AtkinsRéalis

Evidence Review: Final Report

Department for Transport

July 2024

ECONOMIC APPRAISAL FOR INVESTING IN LOCAL HIGHWAYS MAINTENANCE

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This document has 73 pages including the cover.

Document history

Document title: Evidence Review: Final Report

Document reference: Deliverable 3.0

Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
1.0	Draft for review	BG/SD/TR	JA/EN	JP/JR	JP	26/04/2024
2.0	Final report	BG/EN	JA	JP	JP	31/07/2024

Client signoff

Client	Department for Transport
Project	ECONOMIC APPRAISAL FOR INVESTING IN LOCAL HIGHWAYS MAINTENANCE
Job number	5226938
Client signature/date	

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Abbreviations

ADEPT	Association for Directors of Environment, Economy, Planning and Transport
AMAT	Active Mode Appraisal Toolkit
AOM	Aggregated Output Module
asPECT	Asphalt Pavement Embodied Carbon Tool
ATOMS	Asset-Management Toolkit: Minor Structures
BCIS	Building Cost Information Service
BCR	Benefit Cost Ratio
CIHT	Chartered Institution of Highways and Transportation
DRC	Depreciated Replacement Cost
FHRC	Flood Hazard Research Centre
HDM4	Highway Development and Management Version 4
HIAMG	Highway Infrastructure Asset Management Guidance
HIRAM	Highways Infrastructure Resilience Modelling
HMAT	Highway Maintenance Appraisal Toolkit
HMB	Highway Maintenance Block
HMEA	Highway Maintenance Economic Assessment
HMEP	Highways Maintenance Efficiency Programme
LCRIG	Local Council Roads Innovation Group
LGA	Local Governments Association
LgTAG	Local Government Technical Advisers Group
LoTAG	London Technical Advisers Group
MCM	Multi-Coloured Manual
MHCLG	Ministry of Housing, Communities and Local Government
NHT CQC	National Highways and Transport Customer, Quality, Cost
NTM	National Transport Model
PIARC	World Road Association
QUADRO	Queues and Delays at Roadworks
RCI	Road Condition Indicator
RCMG	Road Condition Management Group
RoI	Return on Investment
RSTA	Road Surface Treatments Association
SAVI	Structures Asset Valuation and Investment (Tool)
SCANNER	Surface Condition Assessment for the National Network of Roads
SRN	Strategic Road Network
TAG	Transport Analysis Guidance
TRL	Transport Research Laboratory
UKRLG	UK Roads Leadership Group
VfM	Value for Money

INTRODUCTION

Background

The local highway network is the largest physical public sector asset, valued at approximately £400 billion and maintained by local authorities, who have a statutory obligation to keep it in a safe condition [1]. The local highway network totals almost 175,000 miles, which is 92% of the overall road length in England. As well as carriageways, the network also contains footways, cycleways, street lighting, structures, drainage, street furniture, trees, traffic signals, signs, and road markings. Local highways are much more than routes for traffic; they create the atmosphere of a place and provide corridors for utilities networks. When planned and maintained properly, they add to feelings of safety, security, and well-being and enable active travel, promoting social cohesion and economic development [2].

Virtually every journey begins and ends on a local road, and maintaining the local highway network in good condition is crucial for society. Local roads provide access to basic goods and services, and even those who never drive still rely on the local roads when travelling by bus, or any active travel mode. The local network delivers food to supermarkets and goods to shops. It connects communities and, as social networks and extended families become more dispersed, transport plays an even bigger role in holding them together.

Purpose and objectives

The Department for Transport (DfT) has commissioned this evidence review as a first stage in responding to a recommendation from an internal review “that DfT take additional steps to assess and demonstrate the Value for Money (VfM) of the funding at a wider programme level”.

The aim of the review is to provide DfT with a better understanding of the economic benefits of investing in local highways maintenance, especially following the Network North announcements, which included an additional £8.3 billion investment in local highways maintenance over 11 years [3]. This enhanced understanding will also serve as preparation for the next Government Spending Review, to make the case for investment at local, regional and national levels in England.

The focus of this evidence review is to demonstrate the Benefit Cost Ratio (BCR) and VfM of investing in local highway maintenance; and to ascertain how the existing evidence can be improved to inform future spending decisions on local highways maintenance. The review covered all asset types within the remit of local highway maintenance, including pavements, structures, active travel provisions, lighting, etc. Furthermore, publications or evidence relating to local highway maintenance from London (previously excluded from such studies covering England) has also been incorporated in the review; as well as evidence relating to other countries (both in the UK and outside of it).

This evidence review aimed to:

- Identify and examine relevant evidence, data, and tools that can be used for an economic appraisal of the VfM of spending on local highways maintenance. Previous research and studies, such as the State of the Nation report, and Highway Maintenance Appraisal Toolkit (HMAT) and Highway Maintenance Economic Assessment (HMEA) tools, were used as the foundation upon which to build from.
- Analyse existing methodologies used to estimate the BCR and VfM of spending on local highways maintenance and identify and address evidence gaps.
- Provide recommendations for how economic appraisal tools can be refined and improved, focusing on strengthening the evidence for spending on local highways maintenance.

The purpose of this report is to provide DfT and local authorities with an overview of the existing tools and methodologies designed for economic appraisal, that are currently available and that are used by local authorities to demonstrate the benefits of local highway maintenance. The document has been structured around the eight research questions, as stated in the project specification, to ensure a clear focus and answer for each question. The report also provides a series of recommendations for how economic appraisal tools can be refined and improved.

Methodology

Discovery phase

The discovery phase involved identifying and examining over 100 sources to gather relevant evidence, data, and tools that are suitable for use of an economic appraisal of the VfM of spending on local highways maintenance. The discovery phase builds on the "The Case for Investing in Local Highway Maintenance" report undertaken by AtkinsRéalis for UKRLG in 2021 by reviewing the existing material against the scope of this task, updating previous analysis with new/updated data and sources, and reviewing additional sources from the past 2 years.

During this phase, the existing economic appraisal tools and methodologies that are in use were reviewed and analysed to better understand the challenges and potential improvements to support analysis of the value for money of local highways maintenance.

Analysis and scenarios

The data collated during the discovery phase was then analysed and synthesised to identify how BCR and VfM was currently being calculated and how it varied for different types of intervention e.g., different types of maintenance, carriageway type, structure type, location. During this phase, multiple investment scenarios and intervention types were analysed.

Stakeholder engagement and case studies

Targeted stakeholder engagement was undertaken during the evidence review to gather the necessary data around different types of maintenance. Some of the stakeholders included National Highways Transport (NHT) Network, CQC Efficiency Network, Local Council Roads Innovation Group (LCRIG), the UKRLG Boards and Road Surface Treatment Association (RSTA). For the case studies, five local authorities were chosen to provide a deep dive into the realities and practicalities of investing in highway maintenance. The table below provides an overview of the five local authorities and why they were chosen.

Table 1: Local authorities that were used for Case Studies Engagement.

Authority	Characteristics	Rationale for choosing
Derbyshire County Council	**Authority type:** County council **Area:** East Midlands **Rural/Urban classification:** Mostly rural	› Known to have previously used HMEA › Link with chair of the UKRLG Asset Management board › Future member of East Midlands Combined authority
London Borough Hammersmith and Fulham	**Authority type:** London borough council **Area:** London **Rural/Urban classification:** Urban	› London borough, previously outside scope of DfT studies › Link with co-chair of LoTAG and currently working on State of the City
Manchester City Council	**Authority type:** City council **Area:** North-West **Rural/Urban classification:** Urban	› Known to have previously used HMAT
Sunderland City Council	**Authority type:** City council **Area:** North-East **Rural/Urban classification:** Urban	› North-East region previously underrepresented in national studies
Surrey County Council	**Authority type:** County council **Area:** South-East **Rural/Urban classification:** Rural and urban	› Long-time adopter of asset management principles › Link with chair of LgTAG and Road Condition Management Group (RCMG)

Recommendations

1. Introduction of an incentivisation scheme for use of the Network North funding. Additionally, engage with stakeholders such as DLUHC and ADEPT to test the appetite for influencing revenue funding.
2. Introduction of the digital data collection portal proposed during original State of the Nation project. This will allow for up-to-date and consistent data to be collected in the condition of the local network on an ongoing basis. The portal could also be used to collect budget and spend data as part of an incentivisation system.
3. Review potential to formally expand guidance for monetisation of some or all of the wider benefits identified in this report. Also, engage with industry groups such as UKRLG, ADEPT, CIHT, PIARC to gather further information on existing highway maintenance business cases that are not publicly available.
4. Define the desired scope for the appraisal of local highways maintenance (e.g., at network whole, network asset or scheme level). Once scope is selected, this will drive selection of options to deliver new tools, update of existing tools, applying automation to simplify use of existing tools, new simplified tools, and/or Excel proof of concept plus spec for systems providers to integrate into commercial offerings.
5. Develop suite of tools to maximise impact of any appraisals, such as development of wider learning and engagement resources beyond highway maintenance specialists, which could include comms toolkit, guidance on consistent reporting, and reporting of Depreciated Replacement Cost (DRC) asset valuation.

RESEARCH QUESTIONS

Research Questions 1, 2 & 3

Research Question 1: Review the published data over multiple years to understand the current total spending on local highways maintenance in England, including funding from DfT, funding from DLUHC, funding from other local authority sources such as council tax.

Research Question 2: Collect real data on costs of different types of maintenance and evaluate how the costs have increased over time.

Research Question 3: Synthesise and critically evaluate the evidence on the benefits and costs of government spending on local highways maintenance.

Funding streams

Local highways network maintenance is currently funded through a combination of central government allocation through DfT and contributions from other sources such as local authority raised funds. The DfT provides 92% of the central government capital funding to English highway authorities – equating to approximately 52% of authorities' total highways maintenance budgets [1]. However, this varies from authority to authority with some authorities topping up the DfT grants with other sources such as with capital borrowing. This funding is not specifically allocated for highway maintenance or improvements and comes from multiple funding streams; the main two being the Highways Maintenance Block needs-based funding and incentive-based funding, and the Potholes Fund.

Other additional funds come from sources such as the Ministry of Housing, Communities and Local Government (MHCLG), Environment Agency grants and regional and mayoral areas growth funding, although this represents a small proportion of local authorities' total highway maintenance budgets. Information about additional funds raised by individual local authorities is not readily or centrally available.

Revenue expenditure is also used to fund maintenance activities through sources including council tax receipts, business rates, as well as through the Revenue Support Grant provided by the MHCLG. However, local government revenue funding has fallen in real terms by about 25% since 2010. The allocation within it for local highways is not ring-fenced and is sometimes used by councils to plug gaps in other budget [2].

Funding for local highways maintenance is currently uncertain from year to year, coming from multiple streams that are not ring-fenced and so can be diverted to local authority spending, for example to local authority provision of social care. DfT funds are allocated to local authorities using existing formulae provided by DfT, shown in Figure 1 [4]. However, how much money each local authority spends on highways maintenance annually or how that compares to funding allocated for that purpose is unclear. Monitoring is performed by each local authority to ensure that it is spent in the most cost-efficient way [2].

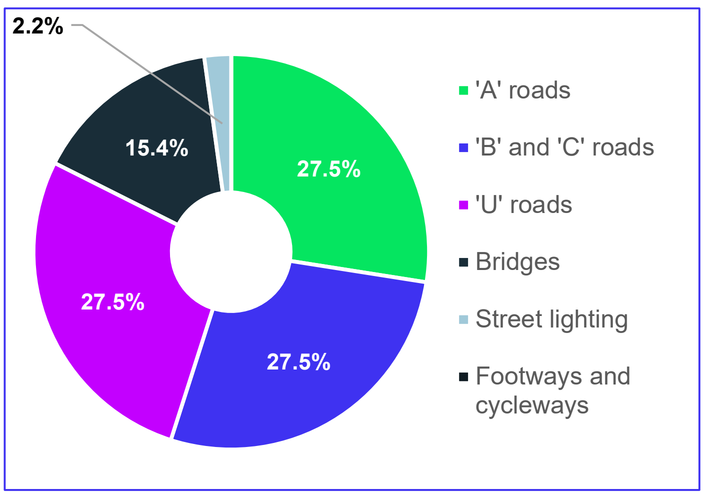

Figure 1: DfT funding allocation by asset type.

Figure 2 below shows the DfT contributions for local highway maintenance over the past 10 years, these figures have been uplifted to 2023 values using the CPI annual rate [5] [6] [7] [8] [4] [9] [10] [11] [12].

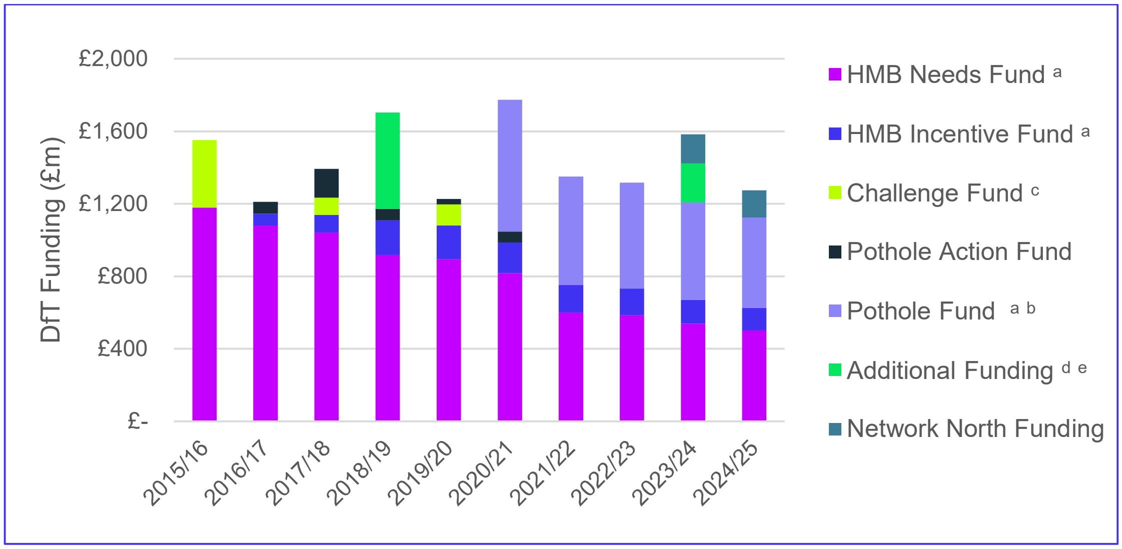

Figure 2: DfT historic funding for local highways maintenance over the past 10 years.

The network

The local highway network is a huge and complex system, and maintaining it includes the inspection, maintenance and renewal of roads, footways, cycle routes, bridges, tunnels, retaining walls, lighting, drainage, traffic signals, trees, land and much more. The Code of Practice on Transport Infrastructure Assets adopts a three-layer approach to grouping assets into categories [13]. This approach is the one currently recommended for authorities undertaking their returns for Whole of Government Accounts. Details of the approach can be found in Appendix E of the HIAMG [14].

Asset data is one of the key inputs when calculating the benefits and VfM of investing in maintenance activities as the benefits will be highly dependent on the characteristics such as the inventory, starting condition and the service life of the asset. For this evidence review, the source of asset data used is the State of the Nation [15].

The table below provides a summary of the assets that encompass the local highway network, including inventory and condition from 2018-2019; there have been significant increase or decrease in these asset numbers in the intervening 5 years since. The State of the Nation report provides an overview of England's Road infrastructure and asset quantities, condition and financial need required to bring the asset to a 'State of Good Repair' which is defined as an asset stock condition level which provides a safe and sustainable network at a low whole life cost, enabling road authorities to accomplish effective and efficient asset management.

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[a] Figures for 2021/22 to 2024/25 of the HMB needs and incentive fund and Pothole do not include funding for London, Birmingham, Sheffield, Isle of Wight and Isles of Scilly.

[b] Figures for 2020/21 the HMB Needs Fund, HMB Incentive fund and Challenge Fund do not include funding for local authorities who opted to receive their retained business rates instead.

[c] The 2020/21 £100 million Challenge Fund was incorporated into the 2020/21 Potholes Fund allocation distributed to local highways authorities by formula.

[d] In October 2018, the Chancellor announced in the Budget the government was allocating a further £420 million of new money for local highways maintenance in 2018/19. This additional resource was allocated using the highways maintenance funding formula and was used for the repair of roads (including potholes), bridges, and local highways infrastructure generally.

[e] Budget 2023 announced £200 million for highways maintenance for the financial year 2023 to 2024 in addition to the existing highways maintenance funding settlement announced in the October 2021 Spending Review.

Table 2: Summary of the inventory and condition of the assets that encompass the local highway network.

Asset category	Inventory		Condition
Carriageways	1,911,000,000	sqm	Classified – 81% in "Good" or "Very Good" condition Unclassified – 45% in "Good" or "Very Good" condition
Footways & Cycleways	224,300,000	sqm	34% "As New" 36% "Aesthetically Impaired"
Drainage	Not provided		
Structures	51,750	bridges	83% in "Good" or "Very Good" condition
Street Lighting	5,390,000	lighting columns	Mean age: 21.03 years Expected life: 40 years SOGR: 20 years
Traffic Signal Sites	12,300	traffic signal junctions	Mean age: 10.51 years Expected life: 25 years SOGR: 12.5 years
	38,200	pedestrian crossings	Mean age: 11.55 years Expected life: 25 years SOGR: 12.5 years

DfT also produces an annual report outlining the condition of all the roads in England, covering surface condition and skidding resistance. Automated survey machines and visual surveys are used by local authorities to monitor the condition of the road surface; however, the report only include local authorities with valid data available. Data is available for fewer London local authorities for the last 4 years in this release, due to changes to how surveys in London were carried out [16].

Road surface condition categories are based on multiple parameters collected by Surface Condition Assessment for the National Network of Roads (SCANNER) machines which are combined and weighted against the type of road to give a single figure of Road Condition Indicator (RCI). The RCI is used by local authorities alongside other evidence to prioritise maintenance. The definitions of road surface condition categories are:

- Red: Should have been considered for maintenance. Treatment may or may not be required, but the road should be investigated fully.
- Amber: Maintenance may be required soon.
- Green: No further investigation or work is needed.

Figure 3: Examples of roads categorised as red, amber and green.

The 2023 report showed that the condition of local roads continues to be broadly stable since 2016, particularly for classified roads. The table below shows the trend in the percentage of local roads that should have been considered for maintenance (red), by road type, for the years 2008 to 2023 [16].

