Long Term Planning Process

Anglia Route Study

March 2016

EB/045

Contents

Foreword

Welcome to the Anglia Route Study, an important milestone in the development of the railway in East Anglia. We are delighted to be able to present this work, the result of much collaborative effort in the industry.

The railway in Anglia plays a vital role in the region's economy, providing links between communities and employment, industry and markets, and providing nationally important freight flows from ports where container traffic arrives in the UK.

The success of the rail industry over the last 20 years, during which it has delivered greater capacity, performance and safety, at the same time as improved efficiency and value, is notable. However, sustaining this growth and progress to meet forecast demand for the next 30 years will present significant challenges, and these are explored and options to address them presented in this Anglia Route Study.

The purpose of the Route Study is to provide an evidence base that will inform funders when considering rail industry investment choices for the future. It is one of a new generation of Studies across Great Britain which will set out how forecast growth could be met through to 2043. Looking ahead to 2043 ensures that those requirements prioritised for the next ten years are consistent with longer-term developments and will help identify opportunities to enable the network to meet the future needs of the passengers and freight hauliers who want the railway to deliver their transport requirements.

The choices for funders included in this Route Study have been developed through a strategy of focussing on making the best use of the existing network wherever possible before considering infrastructure enhancement. Where the outputs required cannot be delivered within the constraints of the current network, trade-offs between outputs have been considered, along with options to enhance the network.

The dominant issue identified is the need to support demand and future growth on the Great Eastern Main Line, the Cross country corridor via Ely, and the West Anglia Main Line. These three corridors are supported widely by stakeholders through the Great Eastern Main Line Taskforce, Strategic Freight Network and West Anglia Taskforce. Investment is required on these corridors to continue to support the region's growth. Growth is also continuing apace on Essex Thameside and the Orbital Routes and options are presented to support these corridors as well.

Network Rail has led the production of this Route Study on behalf of the industry and as such it has been developed collaboratively with industry partners and wider stakeholders, including passenger and freight operators, the Department for Transport, Transport for London, Local Authorities and Local Enterprise Partnerships. We thank them for all their contribution.

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Executive Summary

This document, part of the Long Term Planning Process (LTPP), considers the potential outputs required by the railway network within the Anglia Route in Control Period 6 (2019-2024), as well as further ahead up to the year 2043. It offers funders sets of choices as to how those outputs might be met, having regard to value-for-money, affordability and efficient delivery.

0.1 Introduction

The Anglia Route Study seeks to establish the required future capacity and capability of the railway through a systematic analysis of the future requirements of the network. It seeks to accommodate the conditional outputs articulated in the Long Term Planning Process (LTPP) Market Studies, whilst maintaining and where possible improving operational performance, at a cost acceptable to funders and stakeholders.

The baseline for the Anglia Route Study has been updated following Sir Peter Hendy's review of the Control Period 5 (CP5: 2014-2019) Enhancement Programme. This results in some elements of the baseline being delivered in Control Period 6 (CP6: 2019 - 2024). The options within the study represent a longer term view over the context of the next 30 years and therefore have not been impacted. It is recognised that the baseline used for the Route Study still has potential to change with the ongoing East Anglia Franchise process and agreement on the future train service.

Should any influences significantly change the outputs of, and options identified within, the strategy, we will review and update it accordingly as part of the ongoing process to maintain its validity.

0.2 Scope

The Anglia Route Study area covers five key corridors through Greater London, Essex, Cambridgeshire, Suffolk and Norfolk, as well as having two of the UK's largest ports at London Gateway and the Port of Felixstowe.

- The **Great Eastern Main Line (GEML)** runs between London Liverpool Street and Norwich and carries key commuter flows into London, a fast-growing long distance flow connecting world-leading centres for biosciences, engineering and renewable energy, as well as a significant amount of freight generated by the port of Felixstowe.
- The **Cross country corridor via Ely** supports a nationally important freight route between the Port of Felixstowe and other regions such as the Midlands, Yorkshire and Scotland alongside busy inter-regional passenger services.
- The **West Anglia Main Line (WAML)** runs between London Liverpool Street and Kings Lynn and carries busy commuter and leisure traffic from Stansted Airport and Cambridge into London Liverpool Street. It has the potential for significant housing and employment growth and connects world-leading centres for biosciences and technology.
- The Orbital Routes, which include the North London Line (NLL) and Gospel Oak to Barking line (GOB), constitute a vital part of London's transport infrastructure and a major link between key arterial routes to and from the capital. They provide a nationally important freight route delivering connections from the Thames Estuary ports and the Port of Felixstowe. The lines connect with every arterial route north, east and west of London and with parts of the southern railway network.
- The **Essex Thameside** route runs from London Fenchurch Street to Shoeburyness and carries a mixture of commuter and leisure traffic along with substantial freight movements to and from the ports at Tilbury and London Gateway.

Figure 0.1 sets out the study area.

0.3 Anglia Growth

The East of England has the fastest growth in employment in England outside London and contributes significantly to the UK economy. The Route Study identifies options for development of the train service and railway infrastructure to continue to support this growth, in response to the range of conditional outputs relevant to Anglia outlined in the Market Studies. It should be emphasised that these conditional outputs are aspirations and not recommendations. They are conditional on being deliverable in a manner which represents value-for-money and which is affordable to funders.

The forecast growth in passenger demand is significant across all main service groups in the region.

Since the publication of the draft for consultation, we have worked with Transport for London (TfL) to understand how changes to forecast housing and population and changes to the structure of TfL's public transport forecasting model, Railplan, have affected predicted growth in rail patronage on the Anglia route.

Figure 0.1 Anglia Route Map

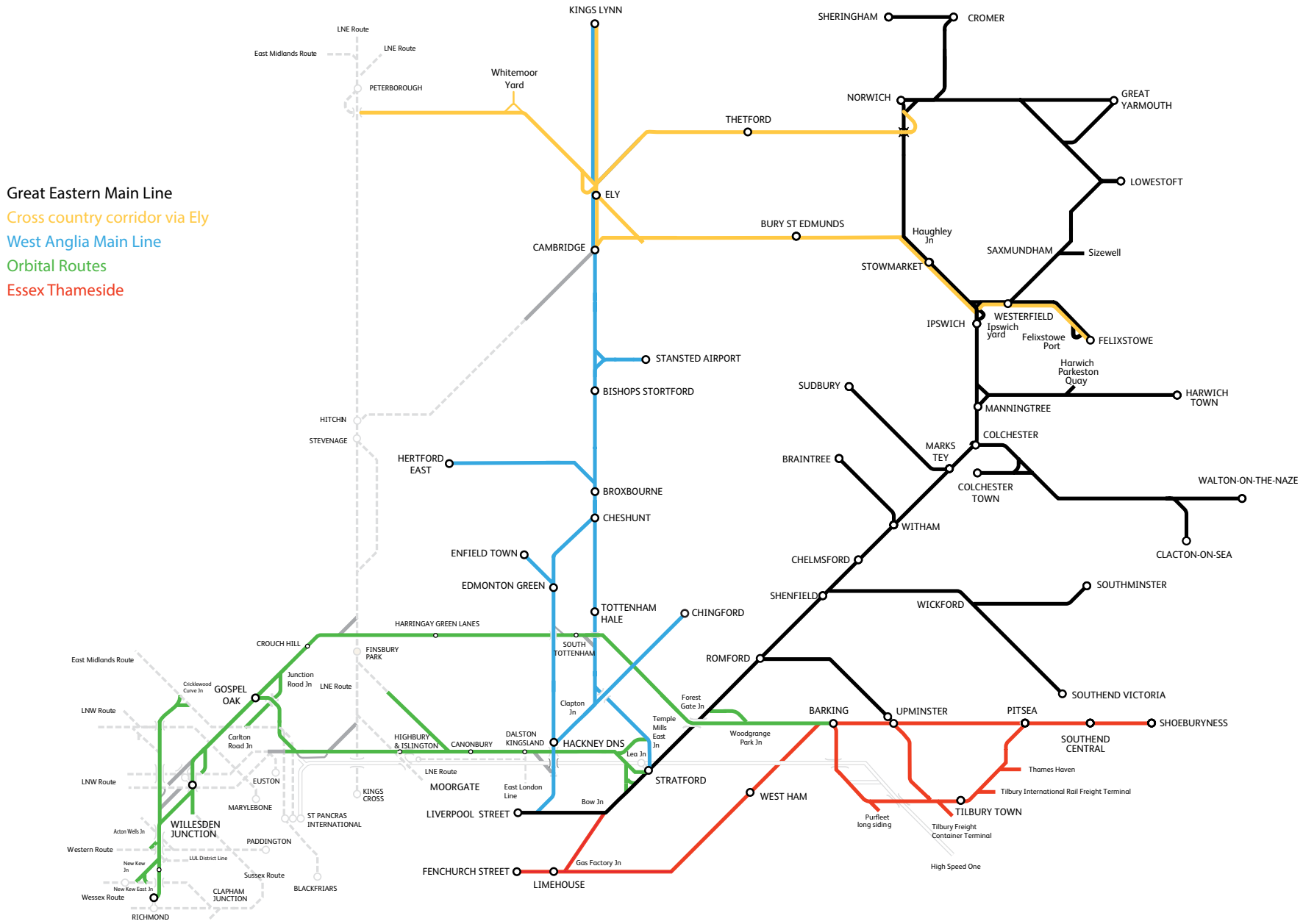
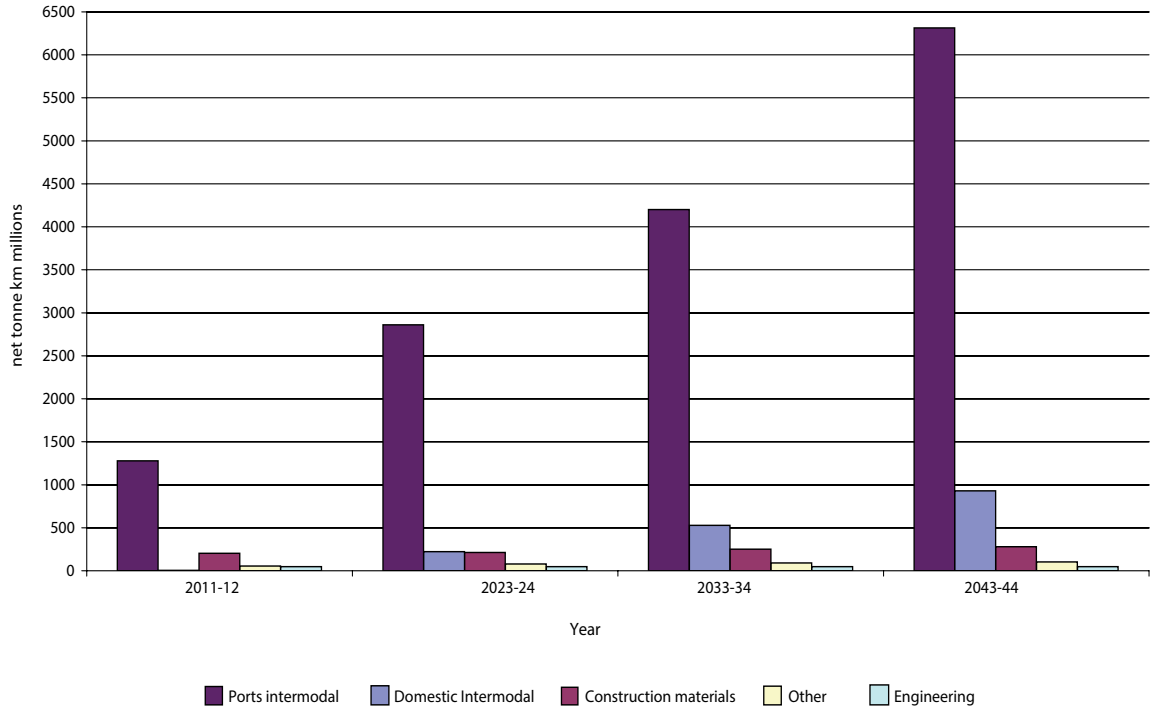


Table 0.1 Increase in morning peak passenger demand into London Termini or at the busiest point on the route from 2013		
Corridor	2023	2043
Great Eastern Norwich and Outer suburban services	32%	75%
Great Eastern Inner suburban and Crossrail services	52%	83%
West Anglia Main Line – all services	18%	39%
North London Line/ West London Line	22%	55%
Gospel Oak to Barking	20%	46%
Essex Thameside	13%	46%
Source: L&SE Market study and TfL Railplan		

Figure 0.2 Freight conditional outputs - Freight growth per commodity



We found that, overall, growth in forecast demand on the West Anglia Main Line was slightly lower than we used in the draft document and growth on Essex Thameside was slightly higher. We decided to keep the forecasts in the draft document as they are broadly consistent, as a reasonable test of the infrastructure in the long term. The changes in forecast growth are unlikely to change the strategy for catering for passengers in the medium and long term.

The forecast increase in peak passenger demand is limited in that it does not fully take into account the latest understanding of housing growth potential on the route. In particular, the methodology for estimating background passenger growth does not take into account the circular effect of improved services on the viability of additional housing, economic regeneration and the resultant increase in passenger demand and requirement for improved connectivity. Choices for CP6 have been developed based on the demand forecasts and on further evidence provided by stakeholders on the growth potential of the route.

Anglia provides nationally important freight routes particularly for intermodal port traffic from the Port of Felixstowe and London Gateway. The forecast growth in freight over the next 30 years is similarly significant across the region.

0.4 Route Study Timeframe and Baseline

The Anglia Route Study has considered the implications of growth in demand and the increased role which the railway could play over the next 30 years to 2043, with choices for funding identified for CP6.

The enhancements which form the baseline[1] for the study are listed below and described further in Chapter 3:

- safety improvements, particularly involving level crossings
- the introduction of Crossrail services
- improvements to cater for freight growth between Felixstowe and Peterborough, such as increased capacity on the Felixstowe branch
- remodelling of Bow Junction at Stratford
- remodelling of Ely North Junction
- electrification of the Gospel Oak to Barking line, which will enable the more efficient operation of passenger services and support development of an electrified freight network, to allow the operation of electric freight services
- the London Overground capacity improvement programme, which has seen trains on the NLL lengthened from 4-car to 5-car
- initial implementation of the National Operating Strategy (NOS), which will eventually have all signalling control on the route located at the Romford Rail Operating Centre (ROC)
- capacity enhancements in the Lea Valley to enable an increase in services running to Stratford.

0.5 Process

The starting point for this Route Study is the Market Studies published in October 2013, which were established by the Office of Rail and Road (ORR)[2] in December 2013. Detailed demand analysis has been undertaken to ascertain the expected amount of growth over the next 10 and 30 years. The analysis identifies where supply and demand is mismatched over 10 and 30 year time horizons and thus where train lengthening or more train services might be required.

The conditional outputs for this study include:

- the level of rail capacity required to meet peak demand into London and Cambridge
- the level of rail capacity needed to accommodate predicted freight demand
- the level of rail connectivity between large towns, cities and airports across the route (for example, the frequency of train services, journey times and the provision of direct journeys which do not require an interchange).

1 Certain baseline schemes are no longer scheduled for CP5 completion following Sir Peter Hendy's review of the CP5 Enhancement Programme; Chapter 3 contains further details.

2 Previously the Office of Rail Regulation

This Anglia Route Study has been developed as a result of considerable analysis and close collaboration between Network Rail, the Department for Transport (DfT), TfL and the passenger and freight operators.

The ORR has acted as an observer. Productive meetings with Members of Parliament (MPs), Local Enterprise Partnerships (LEP), and local authorities (LA) have also been held.

0.6 Consultation

The Anglia Route Study Draft for Consultation was published in November 2014 and the consultation period ran until February 2015. Over 190 responses were received and have been used to review, update and complete further analysis to support the final Anglia Route Study.

0.7 Choices for Funders

The choices identified and appraised as part of the Anglia Route Study are summarised below with a more detailed account in Chapter 5.

In some cases further work may be required to identify additional benefits in order to demonstrate a sufficiently strong economic return.

In all cases, where support exists from funders to progress a particular option, Network Rail will need to complete further engineering feasibility to ensure sufficiently detailed costings, output definitions and delivery plans can be submitted as part of the Business Plan for CP6. All costings published in this Study must be regarded as a high level guide only at this stage and are subject to change.

0.8 Great Eastern Main Line (GEML)

Capacity into London from the Great Eastern Main Line is currently provided by a combination of long distance high speed (LDHS) and suburban services. The long distance services serve cities such as Norwich and towns including Ipswich and Colchester. Outer suburban services serve commuter markets from Southend Victoria, Chelmsford, Clacton on Sea and Braintree into London; the suburban (what will be Crossrail) services serve a predominantly commuter market inwards of Shenfield (referred to as GEML Inner).

For these service groups the London and South East Market Study (2013) predicts 32 per cent growth for outer suburban and 52 per cent growth for inner suburban services into London Liverpool Street in the high-peak between 2011 and 2023. By 2043, 75 per cent and 83 per cent growth respectively is predicted in the high growth scenario.

Peak Capacity: Great Eastern Inners and Crossrail (suburban)

The Route Study assessment shows that the level of capacity provided when Crossrail is delivered in 2019 will meet growth up to CP8 (2029-2034) or CP9 (2034-2039), with a capacity gap expected by the end of CP10 (2039-2044).

Peak Capacity: Great Eastern Norwich and Outers

Analysis of the increased peak demand indicates that by 2043 an additional 5 to 6 trains per peak hour are required over and above the baseline for the Great Eastern Main Line. The increased demand is predominantly on services on the Norwich corridor serving Ipswich, Colchester and Chelmsford. This equates to a need for 31 to 32 main line paths in total per hour in the peak.

Long-term solutions to meet peak demand to 2043 will require significant investment in infrastructure across the route:

- Increased platform capacity at London Liverpool Street
- Signalling headway reduction between Chelmsford and London Liverpool Street
- Passing loop north of Witham
- Doubling of Trowse Swing Bridge
- Improvements at Haughley Junction

The analysis for CP6 indicates that an additional 3tph are required to accommodate peak demand forecasts, which would equate to 27 main line tph in peak hours. The main line inwards of Shenfield is already highly congested in the peak hour. This means that increasing the level of service above the 24tph (stated in Chapter 3 as the baseline) comes with a likely adverse effect on reliability and performance without some major interventions to improve the capability of the infrastructure. To achieve an increase in main line services in CP6 would require significant change to the

infrastructure which is an incremental step towards the 2043 strategy.

Options for CP6 include:

- Additional platform capacity at London Liverpool Street
- Signalling headway reduction between Chelmsford and Stratford
- Provision of a loop to the north of Witham
- Doubling of Trowse Swing Bridge

There is an opportunity for European Train Control System (ETCS) and Automatic Train Operation (ATO) to support the improved signalling headways required between Chelmsford and Stratford to meet the growth on this corridor alongside interventions at London Liverpool Street, north of Witham and Trowse.

Journey Time Improvements

Achieving journey time improvements between London and outer destinations will require a mixture of calling pattern changes, rolling stock improvements and infrastructure interventions. The Great Eastern Main Line Taskforce has been examining these options and working towards a phased approach to achieving journey time improvements on the route.

The best possible improvements to journey time can be achieved through changes to rolling stock to improve acceleration and reduce dwell times (through removal of slam door stock) and altering the calling patterns of the fast services on the route. If calling patterns are reduced, then additional services will be required on the route to replace calls and retain the connectivity to other stations. The interventions for journey time improvement therefore largely correspond to those addressing the capacity gap to allow an increase in main line services on the route:

- doubling of Trowse Swing Bridge (as in capacity options)
- passing loop at north of Witham (as in capacity options)
- additional platform(s) at Liverpool Street (as in capacity options)
- line speed improvements, including through level crossing works.

A feasibility study to examine increasing the line speed on the Great Eastern Main Line has been completed. This has indicated that upgrading the whole route to 110mph will have a very significant cost. Therefore, it is recommended that line speed improvements on the GEML are targeted alongside other enhancement and renewal activity to reduce cost. Level crossing mitigations and power supply enhancements are likely to be required as enabling projects to support achieving the best journey time improvements on this route.

0.9 Cross country corridor via Ely

By 2043 there is a shortfall in freight capacity and a gap in connectivity outputs that require addressing on this corridor. Significant infrastructure change would be required to fully accommodate the forecast growth and improved passenger service (primarily linked to Cross-boundary services and improved connectivity). Infrastructure changes would be required in the following locations:

- Haughley Junction
- Ely area
- Ely to Soham
- Trowse Junction
- Felixstowe Branch

In line with the longer term strategy for this corridor to meet CP6 freight forecasts, choices for funders include:

- Doubling of sections of the Felixstowe Branch
- Improved signalling headways on the Bury St Edmunds line
- Ely area improvements including level crossings and headway reductions
- Ely to Soham – doubling or partial doubling of single line section

There may be an opportunity through the roll out of ETCS to achieve headway improvements on this corridor and this should be examined further through the Digital Railway Programme.

Kings Lynn – Cambridge: Train lengthening

There is peak crowding on services between Ely and Cambridge and the demand is forecast to grow. Development work has commenced

on an option to examine lengthening services on the Kings Lynn to Cambridge section from 4-car to 8-car during the peak hours. The industry, funders and local stakeholders are in agreement that this is a high priority and Network Rail is examining options for early implementation, potentially within CP5.

Lengthening services along this corridor will also support increased on-train capacity to allow for additional calls, such as the new station at Cambridge North.

0.10 West Anglia Main Line (WAML)

By 2043 a significant intervention such as Crossrail 2 is required to meet connectivity and capacity outputs on this corridor. It should be noted that there is an aspiration for Crossrail 2 to be operational by around 2030; this would support the predicted 39,000 to 70,000 new homes along this corridor, which is a priority for central Government. Crossrail 2 also supports improved connectivity and capacity through additional services, which can be achieved through additional track capacity, and the central tunnel section, which removes terminal constraints that limit increasing the service on this route.

Journey time improvements

The longer term strategy for Crossrail 2 would support additional tracks on West Anglia (four-tracking) which will support journey time improvement through the segregation of fast and stopping services on the corridor and the ability to review and amend calling patterns.

An option has been assessed to achieve journey time improvements prior to any four-tracking scheme. The option provides journey time improvements in the off-peak, although no improvement can be made in the peak due to a combination of capacity constraints and the mix of services on the route. It achieves journey time improvements to Stansted and Cambridge in the off peak through:

- rolling stock changes
- line speed improvements
- calling pattern amendments.

Peak capacity to/from London Liverpool Street

There is expected to be a capacity gap of approximately 1,000 passengers on the Cambridge and Stansted Airport services and 1,700 passengers on the suburban services, between 08:00 and 08:59 by the end of CP6. To support the demand gap (based on the existing train service and not supporting further growth on the route) capacity can be increased in CP6 through train lengthening.

Early investment in Crossrail 2 on West Anglia in CP6

Significant housing growth above that forecast as part of the Market Studies could take place along the West Anglia corridor. In part this could be contingent on greater investment in the network to provide better train services. During the consultation period stakeholders have provided further information on the growth potential of the route to support this strategy. Analysis provided by TfL shows that four-tracking the West Anglia Main Line in advance of delivering Crossrail 2, with an explicit future commitment to Crossrail 2, could unlock 20,000 homes and 10,000 jobs sooner than 2030.

Options have been developed as an investment choice to allow an increase in services from the West Anglia route to Stratford. This would require four-tracking[3], alongside additional platform capacity at Stratford and a third track between Stratford and Ruckholt Road. This option would allow between 2 and 4 additional services per hour between West Anglia and Stratford.

The benefits from this option do not fully utilise the capacity generated by a four-tracking scheme and therefore need to be considered in relation to the longer term priorities of the West Anglia Main Line. It is recommended that any further development activity is linked to Crossrail 2 development so that there is no, or limited, abortive infrastructure work or cost. The current Crossrail 2 timelines show construction would need to begin in the early 2020s, therefore this would need to be a joint programme of work. Early work could progress on enabling workstreams for four-tracking such as land take and level crossing closures as these are consistent in all options examined.

3 Assumed to be the same extent of four-tracking as required for Crossrail 2

The extent of four-tracking that could be completed in CP6 will depend on a number of factors including the timeline for relevant consents, available funding, industry resource and the views of funders and the industry on relative priority nationally.

The West Anglia Taskforce will continue to examine this option and potential standalone four-tracking schemes to make the case for investment in this corridor in CP6.

0.11 Orbital Routes: North London Line (NLL) and Gospel Oak to Barking (GOB)

One of the key challenges for both the North London Line and Gospel Oak to Barking line is continuing to support growth for both passenger and freight services whilst maintaining performance.

Options have been developed to support any increase in services:

- Highbury and Islington – headway improvement
- New regulating points at either Gospel Oak or Kensal Rise
- Signalling headway reduction between Gospel Oak and Barking
- 8-car operation on the North London Line.

0.12 Essex Thameside

Anticipated passenger growth on Essex Thameside to both 2023 and 2043 can be met through further train lengthening of services to 12 carriages, although improved signalling headways will be required to achieve any increase in service frequency on this route. Should realised growth in demand out-perform our forecasts for the medium term, the strategy will still cater to this speedier passenger increase, but may require earlier implementation.

For freight, there is adequate capacity to meet the predicted growth in pathing demand. However, there are opportunities to improve the robustness of these freight paths through the further development of Ripple Lane West Yard (Nodal Yard) whilst infrastructure is being delivered at Barking Riverside.

0.13 Priorities for Control Period 6 (CP6)

There are three key corridors where investment is required in CP6 to meet and continue the growth across the region:

- Great Eastern Main Line

  To support increase in main line train services in peak hours to meet projected demand, alongside improvements to journey times.
- Cross country corridor via Ely

  To support increased freight paths to deliver the forecast growth from the Port of Felixstowe alongside improved passenger services.
- West Anglia Main Line

  To support growth on this corridor through delivering peak passenger demand, improving journey times and improving service frequencies on the route.

0.14 Other key options and conclusions

Station Pedestrian Capacity

The Route Study has investigated locations where it is considered that pedestrian flow will become a concern in coming years. Analysis has shown that in CP6 interventions will be required to meet passenger numbers at a number of stations including Seven Sisters and London Liverpool Street.

Improved connectivity

Options to address improved connectivity on all branch lines through increased train frequency have been assessed. These outputs were developed as target frequencies and in each case are subject to value for money analysis.

0.15 Link to other industry processes

The East Anglia and Essex Thameside Franchise as well as the London Overground Concession processes have been running in parallel with the development of this Route Study. The outcome of these agreements may therefore impact the assumptions made around rolling stock and train services. It is recommended that all options are reviewed and updated if required where the franchise or concession agreement significantly changes either assumptions or outputs of the Route Study, or where opportunities are newly presented as a result of these awards.

0.16 Acknowledgements and next steps

The Anglia Route Study has been developed through a process of wide industry collaboration and the Route Study team wishes to acknowledge the considerable assistance provided by industry stakeholders and others in the development of this document.

The Route Study identifies “choices for funders” which will inform the industry’s ongoing discussions with funders concerning the future outputs, investment choices and funding requirements for the railway in the medium and longer term. These discussions will be led by the Rail Delivery Group (RDG) on behalf of the industry, with input from the Planning Oversight Group (POG), which comprises industry stakeholders, and the Strategic Freight Network (SFN) Steering Group.

01: Background

Chapter 1 explains

- how the rail industry's long term planning process is developed
- how investment in rail to meet the needs of Anglia is targeted through choices for funders
- how those choices are developed collaboratively by the rail industry with its wider stakeholders

1.1 The Long Term Planning Process (LTPP)

This Route Study is a key output of the rail industry's Long Term Planning Process (LTPP). Developed following the success of an earlier strategic review – the Route Utilisation Strategy programme – the LTPP is designed to consider the role of the railway in supporting the UK economy over the next 30 years. It comprises a set of documents and activities that:

- address the demands that are likely to be placed on Britain's rail network over the next 30 years
- capture stakeholder aspirations to develop new train services in the light of continuing rail investments
- present investment choices for funders to accommodate demand and future aspirations

The LTPP proposes ways in which train services and infrastructure enhancement could develop over the longer term to 2043 and provides an evidence base for near-term investment in Control Period 6 (CP6: 2019 – 2024).

1.2 Structure

The LTPP consists of a number of different elements which seek to define the future capability of the rail network.

- Market Studies, which forecast future rail demand and develop conditional outputs for future rail services. These outputs are based on stakeholders' views of how rail services can support delivery of the industry's strategic goals.
- Route Studies, which develop options for future services and for investment in the rail network for each of Network Rail's devolved Routes. Options are based on the conditional outputs and demand forecasts from the Market Studies and are assessed against industry appraisal criteria to provided choices for funders.
- Cross-boundary analysis, which consider options for services that run across multiple routes to make consistent assumptions in respect of these services.
- In addition to these studies, Network Rail facilitates the production of Network Route Utilisation Strategies (Network RUS). These strategies look at network-wide issues and address the future capacity and technology-related issues for the railway.

1.3 Safety

Network Rail set out a vision for safety in its Transforming Safety and Wellbeing report which takes a view through to 2024. Many of the choices for funders set out later in this document are at an early stage of maturity and safety considerations and requirements will be embedded from the outset of their development. By their very nature, proposals to remove junction conflicts, eliminate crossing movements and ease the flow of passengers at stations will improve the safe operation of trains. Equally, some investment proposals have the potential to eliminate level crossings; where this is the case, these opportunities have been identified and costed and will be progressed if the schemes are developed further.

1.4 Performance

In developing the schemes set out in this Route Study, the rail industry has principally considered how the conditional outputs identified via Market Studies could be met, both for CP6 and in the longer term to 2043. More immediately, Network Rail has been set targets to improve performance by 2019; these are set out in detail within the Delivery Plan for Control Period 5 (2019 – 2024). The trajectory of these changes is to improve performance, monitored through the Public Performance Measure (PPM); the target is a PPM of 92.5 per cent for England, Wales and Scotland by the end of Control Period 5 (CP5).

The performance objectives for the rail industry in CP6 are not yet established. However, the trend is likely to be one of continuous improvement across the industry. As the choices for investment in CP6 (set out in Chapter 5) are developed further, emerging opportunities for performance improvement can be considered in more depth.

1.5 Resilience

The resilience of transport networks was severely affected by the series of winter storms in recent years. These events have brought into sharp focus the vulnerability of parts of the network to changes in climate and the increasing incidence of extreme weather events. Whilst the immediate response to address these challenges has

been well received, there is also a need to consider resilience broadly as a strategic issue for the railway.

To this end, the Anglia Route has developed a Weather Resilience and Climate Change Adaptation Plan (WRCCA) which was published in September 2014. This document sets out a management plan for weather and climate change resilience. It is supported by an evaluation of the effects of historical weather events on infrastructure and an awareness of potential future impacts based on regional climate change projections. The Action plan for the Anglia Route can be found in Appendix D.

There are a number of proposed interventions detailed in the WRCCA that are currently unfunded. These address vulnerabilities on the Route relating to flooding, high and low temperatures, wind and snow, among others, and should be considered in conjunction with any enhancement options set out in the Anglia Route Study. Ensuring the foundations for a robust network are in place is imperative in maintaining its functionality and the performance requirements set for both freight and passenger services.

1.6 The Digital Railway

The Digital Railway is an industry-wide programme designed to benefit the UK economy by accelerating the digital enablement of the railway.

The programme sets out to build the industry business case, to accelerate the digital enablement of the railway ,in several key areas including infrastructure, train operation, capacity allocation, ticketing and stations.

The output of the programme will be a business case to the DfT for consideration of its inclusion in CP6. Digital Railway options have only been considered where they support achievement of conditional outputs.

We are working on the potential early deployment of Digital Railway technology on the Norwich - Yarmouth - Lowestoft (NYL) lines, which could bring benefits to passengers in terms of performance.

1.7 Interoperability

The Railways (Interoperability) Regulations 2011 and associated Technical Specifications for Interoperability (TSI) apply to the entire UK rail network with the exception of the exclusions defined on the DfT website.

European and UK legislation defining objectives for Interoperability and the Trans European Transport Network (TEN-T) have been taken into account in the development of this Route Study.

For works being carried out on the UK component of the TEN-T network, European Union funding support is available for qualifying projects. Network Rail will work with the DfT to ensure that the UK takes maximum benefit from this opportunity.

1.8 Declarations of congested infrastructure

When Network Rail receives more requests for train paths to be included in the Working Timetable (WTT) than can be accommodated on a section of line, the section of line concerned should be declared as 'Congested Infrastructure' under paragraph 23 of The Railways Infrastructure (Access and Management) Regulations 2005.

If infrastructure is declared as congested Network Rail will undertake and publish a capacity analysis within six months under paragraph 23 of the regulations. Thereafter Network Rail will also undertake a capacity enhancement study and publish that within a further six months under paragraph 24 of the regulations. The Route Study will be used to support the capacity enhancement element.

1.9 Accessibility and diversity

Network Rail's vision is to provide world-class facilities and services to everyone who uses the network. For the passenger interface this is particularly around stations where Network Rail seeks to make all stations:

- safe
- accessible and inclusive
- efficient in the way natural resources are used and waste is managed
- focused on the needs of all Network Rail customers
- staffed by a competent, high quality team

Travelling by train should be as easy as possible for everyone who uses the railway network, irrespective of their age, disability, race, religion or belief, sex or sexual orientation. This brings Network Rail in line with the Public Sector Equality Duty (PSED).

Network Rail receives specific funding for accessibility at stations through the Access for All (AfA) fund and will continue to design infrastructure that meets all accessibility legislation.

1.10 Link to other industry processes

The East Anglia and Essex Thameside Franchise as well as the London Overground Concession processes have been running in parallel with the development of this Route Study. The outcome of these agreements may therefore impact the assumptions made around rolling stock and train services.

It is recommended that all options are reviewed and updated if required where the franchise or concession agreement significantly changes either assumptions or outputs of the Route Study, or where opportunities are newly presented as a result of these awards.

1.11 Next Steps

The Anglia Route Study has been developed through a process of wide industry collaboration. It identifies “choices for funders” which will inform the industry’s ongoing discussions with funders concerning the future outputs, investment choices and funding requirements for the railway in the medium and longer term.

The Rail Delivery Group (RDG) will be leading these discussions on behalf of the industry, with the Planning Oversight Group (POG), which comprises industry stakeholders, and the Strategic Freight Network (SFN) Steering Group overseeing industry stakeholder input.

02: Consultation

Chapter 2 explains

- the consultation process undertaken to inform the development of the Anglia Route Study
- key themes of the consultation responses received

2.1 Route Study Governance Arrangements

The Anglia Route Study has been developed through a joint working group that is made up of stakeholders from across the rail industry. The documentation and analysis that support the study have been produced by Network Rail on behalf of the Route Study Working Group.

A three-tier structure for stakeholder dialogue was established to oversee and help produce the Anglia Route Study (Figure 2.1):

- The **Route Study Programme Board** chaired by Network Rail's Route Managing Director Anglia, with senior level representation from passenger and freight train operating companies, the Rail Delivery Group (RDG), Department for Transport (DfT), Transport for London (TfL) and the Office of Rail and Road (ORR). The Route Study Programme Board directs the output from the Route Study Working Groups and provides a forum to resolve any significant issues which the Working Group wishes to remit to the board for decision.
- The **Working Group**, comprising representatives from DfT, TfL, the current Train and Freight Operating Companies (TOCs and FOCs) who operate on the route, RDG, Network Rail and the ORR, as an observer. The Working Group determines if and how the conditional outputs from the Market Studies can be accommodated on the route. The Working Group has a mandate to discuss the study on behalf of the rail industry with other stakeholders and is supported by a Technical Working Group led by Network Rail which evaluates options for technical feasibility and cost. Where conditional outputs cannot be accommodated, options and trade-offs are developed for both services and infrastructure, and choices for funders are presented for both Control Period 6 (CP6: 2019-2024) and to 2043.
- The **Regional Working Group**, providing location specific oversight as well as an opportunity to collaborate in the production of the Route Study with the rail industry. The Regional Working Group membership comprises Local Authorities (LAs), Local Enterprise Partnerships (LEPs), Airports and Freight stakeholders on the route.

The Cross-boundary assumptions for the study have been managed by the **Cross-Boundary Working Group**. This national group, consisting of representatives of the passenger and freight operators along with funders, meets to consider the implications of Cross-boundary services across the country.

In addition, these groups have been complemented by wider stakeholder events, Technical Working Groups and one-to-one discussions with Members of Parliament and individual group members to guide and develop the work.

2.2 The Anglia Route Study

The Anglia Route Study takes as its starting point the railway as it will be following the delivery of investment which is already committed. Details of the changes which will result from this investment are articulated in Chapter 3.

In developing the investment choices for funders detailed in Chapter 5, the Route Study has taken into account a number of key issues that shape the way the UK railway will develop. These are: safety, performance, the implications of High Speed 2 (HS2), East West Rail, resilience, moving towards a digital railway and congested infrastructure on the Route Study area.

2.3 Development of the process

Network Rail has taken a collaborative and consultative approach to the development of the Long Term Planning Process (LTPP). The Anglia Route Study has been a key part of this process.

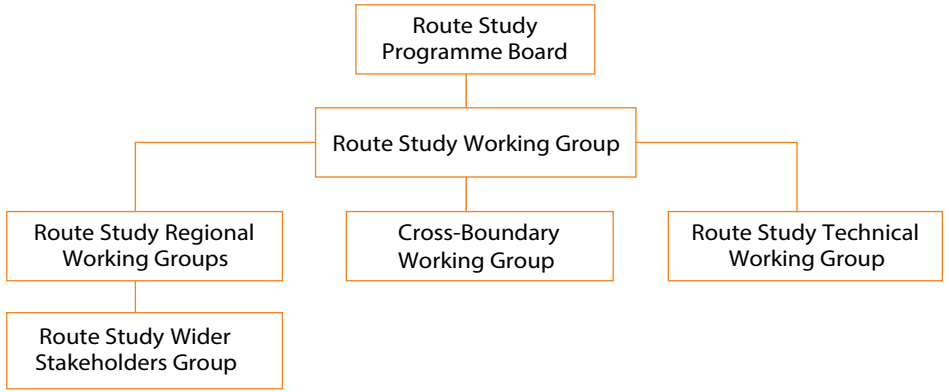
As a new approach to industry planning, it has been important to develop a process that allows an opportunity for all interested stakeholders, both within and outside the rail industry, to contribute if they wish to influence the rail industry's plans for the future.

2.4 Consultation

The Anglia Route Study Draft for Consultation was published on the Network Rail website on 5 November 2014. A 90-day consultation period on the document closed on 3 February 2015.

Additional analysis of the proposals within the Draft Anglia Route Study was undertaken both during and after the consultation period, which has been incorporated into the final document. The various Route Study forums have continued to convene during the

Figure 2.1 Anglia Route Study Governance Arrangements



consultation period and further meetings have been held with all groups following the consultation period to determine and share further work and the final strategy.

2.5 Consultation responses

Over 190 responses were received from stakeholders; these are published on the Network Rail website alongside this study.

The types of responder comprise the following and have been captured in Figure 2.2:

- Private Individuals
- Local Authorities/Umbrella Organisations
- Interest and User Groups
- Elected Representatives (MPs/Councillors etc.)
- Businesses
- Local Enterprise Partnerships
- Train Operating Companies (TOCs)
- Freight Operating Companies (FOCs)
- Educational and Professional Institutions
- Office of Rail and Road[1]

1 Previously the Office of Rail Regulation

Some of the key and recurring themes have been captured in Figures 2.3 and 2.4.

2.6 Key themes and summary of line of route consultation responses

The responses Network Rail received were in many cases comprehensive and detailed. As a result, it is difficult to provide a précis of each individual response. These included constructive suggestions and requests for clarification, which have been reviewed and addressed within the Final Anglia Route Study.

