made for bridge costs, however, as described below. In addition, the costs of major realignments or town bypasses vary greatly according to the nature of the project. Nevertheless, both the costs and benefits of such realignments could be expected to be higher than the projects derived by the models on the existing alighments.

Cost and benefit equations were derived from the NIMPAC model for each State, and for each type of potential road project. The cost equation was a function of the volume of the new pavement and the change in volume from the old pavement to the new. The benefit equation was a function of the cumulative vkt over a 30 year period and the improvement in the road conditions. The improvement factor was a function of the change in level of service and change in roughness from the old road to the new road.

Each model incorporated the following processes for each year of the analysis period:

- examination of a section's inventory to determine its status as described by surface type and width, traffic, speed, roughness, pavement thickness and level of service;
- determination of two possible projects for a section, an upgrade and a rehabilitation, based on its existing status and possible future status;
- identification of the project with the higher bcr;
- application of one of the three selection criteria stated above to determine if the project would be carried out (see below); and

- updating of the section inventory annually to allow for changes in traffic and roughness levels (and periodically to allow for resealing or resheeting activities), and to reflect the construction of a project which meets the selection criteria.

In the model for which the minimum project bcr was specified, a project was undertaken if its bcr was calculated to be greater than, or equal to, the nominated bcr (0.5, 1.0, 2.0 or 3.0).

In the budget analysis model, the upper and lower funding scenarios were applied as expenditure limits in each year for the period 1989 to 2000, and project costs and benefits were determined for the rehabilitation or upgrading of all sections of roads. Projects were scheduled in each year in order of progressively decreasing bcr, until the expenditure limits were reached. The status of the road system was updated to allow for projects scheduled during the year, and sections were then re-examined in the following year under the changed physical and traffic conditions. Further projects were then scheduled for the expenditure limit in that year and so on, until the year 2000.

In the steady-state model for maintenance of the physical asset, the mean roughness of the road system (based on weighting by carriageway length) in each State, as at June 1989, was initially calculated. This was the target mean roughness to be maintained each year up to June 2000. The State road inventory was processed with only potential rehabilitation projects being considered for each section. These were sorted into a descending order of bcr. Projects were undertaken and the inventory updated, until the target average roughness was achieved for that year.

The steady-state model for preservation of operational performance first calculated the State mean roughness and mean level of service (based on weighting by carriageway length) at June 1989 and preserved these means for each year up to June 2000. The inventory was then analysed to identify potential improvements and projects were sorted in descending order of bcr. The projects were further examined in two sweeps:

- the first sweep involved undertaking upgrade projects and updating the inventory until the target level of service was achieved for that year; and
- the second sweep involved undertaking rehabilitation projects and updating the inventory until the target roughness was achieved for that year.

PROJECTION OF EXPENDITURE DATA

Road expenditure estimates were projected to the year 2000. Expenditure projections were used primarily as controls for the budget analysis discussed above. They were also used as a yardstick for comparions with the results of the economic analysis of road expenditure and for projecting the status of the rural arterial road system to 1989. The projections were based on the pattern of past levels of expenditure to the year 1985-86. The divisions between construction and maintenance, and between Commonwealth and State components were based primarily on the divisions existing in each State in 1984-85 (BTE 1986a). An upper level of projected expenditure was designed to reflect a continuation of the level of funding achieved through the ABRD program beyond 1988, and a lower projection to reflect cessation of the ABRD program in 1989 with no replacement. The projections were amended to allow for reductions in Commonwealth road grants made in the August 1986 budget.

Bridge expenditures

The Bureau's models did not incorporate any evaluation of bridge expenditure, and separate allowances were made for this additional cost. The various bridge expenditure data reported in the National Association of Australian State Road Authorities (1984a, 1985), SRA annual reports and advanced works programs for National Highways, indicate that bridge expenditure has varied from 5 to 25 per cent of total road construction expenditure. This variation occurred both with in the State involved and the total construction expenditure available. The bridge expenditure proportions generated by NIMPAC (National Association of Australian State Road Authorities 1979), reflected these variations, and they were adopted for this study. For both National Highways and rural arterials, functions relating road construction expenditure to total construction expenditure were developed for each State.

Calculation of total road expenditure

The economic analyses presented in Chapter 5 related to road construction projects (excluding bridges). However, to provide some indication of the implications of these analyses for total road expenditure levels, some estimates of these total expenditure levels were also given in Chapter 5. These estimates were calculated by:

- adding bridge expenditure to road construction expenditure, as described above, to produce total construction expenditure; and

- adding routine maintenance expenditure to construction expenditure to produce total expenditure. Routine maintenance expenditure was calculated by converting, where necessary, the data in Table 5.4 to a cost per route kilometre and multiplying by the route length of the road concerned.

