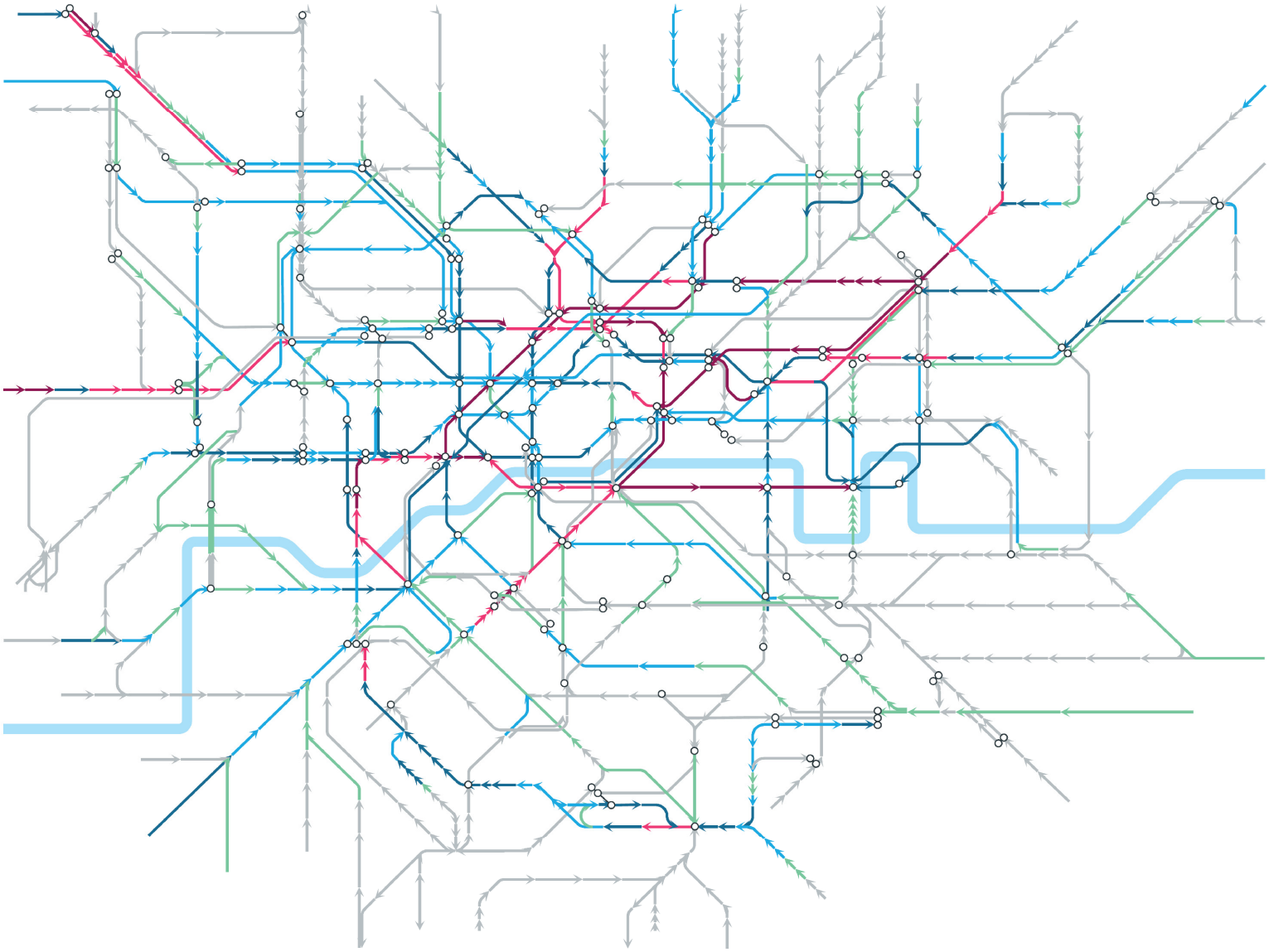

Mayor's Transport Strategy: Supporting Evidence

Outcomes Summary Report

July 2017

MAYOR OF LONDON

TRANSPORT FOR LONDON

EVERY JOURNEY MATTERS

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Mayor's Transport Strategy: Supporting Evidence

Outcomes Summary Report

Executive Summary

The Mayor's Transport Strategy is the statutory document that sets out the Mayor of London, Sadiq Khan's, policies and proposals to reshape transport in London over the next 25 years. It is an ambitious strategy that puts people's health and quality of life at the very heart of planning the city's transport. Along with the new London Plan and the Mayor's other strategies for economic development, the environment, housing, health inequalities and culture, it provides the blueprint for making London a city that is not only home to more people, but is a better place for all of those people to live in.

This document presents a summary of the strategic modelling carried out to inform the development of the draft Mayor's Transport Strategy, and to assess its impacts and effectiveness. A series of policies and schemes have been assessed that could help to meet the challenges set out in the draft MTS Supporting Evidence Challenges and Opportunities Report. The analytical work presented here describes the quantified outcomes of the strategy, assessing the benefits of the strategy in terms of the Mayor's aims and compared to the current funded plan.

The key conclusion is that, with the actions identified in this strategy, a sustainable mode share of 80 per cent can be achieved, meaning that eight in ten journeys made in London will be made on foot, by bicycle or by public transport and just two in ten by car, taxi, private hire vehicle or motorcycle.

TfL's approach to strategic modelling has ensured that the MTS is grounded in evidence about current and future travel patterns and has assessed the outcomes and effectiveness of the strategy in delivering the Mayor's aims

The MTS is an evidence-based document that builds on TfL's empirical understanding of how Londoners travel today, and may travel in the future. Analysis has been undertaken to inform strategy development and assess the effectiveness of various policies and schemes (interventions). The analysis includes a programme of modelling, using TfL's suite of strategic models and supporting analytical tools, described in this report.

The MTS relies upon an understanding of what could happen in the future without the measures proposed in the draft strategy. A Core Reference Case has been produced to build on TfL's understanding of current travel and present possible future travel volumes, distribution and mode share. This has formed the basis of analysis identifying the challenges and opportunities facing London and its transport network over the period to 2041.

All forecasting must accept that the future is inherently uncertain, and this uncertainty increases as we look further into the future. To ensure the forecasting

assumptions underlying the strategy are robust, sensitivity testing has been carried out exploring a range of possible future scenarios.

A series of policies and schemes have been assessed that could help to meet the challenges set out in the Challenges and Opportunities report. Various 'packages' have been developed from these alternative policies and schemes and an assessment of their relative effectiveness carried out against the Mayor's vision for travel in London.

Finally, an assessment has been made of the expected outcomes for London from implementing the MTS policies and proposals – the MTS scenario.

The Core Reference Case provides an understanding of what could happen in the future without the measures proposed in the draft MTS, based on current trends, forecasts and the funded programme

The future challenge is set by developing a core reference case, which includes current funded schemes for London and reflects a 'business-as-usual' scenario based on current conditions and assumptions. The core reference case takes account of London's projected population growth from 8.6 million people in 2015 to 10.5 million in 2041 and employment growth from 5.5 million jobs in 2015 to 6.7 million in 2041. It includes fully funded schemes such as the opening of the Elizabeth line in 2019, the funded programme of Tube upgrades, the delivery of HLOS, the Thameslink upgrades and HS2 on National Rail. Major schemes under development but not fully funded or committed, such as Crossrail 2, are not included in the reference case.

By 2041, the number of trips made in London on an average day is expected to rise to 32 million, 5 million more than today. With the committed programme of investment but without the interventions proposed in the MTS, the sustainable mode share is expected to rise from 64 per cent to 70 per cent. Despite a falling car mode share, vehicle kilometres will rise by around 8 per cent in the morning peak. This reflects the distribution of trips, with more car travel in outer London where trips are longer. This, coupled with a large rise in van traffic of 26 per cent, will lead to an overall rise in traffic on the network if left unchecked. Coupled with reduced road capacity for general traffic as a result of interventions to promote sustainable travel, speeds will fall, leading to congested and car dominated streets.

Demand for rail services will rise by more than 70 per cent and, despite significant capacity increases to the mid-2020s, by the 2030s and 2040s, demand will rise faster than supply leading to severe crowding on much of the rail network, including the Tube, Elizabeth Line, DLR, London Overground, Trams and National Rail services. Bus demand will also rise, but speeds will fall reflecting slowing general traffic speeds.

NO_X emissions would reduce significantly as a result of the implementation of the Ultra Low Emission Zone, but under the latest Government plans, London would not comply with legal limits for NO_2 until 2025, 15 years after the original deadline and will exceed World Health Organisation recommended maximum levels of $PM_{2.5}$ until well after 2030. Without the action proposed in the MTS, London would not be on track to become zero carbon by 2050.

Sensitivity testing has demonstrated that the conclusions of the reference case, including rapid growth in public transport use, walking and cycling and flat or declining car use but rising traffic, are a robust basis on which to plan.

TfL has developed an approach which recognises the intrinsic uncertainty in forecasting future travel demand. Uncertainty increases as the planning horizon moves further into the future, and as it becomes harder to predict how technology, the environment, lifestyle and travel preferences may change. A set of five sensitivity tests have been fully modelled and assessed, reflecting a range of assumptions about population and employment and economic growth, and the cost of car and public transport use. These tests provide a useful range of plausible outcomes against which to assess proposals and schemes. The results show that the broad conclusions of the core reference case, including rapid growth in public transport use, walking and cycling and flat or declining car use are a robust basis on which to plan. A series of more radical changes have been considered on a qualitative basis to provide an indicative understanding of the possible impacts of 'step-change' type events on the challenges facing London and the case for individual schemes and policies.

A range of major schemes are under development and modelling has supported the development and appraisal process, identifying optimal scheme designs and quantifying the impacts

Major schemes under development include:

- **Crossrail 2** will carry up to 30 trains an hour in each direction - up to 45,000 people - on the southwest to northeast corridor, relieving severe crowding on many lines and at key stations and unlocking around 200,000 additional homes and supporting 200,000 new jobs.

- A **London Suburban Metro** would offer improved frequencies, journey times and interchange opportunities, so that 125,000 more people could travel into Central London in the morning peak and 38,000 more people more people could travel on non-radial services around inner and outer London.

- **Mini-radial hubs and improved orbital rail links** can create interchange hubs; linked together they allow orbital rail trips, relieving crowding and enabling mode shift from the car, offering reliable and fast public transport to local destinations.

- The **Bakerloo Line extension** would deliver an increase in frequency on the Bakerloo Line to 33 trains per hour, providing the capacity for 65,000 more journeys in the morning and evening peaks, and could unlock 25,000 new homes and 5,000 new jobs.

- The **Silvertown tunnel and associated bus services** will provide a reliable and resilient cross-river road link, enabling new bus links, delivering at least 20 buses per hour in the opening year.

- The **Ultra Low Emission Zone** covers the same area as the Congestion Charging Zone and introduces a daily charge for vehicles that that do not meet required emissions standards. Subject to consultation, the original September 2020 start date for the Central London ULEZ is being brought forward to April

2019, ahead of expansions London-wide for heavy vehicles in 2020 and across inner London for light vehicles in 2021. As a result of the ULEZ, 42 per cent fewer people in Central London would be living in areas exceeding the legal limits for NO_2 concentrations.

- **Further upgrades to the Tube, DLR, Trams and Elizabeth line** would increase morning peak capacity in 2041 by 26 per cent, significantly reducing crowding.

A series of illustrative tests explored the possible impacts of interventions at a more conceptual stage and particularly those designed to deliver mode shift

Traditionally, transport models are used to test the impacts of rail and road schemes - schemes delivering new infrastructure or capacity. They are less often used to test the impact of schemes at a more conceptual stage, schemes that could be delivered in a number of ways, or schemes designed to deliver mode shift. Therefore, in order to reflect the Healthy Streets goals of the strategy, a new approach was developed allowing the creation and testing of a series of 'illustrative interventions', typically radical examples of possible policies. Each test was carried out independently on the 2041 core reference case. TfL learned from the illustrative tests and used this improved knowledge to inform the development of 'packages' of interventions for the draft MTS. In general, the illustrative interventions tests shown here are more extreme than the versions included in the final package modelling for the MTS.

Five illustrative intervention tests were designed to test how improved sustainable travel options, traffic reduction measures, more sustainable models of development and changing land use patterns could impact travel patterns in London and inform the wider strategy. The results of the illustrative interventions show that there is scope for further mode shift in inner and outer London beyond the core reference case, and that achieving traffic reduction will require a mixture of 'carrot' and 'stick' measures.

In order to understand the impact and effectiveness of the policies and proposals contained in the Mayor's Transport Strategy, TfL developed a series of cumulative 'packages' to be tested in the strategic modelling suite

The packages drew on existing modelling of major rail and road schemes and on lessons learned from the testing of illustrative interventions. These packages are designed to pull together measures of a similar type, and represent measures to be implemented in the short, medium and long term. The packages get progressively more ambitious – starting with optimising the existing network, then expanding it, then adding new connections, and then introducing measures to reduce traffic and tackle car use. The modelling of policies and proposals concerned with the latter years of the strategy is inevitably more illustrative.

In summary:

- **Package A** is the core reference case.

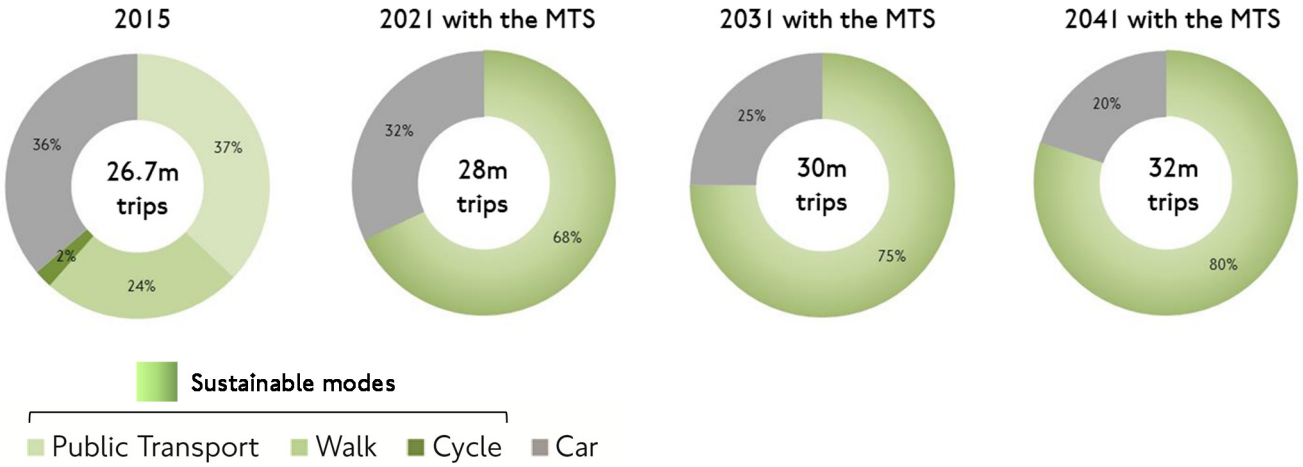
- **Packages B to D** represent the totality of what can be achieved with 'carrot' measures, in other words measures designed to improve the public transport and active travel 'offer'.

- **Packages E and F** represent what more can be delivered with the introduction of measures affecting parking, freight and the way road use is paid for, that reduce traffic demand and free up space to improve the active travel and bus 'offer'.

The MTS scenario demonstrates that the policies and proposals contained in the draft MTS can deliver the Mayor's aims, with 80% of trips expected to be made by a sustainable mode by 2041

The MTS scenario includes all measures tested as part of packages A to F. The analysis demonstrates that London could accommodate 5 million more trips every day by increasing the mode share for walking, cycling and public transport to 80 per cent. With the MTS, by 2041, travel will have risen by around a quarter but car travel will have fallen by around a third. There would be at least 3 million fewer car trips per day (compared to 2015) and 250,000 fewer cars owned in London. General traffic would fall by 10 to 15 per cent, a reduction of 6 million kilometres.

Figure E1 2015 and 2041 MTS scenario mode share.



Source: City Planning

The draft MTS will deliver benefits to London's health and wellbeing, help Londoners to be more physically active, clean up London's air and deliver Healthy Streets

By 2041, between 3 and 5 million more trips could be made by active modes every day than in 2015 and total travel will increase by around 60 per cent on London's buses. Bus journeys will be quick and reliable with a 10 to 15 per cent improvement in speeds and particular improvements expected in Central and inner London.

Traffic reduction and improvements in vehicle technology will deliver large scale reductions of 94 per cent in NO_x and 47 per cent in $PM_{2.5}$ emissions with road and rail transport on a clear trajectory to reach 'zero carbon' status by 2050.

Furthermore, the significant increases in rail capacity recommended by the draft MTS will reduce crowding on public transport and unlock thousands of new homes and jobs

Total capacity on rail and Underground services - Tube, Elizabeth Line, DLR, London Overground, Trams and National Rail - will increase by around 90 per cent, with more than 80 million additional seat kilometres between 7am and 7pm each day. Total travel will increase by nearly 100 per cent on the Tube and rail network. Despite rising passenger numbers, rail and Tube journeys will be less crowded. By 2041, crowding on rail and Underground services will reduce by around 10 to 20 per cent compared to today, measured in terms of the total crowded distance compared to the total distance travelled.

New and enhanced public transport connections and improvements to bus speeds will mean that London residents will be better connected to jobs, services and to one another

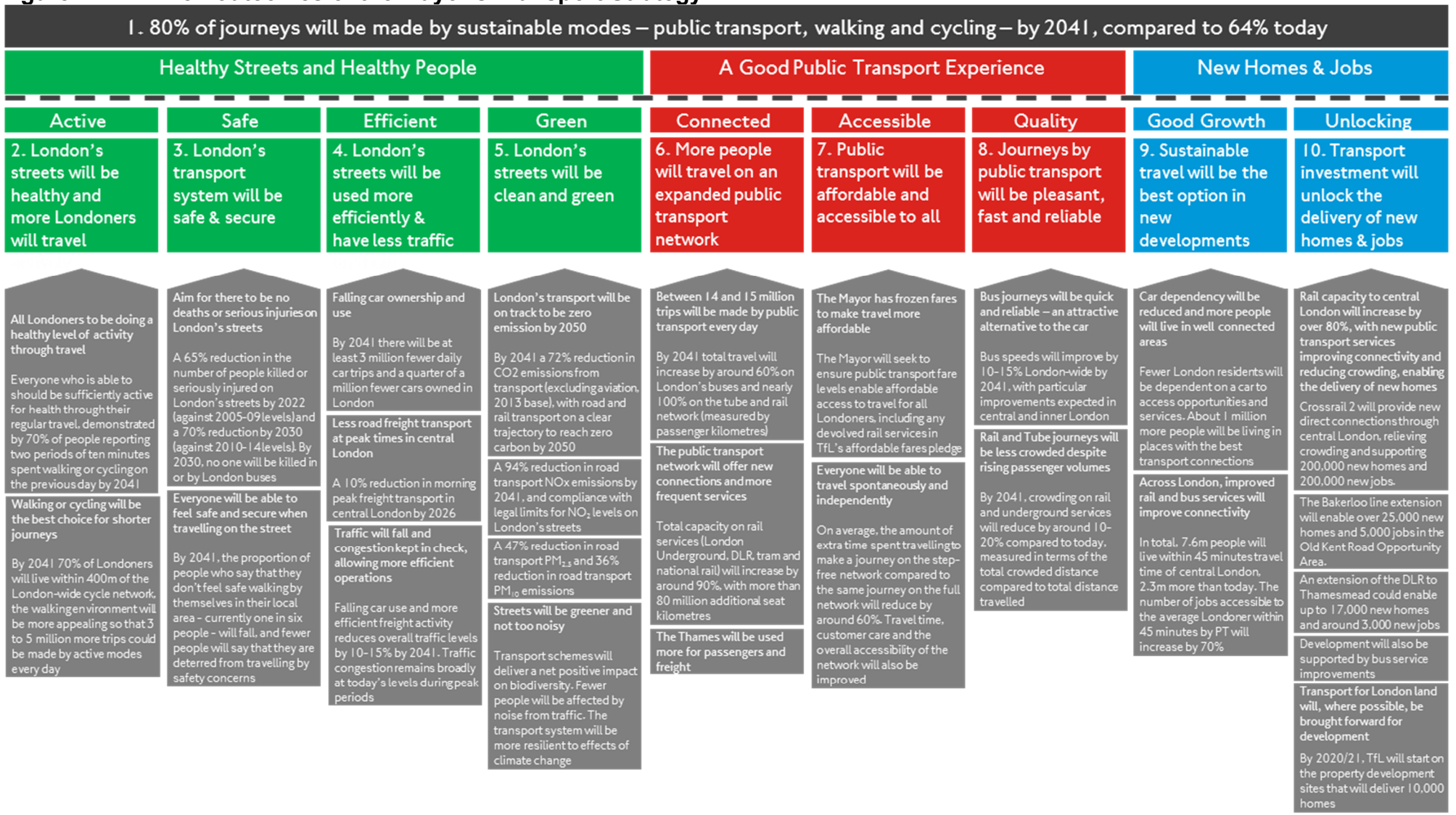
In total, 7.6m people will live within 45min travel time of Central London, 2.3m more than today. The number of jobs accessible to the average Londoner within 45 minutes by public transport will increase by 70 per cent. Fewer London residents will be dependent on a car to access opportunities and services. Nearly 1.8m more people will be living in places with the best transport connections, defined as areas with a public transport accessibility rating of four or above.

Ten outcomes describe how the MTS will deliver the Mayor's aims, transforming the streets and transport network

Ten outcomes have been identified, reflecting the Mayor's aims and the adoption of the Healthy Streets Approach, each incorporating several quantified measures. The outcomes describe how the strategy will mean the 80 per cent of trips are made by a sustainable mode, and how the strategy will deliver Healthy Streets and healthy people, a good public transport experience, and new homes and jobs.

These outcomes are presented overleaf and described in detail in the Mayor's Transport Strategy supporting evidence report on Outcomes and Appraisal.

Figure E2 Ten outcomes of the Mayor's Transport Strategy.



Contents

1. Introduction

The Mayor's Transport Strategy is the statutory document that sets out the Mayor of London, Sadiq Khan's, policies and proposals to reshape transport in London over the next 25 years. It is an ambitious strategy that puts people's health and quality of life at the very heart of planning the city's transport. Along with the new London Plan and the Mayor's other strategies for economic development, the environment, housing, health inequalities and culture, it provides the blueprint for making London a city that is not only home to more people, but is a better place for all of those people to live in.

This document sets out the options analysis and strategic modelling that has been carried out to inform strategy development and assess the effectiveness of the strategy. It is complementary to a sister report[1] which sets out a broad range of evidence collected by TfL to identify the challenges and opportunities facing London's transport network over the next 25 years. This report describes the potential outcomes of the policies and proposals contained in the draft MTS and is primarily informed by a programme of modelling using TfL's suite of strategic models and supporting analytical tools.

The remainder of this report is set out as follows:

- **Chapter 2** outlines how TfL's strategic modelling suite has been used to inform the development of the Strategy.
- **Chapter 3** summarises the results of the 2041 core reference case, a business-as-usual scenario based on current conditions and assumptions.
- **Chapter 4** documents the results of a series of sensitivity tests designed to assess uncertainty in the main drivers of travel demand in London.
- **Chapter 5** details analytical work on the case for major schemes and interventions under development by TfL. These are considered against the challenges outlined in TfL's Challenges and Opportunities report.
- **Chapter 6** provides details on a series of illustrative intervention tests that were undertaken in order to explore the possible impacts of interventions at a more conceptual stage.
- **Chapter 7** details the results of a package modelling exercise, which put together sets of complementary proposals in order to assess their relative impacts compared to the core reference case.
- **Chapter 8** presents the results of the core Mayor's Transport Strategy scenario, which underpins the Strategy and, in essence, is the culmination of all of the strategic modelling work outlined in Chapters 2 to 6. This scenario is a combination of the contents of all the packages and demonstrates the action required to achieve the Mayor's vision.

[1] https://consultations.tfl.gov.uk/policy/9b28c200/user_uploads/mts-challenges-and-opportunities---summary-report-final.pdf

2. Approach to strategic modelling

Introduction

This Chapter outlines how TfL's strategic modelling suite has been used to inform the development of the draft MTS. Firstly, it provides an overview of the role of strategic modelling as part of the draft MTS evidence base. It then steps through the overall framework, covering the development of a core reference case, testing major schemes, illustrative interventions, package modelling and, finally, a preferred MTS scenario.

TfL's approach to strategic modelling - summary

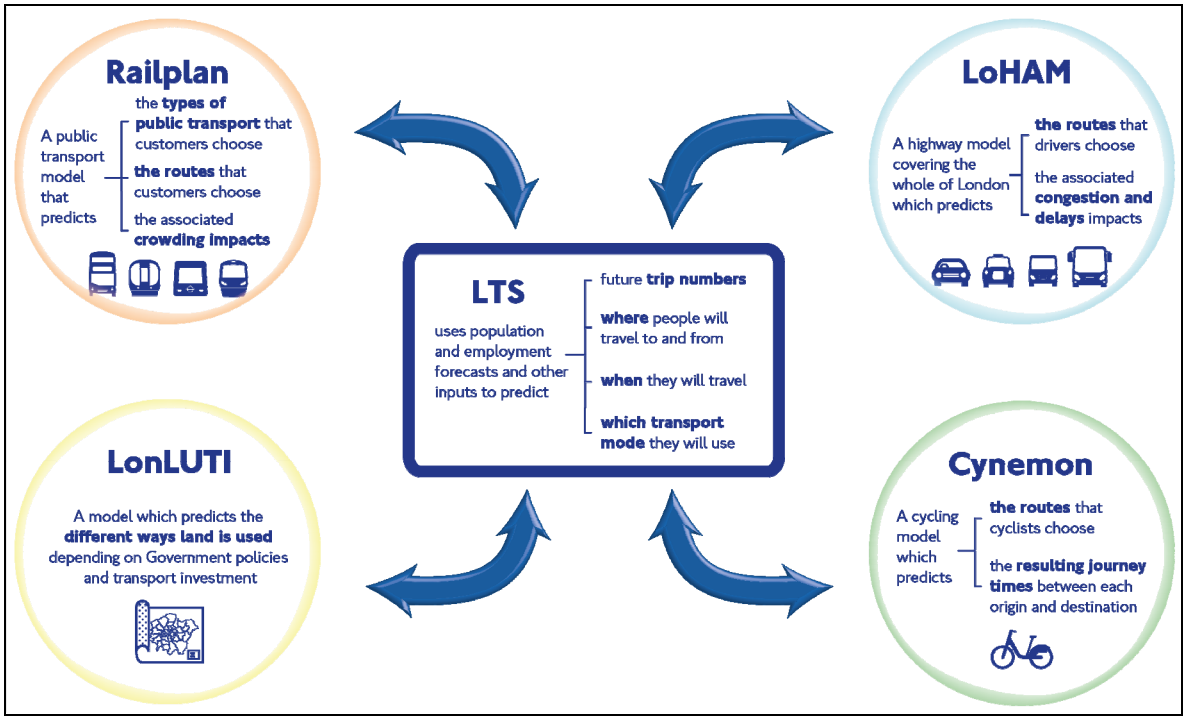
- The MTS is an evidenced based policy document that builds on TfL's empirical understanding of how Londoners travel today, and may travel in the future.
- Analysis has been undertaken to inform strategy development and assess the effectiveness of various policies and schemes (interventions). This analysis includes a programme of modelling, using TfL's suite of strategic models and supporting analytical tools.
- TfL's overall approach to forecasting future travel demand is through developing a core reference case, which includes current funded proposals for London.
- TfL have then assessed a series of alternative policies and schemes that could help to meet the challenges set out in the Challenges and Opportunities report.
- A series of 'packages' have been developed from these alternative policies and schemes and an assessment of their relative effectiveness carried out against the Mayor's Vision for travel in London.
- Finally, an assessment is made of the expected outcomes for London from implementing the draft MTS policies and proposals (the preferred MTS scenario).

Role of strategic modelling

TfL's strategic models have been used widely for forecasting the impacts of transport and land use decisions in London. This has included assessment of previous Mayor's Transport Strategies and London Plans. The models have been comprehensively enhanced and updated for this purpose.

Figure 2.1 below shows the TfL strategic models that have been used to assess the impacts of proposals contained in the draft MTS.

