

# Executive Summary

## Introduction

*The Network Licence requires that Network Rail publish and maintain Route Utilisation Strategies (RUSs), which establish the most efficient ways to use and, where appropriate, to increase network capacity in order to deal with forecast changes in demand. The London and South East RUS represents the latest such thinking for routes into and around the capital, together with other parts of South East England.*

Network Rail published this RUS on its website as a Draft for Consultation in December 2010. This was followed by a 90 day consultation period, during which stakeholder briefings were held and written responses sought from interested parties to the RUS. The many submissions received during this period have now been published on Network Rail's website.

The RUS has involved close working between Network Rail and its industry stakeholders, but the analysis it is based upon and specific content is the responsibility of Network Rail. Since publication of the Draft for Consultation, Network Rail has undertaken further analysis and this, together with feedback received during the consultation and other developments such as the McNulty 'Value for Money' study, has influenced this final strategy.

The recommendations contained in this RUS are designed as a starting point to inform future infrastructure or train service planning, and where necessary, further analysis. Whilst the strategy is an advisory document, and its recommendations are non-binding on future decision makers, Network Rail believes the RUS represents a robust future plan for railway development on this part of the network.

## Scope and planning context

This London and South East RUS builds upon a number of the earlier established RUSs previously produced by Network Rail, which covered most of the area within its remit. This RUS extends the strategy as follows:

- it looks at all corridors into London at the same time and in a consistent way to 2031, so results are now directly comparable between routes and, in many cases, have a longer timescale
- it considers current economic conditions which, despite a strong recovery in passenger growth in the last 18-24 months, result in differing demand forecasts from earlier RUSs on certain routes and affect affordability in the medium term
- it recognises that many infrastructure projects recommended by previous RUSs – for example the Crossrail and Thameslink Programmes, extra capacity at critical locations such as Reading, Gatwick and Hitchin, a major programme of platform lengthening and freight gauge and capacity enhancements – are now under construction or committed. However, it restates most of the previous recommendations which are not yet committed, since these are still valid
- it includes the proposed development of a High Speed Rail network from London to the West Midlands and beyond as a fundamental part of its strategy. This will provide a major increase in north – south capacity between key cities, whilst freeing up space on the West Coast Main Line (WCML) for improved commuter services to areas such as Milton Keynes, and for a continued shift of freight from road to rail
- it considers, at a strategic level, the impacts of rail expansion on the capacity of other elements of the transport system. This particularly has involved working closely with Transport for London (TfL) to develop synergies with schemes which have potential to alleviate crowding problems on the London Underground system
- it fills in some previous gaps in geographic RUS coverage, principally affecting the South Hampshire and Solent area.

### *RUS baseline – committed schemes*

The baseline for the RUS includes committed infrastructure schemes (as defined in Network Rail's Control Period 4 (CP4) Delivery Plan, together with subsequent announcements by Government) and committed service changes (as defined in franchise agreements between the Department for Transport (DfT) and the train operating companies). Construction of many of these schemes has now commenced.

Key investments in this category include the Crossrail, and Thameslink Programmes, Reading remodelling, electrification of the Great Western Main Line (GWML), the Intercity Express Programme, the Evergreen 3 project on the Chiltern Line, a major programme of train and platform lengthening in many parts of the capital, conversion of the former Waterloo International terminal for use by domestic services and several freight schemes (for example initial elements of the Felixstowe to Nuneaton freight upgrade). For all these projects the RUS analysis has used the latest position with respect to future timetables to inform analysis of the effect on travel patterns and associated train loadings.

It is recognised that there is some uncertainty with respect to some elements of committed schemes, principally relating to precise details of the deployment of new and cascaded rolling stock following Thameslink, Crossrail and electrification schemes. The RUS has made assumptions in this area which will be kept under review as the position becomes clearer.

### *Other existing strategy*

In considering its strategy the RUS draws heavily on the interventions considered by earlier established

RUSs, with those recommendations still at present remaining uncommitted normally being carried forward into this RUS.

