Report

'A Bumpy Ride'

The Funding and Economics of Highways Maintenance on local roads in the English City Regions

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Pedro Abrantes
Senior Economist

pteg Support Unit
Wellington House
40-50 Wellington Street
Leeds – LS1 2DE
0113 251 7424
info@pteg.net

Content

Executive Summary

Most people would agree that roads are vital to economic growth. But the national road network is far more than the 7,000 kilometres of motorways and trunk roads managed by Highways England – that's just over 2% of all of England's roads. The remaining 98% are managed by local highways authorities. These local roads carry two thirds of all motorised traffic on the network are also used by every pedestrian, cyclist, bus and tram passenger. This report highlights the poor condition of local roads, describes the declining trend in maintenance funding and summarises the case for a step change in investment on the local network.

Over the next five years, Highways England funding is set to more than double. In contrast, local government funding has been cut year on year since 2010, and this trend is set to continue for the foreseeable future. Although there has been a modest increase in Department for Transport local highways maintenance funding in 2015, local authorities continue to face unprecedented cuts from their main source of income, the Department for Communities and Local Government. And the problem could be made worse if the DfT continues its stop-start approach to maintenance funding.

Despite the bright outlook for motorways and trunk roads, DfT statistics show that the local road network is in a far worse state of repair than Highways England roads. In the six English metropolitan areas alone, there were 5,500 kms of local roads in urgent need of repair in 2014, compared to just 220 kms across the entire HE network. The disparity in road conditions reflects differences in maintenance spending: HE roads received 2.7 times as much maintenance spend per km as local authority-managed A roads and motorways; and 15.9 times as much as local authority unclassified roads.

The poor condition of local roads and the lack of funding for maintenance activities cause two types of problem. Firstly, prevention is better than cure; yet, local authorities have to divert a large proportion of available budgets towards reactive repairs, like filling pot-holes or re-building roads following structural failure. This 'worst-first' approach is less cost effective than a planned, preventive maintenance programme, which tries to fix problems before they threaten the structural integrity of the road. The result is not only that roads are in a noticeably poor condition but also that the money available doesn't stretch quite as far. We argue in this report that an accelerated maintenance programme would pay for itself in the long run.

Secondly, the poor condition of local roads imposes direct costs on road users and society at large. These come in the form of higher vehicle operating and replacement costs, longer journey times, air and noise pollution. These all represent a drag on productivity by making it more expensive to move people and goods around, and reducing the amount of useful interaction between people and places further apart. The Department for Transport, Transport Scotland and local authorities in the West Midlands have all tried to quantify the economic value of highways maintenance spending. Their analyses suggest that maintenance spending is below its optimum level and that a higher level of spending would more than pay for itself in the long run. The West Midlands Road Condition Study suggested that an increase in funding, largely in the form of an accelerated maintenance programme, would generate economic returns of £6.50 for every £1 of tax-payers money.

This report calls on government to:

- Create longer term certainty and stability over highways maintenance funding
- Support an accelerated maintenance programme, which would see a significant increase in maintenance spending over the next five years so as to bring road surfaces back up to a sustainable condition.
- Give local authorities greater flexibility over how overall maintenance funding is spent. This means relaxing some of the artificial distinctions between capital and revenue maintenance, as well as allowing local authorities to determine the maintenance spending profile over time, in accordance with a long term asset management plan.
- Review the formulae used to allocate available funding so as to better reflect the economic opportunity offered by local roads. This would mean allocating funding in proportion to the volume of cars, buses, lorries, pedestrians and cyclists travelling on local roads rather than just in relation to road length.

pteg will also continue to work with our members and other organisations to better understand the economic value of highways maintenance spending on local roads, including its impacts on pedestrians cyclists and public transport users.

1. Introduction

1.1. Streets and roads are vital to any country's economic development. They carry cars, van, lorries, trams, buses, pedestrians and bicycles, which in turn get goods and people to their destinations.

1.2. Yet, for some years, the condition of UK roads has attracted much negative attention. The Asphalt Industry Alliance (AIA) runs an annual survey of local highway authorities, which has successively highlighted the significant amount of additional funding required to bring the condition of the local road network back to a sustainable and satisfactory level. In its 2015 survey, the AIA estimated that it would cost £10.7 billion and take 12 years (based on current spending levels) to bring all local roads in England outside London to a serviceable condition.

1.3. In its 2013 report, the All-Party Parliamentary Group on Highway Maintenance (APPG) explained why cutting back on highways maintenance funding could prove a false economy. Once a road reaches a bad enough condition, more expensive structural repairs, complete replacement or even closure are likely to follow. The APPG points out that there is therefore strong consensus that "*prevention is the best cure*" and argues that funding should be provided in order for road condition to reach a "*satisfactory steady state, making planned, preventative maintenance possible over the long term*".

1.4. This view was supported by the National Audit Office (NAO) in its 2014 report "Maintaining strategic infrastructure: roads", which called for long term funding certainty and an end to short term funding competitions.

1.5. Although there is a powerful argument for more upfront spending and greater funding stability purely on cost-effectiveness grounds, improved road condition can also deliver significant additional economic benefits. In its Road Maintenance Review for Transport Scotland, TRL concluded that a £1 cut in road maintenance budgets would results in wider costs to the economy of between £1.50 and £2. In subsequent work for the RAC Foundation and ADEPT, TRL suggested that the equivalent figure would be higher for England and Wales.

1.6. And there are reasons to believe that road maintenance can generate even greater economic benefits in large urban areas. For example, the West Midlands Road Condition Study, showed that an accelerated programme of road maintenance on the principal local road network would deliver between £6 and £7.5 of economic benefits for every £1 of public spending.

1.7. In recognition of these arguments, the previous Government provided over £1 billion of top-up local highways maintenance funding between 2010 and 2014, in addition to the baseline £3.8 billion maintenance capital grant set out in the 2010 Comprehensive Spending Review[1]. In 2013, DfT also set out plans to increase its annual capital maintenance grant to £1 billion from 2015/16 onwards (compared to an average annual figure of £780 million over the previous four years). Meanwhile, Highways England's (HE) capital grant will go from £1.5 billion in 2015/16 to over £3 billion in 2019/20. Yet, local roads in England carry twice as much volume of traffic as the HE network.

1.8. The increase in local maintenance funding is of course a welcome move after a period during which maintenance spending on the local road network fell by around a quarter in real terms. However, it is important to ensure that the long term funding plans put forward in 2013

[1] See ***pteg*** (2012) and NAO (2014)

Spending Round are confirmed as part of the 2015 Comprehensive Spending Review. Moreover, it needs to be recognised that the DfT's capital maintenance grant funds only a relatively small proportion of total maintenance spending on local roads and that other funding available to local authorities has been on a steep downward trend.

1.9. At the same time, there is a sense that, given the poor current state of local roads as the result of past under-funding, there is a strong case for being even more ambitious and fund an accelerated maintenance programme in order to bring local roads to a more sustainable condition. This would be likely to generate considerable savings in maintenance and infrastructure spending down the years but would require a greater up-front funding commitment from Government and also greater flexibility in how the money can be spent by local authorities.

1.10. It is also important to develop a better understanding of the contribution which local roads make specifically in large conurbations. These tend to be areas where public transport takes front stage, and so it is easy to forget the key role which local road networks play. In fact, in the central areas of the largest English cities, car and van passengers account for just over one third of all trips using the road network. The rest are made by bus, tram, bicycle and on foot. And because large conurbations concentrate large volumes of economic activity in relatively small areas, traffic density on local roads in the six English city regions is, on average, 70% greater than elsewhere in England outside London. Together this means that the benefits from improved road condition are likely to be highest in these conurbations. This should be reflected in any future reviews of government funding allocations for local roads.

