RAC Foundation

# What pattern of Motorway network is needed?


## Royal Automobile Club Foundation

## Motoring Towards 2050 – Roads and Reality Background Paper No.6

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**In December 2007 the RAC Foundation published its report on 'Roads and Reality' along with a supporting Technical Report. As part of this exercise a series of background papers were produced and these are being published during the course of 2008. This is the sixth in the series.**

**The Royal Automobile Club Foundation for Motoring Limited is a charity established to promote the environment, economic, mobility and safety issues relating to the use of motor vehicles.**

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***This report has been prepared for the RAC Foundation by David Bayliss OBE. The report content is the view of the author and does not necessarily represent the views of the RAC Foundation.***

## Introduction

The additional capacity needed to accommodate managed growth in road traffic could take a variety of forms. In an earlier analysis produced in the wake of Motoring Towards 2050 (MT2050)[1] it was argued that the main source of new strategic capacity should be in the form of Motorways because:

- The British Motorway network is sparse by European standards;
- Motorways have lower accident rates than other trunk roads;
- Motorways are generally less close to residential and commercial developments;
- Motorways have higher capacity and service levels than other trunk roads, and;
- New by passes will be largely on other trunk roads.

Implicitly, it was assumed that the rest of the road system would not require major capacity expansion. This is because the existing local road system is lightly trafficked by strategic road standards, and experiences a rate of traffic density increase less than strategic roads due to continuous expansion caused by new housing, commercial and residential development[2]. There will be parts of the 'local' road network that will come under increasing traffic pressure, notably in the suburbs of larger towns and cities, where cars and vans form the main means of motorised transport and traffic is collected for and distributed from longer distance strategic routes.

## The quantum of new strategic road capacity to be provided

Following the publication of MT2050 the author looked at how much additional capacity would be needed to contain congestion. This was a crude analysis, but estimated that between 2001 and 2031 300 Lane kilometres a year would be needed in England alone simply to keep up with traffic growth.

In 'Roads and Reality' it was concluded that the strategic road network should be expanded at a rate of 600 lane kilometres a year up to 2041. The pattern of this capacity was not defined in the study conclusions but the analysis reflects the distribution of capacity developed by the DfT for the Eddington Study[3].

[1] Means to Mitigate Effects of Increasing Strategic Road Capacity in Line with Demand, D. Bayliss & A Muir Wood.
[2] See DB4/4 figure 1.
[3] Eddington R (2006), Transport's role in sustaining the UK's productivity and competitiveness, HM Treasury, London, December.

| Region | Con M/way | Con Trunk | Urban other | Rural M/way | Rural other | All |
|---|---|---|---|---|---|---|
| East of England | - | - | 49 | 904 | 455 | 1,408 |
| East Midlands | - | - | 62 | 664 | 429 | 1,155 |
| London | 192 | 1,134 | - | - | - | 1,326 |
| North East | 23 | 272 | 15 | 159 | 140 | 609 |
| North West | 614 | 499 | 27 | 1,357 | 234 | 2,731 |
| South East | - | - | 53 | 2,245 | 344 | 2,642 |
| South West | - | - | 26 | 1,121 | 419 | 1,566 |
| West Midlands | 177 | 287 | 29 | 1,059 | 286 | 1,838 |
| Yorks & Humber | 718 | 921 | 9 | 396 | 218 | 2,262 |
| Scotland | 221 | 315 | 39 | 934 | 955 | 2,464 |
| Wales | - | - | 24 | 485 | 537 | 1,046 |
| **Total** | **1,945** | **3,428** | **333** | **9,324** | **4,017** | **19,047** |

Table 1: Distribution of Additional Strategic Road Capacity with 600 Lkms/year above the 2041 Base (lane kilometres)

This distribution was based on the application of uniform growth factors by road type to each region's 2041 base network. If some allowance is made for the allocation of additional capacity under 'optimisation' conditions the picture in table 2 emerges.

| Region | Con M/way | Con Trunk | Urban other | Rural M/way | Rural other | All |
|---|---|---|---|---|---|---|
| East of England | - | - | 200 | 1,000 | 645 | 1,845 |
| East Midlands | - | - | 150 | 800 | 1,060 | 2,010 |
| London | 240 | 1,180 | - | - | - | 1,420 |
| North East | 50 | 300 | 10 | 80 | 60 | 500 |
| North West | 600 | 500 | 25 | 900 | 275 | 2,300 |
| South East | - | - | 150 | 2,480 | 700 | 3,330 |
| South West | - | - | 30 | 820 | 400 | 1,250 |
| West Midlands | 200 | 300 | 25 | 750 | 225 | 1,500 |

| Region | Con M/way | Con Trunk | Urban other | Rural M/way | Rural other | All |
|---|---|---|---|---|---|---|
| Yorks & Humber | 700 | 900 | 10 | 240 | 150 | 2,000 |
| Scotland | 200 | 300 | 35 | 760 | 760 | 2,045 |
| Wales | - | - | 20 | 350 | 430 | 800 |
| **Total** | **1,990** | **3,480** | **655** | **8,170** | **4,705** | **19,000** |

Table 2: Modified Distribution of Additional Strategic Road Capacity with 600 Lkms/year above the 2041 Base (lane kilometres)

An indication of the relative densities of additional strategic road capacity needs is given in Figure 1. This shows that the need for additional capacity on an area basis is almost seven times as great in the South East as in Scotland. To give some perspective on this diagram, the area that would be required for additional capacity in the South West would be equivalent to around 6 $km^2$ or 0.026% of the region's land area.

**Network density and journey lengths**

The propensity for traffic to use a relatively high quality but sparse road network is affected by the distribution of journey lengths. The higher the proportion of longer journeys, the more traffic will use such a network.

Estimates of road traffic journey lengths are not readily available from published statistics, so estimates have been made, using a variety of sources (See Appendix). These estimates include light and heavy vehicle national trip length distributions showing the amount of traffic generated by journeys in each length range. So, whilst there are substantially fewer longer journeys, there is still a substantial amount of traffic associated with these - as the longer journeys involve correspondingly more vehicle kilometres. Figures 2 & 3 show the estimated distributions for light and heavy traffic. The much higher proportion of long distance traffic for HGVs compared with light vehicles is evident. This means that the likelihood of heavier traffic using the strategic road network, and in particular Motorways, is much greater than for light traffic. However, as can be seen from figure 4, in which the two distributions are combined, because light traffic is so much greater than heavy traffic, it dominates except at the very longest journey ranges.

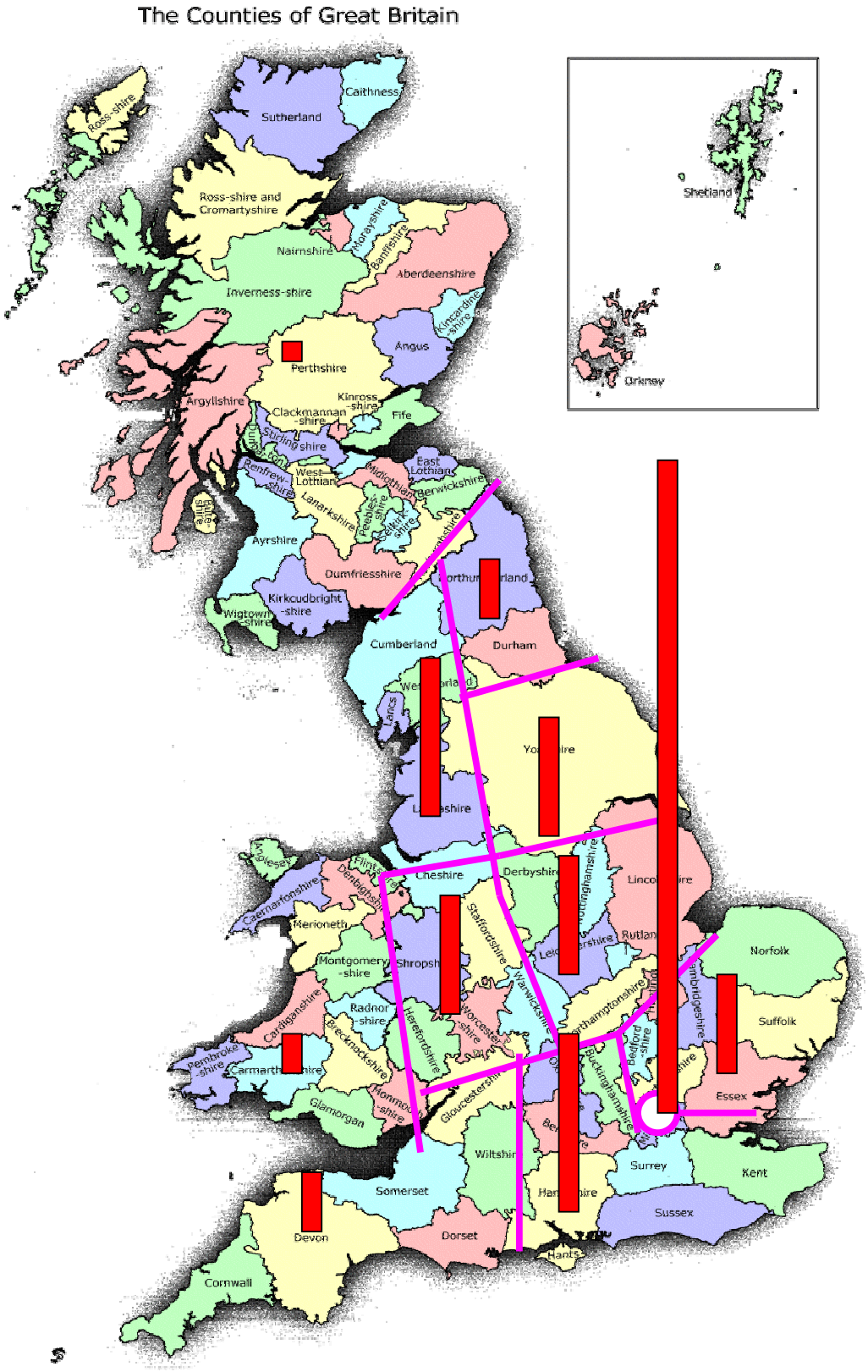



Figure 1: An Illustration of Relative Strategic Road Capacity Density Needs by Region / County

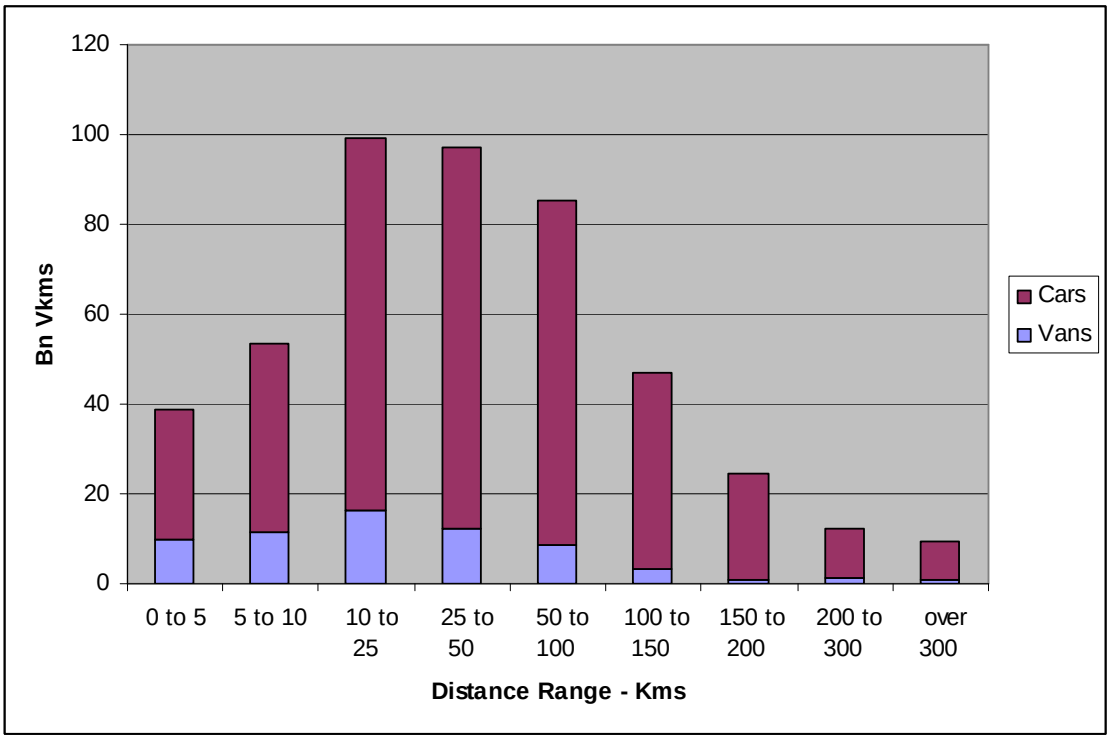



Figure 2: Estimated Light Traffic Journey Length Distributions 2006

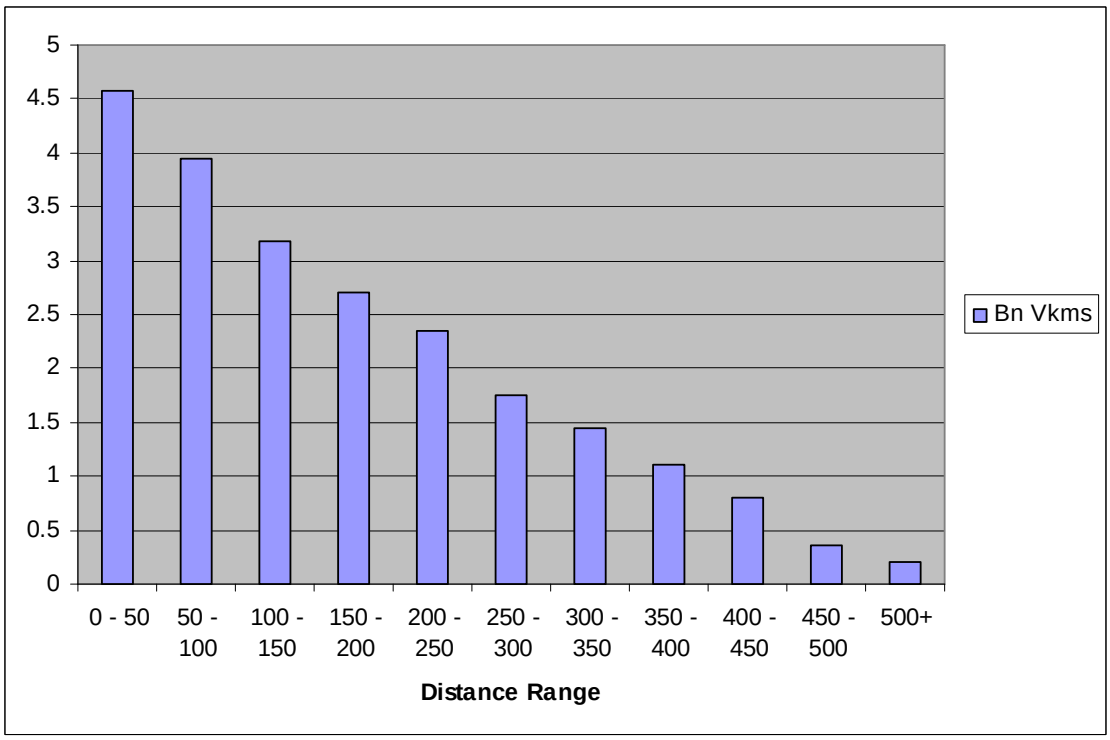



Figure 3: Estimated HGV Traffic Journey Length Distributions 2005

It is well known that a high proportion of car journeys are for short distances, but this does not result in most car traffic being over short distances as longer trips, by their very nature, create more traffic. Thus whilst three quarters of car trips are shorter than 15 kms, over seventy percent of car traffic is by trips over 15 kms in length.