Elements of existing capacity strategy carried forward include additional rolling stock to enable further train lengthening on many routes and, in a few cases, additional peak trains. Infrastructure schemes in this category include further platform extensions, enhancements aimed at resolving key operational constraints and further electrification of the network.

Construction of High Speed 2 (HS2) is also considered in this category, as the only realistically viable means of alleviating north – south capacity constraints. Comments are provided in this RUS regarding its potential interaction with the transport system in London.

### *Forecasts of passenger growth*

The RUS is based upon the following weekday peak growth forecasts to 2031 for each route corridor into and around the Capital. It concentrates primarily on the busiest hour of weekday morning peak arrivals into London since, at a strategic level, if the infrastructure can accommodate morning peak demand then loadings at other times should also be manageable. The forecasts are based upon ongoing schemes and incremental interventions from previous RUSs, and existing fares policy. They are sensitive to any future changes in these issues, since additional capacity through major schemes (for example HS2) or further interventions, including those in this RUS, would stimulate additional demand in their own right, and changes to fares policy could affect demand.



<i>Busiest morning peak hour growth forecasts (committed schemes only)</i>					
Route into	Service group	Passengers on route in busiest morning peak hour			
		2010 total	2031 total	Extra passengers	Growth
London Paddington	Crossrail GW route	n/a	12,800	8,700	211 %
	Relief line trains (excl Crossrail)	4,100			
	Main line + other fast trains	9,000	13,600	4,600	51 %
	Heathrow Express	800	1,300	500	55 %
London Marylebone	All services	6,100	7,800	1,700	28 %
London Euston	Long Distance	3,700	6,500	2,800	76 %
	Suburban	8,100	12,100	4,000	50 %
London St Pancras	High Speed 1 (domestic)	2,500	5,300	2,800	111 %
	Thameslink MML	9,900	14,700	4,800	49 %
	MML Long Distance	2,300	3,800	1,500	68 %
	Thameslink ECML	n/a	13,000	5,100	66 %
London King's Cross	Great Northern	7,900			
	ECML Long Distance	2,000	3,000	1,000	52 %
Moorgate	All services	7,900	8,000	100	1 %
London Liverpool Street	West Anglia	14,300	18,000	3,700	26 %
	Great Eastern Main Line	16,500	24,600	8,100	49 %
	GE Inners	12,900	21,000	8,100	63 %
	Crossrail GE route	n/a			
	Crossrail Abbey Wood route	n/a	11,900	11,900	n/a
London Fenchurch Street	All services	15,300	17,000	1,700	11 %
London Bridge	Charing Cross	26,200	50,900	3,800	8 %
	Cannon Street	20,900			
	Thameslink Kent	n/a			
	Thameslink Sussex	n/a in peak	24,400	11,100	83 %
	Terminating (fast trains via East Croydon)	13,300			
	Terminating (inners)	9,200	11,500	2,300	25 %
London Blackfriars	All services via Elephant & Castle	10,400	11,900	1,500	15 %
London Victoria	Kent routes	10,300	8,700	-1,600	-16 %
	Fast trains via East Croydon	14,200	19,500	5,300	37 %
	Inner Suburban (via Balham)	9,700	10,300	600	6 %
London Waterloo	Windsor Lines (all services)	13,600	17,100	3,500	26 %
	Inner Suburban (via Wimbledon)	22,700	25,500	2,800	13 %
	South West Main Line	14,800	18,300	3,500	24 %
<b>Radial routes totals</b>		<b>288,600</b>	<b>392,500</b>	<b>103,900</b>	<b>36%</b>
Main Orbital routes	West London Line	2,700	5,500	2,800	109 %
	East London Line	4,200	9,800	5,600	132 %
	North London Line	2,700	3,000	300	11 %

Note: Major uncommitted schemes (e.g. HS2) and interventions from this RUS would further increase demand.

### **2031 Commuter peaks to London; gaps and options beyond existing strategy**

The RUS process is built around the identification of 'gaps' (between future supply and demand) and then the identification and assessment of options which bridge these gaps.