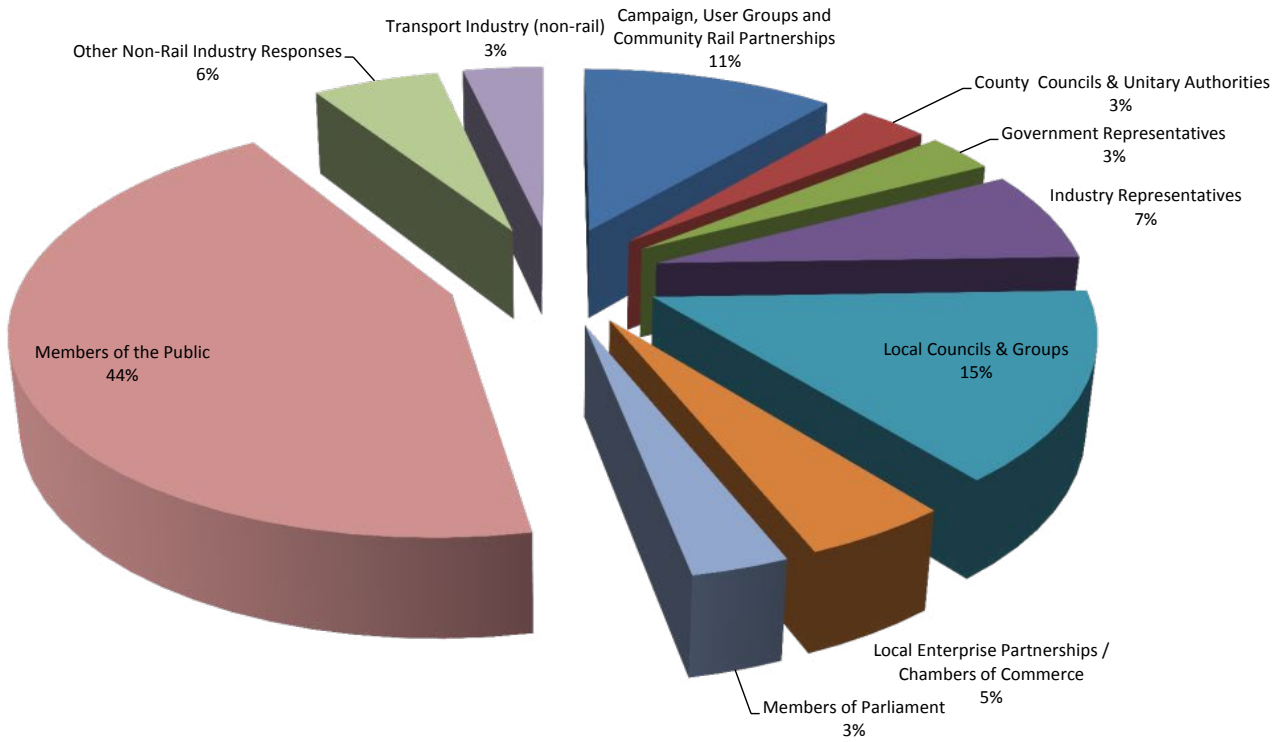
2.7 General comments

2.7.1 Principles of the Route Study

By and large, consultees were supportive of the options identified by the study as a means of catering for future growth and improved connectivity.

There was significant support for journey time and line speed improvements on the Great Eastern Main Line (GEML) and West Anglia Main Line (WAML), as well as for electrification of the Felixstowe to Nuneaton Line, which would improve both passenger and freight services.

Figure 2.2 Responses by type of responder



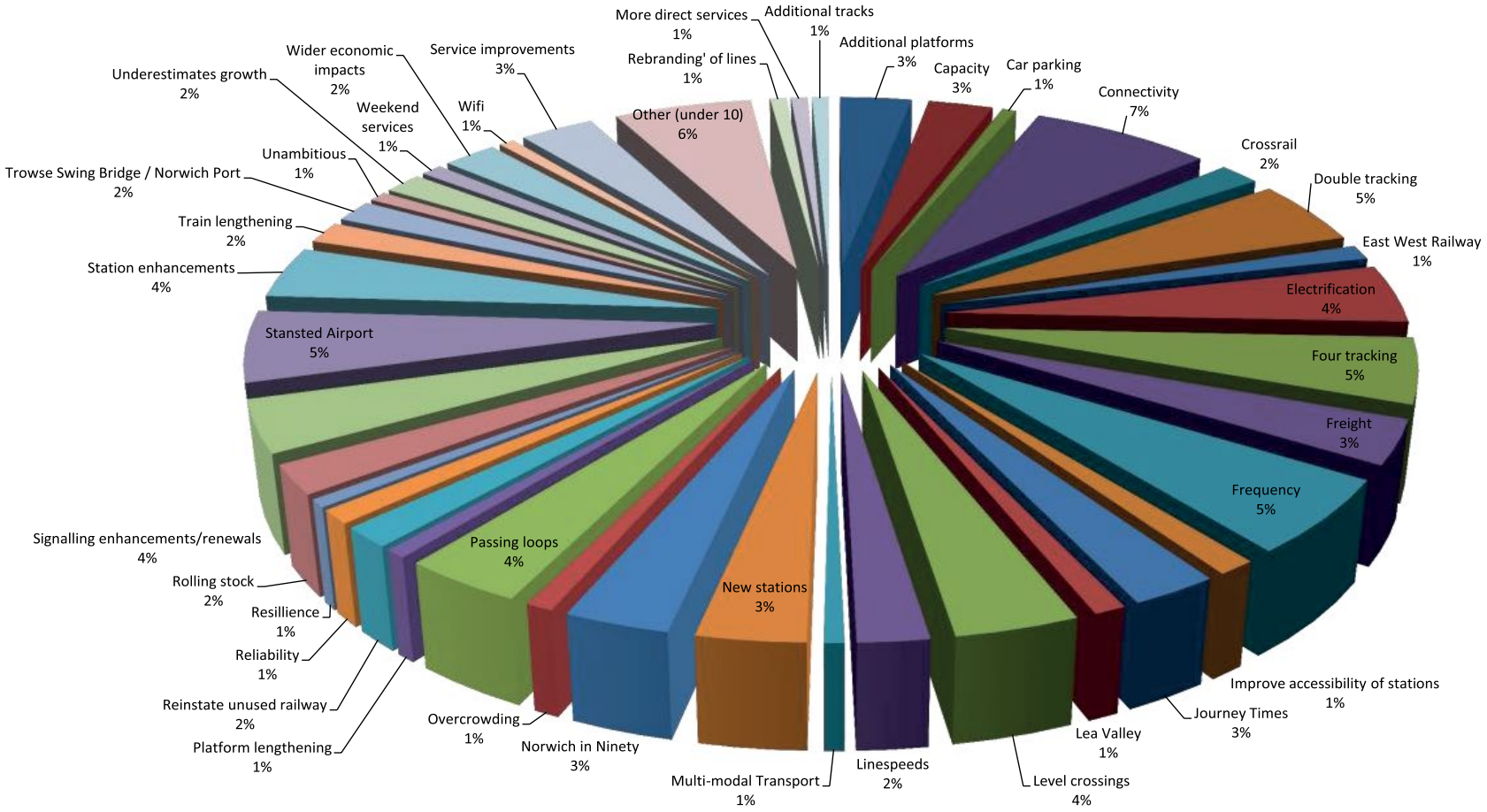
Some respondents considered that the document focused too sharply on commuting into London at the expense of other parts of the Anglia route, in particular the level of connectivity outside London. It is, of course, the case that meeting predicted demand into London Liverpool Street and London stations forms the biggest strategic challenge facing the route, as is noted in other route studies facing similar challenges. However, we remain open and willing to discuss with funders how to achieve desired outputs at other locations on the route.

2.7.2 Demand data

Several consultees expressed the view that future passenger demand projections may be underestimated on WAML, GEML and Essex Thameside. Local Authorities in particular were concerned that planned or proposed housing and employment growth in their areas may not have been fully captured by the modelling. However, the passenger demand forecasts used in the Route Study comprise centrally developed projections of population and employment. Many of the proposals put forward are to deal with commuting capacity into Central London that is largely driven by central London employment growth rather than population.

This approach allows for the development of plans that are in line with Central Government policy. Using local forecasts of housing

Figure 2.3 Responses by theme



and population would bias the industry's investment towards those areas with the most ambitious aspirations, rather than where investment is most required.

Some questioned whether Network Rail's baseline passenger data accurately reflected reality. Averaging loadings across an hour masks the crowding situation on individual trains. Nevertheless, the Route Study does have data on individual trains and the proposed solutions would still be applicable in any event. It is also worth noting that an earlier increase than expected in passenger numbers would change the timing of interventions, rather than the interventions themselves.

The point was also made that, quite apart from exogenous growth, capacity improvements may in themselves unlock currently suppressed demand. This in turn could mean that the proposed interventions may prove to be insufficient. The Route Study can be reviewed and updated as necessary if demand exceeds that analysed.

2.7.3 Rolling Stock

Rolling stock featured often in the consultees' responses, in particular the need for new stock that would assist in the enhancement of both passenger experience and journey time. Network Rail considers rolling stock to be a significant part of any performance, capacity or journey time improvement scheme.

The need for longer trains was also voiced and this is recognised by the Route Study as a key option for meeting future capacity needs and this has been fed into the East Anglia Franchise process.

2.7.4 New or re-opened stations

Both support and concern were expressed over some of the proposed improvements and the reasoning behind new station proposals, suggesting that funding should be spent elsewhere.

In particular, it was proposed that the industry should instead concentrate on improving performance by maximising the existing infrastructure. It is worth clarifying that a number of sources may lead to the funding for any railway infrastructure improvement schemes, including stations (which are usually third party funded): Network Rail, Local Authorities, Local Enterprise Partnerships, the DfT and others.

Conversely, new stations were proposed by respondents at Haverhill, Junction Road, Great Blackenham and Addenbrookes. Readers may be interested in the document Investment in Stations: A Guide for Promoters and Developers available here.

2.7.5 Customer service issues

A number of respondents raised some customer service issues, including:

- issues specific to individual stations such as full accessibility, the provision of shelters and seating, smart ticketing, car parking facilities and similar concerns
- lack of facilities at some stations
- use of redundant station buildings
- improved information provision, especially during disruption.

These issues have been fed back to the relevant TOC and shared with the shortlisted bidders for the East Anglia Franchise, which is due to commence in October 2016.

2.7.6 Cross-boundary passenger services

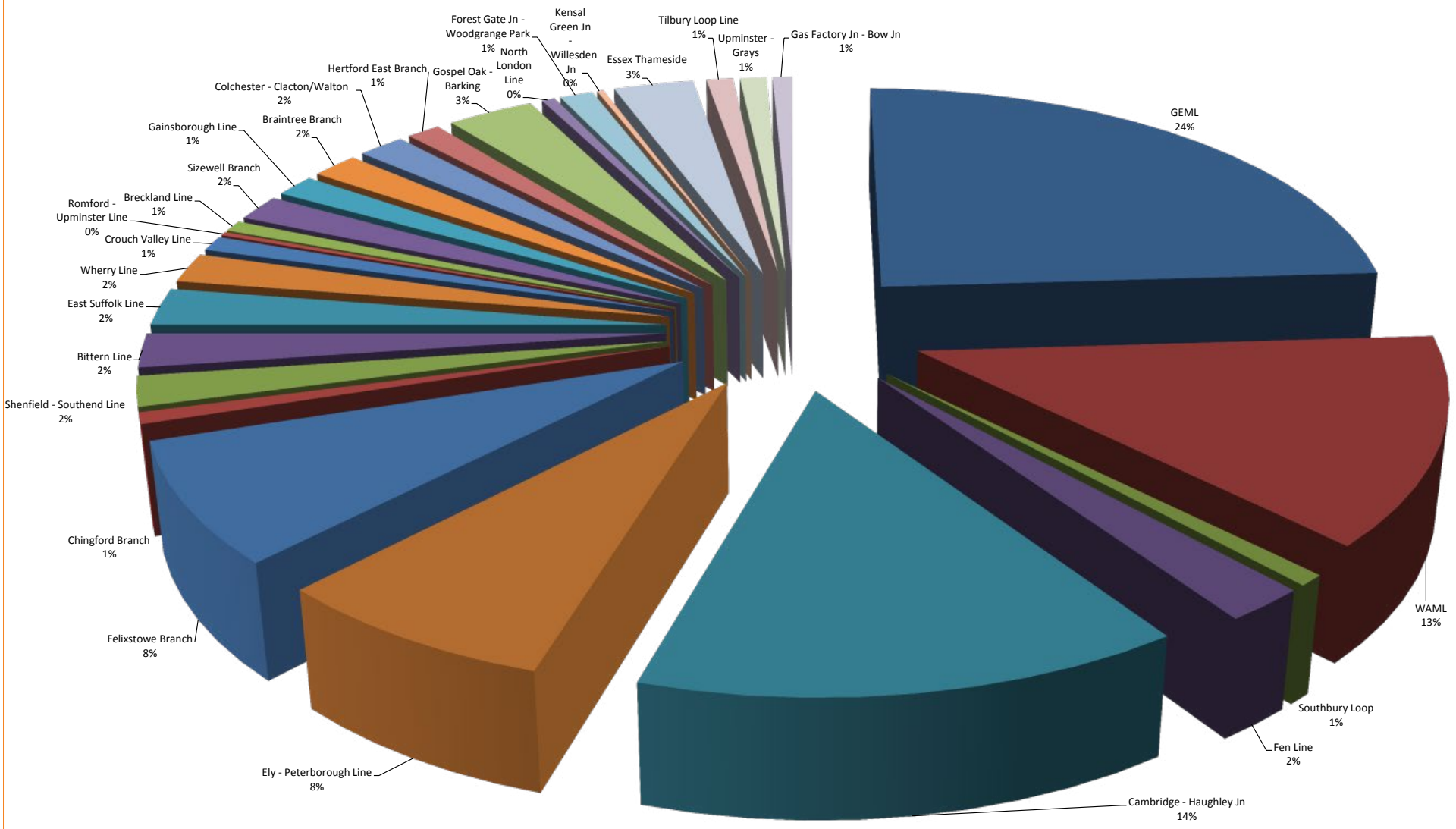
Much support was expressed for the potential Cross-boundary schemes such as East West Rail.

Some respondents also expressed support for the reinstatement of the March to Wisbech line. Network Rail is working with Cambridgeshire County Council to understand the feasibility and business case for reopening the line to Wisbech.

The service frequency, connectivity and station facilities for Newmarket Station were the subject of much contention for many who expressed frustration at the irregular services, short trains and difficulty in travelling to and from London outside certain times.

A number of consultation responses highlighted the risk of mismatches between Route Studies and how train services will be timed over constrained parts of the network such as the Cambridge area. Appendix A describes the Cross-boundary approach which has been established to co-ordinate treatment of passenger and freight trains which cross Route Study boundaries.

Figure 2.4 Responses by line of route



2.7.7 West Anglia Main Line

A large proportion of the responses received for West Anglia were supportive of four-tracking West Anglia Main Line (WAML) in CP6. Many consultees provided evidence to support the growth potential on the West Anglia corridor.

There was widespread support for proposals to improve journey times and connectivity to Stansted Airport on the West Anglia Main Line. Conditional output WAC05 concerns sufficient capacity for passengers travelling to Stansted Airport to 2043, which would look to address connectivity from other areas of Anglia.

Several consultees expressed a need for improved connectivity between the different services on WAML, more frequent and regular trains (e.g. hourly, half hourly) and consistent services (for example similar weekday and weekend services).

These responses have been shared with the shortlisted bidders for the East Anglia Franchise, which is due to commence in October 2016.

2.7.8 Great Eastern Main Line services

A number of respondents addressed the need for journey time improvements and more frequent and regular services both during the week and weekend on the Great Eastern Main Line, while the Norwich in Ninety scheme was generally favoured.

Particular attention was paid to the various branch lines and the need to enhance the existing services through frequency and line speed improvements.

There was much opposition to the proposal of level crossing closures, in particular at Stowmarket, over concerns that these would segregate communities and adversely impact the public's ability to traverse locally. In response to this Network Rail would like to clarify that each public level crossing closure is examined on its merits and in the context of the surrounding network of rights of way. Depending on use and risk profile a level crossing may be extinguished, a bridge built instead or, where usage at a crossing is measurably low, Network Rail would look to create alternative routes that would be useful to the public and enhance the local network. These are not exclusive options; the solution will depend on local factors and will take place following close collaboration with the Local Authority and local consultation.

Several respondents were also opposed to the fixing of Trowse Bridge and stipulated a minimum air draught requirement for any new bridge should this be the case, to allow for the continued passage of vessels beneath. The option of double-tracking of the existing bridge was also questioned. Network Rail would like to clarify that although the bridge was originally double track, the second track was removed to allow for the electrification of the line thereby preventing a second line from being reinstated. The solution to Trowse Bridge is being developed in close collaboration with the Broads Authority and Local Authorities, to ensure all aspects are considered.

2.7.9 Freight

Much of the discussion about freight centred on the Felixstowe to Nuneaton route and the London Gateway Port.

Concern was expressed by freight stakeholders about the assumptions used for freight growth over the coming Control Periods, with some specifically highlighting that the London Gateway Port is predicted to operate at full capacity by the end of CP6. The forecasts used in this Route Study are, however, those agreed by the industry for the Freight Market Study and subsequently adjusted (particularly in respect of aggregates traffic). During the consultation period the aggregates forecast has been amended and updated in the Final Route Study.

Freight operators also made the point that it is not always appropriate to spread demand equally across the day (in terms of paths required per hour), as this can ignore their customers' needs (such as terminal opening hours). This issue is closely connected to what the path utilisation rate is for the various types of flow.

Network Rail would like to add that hourly freight path diagrams have been included in the Route Study in order to depict the projected increase in flow and number of freight paths at high level, for reference in comparison to passenger train paths. These paths will however vary at different times of the day and between peak and off-peak hours.

2.8 Publication of responses

Except where respondents have specifically requested otherwise, all responses to the consultation are being published on Network Rail's website.

To comply with the requirements of the Data Protection Act, Network Rail holds (where supplied) the name, email, telephone, organisation and postal address information of respondents for the purpose of strategic route planning. This includes the Long Term Planning Process including the Market, Route and Route Utilisation Study projects, as well as ongoing route planning purposes. This information will not be used for any other purpose by Network Rail.

We would like to thank all stakeholders who have supported the Route Study through the provision of evidence to support the process.

03: The Starting Point

Chapter 3 explains

- the rail network in Anglia as it will be following significant enhancements already planned
- the development of additional services alongside franchise specifications
- the importance of the Anglia route as a freight artery

This chapter begins with a summary of the Anglia rail network which forms the baseline against which the strategy is developed: it sets out infrastructure capabilities – the characteristics of the railway and what it can accommodate. This picture is used to model future demand and to test investment choices – choices that can account for demand and promote economic growth. A future baseline has been deliberately chosen for this strategic outlook because it represents a point at which important enhancements will be in place for the Anglia route.

The baseline is formed of the present infrastructure and committed enhancements. It includes improvements that Network Rail has planned to deliver or enhancements that other industry groups are funding.

The baseline for the Route Study has been updated following Sir Peter Hendy's review of the Control Period 5 (CP5: 2014-2019) Enhancement Programme. The review output has meant that some enhancements included in the baseline are due to be delivered in Control Period 6 (CP6: 2019-2024). The options presented for funding represent a longer term view over the context of the next 30 years and therefore have not been impacted by the review.

It is recognised that the baseline used for the Route Study still has potential to change with the ongoing East Anglia Franchise process and agreement on the future train service.

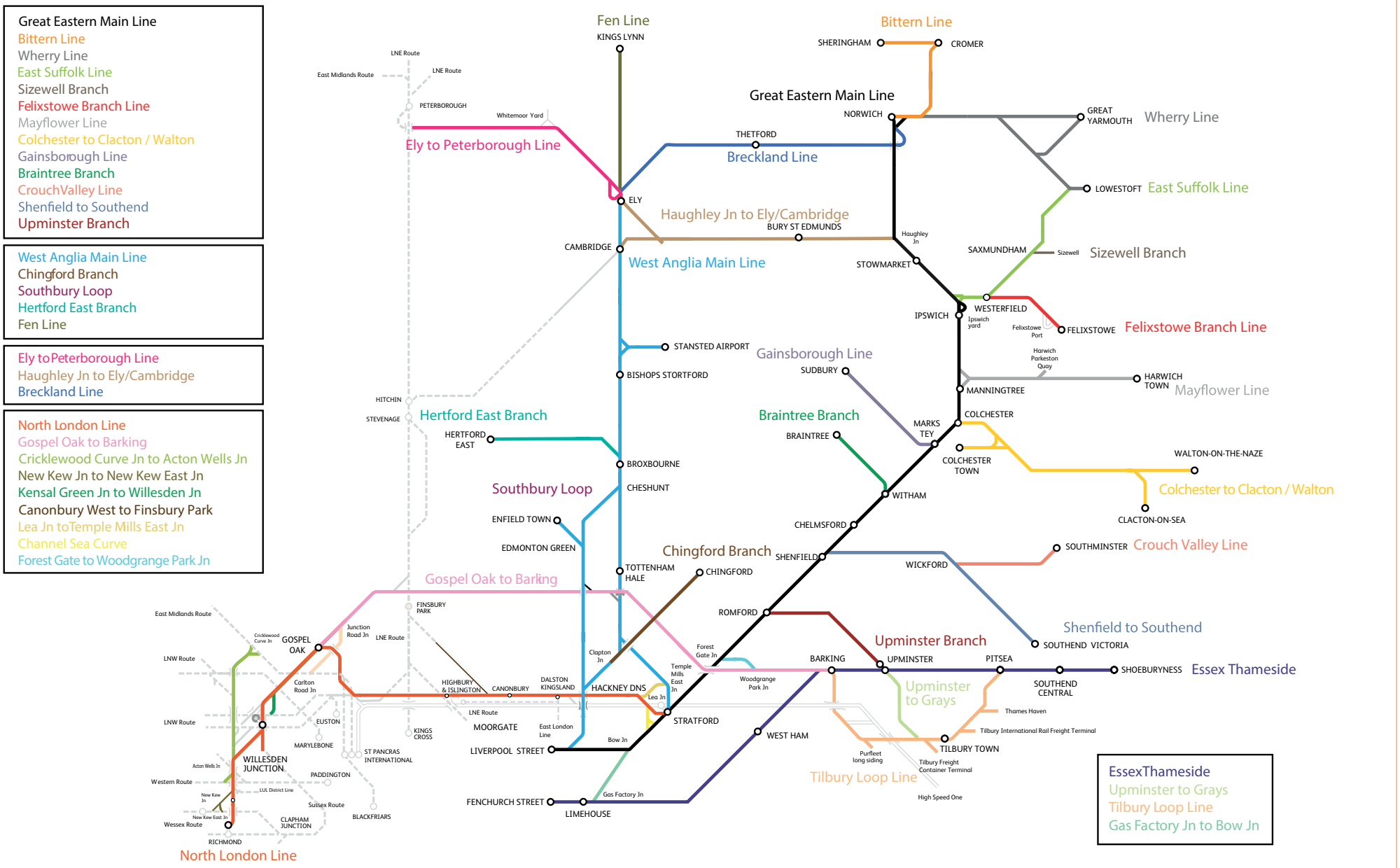
Should any influences significantly change the outputs of, and options identified within, the strategy, we will review and update it accordingly as part of the ongoing process to maintain its validity.

3.1 Geographic scope

The Anglia Route Study area shown in Figure 3.1 comprises 1,426 track miles covering the whole of East Anglia and routes into and around London. The route covers five key corridors through Greater London, Essex, Cambridgeshire, Suffolk and Norfolk, as well as having two of the UK's largest ports at London Gateway and the Port of Felixstowe.

- The Great Eastern Main Line (GEML) runs between London Liverpool Street and Norwich and is predominantly formed of two tracks from Norwich through to Shenfield, at which point it becomes a four-track railway inwards to London Liverpool Street. It carries key commuter flows into London as well as a fast-growing long distance flow connecting world-leading centres for biosciences, engineering and renewable energy, together with a significant amount of freight generated by the port of Felixstowe.
- The Cross country corridor via Ely supports a nationally important freight route between the Port of Felixstowe and other regions such as the Midlands, Yorkshire and Scotland alongside busy inter-regional passenger services. The route includes the Felixstowe to Nuneaton route in terms of freight and Ipswich/Norwich to Cambridge / Peterborough via Ely passenger services.
- The West Anglia Main Line (WAML) runs between London Liverpool Street and Kings Lynn and is formed of a two-track railway through to Ely where the line becomes a mix of single and double track sections through to Kings Lynn. The route carries busy commuter and leisure traffic from Stansted Airport and Cambridge into London Liverpool Street, as well as serving increasing demand for connections to high tech industries within Greater Cambridge and through to Peterborough.
- The London Orbital Routes, which include the North London Line (NLL) and Gospel Oak to Barking line (GOB), are formed of two-track railways which constitute a vital part of London's transport infrastructure and a major link between key arterial routes to and from the capital, as well as forming an important orbital rail route for passengers in commuter and leisure markets. They provide a nationally important freight route delivering connections from the UK's largest ports at London Gateway and the Port of Felixstowe. The lines connect with every arterial route north, east and west of London, and with parts of the southern railway network.
- The Essex Thameside route runs from London Fenchurch Street to Shoeburyness with a loop line between Barking and Pitsea via Tilbury formed of two tracks with a single line section on the Ockendon line between Upminster and Grays. These lines carry a mixture of commuter and leisure traffic along with substantial freight movements to and from the ports at Tilbury and London Gateway.

Figure 3.1 Geographic Scope of the Anglia Route Study



3.2 Route characteristics

Figures 3.2 to 3.4 show the gauge and electrification capability of the infrastructure on the Anglia Route Study area following planned enhancements.

Figure 3.2 Anglia Route Gauge

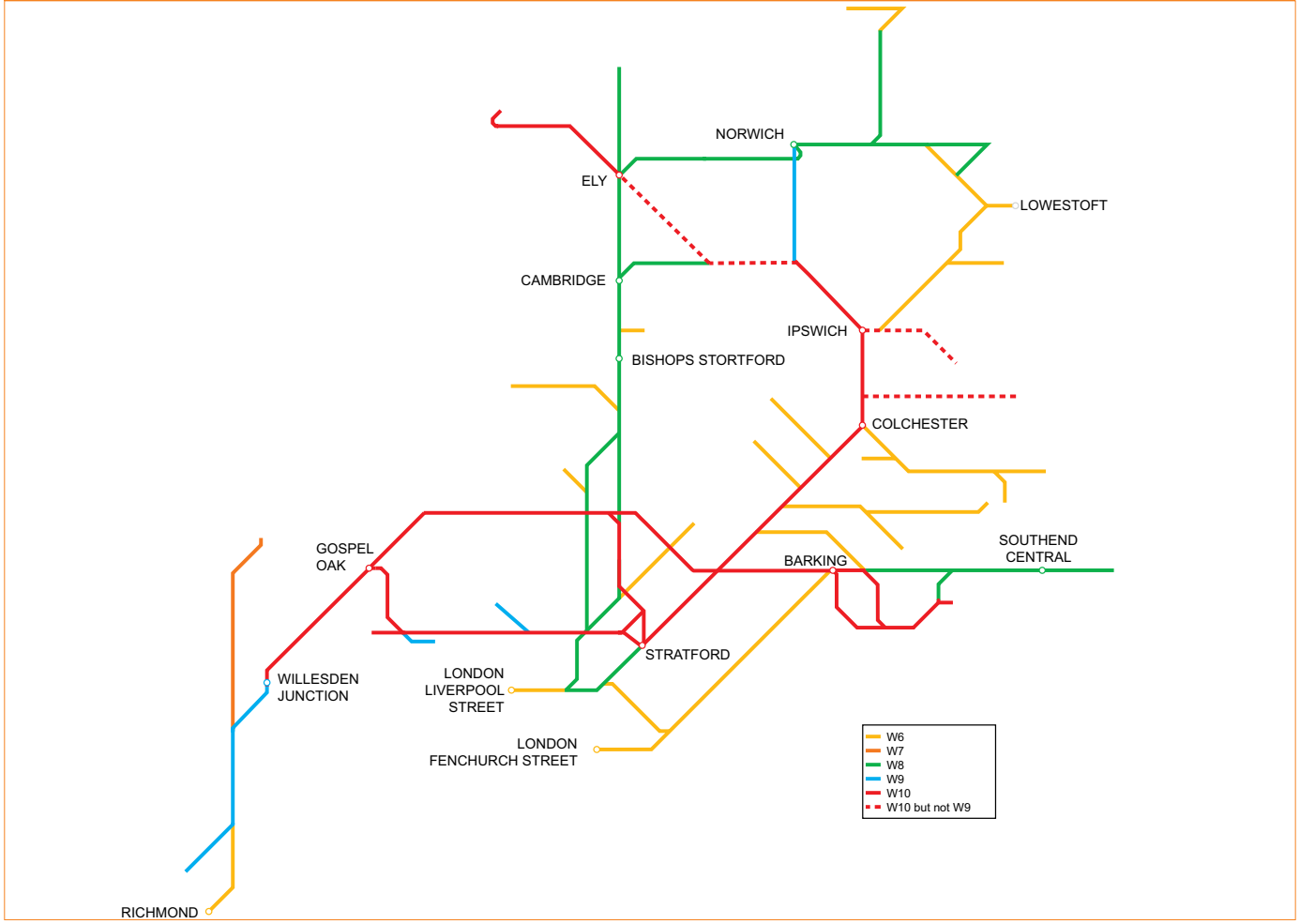


Figure 3.3 Greater Anglia Electrification Capability

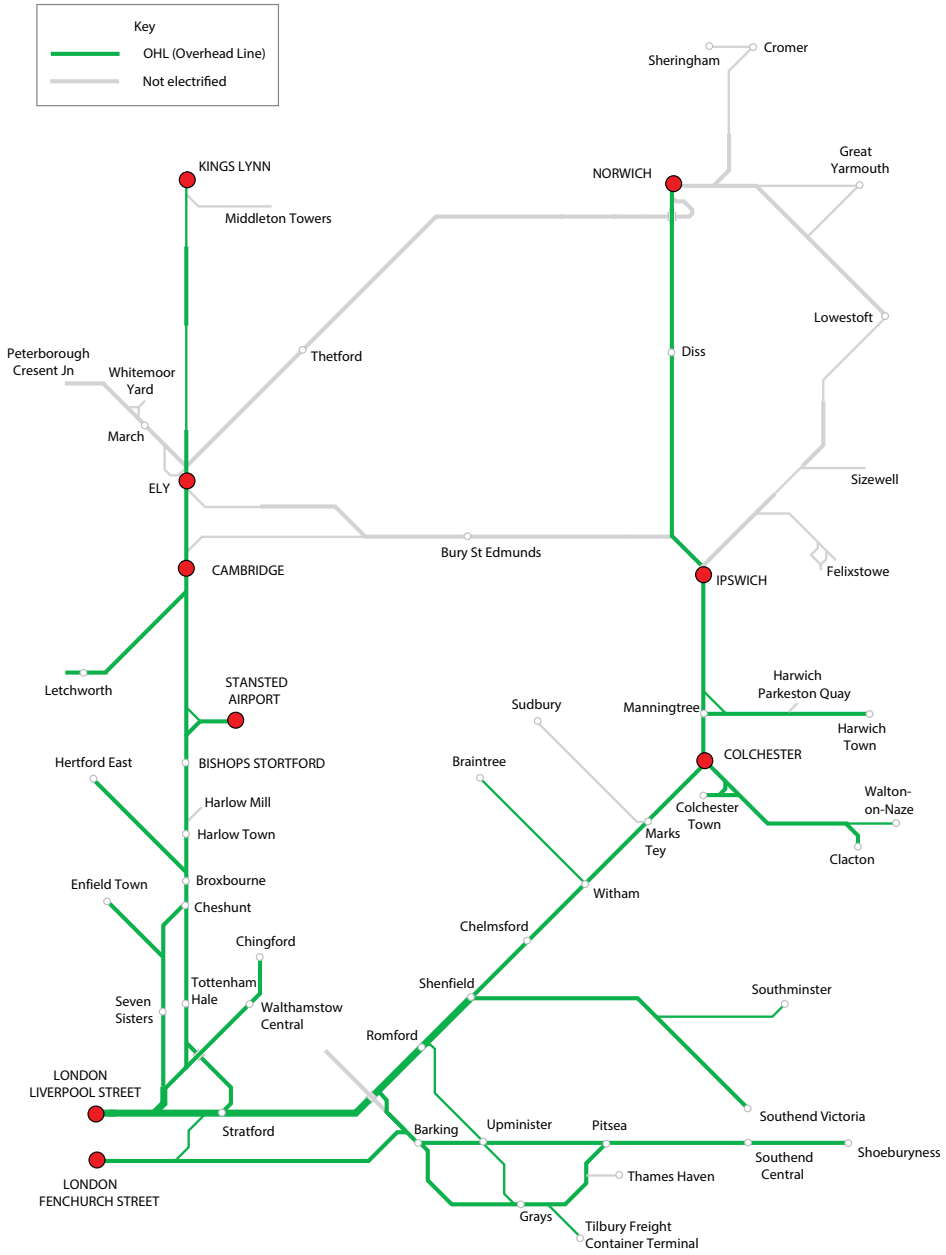
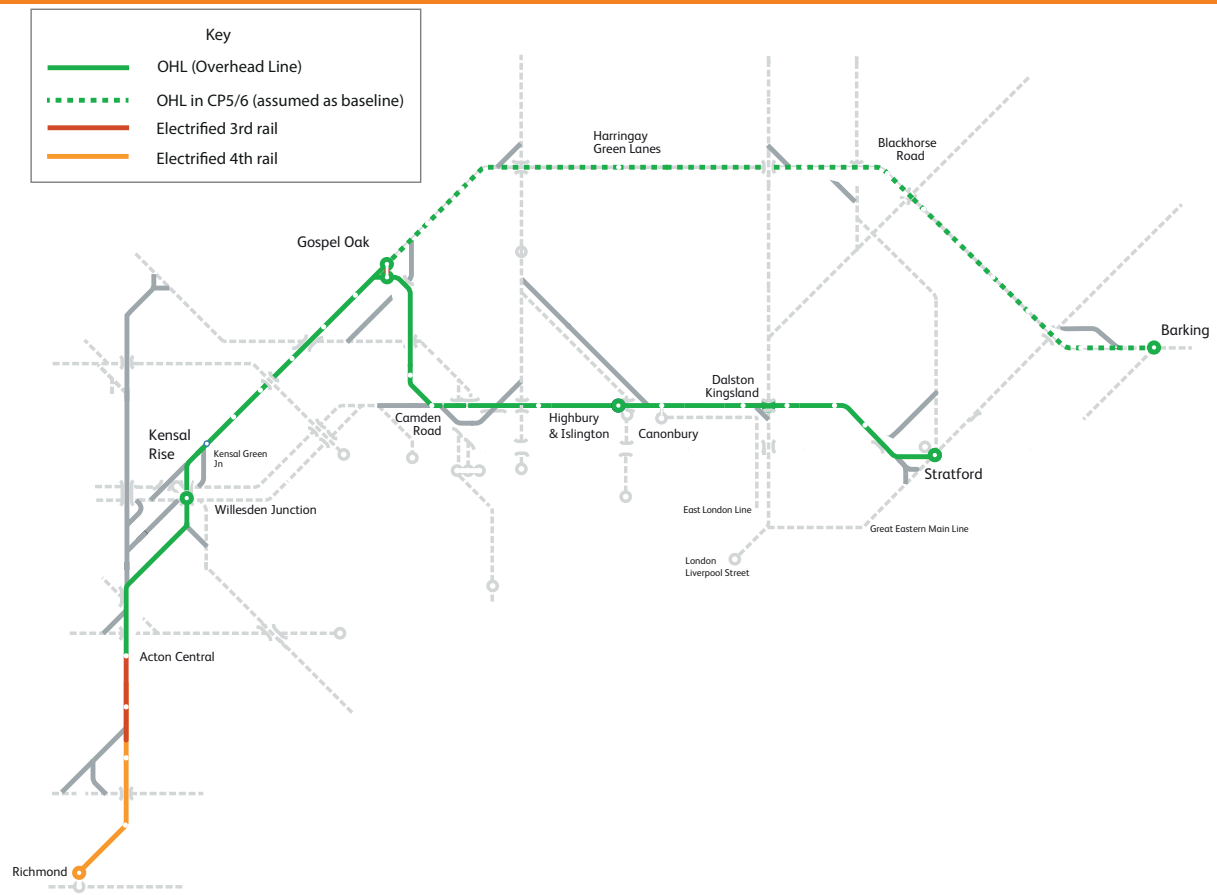


Figure 3.4 Orbital Routes - North London Line and Gospel Oak to Barking Electrification Capability



3.3 Signalling and control

Trains are currently signalled from numerous signal boxes and area signalling centres across the Route. Signalling control is due to be centralised at Romford Rail Operating Centre (ROC) which opened in CP5 and is planned to be fully operational over successive control periods.

The consolidation of all signalling into the ROC will see modern technology, such as traffic management systems, eventually offering improved control of the train movements. Figure 3.5 shows the intended resignalling and recontrol for CP5, CP6 and beyond.

The industry is currently reviewing the roll out of future signalling technology through the Digital Railway Programme in the form of European Rail Traffic Management Systems (ERTMS).

ERTMS is presently being introduced in parts of the UK and has two main components:

- Global System for Mobile communications – Railway (GSM-R), which has been installed across the network providing secure and reliable communications between train driver and signaller.
- European Train Control System (ETCS), which will be deployed on a longer timescale. ETCS sees the signalling of trains move from the lineside to within the driver's cab.

The current plans would not see ETCS in place in most of Anglia Route until the 2030s but this is currently being reviewed. The Route Study has identified areas where improved signalling capability could support the long term strategy.

3.4 Electrification

The vast majority of the study area is electrified with 25kV AC overhead line equipment. There are interfaces with 750V DC through a conductor (or third) rail with adjacent routes that are electrified in addition to the overhead line for a short section at North Pole Junction, between Willesden Junction High Level and Shepherd's Bush.

The cross country routes, between Ipswich and Peterborough (via Ely), Norwich and Peterborough (via Ely), along with the majority of the GEML branch lines and the East Suffolk Line are non-electrified and operated by diesel multiple units (DMUs). In the case of Ipswich to Peterborough (via Ely), Norwich to Cambridge and services from Birmingham New Street to Stansted Airport, diesel rolling stock operates on electrified lines for significant parts of the journey.

On the NLL, the electrification switches from overhead line to third rail at Acton Central and thereafter to third and fourth rail electrification at Gunnersbury Junction, until Richmond.

Figures 3.3 and 3.4 depict the electrified routes in Anglia.

The Network RUS: Electrification is expected to be published as a draft for consultation in spring 2016 and will review the case for in-fill electrification schemes.

3.5 Line speeds

Network Rail is working with the passenger and freight train operating companies to improve journey times where service level aspirations are higher than that of today. Increasing permitted line speeds or removing speed restrictions usually requires improvements to each of the core elements of the infrastructure – track, signalling, gauging, geotechnical (civil engineering concerned with the engineering behaviour of earth materials, e.g. embankments), structures and power supply. Hence, opportunities to improve journey times at an acceptable cost are often linked to planned renewals whereby the overall cost to deliver the enhancement can be reduced as a consequence.

The maximum line speed over the four key main lines on the Anglia route is 100mph, although many sections are slower due to curvature, structures, signalling, level crossings and OLE among others. In certain situations, the rolling stock may also not allow for the maximum permissible speed on a section of line to be achieved (this could be due to gradient, density of traffic or calling pattern).

Figures 3.6 to 3.8 provide an overview of the current line speeds on the Anglia Route.

The Great Eastern Main Line between Shenfield and Norwich is generally 100mph, while the line section between Shenfield and Stratford is mostly 90mph. Network Rail will continue to examine potential increases to line speed to support ongoing improvements to journey times on the line of route.

The West Anglia Main Line between Tottenham Hale and Bishops Stortford ranges between 80 – 95mph; the line between Tottenham Hale and Hackney Downs ranges between 30 – 60mph, with the aspiration to improve the journey times to Cambridge and Stansted Airport by upgrading the line speed.

The Orbital Routes (NLL and GOB) range between 20 – 55mph, with the aspiration to raise the line speed to 60mph on the Gospel Oak to Barking Line.

The Essex Thameside route that runs between London Fenchurch Street and Shoeburyness and on the Tilbury Loop via Tilbury Town and Purfleet has a variation in line speed between 40 – 75mph. There is an aspiration to increase the line speed to 100mph to improve journey times along the route and utilise the capability of the existing rolling stock.