Figure 2.1 TfL strategic models

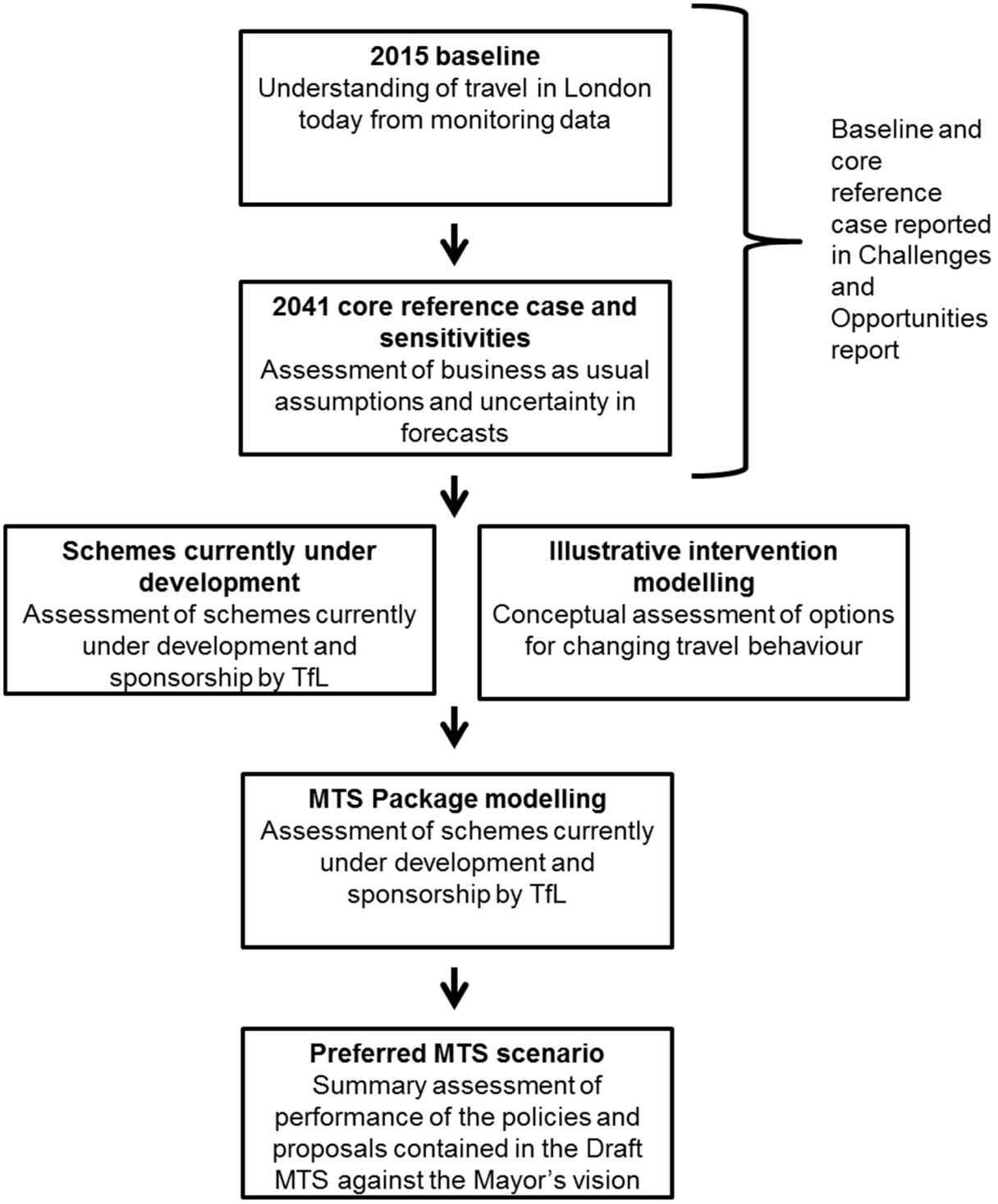


The role of the forecasting work for the draft MTS is threefold:

1. To establish the transport baseline or reference case impact of current plans, alongside other changes that are expected in travel behaviour and transport network performance in London.
2. To inform the policy making process by assessing different interventions and their impacts.
3. To support a strategic assessment of the plans and policies included within the draft MTS, and to assess the expected outcomes from these in the future.

Figure 2.2 below shows the overall flow of the modelling work, the stages of which are summarised in the following sections.

Figure 2.2 Summary of strategic modelling approach for the draft MTS



Core reference case

A **core reference case**, with scenarios up to 2041, has been produced to give a baseline for the assessment of future candidate policies and schemes for inclusion in the Strategy. This shows the change from the 'current' situation, i.e. the 2015 baseline and reflects a 'business-as-usual' assumption. The baseline for emissions is 2013 reflecting the latest version of the London Atmospheric Emissions Inventory.

The core reference case therefore includes population and employment projections from the Greater London Authority (GLA), along with funded changes to the transport network identified in the TfL Business Plan and National Rail funded plans, and wider assumptions about policies relating to aspects such as fares, fuel costs and car parking. It also includes the Mayor's intended investment in cycling which is expected to deliver a 6 per cent cycle mode share in 2041.

Sensitivity testing

In addition, a series of sensitivities and range of outcomes are presented in Chapter 4 in recognition of the uncertainties inherent in forecasting future conditions. These include testing challenges and conclusions against 'higher' and 'lower' growth profiles, and variations in the future cost of car travel.

Treatment of schemes currently under development

Several major transport schemes are under development at TfL, but are not funded in the current TfL Business Plan. The case for these schemes has been developed over time and each is designed to meet challenges or opportunities faced by London. These schemes include amongst others:

- Crossrail 2;
- London Suburban Metro;
- plans for mini-radial hubs and improved orbital rail links;
- Bakerloo Line extensions;
- Silvertown Tunnel;
- the Ultra Low Emission Zone (ULEZ); and
- upgrades to the deep Tube lines and increasing frequencies on DLR, Trams and the Elizabeth Line.

These schemes have been assessed as part of the package modelling for the draft MTS. Station upgrades and other schemes supported by partners such as the Department for Transport (DfT) and Network Rail have been included as part of the package modelling but have not been separately assessed.

Illustrative interventions

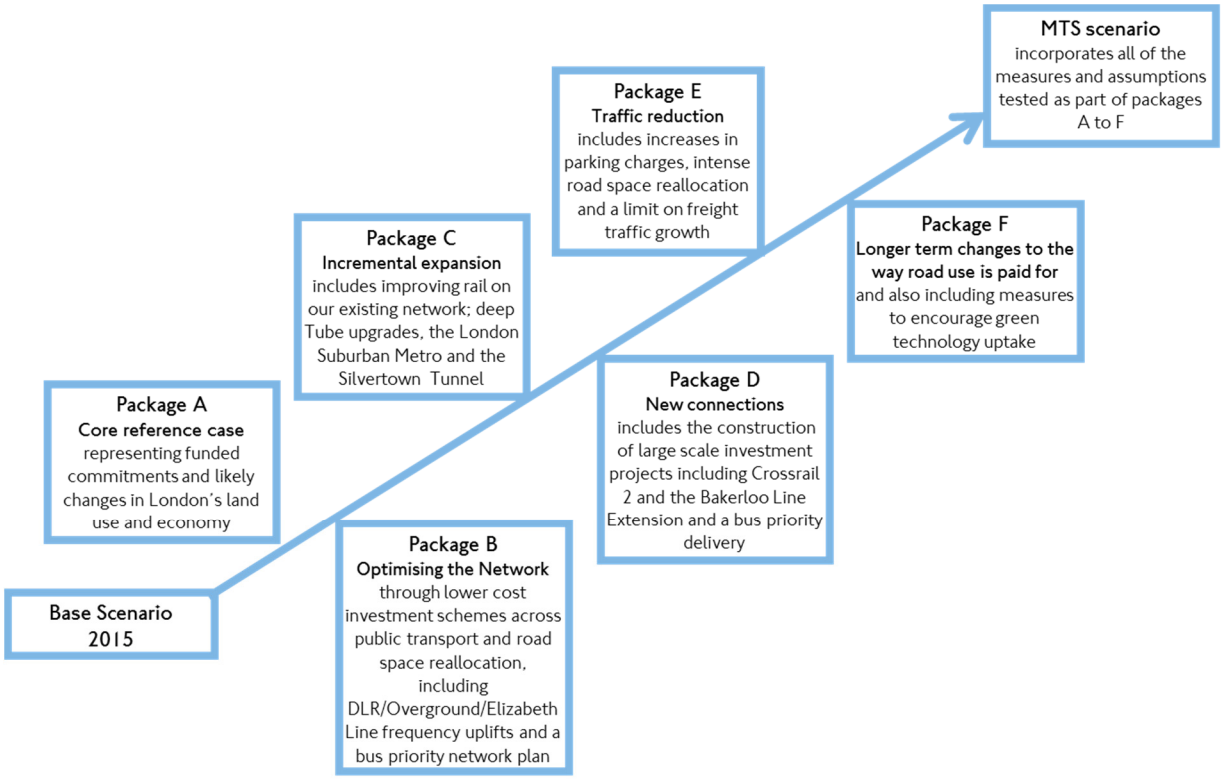
To inform the development of the draft MTS, a series of illustrative interventions have been tested as part of a conceptual assessment of options and mechanisms for changing travel behaviour. The tests involved assessing the sensitivity of travel in London to various supply and demand changes. They were used to inform

policy development and, ultimately, to help form a series of package tests, which build towards a final MTS scenario.

MTS package modelling

In order to understand the impact and effectiveness of the policies and proposals contained in the draft MTS, TfL developed a series of cumulative package tests which build on the 2041 core reference case. The packages drew on existing modelling of major rail and road schemes and on the illustrative intervention testing. The packages are designed to pull together measures of a similar type based on effect and cost, and represent measures to be implemented in the short, medium and long term. The packages get progressively more ambitious, starting with optimising the existing network, then expanding it, then adding new connections, and then introducing measures to manage demand and encourage the uptake of green technology. Figure 2.3 shows the MTS package model tests.

Figure 2.3 MTS package model tests.



Source: City Planning

Package A is the core 2041 core reference case including funded programmes.

Packages B to D assess increasing levels of investment in public transport and Healthy Streets. These include road space reallocation to sustainable modes, bus and rail schemes. These packages are designed to improve the public transport and active travel 'offer'.

Packages E and F present the potential impact of further road space reallocation, traffic reduction measures and longer term changes to the way road use is paid

for. These packages assess how traffic demand can be further reduced to free up space to improve the active travel and bus 'offer'.

The preferred MTS scenario outcomes

Eight key quantified measures have been used to assess the impact of the core reference case on travel conditions in London. These are also used to assess the relative impact of the sensitivity and package modelling carried out subsequently against the core reference case. The quantified measures are as follows:

1. Mode share for walking, cycling and public transport, by area of London.
2. Vehicle kilometres (motorised road vehicles).
3. Congestion for road traffic (traffic speed).
4. Bus speeds.
5. Public transport usage (passenger kilometres travelled).
6. Rail crowding.
7. Emissions – CO_2, NO_x, $PM_{2.5}$ and PM_{10}.
8. Connectivity provided by the transport network.

Finally, the proposals and policies included in the draft MTS have been tested to assess how they perform against the eight key quantified measures above, and, ultimately, against the Mayor's vision for London through to 2041.

3. The 2041 core reference case

Introduction

This chapter describes the core reference case, which sets out expected conditions for travel in London in 2041, given funded schemes and consideration of the most likely set of other conditions affecting travel demand.

It first describes the key assumptions behind the core reference case. It then summarises the outcomes of this scenario against the eight key quantified measures described in Chapter 2 of this report.

2041 core reference case - summary

- London's population is expected to grow from 8.6 million people in 2015 to 10.5 million in 2041. Employment is expected to grow from 5.5 million jobs in 2015 to 6.7 million in 2041.
- TfL has developed a core reference case for 2041 which incorporates this growth in population and employment, together with assumptions around likely economic changes, and the funded schemes in the TfL Business Plan and on National Rail. This reflects a 'business-as-usual' scenario based on current conditions and assumptions.
- Under such assumptions, there would be at least an extra 5 million more trips every day in London, and the sustainable mode share would be expected to increase from 64 to 70 per cent by 2041.
- Despite the falling car mode share, without further action traffic will rise. There are also expected to be significant decreases in average vehicle speeds across the road network.
- The core reference case projects a greater than 70 per cent increase in demand for rail modes, with a smaller increase in bus usage. Demand is projected to increase faster than supply on the rail networks from 2021, so that by 2041 there would be severe crowding on the rail network.
- While NO_X emissions would significantly reduce as a result of the implementation of the Ultra Low Emission Zone and the role out of newer vehicles, London would not comply with legal limits for NO_2 until 2025 and will exceed World Health Organisation recommended maximum levels of $PM_{2.5}$ until after 2030.
- Carbon Dioxide (CO_2) emissions from road transport are forecast to reduce by around 50 per cent in 2050 compared to 2013; this would not be sufficient to achieve the Mayor's ambition for a zero carbon London by 2050.

Description of the 2041 core reference case

The core reference case includes funded public transport and highway schemes and likely changes in London's land use and economy. It assumes the latest available projections of population and employment from the GLA as well as Government assumptions on changes in the wider economy, and current funded

schemes. A scheme list is provided in Appendix 1 and a summary of key schemes is provided below:

- Current view of funded National Rail[2] schemes, HLOS programme, Thameslink programme, HS2, West Anglia and Great Western improvements.
- The opening of the Elizabeth Line in 2019, the Northern Line Extension and Tube upgrades to the Victoria, Jubilee, Northern and Sub Surface Lines.
- DLR, Trams, London Overground and bus service improvements.
- TfL's Road Modernisation Plan, cycling infrastructure schemes and the introduction by 2020 of the Central London Ultra Low Emission Zone (ULEZ).

Wider assumptions have been made about policies relating to aspects such as fares, fuel costs and car parking.

Key forecasting assumptions

Table 3.1 lists key demographic and economic assumptions and Table 3.2 provides greater detail on the population and employment forecasts that are included in the 2041 reference case. Population and employment forecasts are provided for the Central Activities Zone (CAZ) which is London's vibrant centre, the remainder of inner London, and outer London.

Table 3.1 Key demographic and employment assumptions for the core reference case to 2041.

Assumption	Comments	Source
London Population	London's population is projected to grow by approximately 2 million to 10.5 million in 2041	GLA
London Employment	London's employment is projected to grow by approximately 1.2 million to 6.7 million in 2041	GLA
Parking supply and charges	Work place parking supply is expected to decrease from 2015 to 2041 and parking charges are expected to increase significantly reflecting recent trends and expected continued pressure on parking	TfL
Car ownership	Car ownership is expected to decrease in line with increasing population densities to an average of 0.29 cars per person in 2041	TfL
Economic assumptions	Highway and public transport economic assumptions are taken from WebTAG[3] December 2015 guidance	DfT
Public Transport fares	The Mayor's Fares Freeze applies to TfL fares, with other fares assumed to increase with inflation until 2020. An inflation-linked increase is assumed from 2021.	TfL

[2] 'National Rail' refers to rail services franchised by the DfT and not in current TfL control. It includes Crossrail 2 in statistics where the scheme is in place.

[3] https://www.gov.uk/guidance/transport-analysis-guidance-webtag

Table 3.2 Population and employment distribution and forecast growth.

	Population				Employment			
	2015 (m)	2041 (m)	2015 (%)	2041 (%)	2015 (m)	2041 (m)	2015 (%)	2041 (%)
CAZ	0.2	0.3	3	3	1.9	2.3	35	34
Inner (excl. CAZ)	3.2	3.9	37	38	1.5	1.9	26	28
Outer	5.2	6.2	60	59	2.2	2.5	39	37
Total	8.6	10.5	100	100	5.5	6.7	100	100

Source: Greater London Authority.

Performance of the 2041 reference case

This section briefly sets out the performance of the 2041 reference case in terms of the eight key quantified measures summarised in Chapter 2.

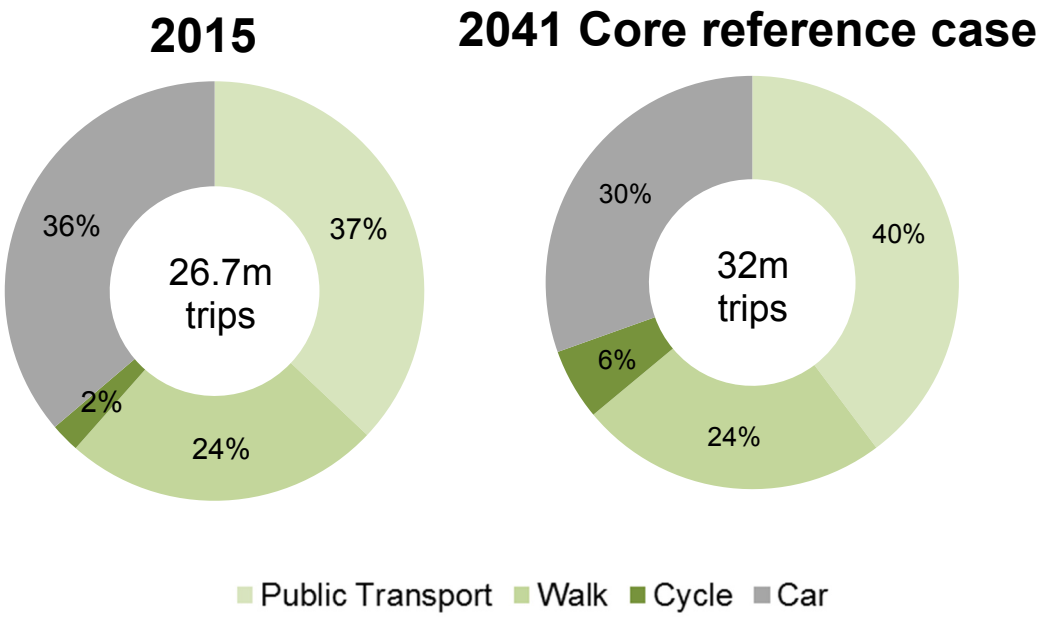
Travel demand and mode share

Population and employment are key drivers of travel. Travel demand is therefore expected to increase in proportion to the growth in population and employment shown in Table 3.1.

Demand for travel in London is forecast to increase by 5 million trips per day, from around 27 million trips per day in the 2015 baseline to around 32 million trips per day in 2041. This represents a 20 per cent increase in trips from 2015 to 2041.

Alongside this growth in overall travel demand, mode share is also expected to change, with the majority of additional trips forecast to be by public transport or active travel, with only a small increase in car trips – reflecting the mix of funded interventions to 2041. As a result of this, the car mode share is projected to fall from 36 per cent in 2015 to 30 per cent in 2041. This is summarised in Figure 3.3.

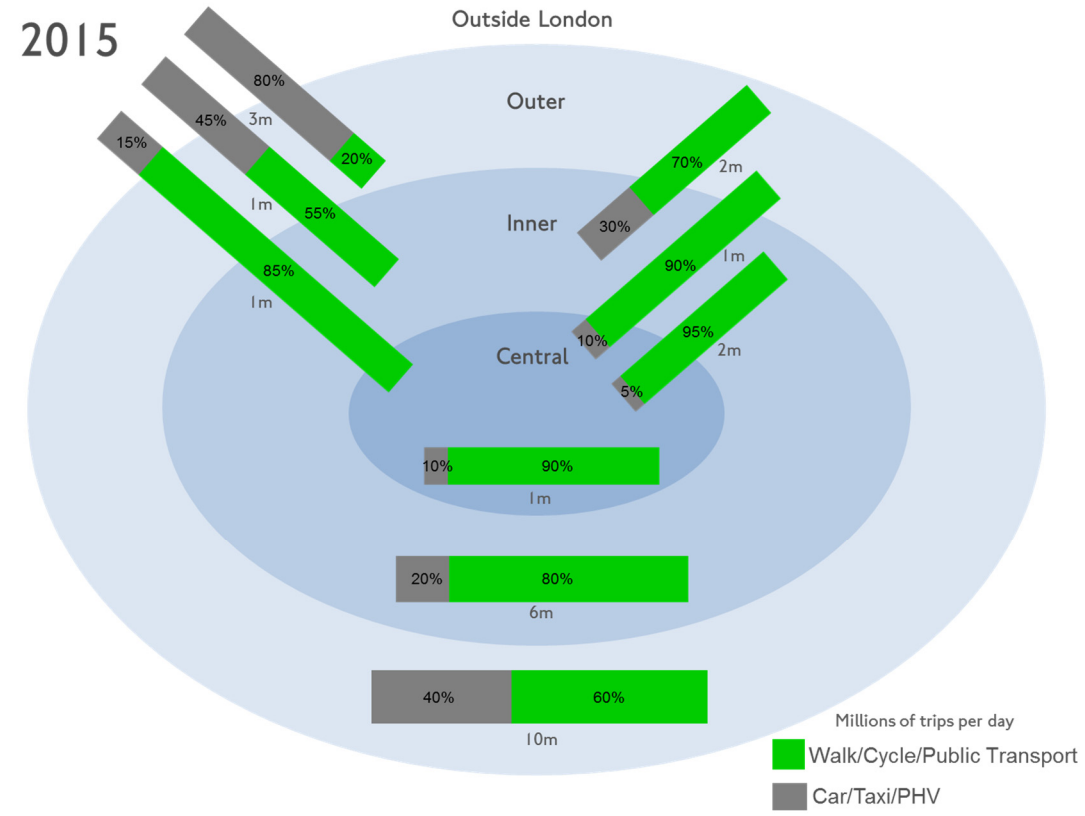
Figure 3.3 Mode share, 2015 and 2041 core reference case.

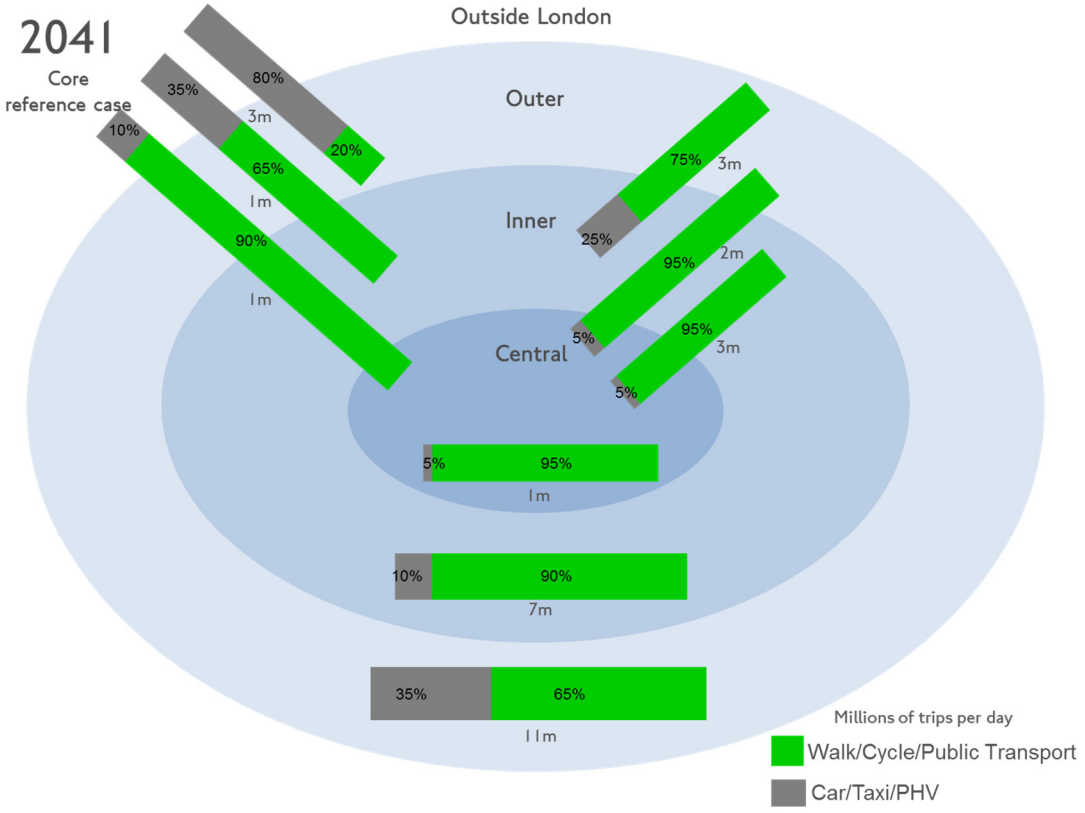


Source: City Planning

The distribution of travel demand spatially across London is likely to continue to change. Figure 3.4 shows the mode share and number of trips made between Central, inner and outer London and the rest of the country, for both 2015 and the 2041 core reference cases. The share of travel by private car is forecast to reduce for all of these types of movement.

Figure 3.4 Daily trip volumes and distribution by mode, 2015 and 2041 core reference





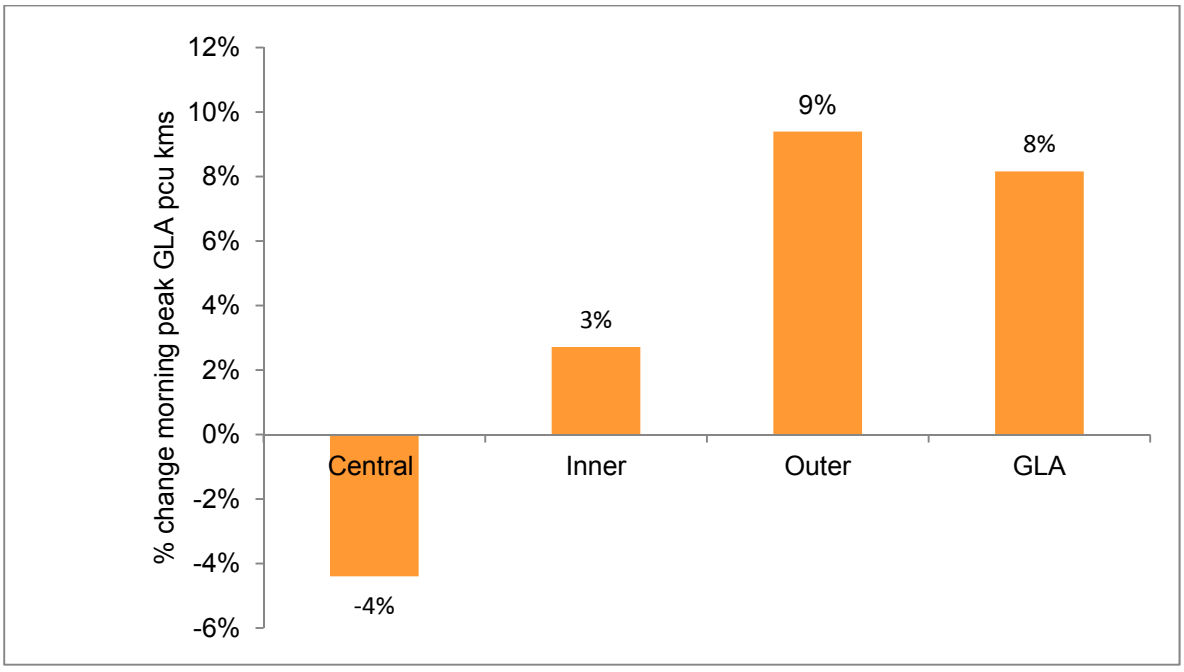
Source: City Planning

Traffic volumes and road congestion

Overall road traffic volumes are expected to grow modestly, at a rate slower than population growth. Figure 3.5 shows that traffic volumes are expected to fall in Central London as a result of reduced highway capacity and increased sustainable transport use, with growth concentrated in outer London where there are fewer public transport options and car ownership and use is less constrained. Growth here is primarily driven by a rising population and growth in van traffic, which will form an increasing proportion of total motorised vehicle traffic.

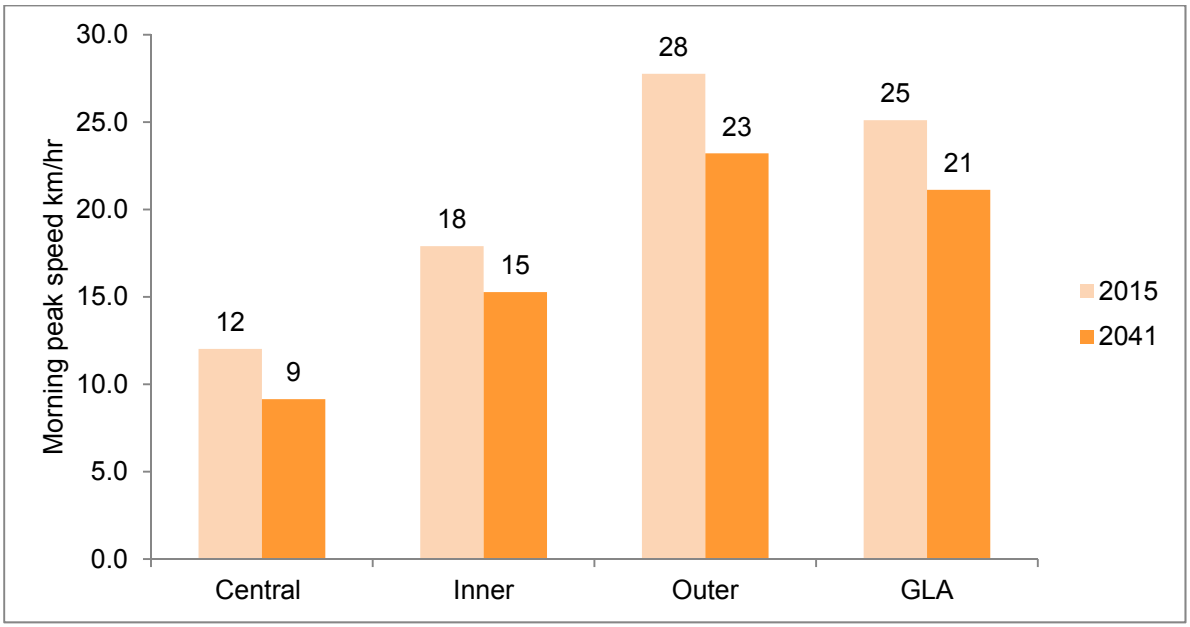
Highway capacity for general traffic is lower in the core reference case as a result of the growth in cycling and a range of other changes, including pedestrian priority and public realm schemes, which remove capacity for general road traffic. This, combined with increases in population and employment, means that congestion is expected to increase. Overall vehicle speeds are expected to decrease by up to 25 per cent in Central London from 2015 levels (Figure 3.6), with average vehicle speeds decreasing across London.

Figure 3.5 Percentage change in morning peak vehicle kilometres, 2015 to 2041 core reference case.