On many routes the RUS considers that the combination of funded schemes and non-committed previous strategy will be sufficient to accommodate the increasing demand. However on certain lines this RUS has carried out an update to previous work, seeking to recommend additional options which would accommodate the latest demand forecasts in the most effective manner and consistent with Sir Roy McNulty's findings. Significant further work has taken place since the Draft for Consultation and is presented in this RUS.

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The RUS now identifies schemes which have potential to provide the necessary level of capacity, at a strategic level, on all routes into and around London. In most cases this appears to be achievable by lengthening or running more trains on existing route corridors, with infrastructure enhancements as necessary, for example on the Great Eastern Main Line (GEML). Elsewhere, as outlined in the Draft for Consultation, the capacity gap on the GWML via Reading appears resolvable, but this is only realistically possible by making changes to currently planned Crossrail and existing Heathrow Express operations, for which an economic appraisal has not at present been undertaken.

On a small number of key corridors more expensive options such as major infrastructure upgrades or new routes appear to be needed if predicted peak demand is to be fully accommodated. This principally relates to the WCML, the capacity constraints on which (for both commuter and longer distance services) can only realistically be

addressed through the construction of High Speed 2 (HS2). However, the South West Main Line (SWML) also represents a major long term challenge, with an extra track from Surbiton inwards providing a potential eventual solution. The alternative, would be to utilise pricing policy and smartcard ticketing technology to manage demand at the busiest times, or to plan for standing over longer distances than is currently considered desirable.

The capacity strategy to 2031 for the main routes in and around the capital is summarised below.

#### **Great Western Main Line capacity**

The forecast capacity gap in 2031 in the busiest peak hour is some 5,800 people, even allowing for implementation of the Intercity Express Programme (IEP), which only provides sufficient peak capacity for growth up to 2019. The anticipated shortfall is on a combination of outer suburban and long distance services from Reading and the outer Thames Valley, with no capacity gap forecast on the inner stopping services (given the planned introduction of Crossrail services to Maidenhead in 2018). In coming to this conclusion the impact of committed schemes including Reading remodelling, the impact of electrification, IEP and the influx of other new vehicles has been included in the analysis.

In identifying a gap of this magnitude the RUS notes, crucially, that the existing IEP strategy for the GWML does not include any additional high-peak trains into London Paddington, though it does provide extra peak capacity through longer trains with more seating. The lack of extra peak services is due to existing capacity constraints associated with London Paddington station and its approaches, and due to the main lines having no spare capacity at present between Ladbroke Grove and Airport Junction (where the line to Heathrow Airport diverges from the main line). The expectation following the implementation of IEP is therefore that the current 15 main line timetable slots in the busiest hour will be replaced by nine IEP trains on long distance services, five outer suburban eight-car Electric Multiple Units (EMUs) and one retained High Speed Train running from the West of England.

The RUS therefore seeks to provide additional capacity in the peak from Reading and the outer Thames Valley in response to the gap. The options

in the Draft for Consultation attracted significant interest from stakeholders and the updated analysis of this RUS is now presented in the table below:

<i>Peak capacity options for Thames Valley commuters</i>		
<b>Option A1</b>	Extend services beyond the committed Crossrail terminus of Maidenhead to Reading.	<p>This option is recommended for implementation in 2018. This is primarily due to capital cost savings in infrastructure which would otherwise be required, mainly at Maidenhead. It would also provide passenger benefits and improve train performance on the route.</p> <p>Further assessment is required but in the short term a peak 10tph Crossrail stopping service west of Paddington is potentially sufficient, rising to 12tph in the longer term (by extending trains otherwise planned to terminate in the sidings at Westbourne Park).</p> <p>However, this alone would do little to resolve the outer Thames Valley capacity gap, since journey times from Reading via the relief lines would be significantly longer than on main line services.</p>
<b>Option A2</b>	Increase peak main line service via Reading from 15tph to 16tph following IEP.	<p>This option does not require additional infrastructure and the RUS assumes that it would be implemented at some stage following IEP before other interventions are required. This would result in 6 peak outer suburban 8-car EMUs, in addition to the 10 long distance services.</p> <p>However this option would not be sufficient to resolve the 2031 gap in isolation.</p>
<b>Option A3</b>	Lengthening of Thames Valley outer suburban EMUs to 12-car.	<p>This option would involve lengthening from 8-car to 12-car of EMUs operating peak outer suburban services on the Oxford &amp; Newbury routes to London Paddington.</p> <p>The RUS assumes that this option will need to be progressively implemented following IEP, with at least 4 of the 6 outer suburban EMUs resulting from <b>Option A2</b> progressively lengthened to 12-car.</p> <p>However this option would not be sufficient to resolve the 2031 gap in isolation.</p>
<b>Option A4</b>	Major infrastructure upgrade between London Paddington and Airport Junction to enable peak additional trains.	<p>This option requires two additional tracks between Ladbroke Grove and Airport Junction and two additional long platforms at London Paddington.</p> <p>Such an approach would be extremely complex and expensive, requiring the use of land outside the current railway boundary in a heavily built-up area.</p> <p>This option has not therefore been considered in detail by the RUS since <b>Option A5</b> below provides a similar level of capacity and passenger benefits without requiring additional infrastructure.</p>
<b>Option A5</b>	<p>New GWML peak service structure based on:</p> <ul style="list-style-type: none"> <li>• 20tph main line (9 IEP, 1 HST, 6 outer suburban EMUs from Oxford/Newbury as planned, plus 4 new outer suburban shuttles between Reading or beyond and London Paddington)</li> <li>• 16tph relief lines (including 10tph to Heathrow Airport).</li> </ul>	<p>This option is the only realistically viable means of fully responding to the peak capacity gap. It is therefore likely to be required within the RUS timescale, providing four extra fast trains per peak hour from Reading or beyond to London in the current Heathrow Express paths.</p> <p>The emerging service for Heathrow Airport, developed in response to feedback received during the consultation, is for 10 Crossrail trains per hour. The journey, based on a skip-stop pattern in the peaks, would be longer than on the existing Heathrow Express, but the trains would be significantly more frequent and would operate through central London, rather than just to London Paddington.</p> <p>This package of service changes has potential to provide major improvements to the GWML. Further development is required, especially in connection with avoiding any reduction to the rail modal share, and passenger experience, to and from Heathrow Airport.</p>



The immediate emphasis is on implementation of Crossrail and IEP, with the latter requiring infrastructure work at London Paddington to provide enough platforms of sufficient length for the new trains. Extending relief line trains beyond Maidenhead to Reading is also recommended as a priority for 2018, to avoid incurring large capital costs associated with new infrastructure for turnback facilities in the Maidenhead area, and also involving an alternative scheme at Slough. This would save capital costs in the order of £31 million, as long as a decision is made within the next few months.

Beyond this the priority for the GWML will be provision of additional capacity from the Reading area to London at peak times. Implementation of **Option A2** and **Option A3** will be a priority beyond 2019, enabling the maximum possible capacity to be provided within the existing structure of services. However these are relatively small scale and if no further interventions were implemented then large numbers of standing passengers from Reading would become a significant problem in the latter years of the RUS timescale. In considering this issue **Option A4** would be extremely expensive and disruptive and is not considered further given that **Option A5** appears likely to be a more cost effective alternative.

Implementation of **Option A5**, which requires more detailed consideration, would broadly address the forecast capacity gap from the Reading area, enabling four extra fast main line trains in the busiest peak hours into London Paddington in response to Thames Valley commuter growth. There remains a variety of sub-options with regard to the origin point (potentially including Basingstoke as described under **Option F6**) and stopping patterns for such services, but the overall concept would be a 20 trains per hour peak main line service from Reading inwards (four trains per hour of which would call at a combination of Slough, Twyford and Maidenhead, with the remainder running fast).