1.11. The evolving governance landscape at local level could also offer a significant opportunity to make more effective use of highways maintenance funding. The move towards Combined Authorities and the increasing government emphasis on devolution of powers and funding to the local level could enable a more integrated and cost-effective approach to the management and development of the entire transport network. The DfT's capital highways maintenance grant is the largest transport-related single grant from central government, which most local authorities receive. However, greater flexibility around grant conditions (e.g., revenue v capital; timing of expenditure, borrowing) and better alignment with economic goals could potentially allow even better outcomes to be achieved.

1.12. The rest of this report is split into three parts. The next section provides some context for local roads: length, traffic volumes, surface condition, maintenance funding and spending. The following section sets out the economic arguments for a higher and more sustainable level of road maintenance, on cost-effectiveness and cost-benefit grounds. The final section sets out our recommendations in terms of future funding and further analysis in this area.

2. Context

The local road network as national infrastructure

2.1. There is no doubt that the road network forms a vital component of the national transport infrastructure. Almost 2 in every 3 passenger journeys in England are made by car, van or motorbike[2]. And if we include walking, cycling, bus, coach and taxi, then almost 97% of all passenger journeys rely on the road network.

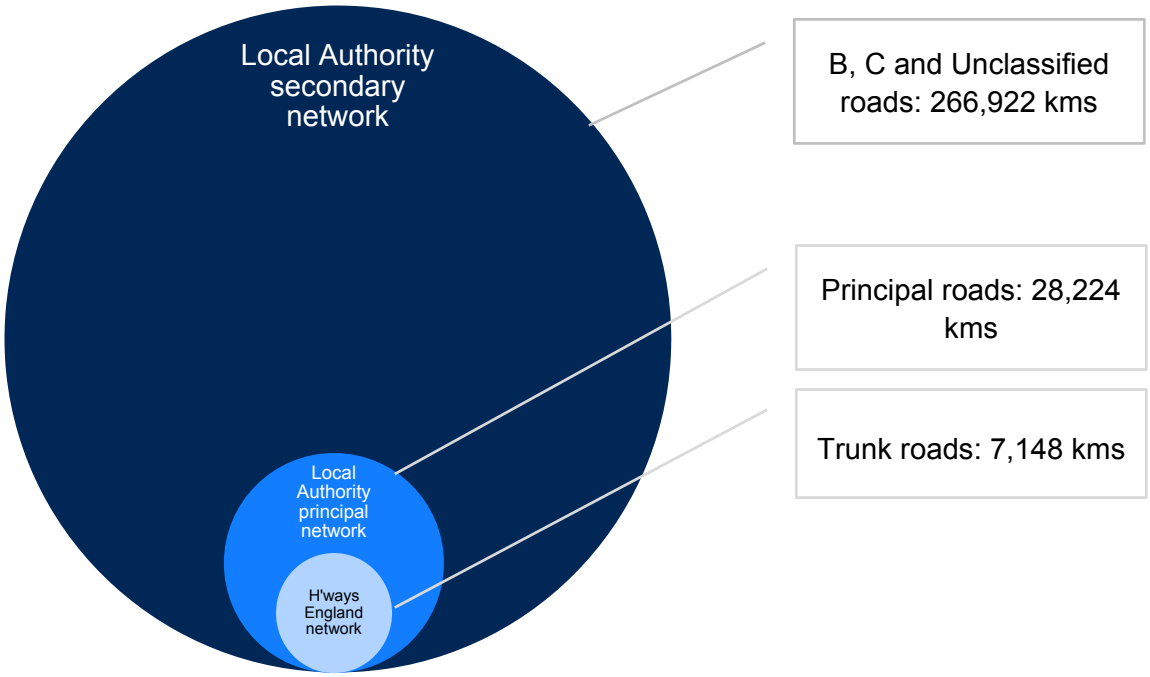
[2] The precise figure is 64%, based on National Travel Survey figures for 2013.

"A well maintained local road network contributes to long term sustainable economic growth, social equality and carbon reduction by ensuring the efficient and safe movement of goods, products and services" *West Midlands Road Condition Study*

2.2. When most people think of the road network they tend to picture motorways and trunk roads cutting across the countryside. Local roads tend to be taken for granted. But while trunk roads, which are managed centrally by Highways England, do carry significant volumes of traffic, they represent only a tiny fraction of the total length of roads that people regularly use.

2.3. There are, in total, over 300,000 kilometres of roads in England. Highways England manages only about 2.4%, or just over 7,000 kms, known as the trunk network. Local highway authorities manage almost four times as many kilometres of motorways and A roads (principal network) as Highways England. And they manage almost ten times more kilometres of B, C and Unclassified (Unc.) roads than they do kilometres of A roads.

Figure 1. Road length by type of road, England

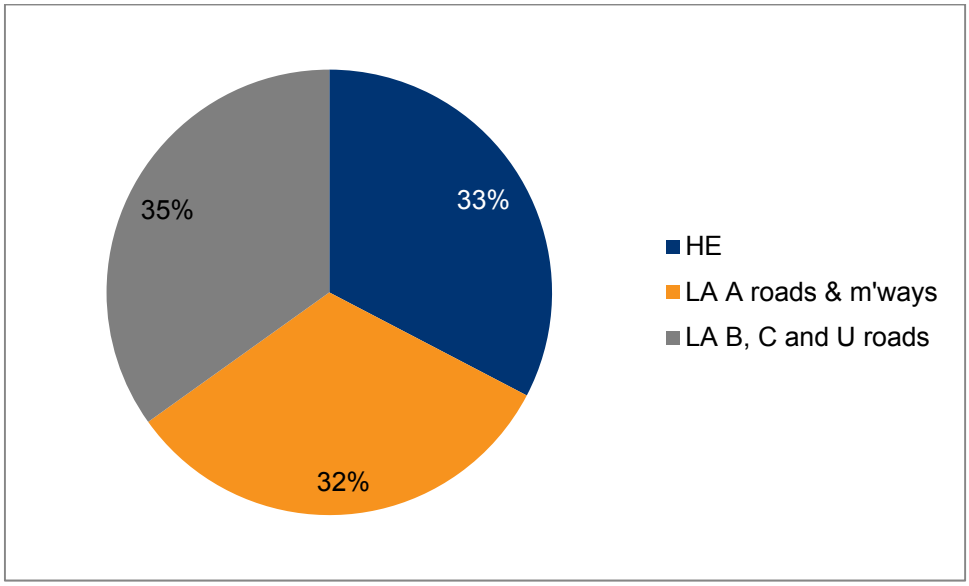


Source: DfT Statistics table RDL0202a, 2014 figures

2.4. Although some people can travel very long distances, 78% of all car and van journeys in England are under ten miles and 57% are under five miles. Many of these journeys are likely to rely entirely on local streets and roads – that's where most people live and that's where their destinations tend to be. Even after taking into account the longer distances travelled on the trunk network, **local authority roads carry two thirds of all motorised traffic volume in England**.