Source: City Planning

Figure 3.6 Morning peak vehicle speeds by area (kilometres/hour), 2015 and 2041 core reference case

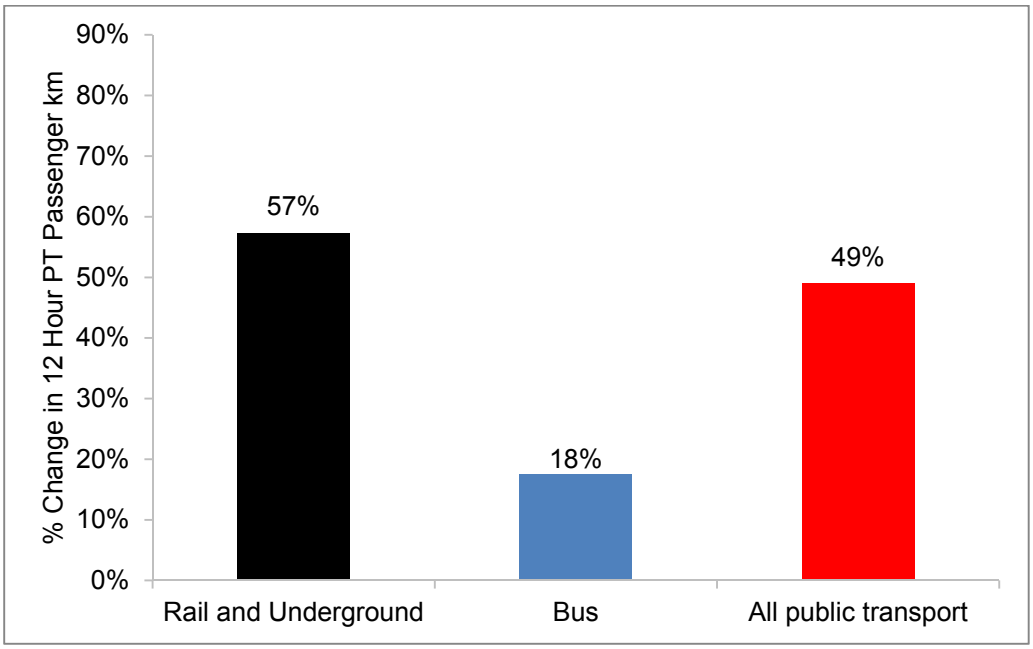


Source: City Planning

Public transport usage

Strong growth in demand for public transport, particularly for rail based modes, is expected between 2015 and 2041. Forecasts show a 54 per cent increase in rail and Underground[4] boardings and a 57 per cent increase in rail and Underground passenger kilometres in London between 2015 and 2041, resulting from London's growth and supported by extra capacity on the networks such as the opening of the Elizabeth Line. Figure 3.7 shows the projected change in public transport passenger kilometres between 2015 and the 2041 reference case.

Figure 3.7 Percentage change in 12 hour passenger kilometres by sub mode, 2015 to 2041 core reference case.



Source: City Planning

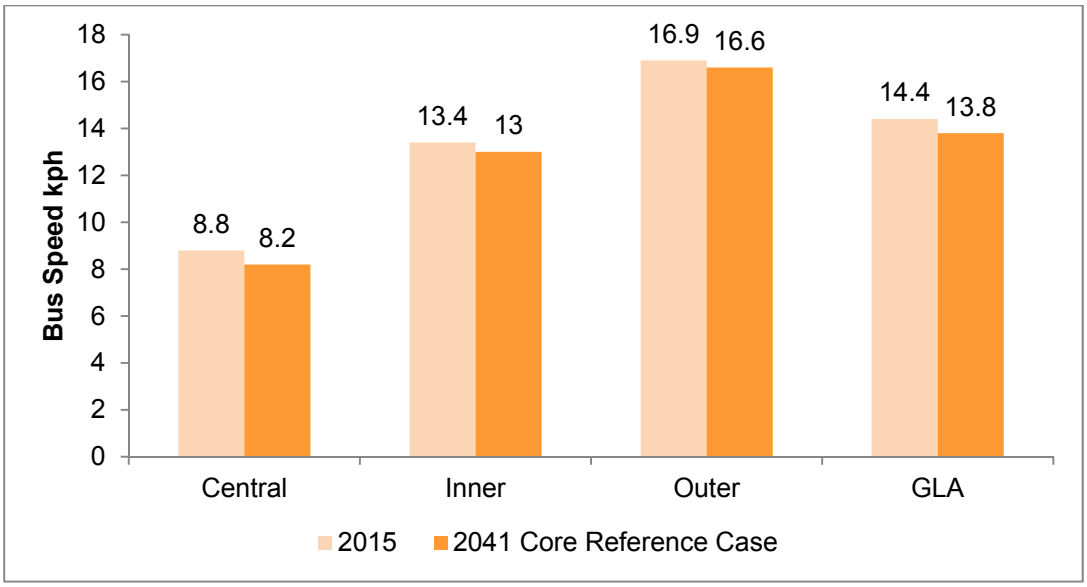
Under current plans, bus patronage growth is forecast to be lower than rail growth, reflecting the expected impact of new rail capacity in Central London on bus demand. The TfL Business Plan proposes a reallocation of bus services from Central to inner and outer London.

Bus speeds

The change in bus speeds from 2015 for the reference case is shown in Figure 3.8. As road traffic slows, there is a detrimental impact on bus speeds. Unmitigated, planned changes to the road network in Central London would reduce general traffic and bus speeds. London wide bus speeds are projected to reduce, from an average of 14.4 kilometres per hour in 2015 to 13.8 kilometres per hour by 2041 in the reference case.

[4] 'Rail and Underground' or 'Tube and rail' refers to all rail services in London including Tube, Elizabeth Line, DLR, London Overground, Trams and National Rail.

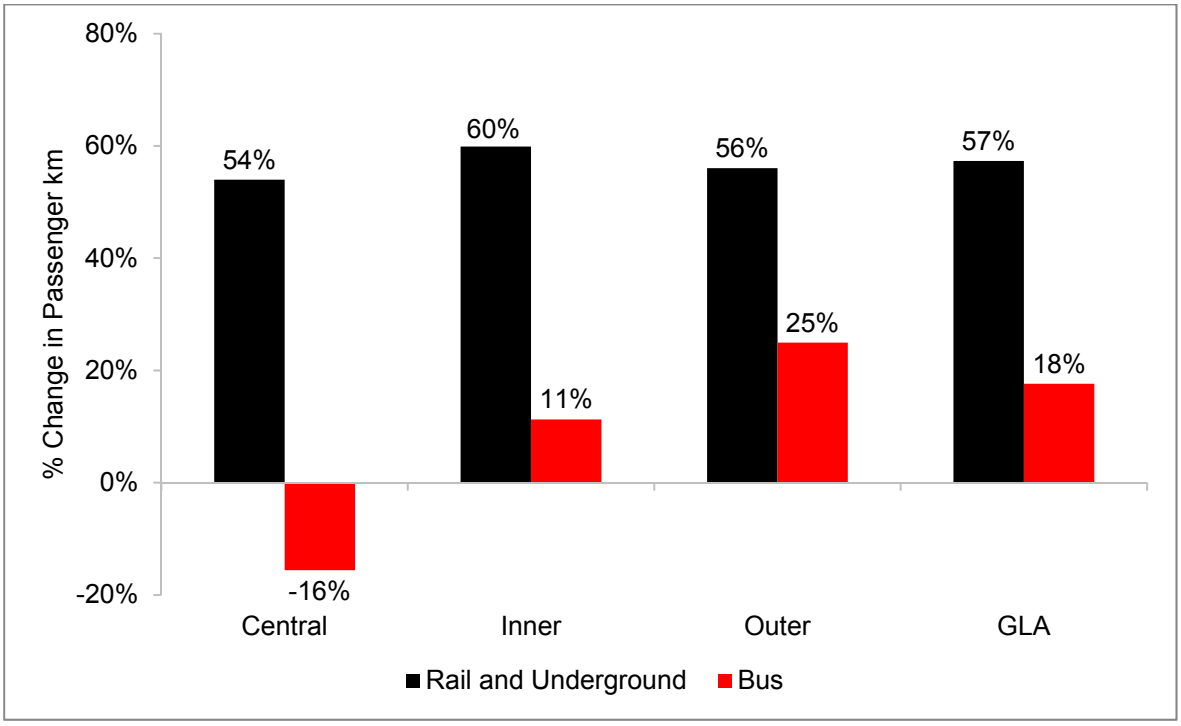
Figure 3.8 12-hour GLA wide average bus speeds by area (kilometres per hour), 2015 and 2041 core reference case.



Source: City Planning

These supply issues are likely to result in reduced bus passenger kilometres in Central London and modest growth in inner London, as shown in Figure 3.9. Bus usage is expected to broadly keep pace with population growth in outer London.

Figure 3.9 Percentage change in 12 hour passenger kilometres by area, 2015 to 2041 core reference case.

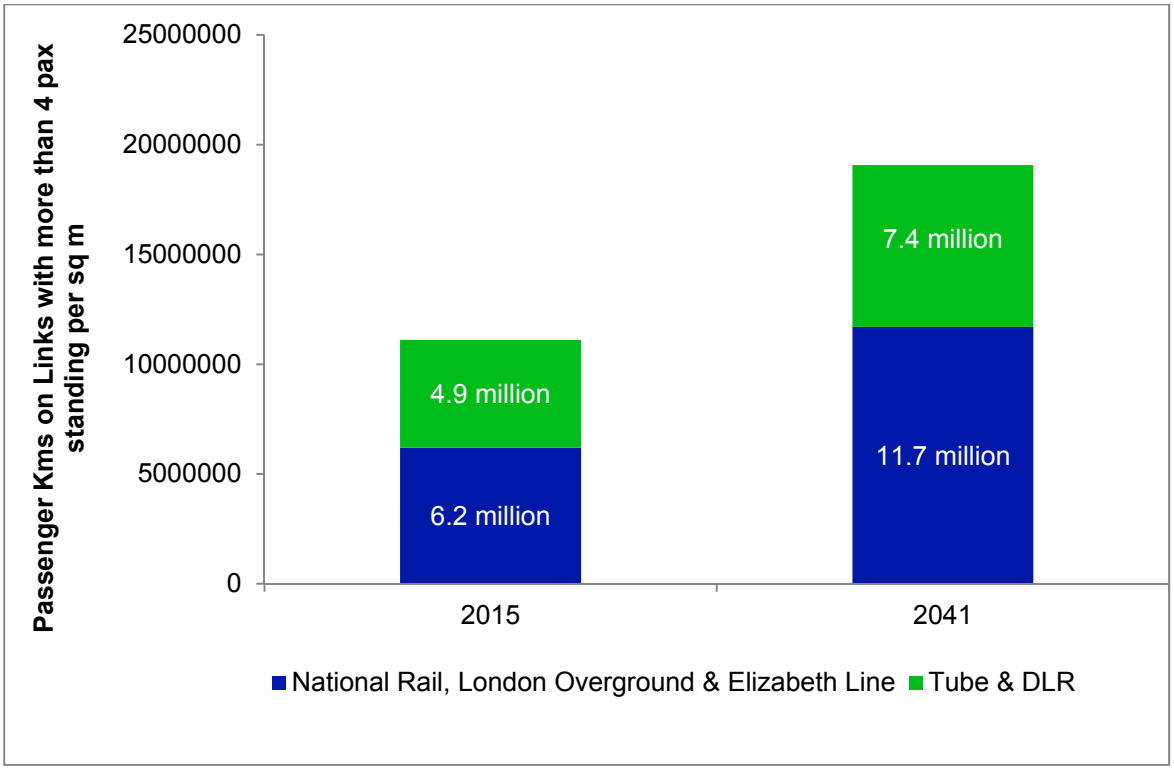


Source: City Planning

Public transport crowding

Demand for rail services will continue to rise after completion of the currently funded investment programme. Demand for public transport is projected to increase faster than supply from 2021. Therefore crowding will worsen without further investment. Figure 3.10 shows that, from 2015 to 2041, passenger kilometres travelled in severely crowded conditions (defined as links with more than 4 passengers standing per square metre) are expected to increase - by 50 per cent on the Tube and DLR, and 90 per cent on National Rail.

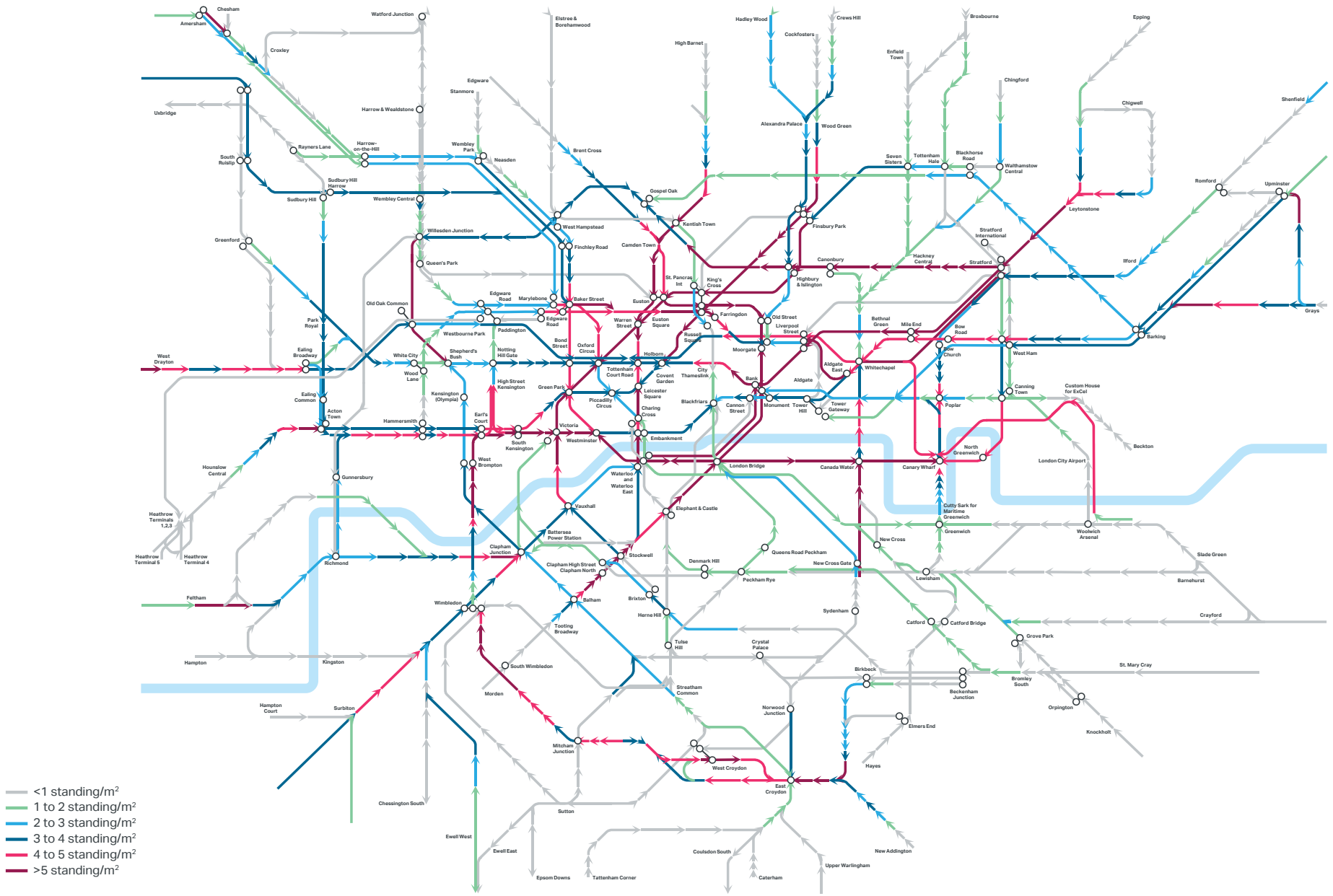
Figure 3.10 Morning peak passenger kilometres exceeding a standing passenger density of four people per square metre on rail services in London, 2015 to 2041 core reference case.



Source: City Planning

Figure 3.11 shows expected crowding levels in 2041 with funded investment and highlights that much of the Tube and rail network would experience crowding such that it would be effectively full throughout the entire morning peak.

Figure 3.11 Morning peak crowding on rail and underground services in London, 2041 core reference case



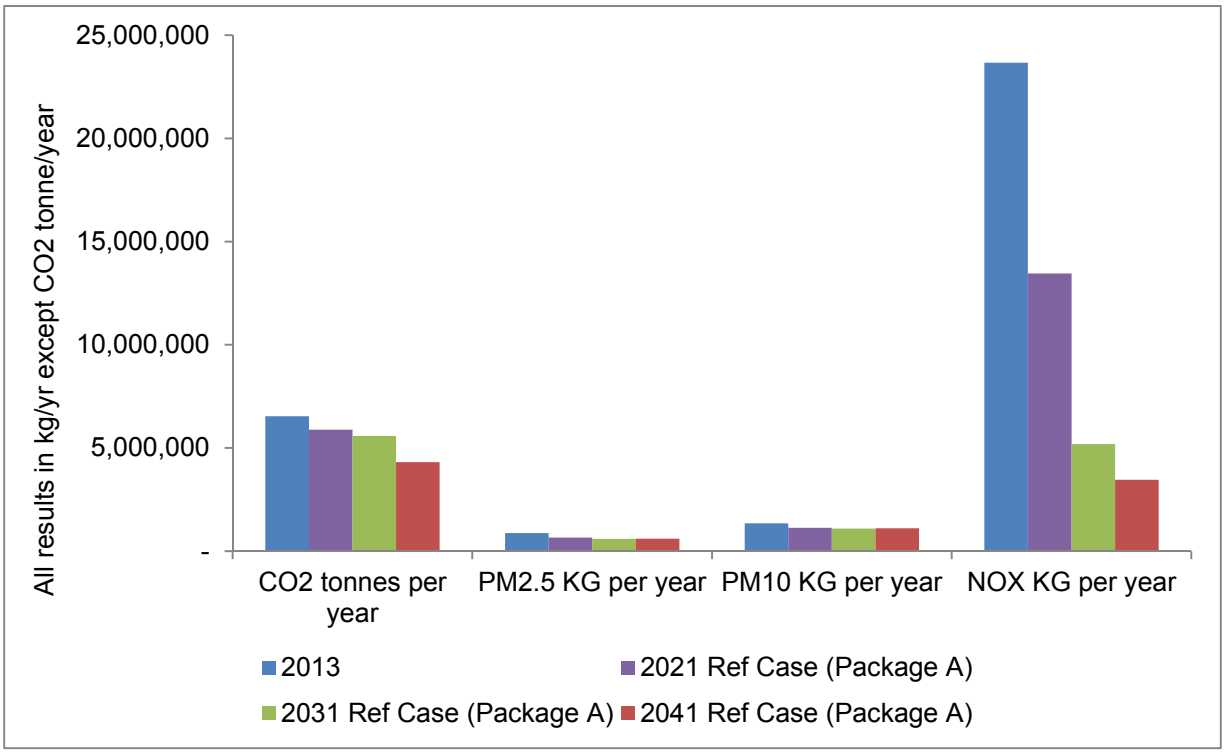
Emissions and air quality

With the planned Ultra Low Emission Zone in place in 2020 in Central London, together with improvements to vehicular technology, levels of the four key emissions (CO_2, $PM_{2.5}$, PM_{10} and NO_x) are expected to fall. In particular, there is projected to be a reduction of over 85 per cent in NO_x emissions across London by 2041 in the core reference case.

Figure 3.12 shows the modelled change in emissions of NO_x, particulate matter (PM_{10} and $PM_{2.5}$) and CO_2 from road vehicles between 2013 and 2041, according to the reference case. Emissions of NO_x reduce in the short term as Euro 6 / VI vehicles are adopted. Further reductions in emissions occur as taxis convert to zero emission capable (ZEC) vehicles and electric and hydrogen buses are deployed. The majority of transport PM_{10} and $PM_{2.5}$ emissions are caused by vehicle tyre and brake wear. As such, following an initial reduction in exhaust PM emissions through adoption of Euro 6 / VI vehicles, emissions are projected to increase in line with additional vehicle kilometres to 2041.

Carbon dioxide (CO_2) emissions reduce steadily due to the transition to ZEC taxis, electric and hydrogen buses and some uptake of ultra-low emission cars and light vans in private vehicle fleets. Some improvements in HGV efficiency reduce emissions further. Carbon dioxide arising from the generation of electricity to charge of electric vehicles represents a larger component of emissions as uptake of electric vehicles increases; it is assumed that the carbon intensity of the National Grid reduces in line with government forecasts.

Figure 3.12 London wide emissions from road traffic, 2013 to 2041 core reference case



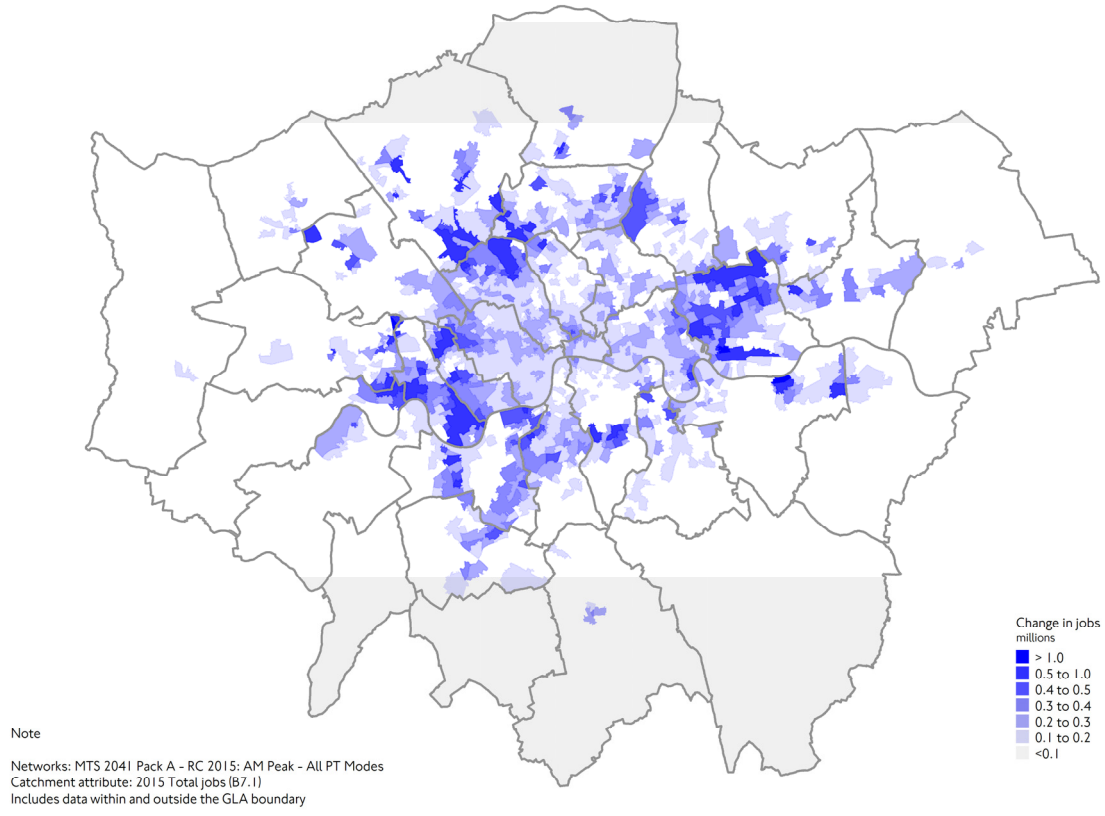
Source: City Planning

Connectivity

Public transport connectivity can be measured in terms of the number of jobs that can be reached from each area of London within 45 minutes public transport travel time. This is an important aspect of the connectivity of residential locations. Similar analysis can be carried out to assess the labour market catchment of employment locations.

Figure 3.13 shows the change in access to jobs within 45 minutes brought about by improvements to public transport services in the core reference case. The assessment only considers travel time changes rather than the impact of new jobs. It shows the impacts of the Elizabeth Line, the funded Tube upgrades and other National Rail schemes. Some areas, such as Abbey Wood and Newham, currently less well connected to the jobs market, gain access to up to one million extra jobs. By contrast Central London shows less significant change because this area is already served by a well-connected public transport network. The change would be greater if the additional impacts of employment growth were taken into account.

Figure 3.13 Change in public transport connectivity, 2015 to 2041 core reference case.



Source: City Planning

4. Sensitivity testing

Introduction

This chapter describes a series of sensitivity tests undertaken in relation to the core reference case, designed to assess uncertainty in the forecasting of future travel patterns and network conditions. These sensitivities are informed by previous work, including TfL's report: '*Drivers of Demand for Travel in London: A review of trends in travel demand and their causes'*[5], which identified important factors that have contributed to change in travel demand over the past decades.

It first describes the sources of uncertainty in travel demand in the context of growth, behaviour and technological change. It then describes TfL's approach to sensitivity testing and concludes with high level results of these tests in terms of the impact on trips, traffic volumes and public transport demand.

Sensitivity testing - summary

- TfL has developed an approach which recognises the intrinsic uncertainty in forecasting future travel demand and which seeks to understand how changes to the assumptions that form the basis of the reference case could change the nature or extent of the challenges facing the transport network.
- Uncertainty increases as the planning horizon moves further into the future, and as it becomes harder to predict how technology, the environment, lifestyle and travel preferences may change.
- A set of five modelled sensitivity tests have been assessed to reflect the range of likely changes to population, the economy and employment, and to the cost of car and public transport use. They provide a useful range of plausible outcomes against which to assess proposals and schemes.
- The results show that the broad conclusions of the core reference case, including rapid growth in public transport use, walking and cycling and a modest decline in car use but rising traffic and congestion are a robust basis on which to plan.
- More radical changes are of course possible, and could change the case for individual schemes and policies. These have been assessed on a qualitative basis.

Uncertainty in forecasting

All forecasting must accept that the future is inherently uncertain and that this uncertainty increases as we look further into the future. Robust assessment involves understanding how different trends or circumstances could alter the challenges facing London and the policies and schemes designed to tackle these challenges. There are several sources of uncertainty in future travel demand, including uncertainty in growth forecasts, changes in travel behaviour/preferences and other external and technological changes.

[5] http://content.tfl.gov.uk/drivers-of-demand-for-travel-in-london.pdf

Uncertainty in growth forecasts

Economic growth, the relative success of London and its place in the world, and the location of population and employment all have a direct impact on travel demand. The number of people and jobs in London is a major factor driving total travel demand. The current projections assume continued strong growth, reflecting a continuation of London's success, but a review of historic trends suggests that this is properly subject to some uncertainty.

Spatial distribution of population and employment

The geographical location of population and employment is important for mode share, as people who live and work in inner London make far fewer car trips than those in outer London. The trends in population movement have varied significantly over past decades. Demographics (population structure) are also important. Projections assume a rise in the number of older adults living in London, as well as changes to birth rates over time, both which would have a significant impact on patterns of travel demand.

Uncertainty in travel behaviour and preferences

There is substantial evidence in London that patterns of travel demand have evolved significantly over recent decades. Some of the changes observed have suggested a movement away from what might be regarded as conventional transport planning assumptions, primarily those which assume that rising incomes lead fairly directly to more car use. This is evidenced by the substantial net shift in mode share, away from car and towards public transport, walking and cycling, observed in London since 2000, despite population and economic growth.

If people travelled today as they did in 1991 there would be almost 2 million more car trips a day in London and over 2 million fewer public transport trips. However, most of this change is attributable to changing land use, population change and the costs of travel and not fundamentally different travel preferences.

There have, however, also been trends in some 'lifestyle choices' such as the growth of cycling to work, which may reflect a more fundamental change in travel preferences. There is considerable uncertainty about long term trends in these elements.

Uncertainty in technology changes and adoption

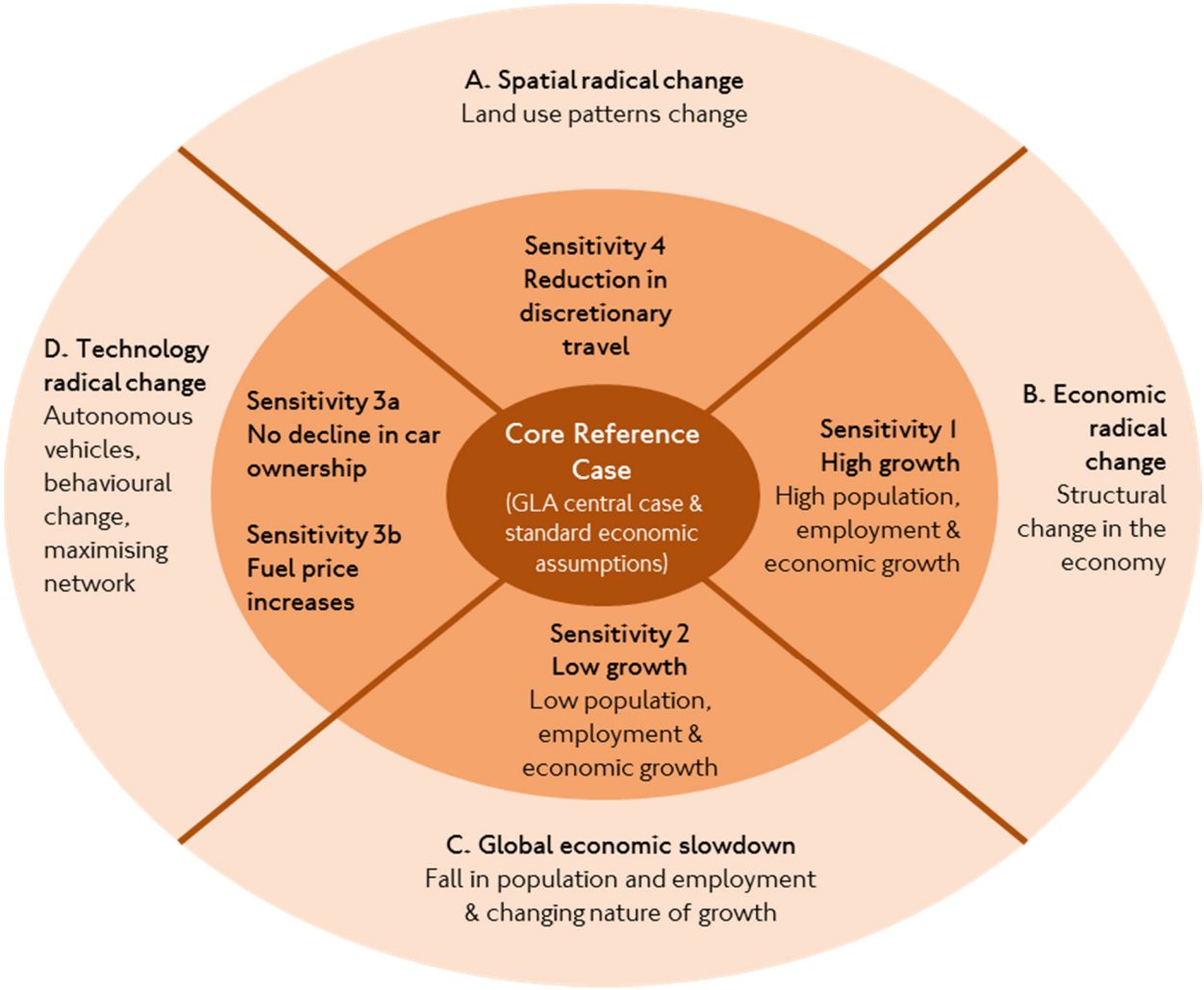
Technology development, reflecting for example the expected development of autonomous vehicles, has the potential to radically change travel demand patterns. Most mainstream travel forecasts used for appraisal do not plan for a significant change in travel behaviour as a result of technology change, in part reflecting great uncertainty about how technologies could develop and whether and how they would impact on travel demand or behaviour. However, the potential for significant change does exist and it is important to have regard to these in designing travel forecasts for the long term.