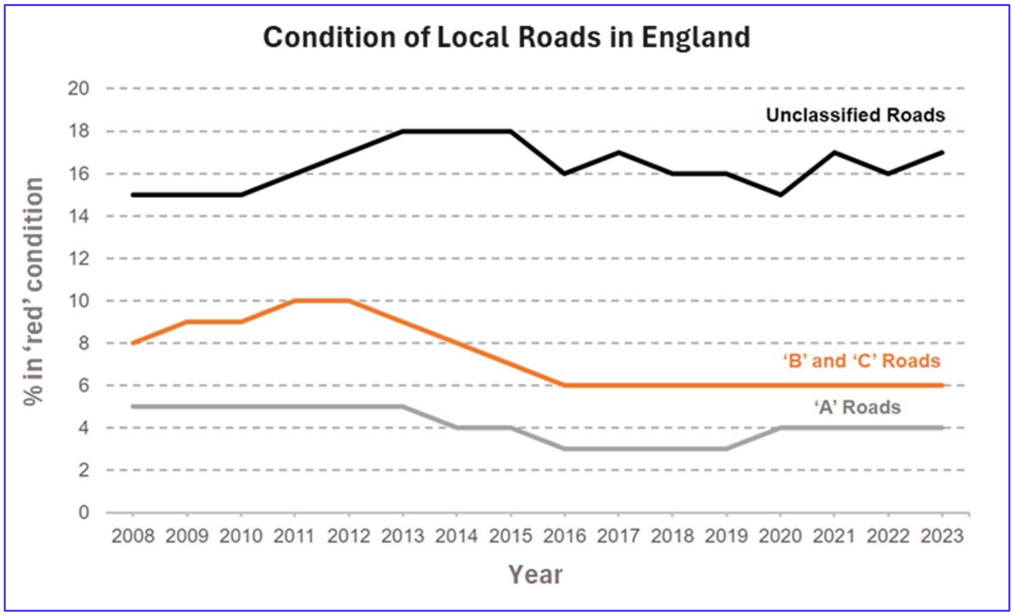

Figure 4: Trend in the percentage of local roads that should have been considered for maintenance.

The 2024 ALARM Survey also showed that roads classed as red (poor overall condition) have again remained stable but still one in every 10 miles (11%) of the local road network in England and Wales is likely to require maintenance in the next 12 months. This equates to around 22,300 miles [1].

Maintenance activities and costs

There are a wide variety of intervention types for the different asset types that encompass the local network. This section provides an overview of some of the unit rate data that has been collated as part of the discovery phase. Unit rates are often a key input into any options assessment and are crucial to determining the VfM of schemes. The tables below show the unit rates for different intervention types according to each asset group from State of the Nation's report, uplifted to 2023 rates using CPI index [17].

Table 3: Intervention types and unit rates associated for pavement.

Asset type	Condition	Intervention	Unit rate range (£/sqm)[f]	
			Lower rate	Upper rate
Strategic Roads	Poor	Resurfacing	£ 78.53	£ 95.71
	Very Poor	Strengthening Works	£ 125.15	£ 154.60
Classified Roads	Poor	Resurfacing	£ 28.22	£ 30.37
	Very Poor	Strengthening Works	£ 58.90	£ 61.04
Unclassified Roads	Poor	Resurfacing	£ 15.95	£ 18.10
	Very Poor	Strengthening Works	£ 28.22	£ 30.37

[f] *The representative upper and lower works costs for UK Road Authorities in the UK were agreed with UKRLG Asset Management Board.*

Table 4: Intervention types and unit rates associated for footways and cycleways.

Asset type	Condition	Intervention	Unit rate (£/sqm)
Footways and Cycleways	Aesthetically Impaired	Surface Treatment	£ 10.45
	Functionally Impaired	Resurfacing	£ 30.44
	Structurally Unsound	Reconstruction	£ 51.37

Table 5: Intervention types and unit rates associated for structures.

Asset type	Condition (based on BCI_{ave} range)	Unit rate range (£/sqm)[g]	
		75th Percentile	85th Percentile
Structures	Very Good	£ 481.33	£ 805.26
	Good	£ 880.03	£ 1,243.82
	Fair	£ 1,548.83	£ 2,277.83
	Poor	£ 2,407.52	£ 3,437.24
	Very Poor	£ 3,077.56	£ 4,361.99

Table 6: Intervention types and unit rates associated for lighting and traffic signal assets.

Asset type	Intervention	Unit rate range (£/unit)[h]	
		Lower Service Level	Higher Service Level
Lighting	Lighting column renewal	£ 551.87	£ 735.37
Traffic signals	Traffic signal renewal	£ 19,986.29	£ 29,918.68

Trends and changes in the maintenance costs

In recent times, inflation has led to the costs of maintenance activities rising significantly. This was mainly determined by construction materials prices increasing and inflationary pressures driven by rising energy prices remain, significantly impacting products that involve energy-intensive manufacturing process. In 2022 Building Cost Information Service (BCIS) forecasted that although materials' prices were expected to fall in the short term, the inflationary pressures would keep labour costs rising, resulting in increases in both costs and tenders [18].

Research conducted by the Local Governments Association (LGA) and Association for Directors of Environment, Economy, Planning and Transport (ADEPT) found that councils are seeing a 22% increase in the cost of repairing a pothole, relaying a road surface and other maintenance costs. The research estimates that the cost of building new roads has risen by 21%, while the cost of repairing streetlights has increased by 37.5% [19]. An average of 20%

[g] *The average cost of works per square metre for each band was calculated utilising the outputs from the Atkins Structures Toolkit. Utilising the backlog methodology, it was determined that 75th and 85th percentile unit costs provided a comparable total figure to the 2019 RAC Foundation Bridges report backlog.*

[h] *Unit rates calculation used the Annual Maintenance, the inventory data and the expected steady state service level. The acceptable steady state service level for lighting columns and traffic signal sites was agreed with the UKRLG Asset Management Board to be 50% consumed. This was then applied to the asset 'expected life' i.e., lighting columns expected life is 40 years, then 50% consumed = 20 years; traffic signals sites expected life is 25 years, then 50% consumed = 12.5 years.*

increase in maintenance costs over the past 5 years was confirmed by multiple stakeholders engaged as part of this task.

Inflationary cost rises are already starting to impact ongoing road building projects with some schemes being paused in the past month due to rising material, labour and energy prices. Some examples of how this impacting Local Authorities include:

- Cumbria County Council has indefinitely deferred the stage 2 of its Carlisle Southern Link Road (CSLR) as inflation has caused costs to rise. The project was initially advertised as a £75m contract in 2020, but the cost of the project has now doubled to £150m according to council documents.
- In Devon County Council, parts of the £67m North Devon Link Road have not been taken forward due to contractor costs rising by 25% since the project was approved in 2019.
- Manchester City Council stated that there has been an impact on maintenance and inspections of assets due to increase in prices. The costs of maintenance and inspections has increased significantly due to global increases in oil prices. Sub-contractor and suppliers have also increased their prices leading to further funding pressures.
- Surrey County Council also stated that their main current challenge is the increased costs due to inflation. However, another challenge they face is the need for more carbon efficient maintenance due to the push to net zero targets, which is expensive.

Overall, major infrastructure projects and maintenance costs in the industry are increasing. The NHT CQC Efficiency Network has been comparing their members maintenance costs on a like for like basis and has been able to quantify their improvements and efficiency savings. In their last Annual Report, they reported that costs in the infrastructure sector were rising between 2017/18 and 2020/21 but slightly decreased in 2021/22; however, there was another increase in 2022/23. The chart below shows the results and indicates that unit costs after deflating by the Tender Price Index have in fact fallen slightly from 2020/21 to 2021/22, but then increased slightly to 2022/23 [21].

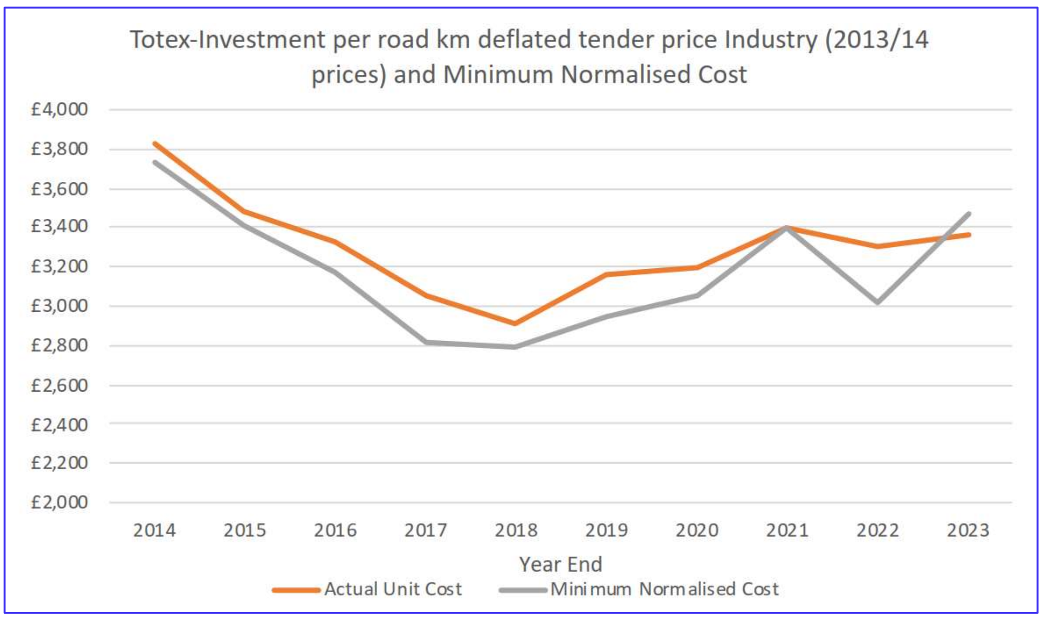

Figure 5: Trend over time of unit rates for carriageway maintenance from NHT CQC modelling.

Benefits of well-managed highway infrastructure

Overall, funding for local highways maintenance provides good to very good return on investment, with a much lower risk than major projects to construct new infrastructure. For every additional £1 invested, an absolute minimum return of £2.20 [22], with further socio-economic benefits estimated to provide up to £5+ return [23].

The user group most affected by a reduction in local road maintenance are pedestrians, (and especially those with mobility and visual impairments). Pedestrians are affected by increased noise and vibration, and emissions of air pollutants, from motorised vehicles, together with negative impacts to visual amenity, cultural and landscape, physical fitness, accidents, security, community and comparative accessibility [24].

This section provides an overview of the available evidence that demonstrates the types of benefits that local highway infrastructure in good condition brings to the community. The sub-sections below have been aligned to typical national, regional and local policy objective themes. Some of the benefits are often hard to quantify with limited data available.

Economic benefits

High-quality local highway infrastructure has been shown to produce a plethora of benefits to society including providing benefits to highways users, supporting economic activity by improving traffic flow, encouraging different demographics to walk and cycle more to their destinations, and reducing the risk of residential and commercial areas being affected by floods. Examples of economic benefits from investing in the local highway infrastructure maintenance, leading to it being in an improved condition, include:

- City centres with an improved urban realm have been associated with as much as a 40% uplift in retail takings [25]. Good quality roads have been shown to encourage people to leave their homes and engage in economic activity; four out of ten people are influenced in whether they go by the condition of the roads [26].
- High-quality street design can have local economic benefits; people are often unsatisfied with the space they live and travel in because of transport [27].
- Increased uptake in cycling. Ten billion annual journeys are undertaken in England every year by bicycle and on foot with an economic value of £14 billion; and the UK market for cycling equipment and goods alone is now worth an estimated £3 billion a year, when considering direct employment and spend [25].
- A reduction in traffic accidents which cause around 250,000 casualties each year and kill almost 3,000 people. The overall costs to society of traffic accidents alone cost around £9 billion [28]. Those who live in the most deprived areas have a 50% greater risk of dying from a road accident compared with those in the least deprived areas. Moreover, accident rates for children are four times higher in deprived areas [29]. However, the physical improvements to roads and footways only account for a small proportion of the interventions required to reduce road collisions [30]. It is hard to determine which proportion of this cost was for accidents caused by poor condition of the roads; driver's error was listed as the most common factor.
- Minimised costs caused by congestion and disruption in urban areas which equate to around £11 billion per annum [28].
- Reduction in damage to vehicles. Potholes have caused damage to vehicles worth £1.25bn in 2020 [31]. In the past year local authorities paid out £22.5 million in compensation claims for damages arising because of defects in the road surface [32].
- Reduction of negative impacts to small and medium-sized enterprises. Badly maintained local roads are costing SMEs £5 billion a year in wasted staff time, production delays, increased fuel consumption and vehicle damage repairs [33]. Additionally, absenteeism costs to business of £5 billion a year due to physical inactivity [34].
- Boost Britain's exports by reducing disruption on roads, meaning quicker journey times for freight drivers and making it easier for the UK to access its export markets [35].

Social benefits

It is often thought that local highways maintenance only directly impacts road, cycleway and footway users; however, the findings of this evidence review shows that there are a variety of wider impacts on different demographics within society. Examples of social value benefits from investing in the local highways network leading to it being in a better condition include:

- Studies demonstrated that for the same proportional budget reductions, the effect on road users of reduced local road maintenance budgets is greater than the effect of reduced trunk road maintenance budgets. For every £1 saved there is a disbenefit on local roads of £1.67 and on trunk roads of £1.12; for the local road network, comparatively greater disbenefits will be realised in the form of social impacts on pedestrians, cyclists and local residents [36].

- Improved links between urban areas and rural communities. For example, lifeline roads that are kept to a good standard, allowing for continuous flow between both areas with limited disruption, leads to a reduction in the imbalances, primarily economic, between areas and social groups across England [37].
- Improving community accessibility reduces isolation by removing barriers to mobility among vulnerable groups and can provide potential savings in social care. 'Age-friendly' neighbourhoods that enable vulnerable people to live in their own home, rather than going into residential care could save the taxpayer about £18,000 a year [38].
- Making places healthier, greener and more attractive places to live and work [39].
- Road traffic is the major cause of local emissions in urban areas costing £5-10 billion per annum [28]. A decline in vehicle use, due to increased modal shift to active travel, would support lower levels of air pollution which may lead to a decrease in respiratory conditions. A disbenefit may be that improved road condition encourages increased motor vehicle usage.

Health benefits

There are multiple health benefits that result from a good quality local road network that positively affect individuals in society and the NHS. Well-maintained footways and carriageway provide huge scale of infrastructure for pedestrians and cyclists encouraging more people to take up active travel options. Examples of health benefits from investing in the local highway network leading to it being in a better condition include:

- Increased levels of physical activity among the public, will lead to healthier societies, decreasing the risk of chronic health conditions including heart disease [34]. For instance, for every £1 spent on cycling provision, the NHS recoups £4 in reduced health costs [39].
- The risk of mortality reduced by almost 40% through cycling to work, reducing the risk of obesity and cardiovascular disease. Considerable savings for the NHS and Social Care by substituting car journeys with walking or cycling and creating safer and more pleasant neighbourhood environments and roads [29].
- Accessible and high-quality active travel provisions help tackle health inequalities, such as physical activity, which can be more effective if people from marginalised and deprived communities and those who are socially isolated are seen as valuable contributors to the local assets [39].
- A reduction in health costs from the current level: physical inactivity is estimated to cost the NHS £1.06 billion per year. Active travel can contribute towards the recommended 150 minutes of physical activity for adults each week, which are hugely important for maintaining health [25].
- Reduction in annual costs to society of transport-induced poor air quality, ill health and road accidents of £40bn [29].
- Decrease in deaths associated with air pollution. Up to 40,000 early deaths are attributable to air pollution each year in the UK and road transport is responsible for 80% of the pollution where legal limits are being broken [34].
- Reduction in NHS costs of £17bn over 20 years due to active travel replacing short motor vehicles, plus potentially additional £2bn per annum due to reduced obesity levels [40]. Encouraging even just one more person to walk to school could pay back £768, with savings of between £539 and £641 a year for every person who cycles instead of using their car [29].
- A reduction in the number of falls taken by the public on pavements. Every year, nearly one in ten people over the age of 65 trip or fall because of damaged or uneven pavements [38]. The removal of defects will lead to less accidents occurring, benefiting the health of the public [41].
- Generally, the benefit to cost ratio of investments in new walking and cycling are estimated at 5.62:1 (or 'very high' VfM) [25]. Although the BCR is for new active travel infrastructure, the long-term benefits are dependent on the assets being maintained sufficiently. The cost of maintenance per unit is considerably less than construction, and thus maintenance is likely to have a much higher BCR than building new provisions.

Environment and sustainability benefits

Maintaining and managing good local infrastructure can also promote an increase in environmental quality and sustainability. An increase in the use of active travel provisions, due to better maintenance of safer cycleways and footways, facilitates this progress but also there is the ability to implement carbon reduction by adopting specific maintenance strategies for different local highway network assets. Examples of environment and sustainability benefits from investing in the local highway network leading to it being in a better condition include:

- Maintaining roads in a steady state condition can lead to a net 1,415 thousand tonnes of carbon saved; and this value can be further enhanced if strategies with a greater focus on preventative maintenance were adopted. Additionally, a progressive increase in the quality of the unclassified roads whilst maintaining the A and B/C roads at steady state, could save a net 1,700 thousand tonnes of carbon [21]. However, here is the challenge around using low carbon materials as they tend to need higher upfront costs.
- As well as carbon savings, good management of the local road network allows for biodiversity net gains to be achieved. These activities not only benefit road users but also benefit species that inhabit in the relevant regions. Some examples of biodiversity related net gains include [42]:
  - The creation of new habitats, through wildflower cultivation, that provide food, shelter, and security for pollinators, as well as providing food for local wildlife and birds. Wildflower cultivation also creates connectivity between different habitats, producing nature recovery corridors.
  - The management of invasive species
  - The enhancement of habitats and the creation of more floristically rich grassland by planting plug plants in the existing grassland.
  - A reduction in the nutrient content of soil by removing grass cuttings and arisings
  - The creation of mixed scrub vegetation by planting native shrub saplings.
- Local authorities are also currently utilising recycled materials in their roads and pavements, maintaining a strong focus on the circular economy approach to local highway maintenance, which is further helping to sustain the environment [43].
- Promoting active travel can result in reduced emissions of Nitrogen Dioxide (NO_2), particulate matter (PM) and CO_2 helping to tackle climate change and improve air quality [25].
- Generate savings in electricity costs by investing in LED upgrades. Lancashire County Council's LED Street Lighting Challenge Fund Bid produced returns on investment such as energy savings of £2.7M and had a carbon reduction commitment energy efficiency savings of £191,000. This intervention also allowed for energy consumption to be reduced by 21,834,000 kWhs per annum [44].
- More sustainable journeys within different councils. In 2017, Greater Manchester transport system set out the ambition that by 2040, 50% of all journeys in Greater Manchester will be made by public transport or active travel, supporting a reduction in car use to no more than 50% of daily trips. This would mean one million more sustainable journeys every day in Greater Manchester by 2040 [45].

Safety and security benefits

Investing in the local highway network promotes a greater feeling of safety and security amongst the public. Communities in general feel less secure as road network conditions deteriorate, lighting is reduced, and streets are cleaned less [36]. Examples of safety and security benefits from investing in the local highway network leading to it being in a better condition include:

- More people encouraged to leave their homes due to the provision of better street-lighting, investment in street-cleaning and dealing with low-level nuisance all help older people to continue getting out of their homes [38].
- Situational crime prevention due to improved street lighting that sees increased levels of illumination on the street and in other public spaces. Crime was reduced by an average of 21% in areas with improved street lighting compared to areas without [46].
- A decrease in the number of cyclists killed due to potholes. Potholes pose a significant risk to non-vehicular road users—pedestrians, cyclists, motorcyclists and others.
  - Data shows that the number of cyclists killed or injured due to defective road surface more than tripled between 2005 and 2017 [32].

  - Since 2017, 255 people cycling have been killed or seriously injured due to road defects [47].
- Decrease in the number of pothole related breakdowns. The AA attended more than 52,000 pothole related breakdowns in April 2023, a 29% increase compared to the same time in 2022 [48].