Figure 3.5 Anglia Resignalling & Recontrol plans for CP5, CP6 and beyond (September 2015)

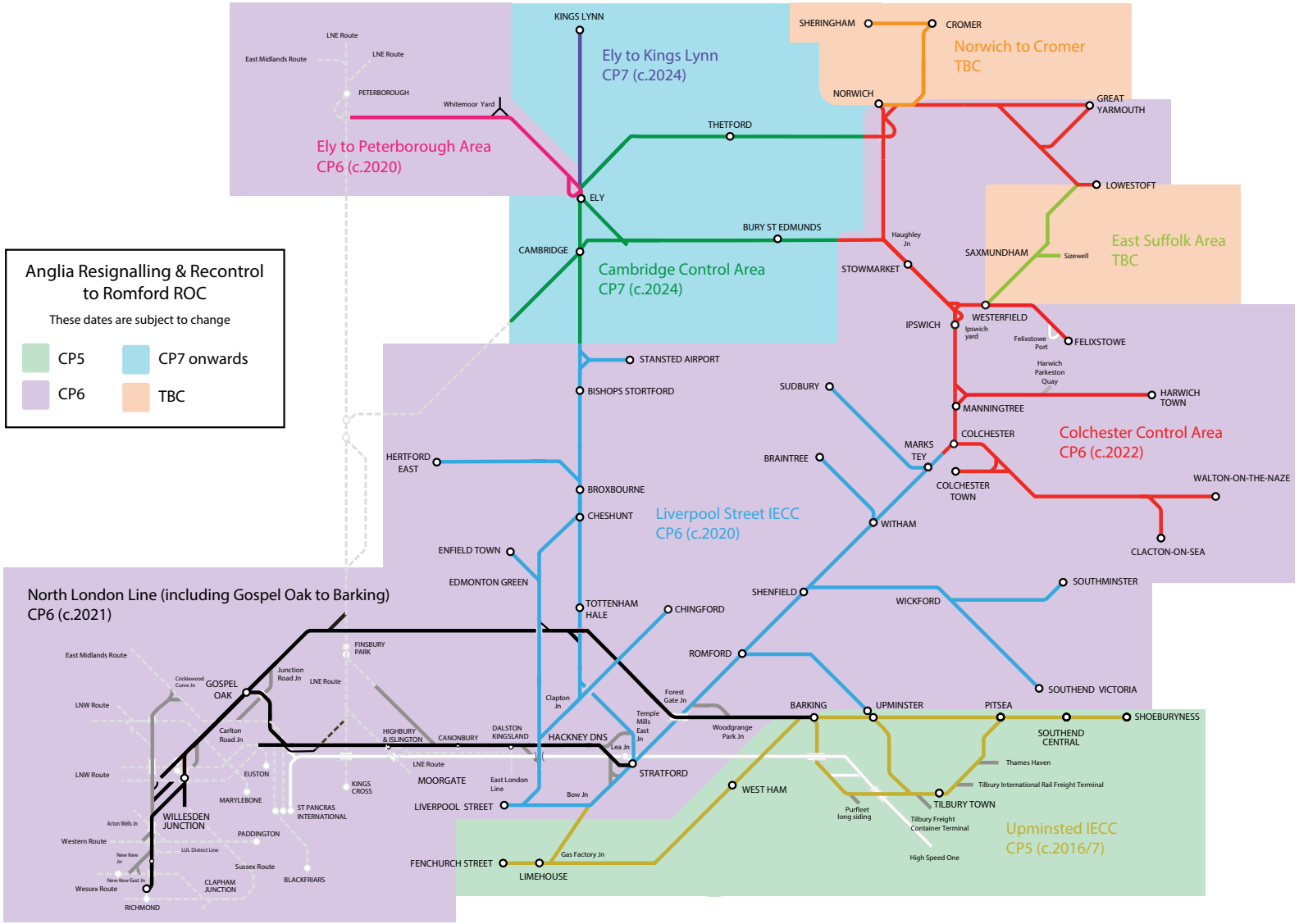


Figure 3.6 Great Eastern Main Line and West Anglia Main Line - Line Speeds

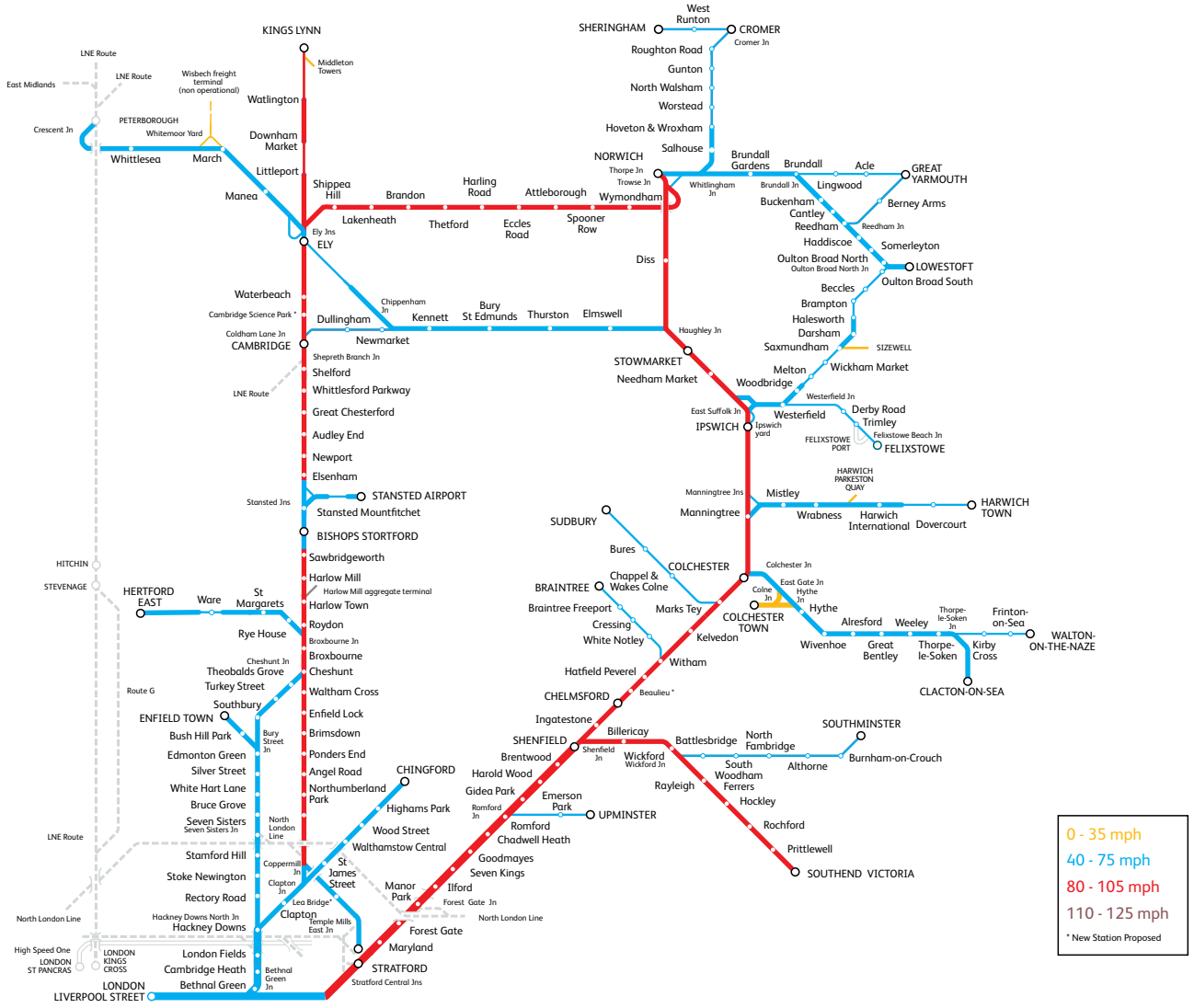


Figure 3.7 Orbital Routes - North London Line and Gospel Oak to Barking - Line Speeds

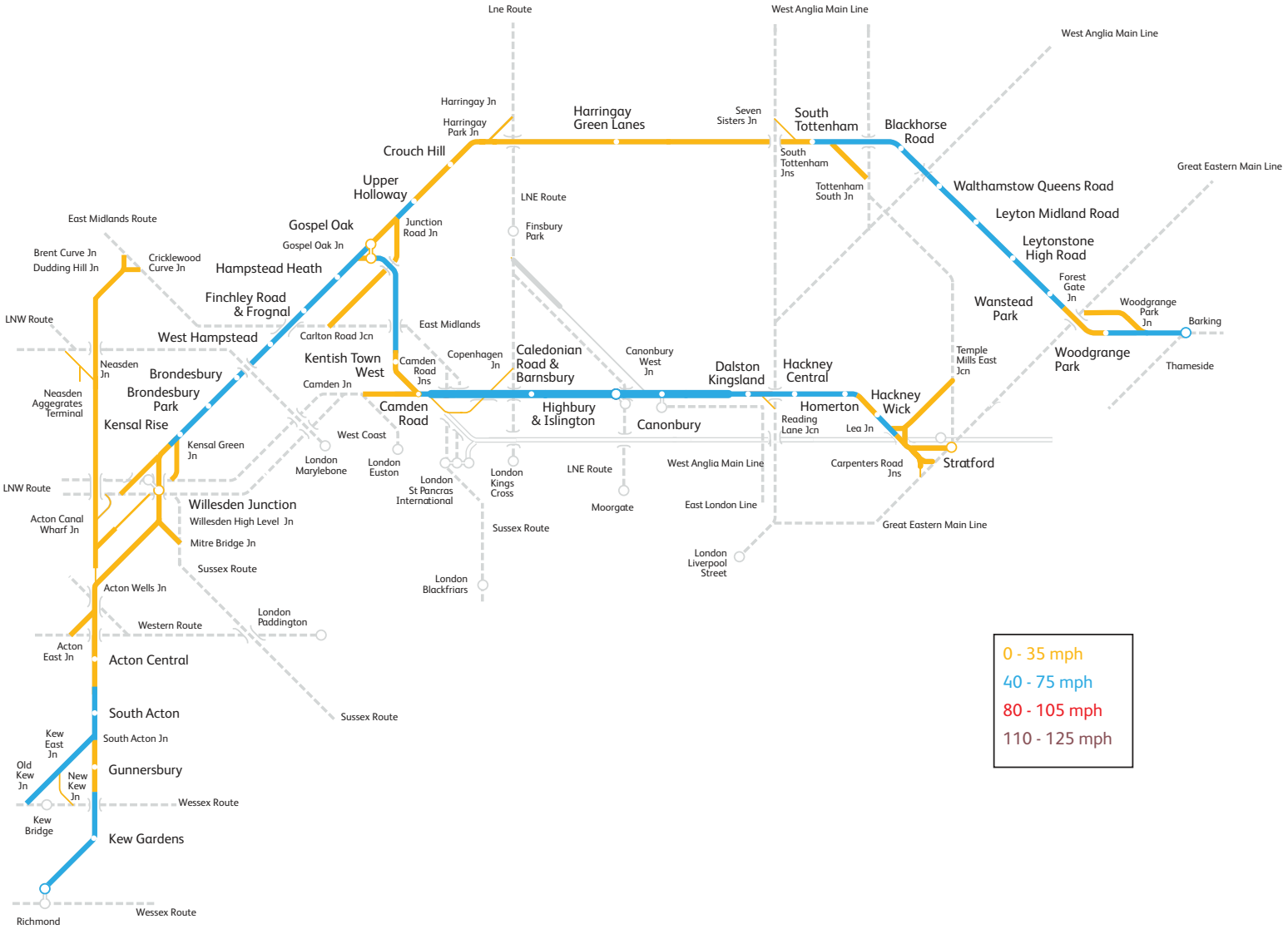
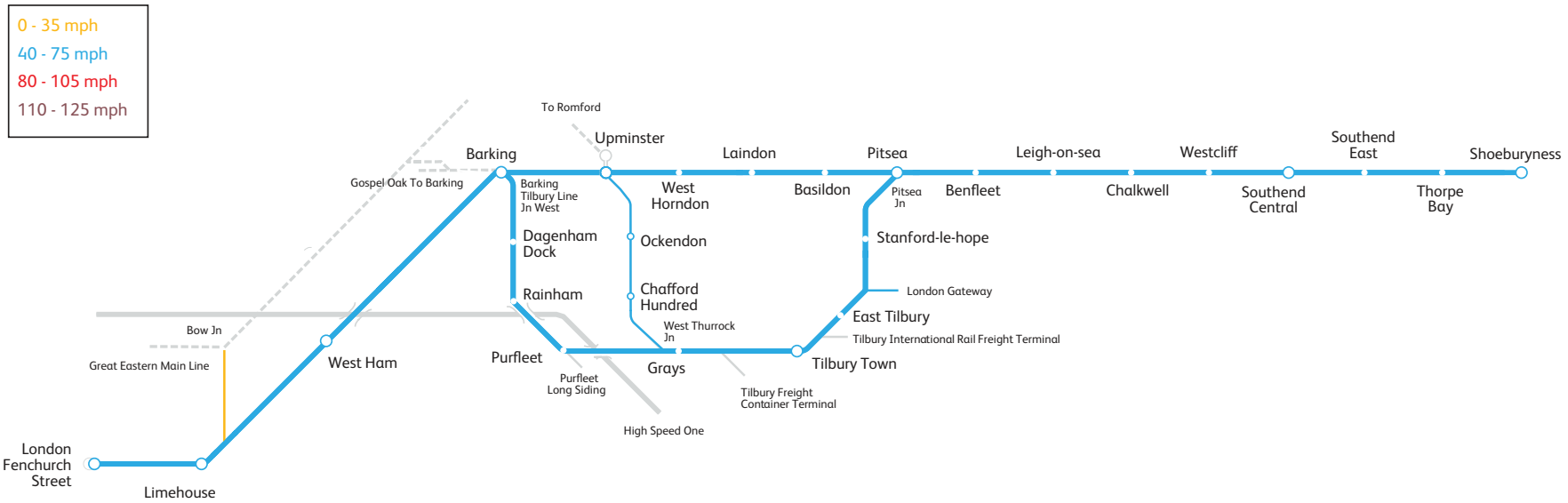


Figure 3.8 Essex Thameside - Line Speeds



3.6 Performance and investment

Performance has suffered in recent times on Anglia, with infrastructure, rolling stock failures and overrunning engineering works being among the causes. Network Rail is investing £170 million this year (2015/16) on renewals and enhancements on the Great Eastern Main Line which will improve the infrastructure performance.

Projects include:

- Overhead line (OHL) upgrade of 60-year-old equipment to improve reliability along the Great Eastern Main Line.
- Witham: Installation of new track and points at Witham.
- Colchester: Installation of new track to deliver a more reliable railway to passengers.
- Crossrail will provide additional passenger capacity, renewed or refurbished stations and new trains will replace the existing trains used on stopping services from Shenfield to London from 2017.
- High Output: Work with the high-output ballast cleaner (HOBC) commenced on the Great Eastern Main Line in January 2015 and will continue through to September 2016. Once completed, track renewals will take place using the Track Relaying System (TRS) from October 2016 until June 2017, delivering 81km of track relaying. This work is absolutely vital to help deliver a more reliable railway and the technology allows us to invest in the railway while trains are still running, avoiding long weekend closures and minimising disruption.

On the West Anglia Main Line Network Rail is delivering the following improvements which will also improve infrastructure performance:

- six kilometres of new rail and ballast between Tottenham Hale and Harlow
- replacing level crossing decks at 12 locations on the line from London Liverpool Street to Cambridge to improve safety and reliability
- strengthening work on seven structures
- upgrading signalling cables to have less power supply issues
- overhead line upgrades at a number of locations from London Liverpool Street to Kings Lynn, Chingford branch line and on the Hertford East branch
- drainage maintenance and inspections across the line, to ensure the railway is resilient to adverse weather conditions
- during spring and summer 2016, the HOBC will commence working between Ely and Peterborough.

Although performance reached an historic high in 2012/13, train punctuality has subsequently declined. During this period more people than ever before are using these services. This underlines the key challenges on this part of the network - providing capacity to meet burgeoning passenger demand and ensuring that performance is maintained at an acceptable level.

3.7 Great Eastern Main Line

3.7.1 Crossrail

From May 2015 the Great Eastern Inner services between Shenfield and London Liverpool Street were taken over by TFL Rail, which will operate the future Crossrail concession.

Crossrail is jointly funded by the Government and Transport for London (TfL) and will provide a cross-London train service between Reading/Heathrow in the west and Abbey Wood/Shenfield in the east, via a new tunnel under central London. The service will operate with 9-car electric trains, capable of carrying around 1,500 passengers in each train delivering substantial economic and passenger benefits across London and the South East.

At peak times Crossrail will run 12tph along the Electric Lines between Shenfield and the tunnel portal at Stratford, calling at all stations. In addition during peak times, a Crossrail residual service will operate 4tph between Gidea Park and the existing London Liverpool Street terminus station.

Following the introduction of Crossrail services, the number of platforms at London Liverpool Street station is planned to be reduced from 18 to 17. This is to enable Platforms 16 and 17 to be lengthened to accommodate Crossrail trains; Platform 18 will be taken out of commission.

3.7.2 Bow Junction remodelling

Network Rail is developing a scheme for delivery in CP6 that will remodel Bow Junction, to allow trains running on the main lines to make use of the Electric Lines between the Crossrail tunnel portal at Stratford and London Liverpool Street station. This will enable longer-distance trains to make better use of the platform capacity freed up at London Liverpool Street by Crossrail.

Initially, this project will provide the infrastructure to support an additional 2 peak tph main line services, likely to originate from the Southend line. This will increase the number of trains using the Main Lines between Shenfield and Stratford by 2tph in the high peak morning hour to 24tph.

3.7.3 Great Eastern Main Line journey time improvements

As part of the Great Eastern Main Line Taskforce, Network Rail and other industry partners are closely involved with work to improve journey times along the Great Eastern Main Line. It is recognised that a variety of changes to infrastructure, rolling stock and service patterns will be needed to achieve these improvements, several of which are considered in this study.

3.8 Cross country corridor via Ely

3.8.1 Cross country corridor via Ely

To cater for freight growth on the Felixstowe to North corridor, the following schemes are in development, with implementation in either CP5 or CP6:

- enhancement of the Felixstowe branch
- Ely North Jn capacity improvements. Following the review of enhancements undertaken by Sir Peter Hendy, this scheme has been deferred to CP6. The project objectives have been redefined to encompass wider constraints of level crossings and will form the basis for development activity in CP6 and is therefore included in the choices for funders in Chapter 5.
- Ely to Soham doubling. Following the review of enhancements undertaken by Sir Peter Hendy, this scheme has been deferred to CP6. The project will be developed in CP6 and therefore is included in the choices for funders in Chapter 5.

3.9 West Anglia Main Line

3.9.1 West Anglia capacity enhancement (Stratford to Angel Road)

A scheme is currently in development for delivery in 2018 that will increase the number of trains along the West Anglia route between Stratford and Angel Road (STAR), to provide increased station stops and additional capacity on the route. This will be achieved by providing an additional track from around the Coppermill North Junction area northwards to Angel Road. This scheme is intended to address the medium-term demand arising from industrial and residential developments in the vicinity of Lea Bridge, Tottenham Hale, Northumberland Park and Angel Road stations, with a view to achieving a standard 4tph between Stratford and Angel Road stations. This is achieved through 2tph using the third track and calls in the existing services on the existing pair of tracks.

3.9.2 Lea Bridge station (WAML)

In advance of the West Anglia scheme, it is planned that the reinstatement of Lea Bridge station situated between Stratford and Tottenham Hale will be completed in 2016. The re-opening of the station will provide connectivity for the communities around the Lea Bridge catchment area to Stratford where there is the Westfield Shopping Centre, access to jobs in the Docklands via connections to the London Underground Lines (LUL) Jubilee Line and the Docklands Light Railway (DLR) and Olympic Legacy venues. The area is currently poorly supported by public transport except via a long bus ride.

3.9.3 Cambridge North station (WAML)

The new Cambridge North station (previously referred to as Chesterton, Chesterton Interchange or Cambridge Science Park station) will be situated on the main line between Cambridge and Waterbeach stations, in the suburb of Chesterton close to Cambridge Science Park. The current station proposal is formed of two through platforms and one bay platform and is expected to be operational in 2017.

3.9.4 East Anglia Franchise

DfT have commenced the process for franchise competition for East Anglia. This includes all Great Eastern Main Line and West Anglia Main Line Outer services and branch lines and interregional services between Ipswich, Norwich and Cambridge. The franchise is due to commence in October 2016.

3.10 Orbital Routes & London Overground Network

3.10.1 London Overground Network and Concession

In May 2015 Transport for London (TfL) took over the West Anglia Inner London train services from London Liverpool Street to Enfield Town, Cheshunt (via Seven Sisters) and Chingford, and the Romford to Upminster services. These services were previously part of the East Anglia Franchise.

The services are being run by the incumbent London Overground operator, LOROL, until November 2016 when the current London Overground concession will end. The services will then be subsumed under the overall London Overground concession, to be run by the new concessionaire from November 2016.

New trains have been ordered to replace the current fleet on the West Anglia and Romford lines to provide a better experience for passengers using the newly devolved rail services from London Liverpool Street to Enfield Town, Cheshunt (via Seven Sisters) and Chingford, and the Romford to Upminster services. New, and longer trains have also been ordered on the Gospel Oak to Barking line, which will enable more capacity on the line (see Section 3.10.3).

3.10.2 London Overground Capacity Improvement Programme (LOCIP)

During CP4 and CP5, platforms at stations between Stratford and Richmond/Clapham Junction were extended to accommodate 5-car trains, which are now running on these routes.

TfL has an aspiration to enhance frequencies between Stratford and Clapham Junction/Richmond from 2018 onwards. This will firstly improve service frequency in the peak hours from 8tph to 10tph. The off-peak aspiration is to increase service from 6tph to 8tph. TfL has committed to purchasing rolling stock for these improvements. However, these aspirations have not been included in the baseline as this is not yet a committed change.

3.10.3 Gospel Oak – Barking electrification

The Gospel Oak to Barking line will be electrified during CP5, which will enable more efficient operation of passenger services. The 2-car Diesel Multiple Units (DMUs) that operate the current passenger services between Gospel Oak and Barking will be replaced by 4-car Electric Multiple Units (EMUs), providing significant additional passenger carrying capacity.

The electrification provides the next part of rail infill electrifications as identified in the Electrification RUS to support the development of an electric freight network. Electrification of the Gospel Oak to Barking line will provide an electric route from the North Thameside to access the North London Line which does not require crossing the GEML at grade at Forest Gate Junction. The scheme assumed in the baseline does not include electrification of the connections to the freight terminals at Thameside or Tilbury, therefore it is important to consider electrifying both these connections in the future.

3.11 Essex Thameside

3.11.1 Essex Thameside Franchise

In June 2014 the Essex Thameside franchise was awarded to National Express who will continue to run these services for 15 years until 2029. This franchise will deliver new rolling stock as well as additional capacity, including a high-peak metro service between Barking and London Fenchurch Street, with more services calling at Barking, West Ham and Limehouse stations. The refranchising for Essex Thameside was undertaken in parallel with the Route Study development, therefore the December 2015 timetable is not assumed as the baseline service specification.

3.11.2 Barking Riverside extension and Barking Riverside station

Barking Riverside is a planned redevelopment in Barking, East London, adjacent to the River Thames. The site has planning permission for 10,800 homes. TfL's proposal is to extend the Gospel Oak – Barking service to a new station at Barking Riverside. The extension would be 4 km in length, including 1.5 km of new track. The service would operate from Barking station along the existing Tilbury Loop line and then via the new section of railway, heading south towards Barking Riverside station. It is anticipated that new services would become operational in 2020.

3.12 Uncommitted schemes

There are a number of other initiatives and schemes which are either being, or are likely to be, developed during the period which this Route Study covers. Whilst these schemes cannot be considered as part of the baseline, it is important to be aware of them in order that planning decisions can be fully informed.

3.12.1 Electrification

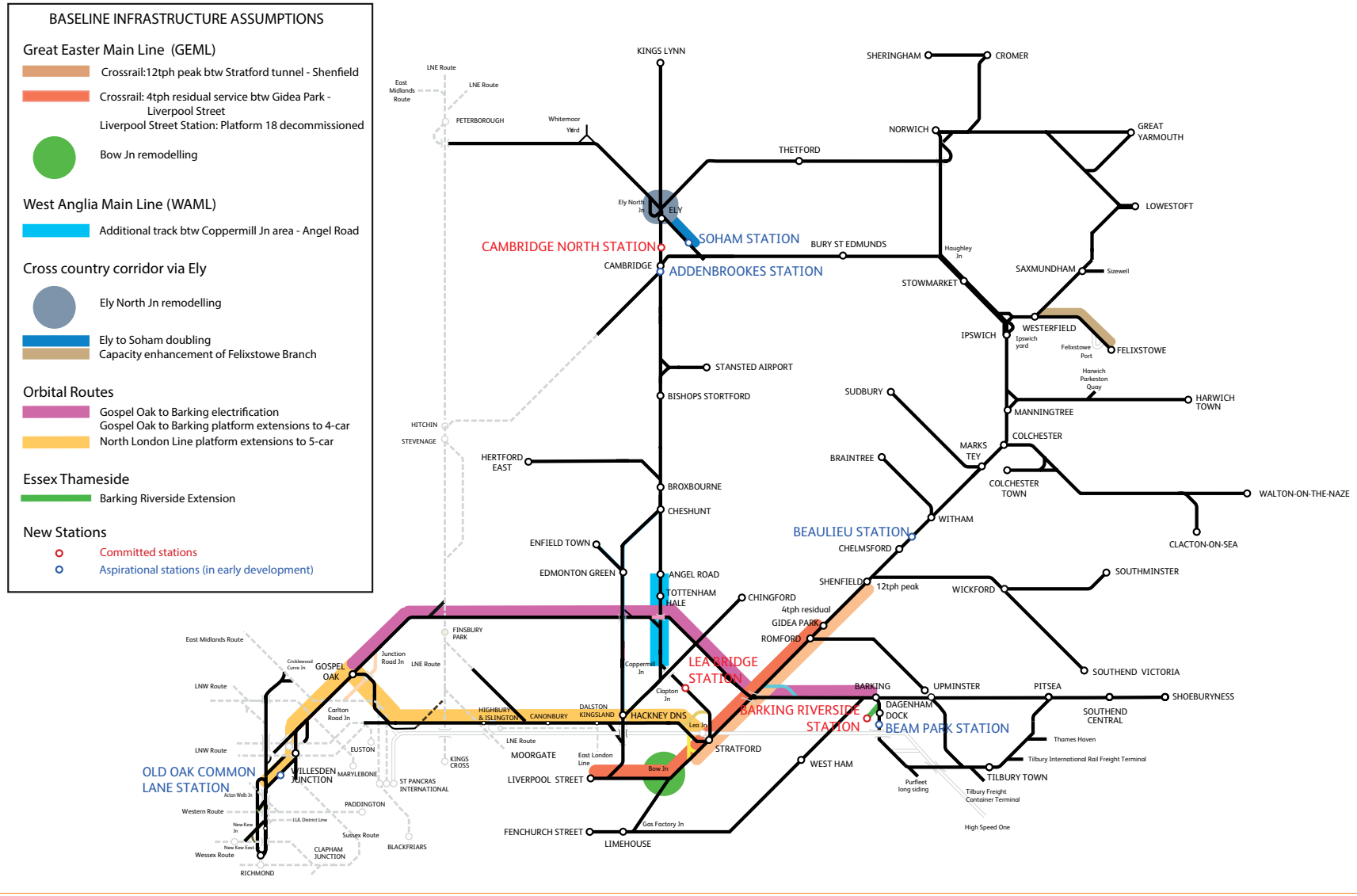
Network Rail is currently undertaking a refresh of the Network RUS: Electrification strategy to consider future options for electrification in the longer term following the completion of publicly committed schemes. The Network RUS: Electrification will look at the case for further opportunities to develop the electrified network in CP6 and beyond. Examples of schemes that have been identified for potential further development as part of the Electrification Strategy relevant to this route study include:

- Felixstowe to Nuneaton
- Chippenham Junction to Coldham Lane Junction.

3.12.2 High Speed 2 (HS2)

HS2 is developing a station at Old Oak Common to provide a direct link between the new high speed services and Great Western Main Line and Crossrail services. Options have been developed for connectivity to the London Orbital Routes. Following a consultation by TfL, the preferred option for development consists of two

Figure 3.9 Anglia Baseline Infrastructure Assumptions



stations on the orbital route, one at Hythe Road on the West London Line (WLL) and one at Old Oak Common Lane on the North London Line (NLL).

These new London Overground stations would allow passengers to interchange between HS2, Great Western Main Line, Crossrail and London Overground services, which would enable the creation of a key strategic interchange point for West London, similar to that in Stratford, East London.

HS2 passengers would be able to connect for onward journeys southwards towards Clapham Junction and Richmond, or eastwards for the North London Line without having to enter central London. The new station would also allow passengers travelling to Heathrow Airport from North London the opportunity to change at Old Oak Common for direct Heathrow and/or Crossrail services. Further information on the current proposals can be found here.

3.12.3 East West Rail

East West Rail is a major project to establish a strategic railway connecting East Anglia with Central, Southern and Western England.

The Western Section is now a committed, funded scheme to re-introduce passenger and freight services between Bedford and Oxford, Milton Keynes Central and Aylesbury. It involves upgrading and reconstructing sections of existing and 'mothballed' rail track, which is to be delivered by Network Rail.

The Central Section, linking the Western Section through to Anglia between Bedford and Cambridge, is the section where there is currently little infrastructure and is currently uncommitted. Network Rail is leading early development work for the Central Section as part of the Long Term Planning Process for identifying future investment options. At this stage of development, it has identified two potential corridors offering the best value for money for the proposed Central Section, via Hitchin or Sandy, for further consideration.

These corridors will be evaluated further to identify a single preferred corridor before any consideration is given to routes within that corridor and feasibility studies are undertaken.

This follows initial work by the East West Rail Consortium which showed that improved rail services in the Eastern region could deliver significant economic benefits sufficient to justify further investment.

The Central Section provides the opportunity to enable a new station to be considered at Addenbrookes to the south of Cambridge to support improved connectivity.

The aim is to identify a single preferred route and develop the study for the Central Section, for consideration of its inclusion in the Initial Industry Plan due for publication in September 2016.

This proposed connection will provide better connectivity from Anglia and therefore if implemented may enable further options for meeting both freight and passenger conditional outputs. Once decisions are made on the Central Section and its feasibility, further work will be required to examine the service offering into and across Anglia to the east coast; this will form part of the 'Eastern Section'.

3.12.4 March to Wisbech line

The project proposes the reopening of the disused railway line between Wisbech and March to allow access to Cambridge, Peterborough, Stansted Airport and London to contribute to the local economy of Wisbech and the surrounding areas. Network Rail is working with Cambridgeshire Country Council to understand the feasibility and business case for reopening the line to Wisbech.

3.12.5 Crossrail 2

Crossrail 2 is the proposed new high-frequency, high-capacity rail line running through London and into Surrey and Hertfordshire. It would add much needed capacity to London's rail network and support economic regeneration. Further information on the current proposals can be found here.

3.12.6 Proposals for new stations

As the following stations are currently in development they have not been included in the Baseline.

Beaulieu (GEML)
The proposed new station (also known as Beaulieu Park) would be situated approximately three miles to the north-east of Chelmsford

Station on the Great Eastern Main Line, estimated to open in early CP6. The current plans consist of a three-platform station and a bus interchange for services in the Springfield area. Modelling work will be undertaken during development to demonstrate that the new station layout will not impair the existing and future timetable proposals.

Soham (Cross country corridor via Ely)
The proposed new station would be on the line between Ely and Bury St Edmunds, approximately five miles to the east of Ely. The current station proposal is formed of two platforms and the local councils are leading plans to develop the scheme further. Modelling work will be undertaken during development to demonstrate that the new station layout will not impair the existing and future timetable proposals and that it is aligned with the Ely to Soham doubling project.

Addenbrookes (WAML)
The proposed new station would be situated on the West Anglia Main Line between Cambridge station and Shepreth Junction. Modelling work will be undertaken during development to demonstrate that the station location and station layout will not impair the existing and future timetable proposals.

Old Oak Common Lane (Orbital Routes)
As described in the HS2 section above, the proposed new station would be situated on the NLL between Willesden Junction and North Acton stations. It would comprise a new two-platform station adjacent to Old Oak Common Lane, with access to the proposed new HS2 station at Old Oak Common (to the east) and Victoria Road (to the west) via a subway link. Modelling work will be undertaken during development to demonstrate that the new station layout will not impair the existing and future timetable proposals.

Beam Park (Essex Thameside)
The proposed new station would be on the line between Dagenham Dock and Rainham. The current recommended option has two platforms. Modelling work will be undertaken during development to demonstrate that the new station layout will not impair the existing and future timetable proposals.

04: A Strategy for Growth - Conditional Outputs

Conditional outputs are aspirations that the rail industry should seek to achieve, conditional on there being a value for money and affordable way of delivering them.

Chapter 4 explains

- forecast passenger growth
- forecast increased freight tonne kilometres
- connectivity opportunities that
  - facilitate economic growth
  - provide access to airports and high speed rail
  - improve the quality of life for communities and individuals

In collaboration with the rail industry, funders, local authorities and other interested parties, Network Rail published four Market Studies in 2013 to understand the demand for rail over a 30-year horizon and show the conditional outputs required to improve the prosperity of the UK. These outcomes are described in terms of four strategic goals:

- **Enabling economic growth**
- **Reducing carbon and the transport sector's impact on the environment**
- **Improving the quality of life for communities and individuals**
- **Improving affordability value for money (to funders)**

In this route study the Market Study conditional outputs are put in the specific context of the Anglia Route Study area. They have been interpreted into an Indicative Train Service Specification (ITSS) that shows the level of train services needed to deliver the conditional outputs and to test the capability of the rail infrastructure compared with the baseline.

The Route has been split into the Great Eastern Main Line, Cross country corridor via Ely, West Anglia Main Line, North London Line (including Gospel Oak to Barking) and Essex Thameside. The passenger capacity, connectivity and freight capacity conditional outputs for each route have been described.

4.1 Freight capacity to cater for demand

Anglia provides nationally important freight routes particularly for intermodal port traffic from the Port of Felixstowe and London Gateway. The forecast growth in freight over the next 30 years is significant across the region.

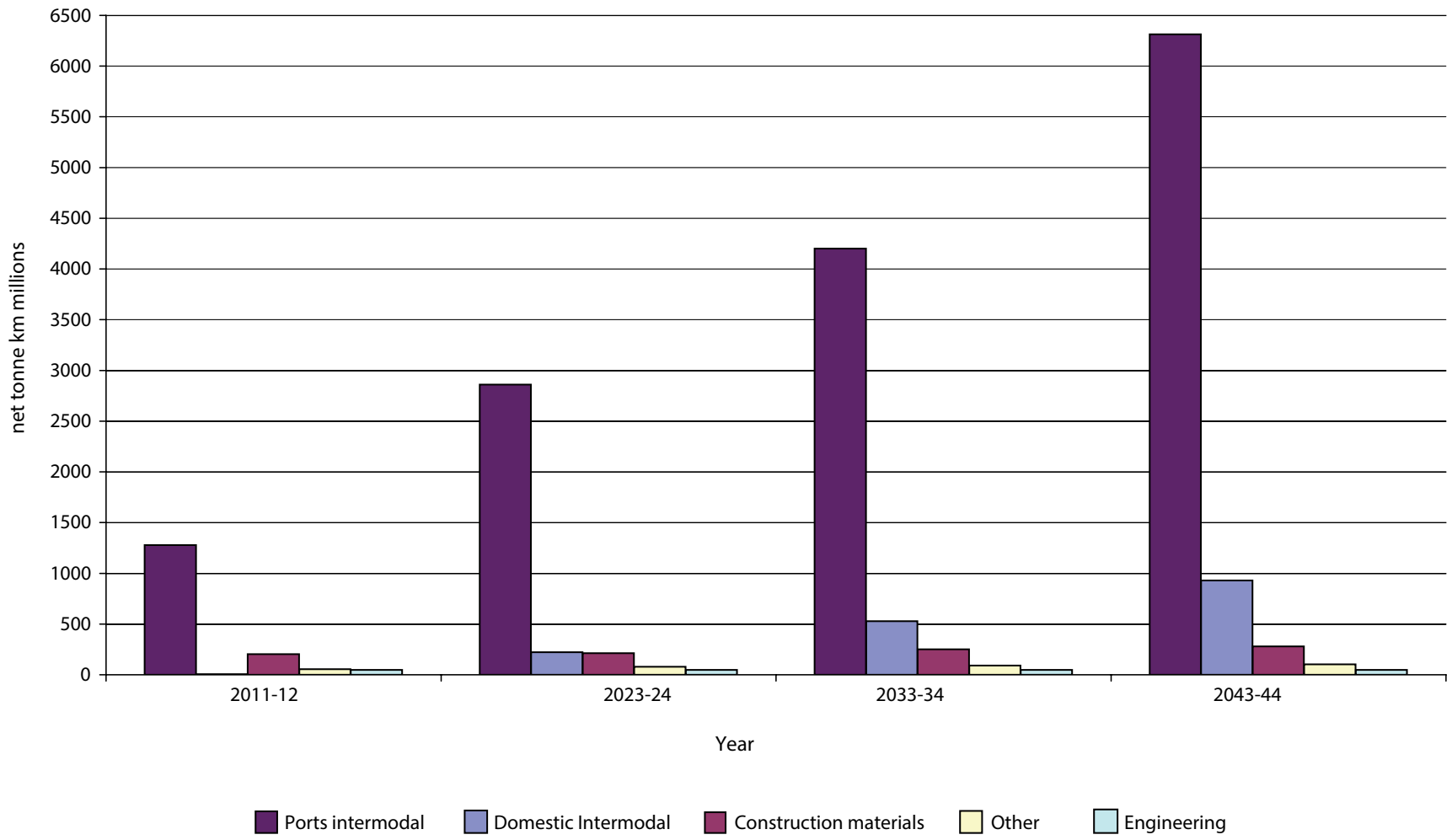
For freight, the conditional outputs are to accommodate the forecast level of freight demand set out in the Freight Market Study in 2023 and 2043.

The overall forecast freight growth across Great Britain is for an increase in total tonne-kilometres of 2.9 per cent per year to 2043, compared to past annual growth of about 2.5 per cent since the mid-1990s. In terms of total tonnes lifted, the forecast is for 2.0 per cent annual growth to 2043, compared with the recent trend of broadly stable tonnage. The forecast growth rate in terms of tonnes is lower than that for tonne-kilometres as a result of changes in the composition of traffic, such as the forecast reduction in coal flows and the forecast increase in longer distance intermodal flows.

Currently, intermodal traffic comprises around 30 per cent of tonne-kilometres nationally. This is forecast to grow to an 80 per cent share of total tonne-kilometres by 2043 as a result of strong forecast growth in intermodal traffic, coupled with the forecast decline in coal traffic. Forecasts for Great Britain show average annual growth in intermodal to 2043 of approximately six per cent, in terms of tonne-kilometres. This reflects growth of about five per cent per annum for the ports and Channel Tunnel sub-sectors and ten per cent per annum for the domestic sub sector. The overall growth reflects forecast trade growth and an improvement in the competitiveness of the rail industry. This improvement in competitiveness reflects the forecast increase in fuel and labour costs which affects road freight proportionally more than rail.

Figure 4.1 depicts the freight growth on the route per year by commodity in tonne kilometres; it shows that demand for freight paths in Anglia is largely driven by growth in intermodal traffic from the ports of Felixstowe, London Gateway and Tilbury. Most of this freight is expected to be carried to destinations outside the Anglia route.

Figure 4.1 Freight conditional outputs - Freight growth per year by commodity



4.2 Freight conditional outputs

The freight conditional outputs are defined in Table 4.1.

Table 4.1 Freight Conditional Outputs to 2023 and 2043	
F2NCO1	To provide sufficient capacity for freight travelling via the F2N route, taking into account anticipated growth over the period to the end of Control Period 6 (2023/2024) - Cross-boundary services
F2NCO2	To provide sufficient capacity for freight travelling via the F2N route, taking into account anticipated growth over the period to 2043 – Cross-boundary services
CLFCO1	To provide sufficient capacity for freight paths across London using the North London Line or Gospel Oak to Barking line to the end of Control Period 6 (2023/2024) - North London Line
CLFCO2	To provide sufficient capacity for freight paths across London using the North London Line or Gospel Oak to Barking line, taking into account anticipated growth over the period to 2043 - North London Line
ETFCO1	To provide sufficient capacity for freight travelling from the London Gateway Port via the Tilbury loop, taking into account anticipated growth over the period to the end of Control Period 6 (2023/2024) – Essex Thameside
ETFCO2	To provide sufficient capacity for freight travelling from the London Gateway Port via the Tilbury loop and from HS1, taking into account anticipated growth over the period to 2043 - Essex Thameside

The forecast changes in freight market demand from the Freight Market Study have been mapped onto the Anglia route with input from the working group, to agree a freight train service specification for 2023 and 2043. This has been used to test options to meet future demand.

