



Department
for Transport

Understanding and Valuing the Impacts of Transport Investment

Progress Report 2017

October 2017

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Foreword

The Department for Transport's appraisal framework and methods have been built up over many years to be a world-class basis for informing decisions about transport investment options. Our analytical strategy within 'Understanding and Valuing the Impacts of Transport Investment' (UVITI) confirms our commitment to keeping our approach to appraisal world class, by maintaining and developing our methods to keep pace with an ever-changing world. We set out our ambitious plans for this development, and our commitment of engaging with experts and stakeholders at the heart of these plans.

In the last three years since the 2014 UVITI Progress Report, we have continued to make significant progress in delivering this agenda. We have already reported on our progress on updating the values of time used in transport appraisal and have consulted on significant proposals to enhance guidance on measuring how transport impacts on economic performance. In this Progress Report, we describe our development of the other aspects of our programme on environment and health, the demand forecasting framework and how we are tackling the fundamental issues relating to forecast uncertainty.

I am therefore pleased to present this progress report, which summarises the progress we have made and our plans for further development. We look forward to continuing to work closely with experts and stakeholders, to ensure the information used to inform transport investment decisions remains relevant and robust.



Amanda Rowlatt, Chief Analyst and Strategy Director
October 2017

Executive summary

Introduction

1. The Department's long term programme of research to improve how we understand and value the impacts of transport investment has produced an analytical evidence base, set out in WebTAG, that is internationally respected as best practice.¹ We continue to work collaboratively with academics and stakeholders to design our analytical strategy and a programme for maintaining and enhancing our evidence base. This latest progress report sets out our strategy and the significant progress we have made in delivering this programme over the last three years.

Analytical Strategy

2. Our analytical strategy aims to build confidence in our evidence base through an open and transparent approach, working closely with experts and stakeholders to provide high quality and robust evidence to inform transport investment decisions.
3. This executive summary describes the progress on developing the evidence base in each of the five key development themes that frame the UVITI analytical strategy. We have already published UVITI progress reports on the themes of Economic Growth and Valuing Journey Improvements, and provide a brief overall summary here.^{2 3} The main focus of this report is with the three remaining themes of:
 - Valuing environmental and health impacts;
 - Forecasting the future demand for travel; and
 - The treatment of uncertainty.

Economic Growth

4. The impact of transport investment on economic performance can be fundamental to the consideration and assessment of transport scheme options. In response to the recommendations of the TIEP report, we are undertaking a major update and restructuring of the guidance to improve the analysis and communication of wider economic impacts and ensure the proportionate assessment of impacts.⁴
5. The improvements aim to give greater clarity about how the analysis of wider economic impacts will be used to inform assessments of value for money by understanding the appropriate level of analysis, including the consideration of using supplementary economic models to better

¹ <https://www.gov.uk/transport-analysis-guidance-webtag>

² <https://www.gov.uk/government/consultations/transport-investment-understanding-and-valuing-impacts>

³ <https://www.gov.uk/government/publications/transport-appraisal-in-investment-decisions-understanding-and-valuing-the-impacts-of-transport-investment>

⁴ <https://www.gov.uk/government/publications/transport-investment-and-economic-performance-tiep-report>

understand the impact of a scheme on land use and economic performance.

6. In addition to the updated units, we identified a number of potential areas for future research. On the basis of feedback from stakeholders regarding appraisal needs and the efficacy of different proposals, we are updating our research strategy which will be made publicly available by late 2018. In response to feedback from stakeholders we have already launched a project to re-examine the agglomeration elasticities. This is due to report in mid-2018.
7. A special UVITI progress report, released in September 2016, provides full details of our progress in this crucial area for transport appraisal, proposed changes to guidance and potential areas for future research.⁵

Valuing Journey Improvements

8. In 2013 we made a commitment to undertake fresh, primary research on people's and businesses' willingness-to-pay for journey time reductions, and a range of other journey improvements. This research was undertaken in 2014/15, and was followed by a consultation in October 2015 on the Department's proposals for changes to WebTAG and future research into the values of travel time savings (VTTS).⁶ Responses were received from a wide range of stakeholders, both in relation to the specific questions the Department set out in the October 2015 consultation document as well as more general commentary on the research and the Department's proposed guidance changes.
9. The conclusion of the value of time consultation process represents a critical milestone in the development of the Department's evidence base for appraising the impacts of transport investment. For the first time, employers' business values of time are directly grounded in willingness-to-pay valuations, which is a big step forward in response to the on-going methodological debates around business values of time.
10. The Department's response to the issues raised, explanation of changes being made to WebTAG guidance and planned research in this area over the medium term were set out in the July 2016 consultation response.⁷ Future steps may include the following areas of research:
 - having in place an on-going programme of research to ensure the VTTS remain robust and reflect the best available evidence;
 - development of estimates of VTTS in congested conditions; and
 - further analysis of the non-work values of time, exploring the potential for further segmentation of these values as described in section 8 of the consultation document.

⁵ <https://www.gov.uk/government/consultations/transport-investment-understanding-and-valuing-impacts>

⁶ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/470998/Understanding_and_Valuing_Impacts_of_Transport_Investment.pdf

⁷ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/544165/understanding-and-valuing-the-impacts-of-transport-investment-values-of-travel-time-savings-consultation-response.pdf

Environment and Health

- 11.** We work closely with other government departments, including DEFRA and BEIS, to ensure that transport appraisal guidance is consistent with the latest scientific findings regarding the environment, emissions, air quality and the impact on health. This has led to work on specific areas of appraisal including:
 - Real world carbon emissions – recent evidence suggests that the gap between car and van emissions on the road and those measured in laboratory tests has been growing over time;
 - Real world NO_x emissions – evidence has also emerged of a gap between the levels of real world emissions of NO_x and standard vehicle test results;
 - NO_x damage costs – recent scientific research has shown that NO_x emissions are likely to be more damaging to human health than was previously thought;
 - Noise – WebTAG has been updated to incorporate an Impact Pathway approach to noise, covering annoyance, sleep disturbance and health impacts, with refinements to reflect the different impacts from road, rail and aviation noise;
 - Active travel – there has been a great deal of academic interest in active travel research, including health benefits in recent years and DfT is currently taking advantage of this expertise to further refine and improve its evidence base.
- 12.** These developments are described in more detail in Chapter 2.

Forecasting the Future Demand for Travel

- 13.** It is important to keep the evidence base for forecasting up-to-date, to allow the Department and the wider industry to produce high quality forecasts for use in strategic analysis and scheme appraisals. Since the December 2014 UVITI progress report, we have undertaken research to build on our forecasting techniques, as well as releasing an update to our core demand forecasts in the National Trip End Model data set.
- 14.** As described in detail in Section 3, we have focused development in the following areas:
 - Investigating key influences on car travel. We undertook an econometric study, researching factors that influence aspects of car travel (driving licence holding, access to car and mileage), to better understand how these factors may inform further areas of research and offers a potential for informing forecasting scenarios;
 - Investigating trends in trip rates. This is an important input into our demand forecasting models; this study investigated how trips per person may or may not be reasonably forecast into the future, covering a variety of variables;
 - A significant update to the National Trip End Model (NTEM). Updated to the latest census, population projections, enhancing the national

car ownership model forecasts, and new evidence on trip rates mentioned above;

- Use of mobile phone data. Research was commissioned in the use of these data in modelling and further research into how to construct high quality base year trip matrices, with a view to developing a new guidance unit in 2018; and
- Understanding commuting trends. We have recently investigated the nature of commuting to gain better understanding of today's behaviour. This understanding could inform the direction of future research and forecasting scenarios.

The Treatment of Uncertainty

15. There is unavoidably uncertainty in future forecasts. This makes demand and scheme benefits harder to predict the further into the future we go. Since much of our transport investment is for the longer term, it has a long-lasting impact on the economy, the environment and society, so how to handle inherent forecast uncertainty is a key theme in our analytical strategy.
16. At the heart of understanding uncertainty is developing our portfolio of ex-post evaluation evidence and using this to identify areas of uncertainty and to inform our model development. We are therefore looking to enhance the ways in which ex-post evaluations can generate and feedback evidence to validate and improve the quality of our modelling and appraisal. We shall also embed advice on evaluation and linking to appraisal in WebTAG. We also aim to commission research to investigate the nature and ranges of uncertainty around core model inputs and parameters, with a view to publishing these as indications for, potentially, more informed sensitivity tests or Monte Carlo analyses.
17. Taking the long term perspective raises the question of how best to forecast transport demand and the impacts of options into the long term. We have published research⁸ exploring difficult questions in this area, with particular emphasis on the validity of our forecasting processes into the longer-term and what to do with benefits for the remainder of the appraisal period after one stops modelling explicitly (i.e. the demand cap).
18. Beyond the analytical issues we discuss the importance of developing an approach to communicating the uncertainty in our analysis to decision makers and our approach to support business case developers to provide a fuller range of information regarding the uncertainties in their modelling and appraisal.

Continued Joint Working

19. We are pleased that we are able to report good progress so far on the work we committed to since the last progress report in December 2014, and that we have extended our ambitious agenda. We have benefitted greatly from the input of many experts and stakeholders, to whom we

⁸ <https://www.gov.uk/government/publications/transport-schemes-appraisal-of-long-term-benefits>

are grateful, and continue to collaborate with to improve appraisal and modelling methods and guidance for all its users.