Resilience and Climate Change Adaptation

Effective local highways maintenance helps to build a resilient local highway network that has the capacity to withstand strong and unprecedented weather events in England, thereby avoiding large defects from forming and preventing rapid deterioration of the assets. Climate change has led to more cases of severe weather events which in turn have increased damage to the highway infrastructure [49]. Examples of the benefits of investing in the local highway network to allow for more resilience and adaptation include:

- Effective maintenance of the local roads network will contribute to reducing the amount of damage done to roads during adverse weather events. Disruptions in the network caused by severe weather can cost up to £280m per day of disruption [50]. The cost of associated damage could increase by about 40% by the 2050s if current management approaches continue as they are [51].
- As road assets age and as the impacts of more extreme weather due to climate change increase, road networks will become increasingly less resilient if not maintained adequately. Effective timing of draining maintenance before, during and after winter/rain seasons can alleviate asset failure which can lead to extensive and expensive emergency repairs [52].
- The 2022/23 very wet winter has generated the highest number of carriageway potholes in East Sussex since 2016 with the relationship between wet winters and pothole numbers clearly evident. Alongside this there was also a visible deterioration in carriageway condition with some areas experiencing sudden surface failure. Most Highway Authorities in the UK experienced similar conditions and reported large numbers of potholes and deterioration to their road networks [53].
- A reduction in the number of ‘one-off’ funds that the government provides as a response to damage created by severe weather events in England. For example, in March 2014 a weather damage grant of £140m was provided to local authorities to help repair the damage caused by the prolonged period of severe weather; and in June 2014 a pothole fund was created to provide of £168m in 2014/15 out of a fund totalling £200m [33].
- A reduction in future costs from climate change, with investments in adaptation capable of delivering strong VfM in the range of £2 to £10 of benefits per pound of investment [54].
- A reduction in regional inequality as it decreases the likelihood that people living in areas that are most at risk from extreme weather will experience higher insurance premiums and lower investment. This is because it would be known that the roads in these regions can withstand severe weather [54].

Research Questions 4 & 5

Research Question 4: Synthesise available evidence and put forward suggestions in relation to the following question: How should the BCR and VfM be estimated at a national level of spending on local highways maintenance in England? What is the estimated BCR and VfM of this spending?

Research Question 5: Synthesise evidence on what the typical BCR and VfM is for different types of intervention e.g., different types of maintenance, carriageway type, structure type, location. Provide recommendations on how the BCR and VfM should be calculated for these different types of schemes.

Existing appraisal tools and methodologies

There are currently several appraisal tools and methodologies which are used to measure the benefits and VfM of different highway schemes and maintenance activities undertaken by the local authorities. These include the Highway Maintenance Appraisal Toolkit (HMAT), Highway Maintenance Economic Assessment (HMEA), Highway Development and Management Model (HDM4) and the Active Mode Appraisal Toolkit (AMAT). A detailed flowchart outlining the links and relationships between the inputs and outputs of HMEP, HMAT and HMEA can be found in Appendix A.

This section provides an overview of the appraisal tools and methodologies that are available to local authorities describing the key attributes, advantages and limitations of each one. Some of these will be explored in more detail as part of the deep dives later in the project and will form the basis of the final recommendations of this evidence review.

Highway Maintenance Appraisal Toolkit (HMAT)

The HMAT, which was developed in 2015 by the Transport Research Laboratory (TRL) on behalf of DfT, is a decision support tool that can process and assess the economic impacts of different road network maintenance scenarios, at network level over a specified analysis period [55]. The spreadsheet-based model, which is freely available online to all highway practitioners, was the first time a holistic approach had been adopted to quantify the benefits of road maintenance and took two years to develop [56]. The tool acts as a contributor to the HMEA toolkit, which is a subsequent development, and incorporates the Highways Maintenance Efficiency Programme (HMEP) Carriageway Life-cycle Planning Toolkit, developed in 2012, to project forward the condition and treatment programme over the analysis period [22].

The tool is a Microsoft Excel-based model that requires the user to enter relevant inputs, then run the analysis from which they will receive detailed projections of carriageway deterioration and resultant impacts on future maintenance costs, costs of travel to users and rates of collisions, according to each funding scenarios.

Table 7: Inputs and Outputs of the HMAT tool

Inputs	Outputs	
› Base year of the analysis › Road types (in the network or sub-network) › Condition bands and treatment types › Forecast traffic	› Scheme analysis › Road works impacts time › Road works impacts carbon › Road works impacts accidents › Material carbon quantity	› Material carbon cost › IRI table › IRI lengths › Road condition impacts output › Accident analysis › Analysis graphs

The HMAT toolkit enables the assessing of different carriageway maintenance options against the impacts to the network. For example, assessing different funding levels, treatment strategies (e.g., proactive vs reactive) or funding strategies (e.g., prioritising maintenance based on road class or rural/urban environment) against the condition, road user delay, CO_2e emissions and road traffic collisions etc. The model builds on other models and approaches such the Transport Analysis Guidance (TAG), HMEP, HDM4, Asphalt Pavement Embodied Carbon Tool (asPECT), Queues and Delays at Roadworks (QUADRO), National Transport Model (NTM), Annual Business Survey and more. The assumptions of the toolkit can be found in Appendix A of the 'Valuing the benefits of Road Maintenance Project Report' [22].

The HMAT toolkit's functionality allows users to enter various datasets and adjust various parameters, plus provides facility to compare the results of different options through the Aggregated Output Module (AOM) [57]. HMAT is a well-established tool, making use of highly relevant local data which is routinely collected. It is therefore recommended as a core component of assessment of the VfM of maintenance of local authorities.

However, there are barriers that limit the HMAT toolkits usage, which include [58]:

1. Visibility / industry awareness – during option testing and development phases of major projects use of HMAT to assess impacts on future maintenance costs appear to be very requested by National Highways, suggesting that they are either not seen as a priority or that scheme promoters are not aware of this tool.
2. Usability / complexity – as HMAT is aimed at measuring long-term efficiency of investment it requires considerable forecast data for inputs such as traffic flows by type across different network sections and planned investment by type, as well as detailed existing network characteristics and road conditions. Such data isn't generally available with long-term traffic forecasts only being prepared at times when new investments need to be justified. This may differ from the times at which maintenance budgets are specified, so data needs to be joined up.
3. Resource intensive – if the tool is used only very infrequently by a given individual it can be difficult to apply, as access to the required data sets may be challenging, coming from a variety of sources. The tool itself is well-structured and once data has been collated it should not take long to populate and assess outputs.
4. Scope does not cover all aspects of transport economic appraisal, such as:
   i. Environmental impacts
   ii. Active Travel
   iii. Social impacts

Highway Maintenance Economic Assessment (HMEA)

HMEA was developed by TRL on behalf of UKRLG Asset Management Board and published in 2021. It is a Microsoft Excel-based tool used to assess the wider economic impacts of different road network maintenance scenarios over a specified analysis period and is freely available online to all highway practitioners [59]. It enables highway managers to forecast the impacts of different highway maintenance strategies on the local economy, assisting in evidencing the benefits to senior decision makers and accountants. Although the HMEA tool is separate from HMAT, the HMEA requires and utilises the outputs from the HMAT analysis. Additional HMEA inputs include:

1. Economic data
   a. Income tax receipts
   b. National Insurance
   c. VAT
   d. predicted growth rates (GVA, Income Tax receipts, VAT, National insurance & Employment)
   e. Discount rates
   f. Composition of and contributions from the local economy across industry sectors (considered in the analysis)
2. Local network information
   a. Accident costs
   b. Annual Accident cost growth rate (%)

    c. Alternative network
        i. Traffic flows and estimated annual growth
        ii. Accidents (Serious and Fatal)
        iii. Predicted redistributed road traffic (if base network is unavailable)
        iv. Estimated free-flowing traffic speed (when base network is available)
        v. Estimated ration of CO_2 emissions between alternative and base network
3. Income Information
    a. Congestion charge
    b. Tolls

Upon completing the entry of the above information, local authorities import the HMAT toolkit(s) and process the information to generate the future economic impact projections for each scenario. These outputs collate the forecasts developed through HMAT and build upon these to provide a more holistic view of economic impacts of differing maintenance programmes, including increased efficiency of businesses from improved transport connectivity leading to uplifts in GVA, employment and generation of tax receipts.

This tool provides a comprehensive overview of the economic impacts of different options for investing in road maintenance, but similarly to the HMAT tool it requires considerable collation of input data be able to generate results, with the operation of HMAT itself being a prerequisite. The additional data on the composition of the local economy is relatively easily available, but some assumptions are required to inform the levels of dependency of each industry sector on the quality of the transport network. It is generally understood that economic outputs indicating uplifts in GVA, such as those produced by HMEA, should be considered in an indicative context and are less robust than the type of impacts measured throughHMAT, but these form a helpful indicator of the knock-on effects to the wider economy of improvements to the transport network.

HMEA is more recently developed than HMAT and has been less used in real-world assessments to date. It also relies on data which can be more difficult to accurately collate based on available sources, and precise relationships between transport and different sections of the wider economy which are less well-established. However, while assessments performed using HMEA may contain an element of uncertainty, the evidence for a strong connection between transport and economic growth is well understood and excluding these impacts from any analysis will result in a significant under-estimate of the value. HMEA is currently the only well-developed tool to undertake this type of assessment, with alternative options such as DfT's WITA requiring extensive additional modelling to capture impacts of changing travel costs on the wider economy. HMEA is therefore recommended as part of the approach to assessing the VfM of maintenance of local authorities.

Highway Development and Management Version 4 (HDM-4)

The HDM-4 [60] is a software tool developed by the World Bank that integrates technical assessment and economic analysis for road investments, maintenance standards, and strategic planning. Its primary purpose is to aid in the analysis, planning, management, and appraisal of road investments and the maintenance of road networks over time. This tool is not freely available as HMAT and HMEA and requires a licence to be able to access it, however, once the license is acquired the user gets access to features including technical support, helpdesk and updates.

The tool projects the medium to long term budget requirements for the entire road network together with forecasts of pavement performance and road user effects, allowing users to model and compare different scenarios, plus calculate the network infrastructure asset value. The tool also calculates the economic benefits for each work programme in which candidate road sections are identified and allotted maintenance or improvement options. It is a highly flexible tool as it is designed to compute for a variety of vehicle types and road conditions, vehicle operating costs, fuel consumption, vehicle speeds, passenger time costs and emission and accident costs. The main outputs include pavement condition, road maintenance works and road improvement effects, road agency costs and road user costs and benefits, standard economic indicators such as the Net Present Value (NPV) and sensitivity analysis that allows the user to explore the impact of disparities in key parameters on the analysis results.

Currently, there is a planned HDM-5 tool, which will build on from the HDM-4 road user costs model, as it has been twenty years since the last major upgrade [61]. Thus, it is expected that the HDM-4 tool will be superseded in the next one to two years, although it is assumed that the HDM-4 tool will also continue to be used internationally in the future.

HDM-4 largely covers similar areas of assessment to HMAT but is aimed at a global market rather than being UK-specific. It does not include the extended areas of assessment covered by HMEA and does not interface with HMEA in the way that HMAT does. Use of this tool may therefore be helpful for sensitivity testing, to compare against HMAT under certain conditions but it is not recommended as a primary means of assessment.

Active Mode Appraisal Toolkit (AMAT)

The AMAT was published by DfT in 2022 and is a freely available Microsoft Excel-based tool that measures the overall benefits and costs of proposed walking and cycling interventions. These interventions can range from capital investments to behaviour change programmes.

Although the tool does not specifically cover maintenance of walking and cycling infrastructure, there are lessons to be learnt from its design. It also facilitates providing a case for active travel provisions in general, prompting maintenance of these provisions to be seen at a higher level of importance.

The tool quantifies a wide range of benefits of cycling and walking including health improvements from increased levels of physical activity, enhancements to journey quality and impacts associated with modal shift away from cars and taxis, such as a reduction in greenhouse gas emissions. Other factors that are used in the AMAT's analysis of costs and benefits of a proposed active travel interventions include congestion benefit, accidents, local air quality, noise, reduced risk of premature death and absenteeism [62].

There are specific approaches in order to quantify the benefits. For example, to assess the improvement of health, this value is monetised using values of life, while to measure the increased productivity, employment levels, rates of absenteeism and average salaries within the working population are used. Improved journey experience is valued using 'Willingness To Pay' methods identified through TAG.

The limitations of the model must also be taken into consideration. For instance, issues surface depending on the scheme length, where there are difficulties calculating the benefits with a shorter walking or cycling route used. Furthermore, only one type of infrastructure can be selected for an assessment despite a typical route encompassing a mix of infrastructure types and infrastructure options for selection are omitted since the AMAT is limited to those that have been monetised in previous studies.

AMAT may potentially be a helpful tool to contribute to assessing the VfM of maintenance of local authorities. However, this will depend upon the nature of data available on existing assets and their use. If available data does not align with the requirements of AMAT, then some of the principles of the tool, such as valuing health and employment impacts of active mode facilities may be best used within a bespoke analysis. This may enable a higher-level assessment to be performed, rather than considering each asset in isolation.

Highways Infrastructure Resilience Modelling (HIRAM)

The HIRAM support tool is a map-based tool that provides data layers from local authority information, local highways asset information, public data on the environment, Environment Agency datasets, climate change datasets, and geological datasets [63].

The HIRAM support tool was developed to enable local highways teams to:

- Record the locations and structures at the highest risk from severe weather across the network.
- Estimate the economic and social costs of disruption if no preventative action was taken.
- Price the intervention measures needed to decrease the risk of impact in the event of severe weather in addition to making the case for investment and preventative works to reduce social and economic impacts of severe weather incidents in the future.

There are benefits from bringing these different datasets together in a single place. Engineers are better able to see where physical highway infrastructure might be at risk of severe weather. Organisations can also understand the knock-on impacts of risk across the network on the economy and society.

The approach therefore allows for quantified evidence to be accessed by local highways teams which will aid them in making more informed spending decisions on resilience measures.

While HMAT considers the VfM of investment in maintenance based on an assumption of steady rates of decline in quality of the network as a whole, HIRAM allows a more focussed assessment to consider impacts of the failure of assets such as bridges focussing primarily on the potential impacts of climate change. Such structures may transition quickly from operational to non-operational, with high user costs at a set point in time, rather than costs gradually building up. This tool can therefore be used as a complementary method of assessment to HMAT in measuring the value of network maintenance.

It may also be used as a method to evaluate the inherent risk in different investment strategies. Failure of assets over time depends in part on unpredictable factors such as severe weather events and the level of investment can be tailored to mitigate these risks to what is considered an acceptable level based on the costs of investment and the impacts on user costs if failure were to occur.

Other appraisal tools

Other tools used by local authorities include:

DfT Challenge Fund Toolkit – released in 2019 for that round of applications, this was a data proforma to be submitted alongside the short strategic case. It was designed to minimise the burden for authorities in producing data and collating information and did not require any new additional modelling. It required some key data to be entered by the applicant, which would then calculate the Net Present Value over a 30-year appraisal period using cost inputs for Present Value Cost and a calculated Present Value Benefit, subject to the type of project. These would then produce a BCR for the project.

This toolkit was designed to enable simplified assessment of small-scale funding applications and is unlikely to be of practical use in a comprehensive VfM assessment of the spending of local authorities on highway maintenance. However, applications developed using this tool provide helpful insight into the range of VfM which have been forecast for different types of intervention.

Structures Asset Valuation Investment Toolkit (SAVI) – Excel based tool developed by Arup on behalf of the UK Bridges Board and is designed to develop long term asset management plans, long-term intervention strategies, model variable budget scenarios against performance and whole life cost, develop tactical short term (5-year) programmes of work and carry out both gross and depreciated valuation of structures stock.

Similar to HIRAM, SAVI enables assessment of different approaches to management of bridge assets. However, this is an asset management tool and focuses on the value of assets based on level of maintenance, rather than their impact on the economy through effects on transport users. Such asset management would only atypically consider allowing manged asset failure and so this tool is only likely to be of use for contributing outputs to the cost component of a cost benefit analysis. This may be of use alongside HMAT, which focusses on the costs of resurfacing and reconstructing the base layer of standard carriageway without identifying costs related to assets such as bridges.

Asset-Management Toolkit: Minor Structures (ATOMS) – produced by the Institution of Lighting Professionals in 2019, this is an Excel based tool covering minor structures related to street lighting. It is intended to support users in developing a management strategy for their long-term operation and deterioration models. This will allow the asset manager to optimise the available funds and support the decision-making process regarding priorities and programmes.

As noted for SAVI, ATOMS is an asset management tool designed to manage investment costs and does not include any assessment of the benefits of street lighting. Some such benefits are measurable in relation to impacts on road safety or quality of the built environment which are discussed below, but these impacts cannot be captured through ATOMS.

Estimating VfM and BCR

Existing Assessments

One of the most comprehensive and well-evidenced review of the value of highway maintenance to road users at a national level remains the study undertaken by TRL in 2015 upon development of the HMAT tool. The findings of this assessment indicated a marginal BCR of general maintenance of around 2.7 to 2.9 depending on whether spending is increased or decreased. It further indicated that by increasing investment to a point that roads are kept in a permanently good condition cost efficiencies can be achieved as well as significantly improving user benefits, resulting in a BCR for the additional investment of 4.3. Analysis by the Department for Transport in 2015, using the Highways Maintenance Appraisal Tool for specific highways maintenance scenarios, estimated an average BCR of around 7.

Scope of the assessments

The assessment conducted using the HMAT tool provides a rigorous and data-led approach to measuring VfM of investment in highway maintenance, but is focussed on the primary areas of cost, i.e. structural repairs and resurfacing, while considering benefits directly generated for users of the roads in motorised vehicles. In reality both benefits and costs of maintenance are more varied. Table 7 above sets out the main inputs and outputs used in the HMAT tool. This range appears to be broadly reasonable for the purpose of the tool, but the potential scope is far greater.

Table 8 gives an indication of the range of key economic factors which the HMAT tool does not capture. This list is not by any means comprehensive but is indicative of the main areas of exclusion.

Table 8: Key Inputs and Outputs not used or captured through the HMAT tool

Inputs	Outputs
› Effects of drainage and water damage at a local or regional level on rates of deterioration › Climate change impacts › Impact of network-specific traffic on carriageway deterioration › Effects of utilities works on road condition › Changing fleet composition, in particular EVs and CAVs › Costs of maintaining other infrastructure, such as bridges, tunnels, signals, signs, footpaths and cycleways	› Impacts on active mode users › Impacts on the wider economy beyond transport users › Potential user disbenefit of major asset failure › Effects of road condition on trip generation › Quality of journey and urban environment › Variations in impacts across society

It is noted that the tool has the facility to include additional localised data to adjust from the default deterioration rates of carriageways. This could enable the user to capture some of the elements above such as impacts of localised traffic levels and water damage at an aggregate level across a specific network section. With local authorities required to undertake frequent road condition surveys covering in excess of 40% of their network annually using systems such as SCANNER [64], the facility is available for this type of data to be collated at relatively low additional cost. However, conversations with different local authorities in the course of this study indicated a range of competencies in using more basic functions of the tool and concerns about budget requirements to employ consultants to perform the work on their behalf. It therefore seems unlikely that such localised assessment methods will have been widely used.

Applying national average rates for a high-level study of this type is reasonable. However, it appears likely that increasing investment in areas where deterioration of the network occurs at a faster rate would add greater value that the same investment elsewhere. Therefore, an optimised uplift rather than a homogenous increase in budget would return higher VfM in such areas and would have the reverse impact in other areas.