With respect to Heathrow Airport services the emerging position is that providing a 10 trains per hour Crossrail route service from central London would provide an overall improvement in connectivity relative to committed schemes only, and is likely to become necessary by the mid 2020s to facilitate the additional peak Thames Valley services described above. At peak times the airport services would need to operate on the relief lines with increased journey times from London Paddington station itself (compared to the current Heathrow Express), but the additional Crossrail services would more than double the planned frequency and avoid passengers needing to choose between Heathrow Express and Crossrail on arrival at Paddington station. This would therefore involve 16 trains per

hour at peak times from the Great Western route into the new central London tunnel, compared to 10 trains per hour under current plans. This would fully utilise all relief line capacity at peak times, so freight operations would need to be outside the high peak hours.

Linked to the above the RUS emphasises the desirability of extending Heathrow services westwards to improve connectivity, as described later. Beyond Terminal 5 a potential split towards the end of the RUS period could be four trains per hour to Reading (via Slough) and four trains per hour to Staines. Each of these requires the construction of new sections of railway and further work on the business case is recommended.

In the longer term the RUS notes ongoing development regarding how best to both construct and serve the proposed HS2 station on the GWML at Old Oak Common. This includes consideration of whether GWML long distance trains should call, the possibility of a Crossrail extension via Watford Junction, and local connections to routes in the area. Network Rail is closely working with the HS2 Ltd. project team to resolve the relevant issues in this area. There is also proposed to be a high speed rail station at Heathrow Airport at a later date, as part of the extension of the High Speed Rail network to Manchester and Leeds.

### ***Marylebone routes capacity***

As outlined in the West Midlands and Chilterns RUS the committed Evergreen 3 project will provide route-wide service improvements; increasing frequencies, reducing journey times and providing a new London Marylebone to Oxford service.

As a result of demand growth, part of which will come from the planned service improvements, there is likely to be a need for further interventions such as train lengthening or timetable changes beyond completion of the Evergreen 3 project. These would not require infrastructure enhancements so the RUS process has not identified a need to make more specific recommendations at the present time.

### ***West Coast Main Line capacity***

In the absence of the proposed High Speed Rail network, this RUS would forecast a significant capacity gap in 2031 on the WCML. The key issue affecting the London commuter market would be a significant shortfall in capacity in the morning peak on outer suburban services into London Euston. Optimisation of service patterns and capacity within the existing constraints on the route will be necessary over the coming years, but this approach alone will be insufficient to keep up with growing demand.

Consistent with proposed Government policy this RUS therefore assumes that construction of a new High Speed Rail network will go ahead, not only resolving the peak capacity gap (with which this RUS is mainly concerned) but also relieving capacity constraints on long distance services, improving journey times and creating capacity for additional services on the existing network.

**Option K1**, as described later, would provide new journey opportunities between the WCML and both Central London and Heathrow Airport and, in addition, may help to address London Underground system capacity at London Euston. Further development is recommended.

#### **Midland Main Line capacity**

On this route the Thameslink Programme will provide a large amount of extra capacity, enabling most peak outer suburban services to be lengthened from eight-car to 12-car formations. Beyond this the principal future crowding concern to London is forecast to relate to commuters on longer distance trains, with a forecast gap in 2031 of some 1,400 seats in the busiest peak hour.

Consistent with the recommendations of the Network RUS: Electrification Strategy and the East Midlands RUS the recommended approach to reduce this gap and provide significant other benefits will be to replace the existing High Speed Train fleet used on the Midland Main Line (MML) with higher capacity IEP trains or similar, following on from High Speed Train replacement on the GWML and East Coast Main Line (ECML).

In the longer term there would be significant transfer of north – south demand from the MML to the North East leg of the proposed High Speed Rail network, assuming the construction of new

stations to serve the East Midlands and Sheffield conurbations. This would therefore fully resolve the capacity gap on the MML.

#### **East Coast Main Line capacity**

Long distance timetables have recently been substantially improved through the East Coast May 2011 timetable and, in the longer term, further opportunities will arise as a result of the major infrastructure enhancements planned at several locations along the route. The strategy for service improvements outlined in the East Coast Main Line 2016 Capacity Review is now established and optimises use of the ECML in the medium term.