TfL's approach to assessing sensitivities

TfL has developed an approach which recognises the inherent uncertainty in forecasting. Robust assessment involves understanding how changes in the assumptions that form future reference cases could influence schemes and policies as well as the core challenge. TfL's approach is to vary the input assumptions in modelling, rather than changing the modelled relationships themselves.

Emerging trends in which there is greater confidence, such as the growth in cycling, are reflected in the core reference case. Other aspects of uncertainty have been tested though sensitivity tests, which are summarised in the 'Wheel of Uncertainty' shown in Figure 4.1.

Figure 4.1 Wheel of uncertainty



Source: City Planning

The inner ring of this diagram comprises a set of five modelled sensitivities. These modelled scenarios vary input assumptions to reflect a range of likely population and employment levels, and to assumptions around the cost of car and public transport use. They therefore provide a useful range of likely outcomes from which to assess schemes. Where strategic modelling is required to take forward a specific scheme or proposal, an assessment will be undertaken against the most relevant of the sensitivities.

The outer ring is a set of four more radical and less predictable sensitivities. It is not expected that these will be necessarily modelled, but reference to their potential impact should be included within the strategic case for a scheme.

These sensitivities give an understanding of the varying transport challenge and identify if proposals have a better or worse case under alternative assumptions. For example:

- Does the case for a scheme depend only on the highest projection of population and employment growth or is it required in all likely futures?
- What effect might sustained low fuel prices have on mode share and will this mean that a traffic reduction proposal will not achieve the desired reduction in congestion?

Identifying challenges and assessing a scheme in a variety of future scenarios addresses the inherent uncertainty in forecasting and provides a more robust basis for assessment.

Five sensitivities have been assessed for this report:

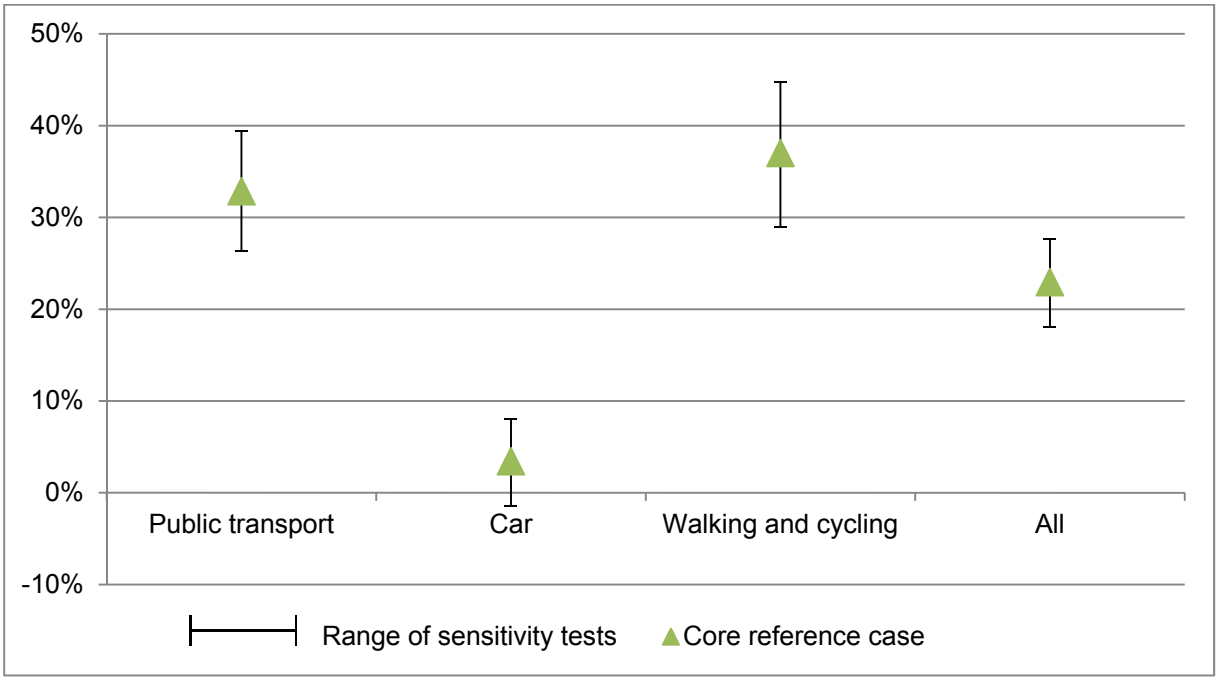
1. Higher short term output growth leading to increased population and employment in London and resultant changes in car ownership.
2. Lower short term output growth leading to reduced population and employment in London and resultant changes in car ownership.
3. a) Car ownership rates remain unchanged from 2011 census levels rather than continuing decline linked to density increases.
3. b) A 20 per cent increase in fuel costs relative to Government assumptions.
4. A 10 per cent reduction in discretionary trip rates from 2011 rates linked to increased digital shopping and leisure activities.

Sensitivity test results

The impacts of the sensitivity tests are reported by adding ranges (shown by the vertical lines) to the point forecasts from the 2041 core reference case (shown with green triangles).

Figure 4.2 shows that under all sensitivity reference case scenarios, London would expect to see mode shift away from car to walking, cycling and public transport. Car trips are expected to grow by between -1 per cent and 8 per cent, indicating that car trips per person in London will continue to fall in future.

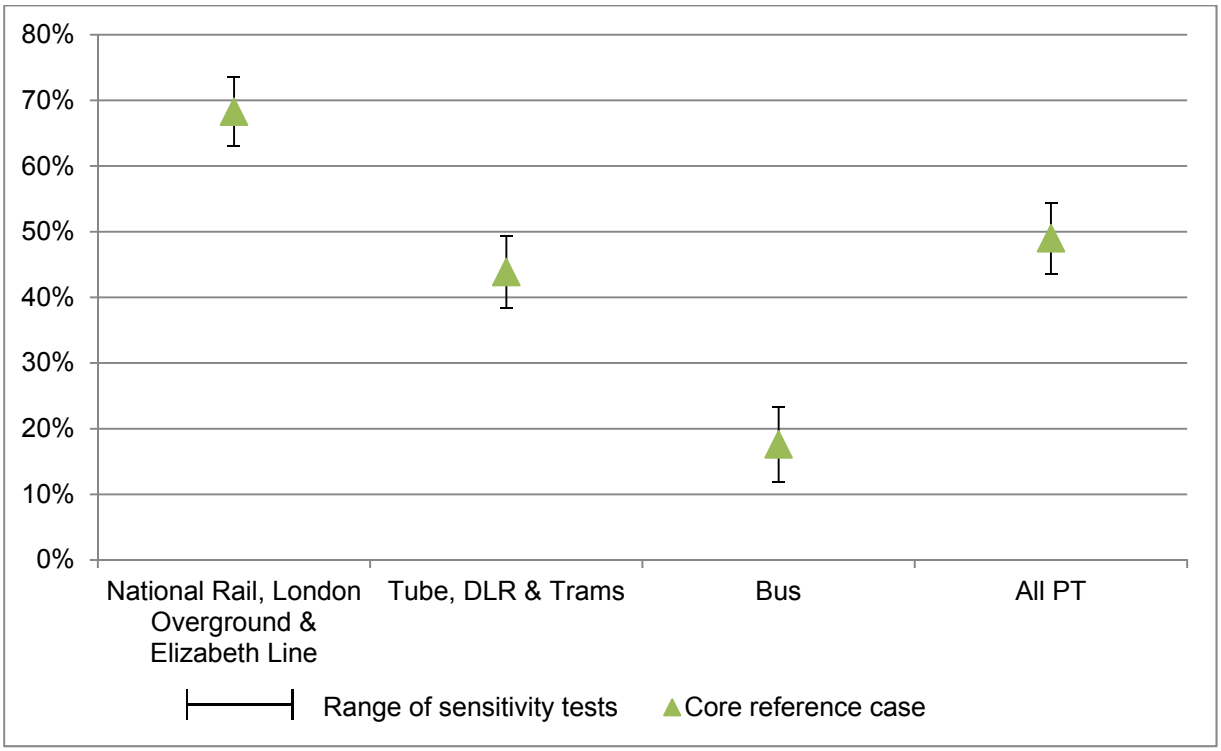
Figure 4.2 Range of percentage growth in trips by mode, 2015 to 2041.



Source: City Planning

Figure 4.3 indicates that with funded investment, all sensitivities support significant growth in rail and underground use and growth in bus use. Under these moderate assumptions growth could vary by 10 percentage points by sub mode.

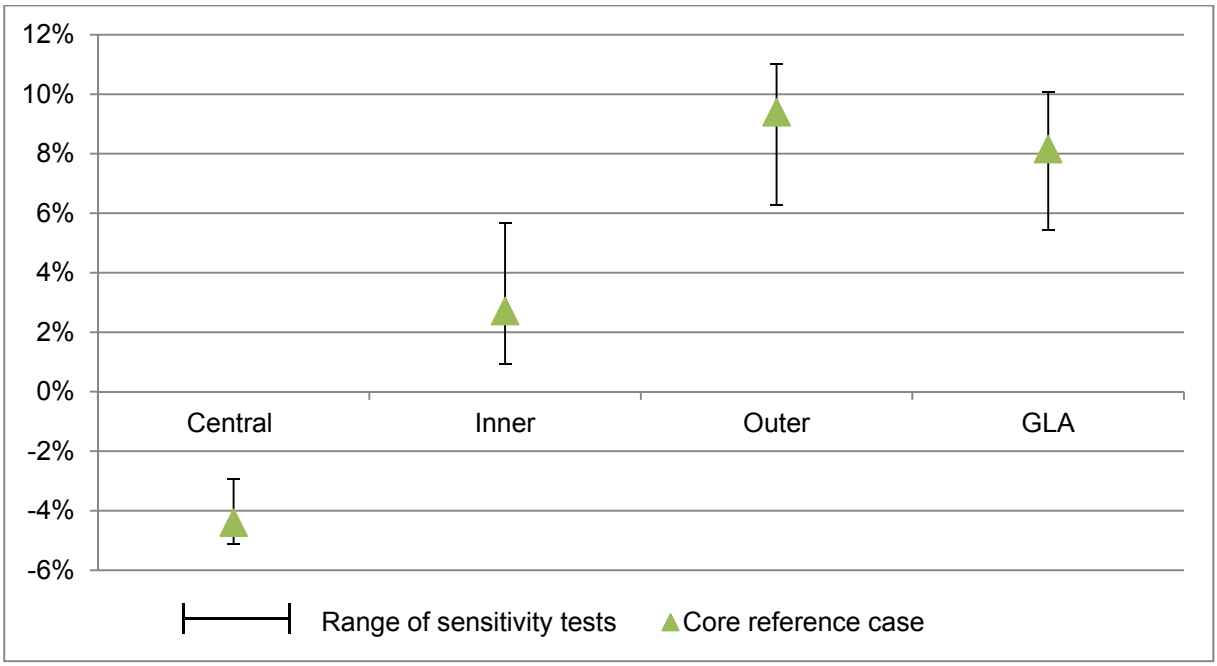
Figure 4.3 Range of percentage growth in passenger kilometres by mode, 2015 to 2041.



Source: City Planning

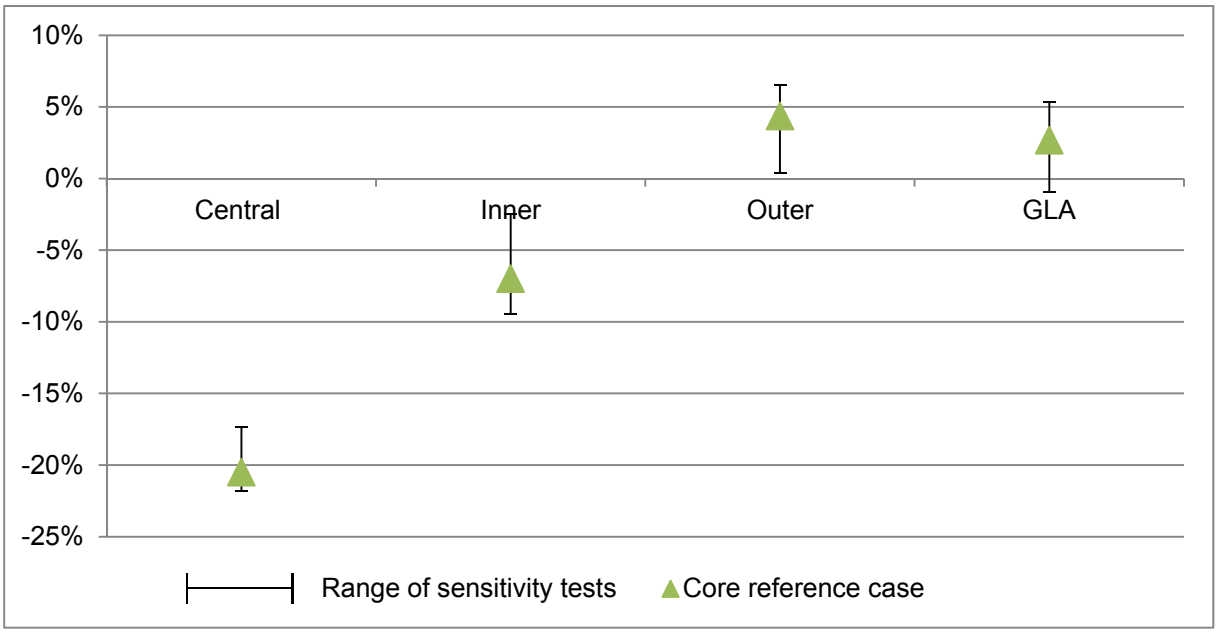
Figure 4.4 and figure 4.5 show ranges in vehicle and car kilometres by functional area of London. In all scenarios, car and vehicle traffic is expected to decline in Central London. Growth in inner and outer London is more dependent on assumptions about car ownership, fuel prices and changes in discretionary travel. Overall car traffic is expected to grow but by less than around 5 per cent with all vehicle traffic growing by between 6 and 10 per cent.

Figure 4.4 Range of percentage growth in vehicle kilometres by mode and area, 2015 to 2041.



Source: City Planning

Figure 4.5 Range of percentage growth in car kilometres by mode and area, 2015 to 2041.



Source: City Planning

The above results show that the broad conclusions of the core reference case, including rapid growth in public transport use, walking and cycling, flat or declining car use but rising traffic and congestion are robust under a wide range of plausible sensitivities and are therefore a sound basis on which to plan for the future.

More radical changes

More radical changes are possible, including radical changes to London's economy, or changes to the automation of vehicles and new models of car ownership and use. The impacts of these changes are too uncertain to be assessed through the use of models at this point, but it will be important to continue to monitor the evolution of such changes and take them into account as necessary.

One such example could be the wide scale adoption of individual autonomous vehicles. These could have a significant impact on highway capacity in London. If cars could run closer together and enhance capacity, with the same volume of traffic then congestion could reduce. Conversely, empty vehicles returning home or circling after dropping off a passenger could have the opposite effect and create further congestion across London. Similarly, if automation had the effect of making it cheaper or easier to travel by car, then car use would be likely to rise. Different trajectories in the development of connected autonomous vehicles could lead to very different outcomes for London.

The draft MTS discusses the uncertainty surrounding connected and autonomous vehicles and the measures that may be needed to ensure the technology evolves in the best interests of London.

5. Schemes under development

Introduction

This chapter details the analytical work undertaken to explore the case for major schemes and interventions under development by TfL, but are not funded in the current TfL Business Plan, for potential inclusion in the draft MTS. For each major scheme it summarises the rationale for the scheme, the detail of the scheme, and its effectiveness.

Schemes under development - summary

- TfL are developing a series of schemes to meet London's transport challenges. These schemes are an important part of delivering the Mayor's vision for travel in London.
- **Crossrail 2** will carry up to 30 trains an hour in each direction on the southwest to northeast corridor, relieving severe crowding and unlocking around 200,000 additional homes and supporting 200,000 new jobs.
- A **London Suburban Metro** would offer improved frequencies, journey times and interchange opportunities, so that 125,000 more people could travel into central London in the morning peak and 38,000 more people more people could travel on non-radial services around inner and outer London.
- **Mini-radial networks to London's town centres** can create interchange hubs; linked together they allow orbital rail trips, relieving crowding and enabling mode shift from the car, offering reliable and fast public transport to local destinations.
- The **Bakerloo Line extension** would deliver an increase in frequency on the Bakerloo Line to 33 trains per hour, providing the capacity for 65,000 more journeys in the morning and evening peaks, and could unlock 25,000 new homes and 5,000 new jobs.
- The **Silvertown tunnel** will provide a reliable and resilient cross-river road link, enabling new bus links, delivering at least 20 buses per hour in the opening year.
- The **Ultra Low Emission Zone** covers the area of the Congestion Charging Zone and introduces a daily charge for vehicles that that don't meet required emissions standards. Subject to consultation, the original September 2020 start date for the Central London ULEZ is being brought forward to April 2019. As a result of the ULEZ, 42 per cent fewer people in central London would be living in areas exceeding the legal limits for NO_2 concentrations.
- **Further upgrades to the Tube, DLR, Trams and Elizabeth line** would increase morning peak capacity in 2041 by 26 per cent, significantly reducing crowding.

Schemes under development

Several major transport schemes are under development at TfL. The case for these schemes has been developed over time and each is designed to meet challenges or opportunities faced by London. The case for each scheme forms part of the initial work for the MTS package modelling. The schemes considered here are as follows:

- Crossrail 2;
- London Suburban Metro;
- Mini-radial hubs and improved orbital rail links;
- Bakerloo Line extension to Lewisham and beyond;
- Silvertown Tunnel and associated bus services;
- ULEZ; and
- TfL unfunded frequency and capacity upgrades.

The following sections set out the case for each scheme, including how it maps to challenges and opportunities for London, give a description of the scheme itself and consider its overall effectiveness in meeting the transport challenge.

Crossrail 2

What is planned?

- Crossrail 2 involves connecting existing national rail lines in Surrey and Hertfordshire with two new 37km tunnels from Wimbledon to Tottenham Hale and New Southgate, carrying up to 30 trains per hour in each direction. It will boost total rail capacity by 10 per cent and rail capacity across it in the critical south west corridor by 40 per cent.
- The new Crossrail 2 line will connect with eight underground lines, the London Overground, the Elizabeth line, HS2 and national and international rail services (Figure 5.1).

Figure 5.1: Crossrail 2 route (2015 consultation)

How effective is it?

- Crossrail 2 will relieve the Victoria, Northern and Piccadilly lines, and will remove the need for planned station control at the Underground stations serving 5 of the 6 busiest National Rail termini, as well as vital interchanges such as Clapham Junction and Vauxhall in the south, and Highbury & Islington, Finsbury Park, Seven Sisters and Tottenham Hale in the north (Figure 5.2).
- Furthermore, by addressing congestion at Euston, it will support High Speed 2's integration into London's transport network.
- To address critical crowding challenges on the South West Main Line, Crossrail 2 will create the space for around 20 extra local and regional trains per hour and 10 further additional trains per hour to serve the corridor from Wimbledon inwards. Capacity released will also allow several new long-distance services to cities such as Portsmouth and Southampton, and key locations for housing and business growth.
- Crossrail 2 will transform connectivity to key Growth Areas in northeast London. The West Anglia Main Line is currently the busiest mixed-traffic two-track railway in the country. Crossrail 2 will four-track this railway, quadrupling service frequencies to some destinations in the Upper Lea Valley, and shorter journey times across the wider London-Stansted-Cambridge Corridor will be possible.
- Crossrail 2 will unlock around 200,000 new homes along the line of the route and support 200,000 new jobs across the region. Around 40 per cent of transport benefits and more than 30 per cent of new housing will be realised in areas outside London.

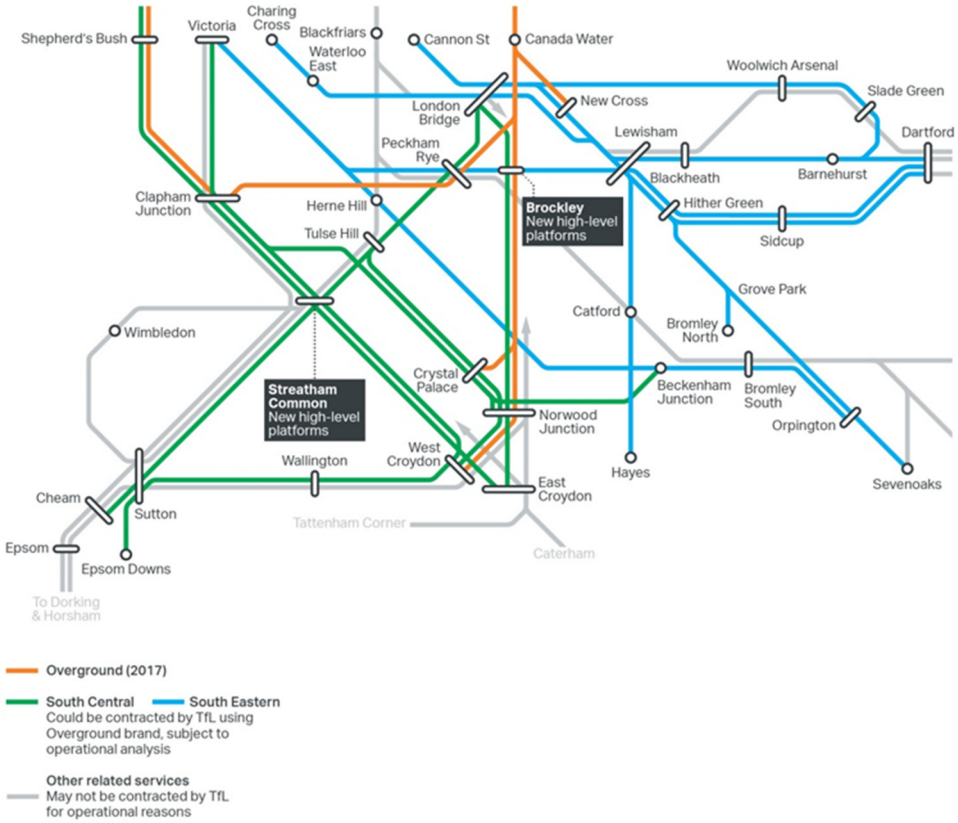
Figure 5.2: Forecast key station performance with Crossrail 2, 2041, AM and PM peaks

London Suburban Metro

What is planned?

- A London Suburban Metro would deliver increased frequencies and improved rolling stock to increase capacity on local train services on the South Eastern, South Western and South Central lines.
- A London Suburban Metro (Figure 5.3) could be delivered by the late 2020s.

Figure 5.3: Proposed London suburban metro in south London



How effective is it?

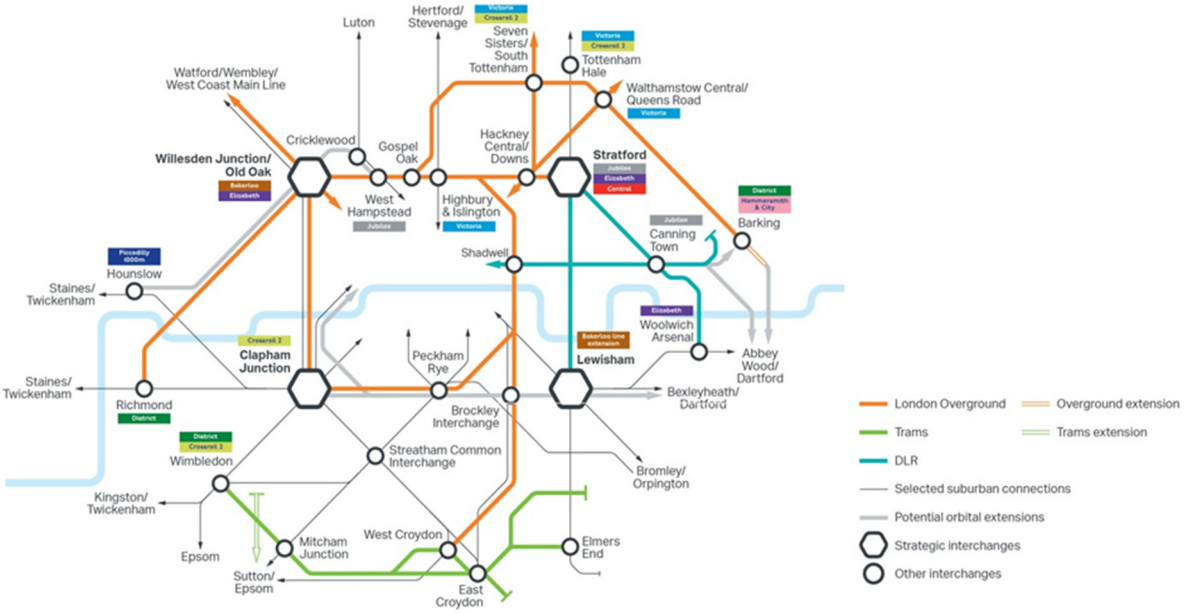
- South London relies on its suburban rail network for connectivity to central London. However, there is a substantial and growing gap between the level of service that can be offered on National Rail in south London, and the frequency and reliability now offered on the Tube and bus network.
- Creating a TfL London Suburban Metro could significantly increase capacity by over a third in peak periods, allowing approximately 125,000 additional passengers to travel to central London in the morning peak.
- This could deliver peak period capacity increaseson suburban services of around two thirds at Victoria and Charing Cross and a half at Cannon Street due to higher service frequencies and longer/improved rolling stock.
- 38,000 more people could travel on non-radial services around inner and outer London.

Mini-radial hubs and improved orbital rail links

What is planned?

- Service changes and potential orbital extensions to create an improved orbital railway for inner and outer London.
- Enhanced strategic interchanges at Clapham Junction, Lewisham, Old Oak Common and Stratford are shown in Figure 5.4.

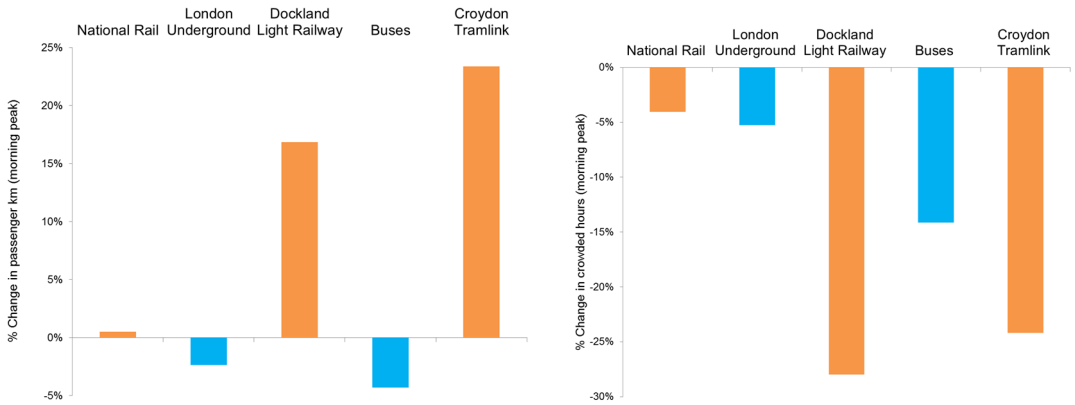
Figure 5.4: Potential mini-radial hubs and improved orbital links



How effective is it?

- Orbital rail and station interchange improvements reduce journey times and improve connectivity in inner and outer London with the potential to deliver sustainable growth.
- Pressure on London Underground and bus services is relieved, with a public transport mode shift onto orbital rail services and a decrease in crowding across all public transport modes (Figure 5.5).