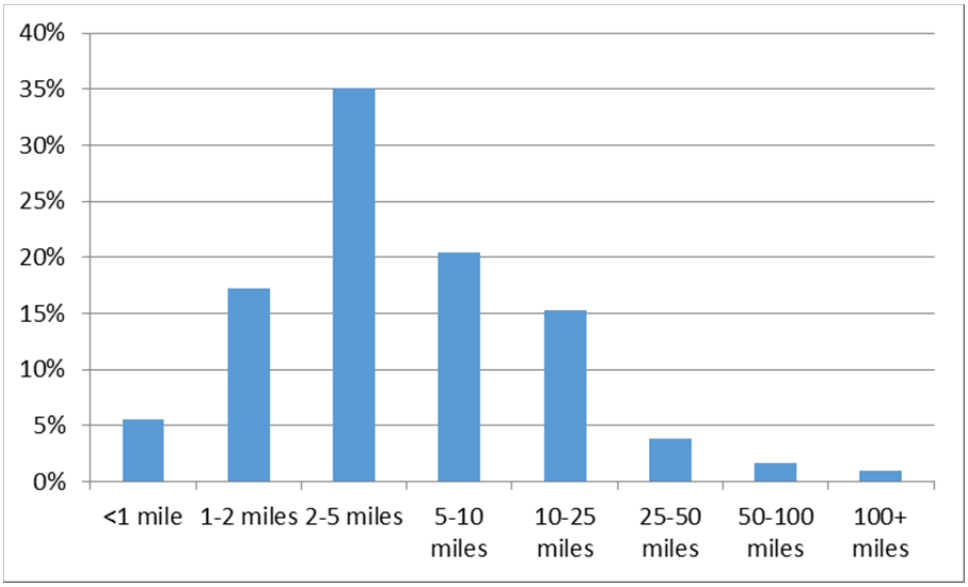
2.5. Local roads are also critical to pedestrians, cyclists and most public transport users, even if this is not always included in transport statistics.

Figure 2. Traffic volume (%) by managing authority and road type



Source: DfT Statistics Table TRA4102

Figure 3. Trip length distribution of passenger journeys, using car or van as main mode



Source: DfT Statistics Table NTS0308

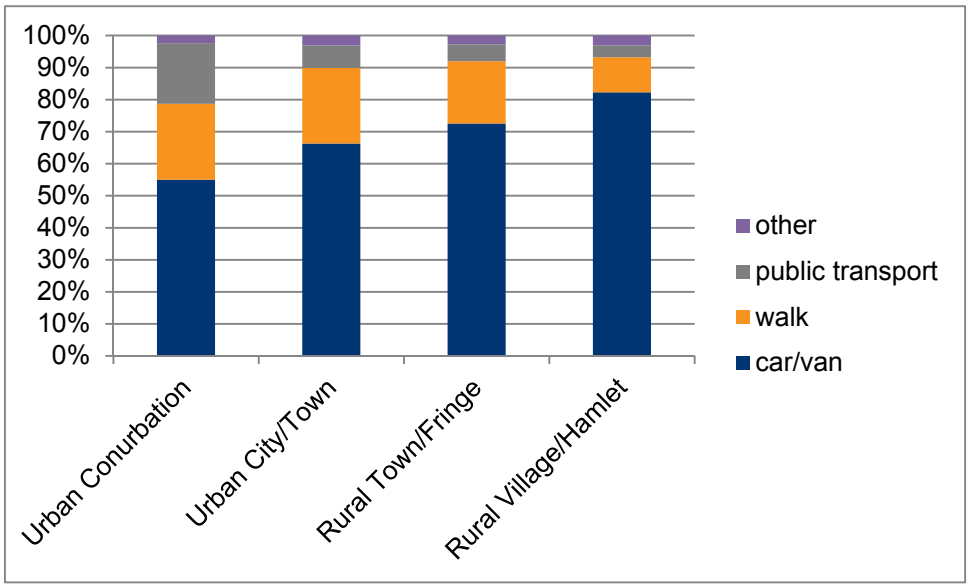
Importance of road networks in the English city regions

2.6. Local roads work especially hard in large conurbations. DfT figures show that local authority principal roads in the six English metropolitan areas carry 1.7 times more traffic per kilometre than roads in the rest of England outside London[3].

2.7. This can seem odd given that, in large conurbations, only 55% of passenger trips are made by car/van, compared to 82% in low density rural areas[4]. And the car is even less dominant in the largest city centres. For example, cordon traffic counts show that only 28% of trips entering Manchester city centre in the morning peak are made by private motorised modes. In comparison, 47% of trips were made by bus, bicycle, light rail and on foot.

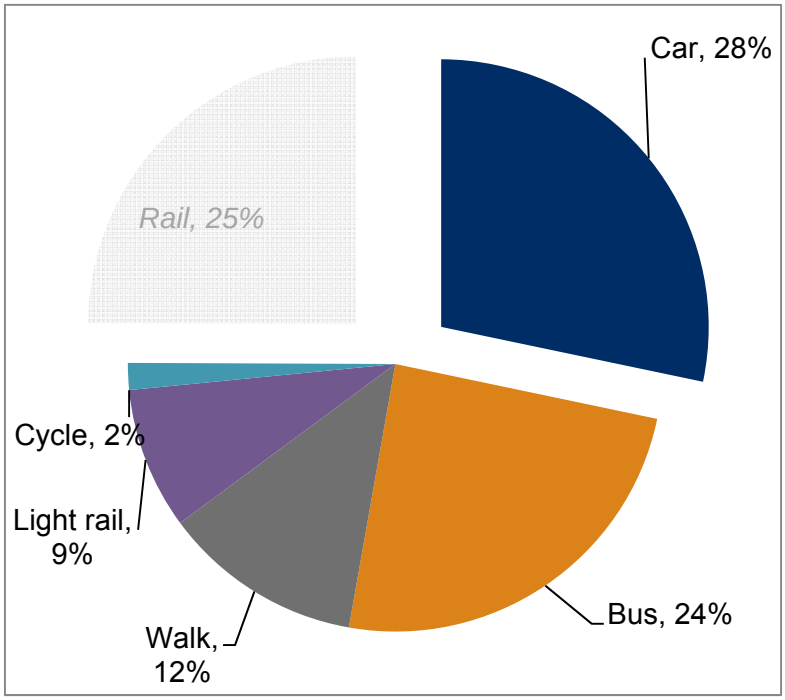
[3] ***pteg*** calculations based on DfT statistics on traffic in major roads
[4] DfT Statistics Table NTS9903

Figure 4. Mode share of all passenger trips (by main mode) by area type, England, 2012/13



Source: DfT Statistics table NTS9903

Figure 5. Share of passenger trips crossing into/out of Manchester city centre, 7:30 to 9:30 AM (2012)