Subsequently to the development of the HMAT tool and the preparation of this national assessment, the HMEA tool has been developed by TRL which adds to the functionality and scope of assessment. This tool enabled the capture of wider economic impacts such as agglomeration impacts, the increased levels of productivity for businesses resulting from an effective increase in density and the employment gains from improving access between the workforce and the job market. It also enables a measure of the impacts of improving road condition on generating new trips.

While the national assessment has not been updated to consider the wider economic impacts captured through HMEA, a comparable assessment was prepared considering the effect on the value of different maintenance investment strategies across a highway authority in the UK. This assessment considered three different strategies:

- Current Budget: Continue with the current level of investment
- Steady State: Increase investment to maintain roads at their current level
- No Backlog: Conduct a period of increased investment to repair the existing backlog and then lower investment to maintain the roads at that level.

The assessment was based on the value of the road network to the economy as a whole and how its impact would vary under each scenario. BCRs of each strategy were first measured as a whole, accounting for both the impact of the maintenance investment and the existing value of the road network. The BCRs of strategies 2 and 3 were then measured incrementally to strategy 1 to identify the marginal impacts of only the change in maintenance investment.

As large parts of the economy are considered to have very high levels of dependence on the road network, accounting for the wider impacts on the economy as well as direct impacts rises significantly the forecasted BCRs of increasing maintenance investment. However, exact levels of dependency of each sector on the roads is difficult to establish and so sensitivity testing was undertaken.

This analysis was undertaken in early 2020 and so did not account for the impacts of COVID or Brexit on the economy or impacts of the Russia-Ukraine war on costs of investment. Therefore, if the assessment were to be repeated now, the results would be expected to be lower, but variations between scenarios would be likely to hold.

The assessment indicated the range of BCRs set out in Table 9. These BCRs measure the incremental benefits and costs relative to continuing investment at current levels. Unless otherwise stated these scenarios were performed over a 30-year appraisal period, including the impacts of traffic growth generated by road improvements and assume a steady 1.4% annual growth in the economy. Sensitivity testing was undertaken on the value of investment if:

- The length of the appraisal period was changed to 20 or 40 years
- The effect of improving road condition on traffic generation was removed
- The assumed dependency of each sector on the economy was reduced
- Economic growth was lower or higher than central forecasts.

Table 9: BCRs of Alternative Maintenance Strategies Based on the HMEA assessment

Inputs	Steady State	No Backlog
Core Assessment	17.1	12.5
Core Assessment (20 years)	16.2	11.7
Core Assessment (40 years)	21.3	15.9
Excluding impacts on traffic growth	13.8	12.0
Core Assessment (10% reduction to dependency on road network)	9.0	6.0
Core Assessment (20% reduction to dependency on road network)	0.9	-0.5
Low Economic Growth (0.7% p.a.)	-6.5	-6.4
High Economic Growth (2.1% p.a.)	47.6	36.6

Key findings of this analysis were that:

- Inclusion of impacts of road maintenance on the wider economy led to significantly higher BCRs than were identified through HMAT when considering road user costs alone.
- The Steady State scenario returned consistently higher BCRs than the No Backlog scenario. This does not imply that removing the backlog is not worthwhile, as BCRs still indicate very high VfM, but shows that the greatest gains will come from avoiding further deterioration in the network.
- Results vary depending on the appraisal period considered. With a shorter appraisal period the continued adverse effects of allowing the roads to deteriorate are excluded and so the benefits of increased investment are perceived to be lower.
- The results are very sensitive to the level of dependency of the economy on the road network. It is likely that these assumptions will have reduced somewhat since the study was performed as a result of increased working from home, but sectors such as construction and retail and trade which were assigned the highest level of dependency are likely to have been largely unaffected.
- Results are also sensitive to long-term economic growth rates. Over the period 2020-23 the average rate of growth had dropped to just 0.3% p.a. but long-term forecasts for the country as a whole remain at between 1.4% and 1.8%.

It is also worth noting that this study was conducted for a particular type of network. If a similar study were to be performed for example across a different region such as London, then the results would likely be different, if the value of the local economy relative to the cost of road travel is proportionally different, economic growth is higher but the dependency of the economy on the road network is not so high.

The range of tests provided an uncertainty range to help inform decision making, however, it would likely be more informative for a series of regional assessments to be performed. Differing levels of road use, rates of deterioration and value added to the economy by the road network in different areas will result in different optimal strategies across local authorities. While the scope of this HMEA assessment is considerably wider than that of HMAT, there are still elements of both inputs and outputs which are not covered. These are discussed further below.

A separate assessment undertaken by National Highways (then the Highways Agency) found through use of their Delay Cost Model that maintenance works to avoid the need for partial closure of the Strategic Road Network (SRN) returned BCRs in the range of 5.3 to 80 dependent of the level of traffic on the affected links. The range of outcomes suggested an average BCR of around 13 [65], which is comparable to the findings from the HMEA assessment.

Additional Considerations

Drainage and Flooding

Of the network details not directly addressed by HMAT the impacts of drainage and flooding appear to be the most significant. Demands for drainage have changed over time as a result of a number of factors. As shown in Figure 6, climate change has led to an increase in average rainfall across the country of around 10% in the last 50 years, with this increase affecting wetter and drier areas to similar extents [66]. Meanwhile high-density developments are increasingly being built in areas which put pressure on existing drainage facilities, while under-investment in drainage infrastructure has added to risks of flooding and burst water pipes. Successive dry summers also add to the risk of pipes being damaged by ground shrinkage.

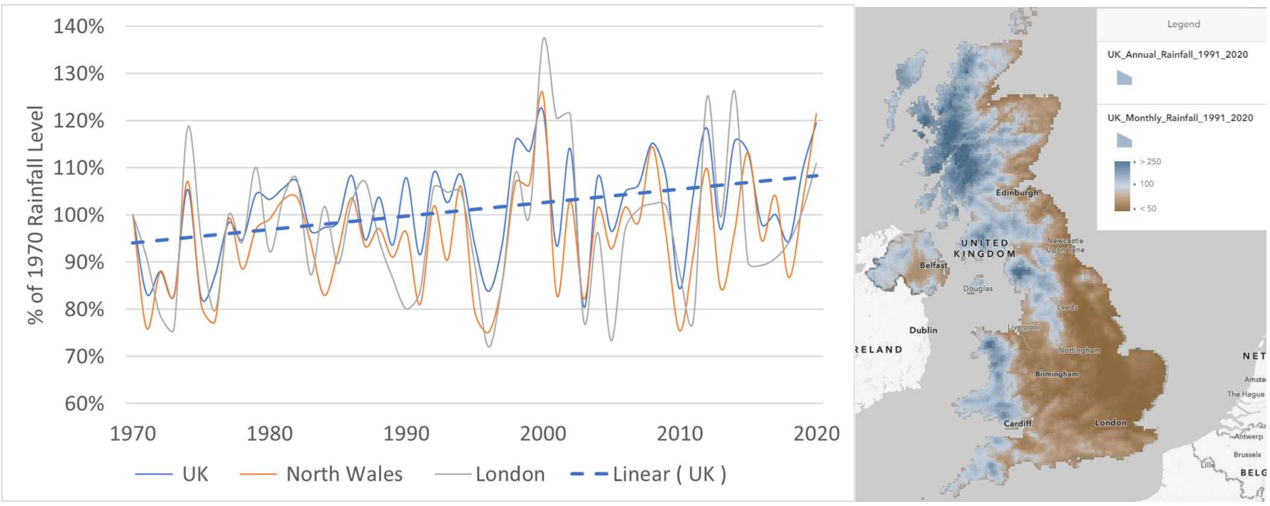

Figure 6: Impacts of Climate Change on UK Rainfall

Roads in urban environments will be most at risk from increased damage from water due to constraints on drainage [67]. These impacts are exacerbated by repeated damage to the carriageway as utility companies carry out works leaving the roads more susceptible to water damage. High frequency works being carried out to install broadband connections, have been highlighted by local authorities as a recent change to expected levels of damage to asset conditions – an impact which extends beyond effects related to water damage and has serious impacts on carriageway deterioration more generally.

An improved understanding of the impacts of water damage to carriageways at a local level and how this is likely to change in the future as a result of climate change would help to inform the type and regularity of maintenance needed in different areas and on different road types.

Impacts on Active Modes

The HMAT and HMEA tools are focussed on the effects of highway maintenance on motorised traffic and do not consider impacts on pedestrians or cyclists. The AMAT tool has been developed to assess VfM of investment in cycling infrastructure. This identifies that health benefits, in the form of reduced absence from work and lower mortality rates with associated costs to the NHS, are the most significant contributors to economic benefit of such investments, with further benefits generated through reductions in traffic levels as a proportion of users switch modes from car leading to decongestion, reduced accident numbers and less emissions.

While typically used to assess the VfM of new active travel schemes the principles and parameters within AMAT are equally applicable to the value of maintaining such schemes, so that the users do not revert to previous travel patterns.

As set out in response to previous Research Questions, active mode investments typically return very high VfM based on health impacts alone. The costs associated with maintaining such schemes are typically low, but can be quite variable, with maintenance of "light segregation" potentially higher than that of more durable segregation as a result of damage from motorised vehicles [68]. Typically, costs can range from around £10/sqm to repair aesthetically impaired foot or cycleways, to £30/sqm for resurfacing and £50/sqm for reconstruction of a structurally unsound section [15], highlighting the value of timely maintenance relative to delaying works until they become imperative. Design standards for cycle infrastructure have been set out to avoid unnecessary expense in maintaining such routes [69].

It is also recognised that maintaining a cycle facility sufficiently to enable regular use encourages users not to revert to travel by car. This therefore reduces the cost of damage to the roads and can lead to a net saving in maintenance cost in areas where cycle paths are well used. These cost savings from maintenance of the main carriageway are reflected through the AMAT tool.

Damage and Injury Related to Potholes

One cost which AMAT does not consider, which is highly relevant to the value of maintaining cycling infrastructure is the impact of injury to cyclists resulting from potholes. These impacts are still more significant to cyclists using the main carriageway, where roads are under greater stress from heavy traffic and the impact of a fall is likely to be more serious. Figure 7 illustrates the rising rate of cyclist killed or seriously injured (KSIs) related to poor road condition based on DfT's Road Traffic Statistic data [70].

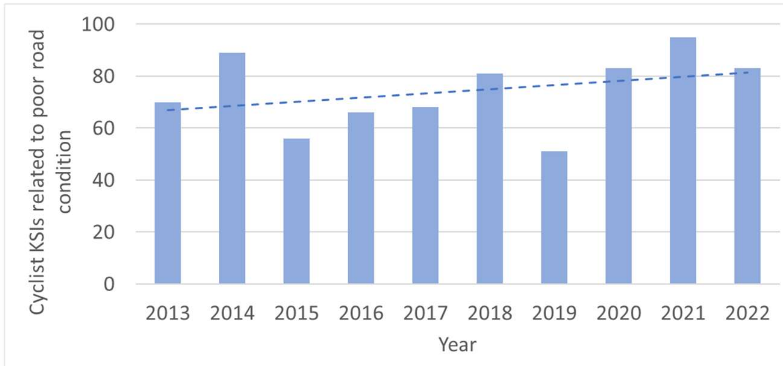

Figure 7: Cyclist KSIs Related to Poor Road Condition

Potholes also have significant cost to motorised road users, as set out in response to previous Research Questions. The causes of this may be understood when considering the changing levels of funding made available to local authorities to invest in highway maintenance. While total funds have remained broadly level over the last 10 years, as set out in Figure 2, when the same data is presented with an adjustment for inflation based on BCIS Maintenance Cost Index to account for the change in what can be achieved with each £1 of investment this highlights a reduction of almost 50% in real terms compared to 2015/16 as indicated in Figure 8.

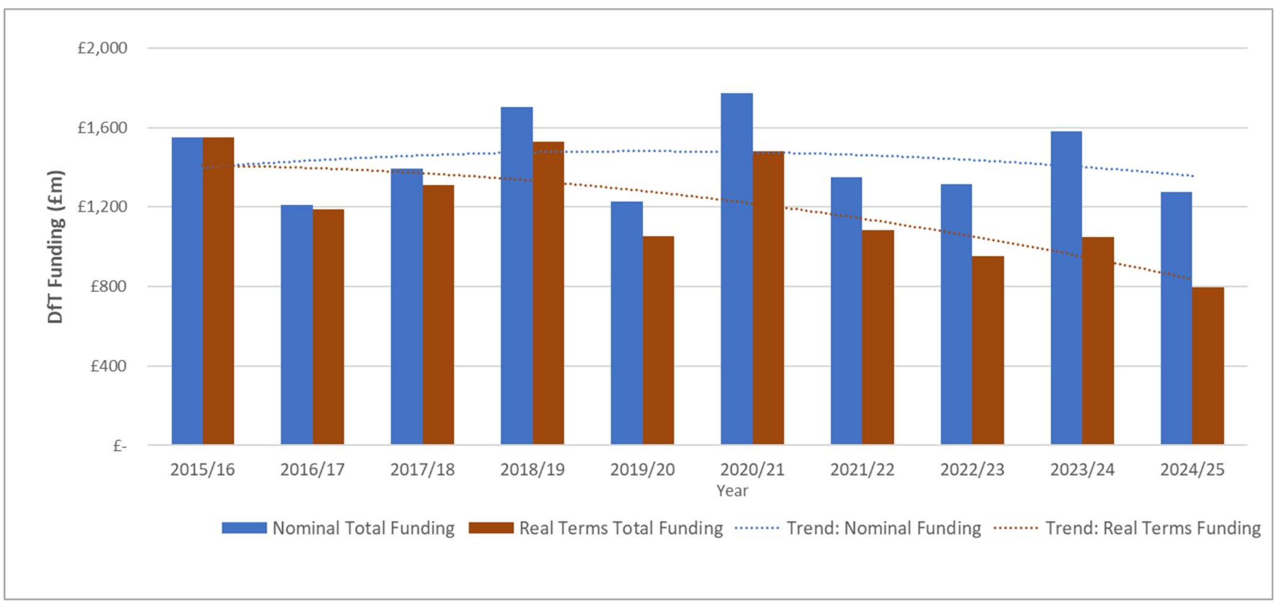

Figure 8: DfT Funding History for Local Roads.

Much of the cost of this damage from potholes to vehicle is recovered from road users' insurance, but costs of liability claims, including legal fees and staff time for local authorities are also increasing resulting in waste of existing budgets to carry out maintenance works.

Major Assets (Bridges and Tunnels)

The latest RAC Foundation 'state of the nation' bridges survey found an existing maintenance backlog on bridges of £5.86bn – a rise of over £400m on the previous year. There are more than 50,000 bridges across the UK of which over 4% are currently classed as substandard and are unable to carry the heaviest road vehicles [71]. Fourteen bridges were reported to have partially collapsed during the year, but no full collapses had occurred.

Investment in maintaining bridges and tunnels typically represents very high VfM because of the lost value of connected infrastructure should those links fail, and the extent of diversion routes needed for trips which are dependent upon those routes. As a result, BCRs for bridge maintenance can reach three figures [23] but can also be low dependent on the level of traffic demand.

The average cost of works per square metre for different conditions bands, set out in Table 5 have been calculated utilising the outputs from the UKRLG Bridges Board Structures Toolkit. Utilising the backlog methodology, it was determined that 75th and 85th percentile unit costs provided a comparable total figure to the 2019 RAC Foundation Bridges report backlog. These figures indicate the high cost of allowing bridges to deteriorate to poor levels of quality before undertaking maintenance works and are indicative of the range of VfM achievable depending on the stage at which maintenance investment is made.

Qualitative Impact Assessment

Condition of highways and associated infrastructure such as lighting not only impact user costs, but can also influence factors such as journey quality, perception of an area and feelings of safety when traveling by active modes. This can have knock-on impacts into regeneration, leading to improvements in passing trade for businesses, increases in property prices and impacts on public approval of local authorities.

Much of this type of impact is not readily quantifiable but contributes to the VfM of investment over and above the value reflected by a BCR. Such additional benefits will typically relate to quality of maintenance within urban environments, as they relate to the environment around the transport network, rather than to the roads themselves.

Relative VfM of Maintenance

To gain some context for the indicative range of values for money of investment in maintenance, analysis has been performed of the VfM ratings of approved new-build transport investments. Data which has been made available covers the period from 2015 to 2019 and the distribution of VfM rates is set out below [72]. Based on the distribution of PVCs of the approved investments shown in Table 10, the average BCR for new investment between 2015-2019 was calculated at between 3 and 4.

However, it should further be noted that, during assessment of new investments such as those considered here, it is routinely assumed that any new highway infrastructure will be maintained to a level that does not lead to reductions in user benefit during the assumed appraisal period, which for major infrastructure investments is often as long as 60 years. If that level of maintenance could not be provided, then BCRs would be adversely affected.

When compared with the range of BCRs identified for prioritised maintenance spend, with values typically in double digits based on the HMEA and National Highways analysis and potentially rising to triple digits for bridge maintenance, this highlights the value which can be achieved through well targeted investment in maintaining existing assets. However, achieving these levels of VfM through increased spend on maintenance is not guaranteed. The long-term strategy, timing and areas of focus for investment are all critical to maximising the return on investment.

Table 10: Average VfM of New-Build Projects 2015-19

VfM category	2015 proportion of approved spending	2016 proportion of approved spending	2017 proportion of approved spending	2018 proportion of approved spending	2019 proportion of approved spending
Poor	0%	0%	1%	0%	1%
Low	17%	0%	2%	0%	6%
Medium	3%	5%	19%	43%	13%
High	20%	86%	28%	57%	70%
Very high	59%	9%	49%	0%	10%
Total	100%	100%	100%	100%	100%

VfM and BCR for different intervention types

There are multiple sources that demonstrate funding for local road maintenance provides good to very good return on investment, with much lower risk than major projects to construct new infrastructure. For every additional £1 invested, there is an absolute minimum return of £2.20, with analyses identifying typical returns of up to £9.10 at national level. BCRs for specific schemes such as critical structures / bridges may reach three figures [73]. Such BCRs may at first appear unrealistic when compared to those typically generated for new-build schemes, but as has been noted above, VfM assessments of new schemes would routinely include costs of maintenance to enable full asset life. Therefore, when re-assessing the value of this maintenance in isolation the benefits will have been largely generated by the much larger initial investment, but the relatively low maintenance cost is required to enable those benefits to continue.

The sections above highlighted how the BCR and VfM is currently calculated and outlines the primary inputs that are being overlooked at a national scale. In order to accurately and reliably model the estimated BCR and VfM, it is important to consider how all the inputs of the road network impact the available tools at differing levels conditional on a multitude of elements outlined in HMEP, HMAT and HMEA process flow chart.

To demonstrate the benefits that investment into the road network generate, the holistic view of the entire network presented above needs to be broken down into the assets that compose its foundations. By demonstrating the BCR and VfM opportunities available for different assets, local authorities will be able to explain and allow a greater visualisation of the social, environmental and economic benefits that are available within the context of their network.

For the purpose of this report, the most appropriate methodology for assets that make up the network have been considered including carriageways, structures, footways and cycleways, drainage and street lighting.

Carriageways

The best method to calculate the BCR and VfM of carriageway maintenance is through the combination of the HMAT and HMEA tool discussed above. Specifically assessing the inputs and outputs of the carriageway asset, which are entwined in the larger, more holistic view of the entire HMAT tool. The table below shows a series of previous challenge fund schemed bid submissions which used HMAT and HMEA to demonstrate the BCR of carriageway schemes.