20. We established the Joint Analysis Development Panel (JADP) in June 2015. The panel has the aim of providing strategic comment and recommendations on the Department's approach to developing its transport modelling, appraisal and evaluation guidance and methods. It brings together eminent academics, professional experts and senior departmental analysts to help shape our analytical strategies and strengthen our links with the academic community.
21. The panel has provided valuable comment and challenge on subjects including our strategy for improving road demand forecasts, the treatment of uncertainty in long-term forecasting and ways to strengthen the links between appraisal and evaluation. The first annual report is being published alongside this progress report, articulating the valuable impact of the panel's activities on our analytical strategy.⁹
22. Following the publication of this UVITI progress report, we would like to continue to build on the success over the past three years with an engagement event in 2018 to discuss our next phase of development.

⁹ ADD LINK: Joint Analytical Development Panel Annual Report

1. Introduction






















- 1.2** The Understanding and Valuing the Impacts of Transport Investment (UVITI) analytical strategy has been designed to ensure that our evidence base, set out in WebTAG¹⁰, remains world class and continues to provide high quality, robust evidence to inform transport investment decisions. It also aims to build confidence in our evidence base through an open and transparent approach, working closely with experts and stakeholders.
- 1.3** The strategy sets out five key analytical development themes that aim to meet the needs of our stakeholders. Detailed work programmes have been developed for each of the themes and these are summarised at a high level in Figure 1 below. The overall progress on the programme, including the latest research and next steps for development, was set out in December 2014 and was shaped further at the UVITI engagement event in March 2015 and subsequent engagement events.
- 1.4** We released two publications in 2016 on the themes of Valuing Journey Improvements (specifically updates to the values of time used in appraisal) and on Economic Growth (specifically launching consultation guidance on Wider Economic Impacts).^{11 12} This document focuses on summarising the other themes in our analytical strategy of:
- Valuing environmental and health impacts;
 - Forecasting the future demand for travel; and
 - The treatment of uncertainty.
- 1.5** This document describes the significant progress we have made in delivering the analytical development strategy in these three areas since the previous UVITI update. It also sets out the path of the strategy in these areas for the next twelve months.

¹⁰ WebTAG is the Department's Transport Analysis Guidance, available at: <https://www.gov.uk/guidance/transport-analysis-guidance-webtag>

¹¹ Values of time: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/470998/Understanding_and_Valuing_Impacts_of_Transport_Investment.pdf

¹² Wider Economic Impacts: <https://www.gov.uk/government/consultations/transport-investment-understanding-and-valuing-impacts>

Figure 1 Type caption here Key Milestones of the UVITI Analytical Strategy

Themes	Aims for Development	Key Milestones			
		2016	2017	2018	
Economic Growth	Developing a picture of the economic impacts of transport investments	 Launched consultation guidance	 Complete Engagement Events	 Consultation response and guidance release	 Agglomeration elasticity research
Valuing Environmental and Health Impacts	Ensuring consistency with latest evidence from inside and outside Government		 Updated guidance on assessing the health benefits of active travel	 Cross-government research of value of life year (VOLY)	
Valuing Journey Improvements	Update our data with new, direct survey evidence of values of travel time savings	 VTTS consultation response and updates to WebTAG guidance	 Feasibility studies: 1. for more frequent VTTS updates 2. applying congested VTTS in modelling	 Non-work values of time research	
Forecasting the Future Demand for Travel	Updating and enhancing our forecasting approach	 NTEM7 data release  NTEM revisions (v7.1 Interim)	 NTEM final revisions (v7.2)  Long-term benefits research publication and updates to WebTAG on long term extrapolation	 1. Base year matrix building guidance 2. Updated high/low scenario ranges	
Treatment of Uncertainty	Building the evidence base to support improved communication of model uncertainty		 Report on Long-Term Benefits Estimation	 Stock-take of input/parameter uncertainty	 Updated uncertainty guidance
Overall Programme	Guidance updates	 Autumn WebTAG Release	 Spring WebTAG Release	 Autumn WebTAG Release	 Spring WebTAG Release

2. Valuing Environmental and Health Impacts

Introduction

- 2.1** The widespread nature of transport systems means they have a key impact on people's lives; a number of these affect the environment and people's health. We are committed to ensuring that our transport appraisal guidance fully captures the nature and degree of these impacts and are constantly engaged with the scientific and academic communities to ensure that we remain up to date with the latest evidence and update our guidance and appraisal processes accordingly. Our appraisal guidance aims to be comprehensive, and to include the impacts of transport projects on both users and non-users. We are committed to looking at transport through a wide lens, considering the impacts of increased levels of active travel and both the positives and the negatives of projects on the wider environment.

Recent Developments in Valuing Environmental and Health Impacts

- 2.2** We work closely with other government departments, including DEFRA and BEIS, to ensure that transport appraisal guidance is consistent with the latest scientific findings regarding the environment, emissions, air quality and the impact on health. In March 2017 this led us to take note of new interim guidance from DEFRA concerning the health impacts of NOx emissions and new findings concerning the real world fuel consumption and emissions of vehicles.
- 2.3** We also play an active role in considering new ways of capturing environmental and health impacts, spurred by both academic and more applied research. We are looking at the valuation of landscape impacts of transport interventions and improving the way we capture impacts on health and wellbeing.

Real World Carbon Emissions

- 2.4** The Department for Transport continues to drive efficiencies in vehicle emissions to ensure the UK meets its climate change targets. The Department's Single Departmental Plan¹³ committed to ensuring transport plays its part in delivering the government's climate change obligations. In addition to EU regulations on manufacturers, the Department has undertaken a number of steps to drive efficiencies in

¹³ <https://www.gov.uk/government/publications/dft-single-departmental-plan-2015-to-2020>

vehicle emissions including grants to reduce the price of ultra-low emissions vehicles and support for efficient driving.

- 2.5** A wide range of factors, such as driving speed, vehicle loading and use of auxiliary systems such as air conditioning determine the level of vehicle emissions, including carbon. The laboratory tests currently used to monitor compliance with the EU regulations that set carbon emission targets for new cars and vans sold in Europe do not fully account for these factors. There is also evidence that the technologies used in cars and vans to reduce emissions in laboratory tests have had a more limited impact on the road. There is widespread awareness (amongst Governments, regulators, NGOs and industry) that, in general, car and van carbon emissions on the road exceed those measured in tests, resulting in what is called a 'real world emissions gap'.
- 2.6** Recent evidence suggests that this gap has grown through time. The most comprehensive attempt to assess the evidence in this area, as applicable to the UK, was commissioned by the Committee on Climate Change (CCC) and published in September 2015.¹⁴ The study concluded that fuel consumption was 10% higher on average than implied by the regulatory test for new cars sold in 2002, growing to 35% higher for new cars sold in 2014.
- 2.7** If the real world emissions gap for new cars and vans has been growing, as suggested by recent evidence, then the average gap across the whole fleet will also increase in future as increasing numbers of newer cars with a large gap take up a larger proportion of the UK car fleet.
- 2.8** Both DECC and DfT previously accounted for a gap between vehicles on the road and official carbon performance in our forecasting and appraisal techniques. This drew on evidence of the emissions outturn across the fleet but assumed that the gap for new cars remained constant from this point onwards. Over the past few months we have been working with relevant experts to review what we assume about improvements in car and van fuel efficiency. We have analysed traffic volumes and speeds, and the relationship between speeds and carbon emissions incorporating the recent evidence on real-world emissions to reflect the growing real-world gap.
- 2.9** This has produced revised car and van fuel efficiency assumptions for use in our forecasting models and in transport scheme appraisal. The new assumptions reflect how the gap in real world emissions for new cars has increased to 2015 and how these changes in the gap will perform across the whole fleet going in future, resulting in higher forecasts of fuel use (and therefore carbon emissions) per kilometre driven. These were incorporated in the July 2017 WebTAG data book.

Real World NOx Emissions

- 2.10** Nitrogen oxides (NOx) are one of the vehicle emissions that affect air quality. They form nitrogen dioxide in the atmosphere, concentrations of which have increasingly been shown to be detrimental to human health.

¹⁴ <https://www.theccc.org.uk/publication/impact-of-real-world-driving-emissions/>

- 2.11** Evidence has also emerged of a gap between the levels of real world emissions of NO_x and standard vehicle test results. Appraisal already included a factor that adjusted for the difference between test cycle and real world road conditions. This is also reflected in modelling.¹⁵ However, following Volkswagen's admission on its use of defeat devices and further research by the ICCT completed in the light of that admission¹⁶, it appears that the gap is larger than has previously been taken into account.
- 2.12** In April 2016, DfT published a report highlighting this new evidence.¹⁷ The internationally developed COPERT tool, which is used to quantify the emissions, has recently been updated, drawing on both global and UK evidence. It provides new emissions factors for NO_x for Euro 5 and Euro 6 standard cars and light goods vehicles. We are continuing to review this and other tools for their accuracy and suitability for use in appraisal.