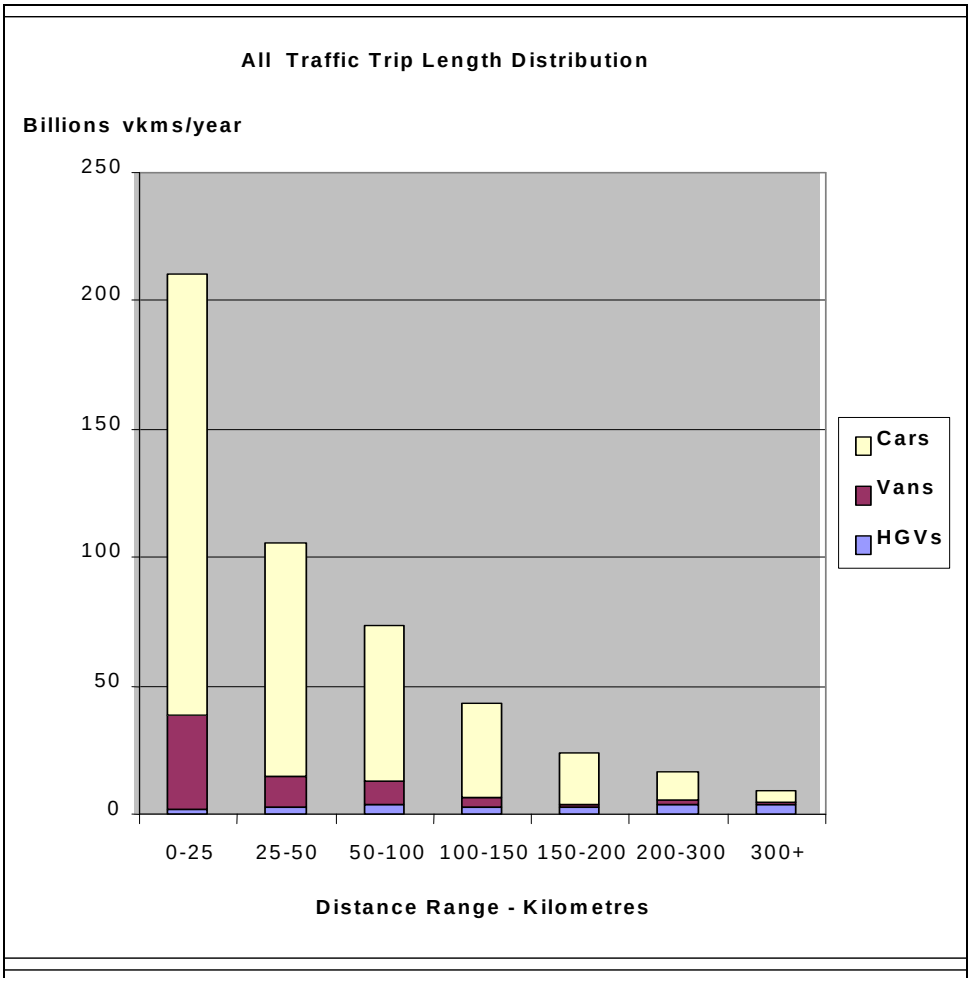



Figure 4: Estimated All Traffic Journey Length Distributions 2002/2005

Journey lengths have grown over the years. Average car driver journey lengths increased from 12.2kms in the mid 1970s to 12.9kms by the early 1990s[4] but do not seem to have changed much since[5]. Average HGV journey lengths are now 26% greater than in 1980 after peaking at 40% higher than 1980 lengths in 1999[6]. Therefore the propensity to use the strategic network has been increasing a little for light traffic but more for heavy traffic.

[4] NTS 1989/91 table2.5.
[5] Car/van driver average journey lengths were 13.7kms in 1995/7 and 2006: NTS 2006 table 3.2.
[6] Road Freight Statistics 2006, table 1.6.

It is to be expected therefore that the development of the Motorway network will, on journey length grounds, have had particular attractions for heavy traffic. In addition to longer journey lengths, greater lane widths, shallower curvatures and gradients, and the absence of at grade junctions enhance their attractiveness to heavy vehicles. Figure 5 shows a plot of the proportion of different types of traffic using the Motorway system as it has grown in length (yellow, magenta and blue lines).

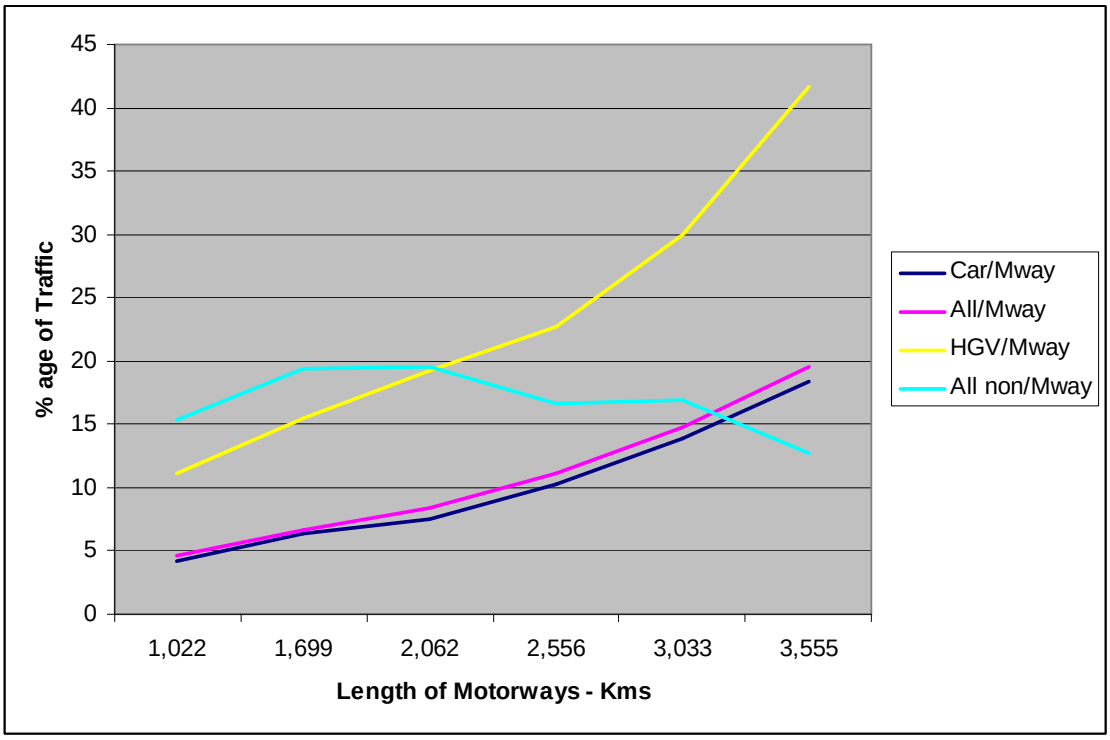



Figure 5: Trunk Road Traffic Share (1970 – 2006)[7].

This shows the proportion of traffic at the various stages of development of the Motorway network, rather than the total amount. These proportions have grown substantially faster as the total amount of road traffic has increased over the years.

Points of particular note are:

- The proportion of heavy traffic using Motorways is double that of light traffic;
- Over the whole period (1970 – 2006) the proportion of traffic using Motorways has risen faster than the growth of the network itself, and;

[7] Source various editions of TSGB from 1974 to 2007.

- The increase in the proportion of traffic using Motorways has been growing faster since 1980 (2,556kms) when the rate of growth of the Motorway network started to slow.

These points indicate that the propensity of British road traffic to use Motorways has been growing faster than the system itself. The pale green line in figure 5 shows the proportion of all traffic that has used non-Motorway trunk roads over this period. This has hovered around 17% dropping off in the last few years as a result of the de-trunking of sections of the non-Motorway network, with Motorways becoming the dominant traffic-carrying element of the trunk road network in the mid 1990s. This is despite the improvements to these trunk roads with the proportion that is dual carriageway increasing from 12% in 1969 to 40% in 2006[8].

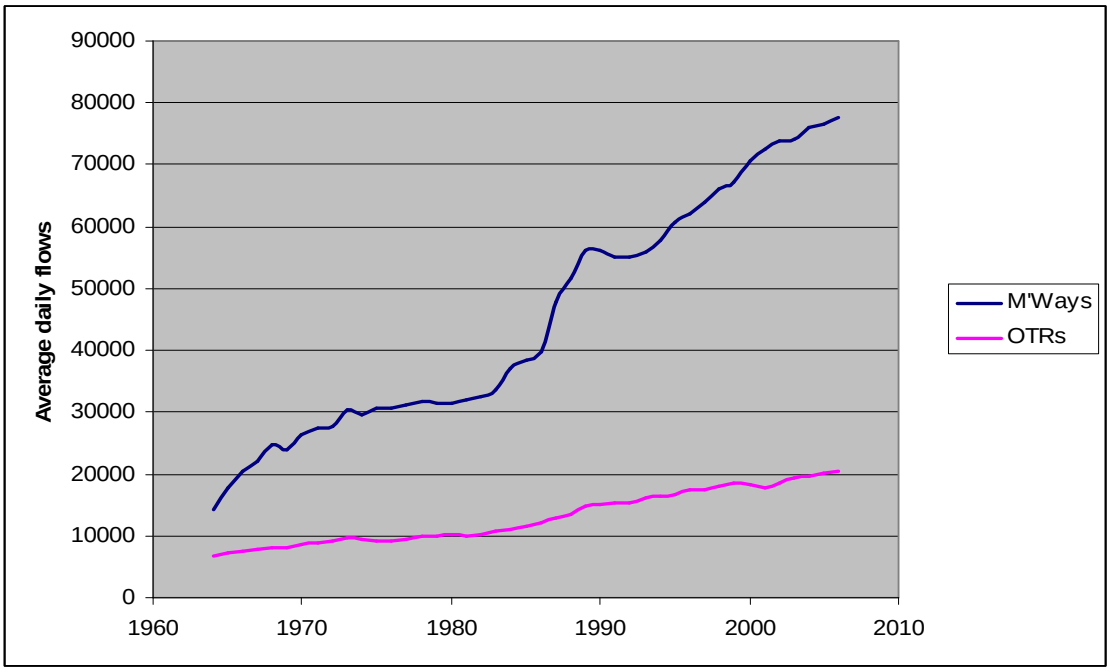



Figure 6: Traffic Densities on British Motorways 1970 – 2004

An obvious consequence of the increasing share of traffic on Motorways without commensurate expansion of the system, is that Motorway loadings and congestion have grown – especially over the last twenty years, as shown in figure 6. It is clear from this that, despite the slowing growth in the network, Motorway traffic has continued to grow and present day traffic densities are now twice what they were in the early 1980s - despite the fact that there has been widening of some of the busiest sections of the network.

[8] TSGB 1964 – 1974 table 19 & TSGB 2007 table 7.9.

**Motorway Density in The European Context**

A look at Motorway provision in other European countries also indicates a sparse provision in Britain as can be seen from figures 7 and 8. Figure 7 includes the seventeen largest EU states and shows Motorway provision in relation to car travel. By this measure of car traffic, the UK ranks next to the bottom of the European League. The ten smaller states, (NB Latvia and Malta do not have any Motorways), have approximately twice the provision of Motorways as the UK by this measure. Looking at provision in relation to road freight the picture is similar, with the UK raking 15th out of the seventeen largest states and again having provision less than half the level of the ten smaller states.