Table 11: BCR for carriageway schemes from challenge fund bids.

BCR	› Range between 1.6 and 22.5 › Weighted average BCR: **6.85** (detail can be found in 1.1.1.1.1Appendix BAppendix B)
Intervention types	› Reconstruction and resurfacing works › Enhancement and extension › Strengthening, re-waterproofing and renewals
Qualitative benefits	› Reduced traffic accidents from improved roads. › Reduced need for frequent remedial patching works, therefore reducing roadworks and disruption. › Wider benefits for cyclists, pedestrians and local businesses. › Regeneration of town centres. › Less traffic noise caused by empty lorries clattering over uneven surfaces. › Promotion of quality route to new business and regeneration.

Adoption of the HMAT toolkit by local authorities enables assessing different carriageway maintenance options (such as different funding levels, different treatment strategies [Proactive vs Reactive], or different funding strategies such as prioritising maintenance based on road class or Rural/Urban environment) against the impacts of treatment, condition, road user delay, CO2e emissions and road traffic collisions, plus wider road maintenance industry job implications. The opportunity to breakdown the impacts of carriageway maintenance dependant of the context of each local authority allows the assessment of the benefits to be categorised in an observable manner for local stakeholders.

The outputs of the HMAT tool can further aid the demonstration of the economic benefits of carriageway maintenance through the use of the HMEA. Adoption of HMEA to assess the wider economic impacts of different road network maintenance scenarios over a specified analysis period, enables highway managers to forecast the impacts of different highway maintenance strategies on the local economy, assisting in evidencing the benefits to senior decision makers and accountants.

Table 12: Inputs and Outputs of HMAT tool

Inputs for HMAT & HMEA toolkits	HMAT outputs	HMEA outputs

› Base year of the analysis
› Road types (in the network or sub-network)
› Condition bands and treatment types
› Forecast traffic
› HMAT outputs
› Maintenance policy
› Accident statistics
› Treatment profile
	› Scheme analysis
	› Road works impacts time
	› Road works impacts carbon
	› Road works impacts accidents
	› Material carbon quantity
	› Material carbon cost
	› IRI table
	› IRI lengths
	› Road condition impacts output
	› Accident analysis
	› Analysis graphs
	› Asset valuation
	› Claim statistics
	› Road noise
		› Condition and treatment impacts
		  › Road type
		  › Region
		  › NPV
		› Annual values undiscounted / discounted NPV of:
		  › Economic impacts – insurance tax from income and employment changes
		  › Public income – Tools and congestion charges
		  › Network benefits – travel time, congestion and carbon emissions

Measurement of the differences in VfM between structural investment and resurfacing is not straightforward, as it depends on a number of factors in how the appraisal is undertaken. In particular, the length of the appraisal period considered is a key influencer of the outcome of this comparison. The residual value of the network following the period of appraisal, based on different strategies of maintenance should ideally be considered, but is too large and imprecise a value to realistically quantify with a sufficient degree of accuracy when compared to the relatively low cost and value added through a period of maintenance. As this cannot be captured, the difference in ongoing cost over an extended period of time to maintain a set degree of surface quality is the best available measure.

When considered incrementally between investment scenarios, high levels of investment in structural repairs indicate higher returns on that investment than more frequent resurfacing. However, due to the high level of value locked into the existing network, when scenarios are considered individually without capturing changes in residual value of the asset, lower cost strategies focussed more on resurfacing have been found to perform more positively. As noted above this higher rate of return on lower cost strategies is a distortion in the appraisal process. Lower cost strategies may return higher immediate VfM, but this passes on a need for higher levels of investment in the future with a net adverse outcome.

Structures

To assess the VfM and BCR of structures maintenance the HIRAM support tool is the most appropriate method. HIRAM provides data layers from local authority information, local highways asset information, public data on the environment, Environment Agency datasets, climate change datasets, and geological datasets [63].

HIRAM support tool was developed to enable local highways teams to:

- record the locations and structures at the highest risk from severe weather across the network.
- estimate the economic and social costs of disruption if no preventative action was taken.
- price the intervention measures needed to decrease the risk of impact in the event of severe weather in addition to making the case for investment and preventative works to reduce social and economic impacts of severe weather incidents in the future.

Table 13: BCR for structures schemes from challenge fund bids.

BCR	› Range between 1.5 and 100+ › BCR: **6.56** (detail can be found in 1.1.1.1.1Appendix BAppendix B) › The BCR for specific schemes involving critical structures and historic bridges is estimated to be 100+, however, these were excluded when calculating the weighted average a BCR.
Intervention types	› Retaining walls reconstruction › Bridge improvement and refurbishment › Waterproofing, repair and upgrade › Resurfacing
Qualitative benefits	› Prevent weight restrictions being implemented on the bridge which would negatively impact alternative routes. › Maintaining the longevity of the structure and preserve historic highway structures for future generations, which are of unmeasurable cultural value. › Deliver fresh commercial space creating additional business opportunities that will generate additional economic activities and revenue. › Will result in safe network, ready to meet the demands of a locally strong economy › Avoided delays to traffic on other (secondary) roads onto which traffic would be diverted to avoid weak structure in the absence of repair works.

HIRAM is able to provide a number of the inputs required to calculate the VfM and BCR of structures maintenance. The inputs that HIRAM produces will need to be converted into monetary terms to derive the total costs and the expected benefits of the proposed scheme. Expected benefits and proposed costs will be appraised relative to the costs and benefits of no maintenance investment, to demonstrate the impacts of structures maintenance. Costs and benefits need to be discounted for the proposed length of the scheme to obtain real monetary terms.

Table 14: Structures VfM and BCR Inputs and Outputs

Required Inputs	Outputs – Measurable benefits	
› Structure type › Condition information › Maintenance options › Maintenance cost › Location › Meteorological data	› Accident reduction › Road surface improvements: › Vehicle speed › Operating cost benefit › Accident reduction › Diversion reduction › Congestion reduction › Road safety improvements › Environmental benefits	› Reduced carbon pressures › Whole life cost of maintenance › Asset valuation › Connectivity – reduced diversion routes › Safety of routes above / below › Closure of routes above / below › Performance of carriageway is supported

Footways and Cycleways

The most appropriate method for obtaining the BCR or VfM of footway and cycleway targeted investment is the AMAT, which measures the overall benefits and costs of proposed walking and cycling interventions. AMAT aligns with UK Government guidance on policy appraisal including the HM Treasury Green Book and DfT TAG. AMAT is able to quantify the key impacts of a proposed intervention, therefore helping provide decision-makers with as full a view as possible about impacts on transport users, the environment, society and the economy. These metrics are then quantified into a measure of the VfM of a proposed intervention, in the form of a BCR.

The table below shows a series of previous challenge fund schemed bid submissions which demonstrate the BCR of footways and cycleways schemes.

Table 15: BCR for footways and cycleways schemes from challenge fund bids.

BCR	› BCR: **3.39** (detail can be found in 1.1.1.1.1Appendix BAppendix B) › Some of the benefits from active travel schemes are currently not being quantified when using the existing appraisal tools and methodologies so it is expected that BCR for footways and cycleways is higher.
Intervention types	› Enhancements and extension › Upgrade › Reconstruction
Qualitative benefits	› Provide a safer, healthier environment for pedestrians, cyclists and vulnerable road users through environmental enhancement and reduce verge maintenance requirements. › Improve the town centre and make more attractive for walking and cycling.

However, to derive the VfM and BCR of investment into footway or cycleway maintenance the AMAT tools will need some re-alignment. The AMAT tool is very useful for providing all the benefits of a new active travel, cycleway or footway intervention but is not yet able to quantity the marginal benefits of improving the condition of interventions that are already in action. To reliably obtain the VfM and BCR of the footway and cycleway assets, areas of the HMAT tool need to be merged into a revised AMAT model.

Table 16: Inputs, Calculations and Outputs of AMAT

Inputs	Calculations	Outputs – Costs and Benefits
› Intervention details › Appraisal period › Local area type › Opening year › Final year of funding › Cycling and Walking › Scheme length › Travel data before and after › Initial infrastructure	› Changes in active travel › Reduction in short term sick leave › Average time and distance on infrastructure › Reduction in lost years of life › Reduction in vehicle accidents › Decongestions › Discounting › Whole life cost of maintenance › Asset valuation	› Congestion Benefit › Infrastructure maintenance › Accident figures › Air quality data › Noise pollution levels / Journey ambience › Greenhouse gas emissions › Indirect taxation › Private contribution › Reduced risk of premature death › Inclusion, safety and wellbeing improvements for vulnerable users › Reduced NHS / social care › Claim statistics

A revised tool that merges the measured costs and benefits of the AMAT listed in Table 16 and the inputs of the HMAT listed in Table 12 tailored to the footways and cycleway assets, would allow the marginal impacts of footway and cycleway maintenance investment to be measured. A primary concern is the possibility of creating a tool of this nature is the quantity and quality of footway and cycleway asset data that is available and recorded at an appropriate frequency. This raises the concern of how reliable the outputs will be with the current record keeping of the local authorities. The required footway and cycleway inputs would include the base year of the analysis, footway or cycleway types (in the network or sub-network), condition bands and treatment types and forecast traffic – active travel patterns.

Drainage

Drainage is not taken into consideration within the HMAT, HMEA, HDM-4 or AMAT tools, which are the most popular and reliable methods for the obtaining a BCR or VfM metric from maintenance investment. Therefore, within this section of the study considers the most appropriate and reflective methodology for deriving the BCR or VfM of drainage maintenance. The table below shows a series of previous challenge fund schemed bid submissions which demonstrate the BCR of footways and cycleways schemes.

Table 17: BCR for drainage schemes from challenge fund bids.

BCR	› Range between 6.60 and 37.00 › BCR: **9.31** (detail can be found in 1.1.1.1.1Appendix BAppendix B)
Intervention types	› Enhancement › Maintenance, renewal and replacement
Qualitative benefits	› Reduce disruption and damages well as the health and safety issues associated with flood events. › A reduction in disruption to the highway network caused by flooding or repair works to existing drainage. › Reduced risk to the user, increased availability of the resilient network, reduced liabilities. › A resilient network will also enhance economic opportunities in the region, promoting job creation and property development.

Drainage maintenance and treatment options are severely overlooked in local road networks, which is particularly concerning when considering how inter-connected the assets within the local road networks are. Drainage issues are known to create bottlenecks and delays across the road network and are only going to be become more sensitive over time with rapidly changing environments, following the patterns of climate change.

Data collection for drainage assets needs to be collated more frequently and in a greater quantity to aid research into the costs and benefits of completing such maintenance schemes. Local authorities can help provide this data if an appropriate amount of attention is provided by funding bodies, into the importance of well-maintained drainage.

The inputs required to help detect the trends of drainage failures are both inside and outside the scope of the transportation sectors expertise. Inputs such as meteorological data primarily their trends and forecasts will require outside input from experts in the respective fields of work. Whilst drainage asset specific data will be able to be collated within local authorities' systems.

Table 18: Required inputs and measurable outputs of drainage maintenance.

Inputs	Outputs – Measurable benefits	
› Base year of the analysis › Drainage type › Road surface › Location – identified with HIRAM › Meteorological data › Flood Hazard Research Centre's (FHRC) Multi-Coloured Manual (MCM)	› Diversion avoidance › Reduced congestion › Decreased health risk from foul water › Road surface improvements: › Vehicle speed › Operating cost benefit › Accident reduction › Material carbon cost	› Accident analysis › Improved surface water capture › Improved flood resilience › Reduced property and business damage › Reduced asset deterioration › Enhanced useability / accessibility › Whole life cost of maintenance

To obtain reliable findings from the inputs and outputs of a drainage maintenance scheme the proposed costs and benefits need to be discounted to reflect the anticipated design life of the proposed scheme. The expected benefits of drainage related damages should be measured using the FHRC's MCM methodology. Drainage schemes tend to have long life cycles often between 25 and 50 years, which leads to difficulties in the visualisation of the success and perceived benefits being widely received, in comparison to projects with short term benefits. Risk allowance must also be relatively high often between 6% and 20% in challenge fund bids, due to the nature of flooding or other major disasters related to drainage failure being a low probability but highly costly events.

Street Lighting

Street lighting maintenance is a vital aspect of the road network. A lack of maintenance not only leads to challenges on the roads but also affects the wider community. Well maintained street lighting creates a sense of community through the actual and perceived improvement in safety for the local population. Improved street lighting creates lower crime rates, often 21% lower in areas with improved street lighting compared to areas without [46]. Lower crime rates create a greater atmosphere within the local community which in turn creates greater levels of economic prosperity, with road users less deterred from traveling to their town centres or local village shops and greater willingness to access areas using active modes, leading to health benefits.

Improved street lighting maintenance also improves the safety of the road network, improved visibility is known to reduce accidents and therefore also creates health benefits including a reduced risk in premature death. Currently 55% of the UK's Streetlighting inventory is LED lanterns, therefore over 3.2 million lanterns would benefit from replacement to more cost effective, energy efficient and longer lasting LED lanterns [74].

The VfM and BCR metrics for streetlight maintenance benefits is clear and are spread across entire local populations through the wide range of benefits they provide that are always in the direction of economic prosperity improvements. The table below shows a series of previous challenge fund schemed bid submissions which demonstrate the BCR of footways and cycleways schemes.

Table 19: BCR for street lighting schemes from challenge fund bids.

BCR	› Range between 1.02 and 4.91 › BCR: **3.83** (detail can be found in 1.1.1.1.1Appendix BAppendix B) › The BCR for street lighting schemes include the benefits of reduction of fear of crime.
Intervention types	› Upgrade and replacement
Qualitative benefits	› Ensuring sufficient streetlight to deter crime and mitigate the fear of crime that can lead to increased isolation and anxiety. › Rapid reduction in energy consumption and costs by installing LED lights. › Rationalisation of the authority's requirements for spare parts for its lighting stock which will increase efficiency and standardise maintenance procedures. › Encouraging uptake of ULEV.

To derive the VfM and BCR of street lighting maintenance several qualitative elements need to be considered including but not limited to an improved sense of community:

- Perceived risk of crime
- Perception of safety
- Reduced risk of traumatic event

In addition to qualitative factors the condition profile of the street lighting assets needs to be measured, using guidance provided by the Institute of Lighting Professional within their ATOMS. To obtain the VfM and BCR of street lighting maintenance a comparison needs to be produce of the outcomes of a do-minimum approach against the outcomes of the proposed scheme. With the calculations including discounting across the whole life of the proposed scheme, optimisation bias being considered as well as risk allowance measures due to the quantitative benefits of the street lighting maintenance that need to be monetised.

Table 20: Inputs and Outputs of Street Lighting Maintenance

Required Inputs	Outputs – Measurable benefits	
› Base year of the analysis › Street lighting type › Age of asset › Likely life of asset › Location of the asset › Maintenance type – cost › Financial cost › Operating cost	› Reduced crime rates › Accident reduction › Road surface improvements: › Vehicle speed › Change in active travel patterns › Change in road use › Asset valuation	› Road safety improvements › Change in business growth › Environmental benefits › Reduced carbon pressures › Whole life cost of maintenance › Energy efficiency › Structural safety › Electrical safety

Other Assets

So far, the focus of this section has been on the key assets that provide the foundations of the local highway network. The sub-assets that fall under or within these assets are not directly considered and are often overlooked. Sub-asset classes include but are not limited to signage, road markings, ITS, street furniture and green estate.

Sub-assets are not considered due to data gaps and the considerable overlaps that these assets have with the key assets of the local highway network. To understand the BCRs and VfM of sub-asset class maintenance further research needs to be conducted and local authorities need to be encouraged to collect data for them more stringently.

Overall BCR

To calculate an overall BCR for spending on local highways maintenance in England a weighted average of the BCRs for each asset type was used. Two options were considered for applying the weightings:

- Option 1: using the existing formulae provided by DfT to allocate the HMB funds.
- Option 2: using weightings based on consultation with SMEs and stakeholders to determine how funds are allocated by LA for different asset classes.

The table below shows the BCR, and weighting used for each asset type, as well as a summary of the assumptions and rationale for each value.

Table 21: Overall BCR spending on local highways maintenance in England from challenge fund bids.

Asset type	BCR	Option 1	Option 2	Assumptions
Carriageways	6.85	82.4%	65.0%	› Option 1 weighting includes the DfT Allocation Formulae for both classified and unclassified roads.
Structures	6.56	15.4%	15.0%	› Option 1 weighting includes the DfT Allocation Formulae for bridges.
Footways and cycleways	3.39		5.0%	› No allocation based on DfT Allocation Formulae.
Drainage	9.31		5.0%	› No allocation based on DfT Allocation Formulae.
Street lighting	3.83	2.2%	10.0%	› Option 1 weighting includes the DfT Allocation Formulae for street lighting.
Other assets	NA			› No BCR available for other assets. These assets are often included in BCR calculations for bigger schemes that cover more than one asset type.
	Overall BCR:	**6.74**	**6.45**	

Research Questions 6 & 7

Research Question 6: Synthesise and compare evidence of the typical BCR between different strategies to support evidence-led funding decisions. For example, assess the efficacy of long-term planned maintenance in mitigating carriageway deterioration and minimising future costs in comparison to patch and amend maintenance strategies.

Research Question 7: Collate evidence on whole life costing and the relative VfM of proactive versus reactive maintenance.

Funding pressures

Even though investment in the local road network will provide significant economic and social benefits, current funding arrangements do not enable those benefits to be more fully realised. Whilst local authorities have a medium-term financial strategy, current budgetary challenges mean that, in reality, spending is often planned on an annual or short-term basis meaning local authorities are often forced into reactive maintenance strategies. The benefits of long-term planning (5-10 years) are well evidenced and have been shown that a reduction in cost of 15% is achievable, whilst also enabling improved quality and delivering wider social value [75].

As an example, it has been estimated that a longer-term funding plan in the order of £5 billion over the period between 2025 and 2035 for repairing the backlog of potholes would allow local authorities and the construction industry to plan and resource efficiently [76]. Long-term planning would enable local authorities to realise the full benefits of investing in maintaining the local road network. This would allow for more efficient asset management and increased value across virtually all public and private activity.

Long-term visibility of the funding available to maintain the network will allow local authorities to coordinate with other government initiatives that often have an impact on the condition of highways assets. For example, the £5bn broadband rollout plus the large-scale installation of EV chargers would involve interventions on the carriageway and footway networks, which, it not properly managed / scheduled, may cause significant deterioration. For EV chargers, depending on the commercial arrangement used, this may also increase future maintenance liabilities [23].

Highway maintenance has been facing funding challenges for a while, and there is a limit to how much can be achieved with current resources. Major challenges relate to increasing demand on the network, increasing levels of expectation of highways users, increasing levels of maintenance backlog, and increasing pressure on maintenance funding. The sector in general delivers extremely effectively with the budgets available, but it is not currently possible to mitigate every risk with the budgets available. Funding pressures on highways authorities have encouraged efficiency and innovation in how budgets for road maintenance are spent, but public value will be lost unless funding becomes more predictable [77].

Equally, highways professionals within local authorities are well aware of the negative impacts of deferring maintenance spend but they are often forced to make hard decisions about deferring schemes due to the increasing backlog of work. Impacts of deferring maintenance which include but are not limited to:

- Reduced VfM
- Increased spend required over the long term.
- Reduced levels of service and progress towards Government targets, including safety, active travel, carbon etc.
- Impacts on the private individuals and businesses in terms of vehicle damage, delays etc.
- Impacts on the wider public sector such as increased social care and health care costs.