Figures 4.2 and 4.3 depict the indicative hourly freight pathing requirements expected in 2023 and 2043. The paths per hour assumptions were developed by rounding up to the next whole number; this has also assisted in providing a comparable context to passenger train services. It should be noted that hourly freight pathing usage will vary depending on the time of day and peak / off-peak hours.

Figure 4.2 Predicted hourly freight pathing requirments by Class in 2023, Anglia

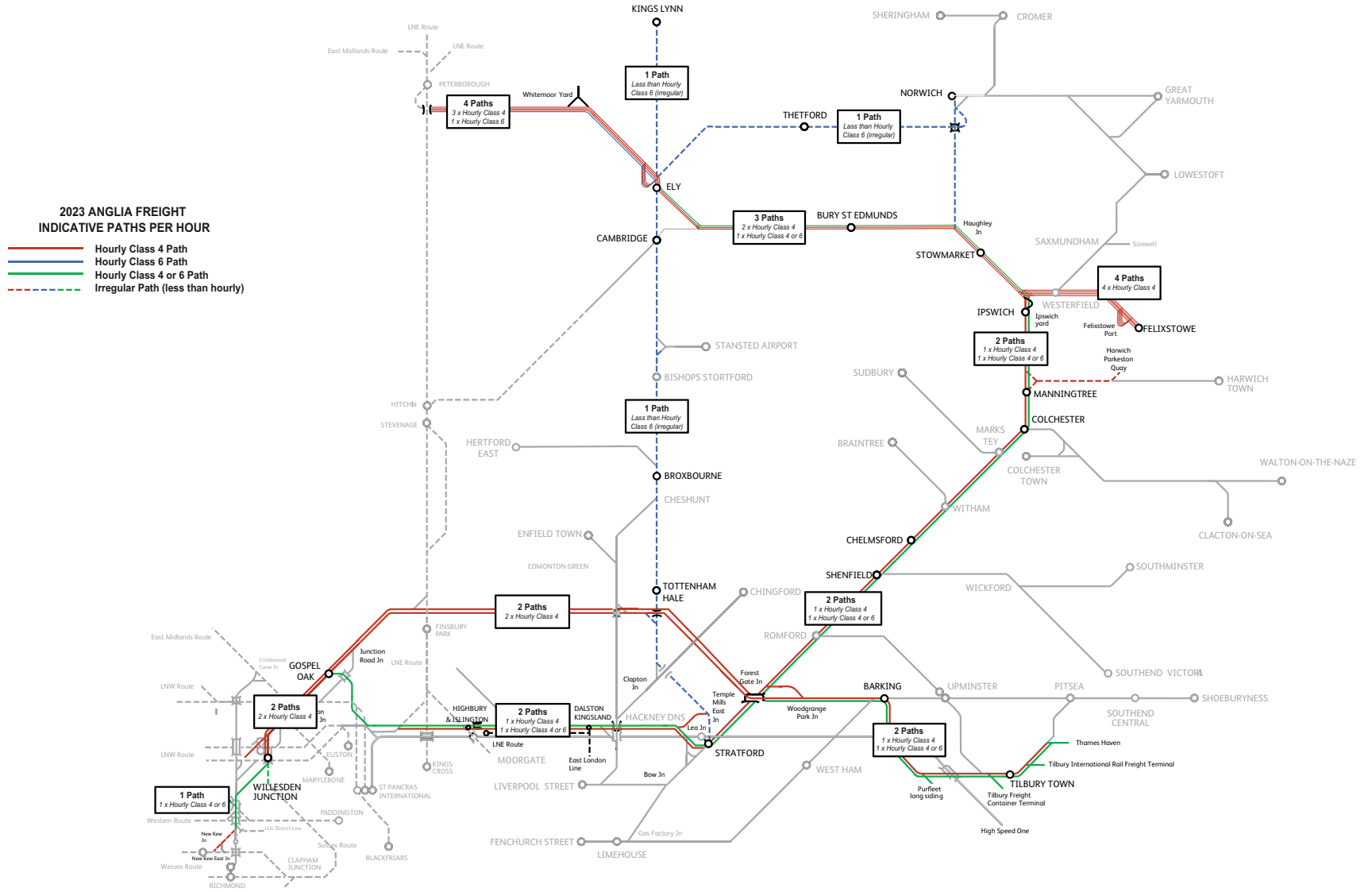
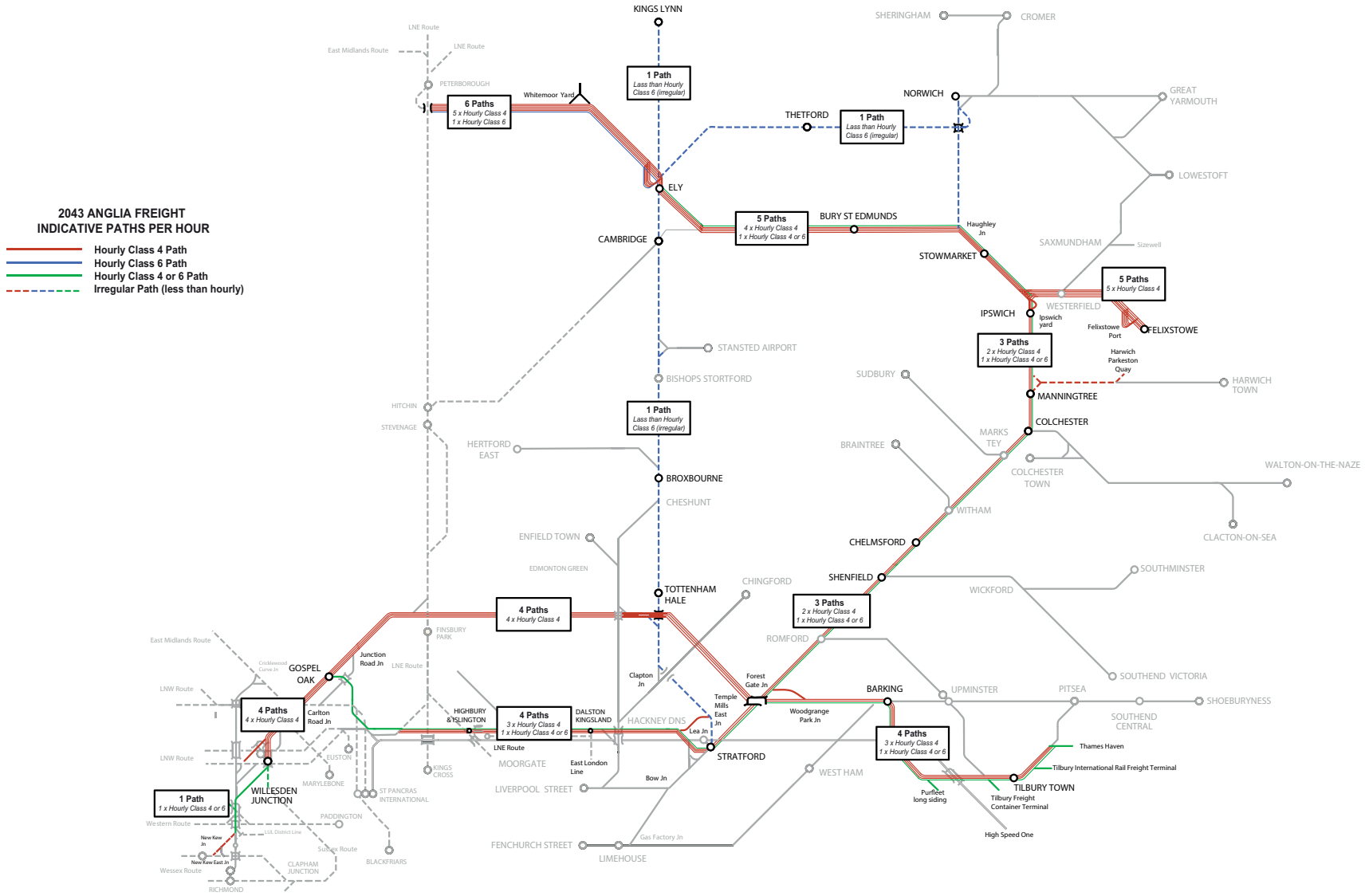


Figure 4.3 Predicted hourly freight pathing requirments by Class in 2043, Anglia



4.3 Passenger demand

In order to understand the requirement for passenger capacity the passenger and freight growth forecasts are based on the 'Prospering in global stability' scenario from the London and South East Market Study and Freight Market Study. This is an optimistic scenario that most closely reflects the conditions that rail has experienced for the last 10-15 years. More detail can be found in the Market Studies; an extract of the increase in morning peak passenger demand can be seen in Table 4.2.

In terms of peak-level demand, the pattern for the Anglia route is largely driven by commuting habits to and from London. Rail already accounts for a large share of the commuting market into London. As a result, additional growth will be driven by employment growth rather than people transferring to rail from other modes of transport.

Since the publication of the draft for consultation, we have worked with TfL to understand how changes to forecast housing and population and changes to the structure of TfL's public transport forecasting model, Railplan, have affected growth in rail patronage on the Anglia route. We found that, overall, growth in forecast demand on the West Anglia Main Line was slightly lower than we assumed in the draft document, and growth on Essex Thameside was slightly higher. We decided to keep the forecasts in the draft document, as they are broadly consistent and therefore a reasonable test of the infrastructure in the long term.

The changes in forecast growth are unlikely to change the strategy for catering for passengers in the medium and long term.

4.4 Passenger conditional outputs

Tables 4.3 to 4.8 show the full range of conditional outputs identified for passenger capacity, for both 2023 and 2043 for the five main arteries of the Anglia route.

4.4.1 Great Eastern Main Line

The forecast demand on the route has been compared with the baseline capacity. Assuming a crowding standard of 0.45 metre squared (m^2) per passenger and that an average load factor to total capacity of 85 per cent will result in a reasonable level of crowding over all peak hour services, then there will be a need to provide further capacity for approximately 2,200 passengers by 2023 and an additional 5,100 by 2043 in the peak hour on the Norwich and semi-fast services via Chelmsford.

In the baseline, two extra 8-car services are expected to run from Southend Victoria in the peak hour into London Liverpool Street, which will meet the required capacity by 2023 and reduce the 2043 gap to 2,400 passengers on the Southend corridor.

Table 4.3 specifies conditional outputs for the Great Eastern Main Line for 2023 and 2043; of these, conditional outputs GECO6 to GECO16 concern connectivity on the branches linking to GEML.

Table 4.2 Increase in morning peak passenger demand into London Termini or at the busiest point on the route from 2013

Corridor	2023	2043
Great Eastern Norwich and Outer suburban services	32%	75%
Great Eastern Inner suburban and Crossrail services	52%	83%
West Anglia Main Line – all services	18%	39%
North London Line/ West London Line	22%	55%
Gospel Oak to Barking	20%	46%
Essex Thameside	13%	46%
Source: L&SE Market study and TfL Railplan		

Figure 4.4 depicts the build-up of demand over and above the current capacity for all services on the route to London Liverpool Street via Chelmsford between 08:00 and 08:59. It shows that passengers on these services will be travelling in crowded conditions for a long time. Without intervention, services will be over seated capacity and between 40 per cent and 100 per cent of standing capacity taken up for well over 20 minutes. Services that start from Norwich, Stowmarket, Witham and Chelmsford tend to have the highest load factors and demand is at, or exceeds, seated capacity now.

Crossrail is expected to provide sufficient capacity to the end of CP6 and into the longer term. There may be a capacity issue nearer the end of the 2030s and this should be monitored after the introduction of the Crossrail services.

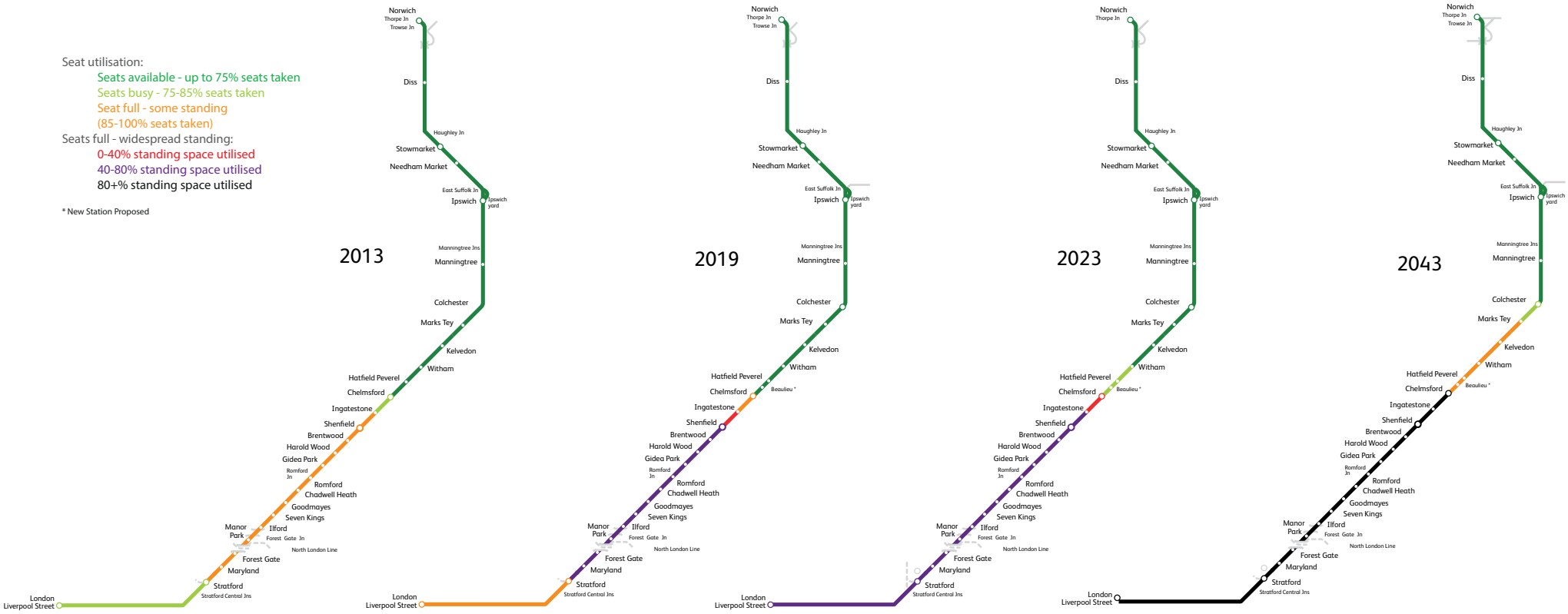
There is an aspiration to improve journey times on the Great Eastern Main Line, improving services from Norwich, Ipswich, Colchester, Chelmsford and other towns into London.

Several branch lines off the Great Eastern Main Line currently run with only an hourly frequency. The Route Study investigates the feasibility of improving the frequency of services on these lines.

Table 4.3 Conditional outputs identified for passenger capacity and connectivity on the Great Eastern Main Line

GECO1	To provide sufficient capacity for passengers travelling into central London during peak hours, taking into account anticipated growth over the period to 2023 - Great Eastern Main Line services
GECO3	To produce journey time improvements on the route from Norwich to London - Great Eastern Main Line services
GECO4	To provide sufficient capacity for passengers travelling into central London during peak hours, taking into account anticipated growth over the period to 2043 - Great Eastern Main Line services
GECO6	Increase in passenger service frequency between Norwich and Sheringham to 2tph
GECO7	Increase in passenger service frequency between Great Yarmouth and Norwich (via Acle) to 2tph
GECO8	Increase in passenger service frequency between Lowestoft and Norwich to 2tph
GECO9	Increase in passenger service frequency between Lowestoft and Ipswich to 2tph
GECO10	Increase in passenger service frequency between Felixstowe and Ipswich to 2tph
GECO11	Increase in passenger service frequency between Harwich Town and Manningtree to 2tph
GECO12	Increase in passenger service frequency between Walton-on-the -Naze and Colchester to 2tph
GECO13	Increase in passenger service frequency between Clacton-on-Sea and Colchester to 2tph
GECO14	Increase in passenger service frequency between Sudbury and Marks Tey to 2tph
GECO15	Increase in passenger service frequency between Braintree and Witham to 2tph
GECO16	Increase in passenger service frequency between Southminster and Wickford to 2 tph

Figure 4.4 Average load factor of all GEML services into London Liverpool Street via Chelmsford between 08:00 and 08:59 in 2013, 2019, 2023 and 2043



4.4.2 Cross country corridor via Ely

The main driver for this corridor is not peak capacity, rather providing interregional connectivity. There are some crowding issues for services into large cities and towns in the peak hours.

Table 4.4 specifies conditional outputs for the Cross country corridor via Ely for 2023 and 2043. Table 4.5 specifies conditional outputs addressing connectivity for the Cross country corridor via Ely.

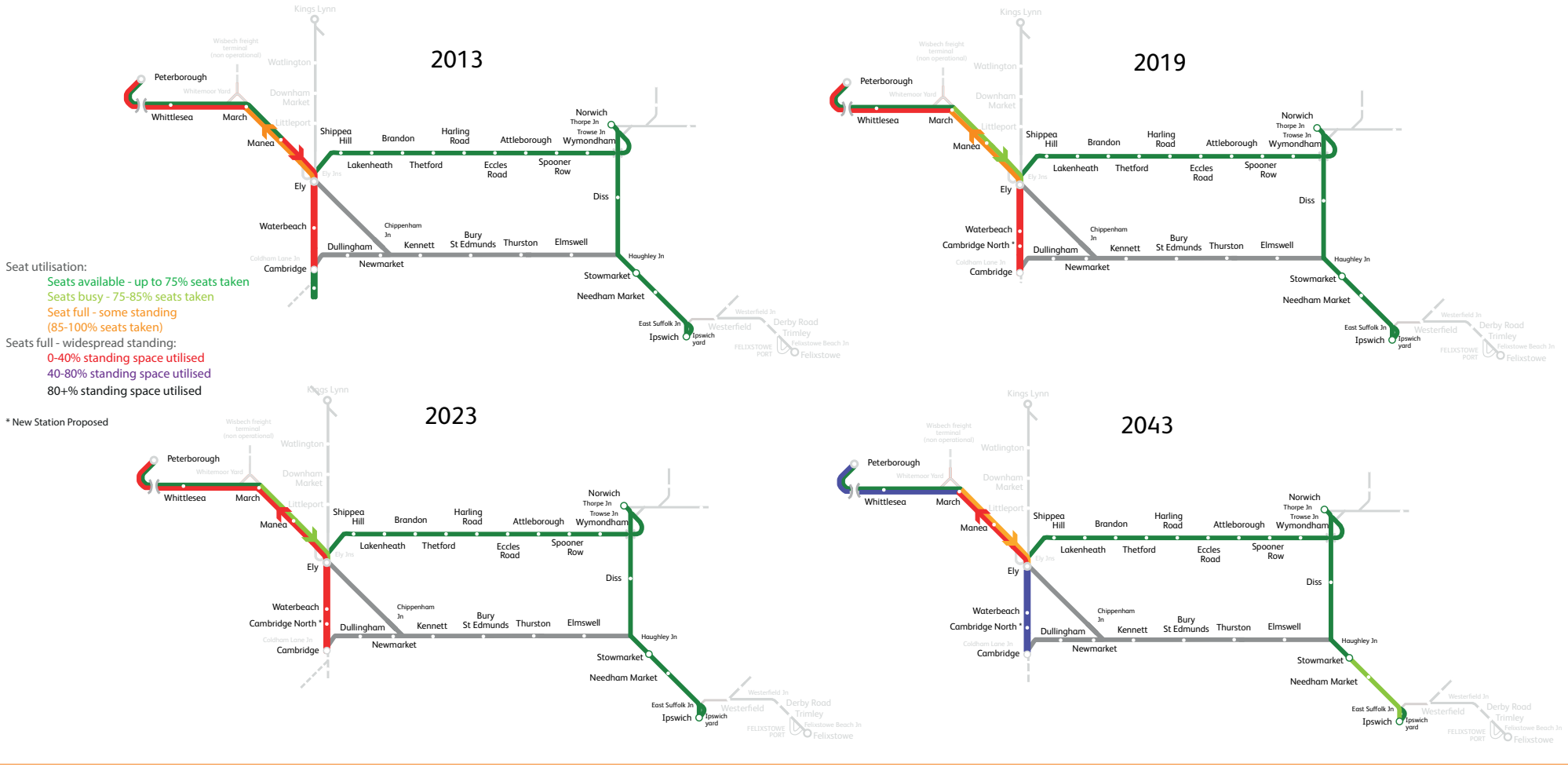
Figure 4.5 shows the build-up of demand on the route to 2043.

Further lengthening on some services can be achieved on the existing infrastructure. There is an aspiration to improve service frequencies and connectivity on the main routes between Norwich/ Ipswich and Cambridge/Peterborough.

Table 4.4 Conditional outputs identified for passenger capacity for 2023 and 2043 on the Cross country corridor via Ely	
GECO2	To provide sufficient capacity for Cross-boundary (including Peterborough) and Cambridge passengers travelling to Norwich via Ely, taking into account anticipated growth to 2023
GECO5	To provide sufficient capacity for Cross-boundary (including Peterborough) and Cambridge passengers travelling to Norwich via Ely, taking into account anticipated growth over the period to 2043
WACO8	To provide sufficient capacity for passengers travelling between Cambridge and Kings Lynn

Table 4.5 Conditional outputs identified for connectivity on the Cross country corridor via Ely	
WACO6	Increase in passenger service frequency between Kings Lynn and Cambridge to 2tph
WACO7	Increase in passenger service frequency between Ipswich and Cambridge to 2tph

Figure 4.5 Average load factor of all Cross country corridor services via Ely, including to/from Peterborough between 08:00 and 08:59 in 2013, 2019, 2023 and 2043



4.4.3 West Anglia Main Line

Assuming a crowding standard of 0.45 m^2 per passenger and that an average load factor to total capacity of 85 per cent will result in a reasonable level of crowding over all peak hour services, there will be a need to provide further capacity for approximately 1,000 passengers by 2023 and 2,100 by 2043 in the peak hour on the Cambridge and Stansted Airport services into London Liverpool Street. On suburban services further capacity for 1,700 passengers by 2023 and an additional 4,200 passengers by 2043 will be required.

Figure 4.6 depicts the build-up of demand on the route. It shows that passengers will be travelling in crowded conditions for a long period of time on the Cambridge and Stansted Airport services.

Figure 4.7 shows crowding on the services from Hertford East, Broxbourne, Cheshunt and Enfield into London Liverpool Street and Stratford. It demonstrates that even to 2043, on average services will not be over standing capacity. However, of the suburban trains, the Hertford East services are the most overcrowded and passengers are in crowded conditions for a long period of time. Other services on inner suburban routes tend to be crowded for shorter periods of time.

Given the size and strategic importance of Stansted and Cambridge as travel and employment centres, the service to and from London is relatively poor; the Route Study investigates how to improve the services. Rail services to Stansted Airport are also not well matched with the times when air passengers are most likely to travel.

The Lea Valley is one of the most deprived parts of London and there is an opportunity to provide better direct access to employment and cultural opportunities in Central London to stimulate regeneration.

Kings Lynn to Cambridge and Ipswich to Cambridge are also infrequently served; as such, the Route Study investigates the feasibility of improving the frequency of services on these corridors.

Using the above as a baseline, the conditional outputs as outlined in Table 4.6 have been identified for the West Anglia Main Line for 2023 and 2043.

Table 4.6 Conditional outputs identified for passenger capacity for 2023 and 2043 on the West Anglia Main Line

WACO1	To provide sufficient capacity for passengers travelling into central London and other employment centres during peak hours, taking into account anticipated growth over the period to the end of Control Period 6 (2023/2024) - West Anglia services
WACO2	To provide sufficient capacity for passengers travelling into central London during peak hours, taking into account anticipated growth over the period to 2043 - West Anglia Main Line services via the Southbury Loop, Harlow Town & the Chingford branch.
WACO3	To provide journey time improvement for services from both Cambridge and Stansted Airport to London Liverpool Street - West Anglia services
WACO4	Improve cross London connectivity, connecting South West and North East London
WACO5	To provide sufficient capacity for passengers travelling to Stansted Airport all day, taking into account anticipated growth over the period to 2043

Figure 4.6 Average load factor of all West Anglia Main Line outer services into London Liverpool Street between 08:00 and 08:59 in 2013, 2019, 2023 and 2043

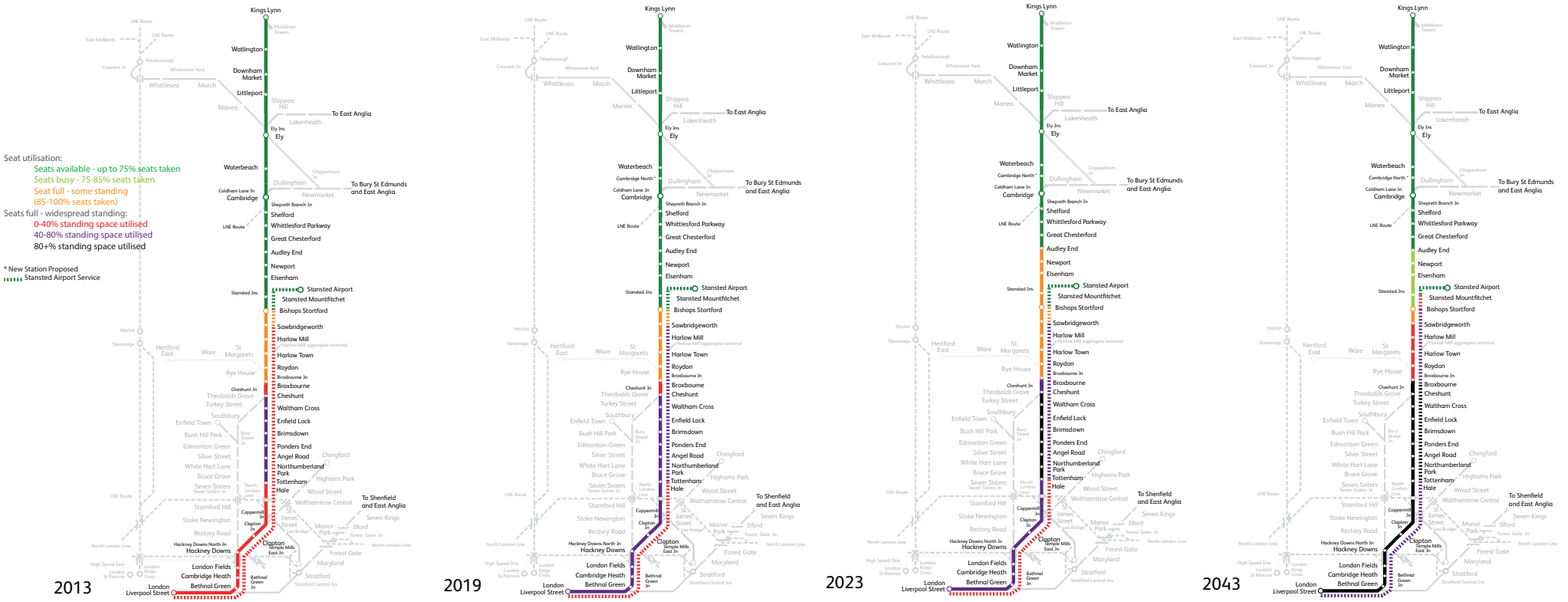
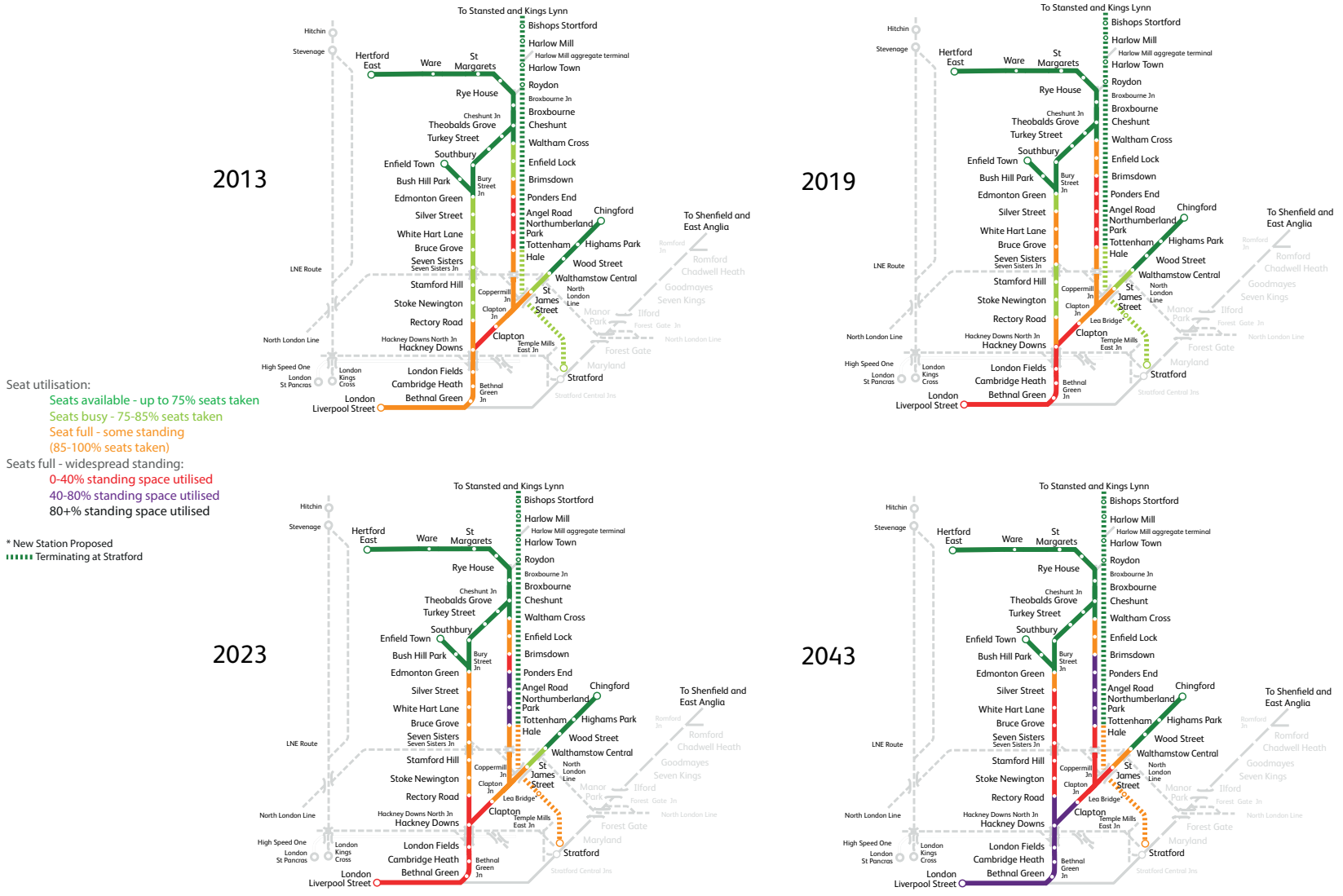


Figure 4.7 Average load factor of all West Anglia Main Line suburban services into London Liverpool Street and Stratford between 08:00 and 08:59 in 2013, 2019, 2023 and 2043



4.4.4 Orbital Routes - North London Line and Gospel Oak to Barking

In the morning peak, the peak loading on the North London Line (NLL) is concentrated in the westbound direction into Highbury and Islington. TfL are providing additional capacity in CP5 through the London Overground Capacity Improvement Programme (LOCIP) which increases the length of services from 4-car to 5-car on the NLL; they also aspire to provide an additional 2tph in the peak in CP5/6. By the end of CP6, this will provide sufficient capacity to cater for demand.

Looking beyond CP6 to 2043, there is expected to be a gap in capacity on the NLL of around 1,500-2,000 passengers . On the Gospel Oak to Barking route, electrification and the introduction of 4-car EMUs on the route with the existing 4tph frequency is expected to provide sufficient capacity over the planning period to 2043. TfL are looking to improve the frequency on the Gospel Oak to Barking line after the introduction of electric services.

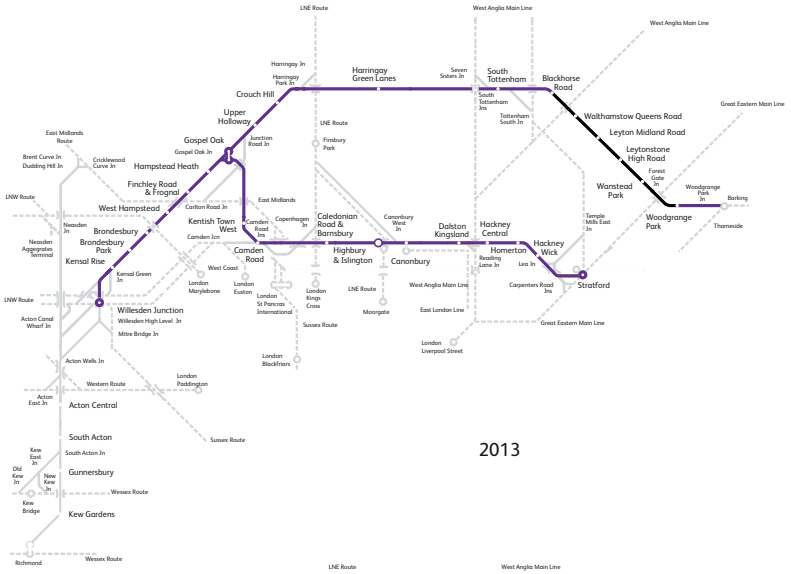
Figure 4.8 depicts demand and crowding on the route. It shows that already both routes are considerably busy and the introduction of additional capacity in CP5 in the form of longer trains on the NLL and the Gospel Oak to Barking route will provide significant crowding relief.

Unlike most suburban commuting lines that tend to pick up passengers en-route to termini for commuting, these routes tend to have many passengers boarding and alighting along the entire route. This provides access to many employment centres in North London and onward connections to the tube and bus network. Consequently passengers tend to travel on the route for short periods of time.

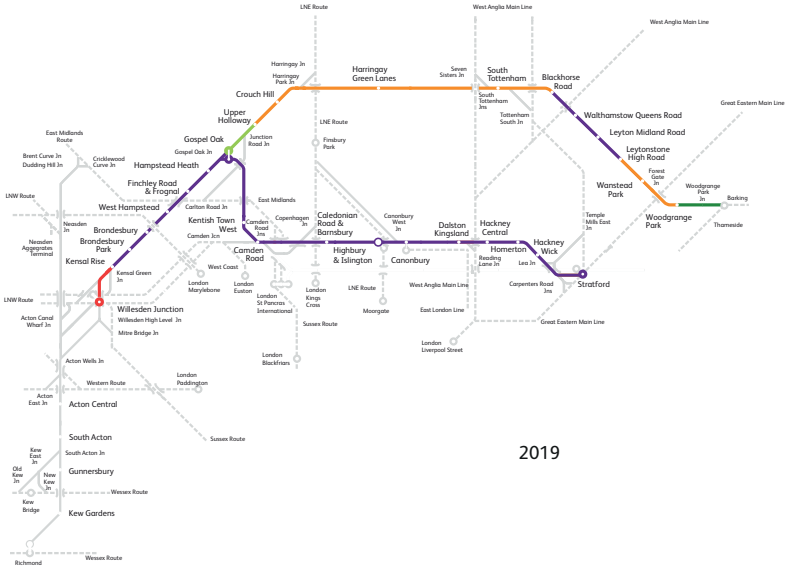
Using the above as a baseline, the conditional outputs as outlined in Table 4.7 have been identified for the North London Line and Gospel Oak to Barking line for 2023 and 2043.

Table 4.7 Conditional outputs identified for passenger capacity to 2023 and 2043 on the Orbital Routes	
CLCO1	To provide sufficient capacity for passengers travelling into central London during peak hours, taking into account anticipated growth over the period to the end of Control Period 6 (2023/4) - North London Line and Gospel Oak to Barking
CLCO2	To provide sufficient capacity for passengers travelling across London during peak hours, taking into account anticipated growth over the period to 2043 - North London Line and Gospel Oak to Barking

Figure 4.8 Average load factor of all North London Line and Gospel Oak to Barking services between 08:00 and 08:59 in 2013, 2019, 2023 and 2043



2013



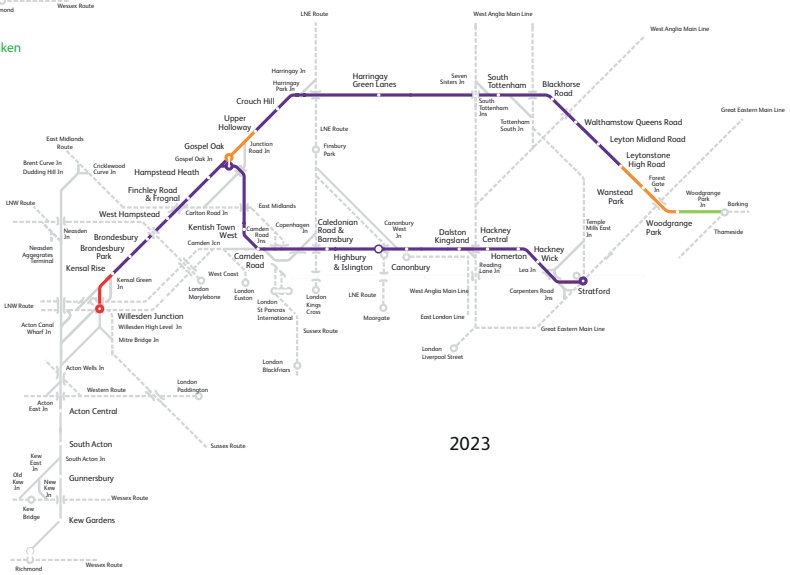
2019

Seat utilisation:

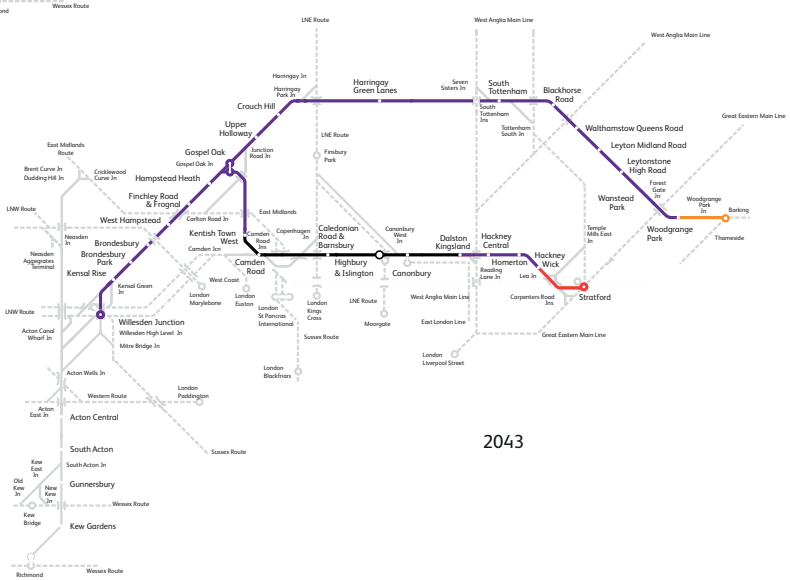
- Seats available - up to 75% seats taken
- Seats busy - 75-85% seats taken
- Seat full - some standing (85-100% seats taken)

Seats full - widespread standing:

- 0-40% standing space utilised
- 40-80% standing space utilised
- 80+% standing space utilised



2023



2043

4.4.5 Essex Thameside

Assuming a crowding standard of 0.45 m^2 per passenger and that an average load factor to total capacity of 85 per cent will result in a reasonable level of crowding over all peak hour services, there will be a need to provide further capacity for approximately 4,700 passengers by 2023 and an additional 11,000 passengers by 2043 in the high-peak hour (08:00 to 08:59) into Fenchurch Street. There will also be a capacity gap in the first shoulder-peak hour (07:00 to 07:59).

Figure 4.9 shows the build-up of demand on the route, depicting how some trains are crowded for a long period of time. Passengers on services from Shoeburyness to Fenchurch Street are expected to travel in crowded conditions for the longest durations. Crowding on inner/suburban services are high but for much shorter periods of time. There may be an argument for using a lower crowding standard on inner services to reflect the short amount of time that passengers are travelling in crowded conditions.