However, existing strategy alone results in a forecast capacity gap of 1,500 seats in the busiest morning peak hour by 2031 on outer suburban services. Whilst this could be reduced marginally with tactical level interventions it is most readily addressable by High Speed Rail, which would shift long distance demand from the ECML to the new route. Passengers travelling to London from Leeds, Newcastle and Scotland would see additional capacity and significant journey time reductions via the new line, which would in turn, free up capacity at the southern end of the ECML for outer suburban commuters, as well as for freight.

The rolling stock strategy for the ECML is based on the planned implementation of IEP as a replacement for existing High Speed Trains and also the Class 365 EMUs currently used on fast Cambridge services. However, the existing Class 91/Mark IV sets will continue to be used on the majority of East Coast long distance high speed services for several years. In the medium term, replacement of these trains would enable a significant increase in seating capacity within the existing 11 vehicles overall length, or possibly more if longer trains were introduced at



the same time. The RUS therefore notes that future replacement of this train fleet will provide the principal opportunity for extra capacity on the key long distance flows in advance of High Speed Rail.

Closer to London the Thameslink Programme will alleviate suburban capacity constraints and improve connectivity on Great Northern routes by enabling many services to continue through the Thameslink tunnels rather than needing to terminate at London King's Cross. However, very limited additional peak trains relative to today are likely to be able to run through the critical Welwyn viaduct area, so outer suburban additional capacity from the Cambridge and Peterborough routes will be mostly restricted to that gained by running as many trains as possible at 12-car length, as recommended by the East Coast Main Line RUS.

Inner suburban services are anticipated to benefit from frequency increments following a combination of the Thameslink Programme and committed infrastructure enhancements in the Finsbury Park to Alexandra Palace area. During the consultation stakeholders have emphasised the need for the frequency increases on the Hertford Loop in particular, and a four trains per hour off-peak service is anticipated by the RUS on this route. On Moorgate routes in general the possible replacement of the Class 313 fleet has potential to provide some additional capacity, with an overall service increase to Moorgate towards the late 2020s implemented through new signalling technologies. In the shorter term direct Thameslink trains from the Potters Bar corridor to Farringdon/City Thameslink can be expected to alleviate crowding on the Moorgate branch.

### **West Anglia capacity**

Several elements of the previous strategy for this route have now been reconsidered, given Government spending constraints in the short term and the Lea Valley four-tracking scheme (recommended by the 2007 Greater Anglia RUS) having being heavily influenced by previous plans for the major expansion of Stansted Airport. This four-tracking concept remains a stakeholder aspiration for this route, but the full scheme does not have a value for money business case at present. The RUS has therefore investigated whether smaller scale schemes could deliver as many of the original aims as possible, but at lower cost and in a shorter term timescale than would otherwise be practical.

As with the Greater Anglia RUS, the capacity strategy for the West Anglia main line is heavily reliant on progressively implementing 12-car operations on all services running fast via the Lea Valley. As a result the small number of stations on the Cambridge line not having platforms lengthened in CP4 will need to be served by longer trains at some stage, possibly with Selective Door Operation. Beyond this running as many peak trains to London Liverpool Street as practical using existing infrastructure is a priority, and a new option has

now been identified which would divert Hertford East line services fast via Seven Sisters, enabling two additional services per hour on the West Anglia corridor overall and improvements to many journey times.

With respect to inner suburban services, in purely peak capacity terms (and based on existing travel patterns), the priority at present is the Southbury Loop, with eight-car platforms in the London area being much harder to extend than those on the main line and a peak capacity gap of 1,400 passengers forecast. The previously proposed new half hourly peak service from Cheshunt to Seven Sisters (for the London Underground Victoria Line) is not compatible with the Hertford East diversions via Seven Sisters, but additional stops could in future be inserted on the latter service in the inner suburban area if demand dictates. Beyond this, higher density rolling stock may be appropriate for certain inner suburban workings, or diverting some demand to the Lea Valley corridor as outlined below.