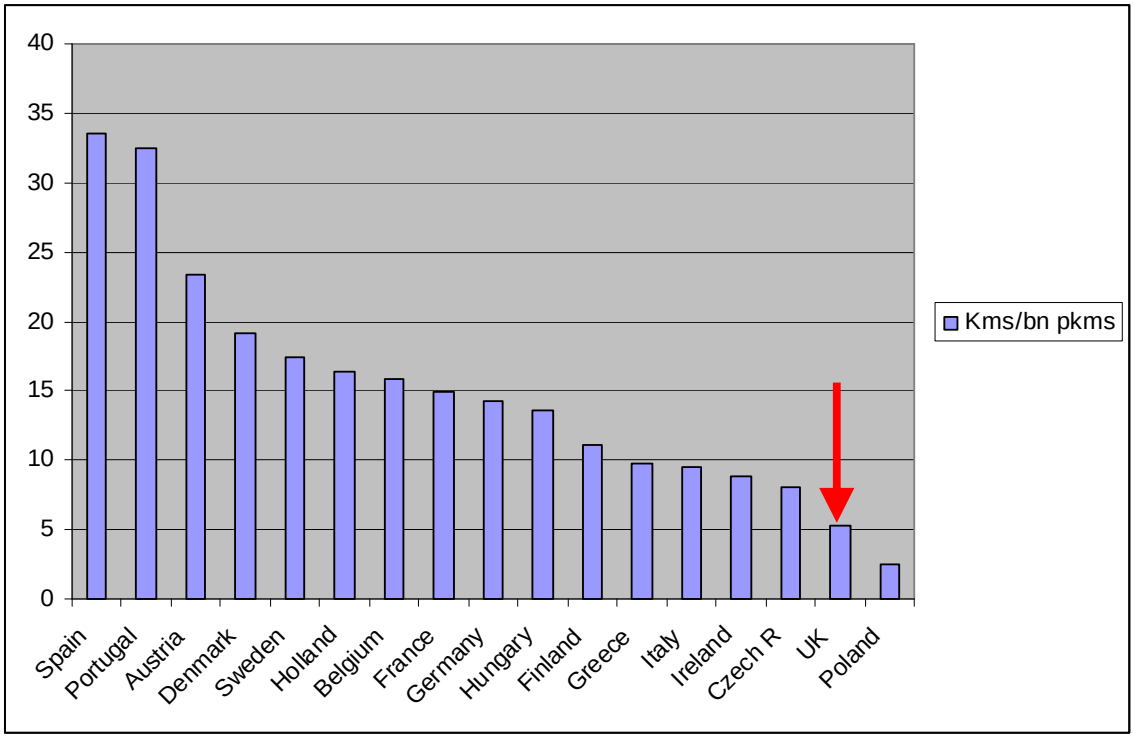



Figure 7: European Motorway Provision Related to Car Traffic 2006[9]

It is sometimes argued that whilst Britain may not have a large Motorway system in relation to its population and amount of traffic, it does in relation to its area. The UK ranks 13th by this measure – lower than large countries such as France and Spain[10].

These indicators point to Britain being poorly provided for with Motorways, in relation to its traffic needs and the general standards of provision in the rest of Europe.

[9] Source EU Energy and Transport in Figures tables 3.3.4 & 3.5.1.
[10] European Road Statistics 2006 (table 2.4) , European Union Road Federation, Brussels 2006

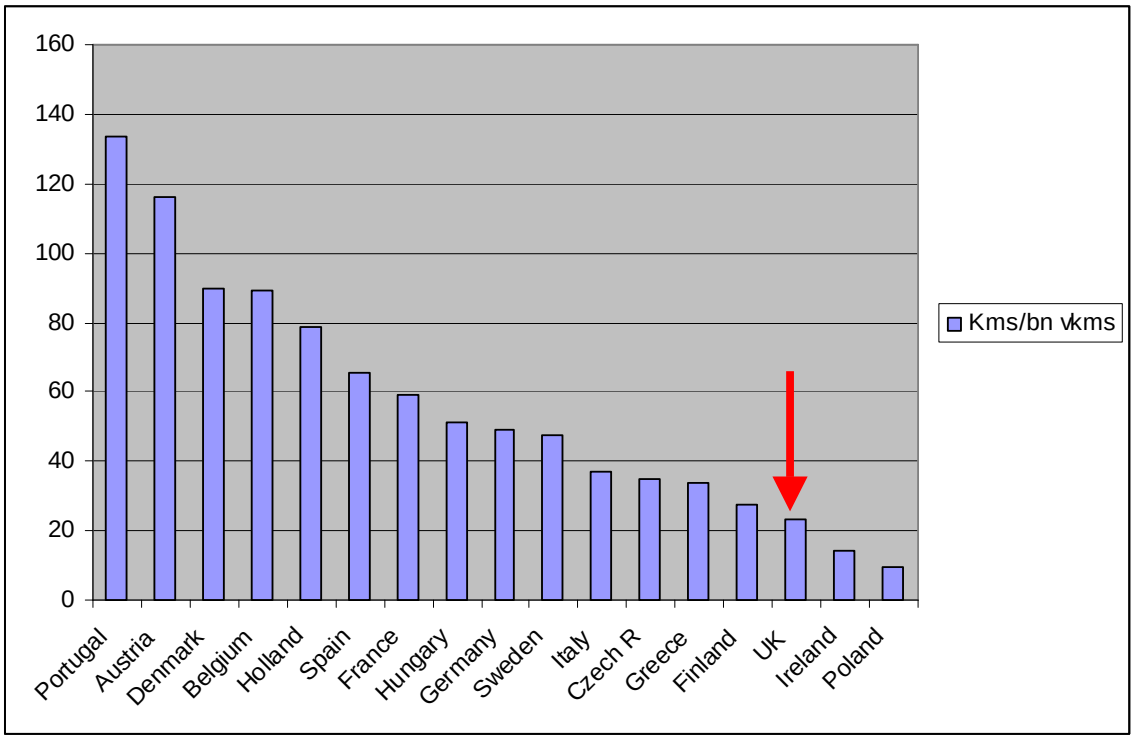
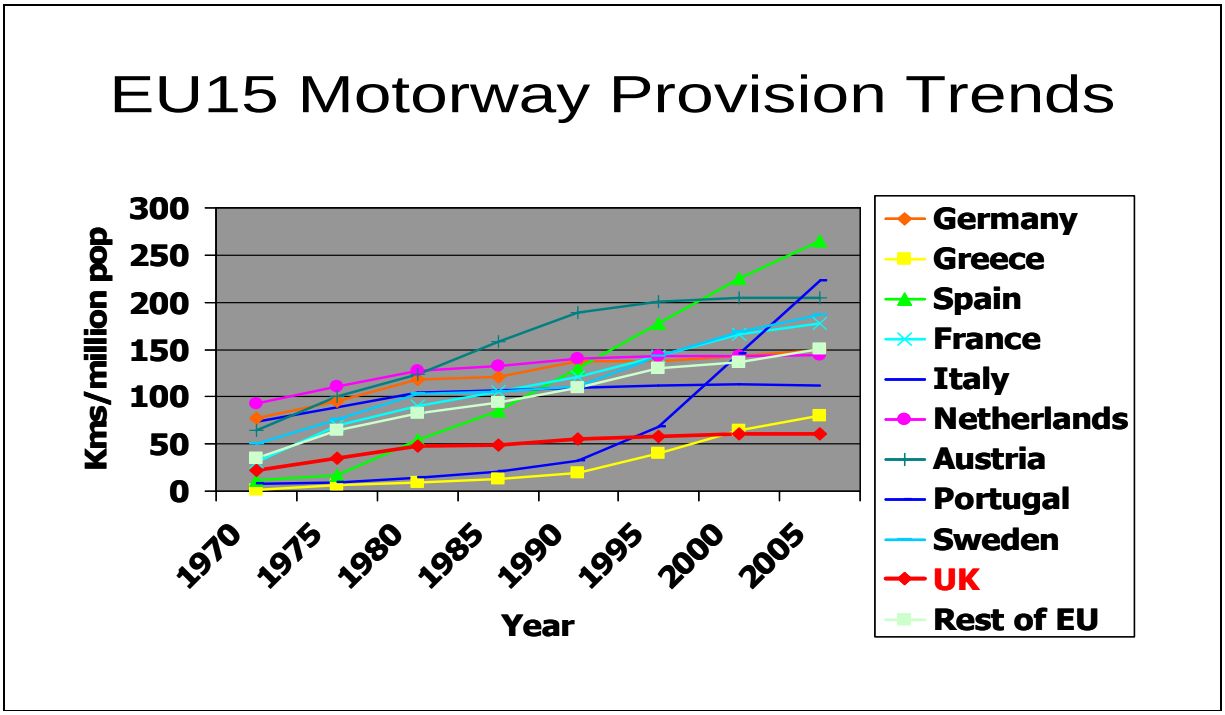



Figure 8: European Motorway Provision Related to Freight Traffic 2006[11]

Figures 7 and 8 provide a snapshot at one point in time rather then how national Motorway systems have been growing. Figure 9 plots the trajectories of Motorway growth of the ten largest European countries. From this it can be seen that as far back as 1970 the UK had relatively poor Motorway provision in relation to its population and has steadily fallen further and further behind from seventh place to tenth. In 1970 its provision level was 44% of the top ten European average and by 2005 this had fallen to 41%. Even if the three and a half thousand kilometres of dual carriageway all-purpose trunk roads are taken into account, the provision rate (per capita) in the UK is still only 80% of that in other larger European countries and this ignores their extensive networks of good quality non- motorway main roads.

[11] Source EU Energy and Transport in Figures tables 3.2.4a & 3.5.1.




*Source: EU Energy and Transport in Figures tables 1.5 & 3.5.1.*

Figure 9: Growth of Motorways in Larger European Countries 1970 – 2005

**Some implications of motorway network density**

The low density of the Motorway network has other important implications. Many parts of Britain are distant from a Motorway or good quality trunk road, and so, other than for the very longest of journeys most trips, have to be made on conventional roads with frontage properties and other activities. This results in a lower service level to through traffic and often a nuisance to pedestrians, frontages and local traffic. The concentration of trunk road capacity enhancement that has occurred in recent years means that much movement cannot benefit, as the sparse network simply does not provide a convenient route. As a consequence, many longer journeys (e.g. Oxford to Norwich, Northampton to Cheltenham and Southampton to Bristol) require passing through a string of towns and villages on roads poorly suited to modern traffic needs and to the detriment of the environment of many small and otherwise attractive towns and villages.

This concentration of improvements on the exiting network, particularly in the case of Motorways, does not reduce the vulnerability of the network in the way that the provision of new high quality links would do. By concentrating more traffic on the existing network, densities are increased, the likelihood of serious congestion increases, and the absence of ready alternative routes make the effects of network failure that much greater.

Another problem that is emerging with increasing Motorway pipeline capacity, is the problems of access and egress capacity, and the ability of junctions designed for much lower flows to carry the heavy loads being imposed on them.

An example of the first of these problems can be seen with the M25, where increased traffic densities resulted in mounting congestion in the mid 1990s. This was relieved by substantial remodelling of the slip roads to provide more space over a longer distance to feed traffic onto the main carriageways. Recent further increases in traffic, enabled through main carriageway widening, have once again resulted in access and egress congestion on a substantial scale and queues of a kilometre or more to enter and leave the busier Motorways (e.g. joining the M25 from the westbound carriageway of the M40) where remodelling has been necessary.

Many junctions between Motorways and access roads are two-level with the 'surface' component being a large diameter gyratory. Whilst adequate for the flows of the 1970s and 1980s these are becoming increasingly overburdened as traffic volumes mount. The use of signalisation has helped, but even with this an increasing number are overloaded. An example of this is the Handy Cross junction on the M40, which after initially being free flow, was then signalised for the peak period, then signalised all day, and subsequently, has had to be extensively remodelled to continue working reasonably. Continued widening and the use of other techniques to increase pipeline capacity, such as 'hard shoulder running,' will increase the pressure on these intersections. The two level gyratory junctions are not the only ones that that are being subject to increased stress, as the British Motorway system includes a range of *partial* free flow junctions, many of which can have their capacity increased significantly only by substantial remodelling.

The British Motorway network is very limited by European standards, and has been under increasing pressure since the 1980s when its growth slowed; traffic volumes continued to grow; and its appeal to heavy traffic continued to improve. Focusing improvements on a sparse core network, means that most traffic will not benefit, with much longer distance traffic continuing to use unsuitable roads; the core network coming under increasing stress; and major junction remodelling becoming a necessity.

**Past proposals for a national Motorway network**

Plans for a national Motorway and trunk road network have been proposed from time to time since the mid 1930s. Experienced highway engineers and administrators have drawn many of these up with contemporary and anticipated traffic needs in mind; and it would be surprising if these did not provide valuable pointers as to how today's Motorway network should develop.

In 1936 the Institution of Highway Engineers (now the Institute of Highways and Transportation) proposed a Motorway network comprising 51 routes with a total length of about 4,500 kms. If this is superimposed on a map of the United Kingdom figure 10 emerges.

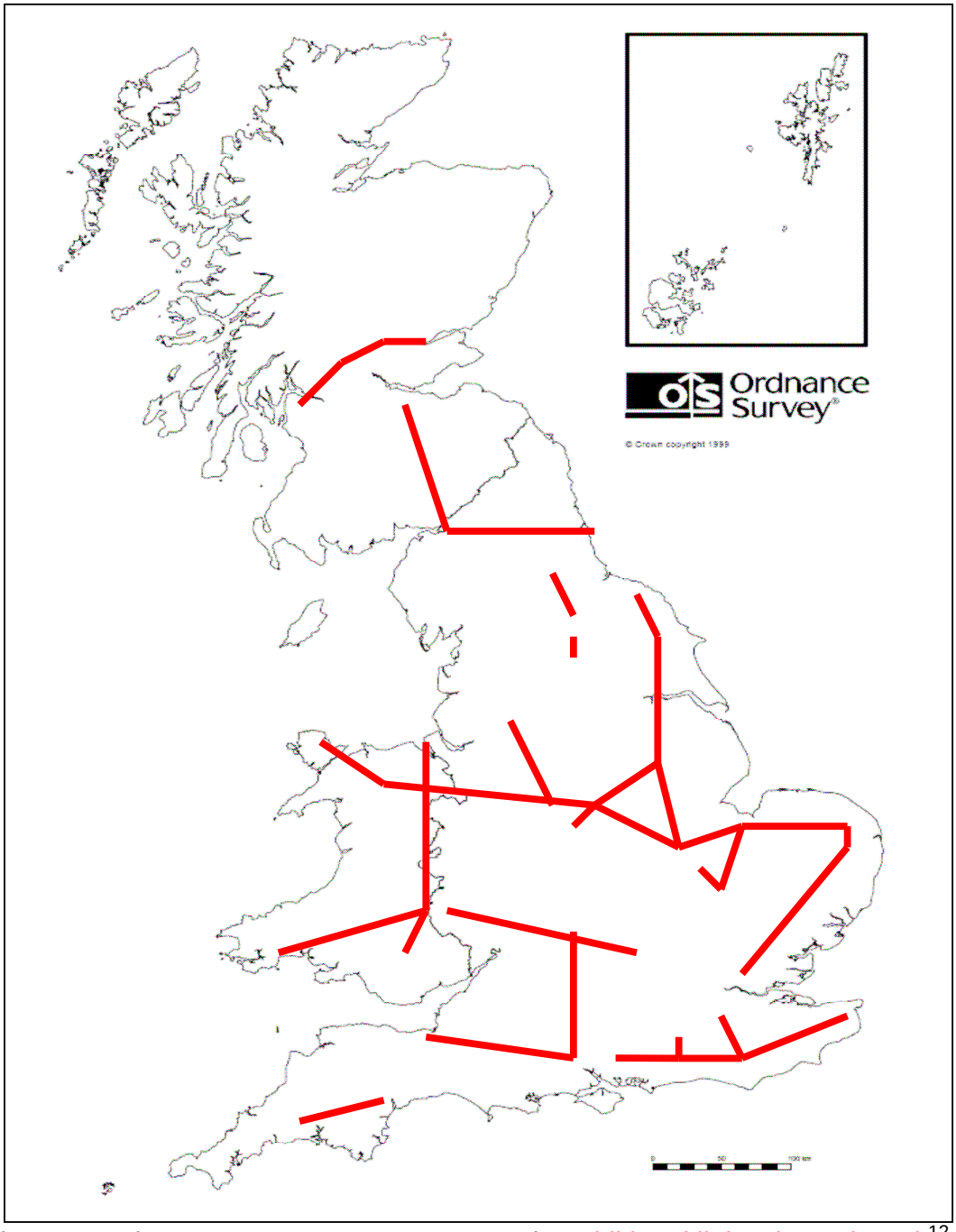



Figure 10: The 1936 IHE Motorway Proposals, additional links shown in red.[12]

[12] Source: A History of British Motorways page 12.