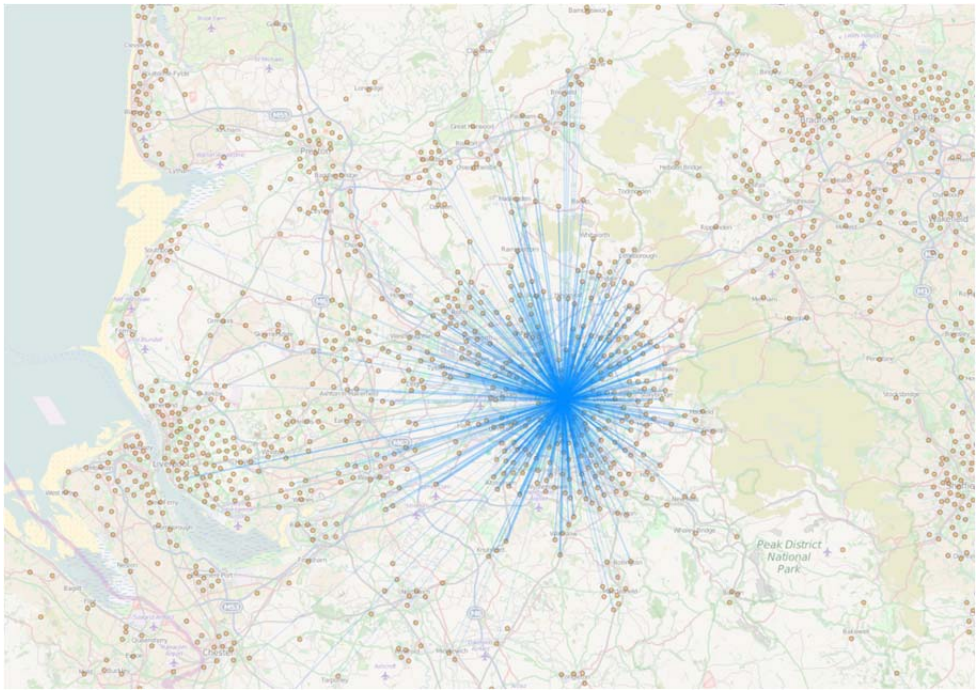


Source: TfGM (HFAS Report, based on cordon count data)

2.8. But therein lies the answer. Urban roads need to accommodate large volumes of buses, pedestrians, cyclists and, in some cases, trams, alongside cars, vans and lorries. Manufacturing and construction traffic also relies heavily on urban road networks. And because economic activity tends to be more densely concentrated in large conurbations, the transport network needs to carry larger volumes of traffic using less road infrastructure. This means that reliable road networks play a key role in enabling agglomeration economies and contribute significantly to higher productivity in dense urban areas.

Local highway authorities in the six English metropolitan areas manage 4,753 kms of A roads; 4,444 kms of B and C roads; and 32,545 kms of Unclassified roads. Their classified network is larger than the entire network operated by Highways England.[5]

Figure 6. Main car commuting flows into central Manchester



Source: 2011 Census method of travel to work data (via datashine.org.uk)

Road condition is a problem

2.9. Few people tend to notice local roads unless, of course, something goes wrong. Unfortunately, the condition of local roads in England is a regular cause of complaint.

2.10. The annual National Highways and Transport Public Satisfaction (NHTPS) survey[6] consistently shows the condition of roads, pavements and footpaths as both the most important issues and those most in need of improvement. The 2014 results show that fewer than one third of survey respondents are satisfied with the condition of local roads in their area.

2.11. This is echoed in the RAC Report on Motoring, which reported that 66% of those surveyed believe that their local roads have worsened in condition. When prompted, nearly all respondents pointed to road surfaces and potholes as the main areas of deterioration. Moreover, eight in ten motorists felt that taxes are not sufficiently reinvested into the maintenance of local roads. And, perhaps surprisingly, over a third claim they would be willing to pay more motoring tax if the funds were ring-fenced to improve roads.

36% of drivers would be willing to pay more tax if the funds were ring-fenced to improve roads, *RAC Report on Motoring, 2014*

[5] ***pteg*** calculations based on DfT Statistics table RDL0202
[6] http://nhtsurvey.econtrack.co.uk/Content.aspx?6360

2.12. Poor road conditions are also a regular cause of complaint for pedestrians and cyclists. In a 2012 survey by YouGov for Living Streets, 72% of respondents felt that their council should maintain pavements on an equal footing with roads. As Living Streets point out, well-lit roads and well-maintained pavements are particularly important for the elderly, for families with pushchairs, for children and for those with visual or mobility impairments[7]. The ALARM survey also shows that local authorities spend tens of millions of pounds in compensation claims every year due to injuries incurred as the result of trips or falls on badly maintained streets.

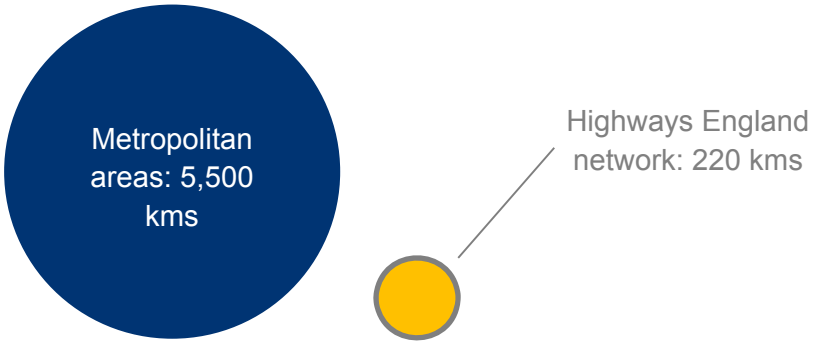
2.13. Surface quality can make a big difference to cyclists' journey experience as well, and Sustrans has recently produced guidance relating specifically to the maintenance of routes used by bicycles[8]. Meanwhile, the national cycling charity CTC has called on government to increase the amount of highways maintenance funding targeted specifically at local cycling routes[9].

"Road markings and coloured surfacing indicating cycle lanes will wear out as countless vehicle tyres pass over them each day. Once the marking for a cycle lane has become so faint that a driver does not see it - the cycle facility is lost!"

2.14. Complaints over the state of local roads are not surprising. In PTE areas alone, there were over 5,500 kilometres of local roads in urgent need of repair in 2014[10].

2.15. According to the 2015 Annual Local Authority Road Maintenance (ALARM) survey[11], the overall cost of catching up with the maintenance backlog across all local roads in England outside London would come to £10.7 billion. This is the amount that maintenance spending would need to increase by, above current budgets and over a period of time, in order for local road surfaces to eventually reach, and maintain, a high quality condition on a sustainable basis.

Figure 7. Road length in urgent need of repair (2014)



*Source: **pteg** calculations based on DfT Statistics Tables RDL0202, RDC0120 and RDC0130*

2.16. Lower grade roads appear to be in particularly bad condition, with over 5,000 kilometres of the PTE unclassified network (or 15.5% of U roads) in need of maintenance. In contrast, only

[7] Living Streets (2014), Blog post: Pavements, Parliament and MPs.
[8] Sustrans (2014), Maintenance and management of routes for cyclists.
[9] CTC (2014), Funding for road maintenance welcome, do the same for cycling says CTC, http://www.ctc.org.uk/press-release/2014-12-23/funding-road-maintenance-welcome-cycling-says-ctc
[10] ***pteg*** calculations based on DfT Statistics Tables RDL0202, RDC0120 and RDC0130
[11] Available from www.asphaltuk.org

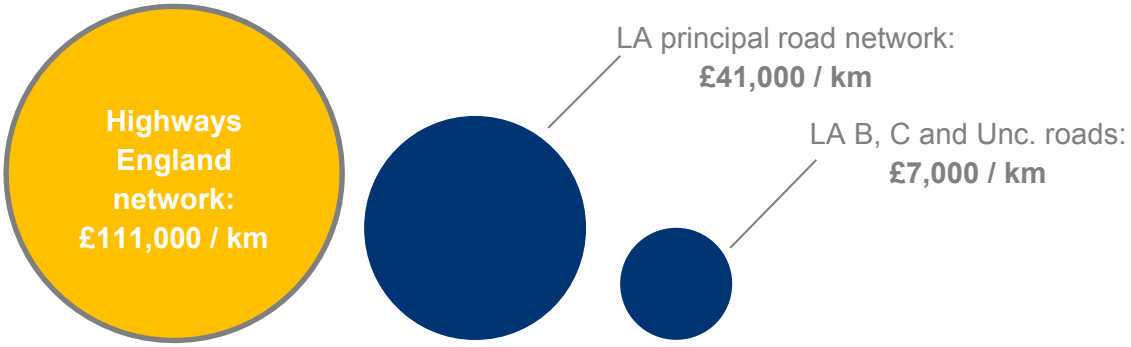
3% of the network managed by Highways England was found to be in need of maintenance, and this figure has fallen consistently since 2007/8[12].