Estimating long term benefits

Given that investment costs are incurred upfront, but savings are realised in the future, there can be several ways to express the return realised on any investment including BCR which is the ratio of the benefits of undertaking an intervention to their costs expressed in present value terms (considers what future costs and benefits are worth today). It is normally assumed that the investment in roads is done in the current year, so the initial outlay does not need to be discounted, but the future savings in road maintenance do need to be discounted. The higher the assumed discount rate, the smaller the present value benefits and thus BCR. Likewise, the longer the time horizon (how many years we compute the savings for) the higher the BCR.

The CQC Efficiency Network statistical model considers the impact of road condition on costs and the trades off the cost of investment with future savings. The model shows that upfront investment in the local road network can also produce substantive future savings. When looking at a 10-year horizon, £1 in investment in road condition will yield between £4.20 and £5.70 in future cost savings expressed in present value terms. The table below shows the BCR over 10 years, over 20 years, and in perpetuity. Demonstrating that even using a high discount rate and considering only the first 10 years of savings, investing in improving the condition of the local network can provide a BCR of 4.2 which translates to savings of £4.20 per £1 of initial outlay [78].

Table 22: Example of BCR over different time horizons and discount rates of undertaking an intervention.

Discount rate	BCR		
	10-year time horizon	20-year time horizon	perpetuity
3.5%	5.709	10.288	21.440
7%	4.2	6.0	10.7

The NHT CQC model can also be used to work out the costs and savings associated with an improvement to the network (e.g., a maintenance scheme) relative to costs of the scheme in the year it is delivered. The table below show the predicted costs and savings associated with a 1% reduction in the percentage of roads classified 'red'. The cash flows shows a predicted net cost of making the improvement in the first year, followed by a constant saving in subsequent years even after the benefits are discounted [78].

Table 23: Predicted costs and savings associated with a 1% reduction in the percentage of roads classified 'red'.

Year			1	2	3	4	5	6	7	8	9	10	∞
Cash Flow			-1.253	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	
Discounted Cash Flow													
	3.50%	Annual Flow	-1.253	0.908	0.878	0.848	0.819	0.792	0.765	0.739	0.714	0.690	
		Cumulative	-1.253	-0.344	0.533	1.381	2.200	2.992	3.757	4.496	5.210	5.899	25.608
	7%	Annual Flow	-1.253	0.879	0.821	0.767	0.717	0.670	0.626	0.585	0.547	0.511	
Rate		Cumulative	-1.253	-0.404	0.363	1.055	1.680	2.244	2.754	3.214	3.630	4.005	12.178

Funding certainty

The UKRLG "The Case for Investing in Local Highway Maintenance" report [23] sets out a series of investment scenarios and their contribution of the local road network towards national Government Policy objectives and socio-economic growth. These scenarios ranged from a declined scenario where funding levels remain at 2021 levels to an accelerated improvement scenario that significantly reduces backlog reduction and improves the overall asset condition and network performance. The table below provides examples of the benefits and disbenefits of long-term investment planning. Even in the case where there are funding pressures in the long term, it is generally useful for local authorities to be able to plan accordingly.

Table 24: Benefits and disbenefits of long-term investment certainty.

	Short term	Long term
Increased funding	Short term increase in funding supports improvement but does not sustain private sector investment in the Sector. Gains are positive but limited compared to potential benefits.	Increased capital investment and longer-term settlement provides virtuous circle, maximizing benefits of asset management, creating economies of scale and encouraging investment in people, skills, technology.
Decreased funding	Short term funding below steady state involves significant impacts and risks. Local roads fail to support key government policy targets and has broader socio-economic disbenefits for all.	Long term certainty of "bad news" allows the sector to cut cloth accordingly and make limited investments to slow down increase in disbenefits over time.

Below are some examples of highway authorities that have developed long term plans for local highways maintenance which can demonstrate the benefits of upfront funding.

- The outputs of the assessment which analysed alternative maintenance strategies using HMEA discussed in Research Questions 4 & 5 show that the current budget scenario leads to poorer network condition over the analysis period, whereas both alternative scenarios (steady state and no backlog) provide better network condition than the condition at the start of the analysis period. The results on Table 9 demonstrate very high marginal benefits from increasing investment and that between the medium and high spend scenarios, the marginal benefit continues to increase.
- Manchester City Council's developed a business case setting out the benefits of providing additional funding over a further 5-year period to continue the improvements delivered from the current investment programme. The business case outlined that given the current levels of our reactive maintenance costs, almost all of the funding coming in from central government (see Figure 2) would be needed to undertake reactive maintenance to fulfil their statutory obligation to repair defects which have been identified as a safety risk for the public, leaving negligible funding for any planned resurfacing or preventative schemes. They stated that the short term, reactive approach is inefficient and allows more defects to develop and is more costly in the longer term. Reactive repairs on carriageways and footways cost about £50/m^2 and £70/m^2 respectively, whereas preventative treatments are around £8/m^2 and resurfacing around £35/m^2;
- Preventative maintenance schemes carried out in Norfolk involved upgrading key drainage infrastructure to address the long-standing flooding issues across the wide residential and economic growth area. This scheme provided a very high BCR of 6.6 [23].

Maintenance strategies

Ideally, a number of maintenance strategies should be considered for the treatment of the asset. These are likely to include combinations of renewal and/or routine maintenance over a specified period. The Highway Infrastructure Asset Management Guidance (HIAMG) [14] described a series of maintenance strategies to be considered:

1. Do-minimum maintenance (reactive maintenance only – e.g. localised defect repair to maintain safety)
2. Reducing the level of serviceability (below current)
3. Sustaining the current level of serviceability (steady state – e.g. patching and surface dressing of carriageways and footways)
4. Prioritised performance to improve targeted parts of the assets (funding being targeted on a prioritised basis – e.g. principal roads)

5. Enhanced level of performance to meet performance targets (this maintenance strategy is important particularly where additional capital funding may be sought – e.g. inlay/overlay or reconstruction of carriageways and footways)

The maintenance strategy to be used should take into account the likely modes of deterioration and/ or failure of the proposed treatment, the service life of the asset and when the next intervention is likely to will occur (see Figure 9). Depending on the planning, different maintenance strategies may provide the lowest whole life costs because as discussed in the section above, the longer the time horizon the higher the BCR of an intervention.

Best practice indicates that the maintenance strategy should align with the approach to asset management and in particular provide the most efficient and affordable way of achieving the performance requirements. Typically, the selection of maintenance strategies considers minimising whole life costs, meeting statutory requirements and performance targets as well as managing risk.

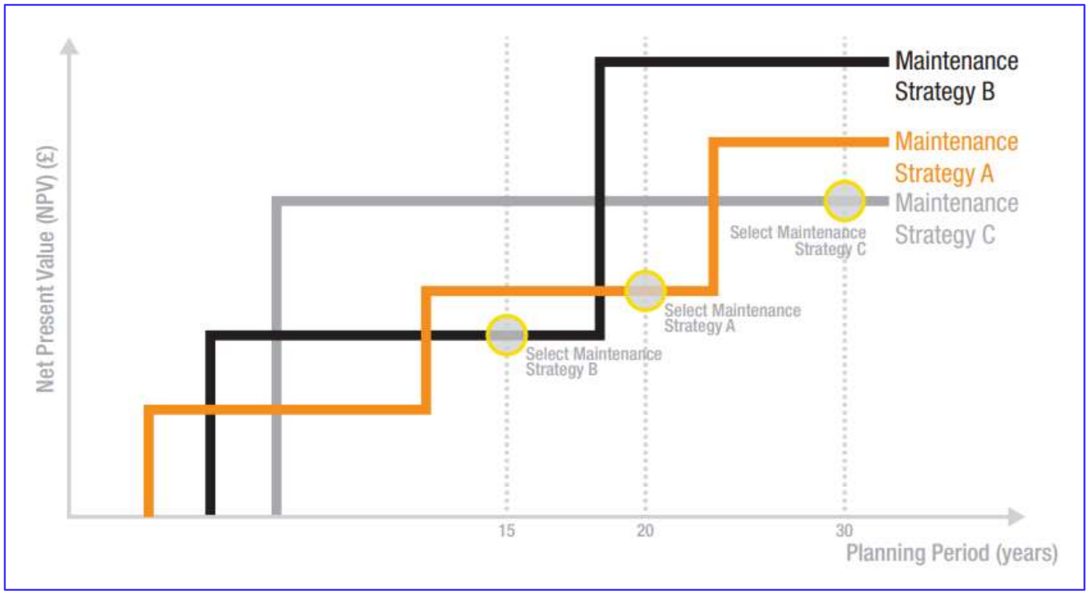

Figure 9: HIAMG Comparison of Maintenance Strategies.

There is limited evidence available on the BCR and VfM of different maintenance strategies. Below are some investment modelling and scenarios that set out the benefits (or disbenefits) of proactive/planned vs reactive maintenance strategies.

Run-to-failure maintenance strategy [79]:

A study about the different strategies to maintain, preserve and rehabilitate urban roads modelled the impacts of a "run to failure" (or reactive only) maintenance strategy which involved doing zero prevention or planned maintenance; only repair treatments in the most critical distress areas during the time. This strategy simulated the current maintenance policy a road authority which consisted in making minor treatments when the failure of the pavement has occurred. These repair and maintenance works were distributed in the five years of the analysis period, and its influence and cost-effectiveness were analysed. The results suggest that a reactive maintenance policy would not be cost-effective if the overall pavement network condition is already below the critical threshold. This study concluded that a "run to failure" maintenance strategy where only reactive and minor treatments are performed without established priorities to allocate funds is actually equivalent to doing nothing.

Proactive-preventative maintenance strategy [80]**:**

A study into the pavement maintenance strategies was undertaken to demonstrate how, by being proactive, a significant reduction in road maintenance expenditure can be realised. The study assumed that if an early intervention strategy was adopted the defects would be treated sooner. The effect of this would be for many defects to be repaired when they were smaller and more importantly, when less complex. This assumes that defects grow in complexity if they are left untreated e.g., where a pothole or crack will overtime grow into a surface repair and then to a structural repair.

A modelled scenario assumed 1 defect in 5 would be shifted to the previous defect category, while the average unit rate per item and the average quantity (measurement) of each treated defect was not changed. The results highlighted a savings figure of 12.8% of the total money spent on the pavement maintenance for the year reviewed.

They then modelled a proactive preventative maintenance program over a 3-year period by reinvesting into the network the savings generated by 1 defect in 5 being treated earlier in the pavement defect lifecycle. The results showed:

- In year 1, the number of repairs increased from 10,650 to 15,779 and the average repair cost was reduced from $325 to $278 to $220.
- In year 2, the number of repairs increases from 15,779 to 20,107 and the average repair cost was reduced from $325 to $278 to $220 to $193 to $172
- In year 3, the number of repairs increased from 20,107 to 23,757 and the average repair cost was reduced from $325 to $278 to $220 to $193 to $172 to $155 to $146

This study highlights that by intervening earlier you can:

- Spend the same money
- Reduce the average cost of repairs
- Increase the number of repairs done.
- Differing preventive maintenance [81]:

An integrated life cycle analysis of the costs and benefits of a delay in maintenance of airport pavement assets was undertaken from perspectives that are not purely economic, by considering direct costs, indirect costs, and salvage values. Results show that a one-year delay in preventive maintenance increases the deterministic life cycle cost by 16%. Based on the sensitivity analysis of the discount rate, the total cost shows more than a 10% decrease as the discount rate increased by 1%.

Based on the simulation of the effects of maintenance activities during the pavement life cycle, it can be concluded that preventive maintenance should start when the roads are in good condition to prompt managers and stakeholders to analyse the costs during the life cycle. Postponing the preventive maintenance of airport pavement could raise the cost by 50%.

Reactive to proactive maintenance [82]**:**

The decline in Finnish budgets for paved roads has caused increasing pavement deterioration rates that has led to increasing problems on national network. To counter this, research on new methods and policies was undertaken to address the issues.

A pilot towards proactive asset management started in 2015 to develop and test new innovative methods to improve the productivity of paved roads maintenance. The project identified the weakest parts of the network and implemented maintenance measures addressing the real root causes of the problems. As a result, calculated annual paving costs were reduced by 20–40%. Results show clearly that improving the productivity of road asset management by using new road condition monitoring techniques based on diagnostics, focused rehabilitation and proactive maintenance can lead to major savings in annual paving budgets.

CASE STUDIES

Derbyshire County Council

Introduction

The value of Derbyshire County Council's highway assets currently stands at approximately £8Bn including 3,280 miles of road and associated bridges, retaining walls, street lighting, footways and other infrastructure assets. The highway service is responsible for maintaining a safe and reliable network for all its users, including pedestrians, cyclists, and bus passengers. Derbyshire's highway infrastructure is crucial for economic prosperity, providing access to work, health, education, and leisure services. The service implemented a £120m capital programme between 2021-2024 to fulfil election promises and address a backlog of Cabinet approved projects not completed in previous years.

The Council receives annual Capital funding through central government grants. The size of the annual funding has been fixed for the past three years at £27.371m and will remain the same for 2024-2025. Carriageways currently needs £40-45m, but Derbyshire only uses £10m. Therefore, they are trying to demonstrate additional investment through using economic appraisal tools which this case study focuses on. Derbyshire County Council's performance is measured by its highway service and road and footway condition, with roads and pavements having the highest reputational impact. A survey of 2431 residents revealed that highway services, including planning and maintenance, are the top priority.

Context and background

The Council estimates a £1.5bn cost to restore highway assets to acceptable standards, taking 185 years at current investment rates. This requires an increasing revenue budget for reactive maintenance tasks, ensuring safety for residents and communities. The highway service touches every resident in Derbyshire whether they travel by car, bus, van, cycle or foot. The standard of the Council's highway maintenance consistently receives the lowest satisfaction level of any Council service.

As part of the Council's asset management policy, the carriageway network has an Annual Engineer's Inspection (AEI) which is a treatment survey based on the existing condition of a road. The Engineer surveys the road and allocates a treatment to bring it back to an 'Up-to-Standard' condition or an 'As New' condition depending on the recommended treatment chosen. Sites are prioritised for treatment based on information collected by the AEI survey which identifies set defects as a percentage of the treatment length. Through these calculations, higher hierarchy assets which hold more risk gets more funding. This prioritisation policy has been in place from 2020 and has been evolving with the help of AI.

Challenges and opportunities

Derbyshire used the HMEA tool to find the short and long-term impacts of road condition. The Council faced many challenges while using the HMEA tool, due to the complexity of Derbyshire's network, it was difficult to feed large data into the tool. The Council had to find several data inputs such as tax receipts, income etc., which was difficult to find and time consuming. Although they had consultant's support to understand the outputs of the tool, they were difficult to understand as it was not straight forward. It required a lot of time and effort to understand the complexities of the HMEA tool.

Additionally, there are other challenges for their Council as well as ither authorities where the road funding has gone down, which has been made worse in the last 3-4 years due to inflation. Furthermore, climate change has also worsened the condition of roads.

Based on their current spending, their maintenance backlog would rise to £585 million, which is not enough to stop the deterioration of the carriageways from accelerating. Additionally, the current levels of investment are not aligned to the expectation of stakeholders that demand improvements to highways. This also results to increased risk to the road users of Derbyshire. The following figure shows the current investment levels based on existing treatments. By not carrying out sufficient preventative maintenance in this timeframe means that there will still be some that deteriorate into a red condition and will require more expensive structural treatments.

Derbyshire has been given an extra £6m for 2024/25 as part of HS2 funding and over £70m has been promised for the next ten years. Derbyshire is looking forward to this promised funding as this would help in the maintenance of their highways and are expecting to have many benefits from it.

The HMEA model was run on a number of investment scenarios compared to existing investment levels, the focus being to assess the impact of an increase of an additional £5m investment in preventative treatments (scenario 3) and structural treatments (scenario 4)

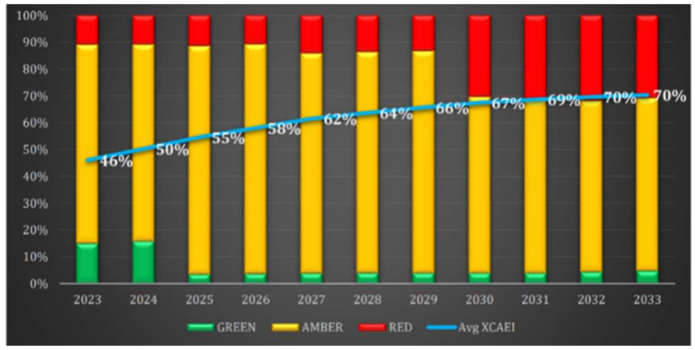

Figure 10: Based on Existing Treatment Mix and Investment Levels.

A summary is provided below based on a 30-year assessment period using scenario 3 increasing preventative treatments by £5m/year over 30 years:

- A circa £70m reduction in costs to road users (vehicle costs, carbon emissions, accidents at roadworks, delays at roadworks, delays due to pavement conditions)
- A circa £90 billion economic benefit to the local economy
- The Return on Investment (RoI) has been calculated as the total change in economic contribution over the 30-year modelling period divided by the total change in the 30-year funding contribution for each scenario. Using this calculation shows that both additional funding treatment blends produce a good RoI:
  - Scenario 3 (increased preventative blend) produces an RoI of £2,109 per £1 of additional spend (1:2109)
  - Scenario 4 (increased structural blend) produces an RoI of £1,791 per £1 of additional spend (1:1791)

The preferred option of Scenario 3 which is a £5m additional funding in favour of preventative treatments saves circa £22m in costs to road users in comparison to Scenario 4. Scenario 3 also provides a better economic return compared to scenario 4 as scenario 3 provides circa £207 billion in additional economic return compared to the existing funding scenario.

Value for money in Derbyshire Highways is measured using the three CIPFA dimensions of Economy, Efficiency and Effectiveness together with Strategic and Stakeholder value dimensions. The benefits derived relate directly to delivering on these dimensions. The Council communicates these benefits to their public with the help of local press and social media. They also report back the findings of their network back to the local government so that the government can see how they are spending money.

Next steps

Derbyshire started prioritising footways recently by starting annual inspections. The first footway treatment program is ongoing for 2024/25 which is still under footway hierarchy review. This also offers preventative maintenance and life cycle activities which is part of the forward program that they have in place.

Derbyshire anticipates DfT to make the economic appraisal tools robust and east to understand so that they can understand the results in a short span of time without using consultant's support which will also help them in cost-cutting.

London Borough of Hammersmith and Fulham Council

Introduction

LBHF's highway infrastructure is the most valuable set of assets for which the Council is responsible. The borough's prosperity relies on a safe and efficient highway network, which offers easy access for residents and businesses, ensuring the economic vitality of LBHF. Its highway network consists of various assets namely, carriageways, footways, highway structures, street lighting, street furniture, drainage and street trees. Maintenance is a key element to deliver the Mayor's Healthy Streets Approach. LBHF believes that 'café culture' in the borough is a key element in supporting economic activity for footways. Research in the borough has indicated that residents see the roads outside of their houses and businesses as a part of their own living space.

LBHF wants to prioritise their green infrastructure and are finding ways to tackle climate change and adapt to it. The council manages over 27,000 trees across various locations, governed by national and local policies. Their Tree Strategy also sets out aims for the strategic management of their urban forest in the future. They commit to annual progress reviews and assess the need for further development with emerging policies.