As the 1936 proposals were schematic and the match between the existing network and its core proposals is only approximate, this figure can be no more then illustrative. However, there is a good level of correspondence between its core network and what has subsequently been built. Moreover, where some links have not been built, such as between Crewe and Bangor, high quality non-Motorway trunk roads have been built – in this case the A55. On the other hand, there are still no decent links in some other corridors such as between Crewe and Nottingham.

It is clearly questionable whether all these links would be justified by today's more demanding standards for road schemes. However, if the entire network had been built, it would not have changed the UK's position in the European league table in relation to passenger car traffic, although it would have moved its ranking on freight traffic up one place.

Following a visit to see the developing German Autobahn network in 1938 the County Surveyors Society proposed a more limited (2,000 km) network, which is illustrated schematically in figure 11. This differs from figure 10 in that the entire proposals are shown and the proposals again correspond quite well with the built network. The exceptions to this are:

- The omission of any Motorways to the east of London and to the south coast east of Portsmouth;
- The omission of a Motorway to the West Country, and;
- The inclusion of a link between Carlisle and Newcastle.

Shortly after the end of the Second World War, the Ministry of Transport published a plan for National Motor Roads. This followed the expansion of the trunk road network to 13,175 kms. This is illustrated in figure 12 and comprised a Motorway network of about 1,700 kms including a London Orbital, plus an improved core trunk road network of about 2,900 kms in length. The Motorway proposals subsequently formed the core of the built network, but with some subsequent editions, notably:

- The M40;
- The M3;
- The M11, and;
- The M8.

Also some proposals to improve exiting roads were changed to Motorway schemes, such as the M5 in South Wales and the M6 north of Penrith. It is striking that there were no proposals to improve the A40 London to Fishguard route, as this subsequently was replaced by the M40, between the London Orbital and Dorridge in the South Midlands.

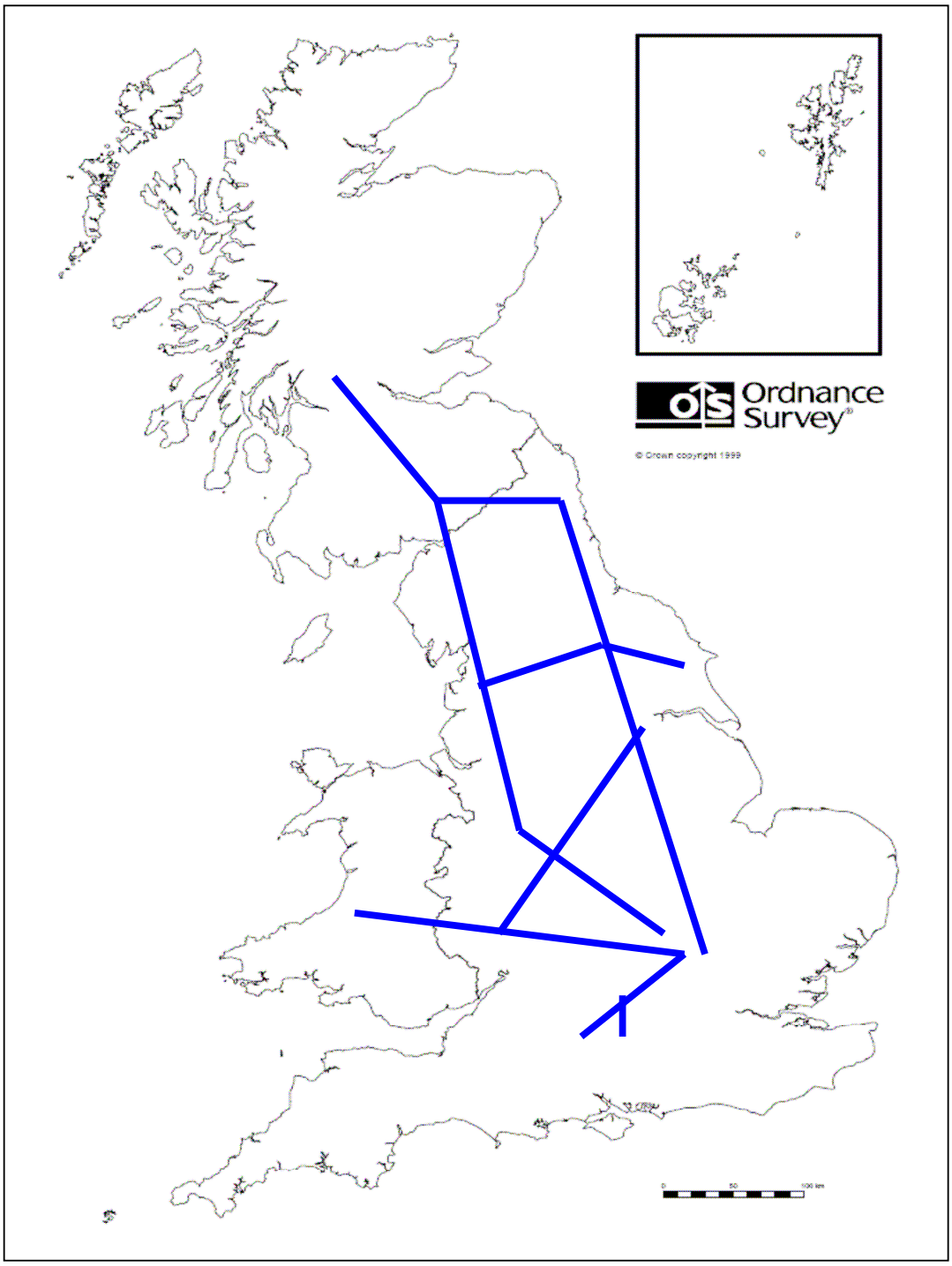



Figure 11: The 1938 CCS Motorway Proposals, shown in blue.[13]

[13] Source: A History of British Motorways page 15.

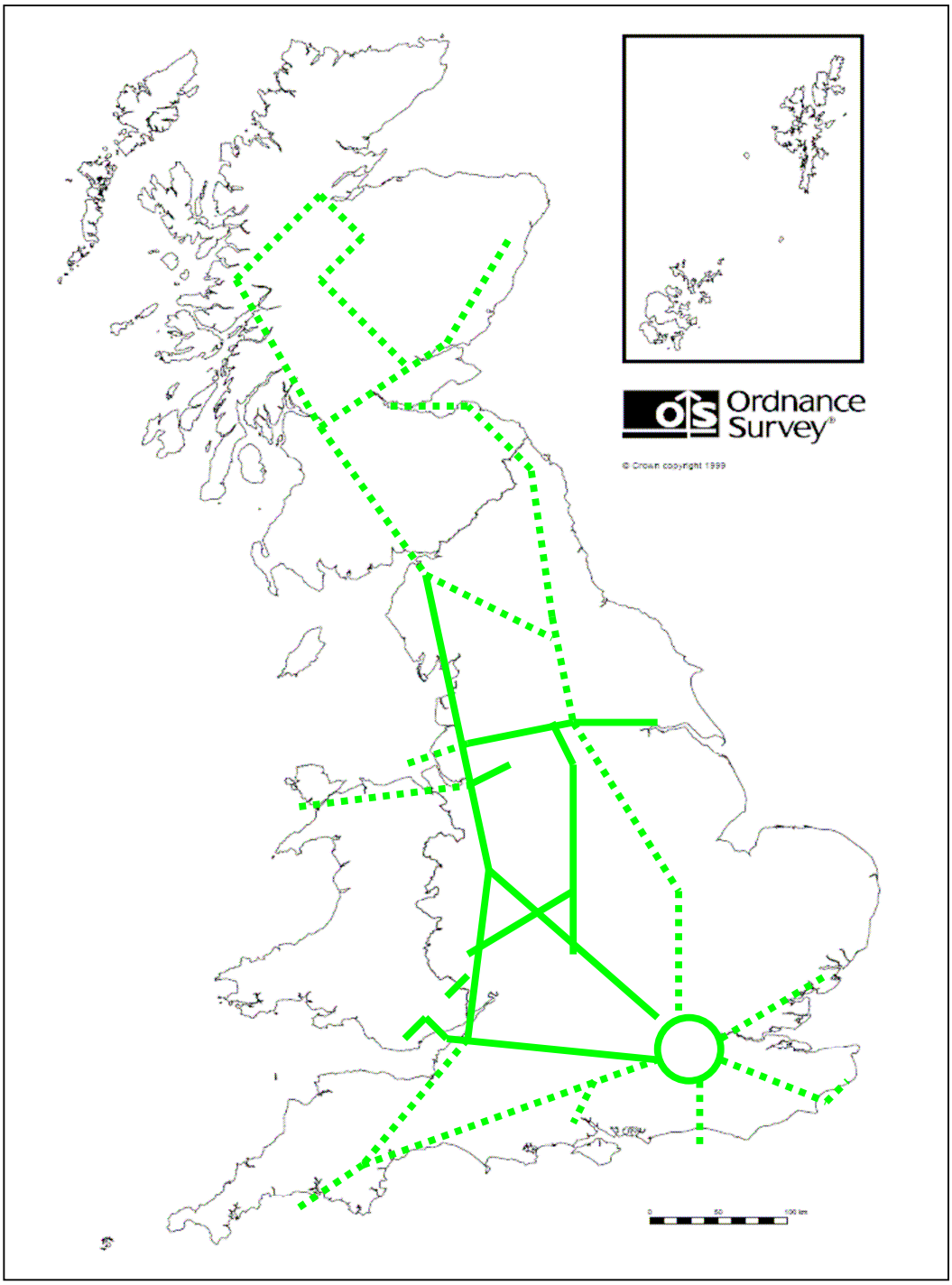



Figure 12: The 1948 MoT Proposed National Motor Roads Proposals, Shown in Green[14] Solid lines – Motorways; Broken lines – Improvements to Existing Routes

[14] Source: The Kings Highway, page 156.

Subsequent events have therefore generally resulted in proposals for the improvement of existing roads to be replaced by new Motorway routes but with the addition on some new routes. Perhaps the most important of these has been the M40, which provided an alternative to the hard-pressed M1 between London and the Midlands, as well as improvements in the London/Oxford/Warwick corridor in its own right. More recently, the M6 toll road between Water Orton and Cannock has provided relief to the parallel section of the original M6 in this corridor, whilst avoiding major road works in a heavily built up area.

A similar solution to the problem of overload on the M6 between Birmingham and Manchester would have similar advantages, but has not been taken up by the DfT as it would cost 15% more and take 50% more land. It is also argued that its construction would cause significant disruption to the existing M6,[15] although it is hard to see how this could be worse than widening the existing road, which could not be fully-open to traffic until 2017.

The County Surveyors Society formulated another set of proposals in 1968 and these are shown in figure 13. Clearly this is by far the most ambitious network that has been put forward by a professional body. Its length would amount to an additional two and a half thousand kilometres or so. As such, it would move the UK up to 14th position in the major European passenger car traffic provision league and 11th in the freight transport provision league. An interesting feature of this proposal is the substantial number of new links – especially in the east and the provision of a complete N/S Motorway link on both sides of the Pennines with a substantial increase in capacity in the heavily developed South East /North West corridor. Additional orbital capacity is proposed well outside the London area, so easing pressure on the M25, whilst direct links between the West Midlands, North Wales and South Yorkshire ease pressure on the M6 north of Birmingham.

In 1974 the Government drew up its proposals for the signing of the European Road Network in the UK. The pattern for Britain is shown in figure 14. Clearly this had to be based on existing roads and so did not include any new routes, however it does give an indication of what were considered to be the most important routes from an international perspective, taking account of a range of factors. This includes some routes that have not featured in proposals for strategic route improvements since the IHE plan of 1936. These include:

- A north/south cross country route between Birmingham and Southampton;
- An east/west route between Birmingham and the east coast ports of Felixstowe and Harwich;
- A link between Carlisle and Stanraer, and;
- A link between Swansea and Cardiff.

[15] Government News Network 20th July: Decision on M6 upgrade announced.