Figure 5.5: Change in passenger kilometres & crowded hours, 2041

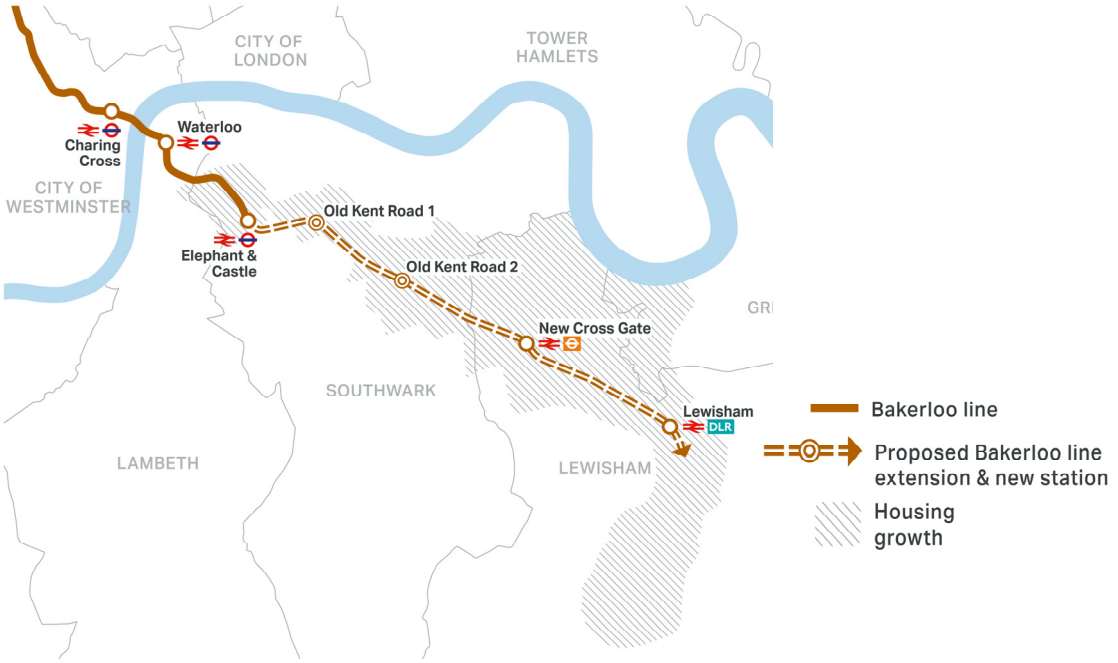


Bakerloo Line Extension to Lewisham and beyond (BLE)

What is planned?

- Extending the Bakerloo line from Elephant and Castle to Lewisham, with interchanges with Overground, DLR and National Rail services at New Cross Gate and Lewisham (Figure 5.6). This would deliver an increase in frequency on the Bakerloo Line to 33 trains per hour.

Figure 5.6: Proposed Bakerloo Line Extension



How effective is it?

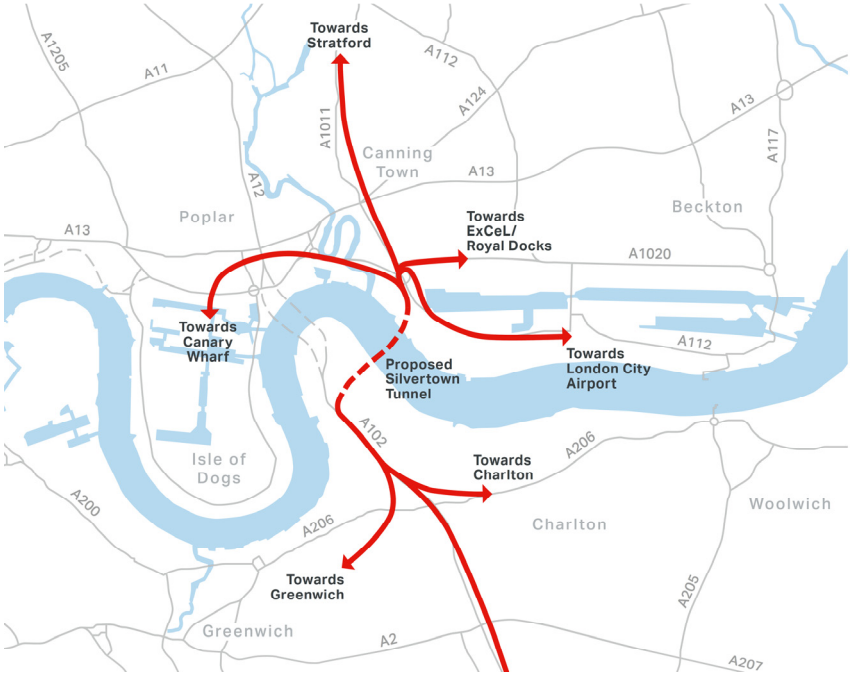
- The Bakerloo extension would unlock 25,000 new homes and 5,000 new jobs in the Old Kent Road and the Lewisham, Catford and New Cross Opportunity Areas.
- There are significant improvements to journey times, with Lewisham to central journey times decreasing by up to 9 minutes.
- Capacity is significantly improved with additional capacity on the London Underground for 65,000 journeys in the morning peak and evening peak
- Access to jobs and services are improved, with up to 2.6 million jobs becoming 10 minutes closer for areas served by the Bakerloo Line Extension
- The Bakerloo Line Extension would also provide crowding relief on National Rail and rail termini by providing an alternative route into London, and on local bus services by providing local London underground capacity.
- The significantly improved connectivity to the Overground, DLR and National Rail services mean that Lewisham and New Cross Gate become even more attractive public transport gateways and interchange hubs.

Silvertown Tunnel and associated bus services

What is planned?

- Construction of a new dual two carriageway highway tunnel under the River Thames between the Greenwich Peninsula and Silvertown (Figure 5.7). The tunnel is proposed to be charged for general traffic and includes a dedicated bus/coach and HGV lane in each direction to provide at least 20 cross-river buses per hour in the opening year.

Figure 5.7: Potential bus routes enabled by the Silvertown Tunnel



How effective is it?

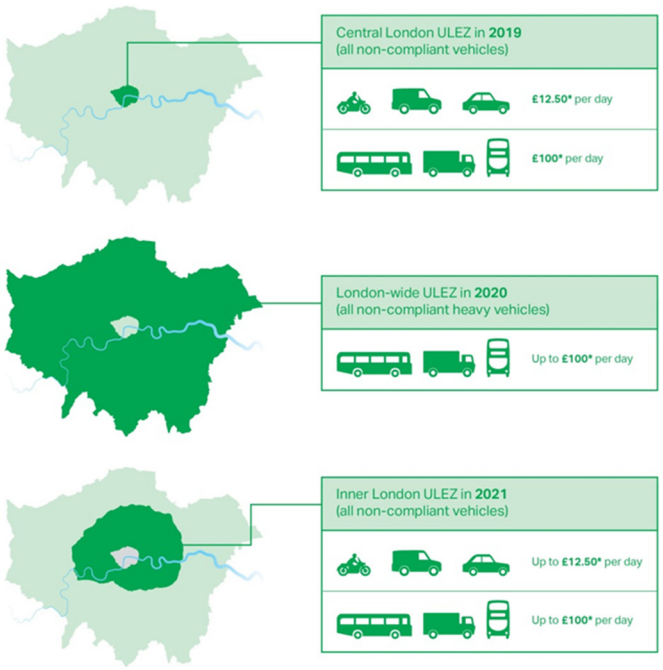
- The Silvertown tunnel would effectively eliminate the severe congestion that routinely affects the Blackwall Tunnel, improving journey time reliability and increasing the resilience of the strategic road network. This would deliver journey time savings of up to 20 minutes at peak times.
- The number of closures at the Blackwall Tunnel is expected to reduce significantly, particularly those caused by over-height vehicles (which typically result in over 1,000 unplanned closures each year).
- The tunnel would enable a transformation of the cross-river bus network, improving public transport connectivity and capacity in growth areas including the Royal Docks and the Greenwich Peninsula.
- It would make east and south-east London more attractive for inward investment by improving cross-river access for businesses, with 3,000 new jobs expected to be created by 2041 as a result of the scheme.
- The scheme 'locks in' the benefits through user charging, which means that there will be minimal changes to overall levels of travel in the area.

ULEZ 2019

What is planned?

- The central Ultra Low Emissions Zone (ULEZ) covers the same area as the Congestion Charging Zone. A daily charge (7 days a week) of £12.50 for light vehicles and £100 for heavy vehicles will be applied for vehicles that that do not meet the relevant standard (Euro 4 for petrol and Euro 6 for diesel).
- Subject to consultation, the original September 2020 start date for the central ULEZ is being brought forward to April 2019. This is ahead of a series of expansions London-wide for heavy vehicles in 2020 and across Inner London for light vehicles in 2021. The implementation plan is shown in Figure 5.8.

Figure 5.8: Ultra Low Emission Zone proposals



ULEZ standards: Petrol – Euro 4; Diesel – Euro 6/VI; Motorcycle and L-Cat – Euro 3
*ULEZ charge levels are indicative only and refer to the current scheme proposals

How effective is it?

- As a result of implementing the ULEZ in central London sooner, road transport NOx emissions in central London are expected to reduce by 20 per cent in 2019.
- The area of central London exceeding legal limit values for NO_2 would reduce from 30 per cent to 22 per cent and 42 per cent fewer people in central London would be living in areas exceeding the legal limits for NO_2 concentrations.
- There will also be 'knock on' benefits outside central London as a result of cleaner vehicles passing through inner and outer London to access central London.
- There are benefits in reducing exposure to air pollution by introducing ULEZ 17 months earlier, for example reducing the risk of hospital admissions for heart and lung conditions worsening symptoms and severity of asthma.

Upgrades to the TfL managed rail and Underground network

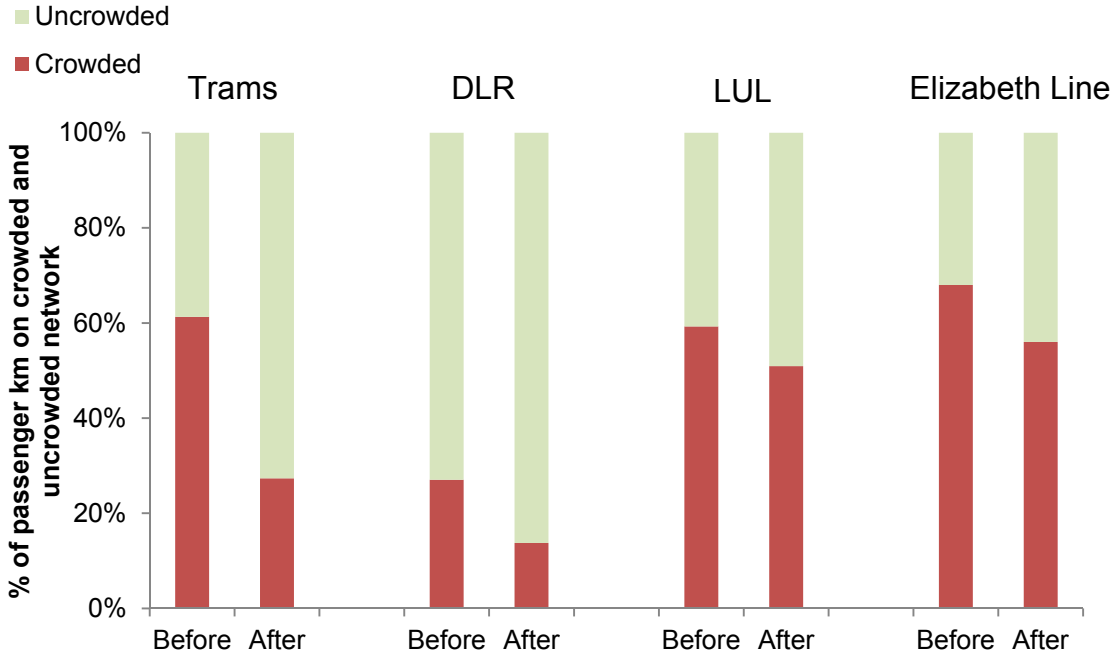
What is planned?

- Tube: Increased capacity and frequency on the Central (37 trains per hour (tph)), Jubilee (36tph), Northern (towards 36tph), Piccadilly (36tph), Waterloo & City (30tph), and Bakerloo Lines (26tph).
- Elizabeth line: increased service frequency to 30 trains per hour.
- DLR: increased frequency to 30 trains per hour.
- Trams: increased frequency to 7.5 trains per hour on all routes.

How effective is it?

- The improvements significantly increase morning peak capacity in 2041 by 26 per cent across the London network, with 1 per cent arising from Tram improvements, 4 per cent from DLR improvements, 16 per cent from London Underground improvements and 6 per cent from the Elizabeth line frequency increase.
- The increase in capacity significantly reduces crowding across TfL's train network in London. On average, the expected proportion of passenger kilometres travelled in London in crowded conditions in the morning peak (greater than 4 people per square metre) is reduced from above 50 per cent to 35 per cent. Impacts by mode are shown in Figure 5.9.

Figure 5.9: Proportion of passenger kilometres in 2041 morning peak in severely crowded conditions (>4 person per square metre)



6. Exploration of illustrative interventions

Introduction

This chapter describes a series of illustrative intervention tests undertaken in order to inform the development of draft MTS proposals. It first summarises the rationale and contents of the illustrative interventions. It then describes the key results of each test and concludes with a summary of outcomes and lessons from the work. These lessons are then taken forward into the MTS scenario forecasting exercise described in section 7 of this report.

It is important to recognise that these conceptual tests are designed to draw out the impacts of a specific range of interventions for the purpose of further analysis, and they do not of themselves reflect preferred or proposed packages of measures.

Illustrative interventions - summary

- Illustrative interventions are conceptual, modelled scenarios designed to assess policy options for changing travel behaviour.
- Some challenges set out in the Challenges and Opportunities report will require policies and interventions beyond schemes set out in Chapter 5 to meet the Mayor's vision.
- Five illustrative intervention tests were designed to test how improvements to sustainable modes, traffic reduction measures, conceptual connectivity schemes and changing land use could impact travel patterns in London and inform the wider strategy.
- The illustrative interventions show that there is scope for further mode shift in inner and outer London beyond the core reference case, but to achieve traffic and congestion reduction will require a mixture of 'carrot' and 'stick' approaches, including traffic reduction measures in the longer term.
- The results from analysis described in Chapters 5 and 6 have been used to inform and develop the MTS package tests in Chapter 7.

Illustrative interventions scenarios

Chapter 5 details the analytical work for major transport schemes under development at TfL. However, meeting the challenges set out in the Challenges and Opportunities report, and delivering the Healthy Streets Approach will require further policies and interventions. Five illustrative intervention tests were designed to test how improving sustainable modes, traffic reduction measures, conceptual connectivity schemes and changing land use could impact on travel patterns in London and inform the wider strategy. The tests are in some cases not geographically specific and instead provide a sense of scale for the potential impact of policy measures focused on achieving mode shift in inner and outer London.

Lessons from the illustrative interventions have been taken forward into the package tests in Chapter 7. Table 6.1 summarises the rationale and contents of each illustrative intervention test.

Table 6.1 Summary of illustrative intervention tests

Scenario	Description
1. Bus connectivity package in inner and outer London	Testing London-wide bus priority, frequency and quality improvements for their ability to deliver more sustainable growth and impact mode share, connectivity and congestion levels.
2. 15 per cent cycling mode share	Testing an exogenous increase in cycling to 15% of all trips and assessing the likely impact on public transport crowding and use, and highway congestion.
3. Opportunity areas and town centres – sustainable growth	A set of public transport connectivity and parking based traffic reduction measures applied in opportunity areas and town centres. This is to understand if Central London mode shares could be achieved in new developments in inner and outer London.
4. Changing the way road use is paid for	Testing a London wide distance-based charge to assess potential traffic reductions, congestion relief, environmental benefits and mode shift to walking, cycling and public transport.
5. Focused population growth	Testing an alternative land use distribution with all population growth in areas with greater public transport connectivity. Assessing how this could impact mode share, achieve vehicle kilometres reductions and reduce congestion.

Results from the illustrative interventions

The following provides more detail on each illustrative intervention, briefly setting out why the intervention was tested; what was tested; how its performance was assessed, and the overall effects and effectiveness of the illustrative policy measures.

1. Bus connectivity package in inner and outer London

Why is this being tested?

To understand the potential demand for improved bus services and to explore the role of buses in delivering mode share from the car.

What is being tested?

Testing a number of measures including bus priority, bus frequency and the quality of buses. Each of these is expected to make buses more attractive.

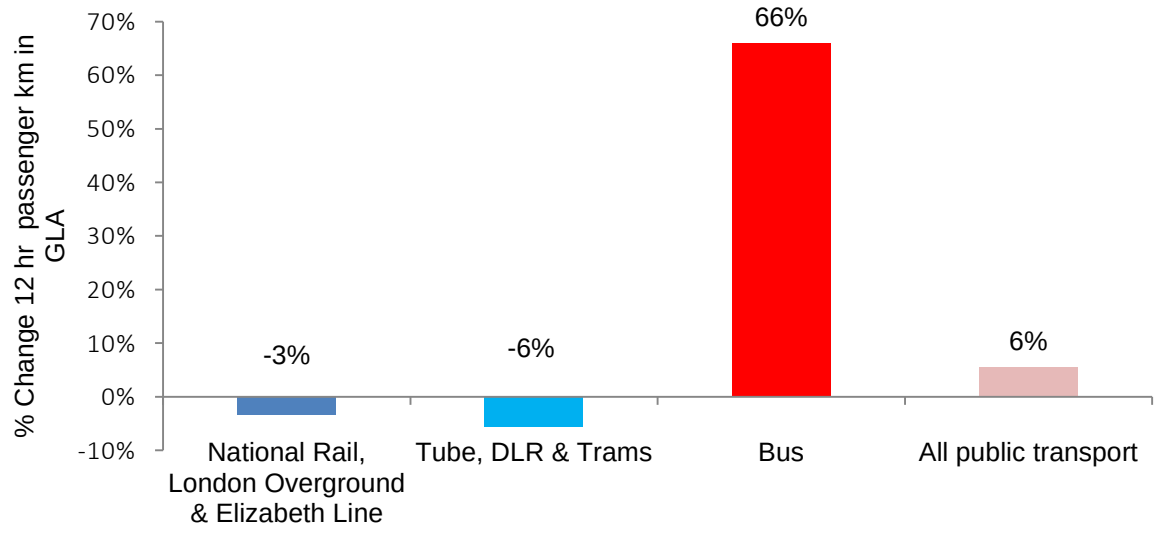
How has the illustrative intervention been assessed?

A number of measures to improve buses were tested. These included a 20 per cent improvement in bus speeds in inner and outer London from a 2011 base and speeds as in 2011 in Central London. Bus frequency increases in line with population growth within London. Improvements in bus quality so that buses are perceived by customers to be more like Tube services within the modelling assessment.

How effective is it?

Improving bus connectivity and quality significantly increases bus usage with a 65 per cent increase in bus passenger kilometres and only small reductions in Tube and National Rail usage. The percentage increase in bus usage is greater than the increase in bus vehicle kilometres applied. This suggests that improving bus speeds and service quality could generate demand and increase the efficiency of the bus network. Some trips come from the car but more come from active modes, reflecting the distribution of those trips and also because car remains attractive. This suggests that improving the bus network would enable mode shift but that measures to deter people from using their cars would also be required. Figure 6.2 shows the growth in bus passenger kilometres and displacement from Tube and National Rail.

Figure 6.2 Change in public transport passenger kilometres, 2041



Source: City Planning

2. Cycling mode share of 15 per cent

Why is this being tested?

The impact of a very significant increase in cycle travel on public transport and the road network.

What is being tested?

The impact of increasing the cycling mode share in 2041 to 15 per cent, compared to 6 per cent in the core reference case and 2 per cent today.

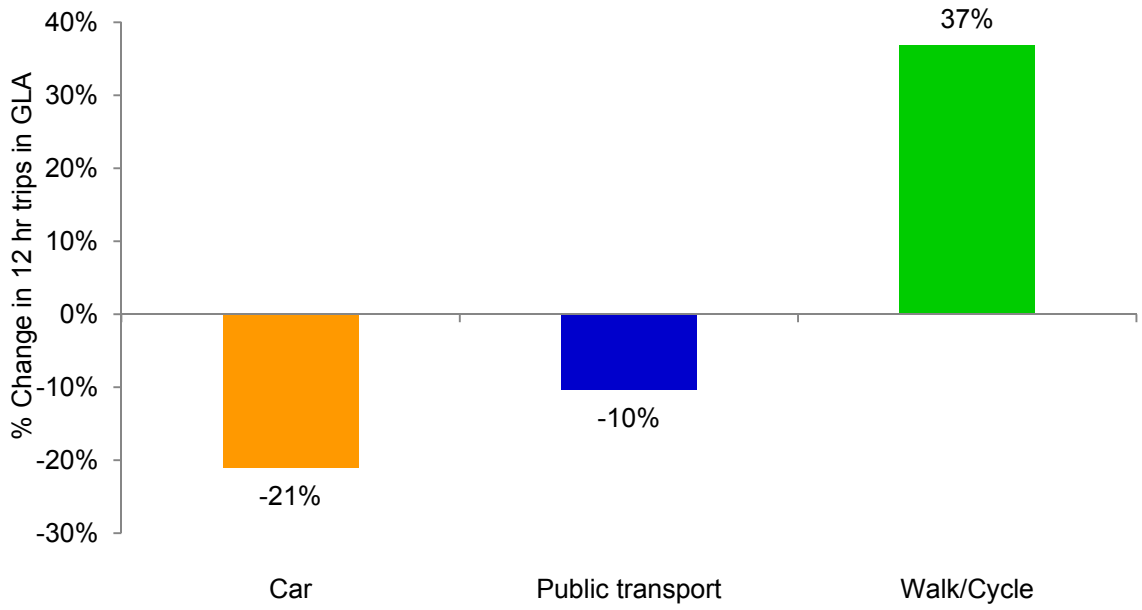
How has this been assessed?

Exogenously increase cycling trips in the strategic modelling to represent a 15 per cent mode share in 2041. In contrast, the core reference case has a cycling mode share of 6 per cent. Assessment of the impact on public transport and car trips and resulting crowding and congestion relief.

How effective is it?

Increasing the cycling mode share to 15 per cent by 2041 has a greater impact on car than public transport travel. The average number of car trips would fall by 1.2 million per day and traffic congestion would reduce by 13 per cent across London. If cycling was to reach 15 per cent mode share, much of the growth would be in orbital trips and travel in outer London. For public transport, this would mean a fall in shorter distance trips, particularly a shift from bus and Tube. Figure 6.3 shows the relative reduction in car and public transport trips as a result of cycling increases.

Figure 6.3: Change in 2041 trip numbers due to increased cycling mode share.



Source: City Planning

3. Opportunity Areas and town centres, sustainable growth

Why is this being tested?

Much of the growth planned for London is due to take place in town centres and Opportunity Areas and without change these areas will generate significant car growth. This test is to understand how congestion and traffic growth might be mitigated by a broad package of interventions.

What is being tested?

Promoting the development of self-sustaining town centres and Opportunity Areas by discouraging car ownership, reducing parking and increasing public transport connectivity.

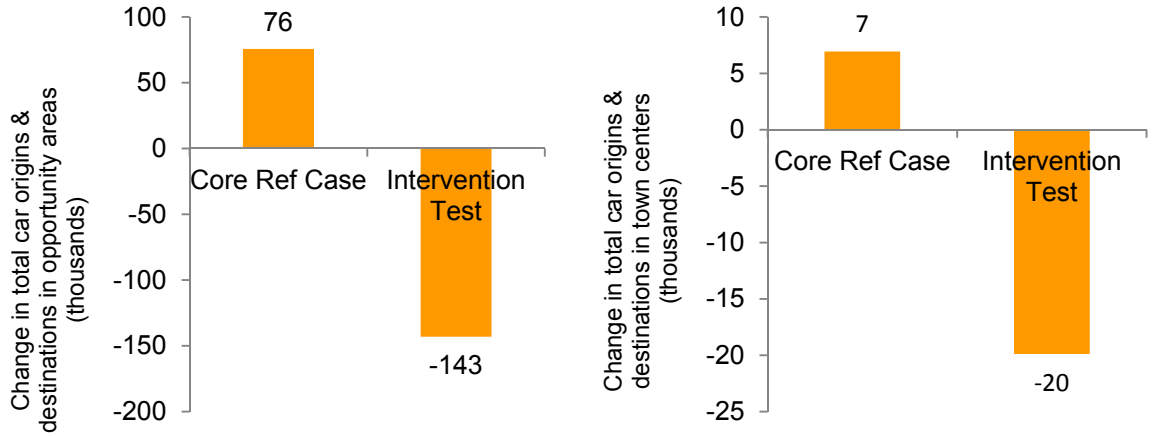
How has the illustrative intervention been assessed?

Public transport generalised costs (overall perceived cost including travel time, crowding and fares) were reduced by 20 per cent, representing as yet unplanned network improvements. Residential properties were made 'car free' in Opportunity Areas and town centres. Free workplace parking was removed in town centres and Opportunity Areas.

How effective is it?

Discouraging car usage and increasing public transport connectivity produces a significant decrease in car use of 600,000 trips per day and an increase in public transport across all modes and some increase in walking and cycling. There is an associated decrease in congestion across London of 9 per cent with the greatest reduction in inner London. Low car ownership on its own could deliver a high sustainable mode share, but public provides the connectivity necessary to make attractive places to live and work. Figure 6.4 shows the change in car trips from 2015 to 2041 in both town centres and Opportunity Areas.

Figure 6.4 Change in car trips in town centres and opportunity areas, 2015 to 2041.



Source: City Planning

4. Changing the way road use is paid for

Why is this being tested?

To explore the benefits that changing the way road use is paid for might achieve in terms of mode shift, traffic reductions, congestion relief and environmental benefits. What would the impact be on public transport, walking and cycling?

What is being tested?

Changing the way road use is paid for; building on the ULEZ and Central London Congestion Charge, a distance-based road charge was tested with different values for inner and outer London.

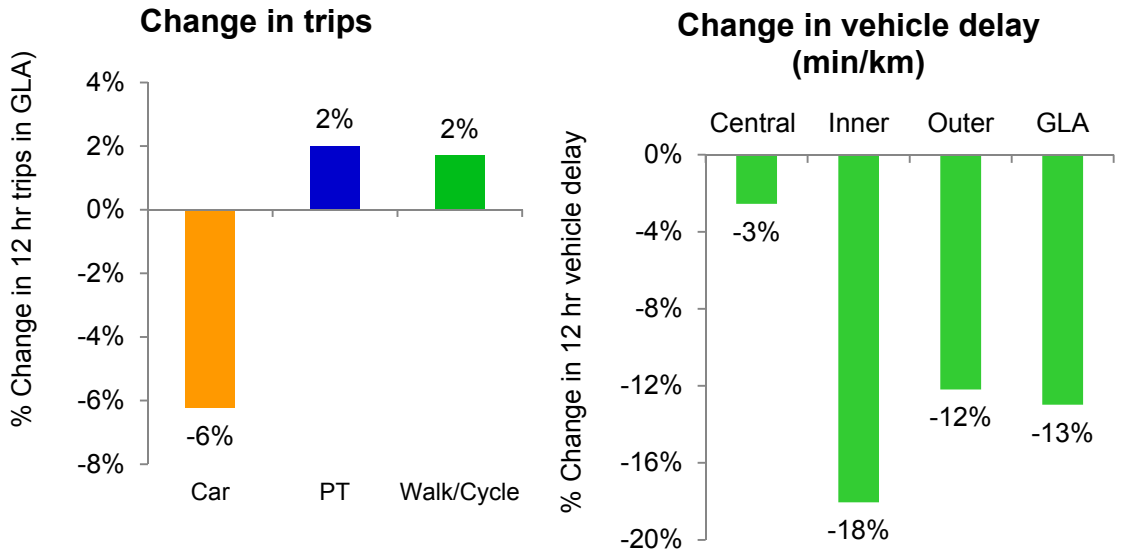
How has the illustrative intervention been assessed?

A distance-based, per kilometre charge was applied on every highway link in inner London and outer London. Higher charges were applied in inner London.

How effective is it?

The test generates mode shift away from the car with a reduction of 350,000 car trips per day which shift equally to walking/cycling and public transport. The major change in public transport trips is in bus passenger kilometres which increase by 6 per cent, indicating the extent to which bus offers an alternative to car in inner and outer London. There are significant reductions in car kilometres and congestion across inner and outer London, with 5,000,000 fewer car kilometres on the roads overall and a 15 per cent reduction in congestion across inner and outer London. There are also vehicle kilometre reductions and congestion benefits in Central London even though the test did not increase charge levels within the Congestion Charging Zone. Figure 6.5 shows the percentage change in trips by mode and the percentage change in vehicle delay in minutes per kilometre (min/km).

Figure 6.5: Change in 12 hour trips and vehicle delay, due to changing the way road use is paid for, 2041 from core reference case.



Source: City Planning

5. Focused population growth

Why is this being tested?

To understand to what extent integrating housing land use and public transport connectivity could deliver mode shift to sustainable modes, achieve traffic reductions and reduce congestion.

What is being tested?

Population growth from 2021 focused in areas of high public transport connectivity.

How has this been assessed?