LBHF was chosen as one of the case studies because it plays a key role in LoTAG and State of the City as they are recognised as one of the leading London boroughs where they coordinate with other boroughs. This case study focuses on the impacts of climate change both now and in the future which are owned or managed by LBHF or are crucial to residents and businesses in the borough. An understanding of current and future climate change hazards is essential for the borough to establish actions to increase resilience to climate change. LBHF needs future investment to investigate and maintain their highways to support the ever-changing climate conditions.

Context and background

LBHF declared a climate and ecological emergency in 2019, outlining three key risks faced by the borough due to climate change: flooding, extreme heat, and drought. LBHF recognises the need to mitigate and adapt to climate change, setting a target to reach net zero carbon by 2030.

The following risks have been identified related to road network in terms of heatwaves, surface water flooding, drought and high winds.

- Infrastructure services
- Public health and health services
- Natural assets and ecology

The assessment of risk is made considering the period to the 2050s and before actions are taken to reduce risks. Heatwaves and temperature increase poses the greatest risk across all sectors, followed by surface water flooding.

To meet future investment needs, LBHF Council investigates alternative internal and external funding opportunities for investing into its highway maintenance programmes. This includes maximising funding from third parties (such as TfL LIP funding) to supplement highway budgets (although such streams from external parties have been constrained since the COVID-19 pandemic). The other funding stream is from DfT from which they get the most funding from.

Challenges and opportunities

The council's budget has not changed from 2016 which is a challenge as they have to stretch this funding to meet the ongoing demands. LBHF needs funding for whole life-costing, carbon reduction, replacing from asphalt to warm mix which costs three times more. They stated that they have become good at managing small resources, but it gets expensive when it comes to new initiatives like warm mix asphalt.

The biggest challenge is to understand how to maintain highways when it was designed for a climate that does not exist anymore. Additionally, LBHF faces challenges in maintaining utilities which does more work on their streets than the borough does for e.g., telecommunications etc. They believe that maintenance of utilities is essential for preventing highway failure.

Adaptation to climate change is needed in tandem with climate mitigation and is a key objective in the LBHF's Climate and Ecology Strategy. Within the strategy there is an objective to develop a more detailed geographical understanding of the risks and level of response required, and mainstream climate adaptation into strategic and capital planning.

To align with this objective, LBHF commissioned a robust and spatially focussed Climate Risk Assessment (CRA) to understand the key physical climate risks the borough faces, and to support the development of an Adaptation Strategy. Key findings from CRA have been mentioned below:

37.8°C maximum summer temperatures by the 2050s, increasing from 35.2°C in the baseline.

Up to 3 heatwave events per year by the 2050s, increasing from 1 event per year in the baseline.

18% reduction in summer rainfall from the baseline to the 2050s.

59 days a year with a risk of road melt and adverse weather days for rail by the 2050s, increasing from 23-32 days a year in the baseline.

Increased heavy rainfall annually from 46mm daily total rainfall to 49mm by the 2050s.

>1,500 basement properties currently at high risk of surface water flooding.

High risk of heatwaves and increasing temperatures to public health and health services, public housing and residences, and infrastructure services.

High risk of surface flooding to public health and health services, public housing and residences, and infrastructure services.

Figure 11: Key findings from Climate Risk Assessment

LBHF's Climate and Ecology Strategy sets out many in aid of achieving the ambitious targets of a net zero council and borough by 2030. Extensive financial and personnel resources will be required to deliver this target.

The following Risks and Opportunities have been identified in terms of highway infrastructure:

Table 25: Manchester's key risks and opportunities.

Risks	Opportunities
› Council Budgetary pressures compounded by decarbonisation costs. › Exposure to volatile & high renewable energy pricing › Risks with supply chain capacity and readiness for decarbonisation › Increasing costs for low carbon materials and fuels › Risks due to slow down in phase out of fossil-fuel vehicles. › Uncertainty in climate-related regulations and potential for increased costs relating to compliance, carbon pricing, and insurance. › Potential for early retirement of high-carbon assets	› Opportunities to save energy, materials and carbon by enhancing efficiency from the implementation of low-carbon and nature-based solutions. › Enhancing resilience and sustainability across LBHF's supply chain to avoid costs and enhance value. › Influence government and stakeholders to play their part and support LBHF's climate action plans. › Integrating climate resilience, nature, and social justice into decarbonisation actions.

LBHF believes that they will only succeed in their aims if they bring people with them. They have listened and worked with residents, by co-producing their work and engaging residents. They will continue to use resident insight and feedback to inform how they work in the future to ensure their ambitions continue to reflect what their residents want.

Their philosophy is to enhance civic life by empowering residents to change their own neighbourhoods for the better. That includes giving residents a leading role in developing policy in public, with the public. The council believe that, if they do this, residents themselves can often change things for the better, and do it faster than anyone else.

Next steps

The findings of the climate risk assessment will be used as an evidence base to inform development of the Adaptation Strategy. Targeted meetings and stakeholder engagement will be a key focus of developing the Adaptation Strategy. The following elements will be incorporated into the Adaptation Strategy:

- **Capacity analysis for delivering local climate adaptation** through the completion of a high-level gap analysis of the council's adaptation maturity and capacity to deliver climate adaptation. Key recommendations will be provided to strengthen how climate resilience is embedded across the council and borough.
- **Assessment of costs in failing to adapt to climate change and assessment of costs of adaptation actions.** Quantification of the costs of selected past climate events in LBHF will be summarised and case studies developed. Costs of key adaptation actions will be estimated.
- **Assessment of adaptation benefits** will be established to understand how adaptation approaches may result in avoided damages and avoided lost productivity. Different opportunity scenarios will be explored for selected climate events to understand high level costs and benefits.
- Options for financing adaptation measures will be explored.
- A high-level **adaptation monitoring and evaluation plan** will be developed to ensure ownership of actions and continual assessment of progress.

LBHF anticipates that DfT will give footways and green infrastructure top priority, emphasising the necessity to pay attention to the changing climatic conditions and how they must adapt to it.

Manchester City Council

Introduction

Manchester's highway network comprises about 1,360 km of road length, 2,600 km of footway length, 119,000 gullies and over 350 bridges and structures. Based on the valuations calculated in 2020, the total highway asset has an indicative gross replacement value of over £2.7billion, making it the Council's most valuable asset.

Manchester City Council has a Highway Asset Management Policy and Strategy to maintain its highway assets, supporting The Our Manchester Strategy. This framework outlines long-term objectives for managing highway assets, ensuring effective decision-making and achieving corporate priorities through informed and consistent actions. The Council is prioritizing the maintenance of its highway assets to meet the Corporate Plan and Greater Manchester Transport Strategy 2040 goals.

The Council also believes in maintaining its highway assets by following the principles of Reduce, Reuse, and Replace by reducing the need to transfer waste material to landfill sites and reusing material where possible and by taking a whole life approach to asset management which optimises maintenance requirements.

Context and background

Manchester City is chosen as a case study because the council was known to have previously used the HMAT tool to determine the Benefit Cost Ratio (BCR) for various investment scenarios. This case study focuses on the business case that was published in 2020, where they used the HMAT tool to assess the benefits of providing additional funding over a further 5-year period to continue the improvements delivered from their previous investment programme. The business case focuses on the Key Route Network (KRN) and Community Network (CN) roads, which has meant that many local roads and footways in a very poor condition have not been treated. MCC wants to prioritise on getting more funding from DfT to improve wider parts of the network for the benefit of the public.

The council has a prioritisation strategy in place which is used to prioritise schemes that are to be implemented within the Council's capital maintenance programmes and covers all highway maintenance activities funded by revenue and capital streams.

As per the business case that was published in 2020, their 5-year investment plan led to improve the overall condition of MCC's network of roads and Carriageways. The council does, however, feel that additional spending would be necessary over a further five years to enhance the state of the Drainage systems and Carriageways; this is covered in more detail in the next section. The next section also talks about the council's experience of using economic appraisal tools.

Challenges and opportunities

The council has used economic appraisal tools to demonstrate the economic costs and benefits of their proposed asset management strategies to secure more funding. However, the council stated that there were many challenges with using the HMAT tool. The HMAT tool could not run on their systems initially but was later run on Team's environment. Council stated that it helped them in getting some figures, but when they used the results as part of HMEA, HMEP tools, it could not integrate well with HMAT results. The Council believes that this should be a seamless process and that it should be user-friendly to use.

As per the business case, the Council proposed further investment based on the following challenges:

a) There is a need for further investment for Carriageways as all their funding goes to reactive maintenance costs for the defects which have been identified as safety risks for the public. This results in leaving negligible funding for any planned resurfacing or preventative schemes. Council believes that this reactive short-term approach is ineffective and is more expensive in the long run.

b) There is a need for further investment for Drainage as well as there is a serious chance that the drainage network won't be able to handle any heavier rainfall events due to climate change, ensuing flooding which will disrupt services and cause property damage. Council stated that DfT should also consider possible health hazards resulting from floodwaters damaging the nearby sewage system and the expenses related to cleaning up after floods.

Inflation has led to increased prices by operating companies, affecting maintenance and inspection activities. Because of the increase in prices, few highway maintenance activities have been postponed. This delay would be difficult to meet in the future as the prices are increasing exponentially.

The council has used HMAT tool to find solutions for the above-mentioned challenges. The following scenarios have been analysed for Carriageways and Drainage to find the most cost-effective solutions.

Table 26: A comparison of different scenarios based on additional funding and how it would help Manchester in the long-term.

Scenarios	Total	Additional investment (over next 5yrs)	Where is it prioritised?	How does it help?
Scenario 1	£4m	£0	Drainage repairs on KRN and CN roads	Funding is insufficient to significantly improve the drainage network
Scenario 2	£6.5m	£2.5m	Comprises about a third of their drainage network (40,000 gullies)	The key routes will remain operational and less flood-prone, but reactive work will not be possible for remaining gullies and the current capital works backlog will not be addressed.
Scenario 3	£19m	£15m	High-risk routes but address all our drainage network.	Additional capital funding will enable the implementation of an intelligent cyclical cleansing regime, reducing emergency reactive work as needed.

The condition of their local roads and footways is a key driver for the council's Active Travel priorities. Active travel has several benefits both for the individual and for the community as a whole.

A communication strategy has been developed as part of their Asset Management principles which documents the advantages the community receives from the local government as well as how they want to communicate to the public and its stakeholders about the benefits. The purpose of their Communications Strategy is to support the council's Corporate Plan. All communication activities must demonstrably promote work carried out to achieve the objectives outlined in the Corporate Plan.

Next steps

Drainage has come to the forefront of maintenance spending in the last couple of years. Manchester is looking to integrate SUDS to alleviate the amount of water going onto the highways. The council is trying to use carbon friendly materials, as it aims to reach net zero by 2038. The council also looks to reduce their carbon footprint, referencing PAS 2080 (carbon management in infrastructure verification) where possible. Additionally, the council is also looking at implementing a carbon strategy for highways. Historically, they have done a lot in terms of recycling.

Overall, the council wants the economic appraisal tools to be user friendly and easy to access to make better judgement regarding investments for the future and how it would benefit to the overall Manchester community. Additionally, the council is also looking to secure more funding to meet the increase in price demands. MCC seeks to maximise resource value, identify new funding sources, invest through savings, develop opportunities, and seek additional resources through competitive funding bids. MCC gets £4 -6m from DfT, however their modelling shows that they require £7m to keep the condition of their assets in 'steady state'. In 2025, Manchester City Council should be receiving £7.5m from DfT. Funding now comes through City region Sustainable Transport Settlements (CRSTS) which is a £5.7 billion investment programme in local transport networks. It provides consolidated, long-term capital funding through 5-year settlement from tax year 2022/23 to 2026/26.

Sunderland City Council

Introduction

Sunderland City Council's local highway network has an estimated value in excess of £2.3bn with its highway assets representing its most valuable asset group under their control and is important to support safe and sustainable movement within the North-East. The network supports businesses and increases accessibility to work, schools, hospitals and leisure facilities. Despite being a smaller authority within the North-East region, compared to Durham and Northumberland, Sunderland has a key role to play in meeting the strategic goals set out in their corporate strategy. Maintenance works carried out on the highway network are funded predominantly by their capital budget however a small proportion of funding also comes from the council's revenue sources such as council tax.

The council maintains a variety of different assets including 1,277km of carriageway, 1,705km of cycleway and footway, 408 structures items, 44,697 highway drainage items, 58,076 streetlights and 157 traffic signals. To support the council's three priority areas of growing Sunderland's economy, ensuring residents have equal opportunities and being an effective commissioner and collaborator, capital funds allocated to the council must be utilised in the most effective way.

This case study focuses on the realities of local highways maintenance for a large urban highway authority located in the North-East of England, exploring what types of intervention programmes the council deems value for money whilst it grapples with limited funding.

Context and background

Sunderland council adopted an asset management approach for its highways network that takes into consideration customer needs, local priorities, asset condition and the most optimal use of available resources. This is balanced against the risk of service failure and the probable future demand for services. To deliver a minimum whole life value cost, both short term and long-term needs have been considered appropriately by the local authority.

The council's asset management strategy is aligned to the themes and commitments set out in the City Plan 2019-2030. The three themes include striving for a dynamic, healthy and vibrant smart city by 2030. The strategy also supports the North-East Transport Plan 2021-2035 objectives that include carbon-neutral transport, overcoming inequality and growing the economy, a healthier North-East, appealing sustainable transport choices and a safe network.

To ensure that these aims and objectives are achieved, the council has a carriageway and footway asset hierarchy that is essential to ensuring that highway maintenance activities are effectively prioritised with the associated risk considered. Factors that the hierarchy takes into consideration include current and expected use, resilience, and local economic and social factors such as industry, schools, hospitals and other associated factors. The council also prioritises schemes by looking at a wide variety of sources such as public reports, highway works orders, condition indicators and technical surveys. Once they have determined which schemes are the most important to undertake, this is then presented to the Council's Cabinet for approval. In accordance with the conditions associated with last year's re-allocated HS2 funding, they have also compiled a suitable list of schemes for 2024-25 and presented it to the Department for Transport (DfT).

Challenges and opportunities

Sunderland Council has experienced major challenges related to a lack of funding for several years. Uncertainty over funding hinders the ability to plan, innovate and generate improvements over the longer term. Significantly, local authorities in the North-East region are experiencing a lack of clarity over exactly how funding will be allocated post 2027. Sunderland Council has not used any economic appraisal tools in the past for individual highway maintenance scheme assessment. Despite this, they asserted that an appraisal tool would be beneficial to them if they received an increased level of funding for advice and consultancy support.

Most of the council's funding is spent on carriageways with resurfacing being the common maintenance activity undertaken; followed by footway works in which the most common failure is damage that occurs due to vehicle over-run and utility works rather than due to an ageing material. Unit costs for maintenance activities have also been rising beyond the level of inflation which has put increased pressure on asset deterioration and backlog. Additionally, a significant amount of Sunderland's roads, are constructed in reinforced concrete due to poor ground conditions. However concrete roads have a longer lifespan although higher costs are incurred when there is structural failure. Low carbon products and services are also currently more expensive making it harder for the council to achieve their net zero goals. Despite this, there are expectations that these costs will decrease as new low carbon materials are adopted and more widely used by the industry.

A further challenge faced by the council is that although maintenance works are currently planned around utilities works, there have been several instances where utilities companies, such as fibre companies, have carried out their works after highway maintenance schemes have been completed, effectively 'scarring' a new surface or causing long term damage to the footway This not only decreases the whole life value of the asset but also reduces the value for money of carrying out effective and sustainable local highways maintenance.

In addition, the council have made steps on achieving carbon savings where possible. For example, Sunderland used Rejuvoflex, which is a hand laid, cold-applied bituminous emulsion-based mixture, for use as an enhanced footway surface treatment. This material is carbon friendly and so far, the council has laid 6,833m^2 of this material on their footway.

The council have produced several Life Cycle Plans for carriageways and footways including detailed scenario analysis that shows the effect of different budget levels on the percentage of roads where maintenance should be considered (red condition roads). The investment scenarios that have been explored in the analysis include:

- Option 1 – Current funding of £3.25 million until 2023 dropping to £3 million.
- Option 2 – Reduced funding to £2.25 million until 2023 dropping to 31.75 million
- Option 3 – Increased funding of up to £4.25 million until 2023 dropping to £4 million

The figure below demonstrates the effects on the whole network that an increased level of funding for Sunderland will decrease the percentage of red condition roads accumulated.

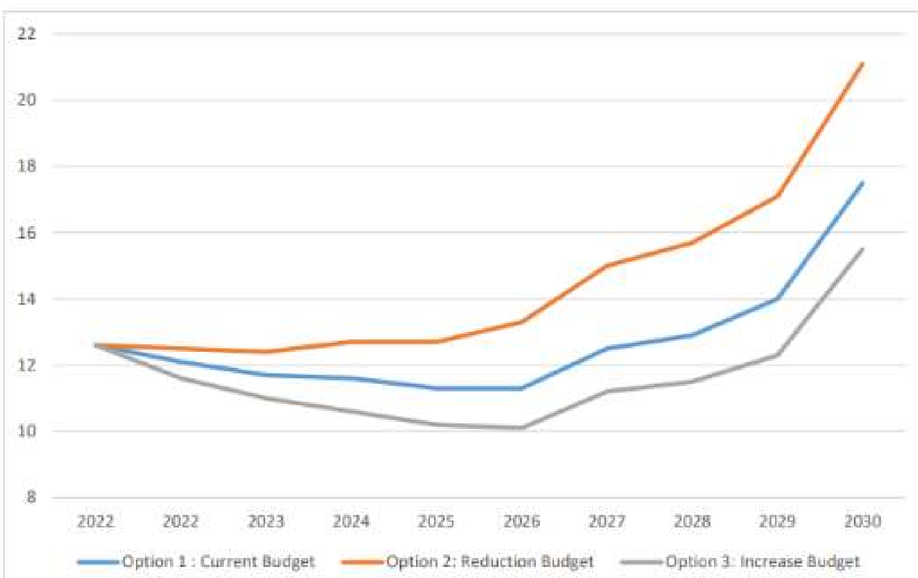

Figure 12: Sunderland whole-network % of red condition assets.

Results and benefits

The council currently abides by their Highways Communication Strategy which enables them to engage with stakeholders to understand their needs and expectations in relation to both local highways maintenance and asset management in general. This provides Sunderland with the information needed to determine and help shape the services that they provide. They are also able to showcase the benefits of local highways maintenance to their community. For example, the council participates in the National Highways and Transport Survey on a bi-annual basis.

Sunderland have also benefited from advanced asset management capabilities. One improvement to their current asset management process is that defects are now recorded with the easting/northing location, which means that areas of defect clusters can be identified and recorded. This data in addition to video surveys and technical surveys enables RAG heat maps to be produced. This highlights that the authority is progressing with its own innovation trials. There is also a clear opportunity here to share lessons learnt to other authorities within the North-East region.

Next steps

Going forward, there is a strong desire for increased coordination and engagement between the North-East authorities which will also facilitate knowledge sharing. Not only does this produce regional social benefits but also means that Sunderland will be more likely to receive increased funding as the case to improve the North-East region's local highways maintenance as a whole is stronger.

An increased level of funding will help facilitate the council's ambition for investment to be targeted on long term planned activities (i.e., preventative maintenance) that decreases the cost of expensive short-term repairs and reduces the strain on revenue budgets. This will help the council to better exploit value for money and better manage the risk involved in a local highway environment, providing a highway network that is both safe and secure and accessible for residents.