On the assumption that all the above interventions are implemented, future peak capacity is forecast to be broadly sufficient for demand to 2031. However capacity is only one of many issues on this route and several stakeholders have emphasised other significant factors, notably limited train frequencies at the lower Lea Valley stations (many of which are in potential regeneration areas), journey times on main line trains and an increasing demand for links to Stratford/Docklands. The RUS analysis has therefore focused on identifying an economically viable strategy to address these issues.

The recommendation in the RUS is for implementation of a four trains per hour Lea Valley to Stratford service. This is potentially deliverable in Network Rail's Control Period 5 (CP5), based upon a limited infrastructure scheme to facilitate turnbacks at Brimsdown. However, with that infrastructure alone some outputs (such as calling patterns) may not be ideal, so further development is required. If more extensive works are needed the business case would still be strong, but affordability constraints will be more of a factor.

A further option beyond the above has been considered for a three/four tracking scheme south of Brimsdown. If required this would provide further benefits including a better timetable and possibly more additional trains, but at significantly lower cost than full four-tracking of the route. It is possible that elements of this might, at some stage, be required to deliver a robust four trains per hour Stratford service. As with any option for extra tracks on this corridor the destination point for any resulting additional trains would need to be Stratford, as the RUS does not consider it operationally viable to further increase peak service levels on the constrained route via Hackney Downs to London Liverpool Street. The RUS also notes the need for power supply upgrade works for service increments on this corridor.



The option of an additional new half hourly service from Chingford to Stratford has also been considered, via a new curve at Hall Farm near Clapton. Whilst this also has significant merits the resulting total six trains per hour service to Stratford (when combined with the above) would reach the upper limit of capacity available to West Anglia routes in the Stratford area, due to interactions with the capacity strategy for the GEML as outlined below. Improving services from the Lea Valley is considered to be a higher priority than the Chingford line, given that the former provides benefits to more people over a wider area. The RUS is therefore unable to support a Chingford to Stratford service at this time, since a six trains per hour Lea Valley

to Stratford service might eventually be justified by demand, though this conclusion should also be kept under review.

The RUS considers that, following the completion of Crossrail, many of the West Anglia to Stratford off-peak trains could potentially be extended to London Liverpool Street, utilising the infrastructure changes recommended for resolving the GEML capacity gap as outlined later. However, this would not be practical during the weekday morning and evening peaks, since the capacity would be required for the GEML route.

The table below updates the options assessed for this route:

<i>Options for the West Anglia route</i>		
<b>From Greater Anglia RUS</b>	Lengthening of all peak main line trains to 12-car.	Recommended progressively as required by peak capacity.
<b>Option C1</b>	Divert Hertford East trains via Seven Sisters and run additional trains to Liverpool Street.	Anticipated in a timetable change in the near future, with Hertford East services rerouted from the Lea Valley via Tottenham Hale to the Southbury Loop via Seven Sisters route.  This will allow 2tph additional at peak times on West Anglia routes overall and facilitate better journey times on certain main line journeys.
<b>Option C2a</b>	4tph Lea Valley to Stratford service.	Requires limited additional infrastructure based upon a new turnback facility at Brimsdown. However at this stage this has not been shown to be operationally robust and further infrastructure may therefore be required.  Recommended for detailed development for potential implementation in CP5.
<b>Option C2b</b>	4tph Lea Valley to Stratford service, with 4tph at all stations.	Requires a mixture of three and four-tracking between Lea Bridge and Brimsdown and turnback infrastructure at Brimsdown.  In the absence of <b>Option C2a</b> this would be recommended, but it is significantly higher capital cost so it should be kept under review.
<b>Option C3</b>	6tph Lea Valley to Stratford service.	Deliverable with an additional length of four-tracking in the lower Lea Valley, beyond that required for <b>Option C2b</b> .  Not recommended as this level of service to Stratford does not appear to be required by demand and the train service prevents <b>Option C5</b> below. However, this conclusion should be kept under review.
<b>Option C4</b>	8tph Lea Valley to Stratford service.	Requires the full four-tracking major upgrade scheme in the Lea Valley. This involves major works at Tottenham Hale and at locations north of Brimsdown, including the need to close several level crossings.  Not recommended due to insufficient evidence of benefits and 8tph to Stratford being inconsistent with <b>Option D2</b> .
<b>Option C5</b>	2tph Chingford route to Stratford service.	Not recommended at present, as it is unclear whether demand from the Lea Valley could eventually warrant a 6tph service to Stratford under <b>Option C3</b> , which would provide a higher level of benefits to a wider area but utilise all available capacity at Stratford.  This conclusion should be kept under review.
<b>Option C6</b>	Extend West Anglia to Stratford trains through to London Liverpool Street.	Operationally viable off-peak only, requires implementation of <b>Option D2</b> .