Table 1. Proportion of road length in urgent need of maintenance across the six English metropolitan areas, by road category

	A roads	B & C roads	U roads
% of all roads in the same category	4.4%	7.0%	15.5%
Road length (kms)	163	309	5,049

2.17. The relatively poor condition of local roads, and U roads in particular, is consistent with differences in the level of maintenance spend. Whereas HE roads receive an average annual maintenance spend of £111k per kilometre, local authority principal roads receive £41k and the local authority secondary road network (B,C, U) receives only £7k. These are obviously different types of road, which will explain some of the disparity. But, if anything, a given amount of money is unlikely to go as far when used to maintain local roads due to the greater emphasis on piecemeal and relatively more expensive reactive maintenance.

Figure 8. Average annual maintenance spend per road-km



*Source: **pteg** calculations based on DfT Statistics Tables RDL0202, RDC0120, RDC0130 and RDC0310*

How much does the maintenance of local roads cost and how is it funded?

Spending

2.18. Not only is the current level of maintenance spending on local roads below that necessary to maintain road surface in a good condition, but the level of spending has also been on a downward trend in recent years. Between 2009/10 and 2013/14, maintenance spending on local roads in England went down by over a quarter, in real terms. Because of changes in accounting rules, it is not possible to compare the change in maintenance spend by HE over exactly the same period. However, between 2010/11 and 2013/14, HE's maintenance budget has gone down by only 10%[13].

[12] source: DfT (2015), Road Conditions in England in 2014
[13] In 2013/14, local highway authorities in England spent £3.4 billion in activities related to highways maintenance, down from £4.1 billion in 2009/10 (source: RDC0310). Highways England maintenance spending was £792 million, down from £815 million in 2010/11.

2.19. In 2013/14, local highway authorities in England spent £3.4 billion in activities related to highways maintenance. Of this, £1.16 billion went towards A-roads and locally managed motorways, £1.93 billion towards B, C and U roads, and £0.3 billion was spent on related policy, planning and strategy activities, which includes resources dedicated to developing and implementing asset management plans.

2.20. One important financial constraint on local authorities is the distinction between spending that can be funded from capital and revenue budgets. Capital budgets can only be used for activities which are considered to be investments, that is, those which will return a stream of benefits over a number of years. Revenue budgets are meant to be used for recurring expenses but can also be used to fund capital spending. There are severe budgets on local authorities' transport revenue budgets as set out in more detail in a report which we published earlier this year[14].

2.21. The table below sets out how different maintenance related activities are classified into capital and revenue, according to the National Audit Office[15]. According to NAO analysis carried out in 2014, around £1.1bn of local authority spending was classified as capital and £2.3bn revenue.

2.22. It is important to recognise that this classification is, to some extent, a matter of judgement. As we will argue later in the report there is a case for giving local authorities greater flexibility over the way in which maintenance funding is spent as this is likely to result in a more effective use of the money available.

Table 2. Classification of maintenance-related activities into capital and revenue

Maintenance activity	Description	Budget
Winter and severe weather	Salting, gritting, activities to combat heat, high winds, flooding and drought	Revenue
Reactive or emergency	Repairing potholes, patching, clearing incidents and traffic management	Revenue
Routine	Cyclic maintenance, including inspections, minor repairs, cleaning drains, fixing street lighting, repainting road markings	Revenue
Planned renewals	Schemes to prevent water ingress, including resurfacing	Mainly capital, some revenue
Structural renewals or improvements	Larger road reconstruction projects and repair to structures	Mainly capital, some revenue
Planning, policy and strategy	Asset management/traffic management/road safety	Revenue

Adapted from NAO (2014)

[14] ***pteg*** (2015), The Revenue-Capital Mismatch.
[15] NAO (2014), Maintaining Strategic Infrastructure: roads.

Funding

2.23. Highways maintenance funding for local roads comes from a range of local and national sources. Despite a number of top-ups from the DfT over the last Parliament, and an increase in its capital highways grant from 2015/16 onwards, DfT funding still only covers about one third of overall spending by local authorities, mainly through the following three main mechanisms: highways maintenance block grant[16], ring-fenced PFI payments and ad-hoc competitive grants.

DfT contribute only 30p for every £1 spent by Local authorities on highways maintenance[17]

2.24. The remaining two thirds are funded by a combination of DCLG grants (including Formula Grant and re-distributed business rates), Council Tax, and other local sources of income, such as car parking charges. Whereas most DfT funding can only be used for capital spending, funding from DCLG and local sources typically offers greater flexibility. Given that the majority of local government maintenance spending is classified as revenue (including fixing potholes and other minor repairs), these sources of funding are critical to ensuring roads remain in an acceptable condition.

2.25. As part of the 2010 Comprehensive Spending Review, the DfT originally planned to reduce roads maintenance funding by around a quarter[18] in real terms, between 2010/11 and 2014/15 (NAO, 2010, Reducing costs in the Department for Transport)[19]. In reality, DfT funding to local highway authorities fell by only 7% due to £1.1 billion of top-up funding, as part of seven separate announcements made between March 2011 and March 2014.

- Budget 2011: +£200m maintenance block, including +£100m to repair winter damage
- AS 2012: +£170m for Local Pinch Point Fund; +£140m formula for 13/14; +£75m formula for 14/15
- Sept 2013: +£80m for Local Pinch Point Fund
- Jan/Feb 2014: +£33.5m for authorities affected by severe weather
- March 2014: +£169m for pothole repairs; +£70m revenue and +£70m capital for additional maintenance and flood recovery

  =TOTAL: £1.1bn

2.26. Turning to DCLG funding and local income sources, we estimate that metropolitan districts revenue purchasing power will have declined by around 30% in real terms between 2010/11 and 2014/15[20], and this trend may well continue in the near future, based on the June 2015 Budget. This has put significant pressure on local authority budgets already, and the current trend could have severe consequences for the condition of local roads, even as DfT funding increases from 2015/16 onwards.

[16] Capital grant distributed to local authorities in proportion to the length of local roads and number of road structures, such as bridges.
[17] ***pteg*** calculations based on NAO (2014)
[18] NAO quoted a nominal figure of 15%
[19] This equates roughly to a 25% real terms cut.
[20] See ***pteg*** (2015) and NAO (2014)

2.27. It is also important to point out that much of the top-up funding provided by the DfT since 2010 has come as the result of short term decisions and much of it has been allocated through funding competitions.