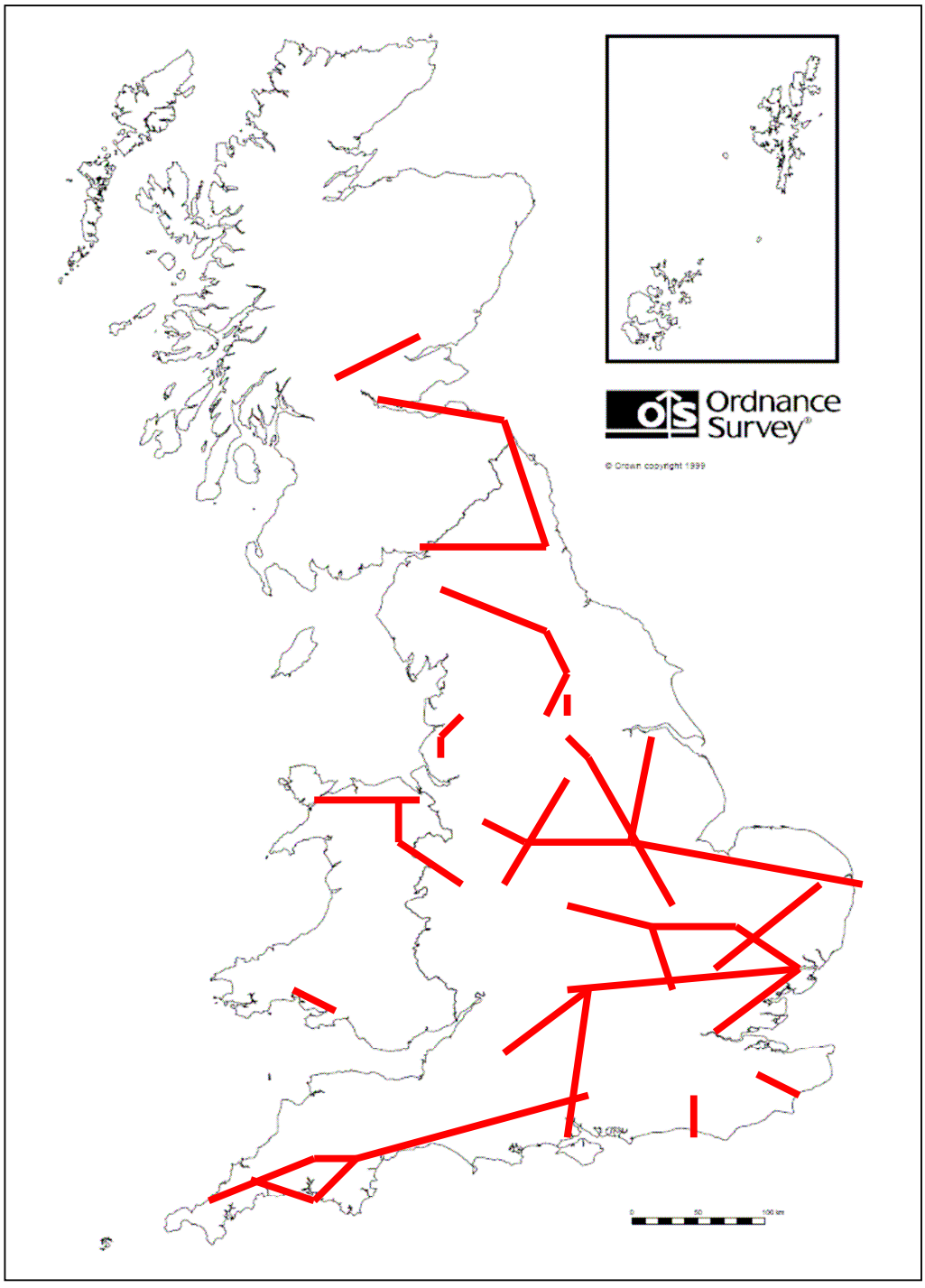



Figure 13: The 1968 CSS Proposed National Motorway plan, Additional Links Shown in Red

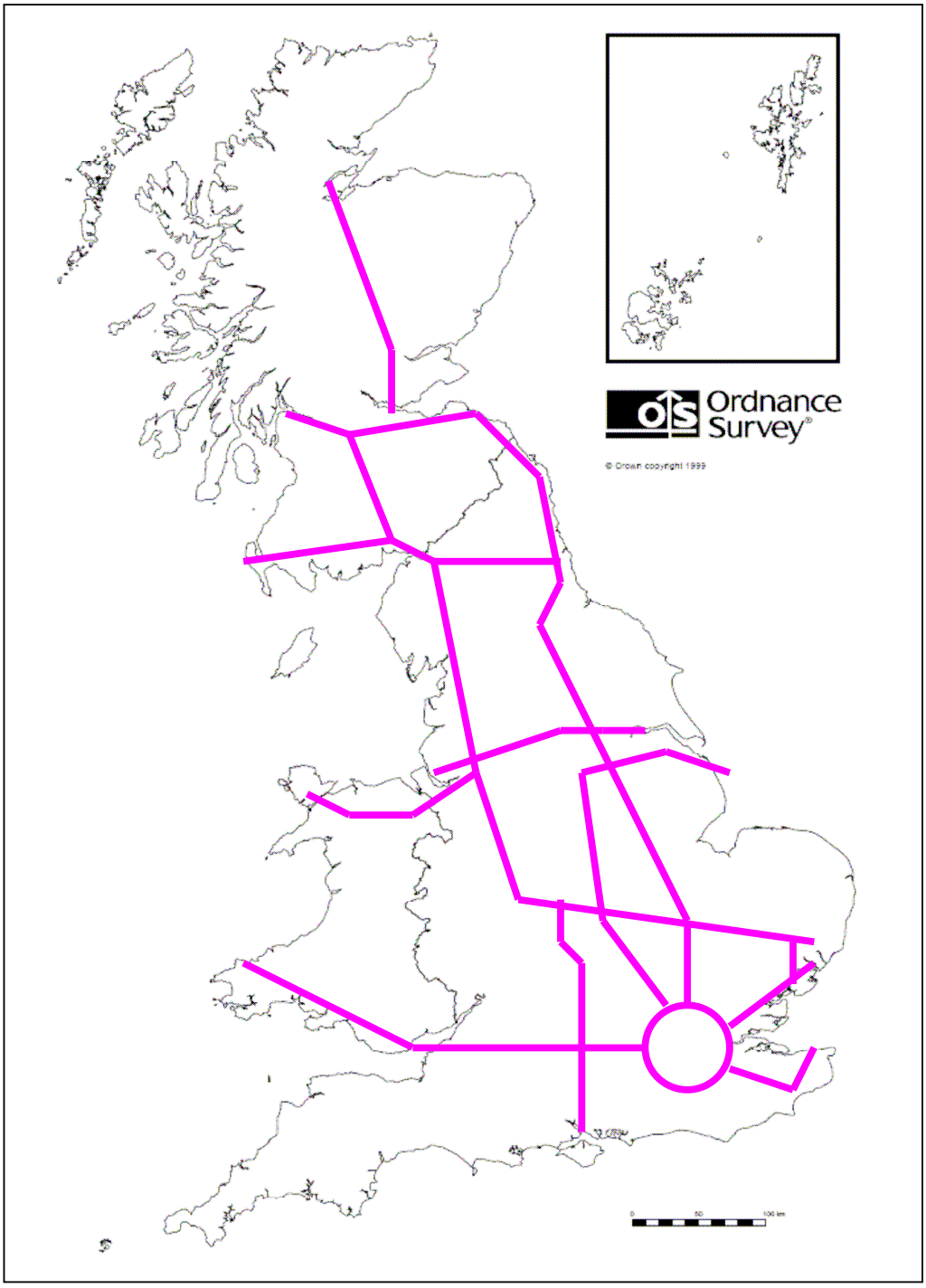



Figure 14: The 1974 Proposed Network of International E Routes, Shown in Pink

As such, connections to ports, which may not carry heavy volumes of traffic generally, but are important for international trade, were given status in this network.

The E Route network was defined by the United Nations Economic Commission for Europe in 1975, but has largely been ignored by the Government and Highways Agency.

In 1971 the then Government set out its six main aims for the trunk road programme for England[16]. These were:

- To achieve environmental improvements by diverting long distance traffic and particularly heavy good vehicles from a large number of towns and cities so as to relieve them of dirt, noise and danger;
- To complete, by the early 1980s, a comprehensive network of strategic trunk routes to promote economic growth;
- To link the more remote and less prosperous regions with this new national network;
- To ensure that every major city and town with a population of more than 250,000 would be directly connected to the strategic road network and that towns with populations of more than 80,000 would be within 10 miles of it;
- To design the network to serve all major port and airports, and;
- To relieve as many historic towns as possible, of through trunk road traffic.

This said little about the standards to which the strategic road network should be built or improved, but with more than half the trunk road network being formed of single carriageway all purpose roads in 1980[17]; the M25 barely started; the M40 only reaching as far as Oxford; and no A74 (M), it is difficult to argue that these objectives were achieved.

In 1989 the Department for Transport produced a White Paper proposing an expanded Motorway and trunk road programme[18]. This came at a time when new traffic forecasts had been prepared and these were rather higher then those previously made. These are shown as the highest trajectory in figure 15.

[16] Roads in England 1971, Department of the Environment, HMSO, London 1972.
[17] TSGB 1972 – 1982 table 2.32.
[18] Roads for Prosperity, Cm 693, Department of Transport, London, May 1989.

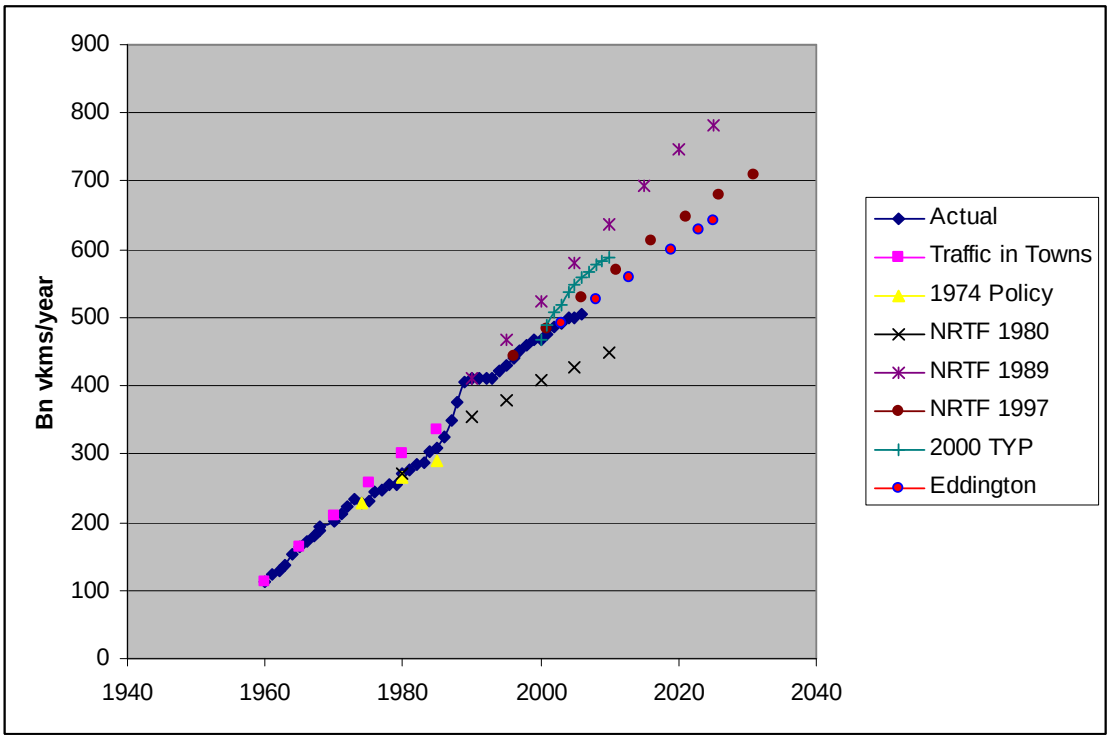



Figure 15: Traffic Trends and Forecasts 1960 - 2031

At that time, the schemes in the trunk road programme were estimated to cost £9bn+ (at 2006 prices) and the additional schemes were thought to cost a further £10bn - £11bn. This totalled up to a £20bn road construction programme for the 1990s, with the timescale aim of programme entry to opening to traffic being 4 years. The aims of the programme were:

- To assist economic growth by reducing transport costs;
- To improve the environment by removing through traffic from unsuitable roads in towns and villages, and;
- To enhance road safety.

The programme would have added over 4,300 kms of new or widened roads to the trunk road network and a number of corridors were identified where new capacity was thought to be necessary in the longer term (possibly including new routes). In the absence of a comprehensive study of new networks, most of the improvements were to existing roads. The busiest sections of Motorways were to be widened to dual 4 lanes with improvements to key junctions. The A1 was to be extensively improved at an estimated cost of £¾bn (2006 prices) and about two and half thousand kilometres of dual trunk routes improved, including substantial lengths of single carriageway.

One hundred and forty kilometres of new routes were proposed; the most significant of which was the Aylesbury to Braintree outer orbital route, although eleven corridors were identified for the provision of further capacity (see figure 16). Also, 14 hot spots and busy junctions (e.g. on the Derby Ring Road) were identified as requiring attention.

More recently, Government proposals for the future road network were set out in The Future of Transport[19] and broadly this proposed:

- Improving road safety;
- Providing additional road capacity where justified in light of wider impacts;
- Managing the network to improve its performance;
- Facilitating 'smart choices' as alternatives to car use, and;
- Developing new ways of paying for roads.

This plan makes no proposals for any significant new roads and envisages capacity increases through widening of existing roads and better management. This approach was reiterated in the Government's response[20] to the Stern[21] and Eddington[22] reports. In its most recent policy statement on roads[23] a similarly cautious approach to new roads is taken – and to national road pricing as well.

The recent work carried out for the RAC Foundation[24] produced an illustration of a possible Motorway/high quality motor road network, striking balances between easing congestion and improving accessibility and between new roads and the widening of existing routes. This is shown in figure 17.

[19] The Future of Transport a network for 2030, Department for Transport, July 2004
[20] DfT (2007) Towards a Sustainable Transport System Supporting Economic Growth in a Low Carbon World.
[21] Stern (2006)
[22] Eddington (2006).
[23] Department for Transport (2008), Roads – Delivering Choice and Reliability, Cm 7445 London, July
[24] Banks, Bayliss & Glaister (2007).