Air Quality Health Impacts

- 2.13** When a transport scheme is being considered we are interested in the effect on air quality from the expected change in emissions. This change in vehicle emissions is derived from the transport model for the scheme. WebTAG captures the impact of that change on air quality by applying estimates of damage cost per ton of emissions. Damage costs are derived from estimates of the health impacts of air quality pollutants.
- 2.14** The Department for Transport works with the Department for the Environment, Food and Rural Affairs to use the latest research on the health effects of pollutants. The departments are advised by the Committee on the Medical Effects of Air Pollutants (COMEAP). The members of COMEAP come from a range of specialist fields in air chemistry and medicine. They review scientific research and use it to make recommendations to government.
- 2.15** Recent scientific research has shown that NO_x emissions are likely to be more damaging to human health than was previously thought. In response to this, COMEAP has published interim guidance on using higher damage costs to value these emissions. We continue to review this evidence and plan to make changes to transport appraisal guidance following the refined recommendations issued by COMEAP to DEFRA on 14th July 2017.¹⁸

Noise

- 2.16** Our appraisal guidance recognises that noise generated by transport has an impact on both users and non-users. Prior to Autumn 2015 the impact of the noise of transport schemes was captured in appraisals by focusing on the annoyance caused to local residents, using house price changes as a proxy. In line with recent research developed by the World Health Organisation (WHO), in their "Burden of Disease from Environmental

¹⁵ [Insert web link to 2014 research report on NO_x in NTM](#)

¹⁶ <http://www.theicct.org/real-world-exhaust-emissions-modern-diesel-cars>

¹⁷ <https://www.gov.uk/government/publications/vehicle-emissions-testing-programme-conclusions>

¹⁸ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/632916/air-quality-plan-technical-report.pdf, pp. 79-80.

Noise" report and resulting DEFRA guidance, WebTAG has been updated to incorporate an Impact Pathway approach to noise, covering annoyance, sleep disturbance and health impacts, with refinements to reflect the different impacts from road, rail and aviation noise.

- 2.17** The WHO are currently reviewing the impacts of environmental noise (with a particular focus on night noise) with a report due to be published later this year. Following this, we will work to reflect new evidence in WebTAG.

Health Impacts of Active Travel

- 2.18** The Department for Transport is committed to increasing active travel with its known benefits on health and well-being. This commitment includes a target to double the number of journeys made by bicycle in the Department's Cycling and Walking Investment Strategy¹⁹. Currently WebTAG values the improvements to people's health that result from the uptake of active travel, walking and cycling. Health benefits form a large component of the benefits of walking and cycling and previously guidance was based on the World Health Organisation's Health Economic Assessment Tool (HEAT).
- 2.19** In recent years, there has been a great deal of academic interest in active travel research, including health benefits, and DfT is currently taking advantage of this expertise to further refine and improve its evidence base. In 2016, a research project was commissioned by the DfT that aimed to build upon HEAT and extend the health benefits captured to include the reduction in morbidity from an active lifestyle in addition to the reduction in mortality. This research was published in August 2017,²⁰ and Forthcoming Changes to WebTAG have been announced for November 2017 to implement the findings of the research.²¹
- 2.20** We are also interested in building on how we capture the broader impacts of active travel. Currently WebTAG captures the reductions in absenteeism from work and de-congestion from walking and cycling. There is potential to include the productivity improvements and reductions in costs to the health budget in appraisals but this work is at an early stage.

Landscape

- 2.21** Currently WebTAG contains detailed guidance on the qualitative appraisal of landscape and historic environment impacts. The Department has also published landscape values that provide an indicative estimate of impacts in an advice note for local transport decision makers. In 2013 the Department published new research into an ecosystems services framework that identified several areas of potential for inclusion in WebTAG. However, it has proved methodologically challenging to bring forward concrete proposals from this work. Issues of

¹⁹ <https://www.gov.uk/government/publications/cycling-and-walking-investment-strategy>

²⁰ <https://www.gov.uk/government/publications/transport-appraisal-valuing-health-impacts>

²¹ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/640472/tag-unit-a4-1-social-impact-appraisal-forthcoming-changes-november-2017.pdf

concern include avoiding double counting and the appropriate appraisal period. Recent developments supported by DEFRA may offer the prospect of tangible improvements to guidance from this programme of work. The Environmental Valuation lookup tool is a database of natural capital values and the Outdoor Recreation Valuation Tool (ORVAL) provides willingness to pay values for a wide range of recreational and leisure sites in England.

- 2.22** While recognising the continued methodological challenges, we are now undertaking research in order to develop transport-context specific guidance on the valuation of landscape impacts within an ecosystem services²² framework. This will be completed in the first half of 2018, after which TASM will consider changes to WebTAG in light of its findings.

Next Steps

- 2.23** Some of the work described above is close to completion and our immediate next steps will be to finalise publication of resulting guidance. However a number of other developments in the environmental and health impact area are at an early stage and significant further work will be required to bring them to fruition. Hence longer term next steps will include further research and development of these ideas.
- 2.24** Key next steps are as follows:
- Work closely with DEFRA on interpreting the revised recommendations from COMEAP in WebTAG;
 - Reviewing the new evidence on real world NO_x emissions;
 - Reviewing the upcoming WHO findings on environmental noise;
 - Development of WebTAG for landscape impacts within an ecosystem services framework.

²² <https://www.gov.uk/guidance/ecosystems-services>

3. Forecasting the Future Demand for Travel

- 3.1** Understanding demand for travel is core to understanding the impact of transport investments. Forecasting demand poses challenges: we can learn from the past, where established trends provide a good basis for predicting how travel demand may develop in the future. But it is also essential to explore factors that may be driving changes in these trends to inform high-quality and robust predictive tools.
- 3.2** In the December 2014 UVITI Progress Report, we set out plans to keep our forecasting evidence base up to date, particularly with regards to factors that drive the use of cars. Since then we published research into understanding the drivers of road travel and incorporated scenario analysis into our 2015 road traffic forecasts.^{23 24} In addition to these, we conducted a range of important research projects:
- Investigating key influences on car travel - to explore how car use has been evolving and if the relationships we model in our forecasting tools are still relevant. We undertook an econometric study, which researched factors that influence aspects of car travel (driving licence holding, access to car and mileage). Better understanding of these factors may inform further areas of research and offers a potential for informing forecasting scenarios;
 - Investigating trends in trip rates - we have extensively researched trip making behaviour (trip rates).²⁵ We reported in the 2014 UVITI Progress Report that the National Travel Survey showed changes in the number of trips people are making. This is an important input into our demand forecasting models. A review of the evidence behind this input helps us ensure that our forecasts remain fit-for-purpose and investment decisions are made on the best available evidence;
 - Updating our forecasting models - we have comprehensively updated our National Trip End Model (NTEM) covering the latest census, population projections, refined car ownership forecasts and new evidence on trip rates mentioned above. This is a significant update that incorporates the latest trends and data and provides a robust foundation for our investment decisions;

²³ Understanding the Drivers of Road Travel, DfT, 2015; <https://www.gov.uk/government/publications/understanding-the-drivers-of-road-travel-current-trends-in-and-factors-behind-roads-use>

²⁴ Road Traffic Forecasts, DfT, 2015, <https://www.gov.uk/government/publications/road-traffic-forecasts-2015>

²⁵ Trip rate is one of the key inputs into forecasting models. In the National Trip End Model, where this input is primarily used, it is defined as the average number of home-based outbound trips per person per week.

- Investigating the use of mobile phone data in transport model matrix building - we have commissioned research from Transport Systems Catapult to better understand the potential to use these mobile network data in transport modelling applications. The report provides guidance on how to treat and use the data and what limitations and issues to be aware of in the use of the data. We have also completed research investigating best practice in base year matrix building, with a view to producing new guidance to provide better advice to practitioners on this fundamental part of modelling; and
- The Department also researched specific areas of travel. We have recently investigated the nature of commuting to gain better understanding of today's behaviour. This understanding could inform the direction of future research and forecasting scenarios.

3.3 This chapter summarises these research projects and explains their contribution to our understanding of travel behaviour and the forecasting evidence base. It sets out progress we have made in reviewing the evidence and developing our forecasting approach as well as our plans going forward.

Investigating key influences on car travel

3.4 Understanding the factors that influence car travel is key to ensuring that our traffic forecasts are based on robust foundations. It is important to critically review whether the factors we capture in our models remain relevant. It is also important to explore if there are changes, which can be explained and used to enrich our evidence base. In this section we describe our recent work reviewing the relevance of key factors and what messages for our forecasting methods we can draw from this.

3.5 In *Understanding the Drivers of Road Travel* (DfT, 2015), we researched the key trends and factors that drive overall road traffic. This work highlighted the extent to which trends in car use varied by segment of the population. For instance, it showed that whilst mileage driven by the young was falling, older age groups were driving more. Similar diverging trends were found between urban and rural areas and income groups.

3.6 In addition, we carried out an evidence review, which considered the relationship between road demand, GDP and fuel costs.²⁶ The review found that these relationships continue to be observed across many studies and across many countries. However, other literature also suggests factors that might be leading to changes in demand for road travel, but did not quantify the impact of these.