2.28. This approach can make it more difficult to implement an effective long term asset management plan and is therefore likely to reduce the effectiveness of maintenance spending. These points have been emphasised by the NAO, in its 2014 report on road maintenance, which concludes that:

> ***"…unless funding for both road networks [HE and local] is made more predictable and the allocation between capital and revenue balanced better, public value will be lost",***
> *National Audit Office (2014, p8)*

3. The opportunity: highways maintenance and the economy

3.1. There are two ways one can think of the costs and benefits of public spending on highway maintenance.

3.2. One is to look at the relative **cost-effectiveness** of alternative profiles of spending, with the objective of identifying the approach that either:

- delivers the best outcome for the money available; or
- achieves a given level of service at the lowest possible cost.

3.3. A more cost-effective approach to highways maintenance improves productivity much in the same way as it would for a private firm, that is, by lowering production costs. A proactive and adequately funded asset management approach is likely to be considerably more cost effective than a more reactive approach, by scheduling maintenance activities so that entire road re-construction and repeated patching up are avoided as far as possible.

3.4. The second approach is to compare the costs and benefits incurred by road users and society, against those incurred by the infrastructure provider. The objective is to determine the overall amount of funding that should be allocated to highways maintenance activities so as to achieve the best outcome for society as a whole through some form of **cost-benefit analysis**. Absent short term funding constraints, the infrastructure provider should increase the level of maintenance spending up to the point where the marginal social return of that spending equals its marginal social costs[21]. In other words, road condition should be improved so long as it generates benefits to road users and society, which are greater than the additional maintenance spending required.

3.5. Under fiscal constraints, cost-benefit analysis can be used to identify the optimal allocation of available funding, for example, between different types of road or different geographical areas. A high benefit to cost ratio suggests that a given intervention is likely to offer a relatively high return for the money spent.

3.6. These two approaches, cost-effectiveness and cost-benefit analysis, can be brought together into a whole life-cycle analysis of road infrastructure spending, to simultaneously determine the optimum budget size and the optimum mix and timing of spending activities. This approach is advocated, for example, by Harvey (2012), in a report for the OECD's International Transport Forum.

[21] See, for example, Harvey (2012).

What happens if maintenance funding is unpredictable or below its optimum level?

3.7. Two problems can arise if maintenance budgets for local roads become less predictable or fail to reflect the full economic value of high quality road condition.

3.8. Firstly, Local Highways Authorities may be unable to prepare and implement an asset management plan over the life of road infrastructure. As a result, whole life cycle costs of the road network will almost certainly be higher than necessary and society will get less value for money (or less productivity) from available public spending.

3.9. Secondly, firms and households will incur higher costs and there will be some loss of productive economic activity as a result, due to poor road conditions. The value of this loss of economic activity would have outweighed the maintenance costs required to avert it. Society would therefore be poorer than had this maintenance spending been incurred.

Cost-effectiveness, or how to get more bang for our buck

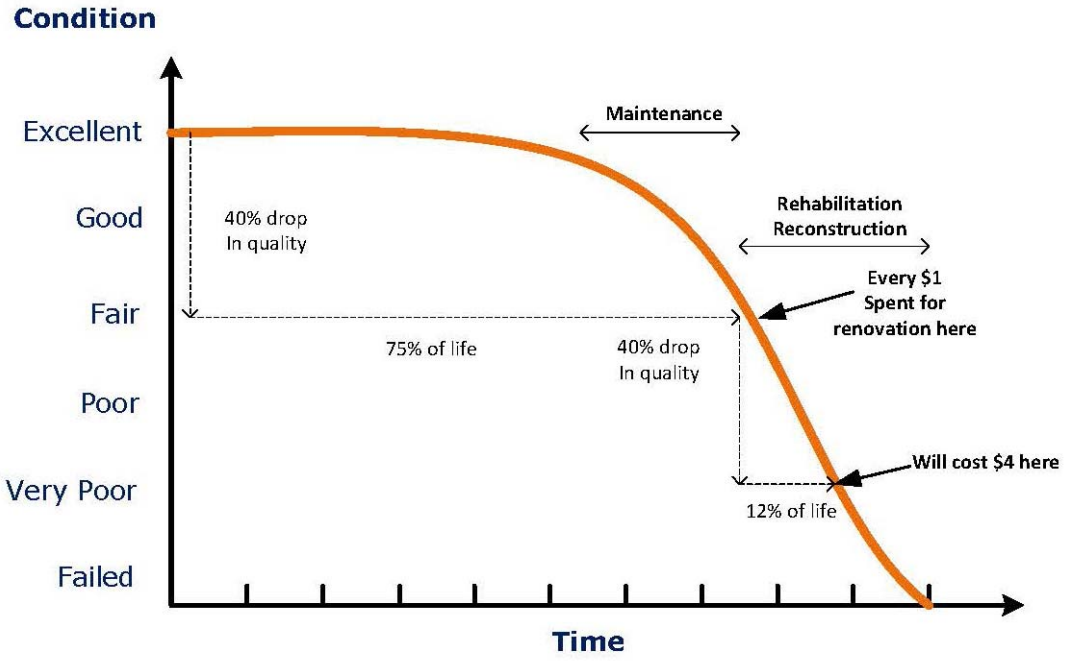
3.10. Roads are a special kind of asset. Just like many other forms of infrastructure, they can last a very long time. In order for that to be the case, however, roads require a considerable amount of maintenance spending throughout their life-time. This is because roads are relatively flexible structures, essentially made up of various loose materials bound together and compacted on-site. Heavy vehicle traffic can cause these relatively flexible structures to begin to deform and crack. Some local roads could see over 10 million vehicles travel over their surface every year so this factor should not be under-estimated.

3.11. But a road surface's biggest enemy is water. Roads are directly exposed to the elements, including extreme variations in temperature, heavy rain, high winds, and occasional flooding. Once a small crack begins to form, let's say as the result of traffic, this allows water in. And once it does, it can wash pavement material away and make cracks bigger over time. The cycle of freezing and thawing during winter accelerates this process, as do wide variations in temperature between day and night time during warmer months.

3.12. Although a newly built road can go several years without visible cracks appearing, once even small cracks begin to form, deterioration is likely to accelerate. Without treatment, a road can then quickly reach the point where reconstruction is the only option left. Usually before this point is reached, surface roughness will have increased to the point where it causes an increase in vehicle maintenance costs and is noticeable by vehicle passengers, often leading to complaints over potholes and likely reactive maintenance interventions. But, by this point, underlying conditions will be such that, if not reconstruction, a significant rehabilitation intervention is required. A cost-effective approach to highways maintenance is therefore about more than just 'filling potholes'.

3.13. It is well known that early intervention is generally more cost-effective than structural maintenance or re-construction, either of which may be required once roads are allowed to deteriorate further. Empirical evidence from local authorities in the United States suggests that every $1 spent on preventive maintenance at the right point in time can avoid a $4 structural maintenance bill at later stages (see figure 9). DfT (2012, Appendix B2) suggests that this ratio is likely to be higher in the UK today given current industry costs.

Figure 9. Change in road condition over time and impact on maintenance costs of alternative maintenance strategies[22]



3.14. Preventive maintenance typically implies sealing visible cracks even before they reach the pothole stage. Because smaller cracks may be difficult to detect, and are labour intensive to repair, a more sensible approach in most circumstances is to establish a long term asset management plan with regular intervals between full scale maintenance interventions on every road, rather than a more reactive or worst-first approach.

> ***"… filling potholes is like chasing your tail and the money would be far more wisely spent on planned preventative maintenance to prevent potholes forming in the first place."*** *Alan Mackenzie, Chairman of the Asphalt Industry Alliance*[23]

3.15. In order for this approach to work, however, the initial condition of local roads and the annual quantum of maintenance spending need to be such that roads remain in a serviceable condition. Given the high proportion of local roads in urgent need of repair (effectively, roads which are likely to require a degree of structural maintenance), it is likely that a move towards a preventive approach would require a degree of accelerated spending in the early years of any asset management plan.