Between 2011 and the present day, the rate of growth on the route in the AM peak has been higher than might be suggested by the long term forecast in the Market Studies. Should demand continue to out-perform the forecasts in the medium term, the requirement for capacity would be higher but is likely to still fall within the longer term strategy to 2043. The options proposed in Chapter 5 to address the originally forecast demand will therefore also cater to this speedier passenger increase, but may require earlier implementation (of longer trains in CP6).

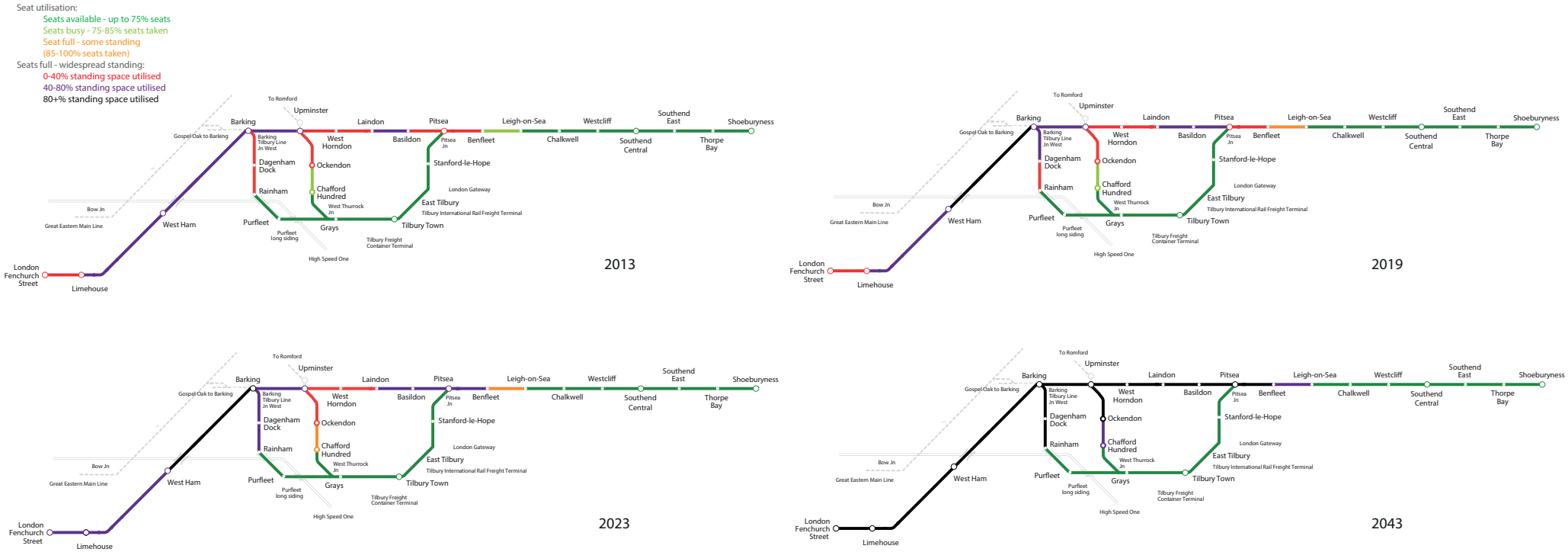
The Anglia Route Study also examines options to improve journey times from Southend to London and to exploit opportunities from running more trains, in order to improve the frequency of services from intermediate stations into London.

Using the above as a baseline, the conditional outputs as outlined in Table 4.8 have been identified for Essex Thameside for 2023 and 2043.

Table 4.8 Conditional outputs identified for passenger capacity on Essex Thameside

ETCO1	To provide sufficient capacity for passengers travelling into central London during peak hours, taking into account anticipated growth over the period to 2023 - Essex Thameside
ETCO2	To improve journey times on the Essex Thameside route
ETCO3	To provide sufficient capacity for passengers travelling into central London during peak hours, taking into account anticipated growth over the period to 2043 - Essex Thameside

Figure 4.9 Average load factor of all Essex Thameside services into London Fenchurch Street between 08:00 and 08:59 in 2013, 2019, 2023 and 2043



4.5 Other conditional outputs

The market studies established further conditional outputs, including:

4.5.1 Rail connectivity to airports

Stansted Airport is located on the branch off the West Anglia Main Line between Bishops Stortford and Cambridge. It is served by a 4tph frequency of service to/from London and is connected to destinations to the north by an hourly Birmingham – Stansted service and Cambridge – Stansted service. There are aspirations for improvements to the journey time between London and Stansted.

Southend Airport is located on the line between Shenfield and Southend Victoria. It is served by a 4tph frequency of service to/from London. Connections to other services can be made at Shenfield or Stratford.

4.5.2 Rail connectivity with High Speed 2 (HS2)

High Speed 2 will provide high-speed connectivity between London, the Midlands and the North. Connectivity and interchange between the Anglia Route and HS2, for onwards travel, is therefore considered to be important.

Crossrail will provide a connection between Anglia and the proposed station at Old Oak Common; this in turn may be accessed from the West Anglia Main Line and Great Eastern Main Line through a connection at Stratford.

As discussed in Chapter 3, development of two stations is underway on the London orbital route, one at Hythe Road on the West London Line and one at Old Oak Common Lane on the North London Line. These new London Overground stations would allow passengers to interchange between HS2, the Great Western Main Line, Crossrail and London Overground services, which would enable the creation of a key strategic interchange point for West London, similar to that in Stratford, East London.

05: Meeting the Conditional Outputs

Chapter 5 explains

- key changes to the train service and infrastructure capability required to meet the conditional outputs to 2043
- choices available for CP6 to meet the growth in demand by 2024

This chapter details the choices or interventions that the Route Study suggests would be required to meet the conditional outputs set out in Chapter 4. These include the priorities identified for Control Period 6 (CP6: 2019-2024), the interventions that build upon CP6 to form the future strategy required to meet the growth and demand to 2043 (CP10: 2039-2044; in the subsequent sections referred to as CP7 or beyond choices), Cross-boundary passenger and freight growth, and connectivity between destinations within the Anglia Route.

In many cases there is no single intervention to meet the conditional output and therefore the choices should be seen as the building blocks for accommodating the conditional outputs to 2043 in an affordable and deliverable way.

The conditional outputs required by 2043 can be broadly categorised as either morning peak capacity or off-peak connectivity.

All of the CP6 investment choices identified for the Anglia Route meet one (or more) of the following criteria:

- Investments which reduce rail industry operating costs (for example further network electrification or the provision of new 'turnback' facilities enabling the rail industry to reduce its operational resources).
- Investments which are required to provide sufficient capacity for the anticipated level of passenger or freight demand at the end of CP6, where this investment is also consistent with the longer-term strategy for the route.
- 'Once in a generation' opportunities where conditional outputs (or some part of the capital works necessary to meet conditional outputs over a longer period of time) can be delivered most efficiently during CP6, for example, in conjunction with the planned renewal of life-expired assets.
- Investing in better connectivity to High Speed 2 stations and airports.
- Other investments which reflect funders' priorities.

Deliverability is another key consideration for this Route Study. It is important that the CP6 priorities and the future strategy are not only affordable but that they take account of when the optimum time for implementation of the proposed interventions would be. The timing of the interventions discussed in this chapter should consider how disruptive an intervention will be, particularly in light of other works on the route (such as renewals) and should be mindful of the impact on Train and Freight Operating Company (TOC and FOC) access.

It is imperative to consider the conditional outputs and options for funders detailed below in the context of the resiliency of the network. There are a number of proposed interventions detailed in the Anglia Weather Resilience and Climate Change Adaptation (WRCCA) plan, primarily in the GEML and Cross country corridor via Ely area, which address vulnerabilities on the Route relating to flooding, high and low temperatures, wind and snow, among others. These interventions are currently unfunded and should be considered in conjunction with any proposed enhancements. Ensuring the foundations for a robust network are in place is vital in maintaining its functionality and the performance requirements set for both freight and passenger services.

5.1 Great Eastern Main Line – Capacity: GECO1 and GECO4

As stated in Chapter 4 the conditional outputs concerning capacity, which seek to address the growth expected on the Great Eastern Main Line, are outlined in Table 5.1.

It is impossible to address these conditional outputs without being mindful of how each one impacts upon the other. It is therefore important that they are consistent with one another and form a coherent strategy for addressing growth on the GEML.

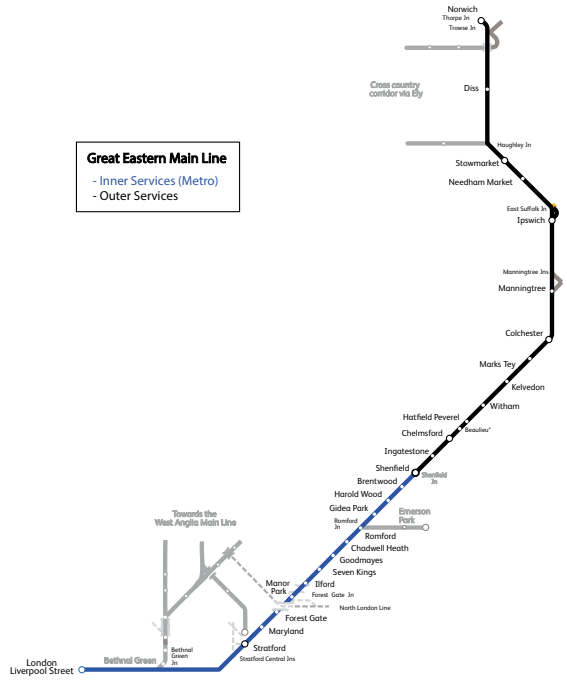
The conditional outputs to 2043 (CP10) are considered first with the CP6 priorities developed based on this strategy; they have been split between GEML Inner and Outer services (see Figure 5.1).

Figure 5.4 depicts the options for funders for CP6 and CP7 or beyond.

Table 5.1 Conditional outputs identified for passenger capacity for 2023 and 2043 on the Great Eastern Main Line

GECO1	To provide sufficient capacity for passengers travelling into central London during peak hours, taking into account anticipated growth over the period to 2023 - Great Eastern Main Line services
GECO4	To provide sufficient capacity for passengers travelling into central London during peak hours, taking into account anticipated growth over the period to 2043 - Great Eastern Main Line services

Figure 5.1 GEML Inner (metro) and Outer services



5.1.1 GEML - CP7 or beyond choices for funders:

5.1.1.1 GE Inner Services

The Route Study assessment shows that the level of capacity provided by Crossrail will meet growth up to CP8 or CP9. By the end of CP10 (2039-2044) there is expected to be a capacity gap of around 2,000 passengers. Options to provide additional capacity on Crossrail would be either by increasing the service frequency or lengthening services to 10-car (23 metres in length per car), as operations will commence as 9-car services. Lengthening would require infrastructure enhancements at Gidea Park sidings, Ilford depot and Heathrow stations to accommodate trains longer than 205 metres.

5.1.1.2 GE Outer Services

By 2043 there is a clear capacity gap on main line services over and above the capacity provided in the baseline. The Norwich and outer services serving Ipswich, Colchester and Chelmsford into London Liverpool Street have the greatest gap of around 7,300 passengers. On services from the Wickford route there is expected to be a capacity gap of around 2,300 passengers.

The main line inwards of Shenfield is already highly congested in the peak hour. This means that increasing the level of service of the outer services above 24 trains per hour (tph), stated in Chapter 3 as the baseline, comes with a likely adverse effect on reliability and performance without some major interventions to improve the capability of the infrastructure.

Lengthening trains beyond 12-car to at least 16-car is expected to be prohibitively expensive because of the extent of remodelling required to achieve longer platform lengths and junction clearances across the network, in particular at Liverpool Street Station, therefore no further work has been undertaken on this option.

Double-deck trains have not been assessed as an option owing to the significant number of structures on the route that would require rebuilding or modification.

Increasing the frequency of the outer services has been shown to be the only option to meet the level of peak capacity required to 2043.

An indicative train service specification (ITSS) has been developed to assess the infrastructure interventions required to deliver an increase in service quantum. The specification is an additional 8tph in the peak hours to accommodate the demand to 2043, totalling 32 peak tph into London from the GE outer area.

To meet the main line demand in 2043, the working group has identified key priority intervention locations where the infrastructure capability cannot meet the future train service:

- London Liverpool Street
- Chelmsford – London Liverpool Street
- Witham – Colchester
- Ipswich – Haughley Junction
- Trowse and Norwich area

Table 5.2 Great Eastern Main Line Peak Capacity (2043)

Description	To support peak capacity on the Great Eastern Main Line in 2043 a series of interventions are required across the route: – platform capacity at London Liverpool Street – signalling headway reduction between Chelmsford and London Liverpool Street – passing loop north of Witham – four-tracking or grade separation at Haughley Junction – doubling of Trowse Swing Bridge
Conditional Output	This is to address peak demand on the Great Eastern Main Line (GECO4). This package of interventions would deliver 32 main line services in the peak hour to London Liverpool Street.
Link to other Options	The requirements between Ipswich and Haughley Junction are driven by both the increased GEML peak services and the increase in freight traffic between Felixstowe and Peterborough (F2NCO2).

These locations have been examined and a series of interventions has been developed to achieve sufficient peak capacity out to 2043.

London Liverpool Street

There is no significant gain in capacity at London Liverpool Street following the introduction of Crossrail. This is because Platform 16 can only accommodate 10-car services and all GEML services are likely to be longer than that. Therefore GEML and WAML services can still only use Platforms 1 to 15 as is currently the case. The remodelling at Bow Junction makes it easier to access platforms 13 to 15 using the Electric Lines, which helps reduce conflicts in the throat, but this does not in itself provide significant additional capacity. Therefore to accommodate the 2043 level of GEML service alongside West Anglia services at London Liverpool Street would require additional platform capacity at London Liverpool Street.

An alternative option has been examined for additional platform capacity at Stratford whereby West Anglia Main Line services would be re-routed to Stratford to support additional platform capacity for GEML services at London Liverpool Street. This option conflicts with options for accommodating growth on the West Anglia Main Line and therefore is not recommended for further development.

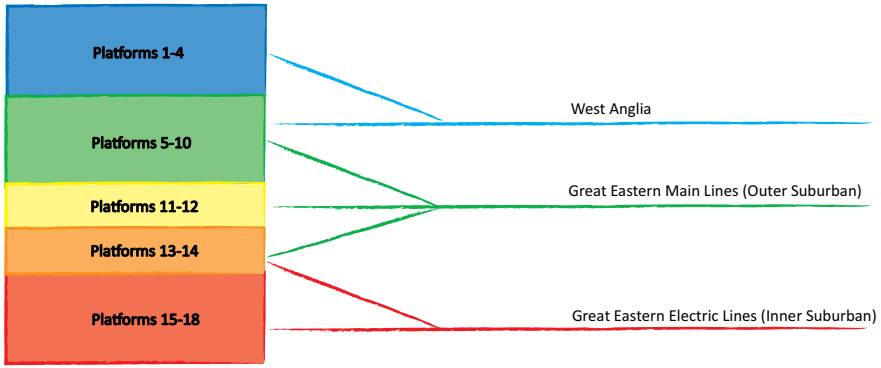
Signalling headway reduction

The capability of the current conventional signalling between Chelmsford and London Liverpool Street on the Great Eastern Main Line is such that successive trains must be two minutes apart (the planning headway). This two-minute gap between services therefore limits the maximum practical capacity of the line to 24tph. To be able to increase the service above this would require the capability of the signalling to be such that successive trains could be 1½ minutes apart or less.

In relation to this, initial modelling work has been carried out to assess the potential capacity benefits of European Train Control System (ETCS) for this section of line. The two levels assessed were:

- ETCS Level 2 which provides a 'fixed block' system of train detection whereby one train remains a set distance away from the train in front. This is done 'in-cab' without the need for signalling infrastructure on the trackside.
- ETCS Level 3 which provides a 'moving block' system of train detection whereby one train is safely able to move closer to the train in front depending on their individual speeds and locations. This is also done 'in-cab' without the need for signalling infrastructure on the trackside. Because 'moving block' allows trains to run closer together, while maintaining required safety margins, it can increase a line's overall capacity.

Figure 5.2 London Liverpool Street station platform usage



The study assessed both Levels 2 and 3 of ETCS with and without Automatic Train Operation (ATO)[1] . The findings suggest that implementation of ETCS Level 3 in conjunction with ATO inwards of Chelmsford could enable up to 32tph to be accommodated on the existing Up Main Line.

Passing loop north of Witham

To accommodate predicted growth, the service specification has been developed with differing calling patterns north of Chelmsford. This is to achieve an increase in train services to meet the increased demand without having to slow down the outer services and requires the opportunity to overtake slower passenger services on the Great Eastern Main Line to achieve the output. An optimal location for a passing loop has been identified north of Witham (see Figure 5.3)

Four-tracking or grade separation at Haughley Junction

Although no increase in main line capacity for freight is assumed within this study, there is significant growth on the Felixstowe to Peterborough (via Ely) corridor. The combination of these freight movements and the increase in outer GE passenger services will require either grade separation or partial four-tracking at Haughley Junction to achieve the crossing of flows in this area. Analysis has shown that the portion of four-tracking would be approximately four miles. Potential options to limit freight growth within peak hours could reduce the need for this infrastructure.

Doubling Trowse Bridge

To achieve additional services to Norwich as well as services to Cambridge/Ely, in order to meet demand to 2043, would require the single track at Trowse to be doubled.

5.1.2 GEML - CP6 choices for funders:

5.1.2.1 GE Inner Services

The introduction of 9-car Crossrail services in 2019 will greatly increase the capacity available in the inner area. In terms of meeting the growth in passengers expected to the end of CP6 this Route Study does not suggest any interventions are required above those already committed in CP5.

5.1.2.2 GE Outer Services

Making best use of existing infrastructure

Apart from some services that start at Witham, all services currently run as 12-car Electric Multiple Units (EMUs) or as 10-car loco-hauled stock. Lengthening the remaining Witham services to 12-car and increasing the frequency of services will cater for the additional capacity requirements. It would also be possible to replace existing 10-car loco-hauled stock with 12-car EMUs.

The infrastructure capability can support 12-car operation, although the length of new rolling stock would need to be reviewed as some units are longer and may trigger infrastructure work. Therefore, the first stage to meeting further demand on the route should be to lengthen the remaining outer services or consider higher-density rolling stock.

Once all outer services are 12-car in length any further capacity to accommodate growth will need to be achieved through additional services. As with the longer-term strategy, no increase above 24tph can be achieved with the current signalling capability on the route between Chelmsford and Stratford.

CP6 choices for funders: GE Peak Capacity

At the end of CP6, there is predicted to be a capacity gap on services from Norwich and outer services serving Ipswich, Colchester and Chelmsford into London Liverpool Street of around 2,200 passengers. To provide sufficient capacity for passengers travelling into central London during peak hours will require three additional peak services per hour.

Utilising the findings from the CP7 and beyond choices, the interventions have been reviewed to understand what is required to deliver the end of CP6 train service assumptions, based on a 27 peak hour train service.

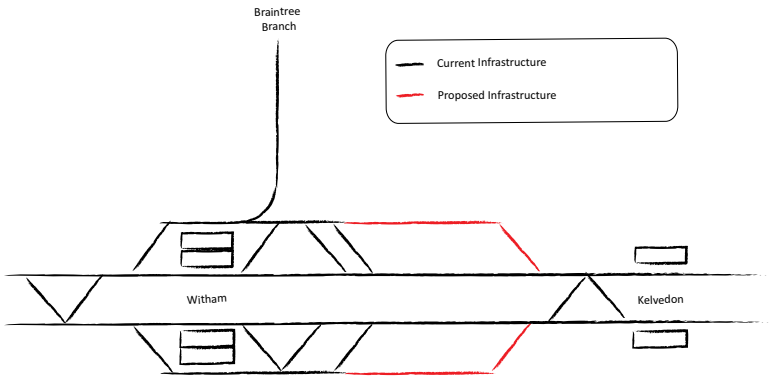
All infrastructure identified to meet CP6 demand is consistent with longer term options to meet 2043 conditional outputs. The only 2043 identified option not required for CP6 is four-tracking or grade separation at Haughley Junction; therefore to achieve 27tph would require the interventions at Liverpool Street, Witham, Trowse and improved signalling capability between Chelmsford and Liverpool Street.

1 ATO is the means by which train operation will be largely automated.

Further work with the Digital Railway Programme is being undertaken to understand the benefit of ETCS Level 2 and whether this can be used to achieve the 27tph output required for CP6.

Table 5.3 Great Eastern Main Line Peak Capacity (2023)	
Description	To support peak capacity on the Great Eastern Main Line in CP6 a series of interventions are required across the route: – platform capacity at London Liverpool Street – signalling headway reduction between Chelmsford and London Liverpool Street – passing loop north of Witham – doubling of Trowse Swing Bridge
Conditional Output	To provide 27 high peak hour trains to/from London Liverpool Street to meet peak capacity conditional outputs (GECO1).
Link to other Options	All interventions are in line with the main line package identified for 2043 (GECO4).
Socio-economic Value for Money	This option is Poor / Low value for money when considered in isolation without the train service uplift in the longer term that is enabled through these infrastructure changes. As insufficient information is available about costings and roll out plan for ETCS signalling technology, this business case includes the costs of a traditional re-signalling between Chelmsford and Stratford. This may not be an appropriate assumption therefore a sensitivity check has also been completed without this re-signalling cost. This achieves a High / Very High value for money. It is recommended that this is reassessed through the Digital Railway Programme.
Conclusions	The challenge for this option is whether there will be an opportunity for improved signalling technology to be rolled-out on the route within this timeframe. The costs and delivery timescale will need to be reviewed once more is understood about the roll-out for the Digital Railway Programme. The infrastructure changes at Liverpool Street, north of Witham and Trowse would support additional peak capacity on the Norwich corridor through utilisation of the base 24tph and therefore could be progressed ahead of ETCS implementation.

Figure 5.3 Provision of a loop north of Witham



5.2 Great Eastern Main Line – Journey Time Improvements: GECO3

The conditional output which seeks to address the journey time improvements expected on the Great Eastern Main Line is outlined in Table 5.4.

To achieve conditional output GECO3 and improve the journey times to outer destinations, a series of interventions has been tested. This is because no single option can achieve reductions in journey times alone and changes to the rolling stock, calling pattern and infrastructure capability will also be required.

The best possible improvements to journey time can be achieved through changes to rolling stock to improve acceleration and reduce dwell times (through removal of slam door stock) and altering the calling patterns of the fast services on the route. If calling patterns are reduced, then additional services will be required on the route to replace calls and retain the connectivity to other stations. The interventions for journey time improvement are therefore very similar to those addressing the capacity gap as they include the infrastructure options to allow an increase in main line services on the route.

Level crossings also play a significant role in setting speed restrictions, therefore removing the constraint they pose will also contribute to improving journey times. Network Rail is working on a rolling programme to identify optimal level crossing opportunities on the GEML (see Section 2.7.8 for more information on our approach to level crossings).

Figure 5.4 depicts the options for funders for journey time improvements.

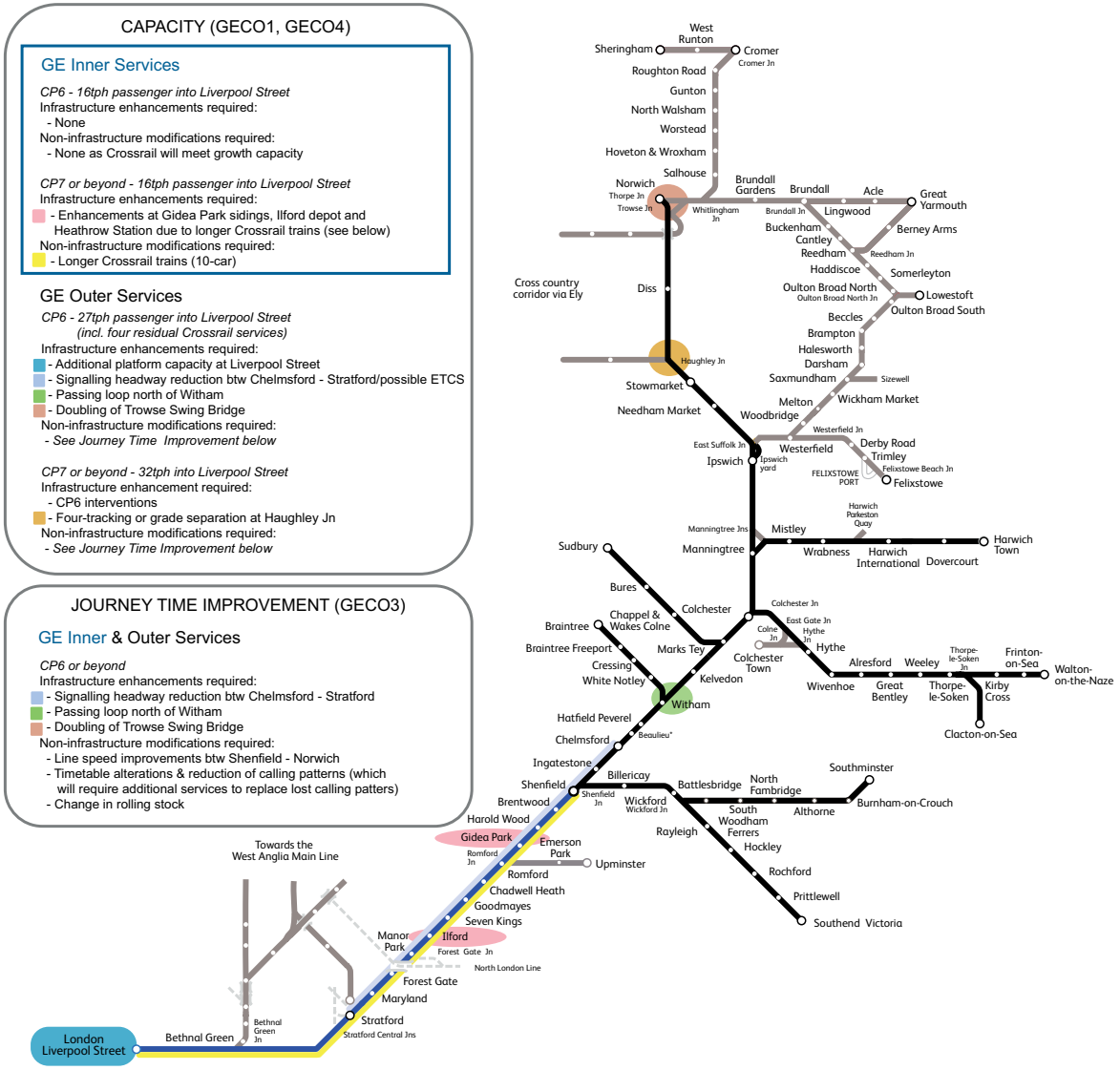
Table 5.4 Conditional outputs identified for journey times improvements on the Great Eastern Main Line

GECO3	To achieve journey time improvements on the route from Norwich to London - Great Eastern Main Line

Table 5.5 Great Eastern Main Line - Journey Time Improvement

Description	To achieve journey time improvements between outer destinations in Essex, Suffolk and Norfolk to/from London, a package of work is required: – timetable alterations – improved rolling stock capability – line speed improvements including level crossing mitigations or closures The best package of journey time improvements is achieved by running additional services on the route to allow the calling patterns to be amended to support quicker journeys. Therefore, the package of work required is the same as the capacity option detailed in Section 5.1 and comprises: – signalling headway reduction between Chelmsford and Stratford – doubling of Trowse Swing Bridge – passing loop at north of Witham – additional platform capacity at Liverpool Street
Conditional Output	To provide an improvement in journey time between Norwich and London Liverpool Street (GECO3).
Link to other Options	Achieving journey time improvements between Norwich and London has a clear link to Great Eastern Main Line peak capacity option (GECO1).
Socio-economic Value for Money	It is recommended that these works are reappraised once rolling stock is agreed through the East Anglia Franchise process due to the criticality of rolling stock performance in achieving journey time benefit.

Figure 5.4 CP6 and CP7 or beyond options for funders addressing capacity and journey time improvement on the Great Eastern Main Line



5.3 Cross country corridor via Ely – Capacity and Connectivity: GECO2, GECO5, WACO6, WACO7, WACO8, F2NCO1 and FNCO2

The conditional outputs for the Cross country corridor via Ely are detailed in Table 5.6.

It is impossible to address these conditional outputs without being mindful of how each one impacts upon the other. It is therefore important that they are consistent with one another and form a coherent strategy for addressing growth on the Cross country corridor via Ely.

The conditional outputs to 2043 are considered first with the CP6 priorities developed based on this strategy. Figure 5.5 depicts the options for funders for CP6 and CP7 or beyond.

5.3.1 Cross country corridor via Ely - CP7 or beyond choices for funders

An indicative off-peak train service specification has been developed to assess the infrastructure interventions required to accommodate the conditional outputs to 2043. The specification has been developed based around the Cross-boundary assumptions which include:

- Liverpool – Norwich and Ipswich (dividing at Ely)
- Derby – Norwich
- Birmingham – Norwich
- London Kings Cross – Norwich

Linking the Cross-boundary assumptions with the requirements to improve frequency, connectivity and journey times on services on the Ipswich/Norwich and Peterborough/Cambridge axis results in the need for an improved frequency of train service on both the route via Bury St Edmunds and via Thetford.

To achieve better journey times between the larger towns and cities will require either a skip stop pattern (where intermediate calling points are not made in every train, although at least one train an hour is retained) or a fast and slow pattern.

Alongside the conditional output for freight, these Cross-boundary assumptions result in the following service specification:

- 2tph passenger services Norwich to Cambridge (potential for these to form Cross-boundary services to the south joining an existing Cambridge – Kings Cross service)
- 3tph passenger services Norwich via Ely to Peterborough/ destinations to the north (to be determined by Cross-boundary analysis)
- 2tph passenger services Ipswich to Cambridge
- 1tph passenger services Ipswich via Ely to Peterborough/ Cross-boundary
- 5tph freight services between Felixstowe and Peterborough via Ely (see Figures 4.2 and 4.3 in Chapter 4 for split between Class 4 and Class 6 paths)

Table 5.6 Conditional outputs identified for capacity and connectivity on the Cross country corridor via Ely

GECO2	To provide sufficient capacity for Cross-boundary and Cambridge passengers travelling to Norwich via Ely, taking into account anticipated growth to 2023 - Cross-boundary services
GECO5	To provide sufficient capacity for Cross-boundary and Cambridge passengers travelling to Norwich via Ely, taking into account anticipated growth over the period to 2043 - Cross-boundary services
WACO6	Increase in passenger service frequency between Kings Lynn and Cambridge to 2tph
WACO7	Increase in passenger service frequency between Ipswich and Cambridge to 2tph
WACO8	To provide sufficient capacity for passengers travelling between Kings Lynn and Cambridge
F2NCO1	To provide sufficient capacity for freight travelling via the Felixstowe to Nuneaton route, taking into account anticipated growth over the period to the end of Control Period 6 (2023/2024) – Cross-boundary services
F2NCO2	To provide sufficient capacity for freight travelling via the Felixstowe to Nuneaton route, taking into account anticipated growth over the period to 2043 – Cross-boundary services

It is recognised that many of these services are conditional on a value for money case and as they link to other routes will need to be assessed through the Cross-Boundary Working Group. The conditional output to improve frequency and connectivity between Norwich/Ipswich and Cambridge/Peterborough axis can be met by services contained in Anglia if the Cross-boundary elements cannot be achieved in other route studies. The working group has identified key priority intervention locations where the infrastructure capability cannot meet the future train service:

- Haughley Junction
- Single track section between Ely and Soham
- Ely area
- Trowse Junction
- Felixstowe Branch

Once proposals for the East West Rail Central Section are developed further, it is recognised that many of the improvements to connectivity provided by the scheme could change the output required in the longer term on this route. Therefore it may be required for the Route Study to be updated to take account of this change.

Haughley Junction (WAC07, F2NC02)
The forecast demand up to 2043 is 5tph for freight and 7tph for passenger services passing through Haughley Junction per direction. Due to the speed differential between passenger and freight trains and the crossing of key flows, to fully achieve the 2043 outcome will require further work in the Haughley Junction area to segregate the flows. This could be through grade separation or through a short section of four-tracking. This option is the same as included in the GEML peak capacity option for 2043 (GEC04).

Single track sections between Ely and Soham (F2NC01, F2NC02)
The single track section between Ely and Soham is a capacity constraint for any increase in either freight or passenger services via this corridor. The Ely to Soham doubling project was developed in CP4 and early CP5. The information arising from consultation with local stakeholders and survey work have identified that the complexity of the project is greater than originally thought and therefore the cost estimate has increased significantly. As a result, the decision was taken not to progress with the design and construction phase of Ely to Soham within CP5. The single track remains a constraint and additional capacity will be required between Ely and Soham to support the 2043 level of service, particularly if the aspirations for a new station at Soham are progressed.

Ely area (GEC02, GEC05, WAC06,F2NC01, F2NC02)
The speed differential of a mix of both passenger and freight in the Ely area would require interventions, such as three to four-tracking between Ely Station and Ely North Jn or grade separation at both Ely Dock Jn and Ely North Jn, to remove the constraints of crossing moves, platform usage and line utilisation in the Ely area. An alternative option has also been assessed which considers the installation of a new railway link on the west side of Ely (an avoiding line). This would remove the interaction between freight and passenger services in the Ely area and therefore reduce the required infrastructure work at junctions, level crossings and platforms.

Trowse Junction (GEC02, GEC05)
Doubling Trowse Swing Bridge not only supports the capacity required on the Great Eastern Main Line but also provides the necessary capacity to cater for an additional Norwich to Ely / Cambridge Service.

Felixstowe Branch (F2NC02)
To robustly accommodate freight conditional outputs to 2043 alongside the passenger service on the Felixstowe Branch will require full doubling of the branch.

5.3.2 Cross country corridor via Ely - CP6 choices for funders:

The Freight Market Study has identified a requirement for 60 freight paths per day by 2024 on the Felixstowe to Ely route; this exceeds the capacity of the current infrastructure. To cater for this demand the following infrastructure solutions are required:

- further (above that assumed in the baseline) doubling of the Felixstowe Branch
- provision of a loop line near Haughley Jn or changes to the signalling on the Bury St Edmunds line
- full or partial doubling of the track between Ely and Soham

Table 5.7 Cross country corridor via Ely (2023)	
Description	To support increase in freight capacity will require: – further (above the baseline) doubling of the Felixstowe Branch[1] – changes to the signalling on the Bury St Edmunds line – full or partial doubling of the single track between Ely and Soham – Ely area improvements including level crossing closures and headway reductions [1] This particular item will remain under review. The outputs of the baseline branch scheme will not reach 60tph but we believe are likely to cater for freight growth in CP6 on the branch itself – it may well not be necessary to revisit the branch for further work for quite some time into the future.
Conditional Output	To provide 60 freight trains per day to/from Felixstowe to meet forecast growth to 2023 (F2NCO1) .
Link to other Options	This option needs to be considered alongside any options from the East Coast Route Study to consider achievement of freight paths from Peterborough onwards. This option also contributes to the longer term objective of increasing the passenger service frequency between Ipswich and Cambridge to 2tph (WACO7).
Socio-economic Value for Money	The business case for this option is predicated on the ability to accommodate growth in freight paths from Felixstowe to the West Midlands which includes routes that are outside the boundaries of this study. Therefore, a full appraisal of benefits and costs cannot be made. If the growth in freight demand to the end of CP6 was fully accommodated between Felixstowe and North the benefit associated with the reduction in lorry miles on Britain's roads would be significant; in the order of PV (Present Value) £2 billion.

- Ely area improvements, including headway reductions and level crossing mitigations or closures

These type of large scale interventions may not have a high value for money case. A reduced service specification with some additional freight and passenger paths but not the full specification considered might drive a lower scope of work, for example:

- Resolution of level crossing issues through closure, upgrade and/or changes to road traffic patterns
- Reduction in headways between Ely station and Ely North Junction

In CP6, the first constraint to delivering any increase in freight and passenger capacity over the route is Ely level crossings (Queen Adelaide and Kiln Lane). Without addressing this, no further increase in capacity is possible over and above currently available paths. This constraint applies to the entire Felixstowe to Nuneaton route.

Having resolved that constraint, there are further interventions that are required to deliver freight capacity regardless of passenger capacity requirements and some that are required to deliver both freight and passenger capacity requirements.

5.3.3 Choices for funders - Kings Lynn to Cambridge peak capacity: WACO8

An option is currently being developed which examines lengthening services on the Kings Lynn to Cambridge section to eight carriages. These services are currently 8-car or 12-car between Cambridge and London Kings Cross but due to constrains on the Kings Lynn line are only 4-car in length north of Cambridge.

There is peak crowding on these services particularly between Ely and Cambridge.

To achieve 8-car services to/from Kings Lynn may require platform lengthening work at Littleport, Waterbeach and Watlington. Lengthening of services will provide additional on-train capacity to support additional calls, such as at Cambridge North Station. The industry, funders and local stakeholders are in agreement that this is a high priority. Network Rail is currently working on a CP5 programme and costing for this scheme for the DfT.

5.3.4 Kings Lynn to Cambridge connectivity: WACO6

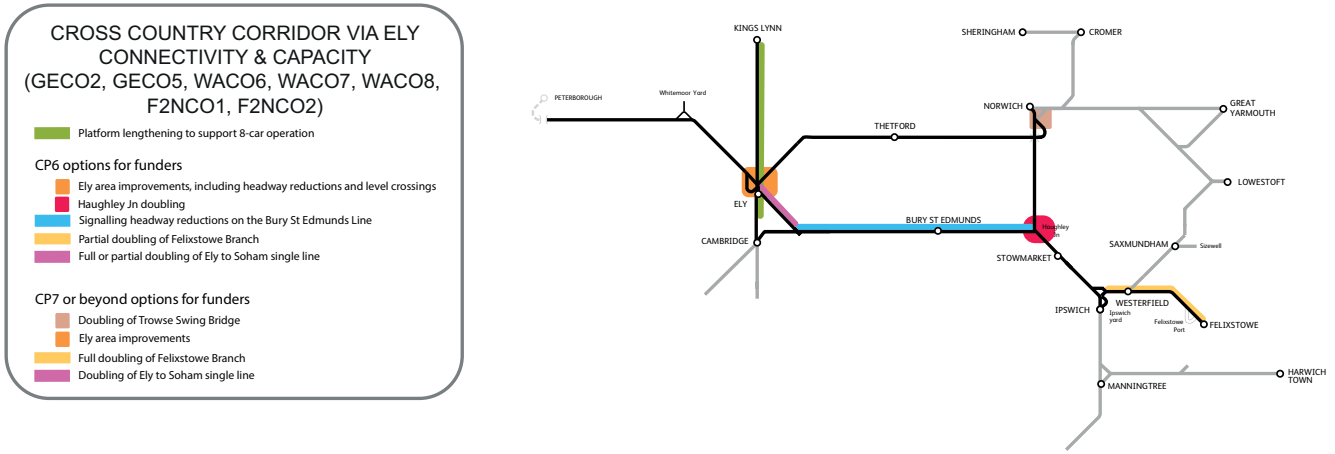
Network Rail is working with industry partners to understand how any of the off-peak gaps in service between Kings Lynn and Cambridge can be filled with a 2tph pattern in CP5.

A standard 2tph pattern cannot be achieved because of freight services operating to Middleton Towers. To achieve the connectivity output alongside freight capacity would require partial doubling of the single lines and could be considered as an option in later control periods, in addition to improvements in the Ely area, including level crossings.

Table 5.8 Cambridge - Kings Lynn Peak Capacity

Description	To support peak capacity on services between Kings Lynn and Cambridge will require train lengthening to 8-car. This may require platform extension work and new passenger bridge/underpasses at: – Littleport – Waterbeach – Watlington
Conditional Output	To provide sufficient capacity for passengers travelling between Kings Lynn and Cambridge to meet peak capacity conditional output WAC08.
Link to other Options	This option needs to be considered alongside any options from the East Coast Route Study to consider platform capacity at Cambridge.
Socio-economic Value for Money	This option is low value for money and further work is required on the development of infrastructure options to understand if the costs can be reduced.

Figure 5.5 Options addressing connectivity and CP6 and CP7 or beyond options for funders addressing capacity on the Cross country corridor via Ely



5.4 West Anglia Main Line Capacity: WACO1, WACO2 and WACO5

The conditional outputs which seek to address the growth expected on the West Anglia Main Line are detailed in Table 5.9.

It is impossible to address these conditional outputs without being mindful of how each one impacts upon the other. It is therefore important that they are consistent with one another and form a coherent strategy for addressing growth on the WAML.