Focus all GLA population growth from 2021-2041 only in areas that:

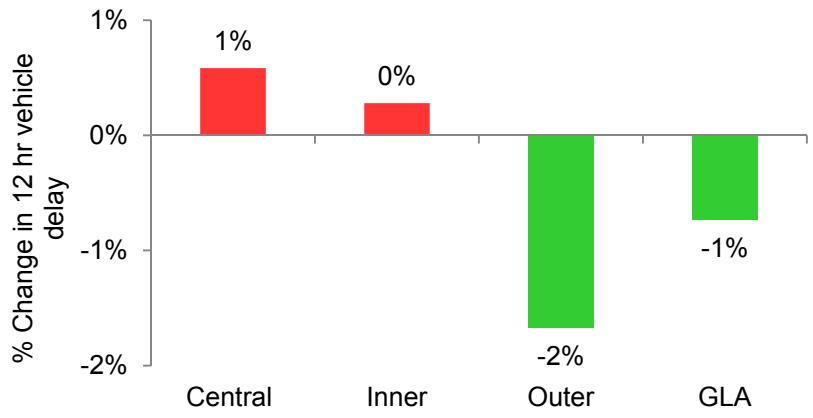
- have public transport access levels (PTAL) of 4 and above;
- are within 1 kilometre of a town centre or rail station; or
- have access to greater than 600,000 jobs within 45 minutes.

The distribution of growth has been weighted according to the core reference case growth and connectivity levels are based on the funded investment programme. The rate of car ownership in each area remains unchanged.

How effective is it?

Shifting population growth into more connected locations results in a 1 per cent reduction in car ownership. Overall, focusing population growth in areas with good public transport connectivity reduces car trips by 74,000 trips per day. Figure 6.6 shows small increases in congestion in Central and inner London of 1 per cent due to an increase in population growth in these areas, and decreases in outer London car kilometres and congestion of 1 to 2 per cent. There is also a small net reduction in public transport passenger kilometres as the land use change results in shorter commuting and travel distances. Overall the impacts on transport outcomes are positive, but the changes are relatively small as a high proportion of development is already planned in well-connected areas in the core reference case.

Figure 6.6 Change in 2041 vehicle delay due to focused population growth.



Source: City Planning

Illustrative interventions summary

Table 6.7 provides a summary of the outcomes of each of the ten illustrative intervention scenarios set out above.

Table 6.7 Summary of lessons from the illustrative interventions.

Scenario	Outcome
1. Bus connectivity package in inner and outer London	Improving bus connectivity and quality has the potential to attract people to buses and significantly increase bus use, but would need to be combined with measures to deter car travel to deliver significant mode shift.
2. 15 per cent cycling mode share	Increasing the cycling mode share results in significant mode shift from the car and reduces vehicle congestion across London. If a high cycling mode share can be achieved, it would reduce pressure on the public transport system and improve the efficient use of road space across London.
3. Opportunity Areas and town centres – sustainable growth	Constraining car ownership and parking in opportunity areas and town centres reduces car use and congestion. Improving public transport connectivity alongside restricting car use is necessary to provide access to jobs and make places attractive to live.
4. Changing the way road use is paid for	Changing the way road use is paid for could significantly reduce vehicle kilometres and congestion, and deliver mode shift away from car.
5. Focused population growth	Focusing population growth in areas with good public transport connectivity reduces car trips, but much of the growth is already expected to take place in better connected areas.

Source: City Planning

7. MTS package modelling

Introduction

This chapter details the package modelling exercise undertaken as part of the development and assessment of the draft MTS proposals. It first describes the purpose of the package modelling and then lists the contents of each package. It then describes the outcomes of the modelling against the eight key quantified measures outlined in Chapter 2, and concludes with a summary of the assessment.

MTS package modelling - summary

- The draft MTS responds to the challenges and opportunities identified as part of the evidence base, aiming to deliver the Mayor's vision and adopt a Healthy Streets Approach.
- Six strategic modelling packages (A to F) have been defined which build on knowledge gained from scheme and illustrative intervention modelling described in Chapters 5 and 6.
- These packages have been assessed through strategic modelling to determine what schemes and policies would be required to meet the full vision set out by the Mayor.
- Package A is the core reference case. Packages B to F contain proposals beyond the funded programme. Each builds on the assumptions included in its predecessor.
- The packages also form the basis of options considered within the Integrated Impact Assessment for the draft MTS.
- Overall the strategic modelling demonstrates that achieving 80 per cent of trips by walking, cycling and public transport is feasible with the application of the policies and proposals contained in the draft MTS and modelled in packages A to F

Introduction to MTS packages

The draft MTS responds to the challenges and opportunities identified as part of the evidence base and sets out the Mayor's for London. Chapters 5 and 6 of this report describe a series of schemes and policies which could contribute to achieving the Mayor's vision.

The MTS packages shown in Figure 2.2 are a series of model scenarios that have been developed to consider how these prospective schemes and policies could collectively contribute to meeting the challenges set out in the evidence base and, ultimately, what schemes and policies would be required to meet the vision set out by the Mayor. The packages also form the basis of options considered within the Integrated Impact Assessment for the draft MTS. The package model tests build on knowledge gained from all previous work, including analysis of the core reference case and illustrative intervention model tests described in previous sections. The 2041 Reference Case is considered to be 'Package A' in this sequence.

Description of the packages

A summary description is provided for each package. Each successive package builds on the assumptions included in its predecessor. A full scheme list is provided in Appendix 1. Package A is the core reference case described in Chapter 3.

Package B: Optimising the network

One of the main challenges identified in the core reference case is continued traffic dominance with highway congestion affecting bus speeds. Package B aims to enhance the existing network through bus priority schemes the reallocation of road space in areas of high place value identified by the *Street Types for London*[6]. It also includes frequency improvements to some rail services. A summary of key schemes is provided below:

- Bus priority schemes, enabling faster journey times in Central London; low emission bus zones; and high frequency links;
- 30 trains per hour on the Elizabeth Line;
- Some selected National Rail and London Overground improvements;
- Tram frequency uplifts; and
- 10 to 30 per cent reduction in highway capacity on the highway links with the highest value ('place') as identified in *Street Types for London*.

Package C: Incremental expansion

Crowding on the Tube, Elizabeth Line, DLR, London Overground, Trams and National Rail is a key challenge in the core reference case because funded improvements do not go beyond the mid-2020s and demand for travel will increase. Building upon the improvement schemes included in package B, package C aims to reduce crowding, encourage further mode shift from the car and increase public transport demand. London can also maximise the benefits of National Rail in south London by creating a London Suburban Metro. These schemes represent improvements that require line or track upgrades and new rolling stock but not new rail lines. A summary of key schemes is provided below:

- Deep Tube upgrade & World Class Capacity programmes including upgrades to the Bakerloo, Central, Waterloo & City, Piccadilly, Jubilee and Northern Lines;
- Creating a London Suburban Metro;
- Further National Rail investment including upgrades to West Anglia mainline, Brighton mainline, Chiltern Line and new stations;
- 30 trains per hour on the DLR;
- London Overground frequency increases; and
- Construction of the Silvertown Tunnel and associated bus improvements.

[6] https://tfl.gov.uk/info-for/boroughs/street-types

Package D: New connections

New public transport connections are needed to unlock growth in jobs and homes, provide an improved public transport service and reduce crowding. These schemes also support further agglomeration benefits in London's economy. A summary of key schemes is provided below:

- Crossrail 2, linking Surrey and Hertfordshire with two new 37 kilometre tunnels from Wimbledon to Tottenham Hale and New Southgate;
- Bakerloo Line Extension to Lewisham and beyond;
- Elizabeth Line extension to Slade Green;
- DLR extensions from Gallions Reach;
- London Overground extensions and strategic interchange investment including to Barking Riverside and Abbey Wood, and to Hounslow;
- Tram extension from South Wimbledon to Sutton; and
- Further bus network development.

Package E: Traffic reduction

Package E contains a range of measures to reduce traffic and achieve Healthy Streets for London. A summary of key schemes is provided below:

- Further road space reallocation to walking, cycling and bus priority in order to reduce traffic dominance and deliver Healthy Streets for London.
- Further increases in parking charges, limits on free commuter parking or a work place parking levy;
- Measures to accelerate the rate of car ownership reduction resulting in a quarter of a million fewer cars owned in London; and
- Measures to limit the growth of freight traffic, so that HGV traffic does not rise and van traffic grows only in line with population.

Package F: Longer term changes to the way road use is paid for

Changes to the way road use is paid for in the longer term could help achieve an 80 per cent mode share for walking, cycling and public transport. A summary of the illustrative measures included is provided below:

- An indicative distance-based charge. The inner London distance-based charge assessed was twice the outer London charge per kilometre; and
- Measures to encourage green technology uptake.

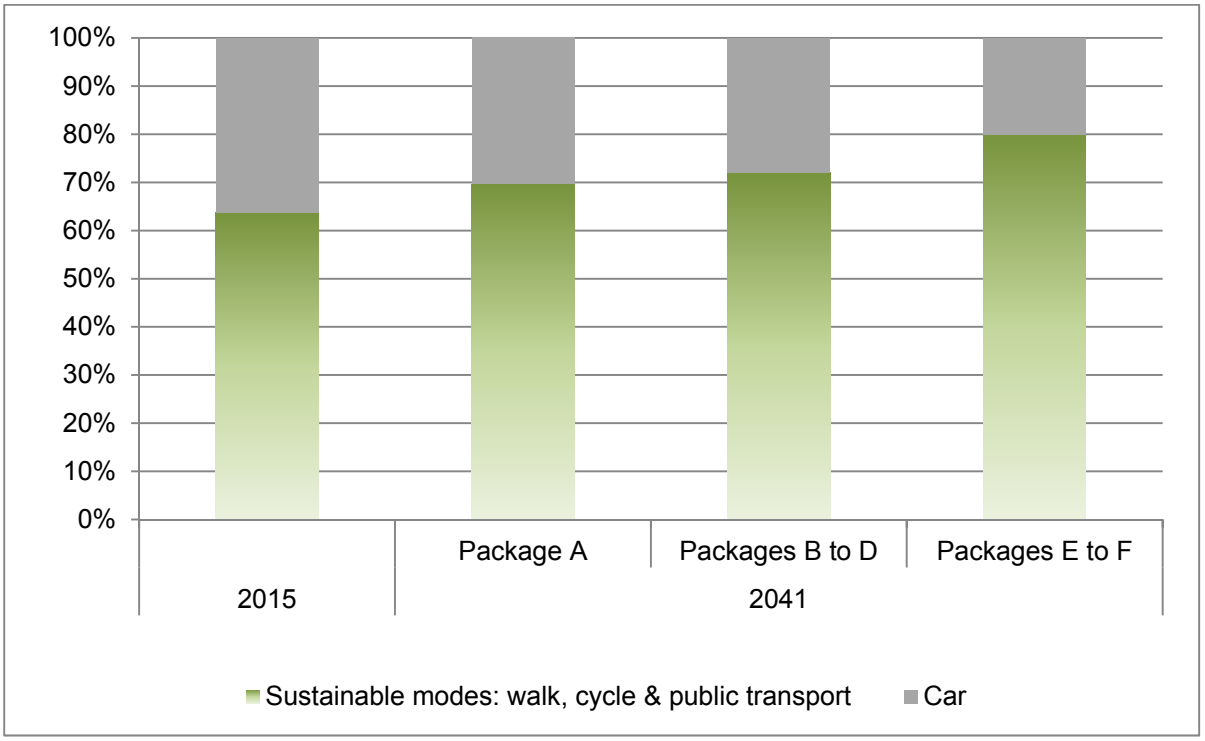
Outcomes from the MTS packages

The outcomes of the incremental MTS packages from the 2015 base and the 2041 core reference case (Package A) through to Package F are compared below. The comparison uses a series of waterfall diagrams for each of the key quantified measures for assessment as set out in Chapter 2. The diagrams show the relative contribution of each package towards achieving the Mayor's vision.

Travel demand and mode share

With the measures included in the core reference case and the continuation of current trends, the sustainable mode share is forecast to increase from 64 per cent in 2015 to 70 per cent in 2041. The Healthy Streets Approach and public transport measures included in packages B to D increase the sustainable mode share to 72 per cent. With packages E to F containing traffic reduction measures and changes to the way road use is paid for in the longer term, the sustainable mode share increases to 80 per cent by 2041. Figure 7.1 shows the outcome mode shares for packages A, B to D, and E to F.

Figure 7.1 Mode share, 2015 and 2041 for packages A, B to D, and E to F.

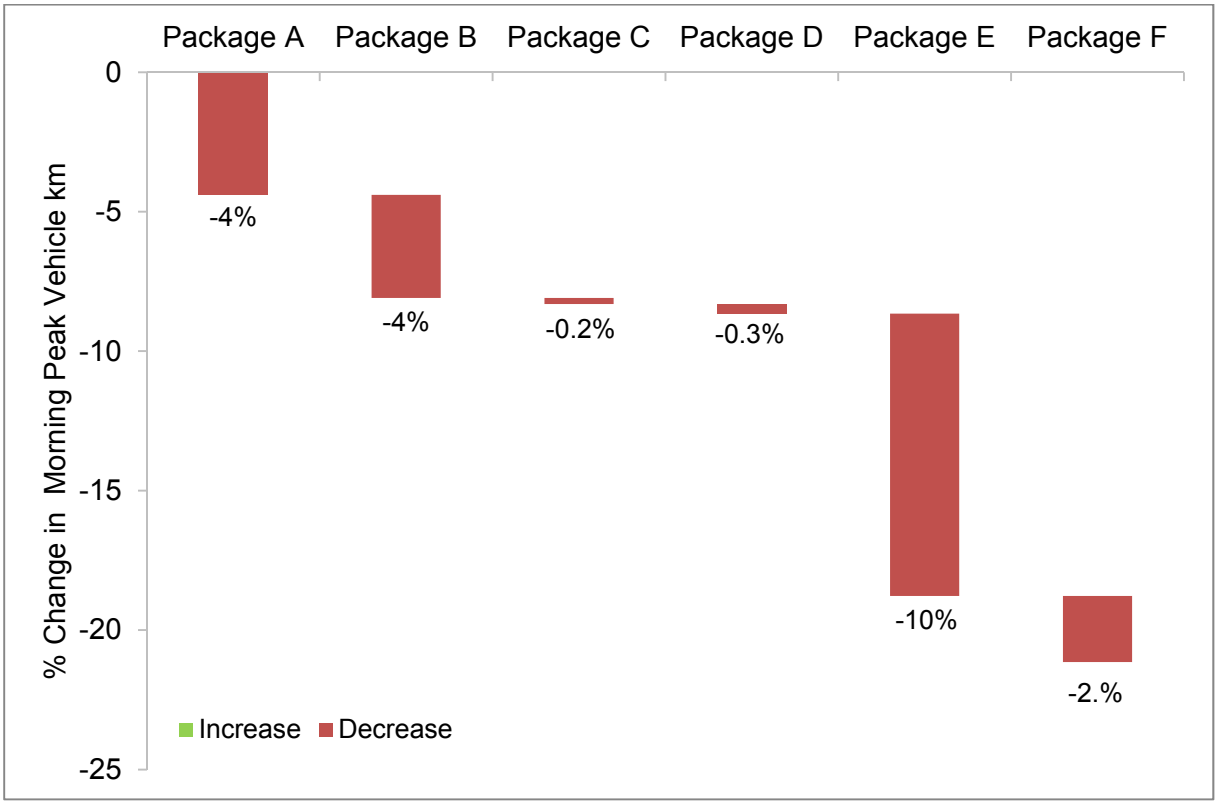


Source: City Planning

Traffic volumes and road congestion

In Central London, the funded schemes in package A with the additional network-optimising schemes proposed in package B contribute to moderate decreases in traffic volumes. Beyond this, the traffic reduction measures included in package E bring the greatest reduction in vehicle kilometres for general traffic. Figure 7.2 shows the forecast change in morning peak Central London vehicle kilometres in each package.

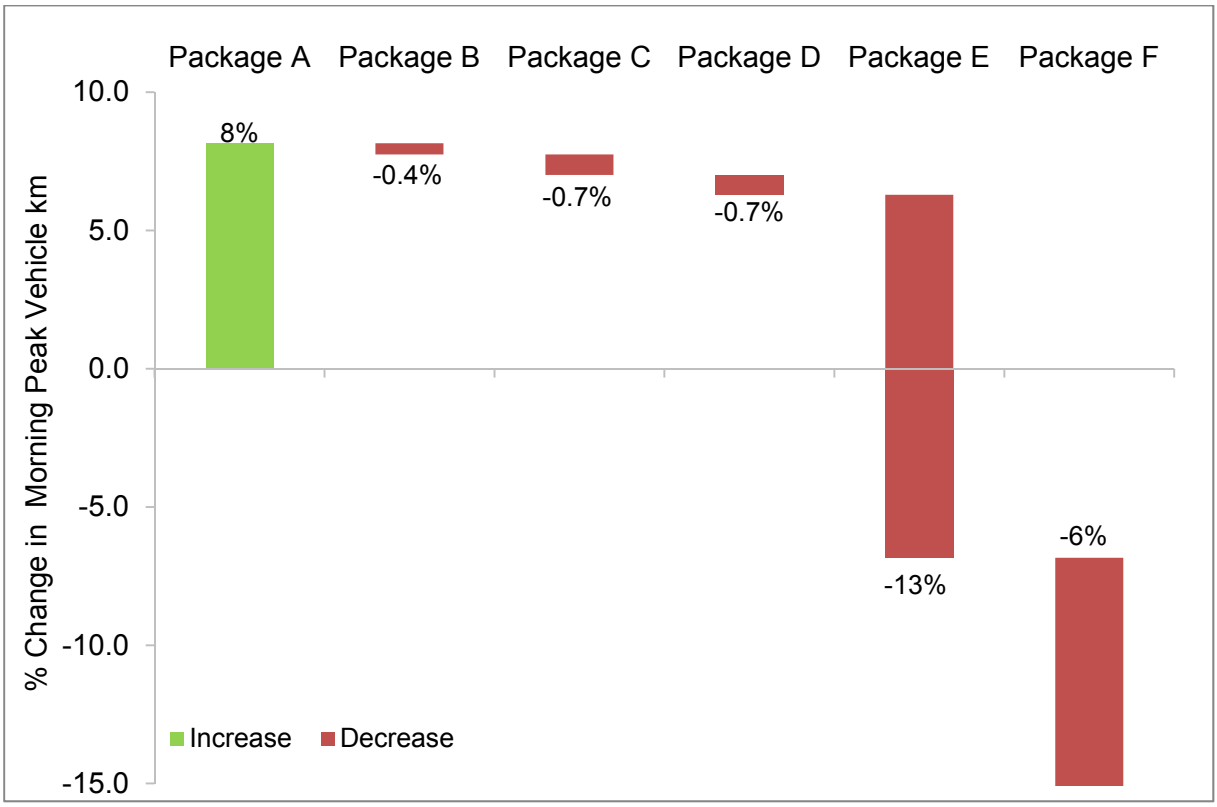
Figure 7.2 Change in Central London morning peak vehicle kilometres, 2015 to 2041 for packages A to F, 2015 to 2041.



Source: City Planning

In outer London and across the GLA, road traffic volumes are expected to grow moderately from 2015 to 2041 in the core reference case (package A). The proposed large scale investment in public transport infrastructure (packages B to D) mitigates that somewhat, but the traffic reduction measures in packages E and F are required to significantly reduce road traffic, reducing road traffic by 13 per cent from 2015 levels. Figure 7.3 shows the forecast change in morning peak London wide vehicle kilometres brought about by each package.

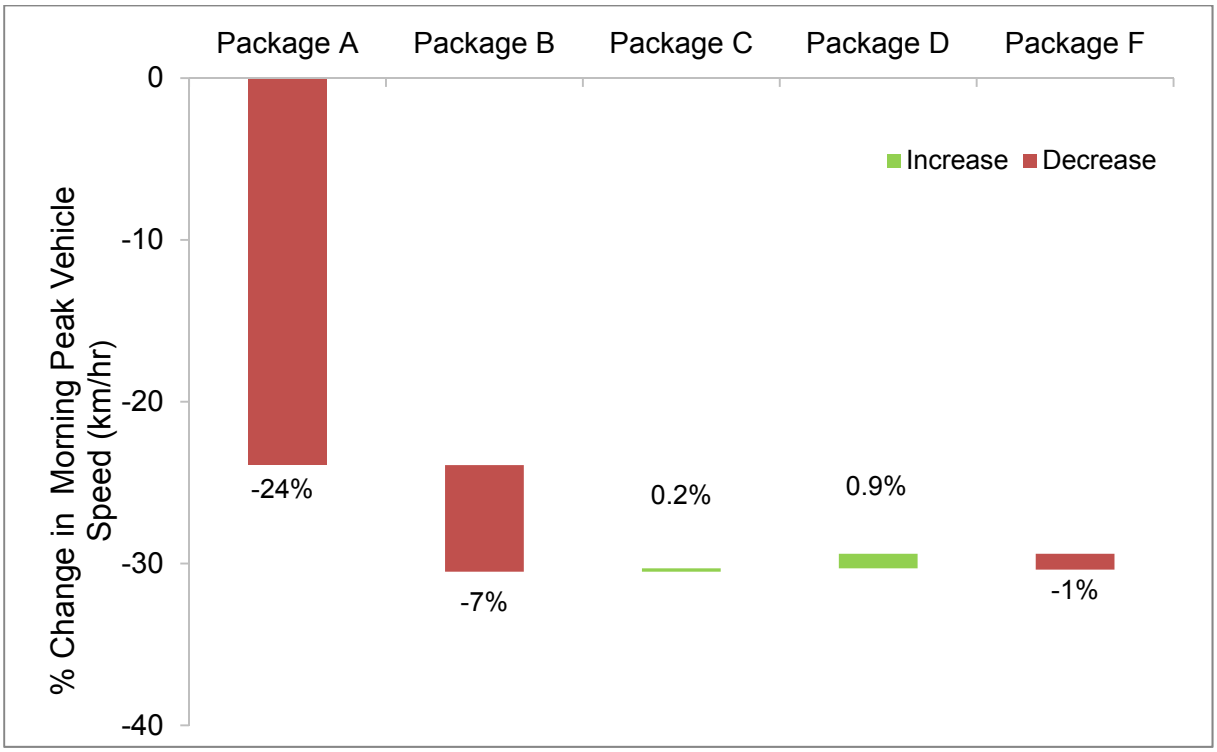
Figure 7.3 Change in London morning peak hour vehicle kilometres, 2015 to 2041 for packages A to F.



Source: City Planning

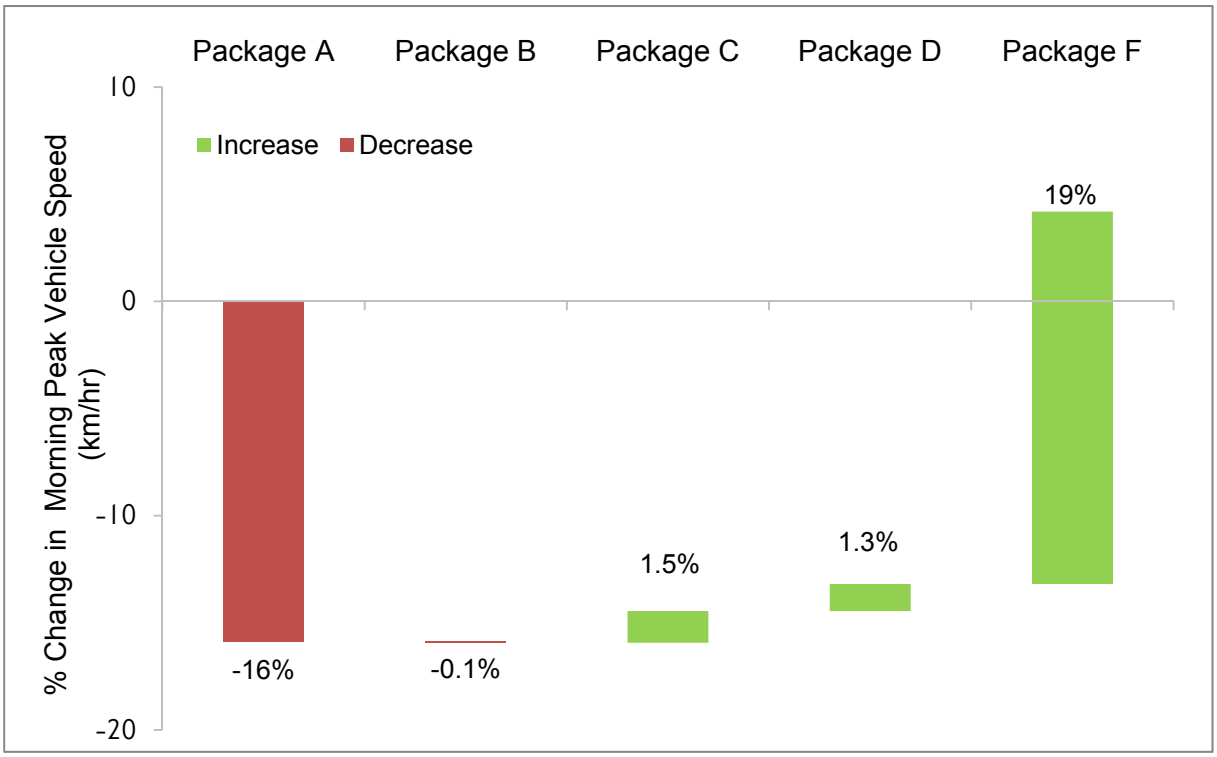
Highway capacity for general traffic is lower in the core reference case (package A) as a result of a range of changes related to the implementation of the Healthy Streets Approach. This capacity reduction results in lower average vehicle speeds. Packages B to F propose further reductions in capacity for general traffic to enable Healthy Streets and associated traffic reductions mean that speeds increase in inner and outer London, but fall in Central London. Figure 7.4 shows the projections for vehicle speed in Central London under each package and Figure 7.5 shows the projections for vehicle speed in London under each package.

Figure 7.4 Change in Central London morning peak vehicle speed, 2015 to 2041 for packages A to F.



Source: City Planning

Figure 7.5 Change in London morning peak hour vehicle speed, 2015 to 2041 for packages A to F.

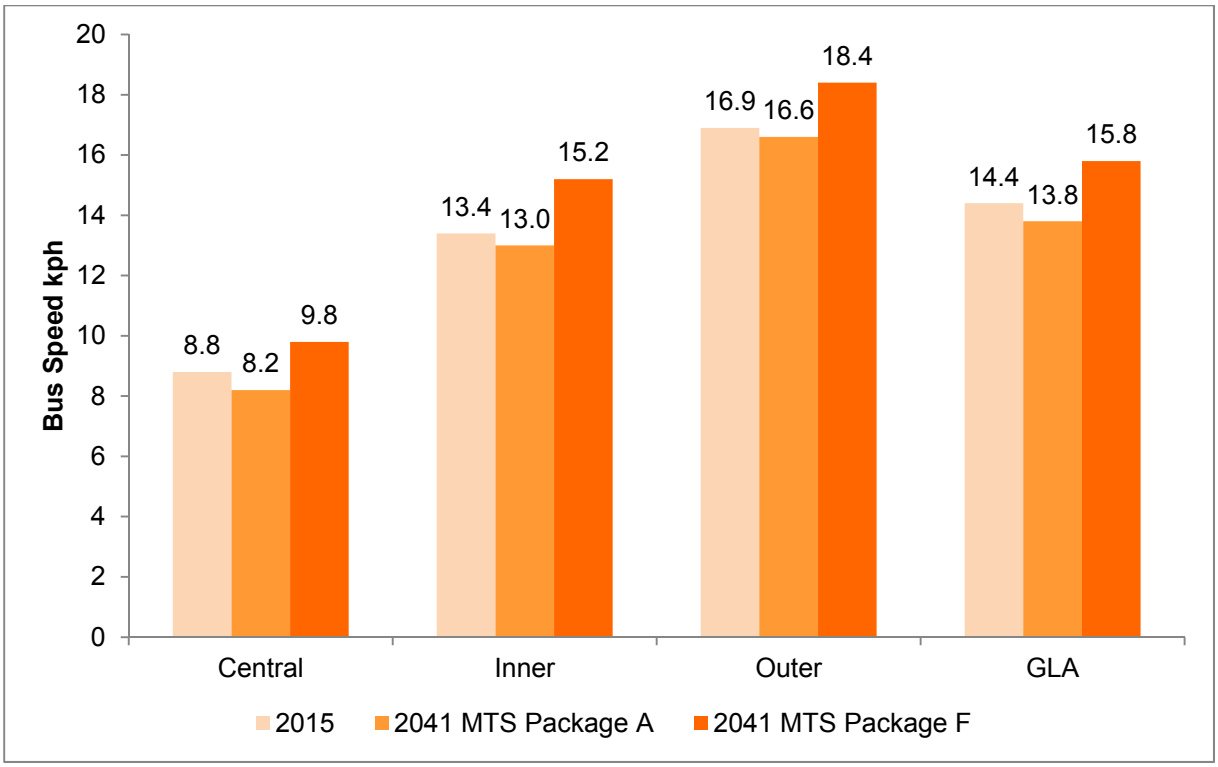


Source: City Planning

Bus speeds

In the core reference case (package A), bus speeds are projected to fall due to the detrimental impact of congestion from general traffic. The implementation of a bus priority network plan in package B, could significantly improve bus speeds across London. The impact of traffic reduction measures (package E and F) further reduce congestion and improve bus speeds across the GLA and could result in increased bus speeds relative to 2015. The change in bus speeds from 2015 to package F (2041) is shown in Figure 7.6.

Figure 7.6 12 hour London bus speeds (kilometres per hour), 2015 and 2041 for packages A to F.