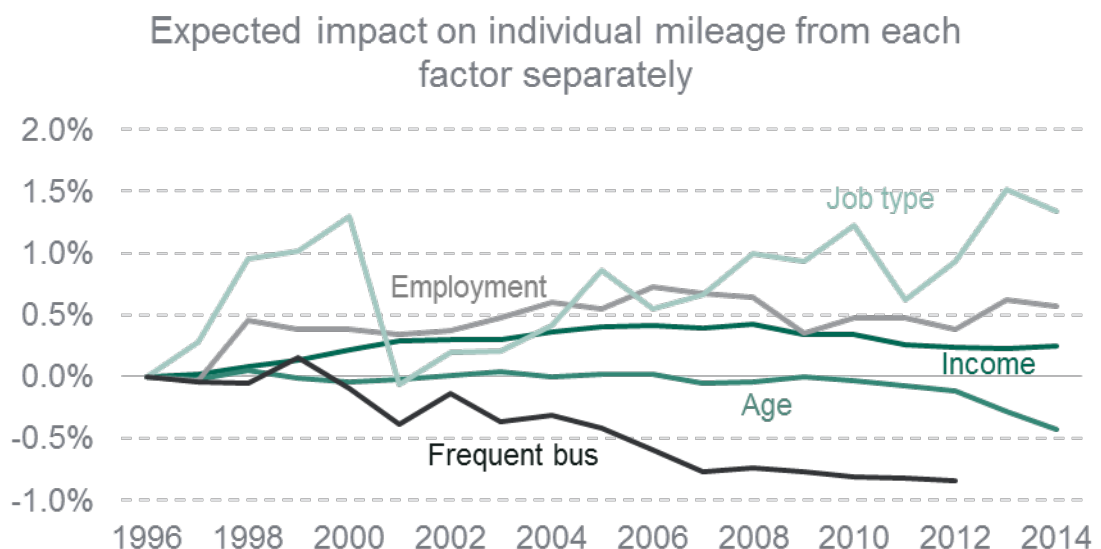
3.7 Following these work streams, we identified a need to investigate this further. Using NTS data, we developed three econometric models focussing on car travel to explore the effect of demographic, economic

²⁶ [Road traffic demand elasticities, a rapid evidence assessment, RAND Europe for DfT, December 2014, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/395119/road-traffic-demand-elasticities.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/395119/road-traffic-demand-elasticities.pdf)

and location factors on driving licence holding, car accessibility and, given both of these, how far people drive.²⁷

- 3.8** A range of factors that influence car mileage were investigated, including potentially influential factors not conventionally considered. The investigation showed that the key factors typically captured across our forecasting suites (i.e. income, employment status, area type, age, household type, car ownership) continue to be significant. The study also corroborated a finding of the evidence review that there continues to be a positive relationship between income and car mileage. The evidence review highlighted that cost of driving is important for car travel demand, however, this was not investigated further in this analysis as a significant expansion of the econometric models would have been required to include this variable and was not possible to accommodate within the timescales of this study.
- 3.9** Employment status is an important factor that influences car mileage. Location is also shown to be important. This will reflect many factors such as development density, availability of parking and public transport accessibility. The influence of these factors and an indication of change of the strength of their influence over time are shown in Figure 2 below.

Figure 2 Factors influencing car mileage



- 3.10** The study suggests that in addition to these key factors there are more subtle interactions. We confirmed that differences in the use of car between age groups narrowed: younger people used to drive more; they drive less now, but the use of car among older people has increased. In also detected a London effect additional to age: younger people living in London differ in their use of car from other groups more than could be explained just by their age.

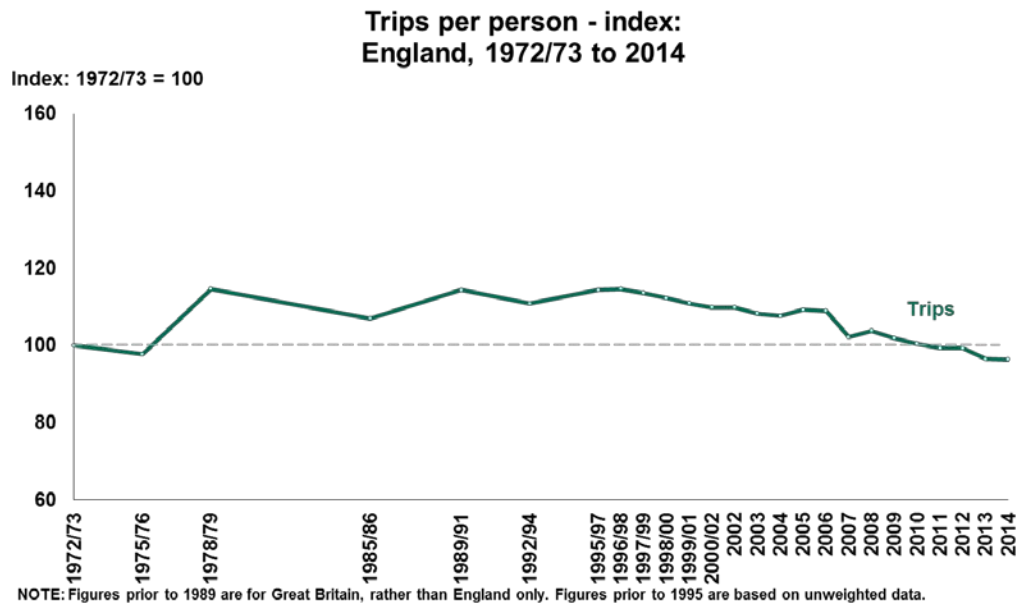
²⁷ A separate technical report is published alongside this progress report which discusses the methodology and results in more detail. Here we give the top line of the results.

- 3.11** The effects of employment status and location have increased over time. Job type (occupation) also became more important in determining car travel behaviour: professionals and managers are more likely than unskilled workers to hold a full driving licence, to have access to a car and to drive further. Similarly, differences between rural and urban locations have increased. Whilst these factors have been present in our models, it is important to update the models to ensure that the current sensitivity to these factors is adequately captured (this is described in the next section).
- 3.12** In summary, this research has led to a greater understanding of factors that influence car travel. The research helped us improve our understanding of more subtle interactions and provided us with a stronger understanding of the impact of changes in the make-up and spatial distribution of population and economic activity, which is not readily available from more aggregate analyses. Given future uncertainty about these variables and impacts it is important to consider these factors in the analysis of potential future travel demand scenarios.

Investigating trends in trip rates

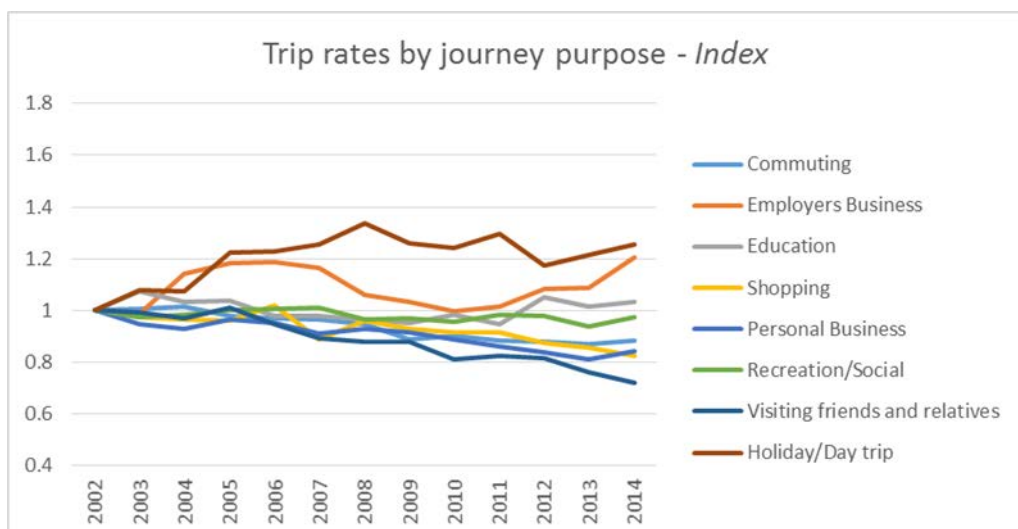
- 3.13** Trip rates capture key aspects of travel behaviour - essentially they are the average number of trips that people from different segments of population make for different journey purposes. They form an important input into our National Trip End Model (NTEM). Good understanding of the factors that drive this element of travel behaviour improves confidence in our forecasts and is necessary to analyse the impact of transport investments. To make sure that our forecasts remain relevant and investment decisions are made with the use of the best available information we commissioned a comprehensive research into the evidence on trip making behaviour (trip rates).
- 3.14** As described in the 2014 UVITI Progress Report, average trip rates since the late 1990s have declined, according to the National Travel Survey (Figure 3 shows the national average across all journey purposes and modes). We identified a need to understand how the behaviour has changed in detail, what the sensitivity of this input is to different factors today, and establish why the changes have taken place.

Figure 3 Annual NTS Trips per Person (all trips)



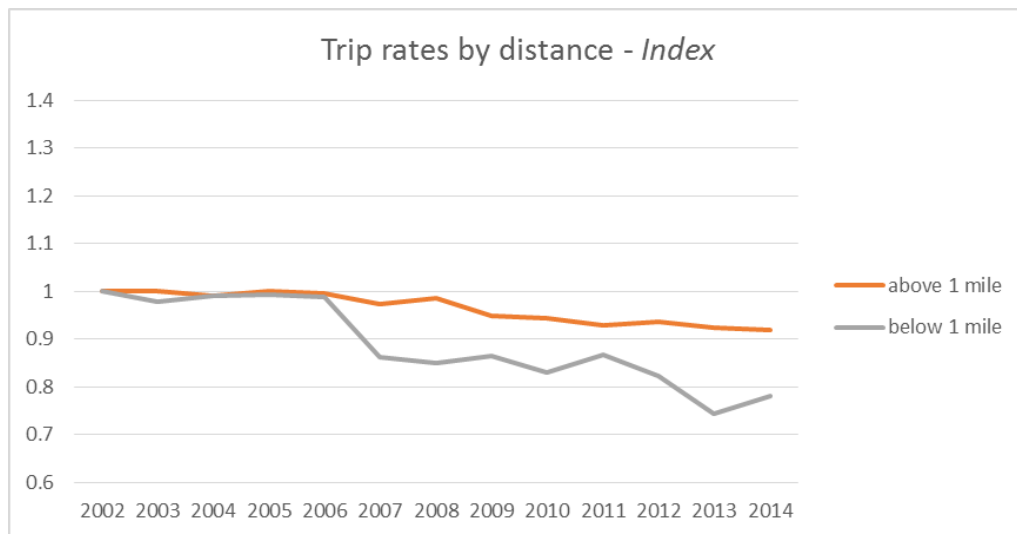
3.15 The reported changes are complex and mixed by mode, journey purpose and distance: rail trips rates have increased, walking trip rates (the shortest of trips) decrease at the fastest rate, and changes in car trip rates vary by distance and area type.²⁸ Commuting, shopping and visiting trips reduced, whilst holiday and business trips increased (Figure 4 and Figure 5).