APPENDIX V TERMS OF REFERENCE

The BTE was directed by the Commonwealth Minister of Transport:

- To investigate in an economic and social context the maintenance and improvement of the Australian land transport system to the year 2000.
- Recognising the continuing responsibility of the Commonwealth Government for fully funding the National Highway System, to assess
  - the tasks and costs of maintaining the system to standards expected to be reached by 1988 and the on-going costs of maintenance
  - the tasks and costs of upgrading and maintaining the National Highway system to National Highway standards where this is economically justified
  - the implications of incorporating any additional major rural or urban roads into the National Highway system taking into account the importance of such roads (that is, for carrying international, interstate or interregional traffic and their role in collecting and distributing such traffic in major cities).
- Having regard to the likely level of Commonwealth funding available for land transport infrastructure and the primary responsibility of State and Territory Governments for arterial roads
  - to consider the issues that the Commonwealth Government should take into account in regard to the funding it directs to urban and rural roads
  - in considering these issues the necessity to maintain the arterial road system should be taken into account.
- To assess the requirements of local roads.
- The Bureau may examine other transport infrastructure investment requirements and any other matter it believes relevant to this study.

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BTE Federal Bureau of Transport Economics
AGPS Australian Government Publishing Service

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ABBREVIATIONS

aadt	average annual daily traffic
ABRD	Australian Bicentennial Road Development
ABS	Australian Bureau of Statistics
ACT	Australian Capital Territory
ALTP	Australian Land Transport Program
bcr	benefit-cost ratio
BTE	Federal Bureau of Transport Economics
CPI	Consumer Price Index
FRG	Federal Republic of Germany
km	kilometre
LATM	Local Area Traffic Management
LGA	Local Government Authority
NAASRA	National Association of Australian State Road Authorities
NDB	NAASRA Data Bank
NIMPAC	NAASRA improved model for project assessment and costing
NRM	NAASRA roughness meter
RED	Regional Employment and Development
SLGFS	Standardised Local Government Finance Statistics
SMVU	Survey of Motor Vehicle Usage
SRA	State Road Authority
teu	twenty-foot equivalent unit
vkt	vehicle kilometres travelled
vpd	vehicles per day

GLOSSARY

arterials	those roads declared by the Commonwealth Minister of Transport as arterial roads under Federal legislation. They form a primary network of roads and exclude National Highways.
annual average daily traffic	the total number of vehicles passing a given point during a specified year divided by the number of days in the year.
benefit-cost ratio	the ratio of present worth of the benefits of a project to the present worth of the cost of implementing the project.
casualty accident	those accidents which result in injuries requiring hospital attendance or death within 30 days of the accident.
construction	includes provision of new roads and the upgrading and rehabilitation of existing roads.
divided road	a road with a physical separation between carriageways to divide opposing traffic flows.
inner urban area	principal contiguous built-up portion within an urban area, having a population density which is estimated to exceed 200 persons per square kilometre.
local roads	roads other than arterials and National Highways.

National Highways	those roads which are declared by the Commonwealth Minister of Transport, comprising the major links between the capital cities and the highways between Brisbane and Cairns and between Hobart and Burnie.
pavement	a layer (or layers) of compacted material which distributes wheel loads to the natural surface (or compacted fill).
rehabilitation	construction work carried out on the existing alignment to return the pavement to its structural design strength, with negligible upgrading of geometric standards.
(re)sheeting	the addition of a gravel course (to a gravel road) or a layer of bituminous concrete course (to a sealed road).
restoration	routine maintenance and rehabilitation works.
(re)surfacing	the application of a surface course to a sealed road.
routine maintenance	all works required for the preservation of a road excluding construction activities. Includes linemarking, pothole repair, resealing or resheeting.
sealed road	a road having a surface course which protects the pavement against effects of rainfall and traffic. Cement concrete roads are included with sealed roads for the purposes of this report.
upgrading	construction work which improves the design standard of the road. For this report, all construction works which do not include improvement of geometric design standards are treated as rehabilitation projects, although improvements to the structural design standard may sometimes occur.

urban area	an area within the ABS boundaries of the: . statistical division of the capital cities . statistical districts of Newcastle, Wollongong and Geelong . urban areas of Ballarat, Bendigo, Townsville, Toowoomba, Gold Cost, Rockhampton and Launceston.