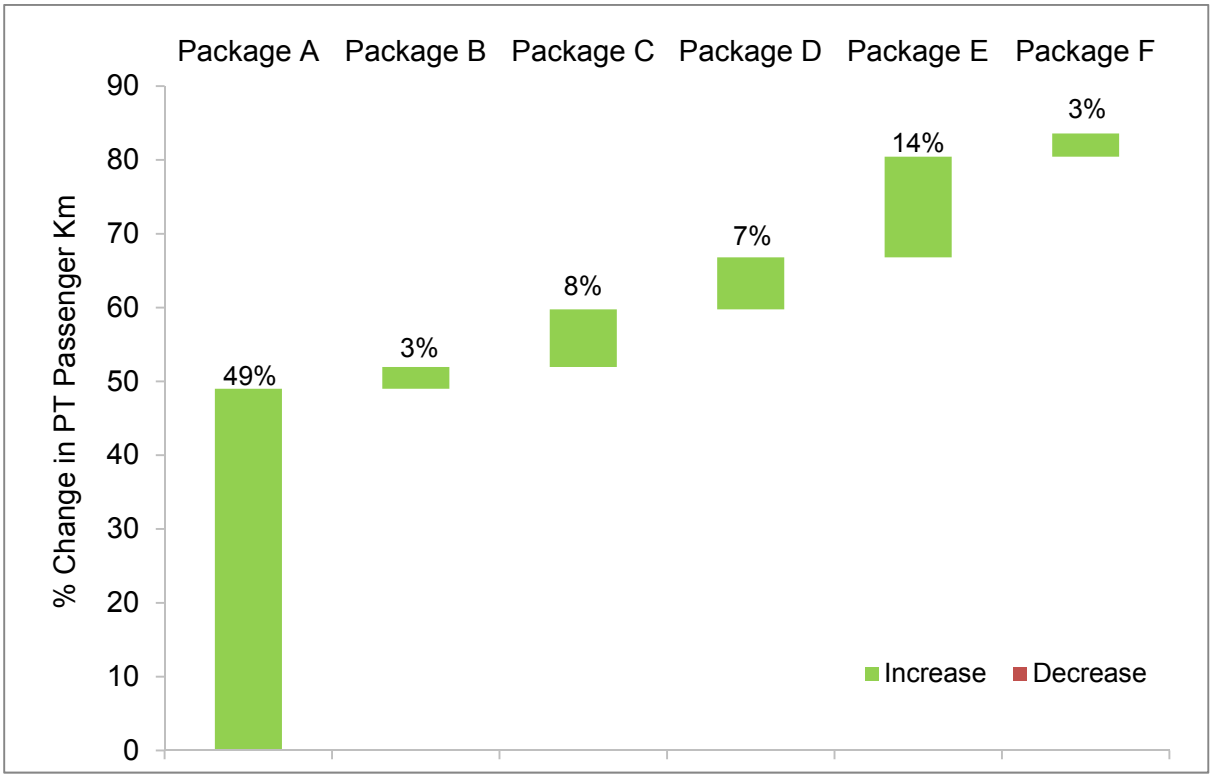
Source: City Planning

Public transport usage and crowding

Strong growth in demand for public transport, particularly for rail based modes, is expected between 2015 and 2041 in the core reference case (package A).

Further public transport investment and traffic reduction measures significantly increase public transport patronage. Large scale infrastructure investment (packages B to D) could increase public transport passenger use by 18 per cent, and traffic reduction measures (packages E and F) by a further 17 per cent. Figure 7.7 shows change in overall public transport use under each package.

Figure 7.7 Change in 12 hour public transport passenger kilometres, 2015 to 2041 for packages A to F.

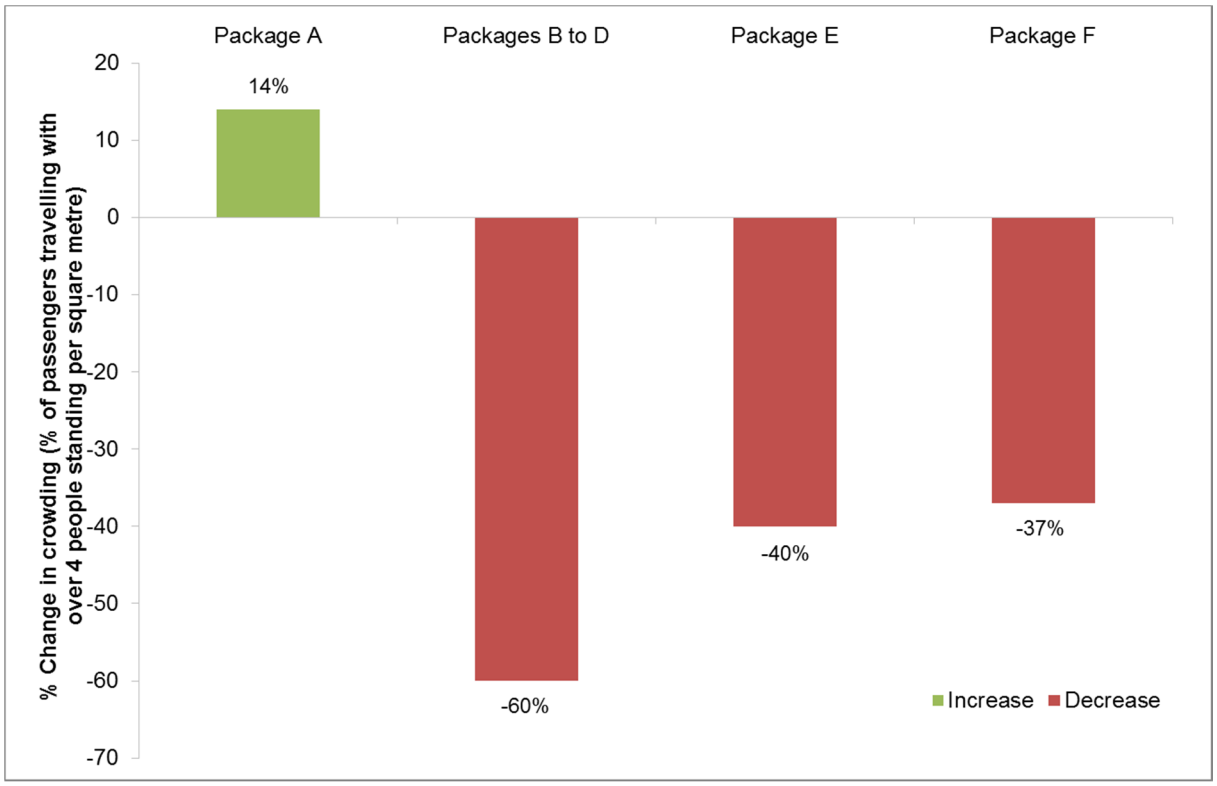


Source: City Planning

Demand for public transport is projected to increase at a faster rate than funded supply from 2021 in the core reference case (package A) and therefore crowding is expected to worsen without further investment. Further investment in public transport capacity is required to meet the needs of London's growing population and changing travel behaviour.

The large scale public transport infrastructure investment included in packages B to D has the effect of reducing the proportion of passenger kilometres travelled in severely crowded conditions from 40 per cent in the reference case to 16 per cent. The traffic reduction measures included in packages E and F deliver mode shift from the car to public transport and active modes. This has the effect of increasing crowding somewhat compared to packages B to D, but crowding remains at nearly half the level seen in the reference case. Figure 7.8 shows the proportion of passenger kilometres in severely crowded conditions for each of the packages.

Figure 7.8 Change in proportion of passenger kilometres on links with greater than 4 passengers standing per square metre in the morning peak, 2015 to 2041 for packages A, B to D, E and F

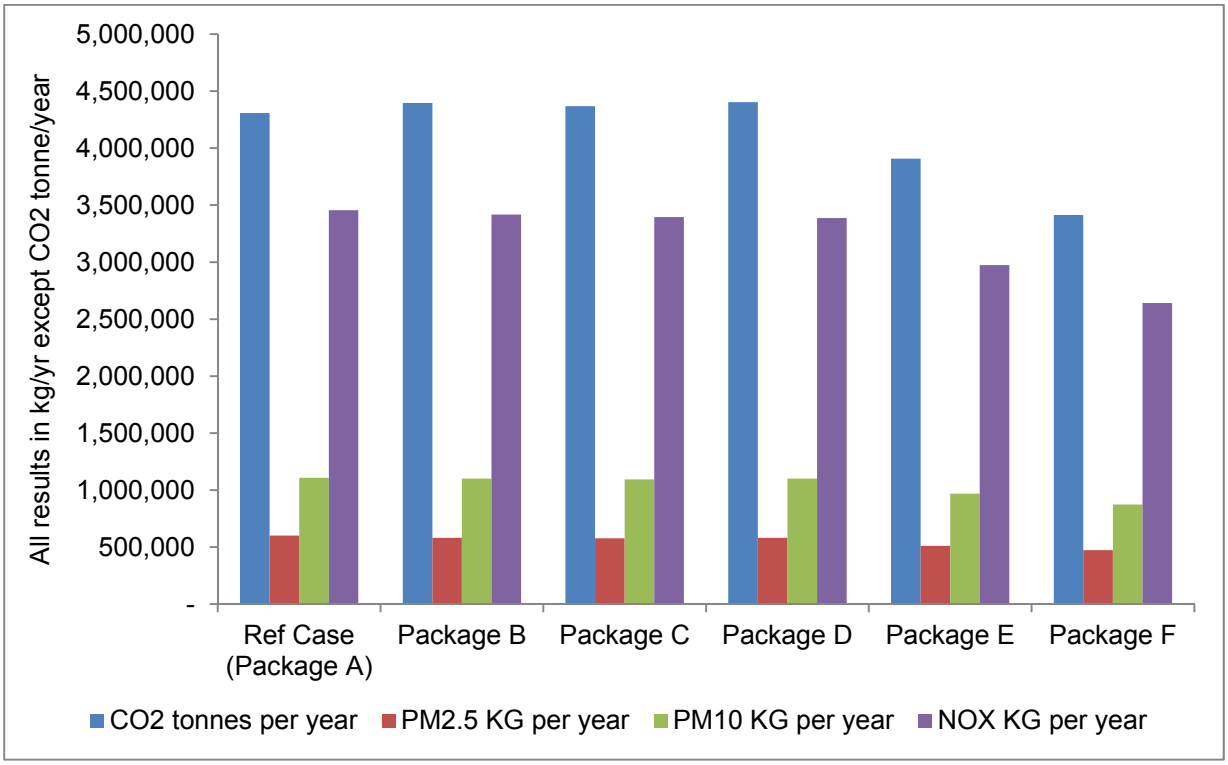


Source: City Planning

Emissions

Figure 7.9 shows the variation between road vehicle emissions in each MTS package. With assumptions on vehicle technology kept constant, changes in emissions are dependent on the overall level of vehicle kilometres produced in each package. Packages B to D have little impact on emissions and the traffic reduction measures included in packages E and F are required to reduce vehicle kilometres and therefore to reduce emissions beyond the core reference case. Figure 7.9 only shows the impact of vehicle kilometre changes without further action on vehicle technology. The MTS Scenario in Chapter 8 includes the impact of intended changes to the vehicle fleet proposed in the draft MTS.

Figure 7.10 CO_2, $PM_{2.5}$, PM_{10} and NO_X emissions from road based transport, 2041 for packages A to F.



Source: City Planning

Conclusions

In summary, the packages deliver:

Package A: Core reference case. Without further investment beyond the current programme, London would experience traffic dominance, congestion, crowding and poor bus performance by 2041.

Package B: Optimising the network. Bus priority and some limited rail based frequency improvements to the existing network could improve travel experience and particularly bus services, but would not meaningfully deal with traffic dominance or crowding.

Package C: Incremental expansion. Upgrades of the remaining Tube lines and other rail services including a London Suburban Metro are needed to tackle crowding on the Tube and maximise the potential for rail in South London.

Package D: New connections. New rail connections will unlock development and enable London to accommodate greater growth. New lines such as Crossrail 2 and the Bakerloo Line extension will reduce crowding on some of the most congested lines and stations.

Package E: Traffic reduction. Traffic reduction measures could free up the space for achieving Healthy Streets for Londoners, reducing traffic and emissions.

Package F: Longer term changes to the way road use is paid for. In the longer term, changing the way road use is paid for could deliver an 80 per cent walking, cycling and public transport mode share for London.

Delivery of 80 per cent mode share for walking, cycling and public transport

In the development of the draft MTS, mode share has been a particular focus. In 2015 the mode share for walking, cycling and public transport was 64 per cent, 10.4 percentage points lower than when TfL was formed in 2000.

The Mayor vision is to achieve an 80 per cent sustainable mode share by 2041. The overall conclusion of the MTS package modelling is that delivering a further 16 per cent mode shift from 2015 to 2041 and achieving 80 per cent of trips by walking, cycling and public transport is feasible with the application of the policies and proposals in packages A to F.

8. The MTS scenario

Introduction

This chapter describes the preferred MTS scenario. Firstly, it outlines the contents of the MTS scenario and is then structured as a description of the outcomes of the modelling against each of the eight key quantified measures outlined in Chapter 2. Results are provided 2041 and for interim years.

MTS scenario outcomes - summary

- TfL has assessed a scenario which assumes delivery of the policies and proposals set out in the draft MTS in full through to 2041. This includes all measures tested as part of packages A to F.
- Under such assumptions, London could accommodate 5 million more trips every day by increasing the mode share for walking, cycling and public transport to 80 per cent.
- With the draft MTS, by 2041, travel will have risen by around a quarter but car travel will have fallen by around a third. There would be at least 3 million fewer car trips per day (compared to 2015) and 250,000 fewer cars owned in London. General traffic would reduce by 10 and 15 per cent, a reduction of 6 million kilometres.
- By 2041, between 3 and 5 million more trips could be made by active modes every day than in 2015 and total travel will increase by around 60 per cent on London's buses. Bus journeys will be quick and reliable with a 10 to 15 per cent improvement in speeds and particular improvements expected in Central and inner London.
- Traffic reduction and improvements in vehicle technology will deliver large scale reductions of 94 per cent in NOx and 47 per cent in PM2.5 emissions with road and rail transport on a clear trajectory to reach 'zero carbon' status by 2050.
- Total capacity on rail services - Tube, Elizabeth Line, DLR, London Overground, Trams and National Rail - will increase by around 90 per cent, with more than 80 million additional seat kilometres between 7am and 7pm each day.
- Total travel will increase by nearly 100 per cent on the Tube and rail.
- Despite rising passenger numbers, rail and Tube journeys will be less crowded. By 2041, crowding on rail and underground services will reduce by around 10 to 20 per cent compared to today, measured in terms of the total crowded distance compared to the total distance travelled.
- In total, 7.6m people will live within 45 minutes travel time of Central London, 2.3m more than today. The number of jobs accessible to the average Londoner within 45 minutes by public transport will increase by 70 per cent. Fewer London residents will be dependent on a car to access opportunities and services. Nearly 1.8m more people will be living in places with the best transport connections, defined as areas with a public transport accessibility rating of four or above.

Description of the MTS scenario

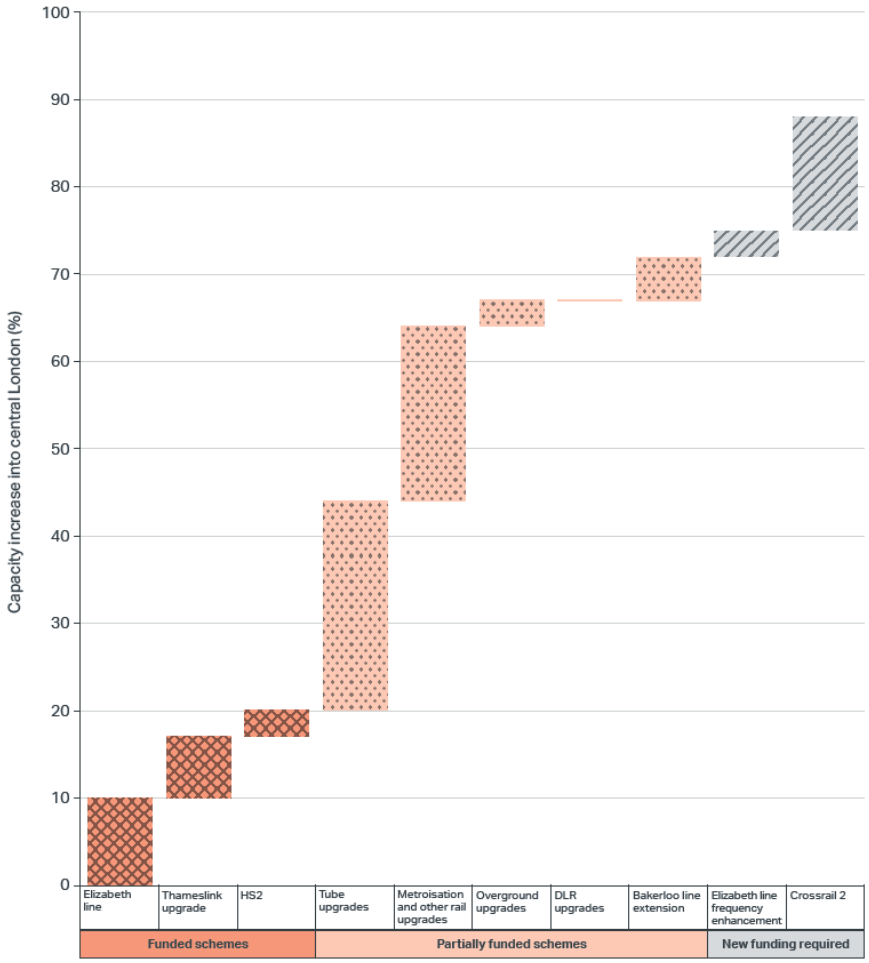
The MTS scenario begins with the contents of the core reference case set out in Chapter 3 and then includes policies and proposals outlined within the draft MTS. A scheme list is provided as Appendix 1. A summary of key schemes beyond the current funded programme is provided below:

- Rail: deliver Crossrail 2, a London Suburban Metro, Elizabeth Line extension east of Abbey Wood and other upgrades to the national rail network.
- Tube: deliver World-Class Capacity programme, Deep Tube programme, Bakerloo Line extension to Lewisham (and beyond), station capacity programme and step free Tube stations.
- DLR: deliver the DLR upgrades and potential DLR extensions from Gallions Reach.
- Trams: deliver Tram upgrades and potential Tram extension to Sutton.
- London Overground: deliver network-wide frequency upgrades, strategic interchanges, Barking Riverside extension and potentially other London Overground extensions
- Buses: develop the bus network to meet existing and future demand and deliver the bus priority network and Low Emission Bus Zones.
- Streets: implement the Healthy Streets Approach to deliver improved streets and priority for walking and cycling, and deliver Silvertown Tunnel and associated bus improvements including at least 20 buses per hour in the first year.
- Environment: deliver the Ultra Low Emission Zone and policies on vehicle emissions set out in chapter 3 of the MTS.
- Traffic reduction: indicative measures including changes to residential and workplace parking, changes to the way road use is paid for and freight demand measures as required to deliver the Mayor's vision for travel in London.

Figure 8.1 shows the overall impact of the rail schemes on capacity. They would deliver an almost 90 per cent increase in capacity to Central London in the morning peak.

The MTS package modelling has demonstrated that traffic reduction measures are likely to be necessary, in the longer term, to achieve the Mayor's vision of an 80 per cent mode share for walking, cycling and public transport in 2041. However, the approach to achieving this is illustrative of the required impact and should not be taken as an indication of specific proposals or scheme designs. The trajectory of the implementation reflects shorter term measures in the draft MTS such as air quality improvement and car reduction strategies and the desire to be more ambitious in reducing car ownership within new developments. Other traffic reduction measures and changes to the way road use is paid for are considered in the longer term. Table 8.2 provides a summary of measures tested.

Figure 8.1 Morning peak rail and Underground capacity improvements to Central London, 2015 to 2041 in the MTS scenario



Source: City Planning

Table 8.2 Summary traffic reduction measures included in the MTS scenario

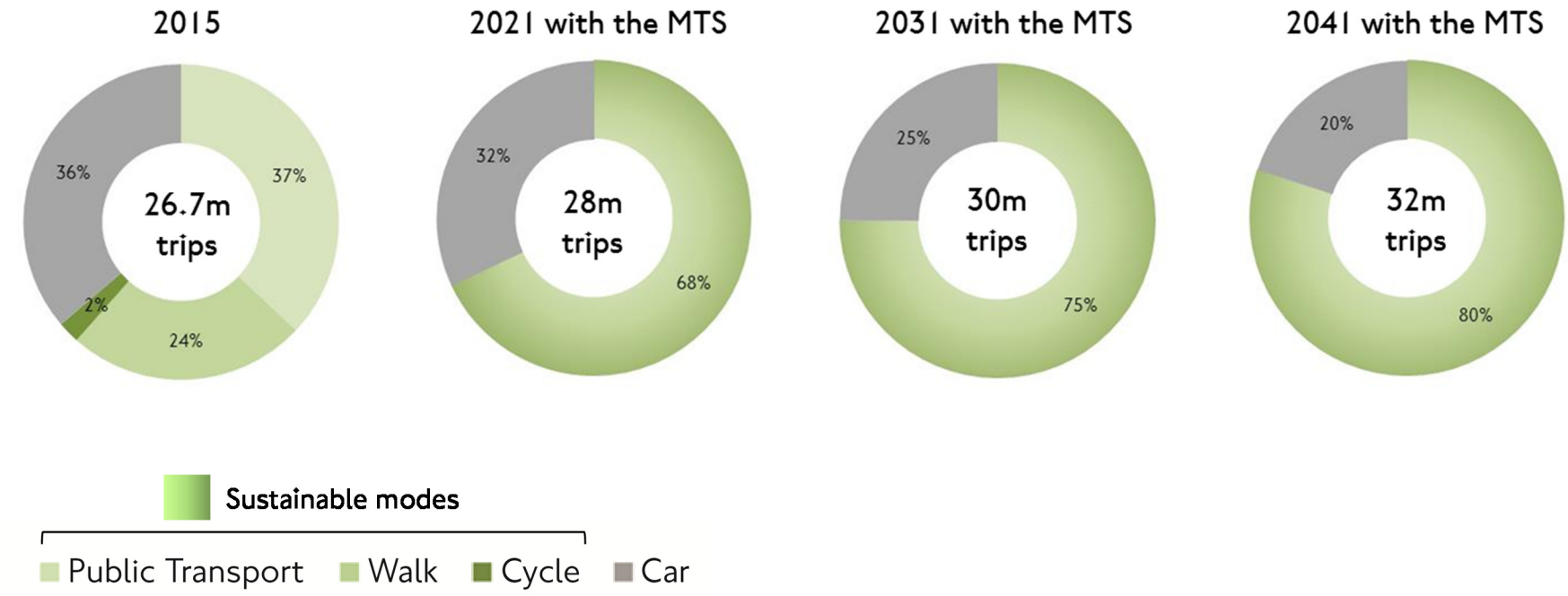
Policy type	Description
Parking supply and charging	Further increases in parking charges, limits on free commuter parking or a work place parking levy
Car ownership and residential parking	Measures to accelerate the rate of car ownership reduction resulting in a quarter of a million fewer cars owned in London
Changes to the way road use is paid for	This has been assessed with an indicative distance-based road user charge in the longer term
Freight demand management	Measures to limit the growth of freight traffic, so that HGV traffic does not rise and van traffic grows only in line with population

Source: City Planning

Summary of outcomes in the MTS scenario

Travel demand and mode share. The delivery of the MTS would enable travel in London to increase, in line with expectations from population and economic growth, by at least 5 million trips per day to 32 million in 2041 in a sustainable way. Within this increase, car percentage mode share is forecast to fall to from 36 per cent of all trips in 2015 to 32 per cent in 2021. There would be further reductions to 25 per cent in 2031, and finally 20 per cent in 2041. This is summarised in Figure 8.3.

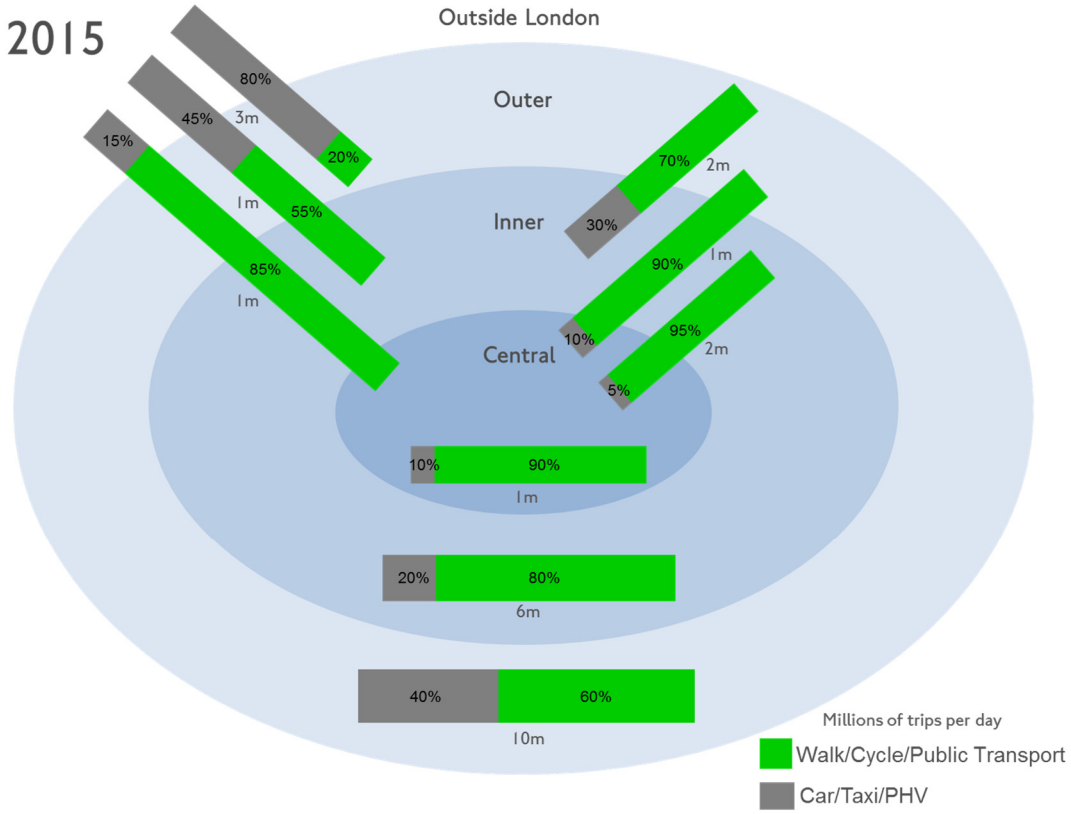
Figure 8.3 Mode share, 2015 to 2041 in the MTS Scenario.

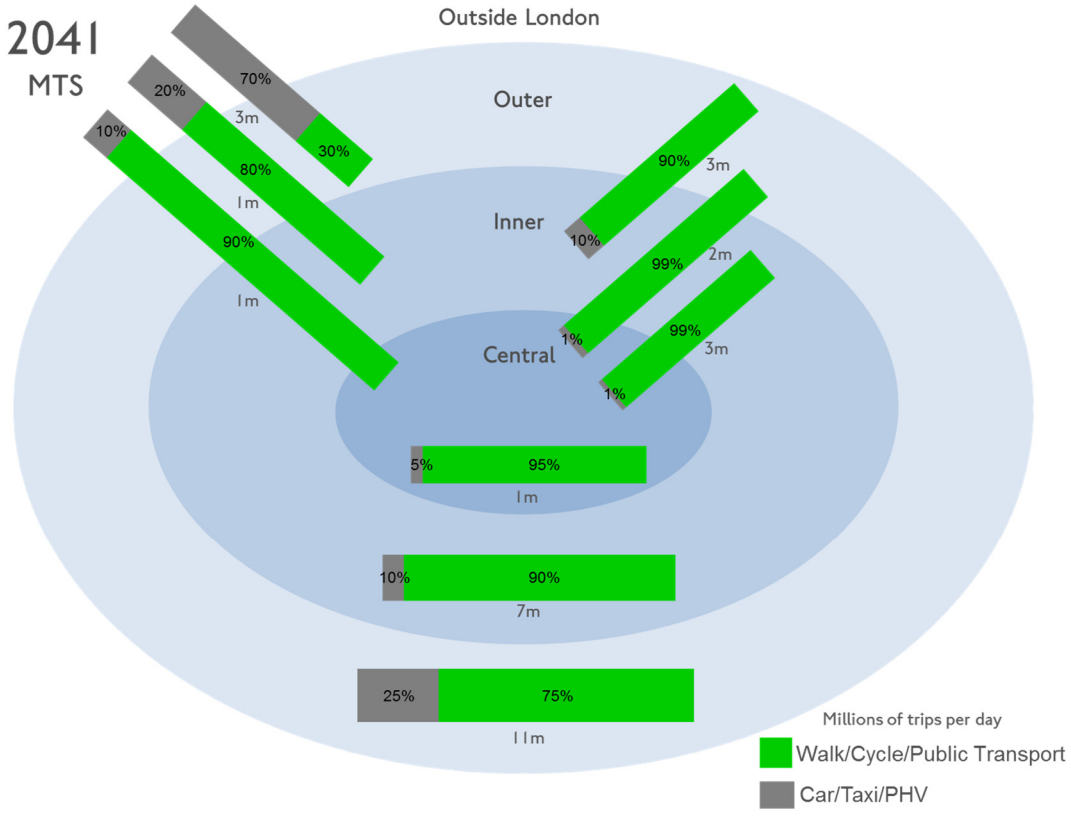


Source: City Planning

Figure 8.4 shows the outcome mode shares by region of London. For each movement with a trip end in Central London, public transport mode shares are at least 90 per cent with 75 per cent achieved for travel within outer London. Car/taxi could still make up 70 per cent of trips between outer London and the rest of the UK.