Figure 4 Observed Trends in Weekly Outbound Home-based Trip Rates by Journey Purpose (NTS 2002-2014)



²⁸ The trend of increasing rail trip rates derived from NTS is consistent with the evidence from the rail ticket sales.

Figure 5 Observed Trends in Weekly Trip Rates by Distance Category (NTS 2002-2014)



- 3.16** In 2015, in conjunction with the Independent Transport Commission (ITC), we commissioned comprehensive research into factors that define today's trip rates and may be influencing trends over time. Based on NTS data the research explored factors that influence total trip rates for a range of journey types (commute, business and a range of personal and leisure purposes). It considered the feasibility of forecasting changes in trip rates in the future and set up tools that provided direct, updated inputs into our models and could be used to construct future scenarios where trip rates might vary.
- 3.17** As part of the research we have undertaken an extensive literature review to gather evidence on trends observed in the UK and internationally. Based on this and a series of workshops with experts on the subject of travel trends, the project steering group has identified a number of hypotheses about factors that could have led to changes in trip rates over time.
- 3.18** The research thoroughly investigated the key factors that have been historically evidenced to influence travel behaviour and are included in our models such as age, employment status, gender, area type and car ownership. These factors are consistent with the key influences identified by the car travel econometrics study described in the previous section.
- 3.19** In addition, the research tested the relationship to travel behaviour to changes in three additional factors: income after housing costs, frequency of internet shopping, and migration (Table 1). The analysis used contemporary econometric techniques to explore methods and models that could improve the estimates of trip rates.

Table 1 Known and potential factors influencing trip rates

'Known', traditionally considered factors	Age and employment status
	Household type and car ownership levels
	Gender
	Geographical area type
Additional, 'known' factors	Greater age segmentation
	Presence of children in the household
	Driving licence availability
Additionally explored variables	Income after housing costs
	Use of internet for shopping
	Migration

- 3.20** The research allowed us to refine the estimates of trip rates with the addition of new factors and delivered improved representation of trip rates for different population segments and different areas of the country. This is a significant step forward in estimating trip rates of today's travellers.
- 3.21** Another element of the research was to explain why average trip rates have decreased. Sophisticated testing of new hypotheses was undertaken, but the research was unable to provide much explanation of the reduction in NTS trip rates over time. It remains unclear what factors caused the reductions in trip rates reported in NTS and this highlights a significant uncertainty about the future trajectory of trip rates.
- 3.22** The study also improved the overall transparency behind the evidence base. It delivered a set of econometric tools that allowed a comprehensive recalculation of trip rates that represent today's travel behaviour. This is important as the evidence from the research shows that, on average (nationally across all journey purposes) in 2011 people made twenty percent fewer trips per person than in our previous estimates based on 1990s data.
- 3.23** In addition, the study developed a Trip Rate Tool that allows us to make estimates of trip rates after 2011, based on assumptions around future trends. The tool provides a transparent and systematic way of testing scenarios and uncertainty around trip rates and provided inputs into the National Trip End Model described later in this document.

Approach to the findings of the trip rate research

- 3.24** As mentioned above, the research has not sufficiently explained what factors have caused a reduction in NTS trip rates. There is therefore

considerable uncertainty around their future trajectory. There are many possible outcomes and there is no apparent evidence that one particular set of assumptions is more probable than other:

- Trips rates could continue to fall - in the longer-term this would increasingly mean a different state of the world where people would not need to leave home to satisfy most of their needs and activities;
- Trip rates could stabilise - after initial reductions, this would mean that the causes of the fall in trip rates will have worked through. For example, recession led to new forms of employment and changes in company car taxation led to fewer car trips. We may have witnessed an optimisation of travel behaviour in line with today's economic and technological conditions and this adjustment may have now plateaued.
- Trip rates could rebound - if low productivity and low real incomes among young people (coinciding with high cost of insurance and driving licence) contributed to the falls, we might witness a rebound in trip rates, if such constraints are removed in the future.

3.25 We recognise that the future trajectory of trip rates is uncertain, and recognise that testing alternative scenarios will be desirable to reflect this uncertainty. In NTEM7 we have provided a core scenario which, assumes that trip rate trends will continue between 2011 and 2016 and that from 2016 onwards the trip rates will stabilise.²⁹

3.26 In testing scenarios around this core, it is important to remember that uncertainty is not limited to trips per person. There is uncertainty about the other factors that impact on demand nationally (such as GDP and energy costs) as well as demographic and technological changes. All these factors may lead to lower or higher than predicted demand and it is this outcome that needs to be captured in the analysis of transport interventions when dealing with national uncertainty across all potential causes.

3.27 Our guidance recognises this and recommends testing of low and high demand, which could be a result of socio-economic or behavioural changes. It provides proportionate recommendations, which allow us to understand the performance of schemes under different levels of demand and the overall robustness of the business case. We continue to recommend the use of these scenarios and scheme promoters are expected to report low and high demand scenarios for their appraisals.

3.28 Over the next year we shall investigate the ranges provided by the high and low national growth scenarios which we already recommend in WebTAG, particularly in the light of the uncertainty around trends in trip rates (see Section 6 for more detail on the wider range of our work that aims to improve our analysis in the face of uncertainty).

3.29 In the longer term we will explore the scope for refinements to guidance in TAG Unit M4 - Forecasting and Uncertainty, taking lessons from work programmes focussed on forecasting and uncertainty. We will also continue to monitor the evidence on trip rates in the coming years and

²⁹ NTS reported further falls in trip rate in 2013, 2014, 2015 and 2016.

monitor the developments of the National Travel Survey aimed at improving the method of collection of data on walking trips, which are believed to be under-represented in NTS.³⁰

Other work on travel trends

- 3.30** The Department has recently commissioned Imperial College London and NatCen Social Research to explore commuting trends in England since 1988 using the data from the National Travel Survey. The research has found that changes to the pattern of commuting have been driven by changing social trends and employment practices.
- 3.31** NTS reported an overall reduction in commuting trips (see trip rates research described above) over the last 15-20 years. Journeys defined as 'commuting' in NTS fell by 16 percentage points, whilst England's population grew by 11 percentage points and employment grew 18 percentage points between 1995 and 2014. This is partly because of changes to working practices such as increases in flexible working.
- 3.32** The research also found that commuting has become more complex with an increase in the number of people with no fixed workplace (working at multiple sites). Trip-chaining has also increased (journeys which include multiple purposes, such as dropping children off at school and then continuing to a workplace). The traditional definition of commuting currently used in NTS (regular travel to/from the usual place of work) does not capture an increasing proportion of these workers whose journeys do not fit these patterns.
- 3.33** Commuting as a car passenger has also declined since 1988, whilst National Rail, London Underground and local bus commutes have increased. However, car driving still accounts for more than half (56 per cent) of all commutes.

Updating the evidence within our models

- 3.34** The investigation into car travel econometrics described at the beginning of this chapter and the research into trip rates gives us further confidence that the relationships reflected within our models are based on the best available evidence and reflect contemporary travel behaviour.
- 3.35** In addition to those work streams we have commissioned a comprehensive update of all elements of the National Trip End Model (NTEM). NTEM brings together projections of population, employment and housing supply to give a consistent view of the planning inputs to transport models and provide a foundation for the appraisal of transport investments. The planning data combined with the projections of car ownership and trip rates (described in the earlier section) allows us to forecast the future number of trips at a detailed spatial level and segmentation of the population.
- 3.36** These forecasts provide an initial estimate of travel demand for input into bespoke transport models used by the Department, Local Authorities and other organisations. These transport models then translate these initial

³⁰ <https://www.gov.uk/government/statistics/collection-of-short-walk-data-in-the-national-travel-survey>

estimates of the number of trips into forecasts of traffic. More specifically, NTEM provides inputs into the Department's National Transport Model (NTM), which forecasts traffic taking into other factors such as income, fuel costs and capacity.³¹

- 3.37** Keeping NTEM up-to-date is important to ensure that decisions about transport investment are made on robust and contemporary evidence. NTEM was updated with the latest 2011 Census, a significant step, and we have updated the projections of all planning data: population, employment, household projections and dwelling inputs.³² We have enhanced the transparency of the planning data by switching to a Government source for employment forecasts.³³
- 3.38** In addition to planning data, we have updated elements of the model that relate to travel behaviour of households and individuals: trip rates as previously described, and car ownership, described subsequently.
- 3.39** The outputs will now be available at a more granular spatial level than before, based on Middle Super Output Areas (MSOA).³⁴ This level of segmentation will make the application of the updated NTEM dataset in transport models more straightforward than before. It will make application in local business cases easier and ultimately improve the transparency of the models.