> ***"Application of surface treatments will seal the road surface and prevent water from entering the pavement structure. This will lengthen the life of the pavement structure. And delay intervention with more expensive structural maintenance. It will also prevent the formation of potholes."*** *DfT (2012, Appendix B2)*

3.16. A planned approach to highways maintenance, centred on the principle of early intervention, is likely to be especially important for secondary roads. Because these roads are designed to cope with lower volumes of traffic (therefore costing less to build in the first place), they are more susceptible to deterioration. Maintenance costs throughout the life of the asset are

[22] Based on Shahin and Walter (1990)
[23] *In 2015 ALARM survey press release*

therefore likely to be of similar magnitudes. Striking the right balance between funding for initial construction costs and maintenance spending is therefore key to ensuring the local road network continues to perform at a satisfactory level.

3.17. Because of this, the APPG argues that not to maintain roads at the right time is a bit like borrowing from the future. In other words, it means that a greater expense and inconvenience will need to be incurred further down the line. If we see timely road maintenance as a way to avoid, or delay, that future investment, then there could be a case for treating most forms of road maintenance as capital spending.

Cost-benefit analysis (/balancing benefits and costs between users + infra providers)

3.18. The poor condition of local roads does not only create a problem for cost-effective management of the infrastructure. It can also impose very large costs on road users, and in some cases, on society at large. The empirical evidence available suggests that, on UK local roads, these costs typically outweigh, by some margin, the additional spending required to keep the network in a satisfactory and sustainable condition. There is therefore a strong case, on cost-benefit grounds, to increase the level of highways maintenance spending on local roads.

3.19. The key tool for the economic analysis of highways maintenance programmes is a modelling framework capable of doing two very different tasks:

1. Predict pavement performance over time, given initial road conditions and a planned maintenance programme;
2. Estimate the resulting change in costs for infrastructure providers, road users and society at large.

3.20. The most commonly used tool for this purpose is the World Bank's Highway Development and Management Model, the latest iteration of which is known as HDM-4. HDM was originally developed to assess investment decisions in developing countries but has since evolved into a more general framework based on empirical research carried out over a number of decades.

3.21. Models such as HDM-4 must be calibrated to very specific local conditions, including unit costs for different types of maintenance activity, user parameters such as values of time, initial road surface conditions, local construction methods and quality, local climate, forecast traffic volumes and vehicle mix, and typical maintenance techniques employed.

Estimating pavement performance

3.22. The change in the condition of road surfaces and underlying structures depends on the interaction between all the factors above, in addition to others which are often not captured in most models, such as the impact of inadequate drainage systems, structural failure of specific elements or utility works on the carriageway. It can therefore be difficult to confidently generalise the economic case for alternative maintenance spending profiles from one road section to another.

3.23. The most widely accepted measure of pavement performance is roughness, which is measured using a standardised method and scale known as the International Roughness Index (IRI). In simple terms, the IRI is obtained by driving a vehicle of known characteristics at a given speed over a section of road. On-board instruments are then used to measure the

bumpiness experienced inside the vehicle. This measure focuses on the experience of road users but it has also been found to correlate well with the underlying structural integrity of a pavement.

Estimating the economic impacts of pavement performance

3.24. A cost-benefit analysis framework of highways maintenance spending typically covers the elements listed in the table below. Most of these are included in HDM-4 although some, such as visual quality and ride quality, typically require bespoke analysis.

3.25. The economic value of a given maintenance spending profile largely hinges on its impact on road users. The relative weight between different types of user impact in turn depends on initial road conditions, typical road speeds and the traffic mix. Research by the World Bank shows that vehicle operation costs tend to dominate the economic impact of changes in pavement performance. This largely relates to the cost of repairing or replacing vehicle suspension systems, in addition to an overall increase in depreciation. These effects are particularly severe for buses and heavy goods vehicles. In the case of passenger cars, changes in journey time come second to vehicle operating costs in absolute terms.

3.26. The effect on fuel consumption (and hence GHG emissions and air pollution) depends on the speed limit on a given road. Below speeds of around 50km/h, fuel consumption increases with falling speed (and hence with worsening road condition), which suggests that increased fuel consumption is also likely to be a relevant factor in the economic analysis of local road maintenance.

Table 3. Elements to be considered in cost-benefit analysis of highways maintenance interventions

Stakeholder	Cost
Infrastructure provider	Maintenance spending profile over the analysis period
Road users	Vehicle operation costs (parts & materials, maintenance, depreciation)
	Travel time, including due to lower vehicle speeds over rough surfaces, and temporary delays due to re-routing during maintenance works
	Fuel consumption
	Accident costs
	Visual quality
	Discomfort / ride quality
Society	Noise
	Air pollution
	Greenhouse gas emissions
	Accidents

3.27. According to the World Bank, going from an IRI of 2 (smooth road) to an IRI of 18 (road in very poor condition) would more than double the overall user cost of operating a bus, from just under $0.6/vehicle-km to over $1.2/vehicle-km. The effect on a heavy goods vehicle

would be to take user costs from $0.7/vehicle-km to $1.2/vehicle-km. The effect on a typical passenger car would be to increase total user costs from $0.21/vehicle-km to $0.33/vehicle-km. In other words, each bus is equivalent to five cars and each HGV is equivalent to four cars when it comes to assessing the economic impact of changes in road maintenance.[24]

3.28. Much of the discussion on the economic value of transport infrastructure tends to focus on wider economic benefits, agglomeration economies and the ability to improve connectivity to, from and between clusters of economic activity. At first glance, changes in vehicle maintenance costs seem to have little to do with connectivity, which is more clearly associated with travel time. But, in fact, travel time and out-of-pocket costs are two sides of the same coin – both represent a drag on productivity by sucking scarce resources out of the system. Higher vehicle maintenance costs mean that it is more expensive to move people and goods around and this reduces the amount of useful interaction between people and places further apart. Ultimately, the economy and society lose out.

3.29. Moreover, it is important to recognise that modelling frameworks such as HDM-4 are incremental in nature. They quantify marginal changes from an initial state and are not designed to predict or quantify the impact of more disruptive changes.

3.30. For example, as road condition deteriorates drastic infrastructure failure becomes more likely. As a result, an entire road could be out of action for an extended period of time, with the economic impact likely to be considerably greater than that estimated using HDM-4. Journey times could increase steeply due to diversions, and greater congestion is also likely to occur on the main diversionary routes.

3.31. Analysis by the DfT, using the Highways Agency's Delay Cost Model, indicates that avoiding partial carriageway closures on the Strategic Road Network could have a benefit to cost ratio of between 5 and 80 to 1. Avoiding a complete carriageway closure would have a benefit cost ratio that could be 100 times greater[25].

3.32. Given the poor condition of many local roads, there is a good case for extending existing cost-benefit analysis frameworks so as to quantify the resilience of local road networks to structural failure and the part that could be played in this by improved maintenance programmes.

Evidence on the value for money of additional maintenance spending

3.33. In order to accurately estimate the economic value of highways maintenance spending it is necessary to hold detailed information on the characteristics of the road network in question. Carrying out such an exercise for the length and breadth of networks serving the city regions is beyond the scope of this report. However, it is possible to draw some inferences from partial analyses of the road network. We are aware of three past UK studies which are worth briefly covering in this report.