Figure 8.4 Daily trip volumes and distribution by mode, 2015 to 2041 in the MTS Scenario



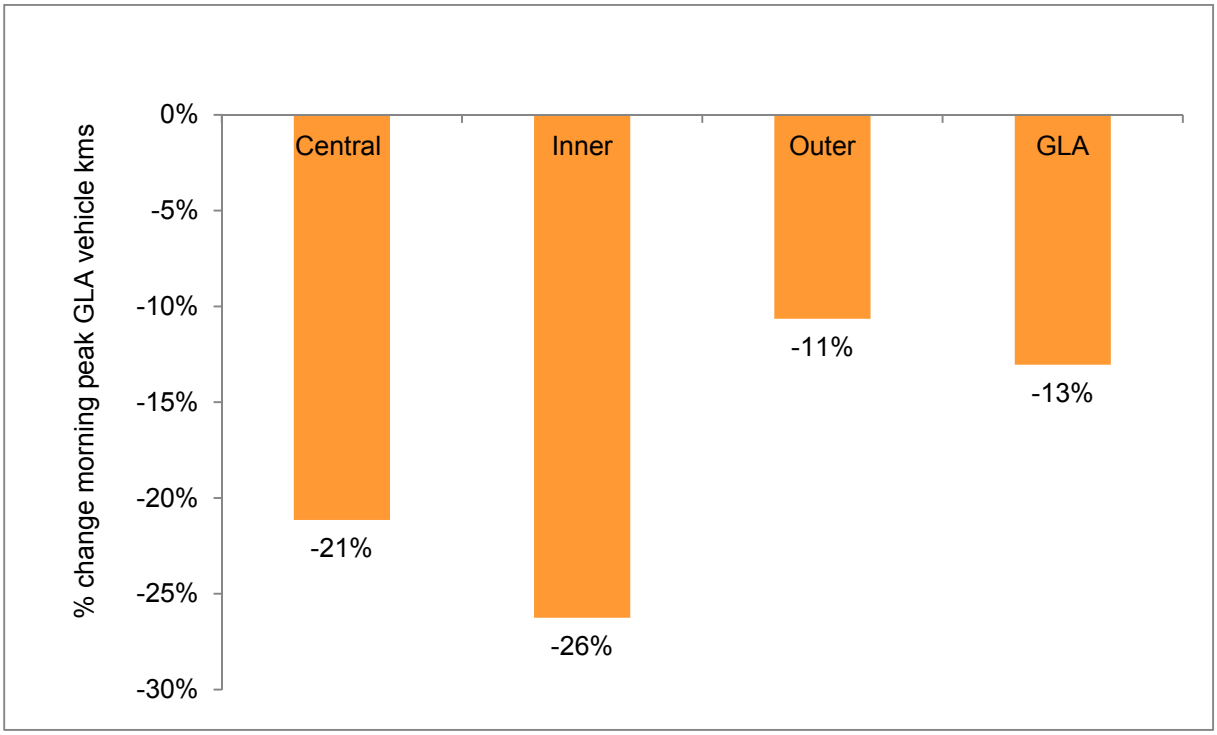


Source: City Planning

Traffic and congestion

The measures proposed by the draft MTS deliver significant decreases in traffic in the morning peak, as shown in Figure 8.5. The greatest change is in inner London - a 26 per cent reduction. London-wide, the reduction in traffic in the morning peak is 13 per cent.

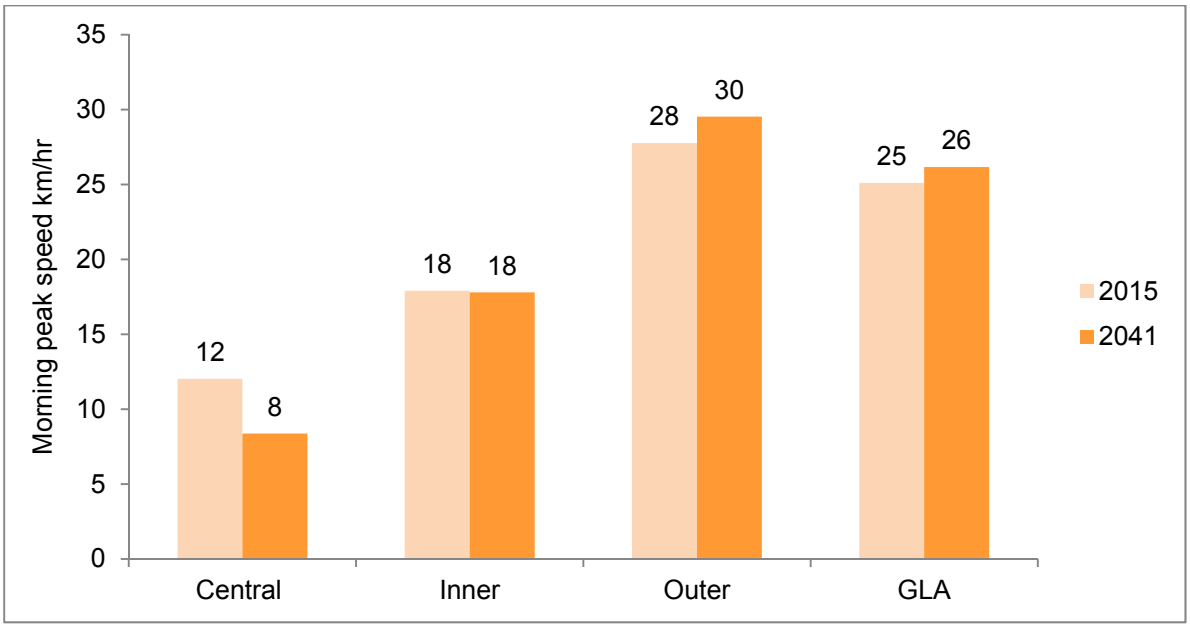
Figure 8.5 Percentage change in morning peak vehicle kilometres, 2015 to 2041 in the MTS Scenario.



Source: City Planning

Fewer cars and shorter journeys mean that speeds increase across most of London, as shown in Figure 8.6. In Central London, very high levels of road space reallocation to sustainable modes means that speeds for general traffic slow, in inner London speeds remain around the same as now, and in outer London, average speeds rise from 28 to 30 kilometres per hour in the morning peak, as shown in Figure 8.6. In conclusion, reallocating road space to meet Healthy Streets objectives could be achieved while reducing delay at a London wide level.

Figure 8.6 Change in London wide morning peak vehicle speed, 2015 to 2041 in the MTS Scenario.

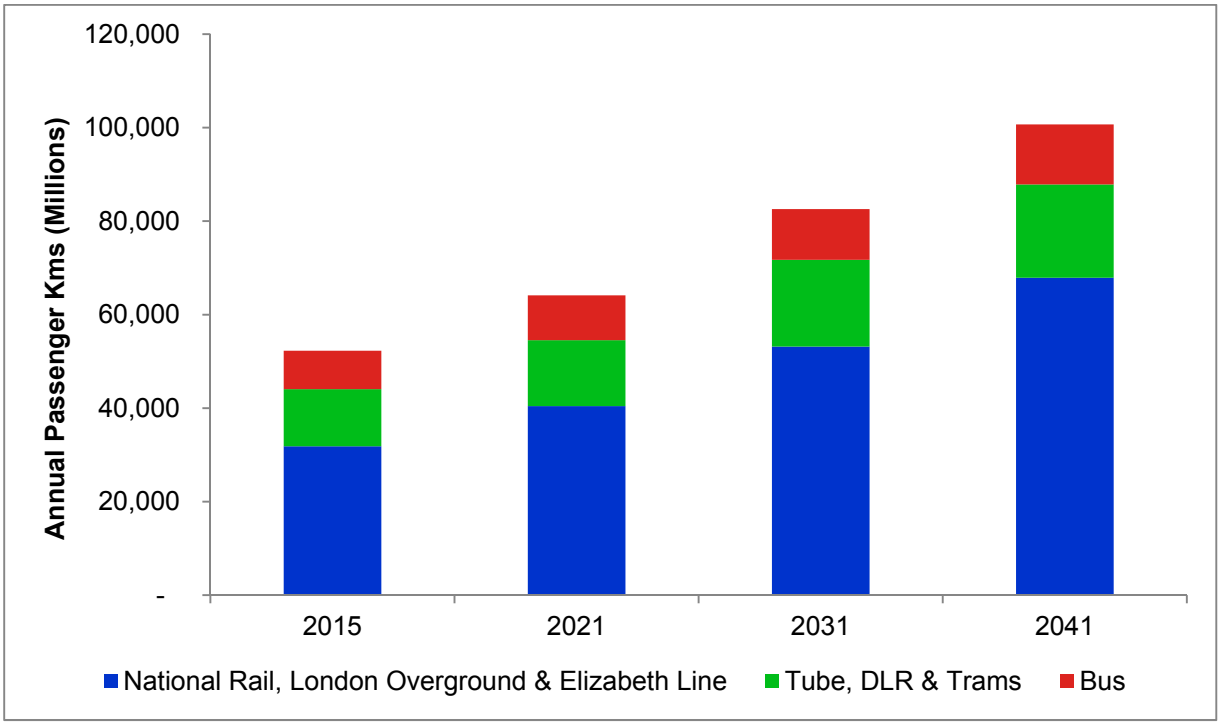


Source: City Planning

Public transport use

The change in 12 hour passenger kilometres by rail, bus and Tube from 2015 to 2041 with the Mayor's Transport Strategy is shown in Figure 8.7. There is a near doubling of passenger kilometres from 2015 to 2041 with the draft Mayor's Transport Strategy as both infrastructure improvements and traffic reduction measures encourage more people to use public transport. The greatest increase is in rail from just over 30 billion passenger kilometres each year in 2015 to nearly 70 billion passenger kilometres in 2041. This is due to the introduction of the Elizabeth Line, Crossrail 2 and the London Suburban Metro. Tube passenger kilometres increase significantly in 2031 due to the introduction of the deep Tube upgrades and the Bakerloo Line extension. Note that these forecasts assume higher mode shift from car to public transport than to active modes; in reality, the implementation of the Healthy Streets Approach may lead to a greater shift to active modes than forecast, reducing public transport passenger kilometres somewhat and also bringing crowding benefits.

Figure 8.7 Change in annual passenger kilometres (millions), 2015 to 2041 in the MTS Scenario.

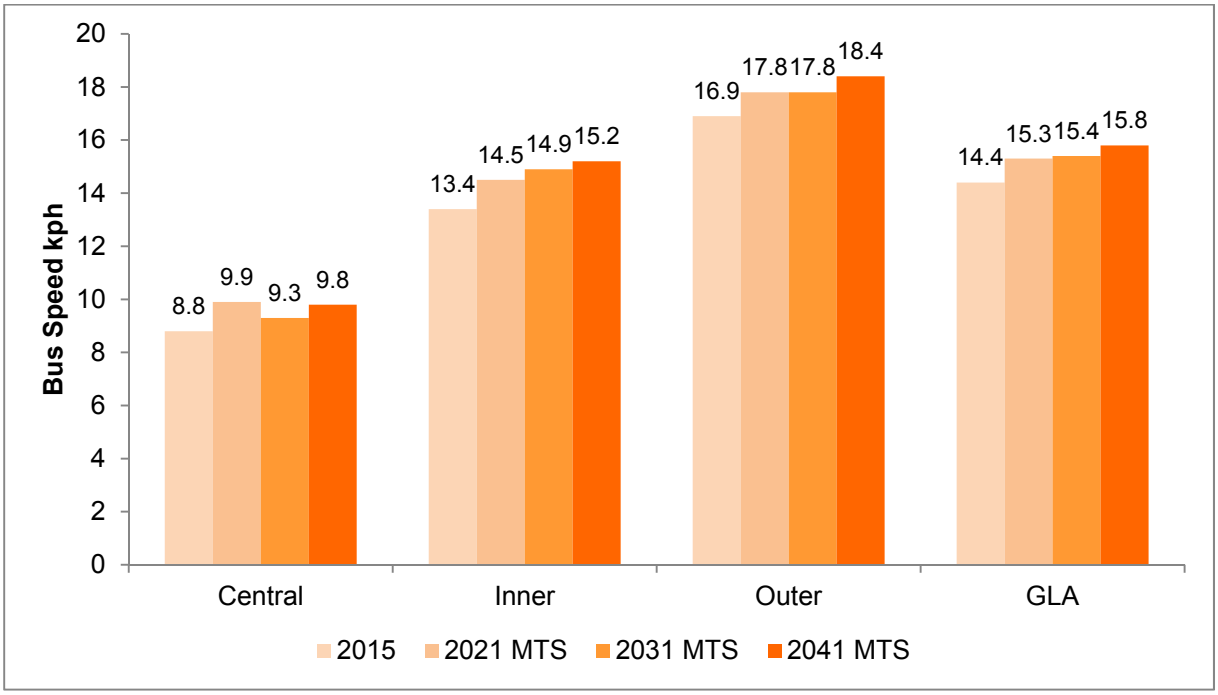


Source: City Planning

Bus speeds

The change in bus speeds from 2015 to 2041 is shown in Figure 8.8. Buses benefit from stable or improved speeds for general traffic as well as the reallocation of road space to buses so that bus speeds improve London-wide from 2021 to 2041. Despite slowing speeds for general traffic, bus speeds improve in Central London due to the reallocation of road space to buses. Consequently, bus speeds are forecast to improve in every region of London. London, bus speeds increase from 14.4 kilometres per hour in 2015 levels to 15.8 kilometres per hour in 2041.

Figure 8.8 12 hour London-wide bus speeds.



Source: City Planning

Crowding on rail and Underground

Crowding on rail services drops significantly as a result of the draft MTS, with the proportion of public transport passenger kilometres travelled on crowded links in the morning peak reducing from 35 per cent of the total in 2015 to 22 per cent in 2041. Crowded links are defined as those with more than 4 passengers standing per square metre in the morning peak. This means that, for an average journey, passengers will experience less crowding, as shown in Table 8.9. Again, if more trips were made by active modes than in the core forecast, and fewer by public transport, crowding would be reduced even further.

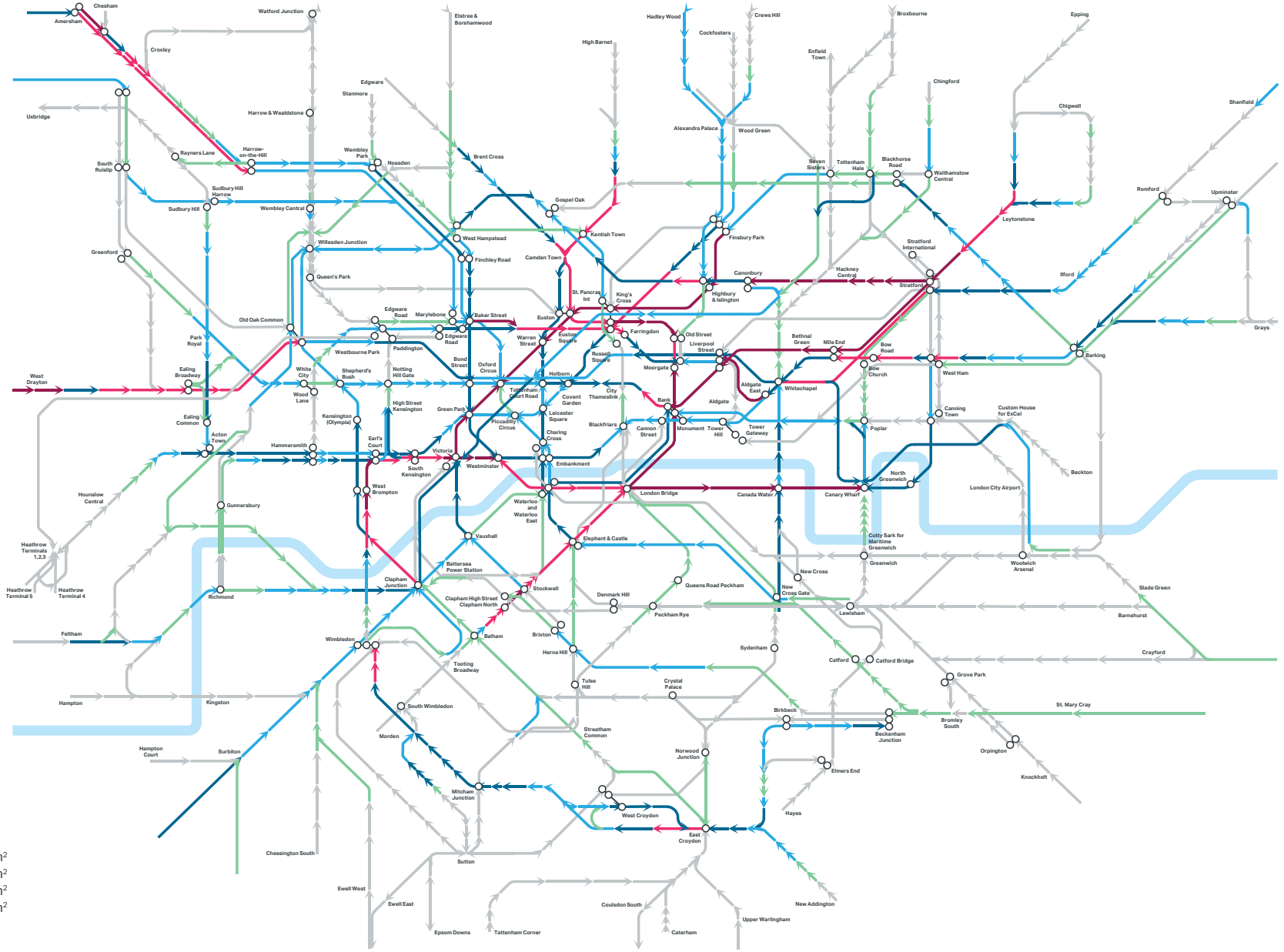
Table 8.9 Proportion of passenger kilometres on links with more than 4 passengers standing per square metre in the morning peak,

Mode	2015	2041 MTS Scenario
All rail and Underground	35%	22%
National Rail, London Overground, Elizabeth Line	32%	19%
Tube & DLR	40%	27%

Source: City Planning

Figure 8.10 shows forecast crowding on National Rail, Tube, DLR, London Overground and Trams in the morning peak in 2041 with the MTS scenario.

Figure 8.10 Morning peak crowding on rail and Underground services in London, 2041 with the MTS scenario



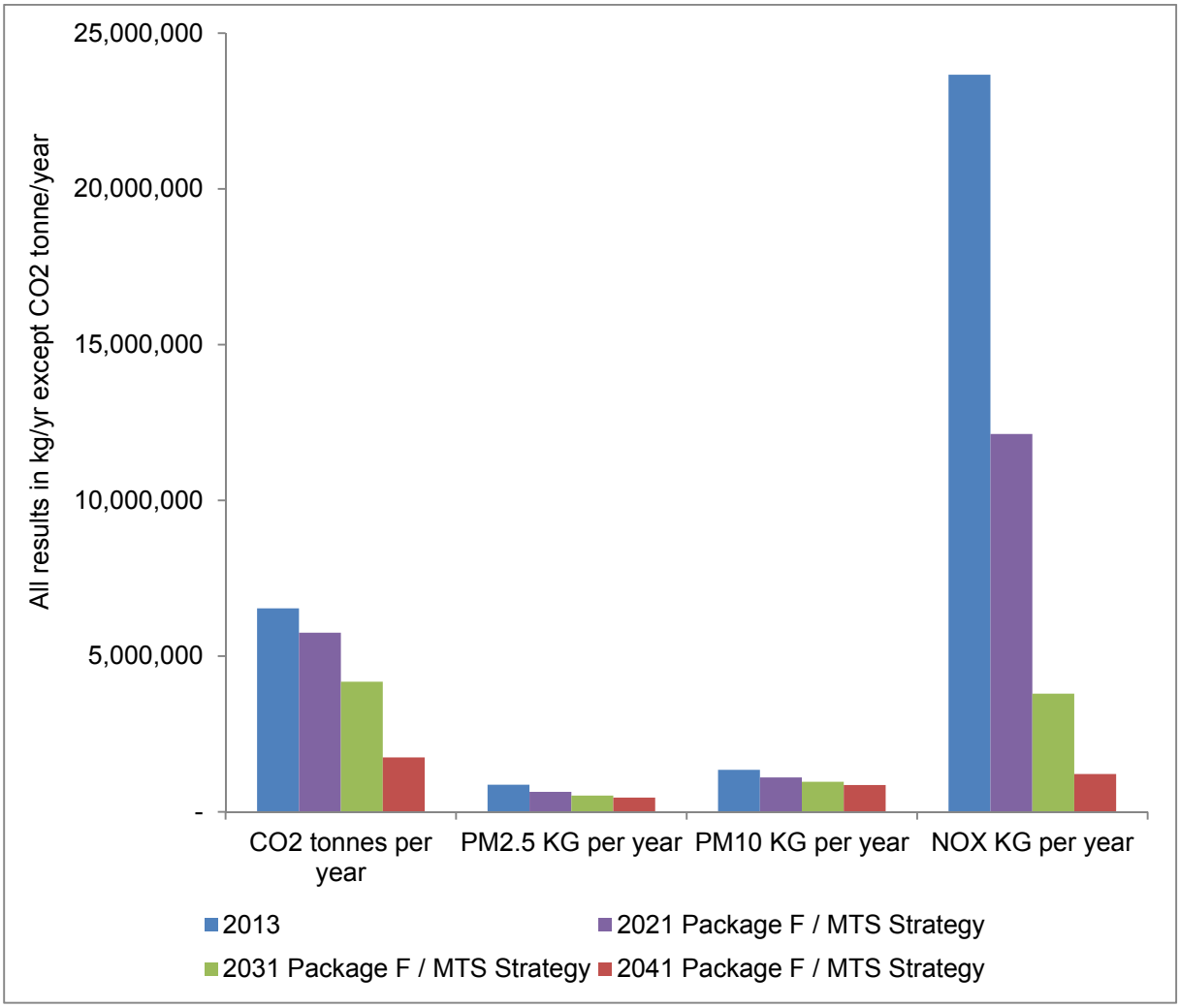
Emissions

Figure 8.11 shows the 2021, 2031 and 2041 road vehicle emissions of the full MTS scenario against the 2013 baseline. Under this scenario, the whole bus fleet becomes electric or hydrogen powered by 2037, and the uptake of ultra-low emission vehicles across all vehicle types is in line with the trajectory required for all road transport to become fully zero emission by 2050.

This could deliver:

- A 72 per cent reduction in CO_2 emissions from transport (excluding aviation, 2013 base) in London by 2041, with road and rail transport on a clear trajectory to reach zero carbon by 2050.
- A 94 per cent reduction in road transport NO_x emissions, and compliance with legal limit values for NO_2 levels on London's streets.
- A 47 per cent reduction in road transport $PM_{2.5}$ and 36 per cent reduction in road transport PM_{10} emissions.

Figure 8.11 Road vehicle emissions including vehicle emissions policy measures, 2013 to 2040.



Source: City Planning

Connectivity

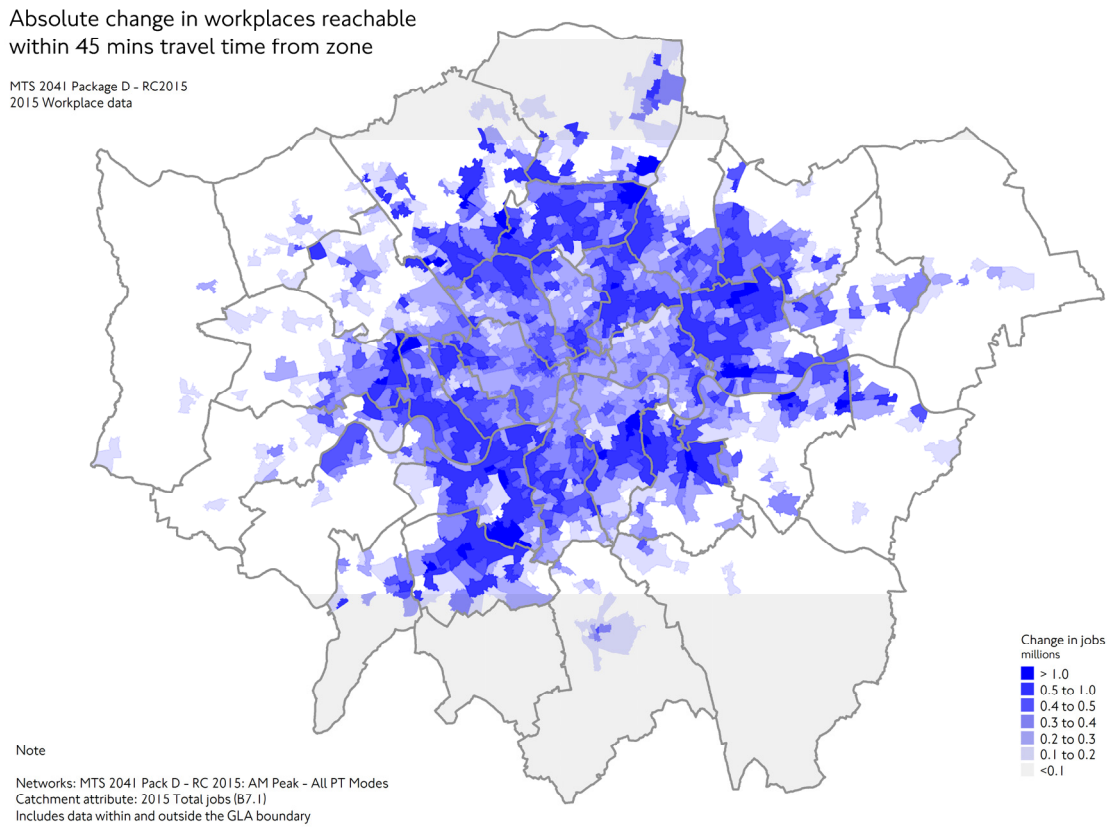
New and enhanced public transport connections and improvements to bus speeds will mean that London residents will be better connected to jobs, services and to one another

Figure 8.12 shows the change in access to jobs within 45 minutes brought about by improvements to public transport services identified in the draft MTS.

In total, 7.6m people will live within 45min travel time of Central London, 2.3m more than today. The number of jobs accessible to the average Londoner within 45 minutes by public transport will increase by 70 per cent. The assessment only considers travel time changes rather than the impact of new jobs and assumes that all identified schemes are in place by 2041. In addition to the Elizabeth line, this package includes schemes such as Crossrail 2 and the Bakerloo line extension. All areas in Central London will see an increase of at least 0.25 million jobs reachable in 45 minutes. In Inner London many areas will experience an increase of over 1 million extra jobs reachable within 45 minutes.

Fewer London residents will be dependent on a car to access opportunities and services. Nearly 1.8m more people will be living in places with the best transport connections, defined as areas with a public transport accessibility rating of four or above.

Figure 8.12 Change in number of jobs reachable within 45 mins travel time by public transport, 2015 to 2041 in the MTS scenario.



Appendix 1: Scheme List

MTS Scenario Scheme	Package*
Elizabeth line	Core Ref Case (A)
TfL Business Plan Tube service improvements to Victoria, Northern and Jubilee Lines	Core Ref Case (A)
Four-Line Modernisation programme – Metropolitan, District, Hammersmith & City and Circle	Core Ref Case (A)
Northern Line extension	Core Ref Case (A)
TfL Business Plan DLR capacity and service improvements including New Train for Docklands	Core Ref Case (A)
TfL Business Plan London Overground capacity and service improvements including Gospel Oak to Barking Line electrification, new trains and increased frequency on North London Line	Core Ref Case (A)
TfL Business Plan Tram service improvements including Dingwall Loop and increased frequency to New Addington	Core Ref Case (A)
TfL Business Plan Bus service improvements including changes to bus routes to improve reliability and reduce congestion and additional services to support residential growth	Core Ref Case (A)
HS2 phase 1 and associated National Rail changes, including mitigation of impacts at street level	Core Ref Case (A)
Thameslink Programme	Core Ref Case (A)
HLOS programme	Core Ref Case (A)
Stratford–Angel Road service	Core Ref Case (A)
Croxley Link	Core Ref Case (A)
Funded improvements to the cycle network	Core Ref Case (A)
Road modernisation plan	Core Ref Case (A)
ULEZ in Central London	Core Ref Case (A)
Elizabeth Line 30 trains per hour	B
Tram upgrades	B
Bus priority network	B
Low Emissions Bus Zones (including bus priority)	B
Essex Thameside Increased frequency	B
Watford DCs increased frequency	B
Great Northern Frequency upgrade	B
Healthy Streets Approach	B
World-Class Capacity programme – Jubilee, Northern, Victoria	C
Deep Tube programme – Piccadilly, Central, Bakerloo and Waterloo & City	C
DLR upgrades	C
London Overground frequency upgrades (network-wide)	C
London Suburban Metro	C
Brighton Mainline Upgrade (higher frequencies)	C
West Anglia Main Line 4-tracking)	C
Increased rail capacity (other lines)	C

Silvertown Tunnel and associated bus services	C
Crossrail 2	D
Bakerloo Line extension to Lewisham and beyond	D
Elizabeth Line extension east of Abbey Wood	D
DLR extension from Gallions Reach to Thamesmead	D
Barking Riverside London Overground Extension	D
Strategic interchanges at Clapham Junction, Lewisham, Stratford and Old Oak Common	D
Other London Overground extensions (including Hounslow–Cricklewood)	D
Other new public transport river crossings in East London	D
Tram extension to Sutton	D
Develop bus network to meet existing and future demand	D
HS2 phase 2	D
Reduce, re-time and re-mode deliveries and encourage more freight consolidation	E
Healthy Streets Approach – further measures	E
Traffic reduction measures	E
ULEZ in inner London	F
Longer term changes to the way road use is paid for	F

*All schemes in packages A to F included in the MTS Scenario. Packages are cumulative from A to F.