Car ownership

- 3.40** There is a strong link between car ownership levels and people's propensity to travel. People who own cars make more trips overall, but in particular more car trips.
- 3.41** Our econometric analysis described at the beginning of this chapter investigated the link between car ownership and car travel. There were important changes in car ownership trends in the last decade. Our car travel econometrics study confirmed the importance of income, driving licence ownership and area type for the car ownership levels. Higher income and employment status drive car ownership in general. However, differences by area types have been observed, with generally lower driving licence holding and absolute car ownership in London than elsewhere in the country. Important differences in driving licence holding by age and gender have also been observed. Fewer young males acquire driving licence than in the past. However, more young females hold a driving licence today than thirty years ago (Figure 6 and Figure 7)

³¹ In addition to NTEM, our modelling and appraisal guidance also describes more specific demand forecasting methods, such as those specific to modelling rail or aviation. These mode specific applications are subject to separate research and are not discussed here in detail.

³² NTEM Planning Data Version 7, Guidance Note, July 2016:

<http://assets.dft.gov.uk/s3.amazonaws.com/tempo/version7/guidance/ntem-planning-data-guidance.pdf>

³³ Working Futures - UK Commission for Employment and Skills

³⁴ NTEM Planning Data Version 7, Guidance Note, July 2016:

<http://assets.dft.gov.uk/s3.amazonaws.com/tempo/version7/guidance/ntem-planning-data-guidance.pdf>

Figure 6 Historical female licence holding by age band

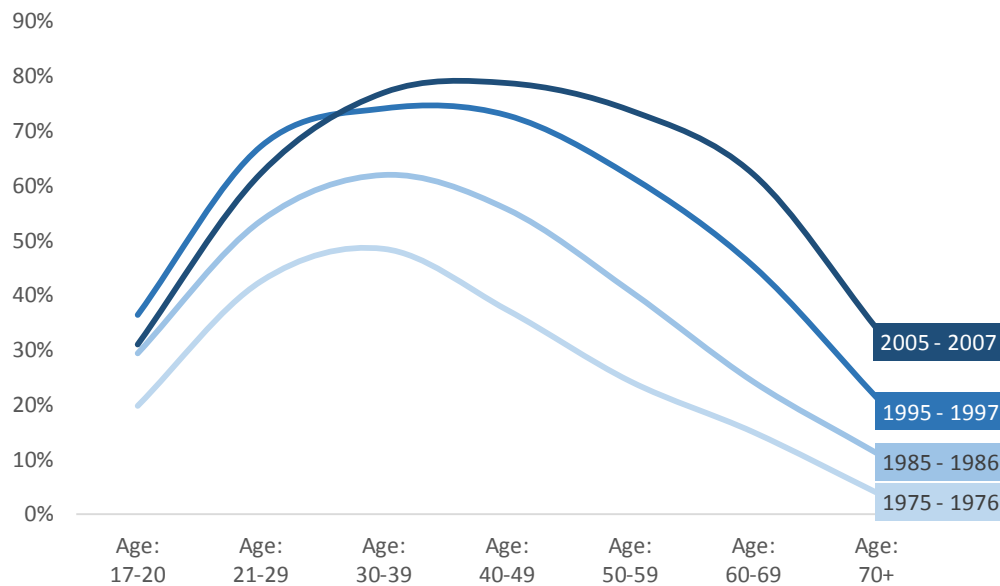
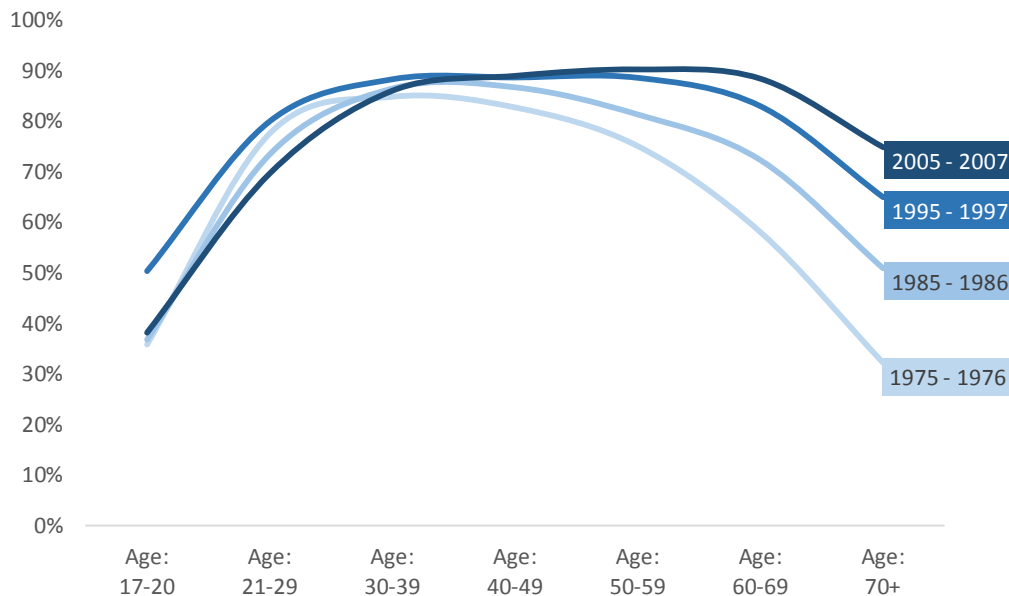


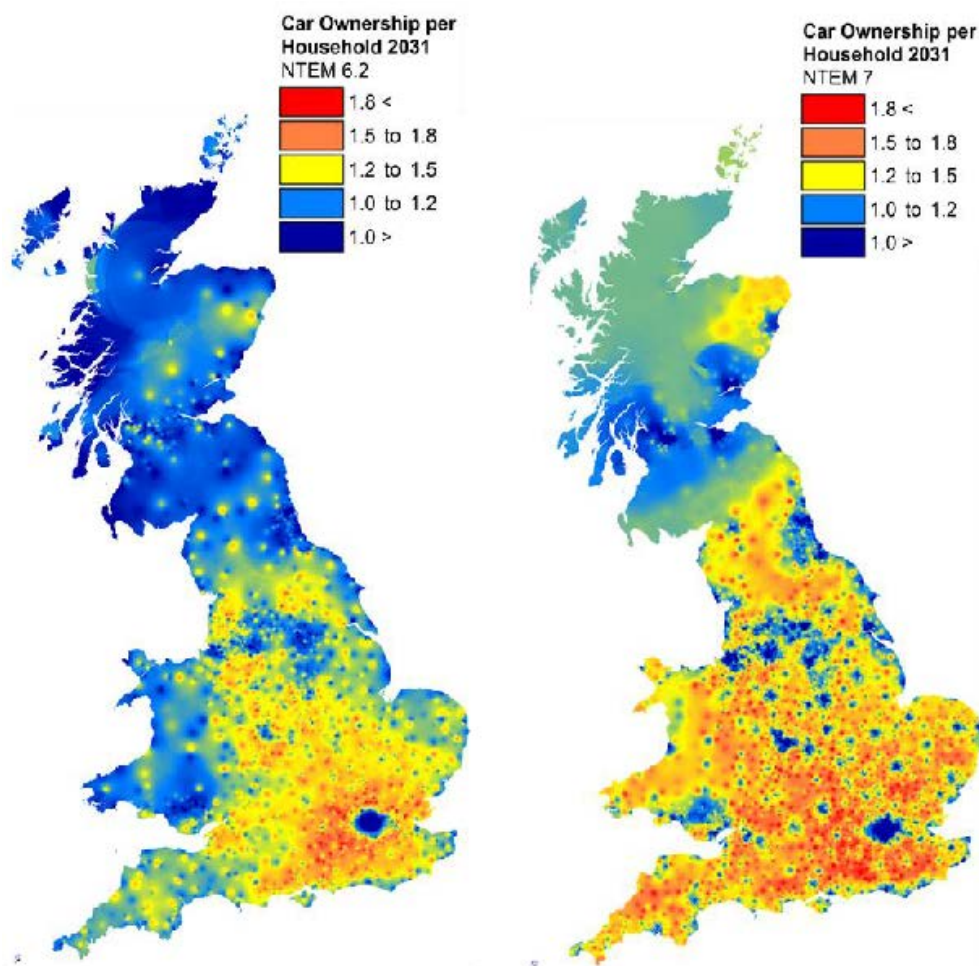
Figure 7 Historical male licence holding by age band



3.42 Our previous version of the National Car Ownership Model (NATCOP), which forms part of the NTEM suite, had a limited ability to represent these trends. To improve upon this we have made refinements to the model. It has been updated with the latest Census and evidence from the National Travel Survey. This brought the forecasts more in-line with the observed car ownership levels. Additionally, Inner London areas were separated from the Outer London areas as significant differences in car ownership levels between these two areas were found.