The conditional outputs to 2043 are considered first with the CP6 priorities developed based on this strategy. Figure 5.6 depicts the options for funders for CP6 and CP7 or beyond.

During the consultation period stakeholders have provided further information on the growth potential of the route to support the long term strategy.

The number of jobs in the West Anglia area has grown by 13.6 per cent in the last 10 years and is predicted to continue according to the London Stansted Cambridge Consortium research:

> *The Strategic Case for Investment in the West Anglia rail route was launched in June 2015 and has identified that on current trends the population of the West Anglia Corridor to Cambridge is forecast to grow by well over half a million people in the next fifteen years, and another 210,000 jobs are expected – all before the predicted arrival of Crossrail 2. With the GVA growth projected to significantly outpace job growth the area will be contributing greatly to productivity growth – helping overcome a persistent shortcoming for the UK.*
>
> *Although Stansted is already the largest single employment site in the East of England, with 10,000 people employed in 200 on-site companies, the "Generation 1" permissions will allow Stansted to grow to 264,000 "air transport movements", including passenger and freight.*
>
> *At the London end of the corridor there is huge potential for growth too. The Upper Lea Valley Opportunity Area is already a major employment zone, and the London Plan expects it to accommodate an additional 15,000 jobs, with potential for more if infrastructure is improved further. Its potential for housing is even greater with the new revised London Plan anticipating a minimum of more than 20,000 new homes, and it could be much higher with Crossrail 2*[1] .

Table 5.9 Conditional outputs identified for passenger capacity on the West Anglia Main Line

WACO1	To provide sufficient capacity for passengers travelling into central London and other employment centres during peak hours, taking into account anticipated growth over the period to the end of Control Period 6 (2023/2024) - West Anglia services
WACO2	To provide sufficient capacity for passengers travelling into central London during peak hours, taking into account anticipated growth over the period to 2043 - West Anglia Main Line services via the Southbury Loop, Harlow Town & the Chingford branch
WACO5	To provide sufficient capacity for passengers travelling to Stansted Airport all day, taking into account anticipated growth over the period to 2043

5.4.1 WAML - CP7 or beyond choices for funders

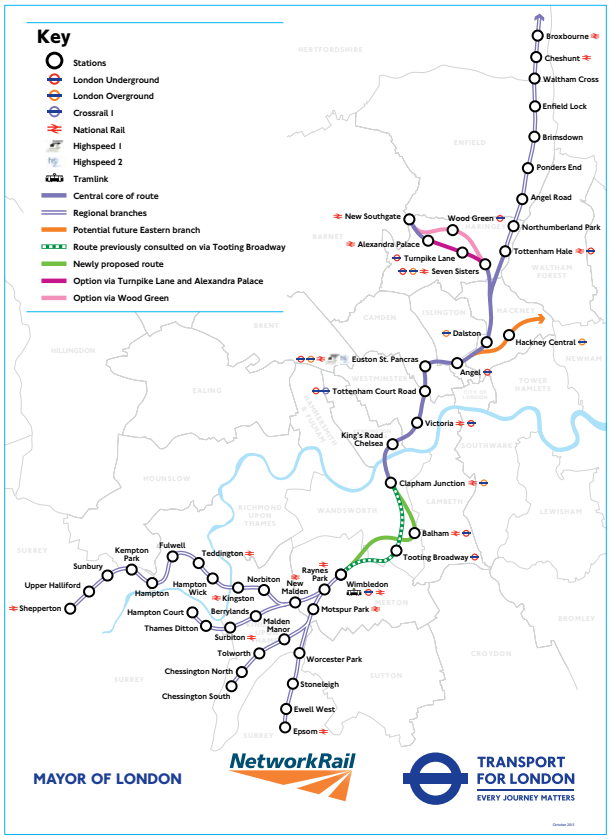
There is expected to be a capacity gap on services from Stansted Airport and Cambridge and on suburban services arriving into London Liverpool Street between 08:00 and 08:59 by 2043. The shortfall is approximately 3,000 passengers on the Cambridge and Stansted Airport services.

On services from Chingford to London Liverpool Street and from Enfield Town and Cheshunt via Seven Sisters to London Liverpool Street, the introduction of high density rolling stock planned by Transport for London from 2018 is expected to cater for the forecast demand up to 2043. Improved rolling stock capacity and service on this route may unlock further demand and therefore further interventions, such as train lengthening, may be required before 2043.

Significant housing growth above that forecast as part of the Market Studies could take place along the West Anglia corridor. In part this could be contingent on greater investment in the route.

1 Chapter 3, The Strategic Case for Investment in the West Anglia rail route, 2015

Crossrail 2 route (autumn 2015)



Proposed Crossrail 2 Route (Autumn 2015)

Based on the opportunity for further growth on this route, improvements to the train service have been examined. The corridor is currently congested and no further peak paths can be achieved south of Broxbourne owing to:

- speed mix of services (caused by different calling patterns)
- headways between Tottenham Hale and London Liverpool Street
- platform capacity at London Liverpool Street and Stratford
- conflicting movements with empty coaching stock for Orient Way

To increase train service quantum and retain or improve journey times additional track capacity is required on the route through four-tracking. Capacity constraints at both London Liverpool Street and Stratford mean that along with additional tracks, more capacity is required at the south of the route to allow additional journeys to London. Two options have been assessed:

- Crossrail 2 which would connect the West Anglia route with South West London via a new tunnel; or
- four-tracking on the West Anglia Main Line with enhancements at Stratford

In either scenario, the provision of four tracks would support off-peak freight capacity. If the route was gauge cleared then further opportunity would be available for freight traffic growth from Thames Gateway and diversionary route capability.

Crossrail 2

Network Rail is currently working closely with TfL on the development and feasibility of Crossrail 2, which would connect South West London with North London via a new tunnel. The northern section of the project is proposed to connect to both the East Coast Main Line (by interchanging at New Southgate) and West Anglia Main Line. The project is still being developed therefore the detailed infrastructure and final origin and destinations of service are as yet unknown. The West Anglia connection is likely to be in the Tottenham area and allow for services from the West Anglia route to connect to both central London and South West London via the new tunnel, providing direct connectivity to Euston, St Pancras and the West End.

Four-tracking the West Anglia Main Line along with grade separation of Coppermill North Junction will support an increase in service of up to 10tph on the route. This will greatly increase the service frequency at stations to the south of the route. The separation of fast and stopping services enabled by the four-tracking will support improved journey times for Cambridge and Stansted services.

Four-tracking

Without a Crossrail 2 connection to central London the capacity at both London Liverpool Street and Stratford will constrain the number of additional services which any 'four-tracking project only' can deliver. The feasibility of four-tracking the route south of Tottenham through to Bethnal Green is very challenging owing to the structures and high density population of surrounding areas. An option has been developed for Stratford which would allow an increase of up to 4tph on the route. This option includes:

- additional platform capacity at Stratford
- a third track between Ruckholt Road and Stratford
- four-tracking (in a non-Crossrail 2 scenario it is possible for a shorter portion of four-tracking on West Anglia).

The Route Study has examined a conventional four-tracking option on the West Anglia Main Line and a Crossrail 2 four-tracking option. Both options would support delivery of the capacity conditional outputs to 2043, although the outputs achievable are limited in the stand-alone four-tracking option. The Crossrail 2 option also supports delivery of improved cross-London connectivity and an increased train frequency, in addition to improved generalised journey times. The increase in train frequency allowed by the Crossrail 2 option would support the potential growth on this corridor over and above the current demand forecast.

Stansted Tunnel and platforms

Stansted Airport is a key destination on the West Anglia route which has seen large growth and is predicted to continue to grow. In 2014, passenger volumes at the airport increased by 12 per cent from 17.8 million to 20.0 million, with forecasts showing Stansted reaching its planning cap of 35mppa in around the next ten years . Options have been assessed to support this growth and also to improve connectivity to the airport from more locations.

To achieve additional services from the south will require either the Crossrail 2 or four-tracking options described above. This would support new connections from Stratford to Stansted. Increasing the frequency from the north has also been assessed; this could be by an additional service from Cambridge, Peterborough, Norwich or Ipswich.

The key constraint to improving connectivity at Stansted (from either north or south) is Stansted Tunnel and platform capacity at the airport. The current feasible capacity of the single line to Stansted Airport is 6tph; doubling of the Stansted Airport line is required to achieve greater connectivity above 6tph.

5.4.2 WAML - CP6 choices for funders: Train Lengthening

There is expected to be a capacity gap on services from Stansted Airport and Cambridge and on suburban services arriving into London Liverpool Street between 08:00 and 08:59 by the end of CP6. The capacity shortfall is for approximately 1,000 passengers on the Cambridge and Stansted Airport services and 1,700 passengers on the suburban services.

The forecast increase in peak passenger demand is limited in that it does not fully take into account the latest understanding of housing growth potential on the route. In particular the methodology for estimating background passenger growth does not take into account the circular effect of improved services on the viability of additional housing, economic regeneration and the resultant increase in passenger demand and requirement for improved connectivity. Choices for CP6 have been developed based on the demand forecasts and on further evidence provided by stakeholders on the growth potential of the route.

To support the demand gap (based on the existing train service and not supporting further growth on the route) the capacity gap can be met in CP6 through train lengthening.

Cambridge and Stansted capacity

Cambridge and Stansted Airport services arriving into London Liverpool Street between 08:00 and 08:59 comprise a mixture of eight and 12 carriages in length. The Stansted Airport services and one of the Cambridge services are run using rolling stock that tends to have a low number of seats per carriage. This is appropriate to meet the market for travel to and from the airport because passengers value comfort and space for luggage. Higher density rolling stock could mitigate the capacity gap into London in the peak but will impact adversely on the airport passengers. Lengthening two of the services from 8-car to 12-car between 08:00 and 08:59 would meet the capacity gap by the end of CP6.

An appraisal has been carried out which demonstrates that providing additional 4-car units to lengthen Cambridge and Stansted services in the AM peak would have a low/medium value for money case.

Suburban service capacity

The suburban gap is driven by the better journey time for Hertford East services calling at Edmonton Green and Seven Sisters on the Southbury loop during the peak. An option has been examined to lengthen these services in peak hours, although the cost of platform lengthening is considerable, particularly due to platform lengthening requirements on the Hertford East Branch. Therefore it is recommended that timetable amendments through changes to the calling pattern on the Southbury loop is considered before any infrastructure investment.

Table 5.10 West Anglia Train Lengthening (2023)

Description	To support peak capacity on the West Anglia Main Line in CP6 the service pattern remains unchanged, with the following lengthening: • The procurement of two additional 4-car units lengthening peak Stansted Airport and Cambridge to London Liverpool Street services from 8 to 12-car. This would provide an additional 8-car arrival in the peak hour to London Liverpool Street by the end of CP6.
Conditional Output	To provide sufficient peak capacity at the end of CP6 on the outer suburban services into London Liverpool Street (WACO1).
Socio-economic Value for Money	This option is low/medium value for money due to the relatively small capacity increase.

5.4.3 CP6 choices for funders: Early investment on West Anglia prior to Crossrail 2

A major theme within the consultation responses was support for earlier investment in the West Anglia corridor to unlock growth. Network Rail has worked closely with TfL during the consultation period to further understand the growth potential of West Anglia.

To achieve additional services on the West Anglia Main Line corridor will require an element of four-tracking and investment at either London Liverpool Street or Stratford to allow trains to serve London. Options for London Liverpool Street have been discounted due to the scale and complexity of providing additional track and platform capacity for West Anglia services. The scale of work would also be abortive in a future Crossrail 2 scenario.

Options have been developed to allow an increase in services from the West Anglia route to Stratford, alongside four-tracking . These involve additional platform capacity at Stratford and a third track between Stratford and Ruckholt Road to enable better access to Orient Way Carriage Sidings (from the Great Eastern Main Line) while increasing the services from West Anglia Main Line to Stratford. Work is on-going to safeguard the land for two additional platforms at Stratford to serve Stratford from the West Anglia corridor. TfL has assessed the growth potential of a range of service and infrastructure options on the West Anglia corridor, both with and without Crossrail 2. The key findings include:

- do minimum, which includes the baseline Stratford to Angel Road (STAR) scheme and train lengthening in CP6. This will limit the potential for locating new homes and jobs on the corridor
- delivering between 2 and 4 additional services per hour between WAML and Stratford achieved by four-tracking the railway between Broxbourne and Coppermill North Junction and capacity enhancements between Coppermill North Junction and Stratford. This option was assessed as a standalone option with no long term commitment to Crossrail 2. This would support the delivery of a further 10,000 – 17,000 new homes and 4,000 – 6,000 new jobs on the corridor, on top of the growth that would occur in the event of doing nothing. In this option, longer term growth would be limited by the small number of additional paths on the network possible south of Coppermill North Junction and capacity constraints elsewhere on the rail-based public transport network (on the Victoria Line for instance)
- Crossrail 2 delivered by 2030 (CP8) could unlock between 39,000 – 70,000 new homes and 15,000 – 27,000 new jobs in the WAML corridor
- delivering between two and four additional services per hour between WAML and Stratford through four-tracking and Stratford enhancements delivered by 2024 as a precursor to Crossrail 2. This could bring forward the development of 6,000 – 12,000 new homes and the creation of 2,000 – 5,000 new jobs in the 2020s, instead of the 2030s.

The evidence demonstrates that investment in this corridor can generate growth and the maximum benefit is achieved when early investment is linked with the longer term Crossrail 2 options. An option to deliver four-tracking on the West Anglia corridor prior to 2030 is at a very early stage of development. Because of the link between four-tracking and Crossrail 2 it is recommended that any further development activity on this option is linked to Crossrail 2 development so that there is no, or limited, abortive infrastructure work or cost. This is particularly important when considering the junction changes required in the Coppermill Junction area and the alignment of the fast and slow lines. The current Crossrail 2 timelines show construction would need to begin in the early 2020s (CP6/7), therefore there is opportunity for this to be aligned as a joint programme of work. It is recommended that work starts on enabling workstreams for four-tracking such as land take and level crossing closures as this supports either an early four-tracking or Crossrail 2 output.

The extent of four-tracking that could be completed in CP6 would depend on a number of factors, including the timeline for relevant consents, available funding and industry resource.

Table 5.11 Early investment in West Anglia prior to Crossrail 2 to improve service frequencies	
Description	To unlock employment and housing growth on the route prior to Crossrail 2 implementation in 2030. This option supports an additional 2 to 4tph from West Anglia to Stratford alongside alterations to the existing service to improve journey times and service frequencies. To achieve this service level would require: – four-tracking of West Anglia Main Line with turnback facilities – additional platform capacity at Stratford – third track between Stratford and Ruckholt Road
Conditional Output	Supports conditional outputs WACO1, WACO2, and WACO5.
Link to other Options	This option would need to be considered in relation to long term development of the route and the alignment of Crossrail 2 to limit any abortive work through early implementation. The additional infrastructure at Stratford is not required in the Crossrail 2 scenario therefore provides additional capacity for improved connections to Stratford. There are options to examine improved connectivity to north of Broxbourne through use of the Stratford enhancements to support improved outer services post Crossrail 2 to Stratford.
Socio-economic Value for Money	A business case has not been completed for this as a standalone option as this has been considered as an early implementation of Crossrail 2. Further development of this option and a standalone four-tracking option will be considered by the West Anglia Taskforce.
Conclusions	There is an opportunity to unlock growth on the route and it is recommended that this option is considered further through Crossrail 2 development activities to understand the feasibility of early four-tracking infrastructure on the West Anglia Main Line.

5.4.4 Choices for funders - Kings Lynn to Cambridge peak capacity and connectivity: WACO8 and WACO6

Options for funders addressing WACO8 and WACO6 (Kings Lynn to Cambridge) are detailed under Cross country corridor via Ely Sections 5.3.3 and 5.3.4.

5.5 West Anglia Main Line – Journey Time Improvements: WACO3

The longer term strategy of additional tracks on West Anglia will support journey time improvement through the segregation of fast and stopping services on the corridor and the ability to review and amend calling patterns.

An option has also been assessed to achieve journey time improvements in the off-peak without any four-tracking. No improvement can be made in the peak due to a combination of capacity constraints and the mix of services on the route.

To achieve journey time improvements to Stansted and Cambridge prior to any four-tracking would require new and improved rolling stock, an increase in line speeds and amendments to calling patterns (see Table 5.13). This may require some trade-offs with West Anglia inner calling patterns and the journey time for Hertford East services.

Further review of any shorter term opportunities to improve journey times to both Cambridge and Stansted should therefore be undertaken after the specific rolling stock and service proposal from the successful bidder for the East Anglia Franchise is known.

Figure 5.6 depicts the options for funders for journey time improvements.

West Anglia Taskforce

The West Anglia Taskforce has been established to look at opportunities to improve connections to Stansted and Cambridge from Liverpool Street and Stratford and to encourage opportunities for economic growth along the route including through the improvement of services in the Lea Valley.

The Taskforce will be seeking to achieve the key outcome of supporting and enhancing the economy of London and West Anglia. As such it will challenge local authorities and local economic partnerships to demonstrate and build upon the economic benefits derived from improvements to journey times and frequencies along the route.

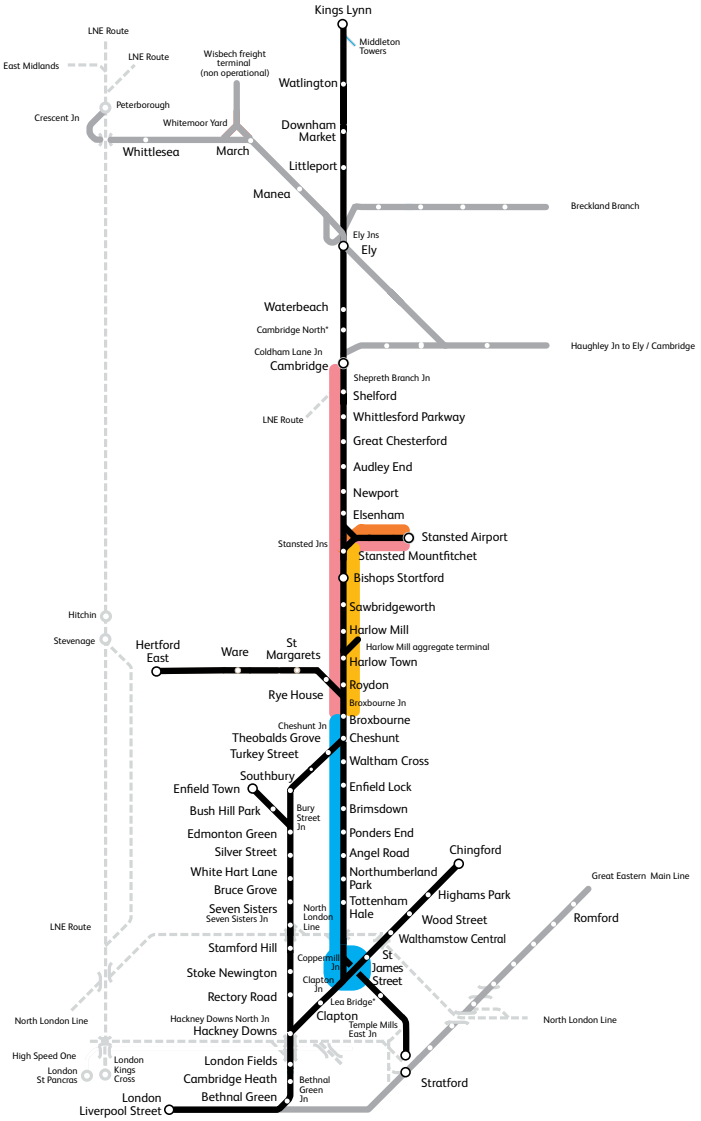
Table 5.12 Conditional outputs identified for journey time improvements on the West Anglia Main Line

WACO3	To provide journey time improvement for services from both Cambridge and Stansted Airport to London Liverpool Street - West Anglia services

Table 5.13 West Anglia Journey Time Improvements (2023)

Description	To support improved journey times on the West Anglia Main Line in CP6, an off-peak improvement can be achieved with: – line speed improvements to 100mph – changes to off-peak timetable structure and calling patterns – improved inner rolling stock (assumed as Class 379) Together, these can deliver between two and five minute journey time improvements for Cambridge and Stansted services.
Conditional Output	To improve journey times to/from Cambridge and Stansted (WACO3).
Link to other Options	This option would need to be considered in relation to long term development of the route through a four-tracking or Crossrail 2 scenario. Rolling stock and calling pattern changes in the off-peak could be delivered alongside line speed improvement work north of Broxbourne, to limit any abortive work between Broxbourne and Tottenham Hale due to the potential impact of Crossrail 2.
Socio-economic Value for Money	Initial assessments show that line speed improvements aligned with rolling stock and timetable changes are high value for money. It is recommended that this is reappraised once the rolling stock plan is agreed through the East Anglia Franchise process due to the criticality of rolling stock performance in achieving journey time benefit.
Conclusions	Line speed improvements should be considered north of Broxbourne in CP6 if supported with rolling stock change through the East Anglia Franchise. There is limited benefit of line speed improvement work without supporting rolling stock change.

Figure 5.6 CP6 and CP7 or beyond options for funders addressing capacity and connectivity on the West Anglia Main Line (for the Fen Line see Figures 5.6 and 5.10)



WAML CAPACITY (WACO1, WACO2, WACO5)

CP6 - 22tph passenger into Liverpool Street
- Lengthening of two services to 12-carriages on WAML (btw Cambridge/Stansted Airport - Liverpool Street)
- Early investment in Crossrail 2 on West Anglia to support longer term outputs and unlock growth on the route earlier

CP7 or beyond - 22tph passenger into Liverpool Street
- Crossrail 2, including four-tracking between Coppermill Jn and Broxbourne and tunnel into Central London and grade separation at Coppermill Jn

Infrastructure enhancements required for improved Stansted connectivity:
- Doubling of the Stansted Airport Line

WAML JOURNEY TIME IMPROVEMENT (WACO3)

Shorter term options
Infrastructure enhancements required:
- Line speed improvements

Non-infrastructure modifications required:
- Minor changes to off-peak timetable calling patterns
- Rolling stock (assumed as Class379)

Longer term options
- Crossrail 2, including four-tracking between Coppermill Jn and Broxbourne and tunnel into Central London and grade separation at Coppermill Jn

5.6 Orbital Routes - North London Line and Gospel Oak to Barking: CLCO1, CLCO2, CLFCO1 and CLFCO2

The relevant capacity conditional outputs considered by the Anglia Route Study are detailed in Table 5.14.

On the Orbital Routes, there is expected to be a gap in capacity on the North London line to 2043 of around 1,800 - 2,000 passengers, or the equivalent of three to four extra 5-car trains. On the Gospel Oak to Barking Line route, the proposals for electrification and longer services are expected to provide capacity towards the 2043 target demand. However, as demonstrated by the strong growth on the orbital services over the past few years, when the frequency and capacity of the service provided improves, passenger demand quickly follows. Previous forecasts have also typically underestimated the level of suppressed demand on the route. Therefore, opportunities for frequency improvement or train lengthening for passenger services should be considered. TfL has an aspiration to run 5tph in the peak on the Gospel Oak to Barking Line in CP5. Further capacity on the route may be required to meet demand when the orbital route is linked to HS2 by stations on the NLL and WLL.

Freight growth particularly from Thames Gateway Port will drive the need for more paths on the Gospel Oak to Barking line up to 2043. Up to five freight paths an hour are required by 2043 which will be very challenging to deliver alongside the passenger services.

One of the key challenges for both the North London Line and Gospel Oak to Barking line is continuing to support growth for both passenger and freight services whilst maintaining performance.

This should firstly be through making best use of the existing infrastructure through frequently reviewing paths and examining potential improvements through restrictive aspect running. Options have been developed for this route to support any increase in passenger or freight services and to maintain adequate performance levels.

In order to provide sufficient capacity and maintain performance for the forecast demand up to 2043 options for infrastructure interventions should be assessed.

It is impossible to address these conditional outputs without being mindful of how each one impacts upon the other. It is therefore important that they are consistent with one another and form a coherent strategy for addressing growth on the North London Line.

The conditional outputs to 2043 are considered first with the CP6 priorities developed based on this strategy. Figure 5.7 depicts the options for funders for CP6 and CP7 or beyond.

5.6.1 Orbital Routes: CP7 or beyond choices for funders

Gospel Oak to Barking: Train Frequency

To support 6tph passenger and 4tph freight on the Gospel Oak to Barking Line with an even passenger service pattern results in the requirement for a standard 12 paths per hour pattern (therefore providing six potential freight slots). To achieve this would require:

- signalling headway reduction between Gospel Oak and Barking
- additional platforms at either Gospel Oak or Barking
- freight regulating point between Upper Holloway and Gospel Oak junction of sufficient length to hold westbound container trains from North Thameside

Table 5.14 Conditional outputs identified for passenger capacity for 2023 and 2043 on the Orbital Routes

CLCO1	To provide sufficient capacity for passengers travelling across London during peak hours, taking into account anticipated growth over the period to the end of Control Period 6 (2023/2024) - North London Line and Gospel Oak to Barking
CLCO2	To provide sufficient capacity for passengers travelling across London during peak hours, taking into account anticipated growth over the period to 2043 - North London Line and Gospel Oak to Barking
CLFCO1	To provide sufficient capacity for freight across London using the North London Line or Gospel Oak to Barking line to the end of Control Period 6 (2023/2024) - North London Line (Cross-Boundary)
CLFCO2	To provide sufficient capacity for freight across London using the North London Line or Gospel Oak to Barking line, taking into account anticipated growth over the period to to 2043 - North London Line (Cross-Boundary)

To provide a robust service level consisting of 6tph passenger and 4tph freight along the whole route would require a reduction in signalling headways and potentially an additional platform at either Gospel Oak or Barking station. If the proposed extension of the Gospel Oak to Barking line to Barking Riverside is implemented, additional platform(s) would not be necessary unless the additional services are to terminate at Barking Station.

Current capability of the signalling limits the Gospel Oak to Barking line to 8tph. A planning headway of three minutes would be required to fully achieve the 2043 service specification.

In order to allow for high utilisation of paths on both the Gospel Oak to Barking line and North London Line without serious performance implications in the future, more freight regulating points will be required on this two-track railway. Gospel Oak has been considered as an option as it would support robustness of both the Gospel Oak to Barking line and North London Line. The development of a nodal yard at Ripple Lane (Barking) would also support the robust operation of freight growth over this congested two-track railway. Due to the proximity of the Barking Riverside project it is recommended that the Nodal Yard is developed alongside this project.

Gospel Oak to Barking: Train lengthening

The Gospel Oak to Barking line requires additional capacity to meet passenger demand in the future. Train lengthening from 2-car to 4-car will happen as part of the electrification planned for the line. This is to be considered before increasing service frequency on the line, which is already busy due to its mixture of passenger and freight services.

As mentioned earlier, lengthening to 4-car will provide sufficient passenger capacity to 2043 based on current predictions, although passenger projections for London orbital rail services have historically been below the growth resulting from service improvements.

North London Line: Train Frequency

To support 12tph passenger and 4tph freight on the NLL, the following would be required:

- signalling headway reduction on North London Line
- regulating point at Kensal Rise (Kensal Green Jn) catering for a 775m long freight train

Current capability of the signalling limits the NLL to 12tph. The Hampstead Heath tunnel area is the most constrained. To prevent trains coming to a stand at a red signal inside Hampstead Heath tunnel, a 'double block' control system is applied. This effectively increases headways through both the tunnel and across the whole of the North London Line.

A planning headway of 2½ minutes on the whole route is required to achieve the conditional outputs to 2043. Due to the nature of the traffic and speed of this route, a digital signalling solution with Automatic Train Operation (ATO) may achieve this in the longer term. To achieve the passenger service increase also requires infrastructure at Clapham Junction as defined in the South East Route: Sussex Area Route Study.

In order to allow for high utilisation of paths on the North London Line without serious performance implications in the future, more freight regulating points will be required on this two-track railway.

Kensal Rise has been identified as an option as this could provide both a regulating point for freight awaiting a path at Kensal Green Junction and also provide the opportunity for an 8-car turnback from the West London Line (WLL).

North London Line: Train Lengthening

(Please also refer to the South East Route: Sussex Area Route Study)

The WLL is already an 8-car capable railway and in future the capability of the turnback points and stations on the NLL for WLL services will determine whether London Overground services can ever take full advantage of the capability of the WLL. In the long term, it will normally be preferable from a performance and reliability point of view to lengthen trains before operating additional services in the peaks. This is also true in the off-peak, in particular because of the critical interface with freight on this route.

The capability of turnback facilities and stations on the NLL to handle up to 8-car operation is likely to become the focus of capacity strategy in the long term - as long as services operating from the WLL continue to operate to/from this route.

5.6.2 Orbital Routes: CP6 choices for funders

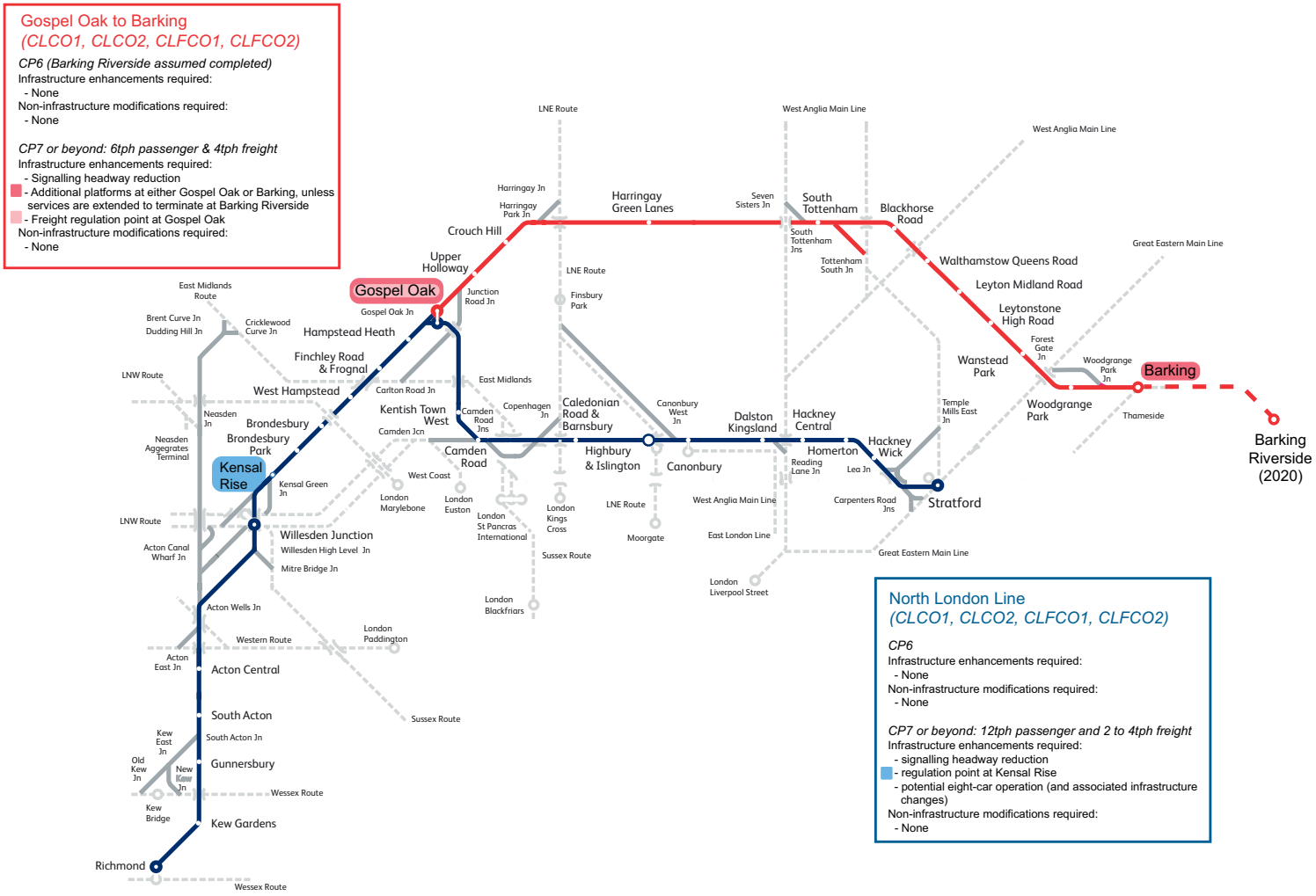
Choices for funders: North London Line and Gospel Oak to Barking

The Route Study's assessment is that extra capacity planned for CP5 (see Chapter 2) will be sufficient to accommodate the anticipated demand on the NLL and GOB line up to the end of CP6.

As a result, the capacity requirements outlined in CLCO1 and CLFCO2 will be met on the Orbital Routes up to the end of CP6.

For freight there is adequate capacity on these lines to accommodate the forecast traffic to 2023. As both freight and passenger numbers continue to grow on this route, headway reductions and provision of freight regulating points should be considered as shorter term priorities to support any increase in service in CP6 (described in Section 5.6.1 CP7 or beyond).

Figure 5.7 CP6 and CP7 or beyond options for funders addressing capacity and connectivity on the Orbital Routes



5.7 Essex Thameside: ETCO1 to ETCO3, ETFCO1 and ETFCO2

The relevant capacity conditional outputs for Essex Thameside are detailed in Table 5.15.

It is impossible to address these conditional outputs without being mindful of how each one impacts upon the other. It is therefore important that they are consistent with one another and form a coherent strategy for addressing growth on Essex Thameside.

The conditional outputs to 2043 are considered first with the CP6 priorities developed based on this strategy. Figure 5.8 depicts the options for funders for CP6 and CP7 or beyond.

The Route Study's assessment shows that there will be a need to provide further capacity for approximately 4,700 passengers by 2023 and 11,000 passengers by 2043 in the peak hour into London Fenchurch Street.

There will also be a capacity gap in the first shoulder peak hour (07:00 to 07:59).

5.7.1 Essex Thameside: CP7 or beyond choices for funders

A programme of platform lengthening work was completed in CP4 to enable the operation of 12-car services on this route. Therefore, to make best use of the infrastructure capability, the first step to meet future demand would be to lengthen services to 12-car operation in peak hours.

Options have been developed for lengthening services to 12-car to meet the capacity required to 2043. The current infrastructure

Table 5.15 Conditional outputs identified for passenger capacity and journey time improvement on Essex Thameside

ETCO1	To provide sufficient capacity for passengers travelling into central London during peak hours, taking into account anticipated growth over the period to 2023 - Essex Thameside
ETCO2	To improve journey times on the Essex Thameside route
ETCO3	To provide sufficient capacity for passengers travelling into central London during peak hours, taking into account anticipated growth over the period to 2043 - Essex Thameside
ETFCO1	To provide sufficient capacity for freight travelling from the London Gateway Port via the Tilbury loop, taking into account anticipated growth over the period to 2023 - Essex Thameside
ETFCO2	To provide sufficient capacity for freight travelling from the London Gateway Port via the Tilbury loop, taking into account anticipated growth over the period to 2043 - Essex Thameside

Table 5.16 Essex Thameside Train Lengthening (2023)

Description	To support peak capacity into London Fenchurch Street. Lengthening of six trains by four carriages is required to deliver the required capacity in the peak into London Fenchurch Street on the outer services, three arriving between 07:00 and 07:59 and three arriving between 08:00 and 08:59. Lengthening of two trains by four carriages is also required to provide the required capacity by the end of CP6 on the inner services into London Fenchurch Street.
Conditional Output	To provide sufficient capacity for passengers travelling into central London during peak hours, taking into account anticipated growth over the period to 2023 - Essex Thameside (ETCO1).
Link to other Options	This option would need to be considered with any station capacity scheme at London Fenchurch Street, West Ham and Limehouse.
Socio-economic Value for Money	High value for money
Conclusions	As train lengthening does not require any infrastructure intervention, it should be considered first to meet peak demand before increase in service frequencies which drive infrastructure enhancement.

capability supports 12-car operation therefore no enhanced infrastructure is required to meet this gap. Additional rolling stock would be required.

It is acknowledged that there are aspirations for an increased quantum of services to support further growth on this route, in particular through providing a high peak metro style service between Barking and London Fenchurch Street. To achieve an increase in service frequency on this route will require improved signalling headways.

For freight, there is adequate capacity to meet conditional output CLFCO2, to provide sufficient capacity for freight paths across London up to 2043.

5.7.2 Essex Thameside: CP6 choices for funders

Choices for funders: Essex Thameside Train Lengthening

The refranchising for Essex Thameside was undertaken in parallel with the Route Study development, therefore the December 2015 timetable is not assumed as the baseline service specification. The Route Study assessment of demand shows that train lengthening will be sufficient to meet the capacity gap on this route in CP6. Lengthening six outer and two inner (Laindon to Fenchurch Street) services by four carriages to 12 carriages in length will be required.

The station capacity assessment has indicated that passenger capacity at London Fenchurch Street station will need to be considered in CP6 or CP7. Therefore, further train lengthening will need to be assessed to understand any passenger capacity work at the station.

There is a high value for money case to provide this additional capacity, however this does not include the cost of providing additional passenger capacity at London Fenchurch Street.

For freight, there is adequate capacity to meet conditional output CLFCO2, to provide sufficient capacity for freight paths in CP6. There are opportunities to improve the robustness of freight paths and support the 2043 freight conditional outputs through development of Ripple Lane West Yard (Nodal Yard), whilst infrastructure is being delivered for Barking Riverside.

Figure 5.8 CP6 and CP7 or beyond options for funders addressing capacity and connectivity on Essex Thameside

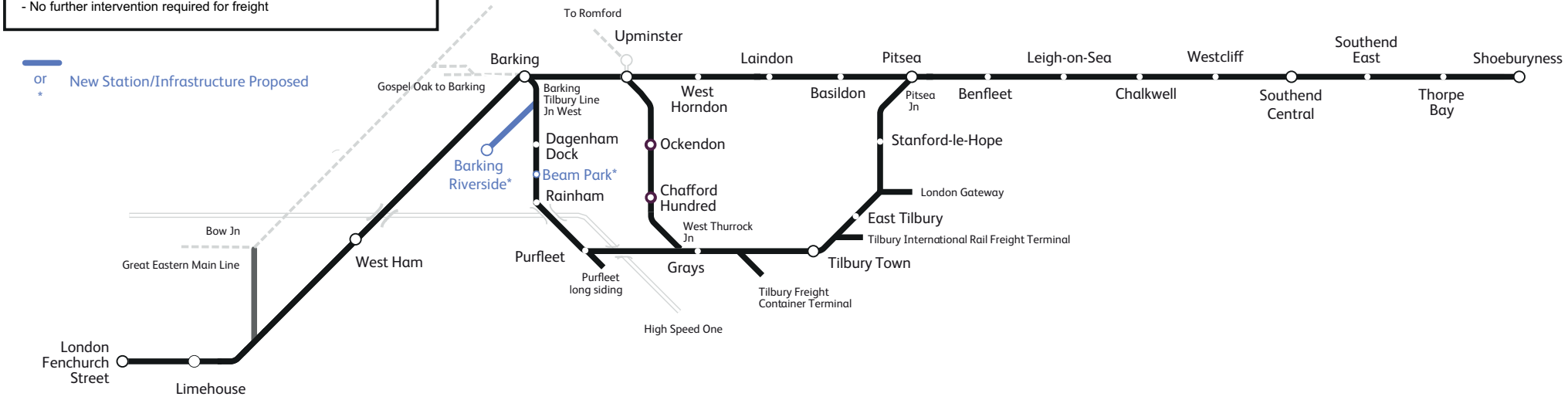
Essex Thameside
(ETCO1 to ETC03, ETFCO1, ETFCO2)

CP6 - 19tph passenger into Fenchurch Street
Infrastructure enhancements required:
- None for passenger
- There are opportunities to improve freight path robustness through development of Nodal Yard at Ripple Lane (during delivery of Barking Riverside)

Non-infrastructure modifications required:
- Lengthening two inner passenger services from eight to twelve-car
- Lengthening six outer passenger services from eight to twelve-car

CP7 or beyond - 19tph passenger into Fenchurch Street
Infrastructure enhancements required:
- None for the above service
- There are aspirations for an increase in service frequency; to achieve this will require improved signalling headways

Non-infrastructure modifications required:
- Lengthening of passenger services to twelve-car
- No further intervention required for freight



5.8 Increasing frequency – the connectivity challenge in 2043

The London and South East Market Study identified conditional outputs to improve the level of rail connectivity between large towns and cities across the country (for example by increasing the frequency of train services, reducing journey times and the provision of direct journeys which do not require an interchange). These outputs were developed as target frequencies and in each case are subject to value for money analysis.