Sunderland has also recognised that there is a need for more focus on carbon reduction to accelerate the council's progress on achieving net zero by 2030. To date, the council has not been actively measuring carbon in its Highway Maintenance Operations and does not have a tool to assess the impacts of different maintenance works, and budgets for those works, on the environment. Some information is available from the council's surfacing contractors but not all are providing the relevant information. Thus, they are looking to adopt a carbon tool in the future in addition to waiting for national guidance. Further to this, in the future, they want to look at both scheme level carbon and whole life carbon data in order to make informed decisions about future highway maintenance expenditure.

Surrey County Council

Introduction

Surrey's local highway network has amongst the highest levels of road use in the UK. It is essential that the council spends their Capital funds in the most cost-effective way possible so that the highway network can be used to make the economy strong and effective and can help to fulfil the Council's purpose. As a Highway Authority and Lead Local Flood Authority, Surrey County Council is responsible for assets with a gross replacement cost of £10 billion (excluding land), including over 3,000 miles of carriageways, 1,800 bridges and structures and 3,520 miles of footways.

Maintenance and improvements to the highway network are funded from the capital budget, which is largely made up of central government grants plus some additional internal funding. The council acknowledges the importance of highways in connecting people and places and therefore developed a business case to secure further funds.

This case study focuses on the business cases that were published in 2019 for assets such as carriageways, structures and Intelligent Traffic Systems (ITS). The business case calculates the potential benefits they could get if additional funds were provided.

Context

Surrey County Council has implemented an asset management approach which aims to maximise value for money, ensuring informed investment decisions can be made, but also allowing them to manage risk and maintain a highway environment that is safe and secure and accessible for its customers. Their asset management strategy aims to manage stakeholder expectations, allocate resources optimally, and implement asset management principles to achieve strategic goals and enable necessary improvement activities.

Their approach is aligned to the HIAMG and HMEP and brings together a range of factors that influence asset management priorities. They have a prioritisation policy in place to selects schemes to maximise risk reduction and minimise whole life costs; ensuring that whatever funds available are spent on the right schemes at the right time.

The methods used to optimise the work programme were developed from best practice and through discussions within National Forums and with other Local Highway Authorities These criteria is reviewed and approved by the Cabinet Member for Highways every two years so that they can take account of changing requirements and priorities, they include:

- Analyse condition data available for each asset to identify need for maintenance and/or improvement.
- Ensure that greater priority is given to roads and key assets on roads that have the greatest usage or need.
- Prioritise schemes that address risks to public safety.
- Use the right treatments at the right time in order to produce cost effective solutions.
- Ensure works are programmed to minimise disruption to users and maximise benefits to the community by combining schemes for different assets together where possible.

Challenges and opportunities

Funding pressures and increased maintenance costs due to inflation are a key challenge for Surrey County Council. Additionally, the nation-wide push for net zero and carbon efficient alternatives to traditional maintenance methods which are often more expensive. Other challenges with regards to delivery of work include road space constraints as well as lack of engagement with the public to communicate the benefits of local highways maintenance. Some of the key risks that Surrey faces if no additional funding is allocated include:

- The overall condition of structures will deteriorate from 2% red condition to 7% red condition by 2033.
- Deterioration of pavements to 40.7% RAY (red-amber-yellow) condition and 16.2% red condition by 2033.
- Replacement of halogen bulbs, which are soon to be obsolete, with LED bulbs will not be possible with current funding levels. If funding levels remain as they are at present 43 % of ITS will still have halogen bulbs in 2025

which presents a risk because when bulbs reach the end of their life/are broken, they will not have stocks to replace them.

To ensure they are getting the best VfM on their schemes, Surrey uses a series of toolkits to undertake investment planning modelling and ensure the right schemes are taken forward at the right time. The business cases developed for each asset class outlines a preferred investment option, based on the levels of funding required for the assets as determined by deterioration modelling carried out using the industry standard HMEP toolkits.

Carriageways: A £7.6m annual funding increase for roads would improve RAY condition to 31% and red to 10% by 2025. Sustained through to 2033, RAY condition would improve to 28.7% and red condition to 8.2% of the network.

Structures: Funding levels increase by £27.62m over 5 years which will strengthen 41 weak bridges in the county over 10 years, or 20 over the 5-year period of increased funding, increasing network availability for road users across the county and reducing the risk of new weight restrictions on bridges.

Increased funding will identify work required to be done from the backlog of Load Assessments & Post-Tensioned Special Inspections and allow it to be prioritised, reducing risk. These can cost approx. £50k per bridge, £0.5m per year would support this ongoing cycle of assessments and inspections.

Traffic Signals: Funding levels increase by £1.9m per annum from 2020 which would see an improvement in condition of the ITS asset from 45% Red and Amber (RA) and 35% Red to 25% RA and 14% red by 2025.

Beyond 2025, a return to the original budget of £1.015m per annum could deliver a steady state in the condition in the short term but the number of amber sites will rise from 11% in 2026 to 46% by 2031.

The funding increase would provide and accelerated replacement of soon to be obsolete halogen bulbs with LED. LEDs could also lead to reduction in energy use by approximately 65%-80% of the ITS energy bill which could deliver a revenue saving of approximately £300k.

Next steps

Surrey County Council is aware of the HMAT tool; however, they use their own investment planning toolkit. They stated that one of the main challenges is that there is no single tool or methodology that every local authority in England uses. They believe that it would be beneficial to have an algorithm produced, which could take the data and present what different scenarios mean. Additionally, they want more support and guidance from DfT on how and when to use economic appraisal tools.

Significant work is ongoing to improve visibility of information for residents and network users through public online maps and dashboard reporting tools – with a focus on accessing information from the Roads & Transport webpage. These tools are used to contribute to, and complement, communications with the public. Improvements in data management, automation and integration between systems is enabling information to be provided to the public more frequently, reliably, and consistently and requiring less officer time.

Some of the priorities for the Council over the next few years include:

1. **Changes in use patterns e.g., increased cycling:** monitoring the changing use of our network by each user group. This data will be used to understand the changing use of the network by all types of users, including vulnerable users.
2. **Cycle facilities and active travel**: planning and management of cycle facilities with the input from relevant stakeholders.
3. **New technology, information sources, innovation:** the ever-changing technological landscape means that new technologies are always emerging. These will be monitored, tested and implemented where possible to help enable service enhancements and cost reduction.

CONCLUSIONS & RECOMMENDATIONS

Conclusions & Recommendations

Funding for highway maintenance is provided by government to local authorities through multiple routes, however, how much money each local authority spends on highway maintenance annually or how that compares to funding allocated for that purpose is unclear. Local authorities do not formally report on actual maintenance budgets, so collating information of this nature requires significant effort. This also results in budget and spend data that is inconsistently produced and of potentially low levels of accuracy, comparability and national coverage.

Funding streams themselves are inconsistent and currently uncertain from year to year, making long term planning near-impossible even with significant announcements like the Network North statement. Additionally, while the statement was welcomed by authorities, there is low confidence from local authorities that there will be a significant and sustained increase in investment over the next 10 years.

Recommendation: Introduction of an incentivisation scheme for use of the Network North funding. Additionally, engage with stakeholder such as DLUHC and ADEPT to test the appetite for influencing revenue funding.

As with the funding data, the availability of inventory, condition and cost data across local authorities is also inconsistent with significant regional variations. The UKRLG State of the Nation Report is the most recent source that gathers all asset types and all authorities across the country, but this is already over 5 years old. However, there was a consistent response from stakeholders regarding the level of inflationary pressure on maintenance budgets over recent years and the impact this has had on work that can be delivered.

Recommendation: Introduction of the digital data collection portal proposed during original State of the Nation project. This will allow for up-to-date and consistent data to be collected in the condition of the local network on an ongoing basis. The portal could also be used to collect budget and spend data as part of an incentivisation system.

Overall, funding for local highways maintenance provides good to very good return on investment, with socio-economic benefits estimated to provide up to £5+ return on £1 investment. Research findings are unanimous in framing local highway maintenance as a good investment, however, there is little understanding of how to quantify and communicate many of the benefits as current tools and guidance only focus on a certain subset of monetised benefits.

Recommendation: Review potential to formally expand guidance for monetisation of some or all of the wider benefits identified in this report. Also, engage with industry groups such as UKRLG, ADEPT, CIHT, PIARC to gather further information on existing highway maintenance business cases that are not publicly available.

BCRs and VfM of local highways maintenance is likely to vary considerably across different regions and different types of assets and even for different investment strategies on a single network section. Therefore, a direct assessment of a national level of VfM of maintenance may not be as informative as it would first appear. The outcome would be likely to enable only a binary decision of whether funds should be targeted at maintenance or not, but with no facility to inform a strategy of how much funding should be invested, where, or over what period of time.

The assets that provide the foundations of the road network all need to be treated and assessed differently in relation to the inputs they require and how they influence the overall network. All the key assets of the network are inter-connected and always have some level of overlap. Being able to break down the benefits and costs that are tied to each asset class is a complex task that is best represented through the comparison of schemes relative to the impacts of no intervention.

With regards to undertaking assessments to inform preferred strategies at a local level, significant investment has been made in developing tools such as HMAT and HMEA to aid this process and continues to be made in gathering data to understand existing and changing road conditions. However, the use of these resources appears to be somewhat limited at a local authority level due to a lack of experience or confidence in their use and concerns over budget to employ consultants. Simplified models or tools requiring less input could be beneficial but once again caution will need to be taken when observing the reliability of these outputs.

Recommendation: Define the desired scope for the appraisal of local highways maintenance (e.g., at network whole, network asset or scheme level). Once scope is selected, this will drive selection of options to deliver new tools, update of existing tools, applying automation to simplify use of existing tools, new simplified tools, and/or Excel proof of concept plus spec for systems providers to integrate into commercial offerings.

Recommendation: Develop suite of tools to maximise impact of any appraisals, such as development of wider learning and engagement resources beyond highway maintenance specialists, which could include comms toolkit, guidance on consistent reporting, and reporting of DRC asset valuation.

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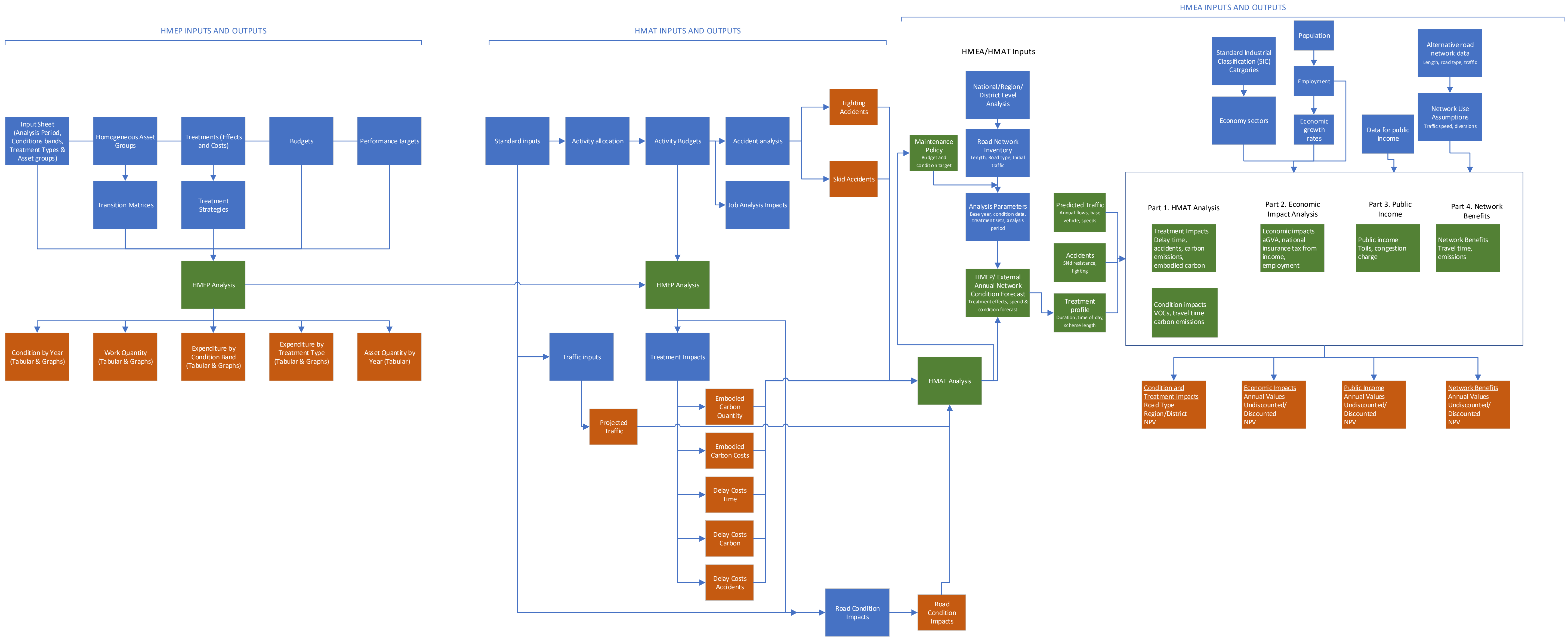
APPENDICES

Appendix A. HMEP, HMAT and HMEA process flow chart



Appendix B. BCR Calculations

The data used to calculate BCRs for each asset type was taken from the publicly available successful challenge fund bid submissions. The following assumptions were made for the calculations:

- For projects/schemes that included interventions to more than one asset type; the BCR was only included in one asset type to avoid duplication.
- Weighting were calculated based on the total cost of the scheme, but no weighting was assigned to projects that did not provide a BCR.
- The BCR for specific schemes involving critical structures and historic bridges is estimated to be 100+, however, these were excluded when calculating the weighted average a BCR.

B.1 Carriageways

Authority	Project	Asset type	Cost (£M)	BCR	Weighting
Bristol City Council & Bath and North East Somerset Council	A4 and A4174 Strategic Routes Major Maintenance	Carriageways	6.40	7.90	13.7%
Bristol City Council and South Gloucestershire Council	A403 Major Maintenance	Carriageways, Footways, Drainage, Street Lighting	14.00	4.09	29.9%
Lancashire County Council	Exceptional M65 Motorway Infrastructure Maintenance	Carriageways	6.60	2.74	14.1%
Metropolitan Borough of Gateshead	Heworth Roundabout	Carriageways	5.50	22.50	11.8%
Nottinghamshire County Council	A38 and A617 Mansfield Regeneration Route	Carriageways	6.00	1.60	12.8%
Southampton City Council	Millbrook Roundabout Major Maintenance	Carriageways	8.30	7.40	17.7%
Bristol City Council	Innovative Proactive Maintenance Programme	Carriageways, Footways, Drainage	3.46	Not provided	
Devon County Council	A361 Network Resilience and Economic Growth	Carriageways	5.00	Not provided	
Essex County Council	Major maintenance to Braintree town centre	Carriageways, Footways, Drainage	2.50	Not provided	
Kirklees Metropolitan Borough Council	A62 Leeds Road resurfacing	Carriageways, Drainage	2.84	Not provided	
Stoke-on-Trent City Council	Keep Stoke Moving: Key corridor maintenance	Carriageways	5.40	Not provided	
The Borough Council of Calderdale	A629 Calderdale Way refurbishment	Carriageways	4.92	Not provided	

Authority	Project	Asset type	Cost (£M)	BCR	Weighting
Warrington Borough Council	Key Route Network maintenance	Carriageways, Structures, Drainage	3.72	Not provided	
West Berkshire District Council	A339 Newbury, Delivering a High Quality Corridor.	Carriageways, Structures	10.70	Not provided	
			BCR	**6.85**	**100%**

B.2 Structures

Authority	Project	Asset type	Cost (£M)	BCR	Weighting
Brighton & Hove City Council	A259 / West Street û Shelter Hall û Highway Structure No BS.5618	Structures	10.60	1.50	48%
Lancashire County Council	A589 Greyhound Bridge refurbishment	Structures	4.60	5.10	21%
Lancashire County Council	East Lancashire retaining walls strengthening	Structures	3.96	19.80	18%
Tameside Metropolitan Borough Council	Retaining Walls	Structures	3.00	9.20	14%
Warwickshire County Council*	Historic bridge maintenance	Structures	6.30	100+	
Bath and North East Somerset Council	Cleveland Bridge repairs	Structures	3.92	Not provided	
City of Bradford Metropolitan District Council	West Yorkshire Joint Retaining Structures	Carriageways, Structures	6.30	Not provided	
Derbyshire County Council	A6 Derwent Valley highway maintenance	Structures	5.02	Not provided	
Stockport Metropolitan Borough Council	A6 Viaduct waterproofing and repair	Structures	3.50	Not provided	
			BCR	**6.56**	**100%**

** Not included in the BCR weighted average.*

B.3 Footways and cycleways

Authority	Project	Asset type	Cost (£M)	BCR	Weighting
Telford & Wrekin Co-operative Council	Telford Town Centre Connectivity Package	Footways	12.3	3.39	100%

Authority	Project	Asset type	Cost (£M)	BCR	Weighting
Bristol City Council and South Gloucestershire Council*	A403 Major Maintenance	Carriageways, Footways, Drainage, Street Lighting	14	4.09	
Bristol City Council	Innovative Proactive Maintenance Programme	Carriageways, Footways, Drainage	3.458	Not provided	
Essex County Council	Major maintenance to Braintree town centre	Carriageways, Footways, Drainage	2.5	Not provided	
			BCR	**3.39**	**100%**

** This scheme was included in the Carriageways calculation.*

B.4 Drainage

Authority	Project	Asset type	Cost (£M)	BCR	Weighting
Norfolk County Council	Greater Norwich Area Surface Water Drainage scheme	Drainage	10.30	6.60	70%
South Gloucestershire Council and Bristol City Council	South Glos and Bristol flood resilience	Drainage	3.70	11.60	25%
Southend-on-Sea Borough Council	Southend highway flood reduction and resilience	Drainage	0.70	37.00	5%
Bristol City Council and South Gloucestershire Council*	A403 Major Maintenance	Carriageways, Footways, Drainage, Street Lighting	14.00	4.09	
Bristol City Council	Innovative Proactive Maintenance Programme	Carriageways, Footways, Drainage	3.46	Not provided	
Essex County Council	Major maintenance to Braintree town centre	Carriageways, Footways, Drainage	2.50	Not provided	
Kirklees Metropolitan Borough Council	A62 Leeds Road resurfacing	Carriageways, Drainage	2.84	Not provided	
Warrington Borough Council	Key Route Network maintenance	Carriageways, Structures, Drainage	3.72	Not provided	
Wigan Metropolitan Borough Council	Drainage infrastructure	Drainage	1.11	Not provided	
			BCR	**9.31**	**100%**

** This scheme was included in the Carriageways calculation.*

B.5 Street lighting

Authority	Project	Asset type	Cost (£M)	BCR	Weighting
Gloucestershire County Council	Gloucestershire County Council - LED Streetlighting	Street Lighting	7.60	1.02	28%
Lancashire County Council	Upgrading of Street Lighting	Street Lighting	19.80	4.91	72%
Bristol City Council and South Gloucestershire Council*	A403 Major Maintenance	Carriageways, Footways, Drainage, Street Lighting	14.00	4.09	
West Berkshire Council	LED Street Lighting - Invest to Save	Street Lighting	7.20	Not provided	
			BCR	**3.83**	**100%**

** This scheme was included in the Carriageways calculation.*

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