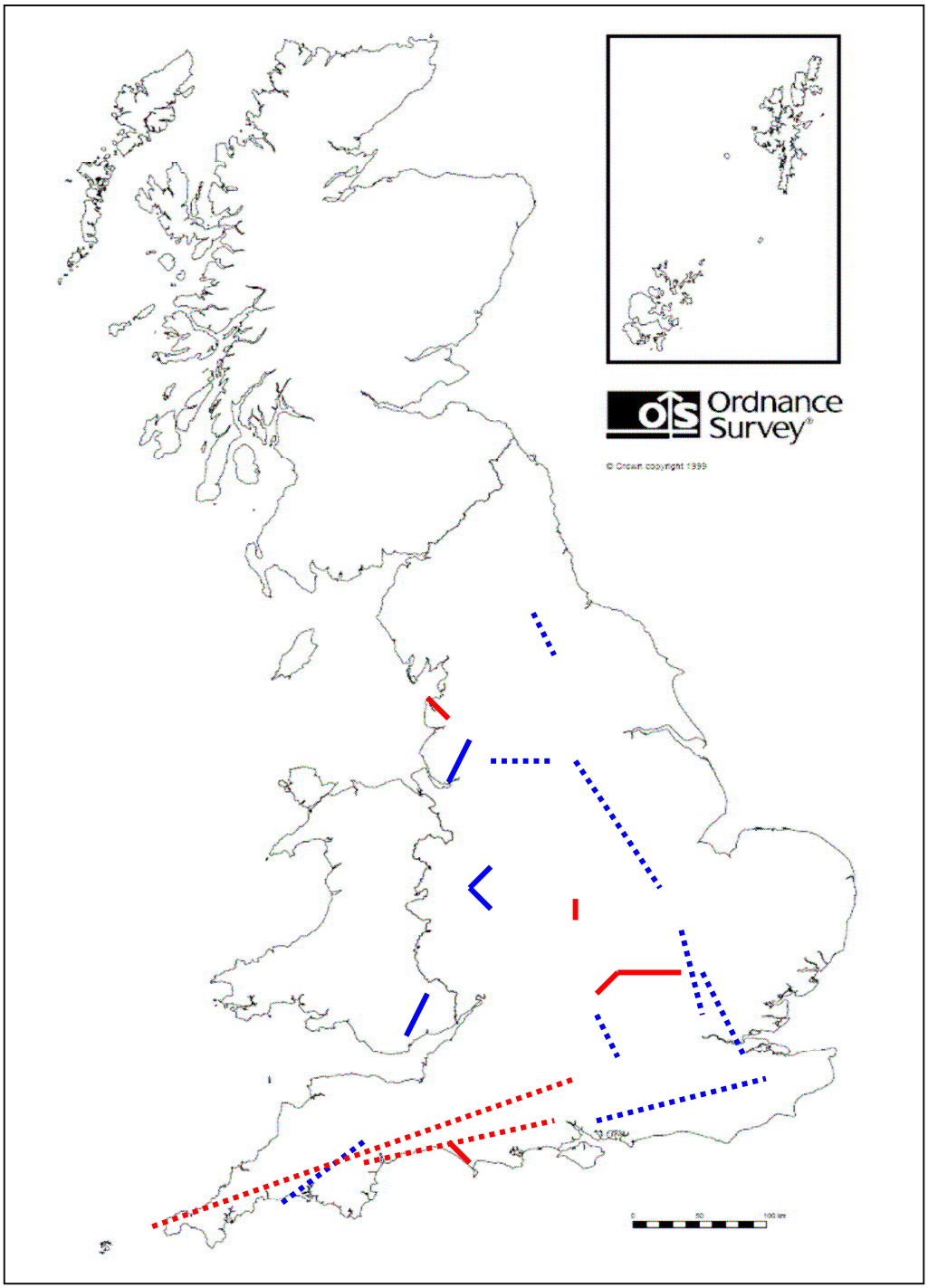



Figure 16: Roads For Prosperity. New routes shown solid and study corridors shown dotted: Motorways Blue and All Purpose Roads in Red

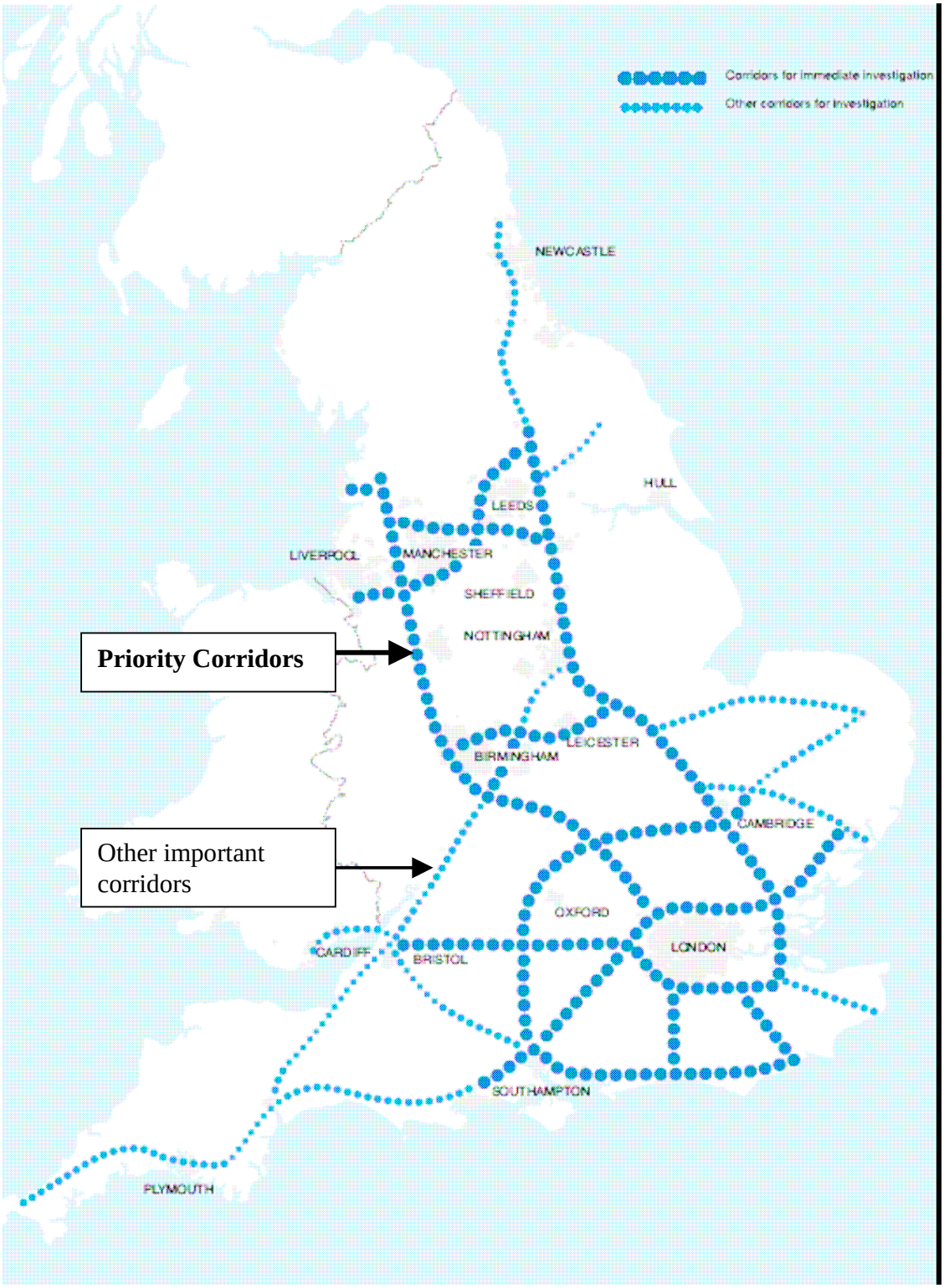



Figure 17: Illustrative Network for England from 'Roads and Reality'

## Conclusions

Much light traffic (cars and vans) is for trips of relatively short length, although the proportion of longer trips has been growing for heavy traffic. This means that the strategic road network can only provide for part of a small proportion of trips, but because these are the longest journeys, it carries a substantial proportion of traffic. About 60% of heavy traffic and 17% of light traffic have journey lengths of over 100 kms and so are strong candidates for using the sparse core of the strategic road network – Motorways.

Whilst the proportion of traffic using non-Motorway trunk roads has hovered between 15% and 20% since 1970 (apart from a recent decline as a result of de-trunking) the proportion using Motorways has climbed steadily from about 5% in 1970, when the Motorway network was just over one thousand kilometres in length, to 20% today, with it having grown to over three and a half thousand kilometres in length. This effect has been more marked for heavy traffic where the proportion has increased from 10% to over 40%. What is remarkable about this increase is that it has not slackened as the growth in the Motorway network has declined. Between 1970 and 1986, when the M25 was completed, the Motorway network grew by 1,860 kms and the volume of traffic on it increased by 31bn vkms/year. However, since then, it has grown by less then a third of that (600kms) whilst traffic has grown by 56bn vkms.

This has resulted in a near doubling of Motorway traffic densities since the mid 1980s; from average daily flows of 38 thousand to over 75 thousand today. To some extent this will have been ameliorated by the widening of the most congested section of the network, however congestion is now a daily event on substantial stretches of the system.

The limited amount of Motorway construction over the last twenty years means that Britain is poorly provided for compared with most European Union countries. Using car traffic and HGV traffic as indicators, the UK comes 23$^{rd}$ out of the 27 EU countries, and in relation to its land area, the UK ranks 13$^{th}$ by this measure – lower than large countries such as France and Spain.

The sparseness of the Motorway network brings with it a number of disadvantages including:

- Many journeys not being able to take advantage of Motorways because there are none nearby since the network does not serve large areas of the country. This means many long distance journeys have to use unsuitable roads, causing a nuisance to frontages and delays to local traffic, as well as poor and less safe driving conditions for through traffic;

- High traffic densities and a lack of reasonable alternative routes which make them vulnerable to disruption, and;

- Great strain being put on junctions and feeder roads that were designed for lower flows caused by widening operations to increase capacity.

Over the last 70 years, a number of proposals have been drawn up for the development of the national Motorway network. Even in the mid 1930s proposals were made, following the examples of Italy and Germany, for a network of national motor roads. At this time, there were less than 3 million vehicles on the roads[25] and motor traffic was about 45bn vkms[26] – less than a tenth of today's[27]. Early proposals were clearly based on providing a network of speedy and safe connections between the main centres of population and industry and the principal ports, as existing arterial roads were generally poorly suited to fast and heavy motor traffic and road casualty rates were very high[28].

The basic elements of the Motorway network appears to have been established shortly after the Second World War when traffic volumes were at similar levels to those of the mid /late 1930s[29] and it was unlikely that policy makers had any real feel for how traffic was likely to grow[30]. Since then, there have been some additions to the basic plan, but over the last two decades the approach has been to expand the capacity of the existing trunk road network, rather than to create new links which could provide relief to the present hard-pressed system and improve connectivity and reach to areas not well serviced.

From past plans, the main additions to the Motorway network would be:

- A south east orbital improving good cross regional links and easing pressure on the M25 including a South Coast route;

- Additional links in the core SE/Midlands/NW corridor to relieve pressure on existing Motorways;

- Extensions from the basic core further into peripheral parts of the country, especially where there are major ports, and;

[25] The Motor Car and Politics, Stephen Plowed 1970, Appendix B.
[26] TSGB 2001 table 9.7 gives 46.7bn in 1938.
[27] Roads Traffic Statistics 2005, table 1.1 – 499.4 vkms in 2005.
[28] In 1938 there were about 142 fatalities per billion vkms compared with 6.4 today – a factor of 22.
[29] TSGB 2001, table 9.7 – 46.5bn vkms in 1949.
[30] In the Ministry of Transport's Greater London Highway Development Survey of 1937 (page 10) it was expected that traffic levels would increase by a factor of four plus any increase in population. Allowing for the subsequent 25% increase in population this would mean traffic being no more than 235 vkms – less than half today's levels.

- Additional east/west links, notably in the North and East Midlands to provide links between the M6 and A1(M) and centres such as Cambridge and the Midlands.

A variant of the second of these proposals is a new East Coast Route,[31] which would run from Newcastle -upon- Tyne via Hull, Peterborough and Cambridge, to connect with the M11, so easing pressure on the A1(M) and improving the development prospects of large areas of East England.

Whilst a rigorous case for these has not been made, they deserve consideration in any review of future roads' needs, as they address the issue of overload of the core network and bring regional development concerns into play.

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[31] East Cost Route Catalyst, R. Lane, D. I. Evans and P. F. Wilkes, Proceedings of the Institution of Civil Engineers, Civil Engineering November 1992.

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## Appendix: Estimates of Road Traffic Trip Length Distribution

Introduction

The strategic road network mainly carries traffic in longer journeys as, because of its sparseness the time and cost of getting to and from the network is not worth the advantage of its higher speeds and greater safety except in the minority of cases where shorter distance journeys are closely aligned with it.

To get a feel for how much traffic would be attracted to strategic networks of different densities it is necessary to have an understanding of road traffic trip length distributions. Such information is not directly available and has to be estimated from other relevant data. This appendix provides such an estimate for the four principal types of road traffic.

Heavy Good Vehicles

HGVs traffic comprised 29.1bn out of a total of 506.4bn vkms in 2006[32] - 5.8%. However it forms a higher proportion (9.6%) of non-Motorway trunk road traffic: 6.2bn vkms out of total of 64.8bn and an even higher proportion (12.2%) of Motorway traffic: 12bn vkms out of a total of 97bn[33]. This is consistent with its long average journey length of 86 kms[34] with articulated vehicles having and average haul length of almost three times that of rigid vehicles (124kms against 43kms).