Table 5.17 summarises the conditional outputs for the longer term options:

The options to address connectivity have been assessed to understand whether the existing infrastructure can support the conditional outputs.

This has been undertaken through development of a 2043 indicative service specification to achieve a minimum of 2tph on branch lines.

Tables 5.18 to 5.28 detail the outcome of these assessments. Figure 5.9 depicts the options identified addressing connectivity.

Where additional services can be achieved on the existing infrastructure, there will be an operational cost to run these services and this has been appraised to give an indication of whether the increase in operational costs is value for money.

Where additional infrastructure is required to meet these connectivity conditional outputs, it is very unlikely that there will be a positive business case for these options and therefore are not deemed value for money as standalone schemes. The Business Case analysis is based on existing passenger numbers and would need to be reviewed if there is a significant change in demand predicted.

Improving frequency and journey time on many local routes is a key aspiration. Network Rail is supportive of working with our stakeholders to examine potential incremental improvements that can be achieved to the rail service through minor infrastructure modifications.

Table 5.17 Conditional outputs identified for connectivity

GECO6	Increase in passenger service frequency between Norwich and Sheringham to 2tph
GECO7	Increase in passenger service frequency between Great Yarmouth and Norwich (via Acle) to 2tph
GECO8	Increase in passenger service frequency between Lowestoft and Norwich to 2tph
GECO9	Increase in passenger service frequency between Lowestoft and Ipswich to 2tph
GECO10	Increase in passenger service frequency between Felixstowe and Ipswich to 2tph
GECO11	Increase in passenger service frequency between Harwich Town and Manningtree to 2tph
GECO12	Increase in passenger service frequency between Walton-on-the -Naze and Colchester to 2tph
GECO13	Increase in passenger service frequency between Clacton-on-Sea and Colchester to 2tph
GECO14	Increase in passenger service frequency between Sudbury and Marks Tey to 2tph
GECO15	Increase in passenger service frequency between Braintree and Witham to 2tph
GECO16	Increase in passenger service frequency between Southminster and Wickford to 2 tph

Table 5.18 Bittern Line – GECO6: Increase in passenger service frequency between Norwich and Sheringham	
Option	To provide up to 2tph between Cromer/Sheringham and Norwich, recognising the line speed aspirations for this line.
Operating cost value for money	Low
Additional infrastructure required	Doubling of the line at either Cromer or between Walsham and Gunton, along with an additional platform at Norwich.

Table 5.19 Wherry Line– GECO7: Increase in passenger service frequency between Great Yarmouth and Norwich (via Acle)	
Option	To provide up to 2tph between Great Yarmouth and Norwich (via Acle), recognising the line speed aspirations for this line.
Operating cost value for money	Low
Additional infrastructure required	Doubling of single line sections between Great Yarmouth and Brundall Junction along with an additional platform at Norwich.

Table 5.20 Wherry Line – GECO8: Increase in passenger service frequency between Lowestoft and Norwich	
Option	To provide up to 2tph between Lowestoft and Norwich, recognising the line speed aspirations for this line. Platforming at Norwich would be fixed, allowing less flexibility, therefore an additional platform at Norwich would be desirable for this option.
Operating cost value for money	Poor
Additional infrastructure required	None

Table 5.21 East Suffolk Line – GECO9: Increase in passenger service frequency between Lowestoft and Ipswich	
Option	To provide up to 2tph between Lowestoft and Ipswich, recognising the line speed aspirations for this line. This would interact with any projects to support freight traffic during construction of The Sizewell C power station.
Operating cost value for money	Poor
Additional infrastructure required	Full doubling of the single track sections or additional looping facilities south of Wickham Market, south of Saxmundham, north of Halesworth, midway between Brampton & Beccles and south of Oulton Broad South. Additional platforms at Ipswich would be required to enable the increase in service frequency.

Table 5.22 Felixstowe Branch Line – GECO10: Increase in passenger service frequency between Felixstowe and Ipswich	
Option	To provide up to 2tph between Felixstowe and Ipswich, recognising the line speed aspirations for this line.
Operating cost value for money	Poor
Additional infrastructure required	The infrastructure highlighted in Chapter 5 (further doubling of the Felixstowe branch line), will also provide sufficient capacity to provide up to 2tph allowing for a half hourly pattern between Felixstowe and Ipswich.

Table 5.23 Mayflower Line – GECO11: Increase in passenger service frequency between Harwich Town and Manningtree	
Option	To provide up to 2tph between Harwich and Manningtree, recognising the line speed aspirations for this line.
Operating cost value for money	Poor
Additional infrastructure required	None

Table 5.24 Colchester to Clacton/Walton – GECO12: Increase in passenger service frequency between Walton-on-the-Naze and Colchester	
Option	To provide up to 2tph between Walton-on-the-Naze and Colchester/Colchester Town, recognising the line speed aspirations for this line.
Operating cost value for money	Poor
Additional infrastructure required	None

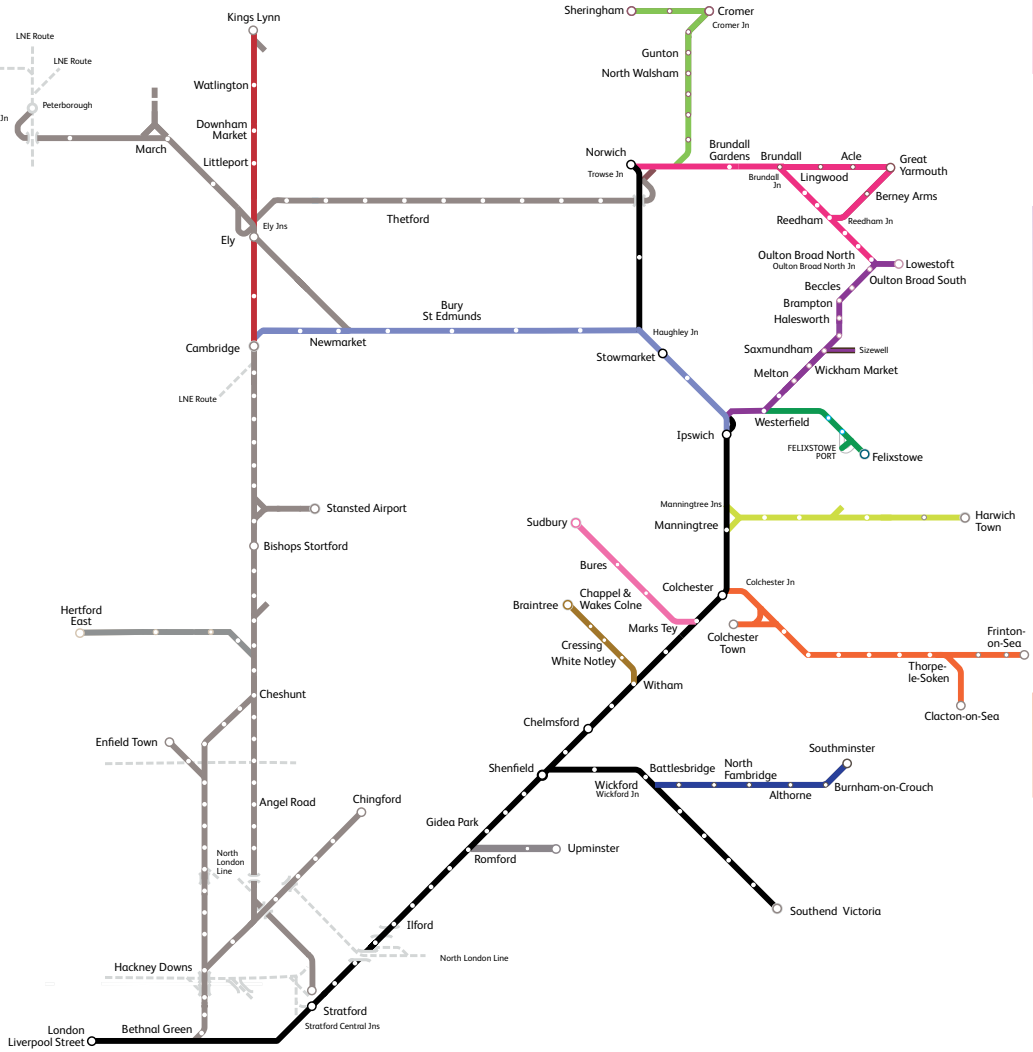
Table 5.25 Colchester to Clacton/Walton – GECO13: Increase in passenger service frequency between Clacton and Colchester	
Option	To provide up to 2tph between Clacton and Colchester/Colchester Town, recognising the line speed aspirations for this line.
Operating cost value for money	Low
Additional infrastructure required	None

Table 5.26 Gainsborough Line – GECO14: Increase in passenger service frequency between Sudbury and Marks Tey	
Option	To provide up to 2tph between Sudbury and Marks Tey, recognising the line speed aspirations for this line.
Operating cost value for money	Poor
Additional infrastructure required	Requires looping facilities between Bures and Chappel & Wakes Colne and signalling.

Table 5.27 Braintree Branch – GECO15: Increase in passenger service frequency between Braintree and Witham	
Option	To provide up to 2tph between Braintree and Witham, recognising the line speed aspirations for this line.
Operating cost value for money	Poor
Additional infrastructure required	Requires looping facilities between Cressing and White Notley.

Table 5.28 Crouch Valley Line – GECO16: Increase in passenger service frequency between Southminster and Wickford	
Option	To provide up to 2tph between Southminster and Wickford, recognising the line speed aspirations for this line.
Operating cost value for money	Poor
Additional infrastructure required	Requires an extra platform at Southminster to deliver one fast (calling at Southminster, Fambridge, Wickford) and one slow (all stations) service. In order to provide for 2tph calling at all stations on a half hourly pattern would require two new loop facilities between Fambridge and Southminster, and between Fambridge and Wickford, as the existing loop at Fambridge cannot be utilised on a standard half hourly pattern. Examining the calling patterns to utilise the existing loop would be better value for money.

Figure 5.9 Options addressing connectivity



Bittern Line (GECO6): 2tph

Additional infrastructure required:
- Doubling of the line at either Cromer or btw Walsham - Gunton
- Additional platform at Norwich

Fen Line (WACO6): 2tph

Additional infrastructure required for the hours when freight operates on this line:
- Partial doubling of the single line
- Ely North Jn interventions
- Level crossing works

Ipswich to Cambridge (WACO7): 2tph

Additional infrastructure required:
- Line speed improvements would be required to provide an even interval service on this route.

Gainsborough Line (GECO14): 2tph

Additional infrastructure required:
- Looping facilities btw Burres - Chappel & Wakes Colne

Braintree Branch (GECO15): 2tph

Additional infrastructure required:
- Looping facilities between Cressing and White Notley

Wherry Line (via Acle) (GECO7): 2tph

Additional infrastructure required:
- Doubling single line sections btw Great Yarmouth - Brundall Jn
- Additional platform at Norwich

Wherry Line (Lowesoft to Norwich)(GECO8): 2tph

Additional infrastructure required:
- None

East Suffolk Line (GECO9): 2tph

Additional infrastructure required:
- Full doubling of single track sections

or
- Additional looping facilities
- Additional platforms facilities at Ipswich

Felixstowe Branch Line (GECO10): 2tph

Additional infrastructure required:
- Further doubling of Felixstowe Branch Line as highlighted in Chapter 5

Mayflower Line (GECO11): 2tph

Additional infrastructure required:
- None

Colchester to Walton (GECO12): 2tph

Additional infrastructure required:
- None

Colchester to Clacton (GECO13): 2tph

Additional infrastructure required:
- None

Crouch Valley Line (GECO16) : 2tph

Additional infrastructure required:
- Additional platform at Southminster
- Looping facilities for 12-car trains

5.9 Station Capacity - All routes

5.9.1 Background

It is recognised that station capacity is an important factor to be considered as part of the Long Term Planning Process on the Anglia route. Stations form an integral part of a passenger's journey and if sufficient capacity is not provided then not only can safety be compromised, but walk times and inconvenience can be increased owing to congestion. Providing sufficient space at stations is a crucial enabler to achieving higher frequency services, maintaining dwell times and running longer or higher capacity rolling stock.

Many of the rail stations on the Anglia Route date from Victorian times and in terms of overall footprint and layout have not changed substantially for many decades. As a result of this and growth in the market, some stations on the Anglia Route are congested during peak hours, making movement through the station to and from the platforms slow and potentially difficult.

The Route Study has identified which stations on the Anglia Route need to be assessed for potential future passenger capacity issues that will require some level of intervention during CP6 (up to 2024). The station capacity review covers safety concerns and passenger discomfort caused by overcrowding, as well as factors that cause delays to passenger journeys. Station maintenance e.g. outdated facilities and improvement to station façades, station ambience etc. are generally not included under the station capacity umbrella. Whilst it may be beneficial to spend money on these, they are not taken into direct consideration in this review unless there is an opportunity to increase capacity, for example as part of a 'Renewal', through 'NSIP – National Station Improvement Programme' or 'AfA - Access for All' funding, which seeks to create step-free access from station entrances to platforms.

In order to generate a station capacity base scenario a review of current station operations was undertaken across the route. A shortlist of stations in need of enhancements was developed and agreed, following which a programme of site visits was undertaken to review station congestion first hand. This information was then used as a starting point to identify potential future capacity issues based on forecast passenger demand and potential infrastructure and operational enhancements. High level station capacity enhancement opportunities were then identified which will be analysed as part of a more detailed station capacity assessment if required.

This analysis is by no means a replacement for a full station capacity assessment. This exercise should be seen as an enabler for the second phase in which shortlisted stations will be assessed according to Network Rail's Station Capacity Assessment Guidance.

Going forward, stations will undergo an annual evaluation with the help of stakeholder involvement in order to identify those in need of enhancement in CP7. External bodies are free to fund and sponsor station improvements outside the LTPP.

5.9.2 Station selection

Due to the large number of stations on the Anglia Route it was not feasible to carry out capacity assessments for all stations. An overall station shortlist was generated by employing a two-stage methodology:

- MOIRA data analysis
- Train Operator consultation

An exercise was carried out using data from the industry's demand allocation tool (MOIRA) to identify the stations with the highest boarding/alighting numbers for individual train services during peak times of the day. Station capacity analysis is predominantly based on the busiest 15 minute periods of the day, the heaviest train boarding and alighting loads. If a station has sufficient capacity to handle the busiest periods then this should be more than enough for all other times of day. For the purposes of this assessment a total boarding/alighting figure of 200 for the busiest train service at each particular station was selected. Stations with a lower maximum churn were discounted and a shortlist of those with a maximum churn greater than 200 was created.

Consultation was held with c2c, Abellio Greater Anglia and TfL in order to incorporate their first-hand knowledge gained from operating the stations on a day-to-day basis. Some station site visits were also undertaken.

The shortlists developed through these two different processes were then combined to create one overall list.

Overlaps were identified between the two lists, with a high proportion of stations appearing on both.

The Route Study anticipates that some of the busiest stations on the Anglia route will be improved via planned or on-going station improvement projects; Table 5.29 details such works.

Table 5.29 Planned or On-Going Station Interventions, Anglia	
Barking	Further development work being carried out as part of the Barking Riverside proposals. As part of their franchise bid c2c have agreed to make improvements to the operation of Barking station.
Billericay	NSIP, AfA to Platform 2.
Bishops Stortford	NSIP, widened gateline and enhanced booking hall.
Blackhorse Road	An AfA scheme in CP5 will provide lifts onto the footbridge and platforms.
Brentwood	AfA proposal to provide step free access to all platforms, and to cater for predicted demand.
Cambridge	A new multi-storey cycle parking complex with space for 3,000 bicycles and a new ticket hall with more space, ticket office windows and additional ticket vending machines will be provided in CP5.
Chelmsford	NSIP works widened gateline and booking hall along with second entrance. Potentially AfA - bid submitted for access from new housing development to station.
Cheshunt	AfA proposal to provide lifts onto the existing footbridge, to reduce pedestrian usage of the level crossing.
Colchester	NSIP & Colchester subway enhancement, potential AfA.
Dalston Kingsland	Proposal to increase the size of the booking hall and widen platforms.
Finchley Road & Frognal	Existing ticket office removed and new enlarged space with extended gateline.
Forest Gate	Crossrail caters for future demand (2026 + 28 per cent).
Grays	AfA proposals to provide new subway and lifts.
Hackney Central	Existing waiting room and booking hall to be removed to allow greater throughput. New gateline and new booking hall in existing car park.
Hackney Wick	Opening up of route through embankment to improve access.
Harold Wood	Crossrail caters for future demand (2026 + 28 per cent).
Ilford	Crossrail caters for future demand (2026 + 28 per cent).
Ipswich	NSIP scheme will improve passenger flows.
Norwich	NSIP, enhanced gateline and cycling facilities, new retail, customer information and waiting room space, refurbished toilets.
Romford	Crossrail caters for future demand (2026 + 28 per cent).
Seven Sisters	AfA proposals to provide step free access, via installation of lifts behind subway to Platforms 1 & 2, with connecting walkways.
Tottenham Hale	WAML capacity enhancement will provide additional platform, AfA proposal and a LU proposal to enhance booking hall.
West Hampstead	New high level concourse and footbridge.
Willesden Junction	Further development work being carried out as part of the QPR development.
Walthamstow Central	New entrance and gateline.

As a result, the Anglia Route Study has not considered these stations for further investment during CP6. Should capacity at any of these stations not be addressed by these projects or should the project not qualify for funding, then they will become a priority for investment during CP6, where they are not already.

The review has also highlighted a number of stations that are recommended for early interventions; these are detailed in Table 5.30.

Table 5.30 Priority Station Recommendations, Anglia

Station	Issue	Possible Intervention
Brondesbury	Booking hall area is congested.	Expansion and remodelling of booking hall is recommended.
Barking	Congestion on Platform 1.	Platforms need to be de-cluttered.
Blackhorse Road	Access to overground platforms is restricted by a narrow footbridge and narrow stairs that lead into the LU ticket hall but access to the ticket hall is also restricted by a narrow entrance. Congestion may get worse with Overground train lengthening.	Possible widening of footbridge may be required. In addition access to the LU ticket hall needs to be improved.
Canonbury	The entrance to the station is too small. There are only two standard gates and a wide aisle gate. There is a lot of queuing in the peaks. The Customer Information System (CIS) is also in the small ticket hall and there is the potential risk of blocking the gates while reading it.	Requirement to widen the booking hall including additional gates and relocation of CIS.
Dalston Kingsland	Potential congestion issue on staircases.	Staircase may need widening depending on level of capacity being provided as part of the current proposal.
Homerton	Access to the station is congested.	The station requires a second entrance.
Kensal Rise	Access to/ from westbound platform is congested. Access is via a ramp into the car park.	Current station access to car park requires improvement to provide sufficient capacity.

Table 5.31 CP6 Station Recommendations, Anglia

Station	Conditional output	CP6 investment priority
Limehouse	ETCO1	Potential increase in capacity for passengers exiting from all platforms required.
London Liverpool Street	GECO1	Increase capacity for passengers exiting/ entering platforms, vertical circulation from the concourse is also very constrained.
London Fenchurch Street	ETCO1	Potentially increase capacity for passengers exiting from all platforms to Tower Gateway exit so as to avoid restricting the passenger flow to the main concourse.
Seven Sisters	WACO1	Increase width of overground platforms and subway capacity for passengers interchanging and exiting at the station.
West Ham	ETCO1	Potential increase in capacity for passengers exiting the platforms and interchanging between National Rail and London Underground services required. The December 2015 Essex Thameside timetable has been assessed and passenger modelling indicates that there will be an increase in interchange volumes at West Ham, which further evidences the need for enhancements at this station.

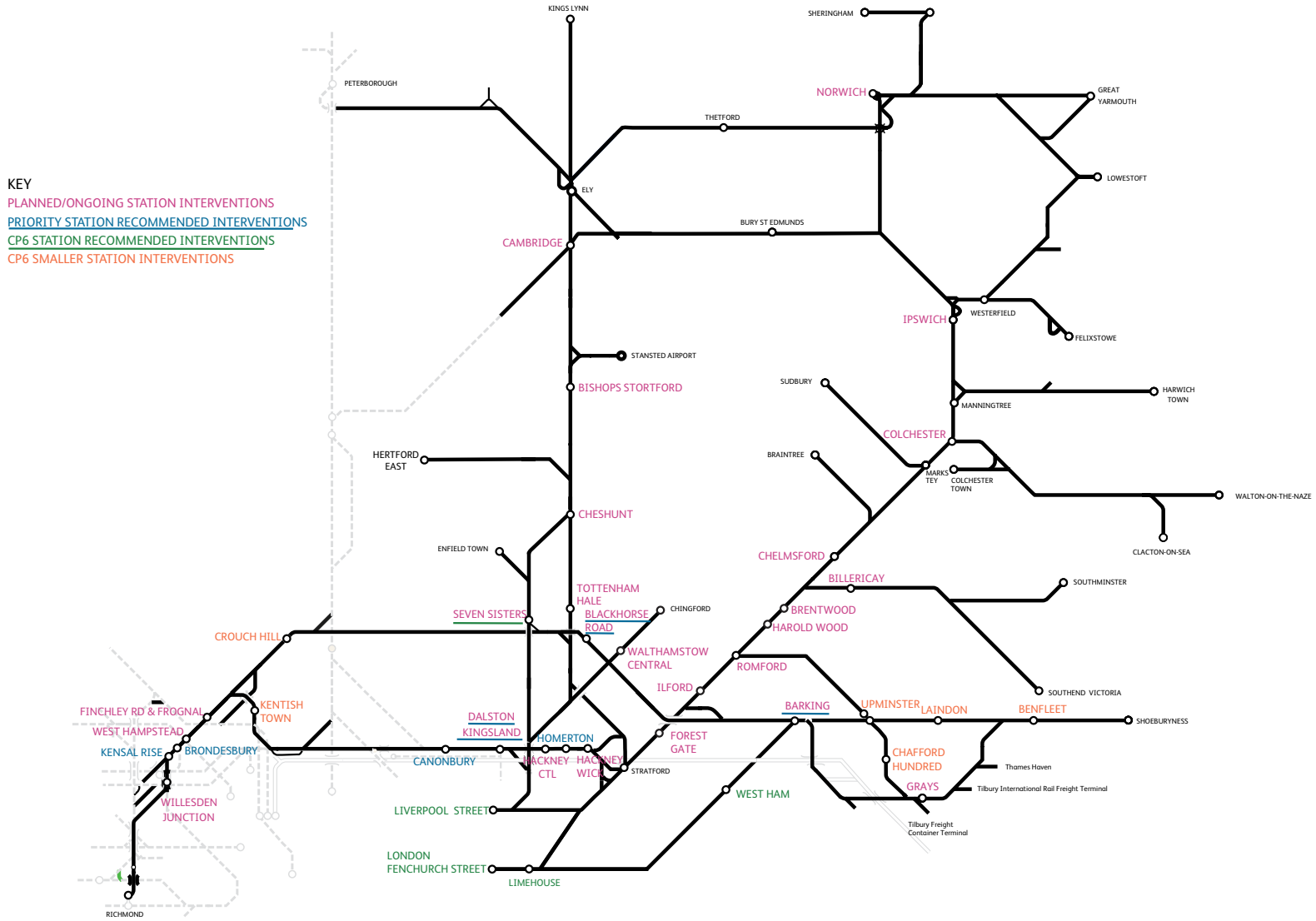
Table 5.32 Other smaller CP6 station recommendations, Anglia		
Station	**Conditional output**	**Issue / Potential intervention**
Benfleet	ETCO1	Congestion when exiting on top of stairs - Improvements to vertical circulation.
Chafford Hundred	ETCO1	Congestion when exiting - Wider exit
Crouch Hill	N/A	Congestion on stairs - Wider stairs
Kentish Town West	N/A	Congestion on stairs - Wider stairs
Laindon	ETCO1	Congestion in front of gateline when exiting - Improvements to allow better access to gateline
Upminster	ETCO1	Congestion at access to platform 1 - Widening of entrance

Elsewhere on the Anglia Route, it is anticipated that investment will be required at a number of other stations to meet the relevant conditional outputs during CP6. Tables 5.31 and 5.32 detail these stations.

Figure 5.10 depicts the planned or ongoing station interventions and future recommendations .

The Route Study recommends that further development is taken forward to determine the level of investment required to provide the necessary station capacity and to determine which stations would be impacted upon by the choices made by funders for development.

Figure 5.10 Planned station interventions and future recommendations



Appendix A: Cross-Boundary Approach

A1 The Cross-boundary approach

By necessity, for the purposes of undertaking the Long Term Planning Process (LTPP), the Network Rail geography is divided into Route Study Areas; this is to make the process manageable. For this reason, the Route Studies do not run in parallel, but are phased over the available time period within the five-year planning cycle.

By working at the Route Study level, the Network Rail route teams and relevant local stakeholders, both within and outside the industry, can be involved in work relevant to them addressing their requirements.

The Route Study boundaries broadly follow those of the Network Rail devolved Routes, with some exceptions to break down into smaller, more manageable areas (from a Route Study perspective), and to reduce the number of interfaces where possible. Due to this division of the rail network geography, it is necessary to co-ordinate the treatment of passenger and freight trains which cross Route Study boundaries, hence the Cross-boundary process.

A2 Cross-boundary services

For the purposes of the Long Term Planning Process passenger and freight services which traverse the study area boundary are referred to as cross boundary services. For the baseline, these can be broadly summarised as follows:

A3 Development of the process

The Cross-boundary process has been developed by a working group composed of Network Rail, passenger and freight train operating company representatives and the Department for Transport.

The group have developed a Cross-boundary Indicative Train Service Specification (ITSS) for passenger services which cross any route study boundary across the UK. This specification is an interpretation of how the connectivity conditional outputs articulated in the established Market Studies could be delivered. There are many ways in which the conditional outputs could be expressed and the Cross-boundary ITSS has as a start point sought to minimise the number of train movements over any given corridor by linking conditional outputs together and where possible having many conditional outputs delivered by the same train service. Given that the conditional outputs are conditional on a value for money business case being found it could be that the Cross-boundary ITSS may need to change in the future.

There are also a number of planning cycles to be undertaken between the time of writing and 2043 which may change priorities in the future. However, it is necessary to develop a set of service level assumptions in order to test the capability and capacity of infrastructure based on professional judgement of industry stakeholders. Using this approach allows a consistent methodology to be applied across Great Britain to ensure that opportunities can be identified and tested.

For freight services, information for the Anglia Route Study has been derived from the Freight Market Study, including preferred routeing of services. These routeings have been disaggregated within the Anglia Route Study area and discussed with the Anglia Route Study Working Group. Similarly to passenger, there are a wide range of origins and destinations for freight. However, freight trains operate to a different timetable according to the needs of industry and are often irregular or operate on specific days of the week. This has been catered for within the forecasting approach by reviewing the exact disaggregated figure for intermodal (Class 4) and other, including aggregate (Class 6), freight services and discussing with the Working Group, particularly freight operators, to arrive at a consistent figure that allows analysis of forecast freight flows alongside passenger. The information has then been rounded within the route study area to the nearest whole number, but remains the precise figure at the Route Study boundary area. This ensures that adjacent Route Studies do not incrementally round up, and result in over provision of timetable slots for freight traffic.

The Cross-Boundary Working Group continues to meet to receive and approve proposals from the Route Studies to amend the Cross-boundary specification (for either passenger or freight trains), and to advise on resolving capacity issues affecting more than one Route Study.

The Route Studies do not all run in parallel so the Cross-boundary process is a continuous one throughout the LTPP period.

Table 6.1 Cross-boundary freight and passenger services		
Boundaries between Anglia and other routes	**Route Boundary**	**Service Details**
LNE (East Coast)	Between Whittlesea and Peterborough	Inter-regional services connecting into Cambridge, Ipswich, Stansted Airport and Norwich via Ely
	Between Meldreth and Royston	Services between Kings Lynn, Ely, Cambridge and Kings Cross/Thameslink
	Between Camden Road and Finsbury Park	Freight services
	Between Canonbury and Finsbury Park	Freight services
	Between Crouch Hill and Harringay	Freight services
LNE (East Midlands)	Between Acton Wells and Hendon/Cricklewood	Freight services
	Between Upper Holloway and West Hampstead	Freight services
Western	Between Willesden Jn and Acton Main Line	Freight services
LNW (West Coast)	Between Camden Road and Queens Park	Freight services
	Between Kensal Rise and Wembley Central	Freight services
	Between Kensal Rise and Willesden Jn (LL)	ECS moves
	Between Acton Central and Shepherds Bush	Freight services
LNW (West Midlands)	Between Acton Central and Wembley Central	Freight services
	Between Acton Central and Wembley Stadium	Freight services
Wessex	Between South Acton and Brentford/Chiswick	Freight services
Sussex	Between Willesden Jn and Shepherds Bush	Freight and West London Line/North London Line services
Other	Between Barking and Ebbsfleet (HS1)	Freight services
	Between Stratford and Whitechapel (Crossrail)	Crossrail services
	Between Canonbury and Dalston Junction (RfL)	East London Line services
	Between Gunnersbury and Turnham Green (LUL)	District Line services

A4 Cross-boundary service assumptions

The Anglia Route Study area is served by a number of Cross-boundary services which are included within the 2043 ITSS. This includes broad groups of services serving markets as set out below. At the end of this section a number of worked examples are provided to show how the conditional outputs have been interpreted in practice and how the subsequent train services in the 2043 ITSS to accommodate them have been derived.

- services from Anglia to the East Midlands and beyond to Liverpool
- services from Anglia to Yorkshire and Scotland
- services to the West Midlands from the Anglia area.

Freight services are included within the 2043 ITSS and include the numbers of trains required to meet the forecast growth in demand for movement of freight by rail.

A5 Worked Examples

The indicative train service specification for Cross-boundary flows includes one service each way between Ipswich/Norwich (joining/dividing at Ely) and Liverpool Lime Street via Nottingham and one service each way between Cambridge/Norwich (joining/dividing at Ely) and Derby via Nottingham. Options to address the Cross-boundary services are detailed in Chapter 5.

Cambridge and Nottingham

Even taking into account the simplifications which connections (rather than direct trains) allow, it is still necessary to include more trains than today to allow the conditional outputs to be met. For example between Cambridge and Nottingham the Long Distance Market Study conditional output is 'B/E' which is defined as two to three trains per hour (tph) with an average speed of 100mph, or three to four tph at 60mph.

The base train service operating at the end of Control Period 5, has no direct train between Cambridge and Nottingham. There is the opportunity to travel to Nottingham once per hour and interchange at Ely.

Thus to fully meet the conditional output requires at least the addition of a direct travel opportunity of one or more trains and/or increased opportunities to interchange (potentially with a significant acceleration of the services).

Note that the conditional outputs are a guide to the overall Generalised Journey Time (GJT) desired. The GJT is composed of in-vehicle time, waiting time and interchange penalty. Thus GJT may be improved by combinations of faster trains, more trains or better connections.

It is also necessary to make further assumptions in order to keep the specification manageable.

Table 6.2 Cross-boundary freight and passenger services

Flow	Conditional Output	Indicative Train Service Specification (ITSS)
Cambridge – Nottingham	B/E (2-3,or 3-4 per hour, 100 or 60 mph)	1tph each way between Ipswich/Norwich (joining/dividing at Ely) and Liverpool Lime Street via Nottingham
1tph each way between Cambridge/Norwich (joining/dividing at Ely) and Derby via Nottingham.	Interchange opportunities at Leicester	1tph each way between Norwich and Birmingham via Leicester.

Norwich–Nottingham

Alongside the Cambridge - Nottingham conditional output there is a conditional output for Norwich - Nottingham at level C (one to two tph at 80mph), but only one train per hour in the baseline. This implies at least one to two additional Norwich-Nottingham train required each hour.

Assuming for a moment that Nottingham – Cambridge and Nottingham – Norwich cannot be served by the same trains, this would equate to between five and eight trains to serve the markets. The extra three to four trains per hour would clearly be impractical and uneconomic from a service provision perspective, even before network capacity constraints are taken into account.

Therefore combination of the conditional outputs onto a number of services allows the diverse markets to be met by a lower net number of trains overall.

Ely has been identified as an appropriate location to undertake splitting and joining of trains, allowing a single train to meet multiple conditional outputs for the Nottingham market.

A6 Routeing Options

For the Anglia Route, there are no alternative routeing options available for Cross-boundary services entering via Peterborough, Should proposals for the extension of the East West Rail route between Oxford and Bedford to Cambridge come to fruition then this new section of route presents an opportunity for some rerouting of Cross-boundary services.

A7 Ongoing Process

The 2043 ITSS for Anglia is unconstrained and is provided as an input to the Route Studies, which seek to accommodate it alongside trains which run purely within the Route Study area. Where it is not possible to accommodate all trains on the baseline infrastructure using the baseline rolling stock assumptions then Route Studies can:

- reroute
- use different rolling stock assumptions
- consider the case for additional infrastructure.

Where these affect Cross-boundary trains (passenger or freight) then it is important to work with all the other Route Studies to ensure that assumptions are consistent on routeing, rolling stock type and length (in the case of accommodating demand). Where a business case is being made for infrastructure to accommodate Cross-boundary trains, then it is important to work with other Route Studies to ensure that all costs are captured on the line of route. This is managed by the Cross-Boundary Working Group which meets throughout the Route Study process.

Appendix B: Option Assessment

Option Assessment

Chapter 5 outlines the packages of interventions required to meet the conditional outputs in 2043.

This chapter summarises each option in turn.

Table 7.1 London Liverpool Street Capacity	
Option 1a: Additional Platform Capacity at London Liverpool Street	
Description	This option is to provide additional platforms at London Liverpool Street to support the increase in services from the GEML.
Conditional Output.	This goes towards meeting requirements of peak capacity for 2043 for GEML services (GECO4), but in isolation would not allow for additional paths into the station.
Purpose	This option is required to support additional main line services into London Liverpool Street. There is no useable increase in platform capacity at London Liverpool Street with the introduction of Crossrail as only Platform 1- 15 will be able to accommodate 12-car services. Therefore platform capacity will constrain any increase in train service.
InterventionDetails	Options for potential additional platform locations: • new platform 0 located within the shopping area to the west side of London Liverpool Street Station, but potentially requiring platform 1 to be shortened • three new platforms between the existing platforms 10 and 11, one adjacent to platform 10 and two within the taxi rank area • remodelling of the existing platforms 1-10 within the western-most train shed to allow provision of an additional three 12-car length platforms or an additional two 12-car and two 10-car platforms

Table 7.2 London Liverpool Street Capacity	
Option 1b: Re-route West Anglia services to Stratford	
Description	This option is to relocate some services originating from the West Anglia Main Line, from London Liverpool Street to Stratford, therefore freeing up platform capacity at London Liverpool Street to allow an increase in GEML services.
Conditional Output.	This goes towards meeting requirements of peak capacity for 2043 for GEML services (GECO4), but in isolation would not allow for additional paths into the station.
Purpose	This option is required to support additional main line services into London Liverpool Street. There is no useable increase in platform capacity at London Liverpool Street with the introduction of Crossrail as only Platform 1- 15 will be able to accommodate 12-car services. Therefore platform capacity will constrain any increase in train service.
InterventionDetails	Would require an additional 12-car bay platform at Stratford located between Platforms 10a and 11, and additional track capacity between Stratford and Ruckholt Road to allow for access to Orient Way Carriage sidings. The number of services diverted from the WAML to Stratford will be constrained by the need to access Orient Way Carriage sidings. This will therefore constrain the number of additional Great Eastern Main Line services delivered by this option and reduce the capacity available to meet WAML conditional outputs.

Table 7.3 Chelmsford – London Liverpool Street Capacity	
Option 2a: Improved signalling	
Description	The option improves the signalling capability between Chelmsford and London Liverpool Street to allow an increase in GEML services.
Conditional Output.	This goes towards meeting requirements of peak capacity for 2043 for GEML services (GECO4), but in isolation would not allow for additional paths.
Purpose	Current feasible capacity that can be delivered robustly on the main line is 24 passenger service arrivals in the high peak hour at London Liverpool Street. This is constrained by the planning headway on the route provided by the signalling.
InterventionDetails	A planning headway of 1.5 minutes is required to achieve the train service specification of 32tph. The alternative to this intervention is a fifth track which would operate in the peak direction to allow for an increase in services. This option has not been developed as initial modelling work has shown that ETCS and ATO can achieve the signalling improvements required. Costs are not available for an ETCS and ATO solution, therefore a conventional resignalling cost has been developed for this option for the purpose of the business case appraisal.

Table 7.4 Trowse Junction Capacity	
Option 3: Double Trowse Swing Bridge	
Description	The option is to double the single track section over Trowse Swing Bridge and Trowse Lower Junction.
Conditional Output.	This goes towards meeting requirements of peak capacity for 2043 for GEML services (GECO4), but in isolation would not allow for additional paths. This option also supports achievement of the capacity required for Cross-boundary passenger services to Norwich and Cambridge via Ely (GECO5).
Purpose	Trowse Swing Bridge was originally built in 1845 as a single track structure then reconstructed as a twin track structure in 1905. Overhead electrification was introduced in 1986 and it was reverted back to a single line structure. The structure is lifted by hydraulic jacks and swings open. There have been frequent problems reported with navigation access caused due to its unreliability. There is a 40mph speed limit across the bridge. The single track restricts the number of services that can be accommodated and therefore limits any additional services which can be achieved on the GEML.
InterventionDetails	The following options have been examined: • new fixed structure adjacent to existing. Existing structure swing mechanism fully disabled along with all power and mechanical equipment decommissioned. (This option is dependent on the 1985 British Railways Act regarding the requirement to open the bridge being rescinded) • new fixed single structure to accommodate twin tracks. Existing structure to be demolished along with all power and mechanical equipment decommissioned. (This option is dependent on the 1985 British Railways Act regarding the requirement to open the bridge being rescinded) • new swing bridge adjacent to the existing along with the existing structure made fully operable • new single structure to accommodate twin tracks with moveable lift function. Existing structure to be demolished along with all power and mechanical equipment decommissioned • new single fixed structure to accommodate twin tracks. Existing structure to be demolished along with all power and mechanical equipment decommissioned • new fixed structure adjacent to existing at higher level along with the swing function made operable on the existing structure. The following options have the potential to provide the additional capacity over constrained single line sections at Trowse Lower Junction: • new 25mph double junction from up and down main line to up and down Thetford line • new 25mph double junction from up and down main line to up and down Thetford line with a facing 25mph crossover on Thetford branch. The solution at Trowse will need to be developed closely with the Broads Authority.

Table 7.5 Ipswich – Haughley Junction Capacity	
Option 4a: Four-tracking between Ipswich and Haughley Junction	
Description	Four-tracking between Ipswich and Haughley Junction would be necessary to provide sufficient capacity for the peak GEML services alongside the freight growth on the Felixstowe to Peterborough corridor.
Conditional Output.	This goes towards meeting requirements of peak capacity for 2043 for GEML services (GECO4), but in isolation would not allow for additional paths. This option also supports achievement of the capacity required for Cross-boundary passenger services to Norwich and Cambridge via Ely (GECO5) and freight services between Felixstowe and Peterborough (F2NCO2).
Purpose	Current speed differentials between passenger and freight (combined with the aspiration for faster journeys between Norwich and London) result in insufficient capacity for both freight and passenger conditional outputs. The key challenge is achieving conflicting movements between freight flows (Felixstowe to Ely direction) and passenger flows (from Norwich to London) at Haughley Jn.
InterventionDetails	This intervention would solve the problem by providing a section of four tracks to allow segregation of key flows. This would extend from Haughley Junction to between Stowmarket and Needham. The extent of four-tracking could be reduced through reduction in headway and junction margins and improved rolling stock acceleration characteristics.

Table 7.6 Ipswich – Haughley Junction Capacity	
Option 4b: Grade Separation of Haughley Junction	
Description	Grade separation of Haughley Junction to support increase in both GEML and freight growth.
Conditional Output.	This goes towards meeting requirements of peak capacity for 2043 for GEML services (GECO4), but in isolation would not allow for additional paths. This option also supports achievement of the capacity required for Cross-boundary passenger services to Norwich and Cambridge via Ely (GECO5) and freight services between Felixstowe and Peterborough (F2NCO2).
Purpose	Current speed differentials between passenger and freight (combined with the aspiration for faster journeys between Norwich and London) result in insufficient capacity for both freight and passenger conditional outputs. The key challenge is removing conflicting movements between freight flows (Felixstowe to Ely direction) and passenger flows (from Norwich to London) at Haughley Jn.
InterventionDetails	This intervention would provide a grade separated junction at Haughley Junction which would remove the flat junction movement between key passenger and freight flows.