- 3.43** To reflect driving licence trends we have enhanced NATCOP with a driving licence cohort model, which captures differences in licence holding by age, gender and area type. This captures regional variations in driving licence holding that previously have not been represented.
- 3.44** As shown in the car travel econometrics project described at the beginning of this chapter, there is evidence that location has an impact on car ownership. Car ownership tends to be lower in densely populated urban areas and higher in rural areas. We have therefore added population density as an additional factor that influences car ownership forecasts.³⁵ Figure 8 illustrates the cumulative effect of these enhancements).³⁶

Figure 8 Car Ownership per Household, 2031, v6.2 (Left) and v7 (Right)



- 3.45** The NTEM7 data set is a significant update that reflects the best currently available evidence on travel behaviour, socio-economic drivers and planning trends. Next, we will be updating the remainder of our forecasting tools, including the National Transport Model (NTM) where

³⁵ Estimation of the National Car Ownership Model for Great Britain, 2011 base, July 2016

³⁶ NB The green colour lies between the yellow and blue categories, indicating car ownership of around 1.1 cars per household.

the new NTEM7 data set will provide inputs. The updated set of tools will form the basis of the future analysis of uncertainty and scenarios that will accompany National Road Traffic Forecasts

Understanding current demand - Big Data

- 3.46** In previous sections, we discussed issues related to forecasting future demand. To forecast demand levels in the future robustly, a reliable representation of today's demand patterns is a prerequisite.
- 3.47** Transport models do this by the means of trip matrices, which not only contain information about the number of trips made, but crucially, about the origins and destinations of those trips.³⁷ This is a fundamental element of travel demand forecasting. Reliable estimates of these travel patterns are one of the most important sources of information for transport planning. They significantly improve the quality of evidence used in the appraisal of transport interventions.
- 3.48** Transport surveys provide an insight into these patterns and have been used in transport modelling and appraisal with success over many years. They are used to inform estimates of origin and destination of trips as well as other information used in appraisal. They continue to be an important source of information for transport modelling and appraisal.
- 3.49** Transport surveys, by their nature, capture a snapshot of travel demand. To derive travel patterns suitable for use in forecasting, different sources of travel data have to be often combined using specialist statistical techniques. Specialist skills are available among industry experts, however, despite this depth of expertise, to date, the body of knowledge of best practice in matrix building was not gathered in a single comprehensive guidance unit. We are seeking to address this and have recently received a technical review of industry practice and recommendations for best practice in building matrices.³⁸ The recommendations of this review will contribute to informing the future direction of the development of our guidance.
- 3.50** Complementary to the wealth of information about travel derived from transport surveys, new methods for gathering data on travel patterns continue to emerge. Among the recent developments is the increased use of "big data" such as mobile phone data from which information about travel patterns could be derived in aggregate format suitable for use in transport models. Such data will form an important source for future transport model development. It also has the potential, when methodologies have been more fully developed and widely accepted, to provide significant cost and time savings during the development of transport models and potentially reduce the disruption to people's journeys associated with frequent Road Side Interviews.

³⁷ Demand matrices contain estimates of the number of trips that are made between different geographical locations (zones). No single dataset contains full information about where people travel from and to. The data used to populate transport models is usually derived from a range of data sources and travel surveys and assembled with the use of statistical techniques.

³⁸ Provision of Technical Advice and Support for Matrix Building Guidance - Technical Report (Arup, 2016); to be published in 2017

- 3.51** To investigate this area further, we have conducted research with Transport Systems Catapult into the potential of Mobile Network Data (MND) and produced a recommendations paper on how to use these data in transport models and consider the inherent biases and limitations of the data and legal / ethical considerations to be aware of. It was conducted with participation of modelling practitioners, representatives of planning bodies, academics and mobile network operators to determine what best practice should consist of and how to extract best value from this new data source and can inform further next steps and research needs in this area.³⁹
- 3.52** We are publishing these two reports alongside this UVITI progress report. In the course of next year, we intend to engage and consult on these two reports and the recommendations contained within them. We expect to use responses from this consultation to draft new best practice guidance on base year matrix building. This new unit will explore the feasibility of combining the recommendations of these two reports to create guidance which would seek to improve and standardise industry practice in this area and provide potential time and cost savings during the development of transport models.

Next Steps

- 3.53** In the longer term, the Department will remain committed to reviews of the evidence base underlying the forecasts. We will monitor the performance of our methods and tools and evaluate the emergent evidence. We will consider what key areas of uncertainty need to be addressed and focus our analysis of Road Traffic scenarios on these issues.
- 3.54** This process will inform the potential direction of the development of our guidance and our methods. Where improvements are possible we will consider future updates based on developing understanding of trends in personal travel and car ownership. We will also monitor the emergent official evidence on the performance of the economy and other external drivers of demand and plan updates when necessary to ensure that our forecasting and appraisal approaches remain relevant in an ever-changing world.

³⁹ Utilising Mobile Network Data for Transport Modelling - Recommendations Paper (TSC, 2016); to be published in 2017

4. The Treatment of Uncertainty

Background

- 4.1** There is, unavoidably, uncertainty in future forecasts. This makes demand and scheme benefits harder to predict the further in the future we go. Within our appraisal framework, we describe the size of the uncertainty in both the calculation of scheme benefits, through the development of sensitivity tests and alternative forecast scenarios, and on the scheme costs side, through the application of optimism bias and quantitative risk assessment.
- 4.2** Since much of our transport investment is for the longer term, it has a long-lasting impact on the economy, the environment and society. We previously identified two key analytical issues that arise from taking the long term perspective:
- How best to forecast transport demand and the impacts of options into the long term; and
 - How to handle the inherent forecasting uncertainty.
- 4.3** The Department has established guidance on how analysts may treat uncertainty in their modelling and appraisal work in WebTAG.⁴⁰ This provides good practice advice on how national and local uncertainty may be captured, particularly in the context of scheme appraisal. The use of transport models as tools to assess not just core scheme benefits, but how a scheme or strategy may perform in a variety of different circumstances in a proportionate manner, is established as a core principle of the guidance.
- 4.4** Testing robustness to uncertain outcomes is achieved through sensitivity tests of more detailed scheme assumptions, wider scenario tests and the provision of ranges around key values. All of this treatment of uncertainty provides the decision-maker a more informed view of the performance of a potential investment in a range of different circumstances.
- 4.5** This chapter sets out our commitment to thoroughly developing our understanding of uncertainty. This covers the following areas:
- capturing uncertainty in the key building blocks of modelling and appraisal;
 - developing our understanding of our forecasting capability through ex-post evaluation;
 - enhancing the approach to modelling benefits in the long term; and

⁴⁰ <https://www.gov.uk/government/publications/webtag-tag-unit-m4-forecasting-and-uncertainty-november-2014>

- communicating uncertainty to decision makers through different technical methods such as scenario analysis and clearer presentational methods that provide a richer analytical picture.

Understanding the Scale of Uncertainty

- 4.6** WebTAG guidance covers the importance of understanding the uncertainty around transport model inputs and describes the principles in accounting for these as best as possible, and in a proportionate manner. For example, inputs are uncertain due to day-to-day variation in traffic flows, sample size limitations in surveys and so on.
- 4.7** As part of our wider analysis development program we continuously reflect upon and take account of elements of uncertainty. For example, the re-estimation of values of travel time will provide ranges around core values that will be reflected by analysts in appraisal work.⁴¹ The trip rates study has also looked at uncertainty around the propensity for people in different households to travel for different purposes. This key input into modelling and appraisal framework can be used to test uncertainty in travel demand forecasting (see Chapter 3). As a final example, the National Transport Model made use of several scenarios to test the impacts of the Roads Investment Strategy, including assumptions about trip rates, or link between income and car ownership.
- 4.8** As part of developing our understanding of uncertainty and improving our ability to communicate uncertainty effectively, we see a need to explore uncertainty around our core model parameters, inputs and assumptions.
- 4.9** Many inputs into transport models are taken from data that do not commonly come with the expected range around these values. This includes planning data, economic inputs, and parameters that govern the performance of these models. Sensitivity tests are recommended and commonplace, as well as specifying scenarios to use the potential of models to present a more detailed picture of uncertainty from the analysis. However, the ranges used in sensitivity tests are not explicitly provided and are varied by individual analysts.⁴²
- 4.10** We intend to explore the ranges of uncertainty around the key variables. It may contribute to better understanding of the impact of uncertainty across the modelling process, better informing sensitivity analysis and ultimately improving communication of transport analysis, and potential risks and opportunities, to decision-makers. It may assist analyses such as Monte Carlo simulation, and can also allow us to develop improved advice to potentially smaller-scale investments where it is disproportionate to run many sensitivity tests. We are expecting this area to feature in our ongoing analytical strategy over the course of next year.

⁴¹ <https://www.gov.uk/government/publications/transport-appraisal-in-investment-decisions-understanding-and-valuing-the-impacts-of-transport-investment>

⁴² Except for the low and high demand scenario set out in WebTAG

Improving the Links between Appraisal and Evaluation

- 4.11** At the heart of understanding uncertainty is developing our portfolio of ex-post evaluation evidence and using this to identify areas of uncertainty and to inform our model development. This has become particularly apparent in emerging methodological areas, such as measuring the impact of transport investments on economic performance.
- 4.12** The Department's 2013 Monitoring and Evaluation Strategy made a commitment to develop good quality evaluation evidence to inform future decision making. Strengthening links with the appraisal process is one of the ways in which provision for future evaluation evidence is being improved.
- 4.13** In the 2014 UVITI progress report, the Department made a commitment to enhance the ways in which ex-post evaluations can generate and feedback evidence to validate and improve the quality of our modelling and appraisal.
- 4.14** To meet the need for guidance in this area, the Department commissioned Frontier Economics to carry out a research study to generate evidence about how links between appraisal and evaluation can be strengthened.
- 4.15** The study used stakeholder interviews and case studies to identify issues with current practice and opportunities for improvement.
- 4.16** The report makes recommendations for improvement under three headings:
- Implement appraisal handover packs as a method of passing forward appraisal information to the evaluator;
 - Develop portfolio approaches for evaluation, since use of more consistent approaches across similar types of scheme will help identify areas where appraisal tools are systematically and materially mis-forecasting outcomes;
 - Align evaluation work with appraisal evidence needs by considering how evaluation can be used to inform appraisal and consulting appraisal leads to identify, at a strategic level, areas where evaluations can be used to address knowledge gaps going forward.
- 4.17** The report has been welcomed by senior analysts within the Department and our independent Joint Analysis Development Panel.⁴³ We believe that its recommendations are practical and can help improve future practice in appraisal and evaluation without incurring significant additional costs.
- 4.18** We have identified actions that can be taken to respond to the report's recommendations, as detailed below:

⁴³ <https://www.gov.uk/government/publications/strengthening-the-links-between-appraisal-and-evaluation>

Implement appraisal handover packs

- 4.19** We will embed this recommendation in future benefits management and evaluation guidance and in the 'Guidance for the Technical Project Manager' WebTAG Unit. We are looking to identify demonstration projects to trial the use of these packs.