Information is available on goods traffic – tonne-kilometres- journey length distributions and this is reproduced in table A1.

| Length Range | Rigid tkms | Artic tkms | All tkms | Rigid vkms | Artic vkms | All vkms |
|---|---|---|---|---|---|---|
| <25kms | 5.56bn | 2.03bn | 7.62bn | 1.70bn | 0.19bn | 1.89bn |
| 25-50kms | 6.99bn | 5.90bn | 12.89bn | 2.12bn | 0.55bn | 2.67bn |
| 50-100kms | 8.12bn | 15.70bn | 23.82bn | 2.47bn | 1.48bn | 3.95bn |
| 100-150kms | 5.18bn | 17.07bn | 22.25bn | 1.57bn | 1.61bn | 3.18bn |
| 150-200kms | 3.22bn | 18.29bn | 21.52bn | 0.98bn | 1.72bn | 2.70bn |
| 200-300kms | 4.18bn | 28.91bn | 34.70bn | 1.28bn | 2.86bn | 4.14bn |
| >300kms | 3.53bn | 30.52bn | 32.97bn | 1.08bn | 2.86bn | 3.84bn |
| All | 36.82bn | 118.94bn | 155.76bn | 11.22bn | 11.18bn | 22.4bn |

*Source: Road Freight Statistics 2006 tables 1.12, 1.13 & 1.25*.

Table A1: HGV Trip Length Distributions

[32] Transport Statistics Great Britain 2007, table 7.1.
[33] Transport Statistics Great Britain 2007, table 7.3.
[34] Road Freight Statistics 2006 table 1.6.

However in order to obtain vehicle kilometres tonne kilometres has to be factored by the average vehicle load which we know to be 3.3 tonnes for rigid HGVs, 10.72 tonnes for articulated HGVs and 6.69 tonnes for all HGVs[35]. If we factor rigid and articulated tonne kilometres for each distance range we get vehicle kilometres for each distance range as shown in the last three columns of table A1. The resulting traffic length distribution pattern is shown in figure A1.

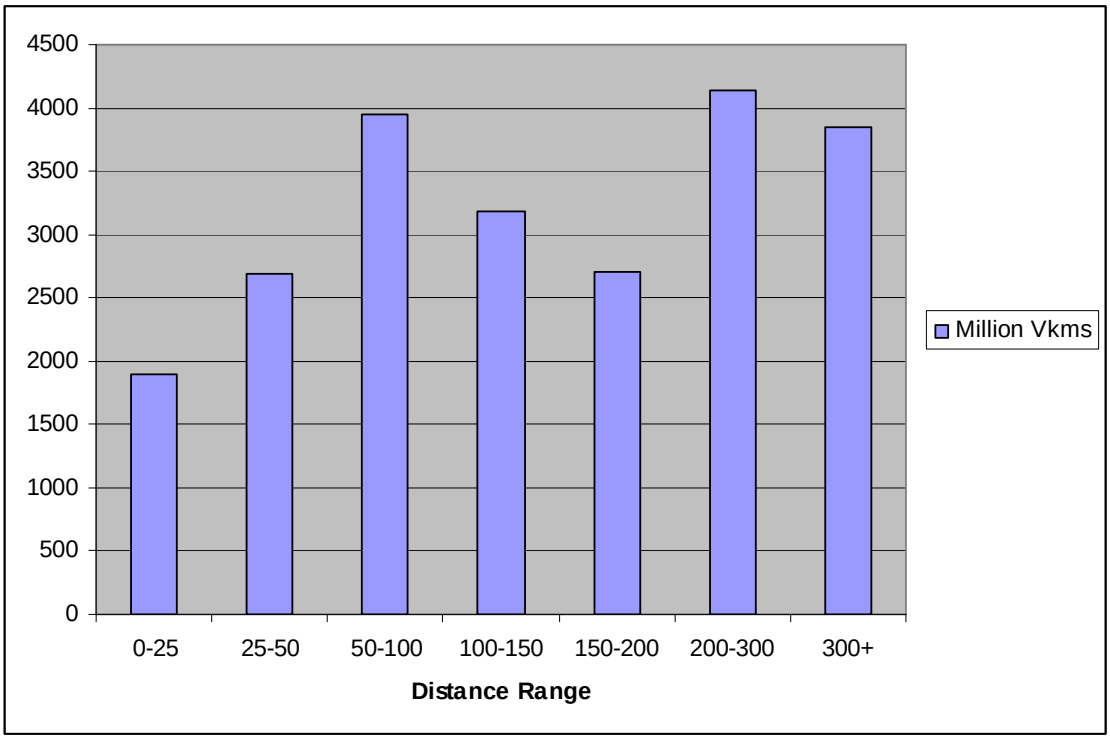


Figure A1: HGV Billion Kilometres by Journey Length Range 2006

The data on which figure A1 is based are not for even intervals and this should be taken into account in interpreting it. If even intervals were used the picture would be more like that in figure A2. This has been formed by taking known data and distributing it between the new sets of ranges such that the total traffic volume is maintained; totals for individual corresponding sets are maintained and totals within larger sets have been divided to give a typical smooth tailed distribution. This use of quite wide standard ranges masks the build up from shorter journeys to be seen in figure A1. However this is not particularly important for consideration of strategic road use as most of the traffic would use these roads.

[35] Road Freight Statistics 2006 table 1.12 &1.13.

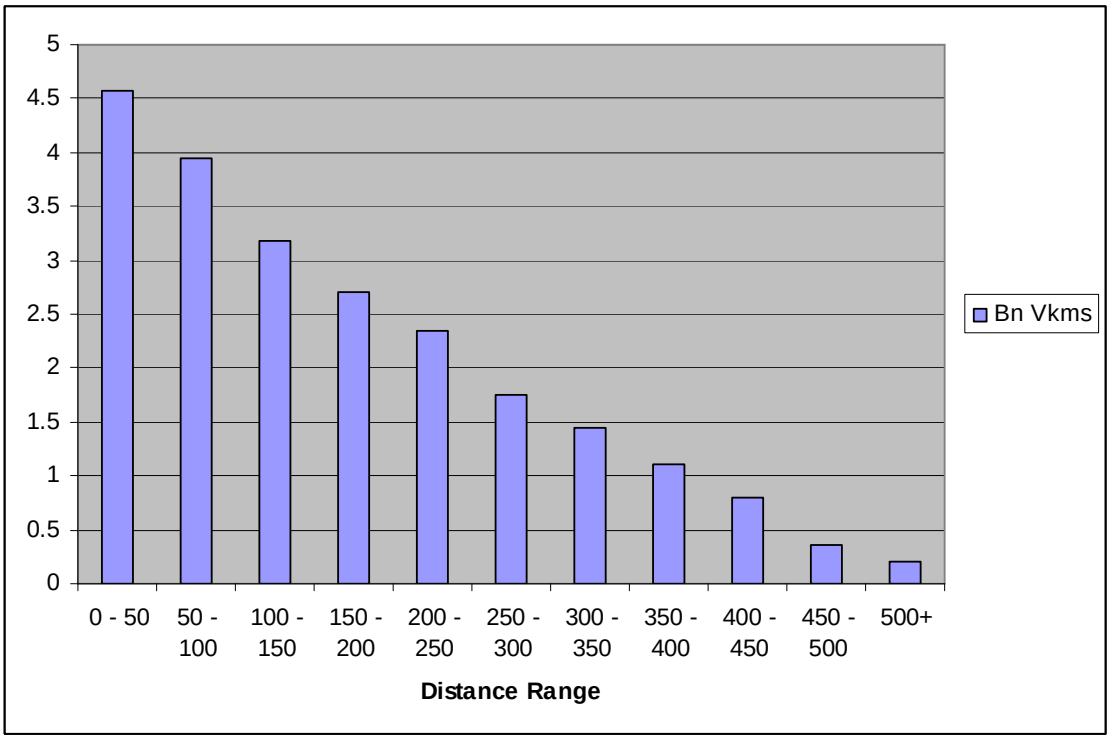


Figure A2: Regularised HGV Trip Length Distribution Britain 2006.

Vans

Van traffic comprised 64.3bn (12.7%) of the total on 506.4bn vkms of motor traffic in 2006. Again vans have longer average journey lengths than road traffic as a whole making up 11.8% of non Motorway trunk road traffic and 11.6% 0f Motorway traffic[36].

There are (unpublished) data on the trip length distribution for company owned van traffic, from the 2004 survey of van activity[37], which have been obtained from the DfT[38] this is shown in figure A3. Due to under-reporting the traffic volumes have to be factored up to match the road count data.

From the van survey 33.81bn vkms were covered in 2004. For 2002/03 a separate survey reported distance travelled by privately owned vans as 11.69bn vkms[39]. Adjusting for growth to 2006 these sum to 49.07bn vkms[40] - 76.3% of the reported total of 64.3bn. The resultant traffic distribution is shown in figure A4.

[36] Transport Statistics Great Britain 2007, table 7.3.
[37] DfT Survey of Van Activity 2004.
[38] E mail from T Spencer 29 September 2006.
[39] Survey of Privately Owned Vans results of survey; October 2002 – September 2003, table 8.
[40] Factors of 1.14 from 2002/03 and 1.058 for 2004 (Transport Statistics Great Britain 2007 table 7.1).

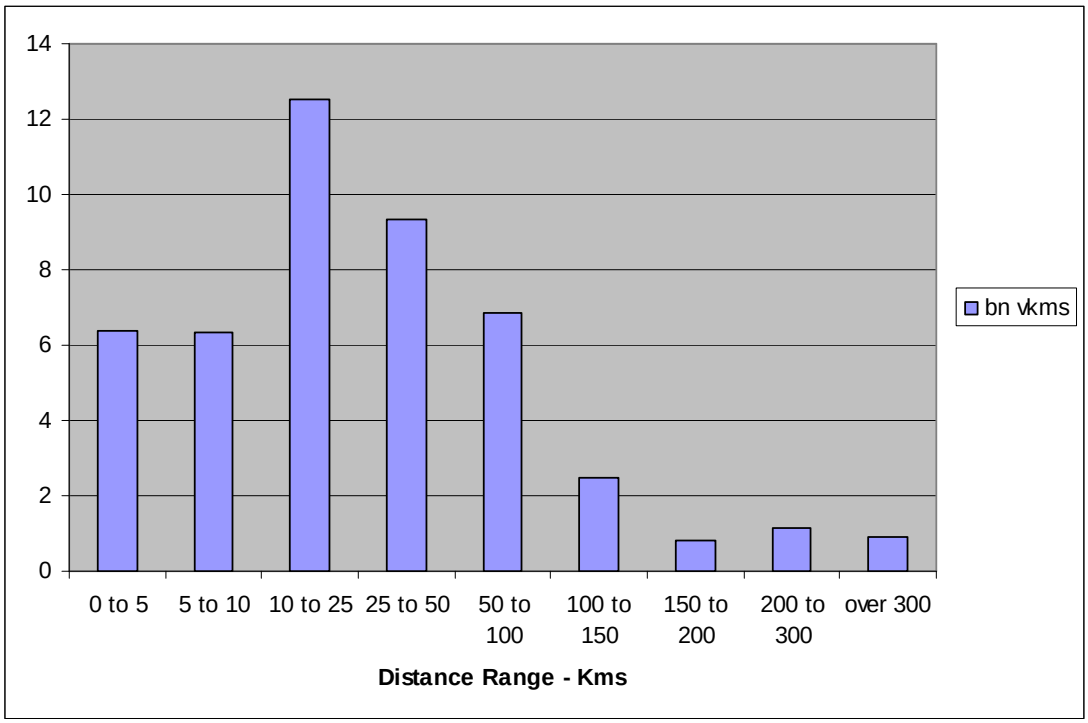


Figure A3: Company Owned Van Billion Kilometres by Journey Length Range 2006

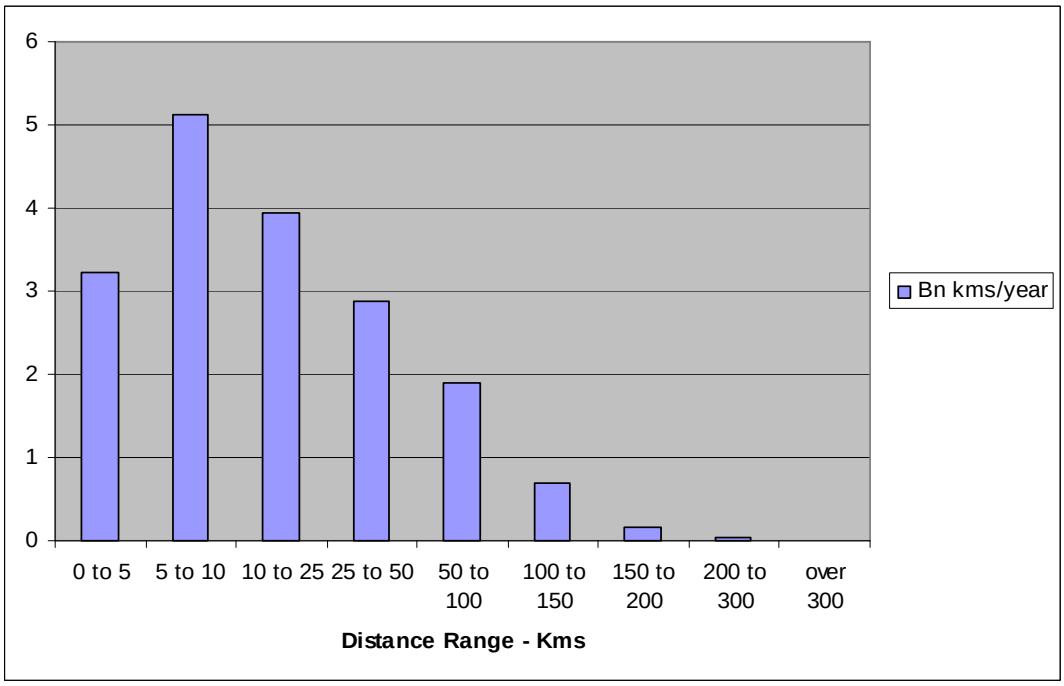


Figure A4: Privately Owned Van Billion Kilometres by Journey Length Range 2006

Similar data are not available for privately owned vans however the average length of privately owned van journeys in 2002/03 was 18kms[41]. It is possible to manually adjust the company van trip length distribution to halve its 36km average trip length. Whilst this is very much a 'guestimate' taking all van traffic together, as the privately owned van share is only 27%, the overall impact will be small. The results of this are shown in figure A5.