Table 7.7 Ipswich – Haughley Junction Capacity	
Option 4c: Loop at Haughley Junction	
Description	A passing loop facility to allow fast Norwich to London services to pass freight services on the Great Eastern Main Line and hold freight services requiring access to the Bury St Edmunds line.
Conditional Output.	This goes towards meeting requirements of capacity for 2024 for freight and GEML services (F2NCO1 and GECO2), but in isolation would not allow for additional paths.
Purpose	Current speed differential issues between passenger and freight results in insufficient capacity for both Felixstowe to Nuneaton freight and passenger conditional outputs. This can be resolved through passing the freight on the Great Eastern Main Line, but this requires the ability to path freight at intervals of 4 minutes. Increased robustness and flexibility of freight paths aids the provision of improved journey times on the Great Eastern (GECO3) for services from Norwich to London.
InterventionDetails	A loop in the down direction approaching Haughley Junction.

Table 7.8 Ipswich – Haughley Junction Capacity	
Option 4d: Headway reduction on Bury St Edmunds Line	
Description	Headway improvements to support pathing freight at intervals of 4 minutes from GEML to the Bury St Edmunds Line.
Conditional Output.	This goes towards meeting requirements of capacity for 2024 for freight and GEML services (F2NCO1 and GECO2), but in isolation would not allow for additional paths.
Purpose	Current speed differential issues between passenger and freight results in insufficient capacity for both Felixstowe to Nuneaton freight and passenger conditional outputs. To be able to alter freight paths on the GEML to meet the passenger outputs requires Headway improvements to support pathing freight at intervals of 4 minutes from GEML to the Bury St Edmunds Line.
InterventionDetails	This option requires line speed improvements for both passenger and freight services to provide the necessary headway reduction. This requires infrastructure upgrades to facilitate the line speed increase and removal of differential speeds to support a 4 minute headway accessing the Bury St Edmunds line.

Table 7.9 Felixstowe Branch Line Capacity	
Description	To provide further two track sections on the Felixstowe branch
Conditional Output.	This goes towards meeting requirements of freight capacity for 2024 (F2NCO1) but in isolation would not allow for additional paths. Would need to be combined with other options to achieve the capacity.
Purpose	The single line sections on the Felixstowe Branch Line provide a constraint to delivering the capacity required for forecast growth in intermodal freight traffic to and from the Port of Felixstowe alongside the passenger service.
InterventionDetails	Further doubling of the Felixstowe Branch is necessary to cater for the forecast of 60 freight trains per day.

Table 7.10 Ely - Soham	
Option 5: Full or partial doubling	
Description	Full or partial doubling of track between Ely and Soham
Conditional Output.	This goes towards meeting requirements of capacity for 2043 for freight (F2NCO2 and GECO5), but in isolation would not allow for additional paths.
Purpose	The single line sections between Ely and Soham (beyond the baseline) provide a constraint to delivering the capacity required for forecast growth in intermodal freight traffic to and from the Port of Felixstowe. Full re-doubling of this section is required to achieve the 60 freight paths per day conditional output.
InterventionDetails	This option requires double track between Ely and Soham.

Table 7.11 Ely area	
Option 6a: Level Crossings	
Description	Ely area level crossings
Conditional Output.	This goes towards meeting requirements of capacity for 2043 for freight (F2NCO2 and GECO5), but in isolation would not allow for additional paths.
Purpose	There are a number of level crossings in the Ely area which constrain any increase in service above the baseline. The headway, particularly between Ely North and Ely, also constrains any increase in train service and would need to be reduced to support any increase in service in this area.
InterventionDetails	This option involves assessing and improving, replacing or closing the level crossings in the Ely area which constrain increase in the train services.

Table 7.12 Ely area	
Option 6b: Avoiding Lines	
Description	Ely area avoiding line
Conditional Output.	This goes towards meeting requirements of capacity for 2043 for freight (F2NCO2 and GECO5), but in isolation would not allow for additional paths.
Purpose	There are a number of level crossings in the Ely area and capacity constrained infrastructure (headway, junction movements and platform capacity) which constrain any increase in service above the baseline.
InterventionDetails	An option has been assessed which considers the installation of a new railway link on the west side of Ely. This would remove the interaction between freight and passenger services in the Ely area and therefore reduce the required infrastructure work at junctions, level crossings and platforms. The scale of this intervention is very significant and would need to be considered further in the longer term to review service levels, particularly whether freight traffic has grown as predicted.

Table 7.13 Witham and Colchester	
Option 6b: Loop facility	
Description	Loop facility to allow overtaking between Witham and Colchester.
Conditional Output.	This goes towards meeting requirements of peak capacity for 2043 and improved journey times (GECO3 and GECO4), but in isolation would not allow for additional paths.
Purpose	To provide robust capacity for the addition of a third London to Norwich service (all day to provide improved journey times to outer destinations on the Great Eastern Main Line) alongside the existing and future freight service levels there would be a requirement for one freight path per hour to be overtaken between Witham and Colchester. To do this, new looping facilities would be necessary between Witham and Colchester. This infrastructure is required in peak hours to allow slower passenger services to be overtaken to support achieving the number of peak services required.
InterventionDetails	The loop facility allows for the holding of Class 4/6 freight to allow for overtaking by faster passenger services; this achieves GECO3 when implemented with Options 3 and 7.

Table 7.14 Line speed improvements between Shenfield and Norwich	
Option 7: Line speed improvements	
Description	To help support journey time improvements alongside rolling stock change and calling pattern amendments the line speed on the GEML could be increased.
Conditional Output.	To support achievement of improved journey time (GECO3).
Purpose	This option goes towards meeting journey time improvements on the route, although in isolation without rolling stock change would deliver negligible change.
InterventionDetails	Raising of the line speed with associated level crossing work, signalling, civils and track work.

Table 7.15 West Anglia line speed increase	
Option 8: Line speed improvements	
Description	This option improves the line speed on the route to enable 100mph running.
Conditional Output.	To enable journey time improvements to support WACO3.
Purpose	This option will not achieve journey time improvements in isolation and is required along with changes to rolling stock and timetable structure.
InterventionDetails	To deliver increased line speeds on the WAML with associated level crossing work, signalling, civils and track work.

Table 7.16 Ely area	
Option 9: Ely remodelling	
Description	This option provides significant layout improvements in the Ely area to remove capacity constraints.
Conditional Output.	This goes towards meeting requirements of capacity for 2043 for freight and passengers (F2NCO2, GECO5 and WACO6), but in isolation would not allow for additional paths.
Purpose	The Ely area is considered operationally to be at capacity by the end of CP6. Conditional outputs from 2024 through to 2043 require the testing of a further growth scenario for passenger and freight services through the Ely area to Felixstowe, Cambridge, Norwich, Peterborough and beyond. These flows introduce four primary constraints into the area: • crossing moves at Ely North Jn • crossing moves at Ely Dock Jn • platform utilisation at Ely (especially if splitting/joining of trains is required) • line utilisation Ely to Ely North Jn
InterventionDetails	It is considered that the following interventions would be required to remove these constraints: • Ely 3 / 4 tracking between Ely Station and Ely North Jn • Ely platform works • Ely North Jn Grade Separation • Ely Dock Jn Grade Separation Previous work undertaken has highlighted the significant difficulties in achieving the above interventions in this area, some examples of which are: • additional span on Stuntney Bridge Road underbridge • additional double-track span on Cutter Bridge over Great Ouse, consent would be required from the Navigation Authority of the Environment Agency. • hydrology issues with new bridges—drainage and scour • land take • embankment widening

Table 7.17 Four-tracking West Anglia Main Line	
Option 10a: Crossrail 2	
Description	Central tunnel connection between West Anglia, Central London and South West London.
Conditional Output.	Supports the following conditional outputs to support capacity, connectivity and journey time improvements WAC02 to WAC05.
Purpose	To facilitate an increase in services on the West Anglia Main Line, thereby delivering improved service frequency journey and time, alongside increased connectivity for the WAML to Central and South West London.
InterventionDetails	Tunnel portal and section to central London along with grade separated junction at Coppermill and four-tracking between Coppermill Junction and Broxbourne.

Table 7.18 Four-tracking West Anglia Main Line	
Option 10b: Prior to Crossrail 2	
Description	Four-tracking and works at Stratford to support early output ahead of Crossrail 2.
Conditional Output.	Supports the following conditional outputs - WAC01, WAC02, WAC03 and WAC05 but cannot deliver any increase in train service in isolation due to network constraints at London Liverpool Street and Stratford.
Purpose	To enable segregation of fast and stopping services on the WAML which will allow improved journey times and provide capacity to increase service frequencies (if combined with another option to provide terminating capacity).
InterventionDetails	Grade separated junction at Coppermill Junction and four-tracking between Coppermill Junction and Broxbourne.

Table 7.19 Stratford	
Option 11: Stratford Additional Platforms	
Description	Additional platform at Stratford between Platform 10a and 11
Conditional Output.	Supports the following conditional outputs - WAC01, WAC02, and WAC05 but cannot deliver any increase in train service in isolation.
Purpose	To facilitate additional terminating capacity in Stratford to support additional services from WAML.
InterventionDetails	To provide a platform in the triangle between Platform 10a and Platform 11 which connects to the north of Platform 11 and 12 to serve WAML.

Table 7.20 Stratford – Orient Way capacity	
Option 12: Improved access to Orient Way Carriage Siding	
Description	Section of third track between Stratford and Ruckholt Road
Conditional Output.	Supports the following conditional outputs - WAC01, WAC02, and WAC05 but cannot deliver any increase in train service in isolation.
Purpose	Orient Way is accessed by empty coaching stock (ECS) to/from London Liverpool Street before and after each peak period. The number of units requiring access alongside the WAML service terminating in either Platform 11 or 12 will constrain any further growth between Stratford and WAML. To terminate services at Stratford in a 4 tracking scenario prior to Crossrail 2 will require some segregation between ECS movements and terminating services.
InterventionDetails	To provide a short section of third track between Stratford and Ruckholt Road to allow ECS to be held awaiting a path into the sidings.

Table 7.21 Stansted	
Option 13: Stansted Tunnel	
Description	Double tracking of Stansted Tunnel.
Conditional Output.	Supports WAC05 to improve connectivity to Stansted Airport.
Purpose	Current feasible capacity of the single line to Stansted Airport is 6tph. Doubling of the Stansted Airport line is required to achieve greater connectivity above the 6tph.
InterventionDetails	Best use of current infrastructure limits access to Stansted Airport to 6 tph due to the single line section. Double tracking removes this constraint allowing additional paths into Stansted Airport. Capacity beyond 8tph would require additional platforms at Stansted Airport.

Table 7.22 North London Line	
Option 14: NLL Headway	
Description	To achieve a 3 minute planning headway on the NLL
Conditional Output.	To meet conditional output CLC02 and CLFC02, 16tph are required. A planning headway of 3 minutes will allow for both conditional outputs to be met.
Purpose	Current capability of the signalling limits the North London Line to 12tph. The Hampstead Heath tunnel area is the most constrained. To prevent trains coming to a stand at a red signal inside Hampstead Heath tunnel, a 'double block' control system is applied. This effectively increases headways through the tunnel itself, and across the whole of the North London Line.
InterventionDetails	Removing the double block control system or improving signalling capability on the route. ETCS has potential to support the improvement required.

Table 7.23 North London Line	
Option 15: NLL regulation at Gospel Oak	
Description	Improved regulation at Gospel Oak and Kensal Green Junction.
Conditional Output.	To support conditional outputs CLCO2 and CLFCO2.
Purpose	Current timetabling of the Gospel Oak to Barking Line allows for multiple standard paths per hour for freight, although current utilisation is low-medium as Thames Gateway is not yet operating at full capacity. Path uptake is anticipated to increase significantly from CP5 onwards. In order to allow for high utilisation of paths on both the Gospel Oak to Barking Line and North London Line without serious performance implications, regulating points will be required to allow overtaking. This intervention is relevant to an increase in passenger traffic on the North London Line as well as on the Gospel Oak – Barking route as increases in passenger services heading to/from Camden Road through Gospel Oak will lead to more instances of freights being held awaiting a path onto the North London Line.
InterventionDetails	Location of a regulating point at Gospel Oak will allow freight services waiting their path onto the North London Line to be held without trailing back over the Barking – Gospel Oak platform connection, therefore reducing the risk of knock on delays to that service group.

Table 7.24 North London Line	
Option 16: NLL regulation at Kensal Green Junction (Kensal Rise)	
Description	Improved regulation at Gospel Oak and Kensal Green Junction.
Conditional Output.	To support conditional outputs CLCO2 and CLFCO2.
Purpose	The South East Route: Sussex Area Route Study sets out some possible options for the North London Line to support the requirement for 8-car services from the West London Line to meet the capacity gap; options include providing an 8-car turnback between Willesden Junction and Kensal Rise to allow for the termination of West London Line Services or platform lengthening on the North London Line to allow for the continuation of 8-car services from the West London Line on to the North London Line. This option examines a third track at Kensal Rise to support both the regulation of freight services at Kensal Green Junction and a turnback facility for the WLL service. Current timetabling of the North London Line allows for multiple standard paths per hour for freight, although current utilisation is low-medium as Thames Gateway is not yet operating at full capacity. Path uptake is anticipated to increase significantly from CP5 onwards. In order to allow for high utilisation of paths on both the Gospel Oak to Barking Line and North London Line without serious performance implications, regulating points will be required.
InterventionDetails	Location of regulating points by Kensal Rise will allow for services to be held on the North London Line in order to await an appropriate path on to the West Coast Main Line and onwards running on the North London Line, therefore allowing for mitigation of performance issues.

Appendix C: Appraisal Tables

Appraisal Tables

The choices identified for the next Control Period (CP6, commencing April 2019) have been categorised from a financial and socio-economic perspective.

In the context of the financial perspective, CP6 choices have been categorised into those that:

- worsen the rail industry's net operating position (in other words, the additional operating costs exceed the value of revenue generated); or
- choices which improve the industry's net operating position. For these schemes, the Route Study also indicates the extent to which this improvement is able to cover the capital cost of the initial investment.

The choices have also been appraised from a wider 'socio-economic' perspective, which compares the value of benefits to users and non-users to the net financial cost to funders. The appraisals have been conducted in line with funders' guidelines, in particular WebTAG, the Department for Transport's appraisal guidelines.

C1 Great Eastern Main Line - Capacity

Table 8.1 Option S1i: Lengthening the remaining 8-car services to 12-car, and increasing the frequency of services by 3 trains in the peak will cater for the additional capacity requirements for 2023.		
Conditional Output.	GECO1	To provide sufficient capacity for passengers travelling into central London and other employment centres during peak hours, taking into account anticipated growth over the period to the end of Control Period 6 (2024) – Great Eastern Main Line services
	GECO2	To provide sufficient capacity for cross boundary services between Peterborough / Norwich and Cambridge via Ely, taking into account anticipated growth over the period to the end of Control Period 6 (2024) – Cross-boundary services.
Timeframe	Sufficient capacity to end of CP6 and also providing for 2043 capacity gap.	
Objectives/purpose	To provide sufficient peak capacity on the Great Eastern Outer service via Chelmsford for 2023 and moving towards providing sufficient infrastructure to provide capacity for the long term.	
Description	An additional service from Norwich, and two services starting from a station where they are able to serve the majority of key stations on the route will best meet the crowding issue on the busiest services.	
Infrastructure requirement	In order to provide sufficient capacity for these additional trains the following infrastructure interventions are required: • **Option 1 and 2**: Additional platforms at London Liverpool Street or the redirection of West Anglia Main Line services to additional platforms at Stratford • **Options 3 and 4**: Improved signalling between Chelmsford and Stratford • **Option 5**: Doubling of Trowse swing bridge (near Norwich) • **Option 9**: Loops north of Witham	
Operational requirement	New train diagrams to lengthen one Witham to Liverpool Street service, two 12-car services from outer Great Eastern and one additional 8-car service from Norwich.	
Passenger impact	Provides an additional 36 vehicle arrivals in the high peak hour into Liverpool street by 2023, provides increased peak frequency of services.	
Freight impact	Haughley infrastructure is also required to provide sufficient capacity for freight to 2023.	
Relates to other options	Relates to options to provide sufficient freight capacity for the Cross country corridor via Ely route and provision of increased frequency between Ely and Norwich (Trowse Swing Bridge)	
Socio-economic Value for money categorisation	Low, central case is borderline between poor and low value for money, sensitivity tests have been carried out around the operating costs of the scheme that demonstrate low value for money.	
Rail Industry financial categorisation	Increases operating subsidies	
Note	• Performance and wider socio-economic benefits have not yet been included in the business case. Network Rail will revise the business case at a later date to reflect this. • The cost of upgrading the power supply to accommodate the extra services has not been included. Network Rail will undertake power supply analysis and examine any depot and stabling implications later in the development process. • The cost estimates that inform the business case are based on initial engineering feasibility assessments but are pre-GRIP. Significant contingencies have been added but as always in these cases Network Rail will need to complete considerable further engineering feasibility work before a reasonable degree of certainty can be reached both on costs and outputs.	

Table 8.2: Option S1i: Financial and socio-economic categorisation

Rail industry financial impact (Categorisation of Revenue, Operating costs & Capital costs over appraisal period)			Socio-economic impact (WebTAG VfM category, see summary TEE table for further details)
Scheme increases operating subsidies (i.e. R – O < 0)		N/A	Poor / Low
Scheme decreases operating subsidies (i.e. R – O > 0)	Low capital cost coverage (i.e. (R – O) / C <33%)	✓	
	Medium capital cost coverage (33-66%)	N/A	
	High capital cost coverage (66-100%)	N/A	
	Positive financial case (> 100%)		

Table 8.3: Option S1i: Appraisal Results

Results of socio-economic appraisal	Option S1 £m (2010 PV)	Excluding Opex OB
Benefits		
Rail user benefits	249.78	249.78
Non user benefits	81.67	81.67
Rail user and non user disruption disbenefits	-11.88	-11.88
Indirect taxation impact	-65.43	-65.43
Total quantified benefits	**254.14**	254.14
Costs		
Investment costs	315.65	315.65
Non user benefits - road infrastructure cost changes	-0.31	-0.31
Revenue	-176.62	-176.62
Operating costs	209.35	150.85
Total costs	348.08	289.58
Net Present Value (NPV)	-93.94	-35.44
Benefit Cost Ratio (BCR)	0.73	0.88

Note:
- *The above costs do not include power supply or level crossing works*
- *The costs will need to be reappraised again at the end of GRIP 2*

Present Values (PVs) are in 2010 market prices and are discounted to 2010 using Social Time Preference Rates.

A sensitivity has been carried out that removes the infrastructure costs associated with Signalling headway improvements.

Table 8.4: Option S1i sensitivity reduced capital cost of headway improvements: Financial and socio-economic categorisation

Rail industry financial impact (Categorisation of Revenue, Operating costs & Capital costs over appraisal period)			Socio-economic impact (WebTAG VfM category, see summary TEE table for further details)
Scheme increases operating subsidies (i.e. R – O < 0)		N/A	Medium / High
Scheme decreases operating subsidies (i.e. R – O > 0)	Low capital cost coverage (i.e. (R – O) / C <33%)	✓	
	Medium capital cost coverage (33-66%)	N/A	
	High capital cost coverage (66-100%)	N/A	
	Positive financial case (> 100%)		

Table 8.5: Option S1i sensitivity reduced capital cost of headway improvements: Appraisal Results

Results of socio-economic appraisal	Option S2 £m (2010 PV)	Excluding Opex OB
Benefits		
Rail user benefits	249.78	249.78
Non user benefits	81.67	81.67
Rail user and non user disruption disbenefits	-4.07	-4.07
Indirect taxation impact	-65.43	-65.43
Total quantified benefits	**261.95**	261.95
Costs		
Investment costs	108.23	108.23
Non user benefits - road infrastructure cost changes	-0.31	-0.31
Revenue	-176.62	-176.62
Operating costs	209.35	150.85
Total costs	140.66	82.16
Net Present Value (NPV)	121.29	179.79
Benefit Cost Ratio (BCR)	1.86	3.19

Note:
- *The above costs do not include power supply or level crossing works*
- *The costs will need to be reappraised again at the end of GRIP 2*

Present Values (PVs) are in 2010 market prices and are discounted to 2010 using Social Time Preference Rates.

C2 West Anglia Main Line - Train Lengthening

Table 8.6 Option 12: Train lengthening to provide capacity West Anglia Main Line		
Conditional Output.	WACO1	To provide sufficient capacity for passengers travelling into central London and other employment centres during peak hours, taking into account anticipated growth over the period to 2024 – West Anglia services.
Timeframe	Sufficient capacity to end of CP6 and also providing for 2043 capacity gap	
Objectives/purpose	To provide sufficient peak capacity on the West Anglia Main Line to London Liverpool Street.	
Description	Lengthening two Cambridge / Stansted to Liverpool Street services in the AM high peak hour and corresponding high peak PM trains.	
Infrastructure requirement	None	
Operational requirement	One way of meeting the capacity requirements is to lengthen trains as follows: • The procurement of two additional 4-car units lengthening peak Stansted Airport and Cambridge to London Liverpool Street services from 8-car to 12-car.	
Passenger impact	This would provide an additional 8 vehicle arrivals in the peak hour to London Liverpool Street by the end of CP6	
Freight impact	NA	
Relates to other options	NA	
Socio-economic Value for money categorisation	Low	
Rail Industry financial categorisation	Increases operating subsidies	
Note	None	

Table 8.7 Option 12: Financial and socio-economic categorisation

Rail industry financial impact (Categorisation of Revenue, Operating costs & Capital costs over appraisal period)			Socio-economic impact (WebTAG VfM category, see summary TEE table for further details)
Scheme increases operating subsidies (i.e. R – O < 0)		✓	Low
Scheme decreases operating subsidies (i.e. R – O > 0)	Low capital cost coverage (i.e. (R – O) / C <33%)	N/A	
	Medium capital cost coverage (33-66%)	N/A	
	High capital cost coverage (66-100%)	N/A	
	Positive financial case (> 100%)		

Table 8.8 Option 12b Lengthening of Stansted and Cambridge services (30 year appraisal) Appraisal Results

Results of socio-economic appraisal	Option S1 £m (2010 PV)
Benefits	
Rail user benefits	15.8
Non user benefits	3.0
Rail user and non user disruption disbenefits	0.0
Indirect taxation impact	-1.4
Total quantified benefits	**17.4**
Costs	
Investment costs	0.00
Non user benefits - road infrastructure cost changes	22.27
Revenue	-6.7
Operating costs	0.00
Total costs	15.5
Net Present Value (NPV)	1.9
Benefit Cost Ratio (BCR)	1.1
Present Values (PVs) are in 2010 market prices and are discounted to 2010 using Social Time Preference Rates.	

C3 Essex Thameside - Train Lengthening

Table 8.9 Essex Thameside capacity options: Train lengthening to provide capacity to meet forecast demand to 2023 on the Essex Thameside route		
Conditional Output.	ETCO1	To provide sufficient capacity for passengers travelling across London during peak hours, taking into account anticipated growth To provide sufficient capacity for passengers travelling into central London during peak hours, taking into account anticipated growth over the period to 2023 – Essex Thameside.
Timeframe	Sufficient capacity to end of CP6	
Objectives/purpose	To provide sufficient peak capacity on the Essex Thameside route to London Liverpool Street.	
Description	An additional six 4-car units on the outer services (option 1) and an additional two 4-car units on the inner services in the high peak hour (08:00 - 08:59). These are assumed to alleviate crowding in the afternoon peak also.	
Infrastructure requirement	All platforms affected by changes are already 12–car in length. In order to meet the capacity requirements, passenger circulation at London Fenchurch Street is a growing concern, and options should be considered to provide more capacity for passengers using the station in peak times. The cost of this intervention has not been included in the appraisal, an estimate of the necessary infrastructure has not yet been completed.	
Operational requirement	One way of meeting the capacity requirements is to lengthen trains as follows: • An assessment of the operational case for delivering extra capacity has been completed. Lengthening of six trains by four carriages is required to deliver the required capacity in the peak into London Fenchurch Street on the outer services, three arriving between 07:00 and 07:59 and three arriving between 08:00 and 08:59. • Lengthening of two trains by four carriages is also required to provide the required capacity by the end of CP6 on the inner services into London Fenchurch street.	
Passenger impact	This would provide approximately an additional 32 vehicle arrivals in the peak hour to London Fenchurch Street by the end of CP6, meeting the required passenger capacity for CP6 (conditional output ETCO1).	
Freight impact	NA	
Relates to other options	NA	
Socio-economic Value for money categorisation	Medium / High	
Rail Industry financial categorisation	Increases operating subsidies	
Note	None	

Table 8.10 Essex Thameside capacity options: Train lengthening to provide capacity to meet forecast demand to 2023 on the Essex Thameside route

Rail industry financial impact (Categorisation of Revenue, Operating costs & Capital costs over appraisal period)			Socio-economic impact (WebTAG VfM category, see summary TEE table for further details)
Scheme increases operating subsidies (i.e. R – O < 0)		✓	Medium / High
Scheme decreases operating subsidies (i.e. R – O > 0)	Low capital cost coverage (i.e. (R – O) / C <33%)	N/A	
	Medium capital cost coverage (33-66%)	N/A	
	High capital cost coverage (66-100%)	N/A	
	Positive financial case (> 100%)		

Table 8.11 Essex Thameside capacity options

Option 1: Lengthening the Outer services

Results of socio-economic appraisal	Option 1 £m (2010 PV)
Benefits	
Rail user benefits	87.74
Non user benefits	19.57
Rail user and non user disruption disbenefits	0.00
Indirect taxation impact	-16.55
Total quantified benefits	**90.76**
Costs	
Investment costs	0.00
Non user benefits - road infrastructure cost changes	-0.07
Revenue	-43.53
Operating costs	75.17
Total costs	31.56
Net Present Value (NPV)	59.20
Benefit Cost Ratio (BCR)	2.88
Present Values (PVs) are in 2010 market prices and are discounted to 2010 using Social Time Preference Rates.	

Table 8.12 Essex Thameside capacity options

Option 2: Lengthening the Inner services

Results of socio-economic appraisal	Option 2 £m (2010 PV)
Benefits	
Rail user benefits	17.07
Non user benefits	2.85
Rail user and non user disruption disbenefits	0.00
Indirect taxation impact	-2.41
Total quantified benefits	**17.51**
Costs	
Investment costs	0.00
Non user benefits - road infrastructure cost changes	-0.01
Revenue	-6.33
Operating costs	16.75
Total costs	10.41
Net Present Value (NPV)	7.10
Benefit Cost Ratio (BCR)	1.68
Present Values (PVs) are in 2010 market prices and are discounted to 2010 using Social Time Preference Rates.	

Appendix D: Anglia WRCCA Action Plan

D1 Anglia Weather Resilience and Climate Change Adaptation Plan (WRCCA)

Network-wide weather and climate change resilience will be driven predominately by Network Rail's Central functions through revision to asset policies and design standards, technology adoption and root cause analysis. The location specific nature of weather impacts will require analysis and response at Route level.

Figures 9.1 to 9.3 provide a concise summary of required Anglia Route actions beyond Business as Usual (BAU), and potential additional actions for consideration (which will require business case evaluation and funding) to increase weather and climate change resilience.

Figure 9.1 Anglia WRRCA identified required actions beyond BAU, September 2014

Vulnerability	Action to be taken
All Impacts	
Climatic conditions and specific weather-related risks to asset renewal and enhancement processes	Include clear requirements for climatic conditions and resilience levels in Route Requirements Documents
Climatic conditions and specific weather-related risks to assets	Review adverse Weather Plans
Flooding	
Level of engagement with flood risk management authorities to support effective discussions	Strengthen relationship with EA through setting up of a Local Liaison Group on flood risk management to share information and resolve issues (e.g. Cattawade Creek).
Bridge foundation scour and surcharging	Increase scour and surcharge resistance of most urgent bridge sites (e.g. River Gipping at Blakenham and Worlingham)
Early identification of flood sites	Install remotely monitored cameras (e.g. Oulton Broad), trash screen monitors (e.g. Johnsons Crossing) and automated pumps (e.g. Gunnersbury).
Surface water run-off flooding	Review of interventions at high-risk and known flooding sites including highway level crossings and pumping station (e.g. Bishops Stortford and Pitsea LC)
Ineffective drainage systems	Effectively manage drainage maintenance interventions
Earthworks	
Embankment instability during adverse weather	CP5 earthworks renewal intervention at critical earthworks sites (e.g. Marsh Farm and Gilsingham)
Embankment instability during adverse weather	Accelerate delivery of other Schedule 8 problem sites and sites showing significantly elevated rates of movement (e.g. Playford Hall and Chitts Hill)
Embankment instability during adverse weather	Programmed business plan earthworks refurbishment and maintenance interventions
Early and continuous warning of unstable embankments	Remote monitoring of vulnerable sites using cameras, movement markers/wires and remote inclinometers (e.g. Tostock)
Near surface slope instability and loss of track support	Review requirements for increased cess support systems (e.g. Hill Farm)

Vulnerability	Action to be taken
High temperatures	
Track buckling in hot weather	Review current adverse weather plans and CRT database including reviews of remote rail temperature monitoring and further white painting of rails.
Loss of OLE wire tension	Remove fixed tension OLE systems
Signal cabinet overheating	Accelerate completion of cabinet ventilation installations
Poor environmental conditions in buildings	Develop building ventilation programme
Coastal and estuarine	
Level of engagement with flood risk management authorities to support effective discussions	Engage with existing Local flood resilience forums (e.g. Lowestoft flood alleviation group)
Flood, scour and washout risks to assets	Development of Coastal Estuarine Management Plans (CERD)
Wind	
Trees falling on to track, OLE and associated assets	Review vegetation management plans including management of third-party trees
Trees falling on to track, OLE and associated assets	Commence programme of third-party tree removal
Trees falling on to track, OLE and associated assets	Increase frequency of lineside vegetation management
Loss of OLE wires	Accelerate programme of OLE wind blow-off resistance
Cold and Snow	
Line blockages	Review weather preparedness plans
Frozen Points	Accelerate delivery of points heating and thermal insulation of points
Frozen Points	Assess capacity of de-icing trains and benefits of increased number of them
Shorting of OLE wires	Review of drainage of structures affected by icicles
Frozen Points	Staff deployment strategy for points at Liverpool Street throat area
Loss of service due to blockages or frozen points	Review weather preparedness plans including assessing third rail heating benefits

Figure 9.2 Anglia WRRCA identified required actions beyond BAU, September 2014(continued)

Vulnerability	Action to be taken
Adhesion	
Loss of adhesion due to crushed leaf falls	Remote monitoring and intelligent infrastructure systems to cover high-risk historic leaf fall sites
Loss of adhesion due to crushed leaf falls	Review weather preparedness plans, vegetation management plans and leaf fall register
Trees leaf falls on to track	Continue programme of third-party tree removal
Tree leaf falls on to track	Maintain frequency of lineside vegetation management
Lightning	
Loss of electrical systems for signals	Accelerate delivery of lightning surge protection
Loss of electrical systems for OLE and signals	Review current weather procedure
Loss of electrical systems for OLE and signals	Review benefits of lightning array protection of sensitive locations
Fog	
Delays resulting from poor visibility	No action to be taken – business as usual as no fog increase expected and no clear mitigation.

Figure 9.3 Anglia WRRCA additional actions for consideration, September 2014

Potential additional WRCCA actions requiring further evaluation

Vulnerability	Action to be evaluated
All Impacts	
Climatic conditions and specific weather-related risks to asset renewal and enhancement processes	Monitor climate change trends and intervention innovations
Flooding	
Bridge foundation scour and surcharging	Increase scour and surcharge resistance of remaining vulnerable bridge sites
Early identification of flooding sites	Install additional remotely monitored cameras
Surface water run-off flooding	Review of interventions at high-risk and known flooding sites including highway level crossings
Earthworks	
Embankment instability during adverse weather	Design development and earthworks renewal intervention at Wrabness
Embankment instability during adverse weather	Additional critical earthworks renewal interventions
Embankment instability during adverse weather	Additional earthworks refurbishment and maintenance interventions
Early and continuous warning of unstable embankments	Remote monitoring of vulnerable sites using cameras, movement markers/wires and remote inclinometers (e.g. Wrabness)
High temperatures	
Loss of track support due to rail tension	Identify sites where cess support, shoulder ballast restoration, replacement of lightweight sleepers or plate support systems would be beneficial for CRT management
CRT speed restrictions	Additional monitoring stations to record more accurate temperatures
Inability to open or close swing bridges	Review alternative measures to improve the heat resilience of swing bridges
Coastal and estuarine	
Loss of support due to scour at the toe of embankment	Increased embankment resilience/scour protection at Cattawade Creek and Harwich
Earthworks washouts during storm surges	Increase washout resilience at storm surge sites at Oulton Broad
Earthworks washouts during storm surges	Reduce washout channelling by raising Haddiscoe sheet piles adjacent to New Cut canal on the Norfolk Broads

Vulnerability	Action to be evaluated
Wind	
Trees falling on to track, OLE and associated assets	Increase frequency of lineside vegetation management
Trees falling on to track, OLE and associated assets	Continue programme of third-party tree removal
Cold and Snow	
Line blockages	Review need for increased MPV capacity
Adhesion	
Loss of adhesion due to crushed leaf falls	Review need for additional RHTT capacity
Loss of adhesion due to crushed leaf falls	Remote monitoring and intelligent infrastructure systems to cover additional leaf fall sites

Glossary

Term	Meaning
AC	Alternating Current, specifically for 25 kV Overhead Line Equipment.
AfA	Access for All
ATO	Automatic Train Operation
BAU	Business as Usual
BCR	Benefit to Cost Ratio, a measure of the value for money presented by an option.
car	train carriage
CIS	Customer Information System
Class 4	A classification of freight train timetabled to operate at up to 75mph, typically carrying intermodal containers or automotive traffic.
Class 6	A classification of freight train timetabled to operate at up to 60mph, typically heavier than a Class 4 train owing to the goods carried such as aggregates.
Control Period 4 (CP4)	Network Rail is funded in five yearly periods. Control Period 4 is the funding period between 2009 – 2014.
Control Period 5 (CP5)	Network Rail is funded in five yearly periods. Control Period 5 is the funding period between 2014 – 2019.
Control Period 6 (CP6)	Network Rail is funded in five yearly periods. Control Period 6 is the funding period between 2019 – 2024.
Control Period 7 (CP7)	Network Rail is funded in five yearly periods. Control Period 7 is the funding period between 2024 – 2029.
Control Period 8 (CP8)	Network Rail is funded in five yearly periods. Control Period 7 is the funding period between 2029 – 2034.
Control Period 9 (CP9)	Network Rail is funded in five yearly periods. Control Period 7 is the funding period between 2034 – 2039.
Control Period 10 (CP10)	Network Rail is funded in five yearly periods. Control Period 7 is the funding period between 2039 – 2044.
Crowding standards	The level of on-train crowding for planning purposes, above which triggers the need for measures to provide extra capacity. The standards used in the Route Study typically reflect funder's aspiration to provide a seat for all but the shortest of journeys (where a short journey is typically defined as less than 20 minutes). For short journeys it is assumed that standing is acceptable, within guidelines specified by funders.
DC	Direct Current, specifically 750 volt third rail.
DfT	Department for Transport, a Government department.
Digital Railway	Digital Railway is a rail industry-wide programme designed to benefit Great Britain's economy by accelerating the digital-enablement of the railway.
DLR	Docklands Light Railway
DMU	Diesel Multiple Unit
Dynamic Loop	A passing loop that allows two trains to pass without stopping.
ECS	Empty Coaching Stock

Term	Meaning
EMU	Electric Multiple Unit
ERTMS	European Rail Traffic Management System - a system for managing train movements using ETCS to signal trains and GSMR to communicate with trains.
ETCS	European Train Control System - a new signalling control and train protection system.
FOC	Freight Operating Company
F2N	Felixstowe to North freight route; previously known as Felixstowe to Nuneaton
Gauge	Key dimensions of the railway which define the size of trains which can be accommodated. Track gauge is the distance between rails. Loading gauge is the width, height and shape of the trains which can be accommodated.
GE / GEML	Great Eastern / Great Eastern Main Line
Generalised Journey Time	A measure of the passenger rail service offer that takes account of in-vehicle time, service frequency and interchange penalty.
GOB	Gospel Oak to Barking line
Grade Separation	Infrastructure which allows trains to pass over or under another route to avoid the timetable conflicts which would otherwise occur.
GRIP	Governance for Railway Investment Projects, a Network Rail standard for project managing changes to the infrastructure.
GSM-R	Global Systems for Mobile Communications - Railway
HLOS	High Level Output Specification, the Government's statement of what it wishes to buy from the industry over a Control Period.
HOBC	High Output Ballast Cleaner
HS1	High Speed 1
HS2	High Speed 2 - the planned high speed railway between London and Birmingham in Phase 1, and beyond to Manchester and Leeds in Phase 2.
IIP	Initial Industry Plan, a plan to examine the key choices and options facing funders in specifying the future outputs of the railway and the level of funding required.
Interoperability	A European initiative enabling the railway to compete more effectively with other forms of transport, particularly road transport, by harmonising rail capabilities across Europe.
ITSS	Indicative Timetable Service Specification
Jn	Junction
kV	kiloVolts

Term	Meaning
LA	Local Authority
LDHS	Long Distance High Speed trains
LEP	Local Enterprise Partnership
LOCIP	London Overground Capacity Improvement Programme
LTPP	Long Term Planning Process, the programme of Market and Route Studies which together define the capacity and capability required of the Great Britain railway network over a 30-year time horizon.
LU / LUL	London Underground / London Underground Limited
Market Study	One of four studies undertaken at the beginning of the Long Term Planning Process, to forecast demand and to articulate Conditional Outputs for the markets, namely London and South East, Long Distance, Regional Urban and Freight.
MP	Member of Parliament
mppa	Million passengers per annum
NLL	North London Line
OB	Optimism Bias
OHL / OLE	Overhead Lines / Overhead Line Electrification
ORR	Office of Rail and Road (previously Office of Rail Regulation)
Peak period	The busiest hours of the day for passenger train loading, often defined as 7:00 to 09:59 and 16:00 to 18:59, at a particular location, for example London Liverpool Street station.
Planning headways	The minimum time which can be used within a timetable for one train to follow another. This is determined by the signalling system, signal spacing, line speed and train braking characteristics.
PPM	Public Performance Measure, a metric of the proportion of trains which arrive within a defined time window starting at the scheduled arrival time.
Programme Board	A body formed to steer development and approve publication of the Route Study composed of senior representatives from Network Rail, passenger and freight train operating companies, Department for Transport and Transport for London.
PSED	Public Sector Equality Duty. This is a duty on public authorities to consider or think about how their policies or decisions affect people who are protected under the Equality Act 2010.
PV	Present Value
RDG	Rail Delivery Group, a cross-industry body which exists to promote greater co-operation between train operators and Network Rail through leadership in the industry and by working together with Government, the supply chain and stakeholders.
Regional Working Group	A stakeholder group formed of representatives of local authorities with transport responsibilities plus ports, airports and freight end-users.

Term	Meaning
RfL	Rail for London (part of TfL - see below)
ROC	Rail Operating Centre
STAR	Stratford to Angel Road scheme
TEE Table	Table summarising the economic efficiency of the transport system for the options appraised.
TEN-T	Trans-European Network – Transport, a strategy to develop a trans-European network in the transport sector, adopted by the European Parliament and the Council in 1996, to establish a 'master plan' connecting national networks of all transport modes.
TfL	Transport for London
Third rail	A system to transfer electric power to trains using an additional (i.e. third) rail running alongside the rails used to carry and guide the trains.
TOC	Train Operating Company
tpd	trains per day
tph	trains per hour
Traffic Management	A system to assist signallers to regulate train services by automating certain functions and providing advice to signallers where there is a decision which requires their input. See also ERTMS.
TRS	Track Relaying System
TSI	Technical Specification for Interoperability
W10	A loading gauge which allows 9' 6" high containers to be conveyed on conventional railway wagons.
W12	A loading gauge which allows a 9'6 high container to be carried on a standard container wagon, including refrigerated containers up to 2,600mm wide; this is the recommended loading gauge for renewed structures.
WA / WAML	West Anglia / West Anglia Main Line
WebTAG	Transport Appraisal Guidance (online version). A document produced by Government to define how the value for money of publicly-funded transport projects should be assessed.
WLL	West London Line
WRCCA	Weather Resilience and Climate Change Adaptation Plan
WTT	Working Timetable

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