Develop portfolio approaches for evaluation

- 4.20** We are addressing this recommendation in three sectors:
- Strategic roads: we are liaising with Highways England (which contributed to the study's project board) about development of the Post Opening Project Evaluation (POPE) series used for its portfolio.
 - Local Transport: we are building on the portfolio approach used for Local Major Schemes and considering how stronger approaches could be developed for Growth Deals.
 - Rail: we are developing portfolio approaches for the benefits management and evaluation of rail projects.

Align evaluation work with appraisal evidence needs

- 4.21** A new study to examine the wider economic impacts of rail infrastructure projects is an example of an evaluation study which has been developed in part to address an acknowledged evidence gap for appraisal.
- 4.22** Successful implementation of these actions will require partnership with arm's length bodies and local scheme promoters. We will publicise the recommendations to these groups and seek to incentivise take-up of improved approaches.

Forecasting Demand and Benefits in the Long Term

- 4.23** It is common to fix the magnitude of benefits attained in the final modelled year across the remainder of the appraisal period, which can often be for a considerable length of time. Given the discount rate defined in the Green Book, and the fact that real values increase over time where values of time increase, this means that commonly a significant amount of benefits can occur after the final modelled year, even assuming that annual benefits cease to grow past this point. This of course can make appraisal results very sensitive to assumptions regarding demand and benefits in the longer-term. The long-term future is uncertain, and as time proceeds, more questions arise regarding how models represent future relationships, what unforeseen events may occur, and how much we can assure ourselves of the fidelity of model forecasts.
- 4.24** The Department has commissioned research investigating the issue of long-term benefits forecasting for use in appraisal.⁴⁴ This investigated the scope of the issue, gathering evidence from evaluations of schemes

⁴⁴ Research Into The Appraisal Of Long Term Benefits Of Transport Schemes - Final Report (Arup, 2016); published in July 2017. Available at: <https://www.gov.uk/government/publications/transport-schemes-appraisal-of-long-term-benefits>.

post-opening of what returns schemes may provide in the longer term. It is in the longer term where it is impractical to run complex transport models due to the inherent uncertainties around future demand and supply relationships. Put simply, there comes a limit to the assumption of past relationships being able to predict the future demand for transport.

- 4.25** The research investigated whether or not any improvements may be made to current methods of benefits extrapolation, or indeed lack of benefits extrapolation (often referred to as a "demand cap"). The project looked at highway and rail modes and whether the different forecasting approaches for each share common issues or in themselves pose separate challenges.
- 4.26** The research looks at how the profile of benefits calculated through a transport model may be linked to an extrapolated profile, and whether more simple assumptions can be made past the final modelled year, such as increasing annual total benefits and revenues in line with national population growth. Key to understanding the applicableness of this assumption will be understanding the impact of capacity restraint on growth in use of the transport system or service.
- 4.27** Although no definite solutions emerged, the findings of this research provide a greater understanding of the challenges associated with benefits of transport schemes in the long-term. It will also help analysts explain to decision-makers the assumptions and rationale used in deriving long term benefits in more robust terms and, where possible and appropriate, in a consistent manner. The Department will look into the merit and scope for strengthening the wider guidance in the areas of forecasting and uncertainty to assist analysts using models to better account for long-term uncertainty.
- 4.28** The research report was released in July 2017. Since then, the DfT has announced Forthcoming Changes to TAG Units A5.3 (Rail Appraisal) and A1.1 (Cost-Benefit Analysis) which implement a revised approach to benefits extrapolation.⁴⁵

Communication of Uncertainty

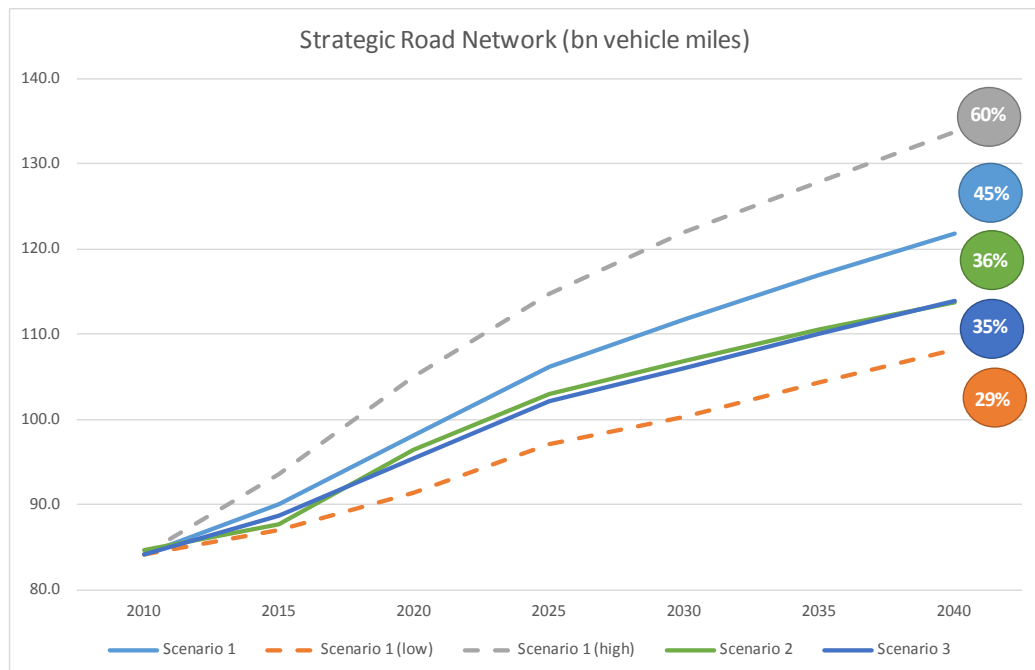
Scenario Analysis

- 4.29** Scenario analysis is an important analytical approach to understanding uncertainty and has been adopted as part of the standard presentation of our National Road Traffic Forecasts; for example, the 2015 forecasts can be seen in Figure 9 below:⁴⁶

⁴⁵ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/625371/webtag-forthcoming-changes-A5-3.pdf

⁴⁶ <https://www.gov.uk/government/publications/road-traffic-forecasts-2015>

Figure 9 2015 Road Traffic Forecasts using Scenarios



- 4.30** We are exploring how to maximise the potential of scenario analysis to best inform policy-making within the Department, using our national forecasting tools such as the National Transport Model. This sheds light on interesting questions regarding the future, such as what key drivers affect different types of schemes and policies across the different modes. It is also a significant challenge to understand the role of future technology on the transport network, as well as more immediate issues such as the impact of the UK's departure from the EU on key macroeconomic drivers.
- 4.31** Over the next year we shall investigate the ranges provided by the high and low national growth scenarios which we already recommend in WebTAG, particularly with regard to the uncertainty around the trends in trip rates (see Section 3 for more detail). In the longer term we may look to provide more detailed guidance in TAG Unit M4 - Forecasting and Uncertainty, on the more general use of scenarios, taking lessons learned from the activities using these analysis in the Department and across the forecasting professions.

Next Steps

- 4.32** We are currently specifying the project to take forward a stock-take of uncertainty ranges for the key building blocks of our models and aim to undertake the research during 2018. We will also continue to reflect on and research potential ways forward on long-term benefits estimation and how best to reflect uncertainty in core appraisals over a long time period.
- 4.33** Following our evaluation strategy, we are committed to raising the profile of evaluation in order to build up the evidence base and make sure our

modelling assumptions are right. This is crucial not only for more conventional evidence and indicators, but also for emerging theoretical areas such as measuring wider economic impacts that result from transport intervention. We aim to embed better guidance in WebTAG in the near future, whilst pursuing research opportunities to trial the recommendations from the Frontier Economics recommendations.

- 4.34** We plan to continue to work closely with academics and stakeholders to ensure that our appraisal framework enables a high quality and proportionate approach to capturing uncertainty. We are keen to collaborate across the industry on the use of scenarios, share experiences, and build on good practice to potentially inform recommendations we can make in guidance.

5. Next Steps

- 5.1** We are pleased that we are able to report good progress on our analytical strategy and that we have extended our ambitious agenda. In this time we have delivered significant updates, expanding the horizons of appraisal to better understand the impact of transport on economic performance, and updating a fundamental part of the appraisal system through our values of time research.
- 5.2** We have kept our approach to valuing environmental and health impacts in line with latest evidence, and we continue to research and develop methods in the areas of travel demand forecasting and uncertainty. In the next phase of work we are also keen to develop approaches that highlight the importance of improving the passenger experience.
- 5.3** We are very grateful for discussions with and input we have had from many experts and stakeholders across the fields of modelling and appraisal. Our engagement with you has been invaluable in developing our strategy in the appropriate direction, and to deliver the best transport analysis guidance we can.
- 5.4** Our immediate next steps will be to continue the ambitious agenda set out in earlier sections of this report, engaging with experts and stakeholders on individual projects at pivotal points. In addition, we would like to continue to build on the success over the past three years with an engagement event in 2018 to discuss our next phase of development. By doing so, we will ensure our approach to understanding and valuing the impacts of transport investment remains world class, and provides relevant, reliable, and trusted information to decision-makers and stakeholders.