3.34. Between 2006 and 2009, the highways group at the University of Birmingham worked with the Department for Transport to adapt HDM-4 to the UK context[26]. The model was then applied to the principal highway network in England in order to estimate the optimal capital and revenue maintenance requirements in order to clear existing maintenance backlogs and

[24] Archondo-Callao, R (2010), HDM-4 Road User Costs Model Version 2.00, Available at:
[25] DfT (2015), Road Investment Strategy: Economic analysis of the investment plan
[26] Odoki et al (2013), HDM-4 adaptation for strategic analysis of UK local roads

to keep the road network in a sustainable adequate condition thereafter. HDM-4 was used to select, for each road section under consideration, the maintenance standards that would maximise economic and social benefits over a 20-year analysis period. The work concluded that, in the absence of a budget constraint, the overall maintenance spend would come to an average annual figure of £880 million per year. As a result, the IRI index would remain between 2 and 3 (i.e., few or no visible cracks).

3.35. We believe that the work used 2010 as the base year, when DfT funding for local highways maintenance totalled £600 million. The Highways Maintenance capital grant is worth close to £1 billion in 2015/16, which is broadly in line with the figure proposed in the report, after taking inflation into account.

3.36. The authors also showed that the difference in road user costs between the optimal budget and the budget in place at the time created costs to road users of around:

- 6p per vehicle-km for cars;
- 18p per vehicle-km for HGVs;
- 7p per vehicle-km for Passenger Service Vehicles.

3.37. A small increase in fuel duty would be enough to pay for the additional budget requirement and would far outweigh the costs incurred by road users due to poor road condition.

3.38. It is important to emphasise that the results of this report relate only to the local authority principal road network, which carries under half the traffic volume using local roads. Moreover, this analysis has not taken into account the impact of poor road maintenance on cyclists and pedestrians. The user cost figure for buses also seems low compared to World Bank research and it is possible it includes only vehicle operating costs rather than costs to passengers. The budget quoted should therefore be seen as a lower bound.

3.39. In parallel to this DfT project, Transport Scotland commissioned the Transport Research Laboratory (TRL) to produce an economic analysis of possible reductions in highways maintenance spending across the entire Scottish local road network[27]. Their work concluded that the benefit to cost ratio of a marginal increase in maintenance spending, from its 2010 base, was in the range of £1.5 to £2 for every £1 of additional spending. TRL was subsequently commissioned by the RAC Foundation to determine the applicability of its earlier findings to the English road network. They concluded that, while the results could not be directly transferred across, there were reasons to believe that the equivalent benefit cost ratio could potentially be higher, in particular the relative size and poor initial condition of the secondary road network in England.

3.40. Earlier in 2015, the West Midlands local highways authorities and the area's Integrated Transport Authority commissioned consultants CH2M Hill to produce a Road Condition Study, quantifying the economic benefits of a long term asset management approach, based around an initial accelerated maintenance programme, reaching a steady state road condition thereafter, across the entire classified network (ie, A, B, C roads and locally managed motorways). The consultants' work showed that the proposed strategy, which involved a significant up-front investment over the first five years, would have generate benefits of between £6 and £7.5 for every £1 spent. Based on the latest available figures, West Midlands road conditions are slightly below the average for the six English metropolitan

[27] Transport Scotland (2011), National Road Maintenance Review
http://www.transportscotland.gov.uk/road/maintenance/national-roads-maintenance-review

areas and so the results are likely to be indicative of the value created if a similar programme were to be applied across all six areas.

3.41. The West Midlands benefit to cost ratio is considerably higher than the equivalent figures produced for the Scottish local road network. This is explained, in part, by the fact that the latter covered the entire local road network, including unclassified roads, which tend to carry lower traffic volumes on average. On the other hand, DfT stats show that traffic densities on city region roads are 1.7 times greater than other local road networks outside London. The Scottish road network would include both larger urban areas, more similar to the West Midlands, as well as much sparser rural areas, with likely lower traffic densities than the typical English local road.

3.42. An important gap in our understanding remains the unclassified road network, which comprises over 80% of the entire road network in most parts of England. Work by Transport Scotland suggests that the economic returns from improving the condition of unclassified roads could be lower than those on the principal road network. At the same time, unclassified carry a considerable volume of traffic and will be the origin or destination point for probably the majority of car trips. Unclassified roads are also in the worst condition of all local roads and have seen maintenance spending levels drop over recent years. This could be storing up trouble for the future and we would suggest that understanding the impact of changes in maintenance spending on the unclassified network should be a priority area for further empirical work.

The case for accelerated road maintenance and for greater financial flexibility

3.43. The West Midlands Road Condition Study found that an accelerated road maintenance programme would be integral to achieving the benefits of improved road condition in a sustainable and cost effective way. This is because it is necessary to bring road surfaces back up to a serviceable level before it is practically possible to shift the emphasis of maintenance spending from a reactive to a more preventive focus.

3.44. The West Midlands study found that the maintenance spending would have to be roughly double its current level for the first five years of the programme. The steady state level of spending beyond that point would be roughly 10-15% above current levels, although with some significant year on year variations due to maintenance needs of some individual major assets. The DfT analysis found that the optimal maintenance programme would imply even greater year on year variations in maintenance spending than in the case of the West Midlands study.

4. What needs to be done

4.1. Local roads are arguably the most important component of city region transport networks. There is also a good deal of evidence to suggest that public spending on improved road condition represents good value for money. Yet, figures show that a significant proportion of local roads are in need of repair. The problem is worst on unclassified roads, where 15% of the network requires urgent structural maintenance. This state of affairs is the result of both a decline in revenue funding and a short-term approach to maintenance budgets by central government, which makes it difficult to implement a cost-effective approach to asset management. Although we understand the significant fiscal constraints which face the UK, we believe there is more which government can do to improve the economic contribution of local roads.

4.2. **There should be greater long-term certainty and stability over highways maintenance funding**. This would enable local highway authorities to develop and implement long term asset management plans which would be sure to deliver a better outcome with the money available. Local roads can be fairly long-lived assets, and several years may pass between major maintenance interventions. Funding cycles of ten years or more would therefore be most appropriate.

4.3. **Funding over the next Comprehensive Spending Review period should be front-loaded, so as to enable an accelerated programme of maintenance spending**. This would enable a gradual reduction in expensive reactive maintenance activities, thus ensuring a more cost-effective use of future maintenance spending.

4.4. **Local highway authorities should be given greater flexibility over how overall maintenance funding is allocated between different types of activity and over time**. This should include a review of the classification of maintenance-related spending into capital and revenue budgets. Local authorities should also be allowed to vary the amount of maintenance spending year-on-year, within a long term funding envelope. Over-spend from any ring-fenced grants should be capable of being carried over and local authorities should be free to borrow against future grant funding so as to bring forward spending where appropriate.

4.5. **There should be a review of the formulae used to allocate available funding between different local authorities areas so as to reflect not only different levels of need but also the economic opportunity offered by local roads**. Any future formulae should also take into account the volume of public transport vehicles, pedestrians and cyclists using the local road network.

4.6. **More work is needed to fully understand the economic value of highways maintenance spending on local roads, including its impact on pedestrians, cyclists and public transport users**. ***pteg*** will continue to work with our members and with local highway authorities in our areas to continue to develop and disseminate our shared knowledge of these issues.

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