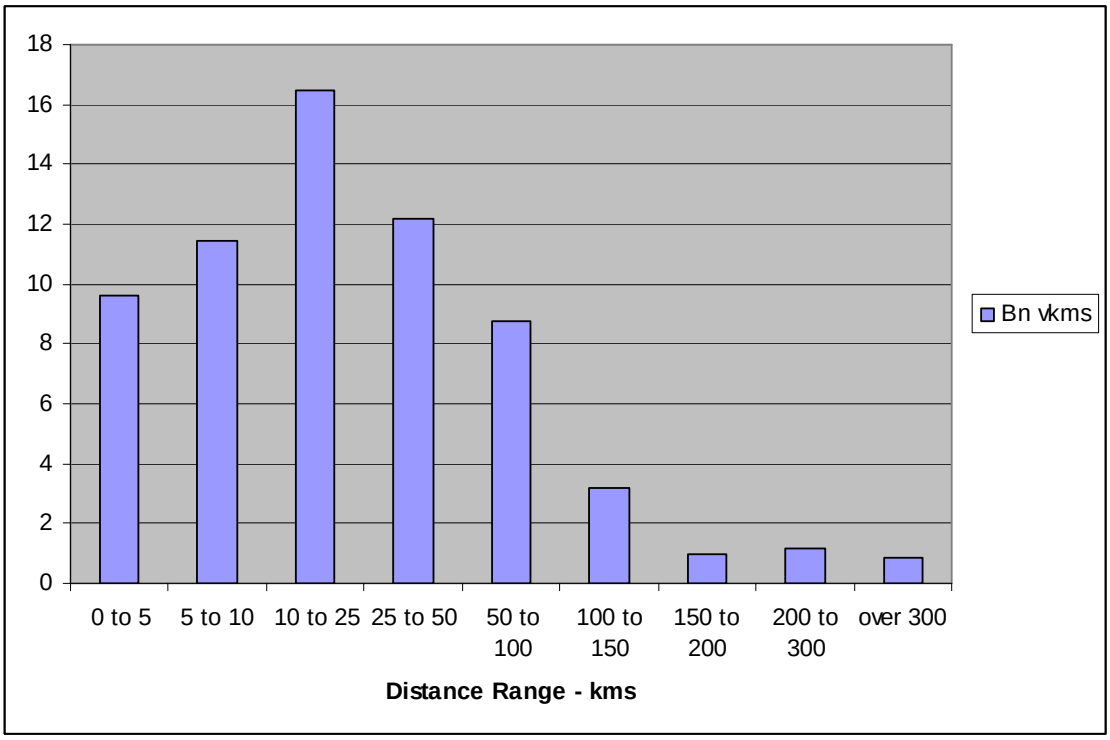


Figure A5: All Van Billion Kilometres by Journey Length Range 2005.

Cars

There is no direct national information on car traffic trip lengths but some information is published in the National Travel Survey on (main mode) car/van driver journey lengths[42]. As this is for main mode it will not reflect those journeys used to access other forms of transport (e.g. park and ride by rail). However these can only be a small proportion of the total[43] so are discounted for the purpose of these estimates.

[41] Survey of Privately Owned Vans results of survey; October 2002 – September 2003, table 1.
[42] NTS 2005, table 3.4.
[43] See DB5 (V1) page 12.

The journey trip length distribution is shown in table A2.

| Range | % Of trips |
|---|---|
| < 1 mile | 6.3 |
| 1 – 2 miles | 16.5 |
| 2 – 5 miles | 33.7 |
| 5 – 10 miles | 21.6 |
| 10 – 25 miles | 15.6 |
| 25 – 50 miles | 4.2 |
| 50 – 100 miles | 1.6 |
| 100+ miles | 0.7 |

Table A2: Car Driver Trip Length Distribution 2005[44]

Unlike the earlier distributions this table shows trips not vehicle-kilometres. So, to be comparable, they must be weighted by trip length. Also the data is in Imperial rather than Metric units, using different distance ranges so this will need to be converted into a structure, which matches that of HGVs and LGVs. This is done below as shown in table A3 and figure A7.

| Range Kms | % Of trips | Average Length (kms) | % Of Traffic | Volume of traffic – bn vkms |
|---|---|---|---|---|
| 0 – 5 | 40 | 3 | 7.2 | 29.2 |
| 5 – 10 | 23.1 | 7.5 | 10.5 | 42.1 |
| 10 – 25 | 20 | 17 | 20.5 | 82.7 |
| 25 – 50 | 10 | 35 | 21.1 | 85.1 |
| 50 – 100 | 4.5 | 70 | 19.0 | 76.6 |
| 100 – 150 | 1.5 | 120 | 10.9 | 43.8 |
| 150 – 200 | 0.6 | 160 | 5.8 | 23.3 |
| 200 - 300 | 0.2 | 230 | 2.8 | 11.2 |
| 300+ | 0.1 | 350 | 2.1 | 8.5 |
| All | 100 | 13.6[45] | 100 | 402.4[46] |

Table A3: Estimation of Car Traffic Trip Length Distribution from NTS 2005

[44] Source: NTS 2006, table 3.4.
[45] Data are for car and van driver. Although van journey lengths are greatet than those for cars van journey lengths for personal travel are not (see Survey of Privately Owned Vans, Results of survey October 2002 – September 2003 figure 1 notes).
[46] Source: Transport Statistics Great Britain 2007, table 7.1.

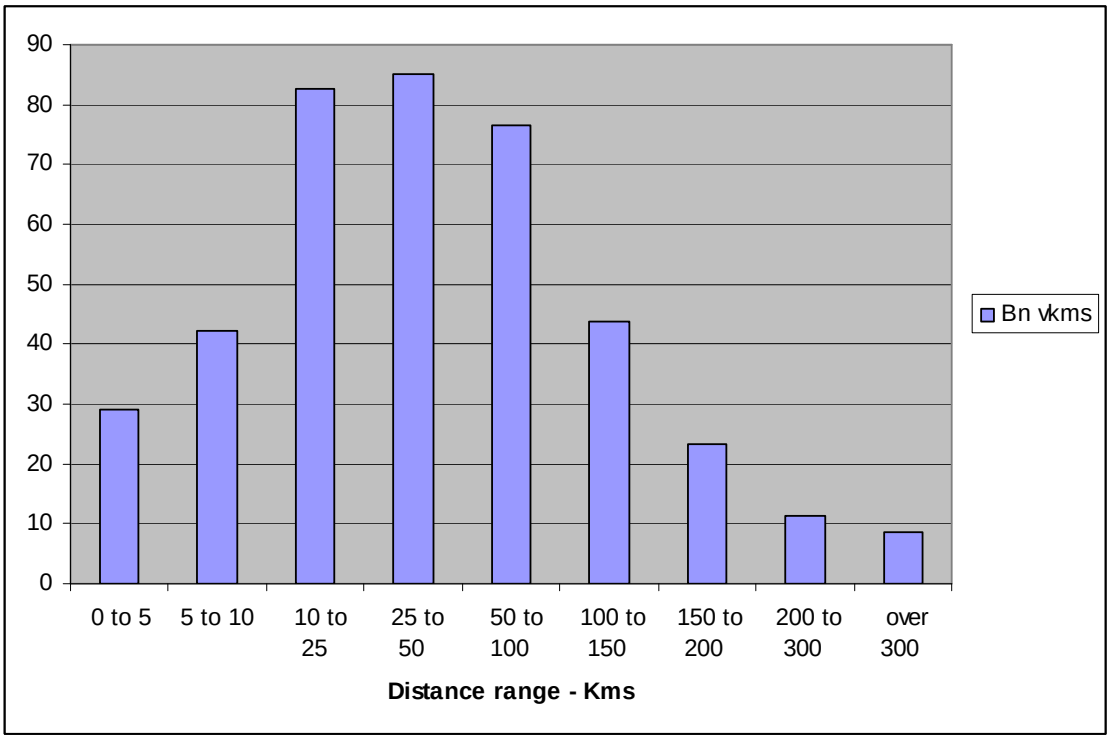


Figure A6: Car Billion Kilometres by Journey Length Range 2005. Consolidated Traffic Trip Length Distributions

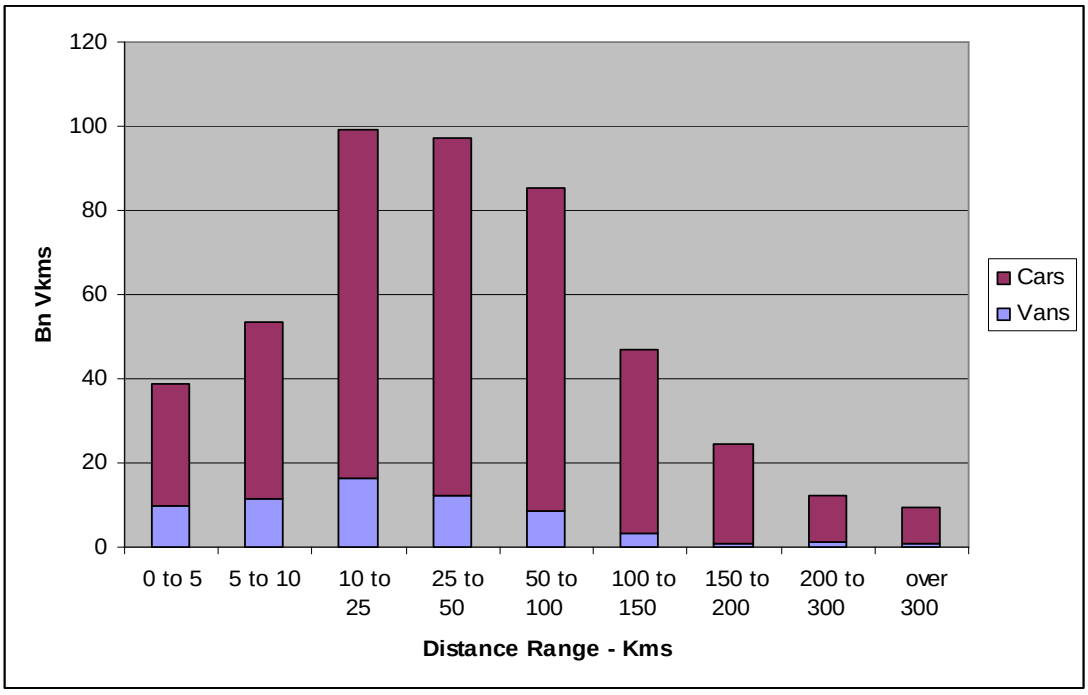


Figure A7: Estimated Light Traffic Journey Length Distributions 2006

It is possible to consolidate these individual estimates into 'light' and 'all vehicles' traffic trip length distributions. Both are set out below, in figure A7 and A8 as the 'all vehicles' distribution masks the detail at the shorter end of the light vehicle range.

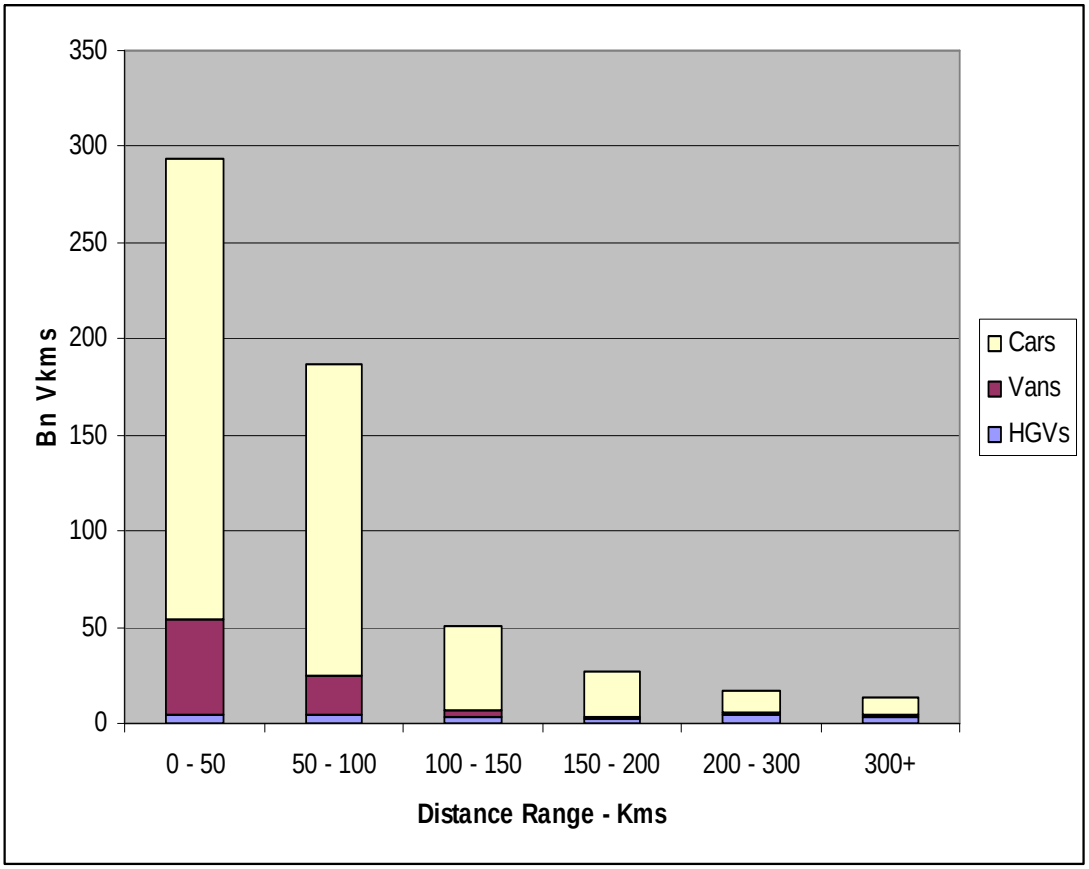


Figure A8: Estimated All Traffic Journey Length Distributions 2006