Finally the RUS notes that the West Anglia corridor may be an eventual destination for trains using a potential variant of the safeguarded Crossrail line 2 (or 'Chelsea-Hackney' line), as described later. Connection of the West Anglia route to such a tunnel through Central London would remove the London terminal capacity constraint, potentially enabling far more trains to run. The case for four-tracking of the Lea Valley should be kept under review in this context.

### **Great Eastern Main Line capacity**

The Draft for Consultation forecast a major capacity challenge on the GEML, with no viable options identified at that stage for further increasing peak capacity once all peak trains via both Chelmsford and Wickford run at 12-car length (and with EMUs replacing the current ageing locomotive-hauled trains used for some services). It was emphasised that Crossrail will address capacity in East London, but not for main line services. The RUS demand modelling therefore forecast a capacity shortfall of space for 3,000 people without further schemes, implying high levels of standing on the route in the future. A number of stakeholders from Essex in particular noted during the consultation that this situation did not appear to be satisfactory, and the rail industry shared such concerns.

Following detailed further analysis the RUS has now identified an infrastructure enhancement scheme for the remodelling of the Bow Junction area, enabling the two 'Temple Mills' lines between Stratford and Bow to be fully usable for passenger trains rather than being generally restricted to freight and empty coaching stock as at present. This would effectively create six, fully usable tracks all the way between Stratford and Liverpool Street, two of which would be in the Crossrail tunnels. Such a scheme would allow use by main line services of the inner suburban capacity which will be released on the 'Electric Lines' following the diversion of services onto Crossrail.

Utilising this additional infrastructure, a morning peak timetable has been developed which would eventually involve 28 trains in the busiest peak hour on the up main line from Shenfield to Stratford, where trains would generally call alternately in platforms 9 or 10. Each of these platforms would then have an independent route to London Liverpool Street, enabling enough trains to be run overall to meet the forecast capacity gap. Further infrastructure enhancements would also be required elsewhere on the route at the starting points for the additional trains, principally in the Chelmsford area.

Some of the additional empty GEML trains running out from London Liverpool Street to clear platforms in the morning peak would need to run via the West Anglia route at Stratford in order to avoid exceeding the capacity of the single available contra-peak direction platform (10A) at Stratford. Additional berthing capacity would be required, and this would need to be in the Orient Way area for the same reason, ideally on the west side of the railway to reduce interaction with West Anglia to Stratford traffic.

It is also noted that at peak times this option would utilise the same capacity between Bow Junction and London Liverpool Street as **Option C6** above. Given that the forecast capacity gap on the GEML is significantly larger than that on the West Anglia routes, the RUS does not therefore support West Anglia to Stratford services running through to London Liverpool Street except potentially during the off-peak. Furthermore it is emphasised that six trains per hour (**Option C3**) appears to represent the absolute upper limit of available capacity at Stratford from the West Anglia route, whilst still enabling **Option D2** to be implemented, given that both involve extra trains in the Orient Way area.

The table below summarises the options now presented:

<b>Options for the Great Eastern Main Line</b>		
<b>From Greater Anglia RUS</b>	Lengthening of all peak main line trains to 12-car.	Recommended progressively as required by peak demand.
	Replace 'intercity' vehicles with new rolling stock.	Recommended to provide additional capacity as rolling stock replacement becomes due.
<b>Option D1</b>	Run 28tph at peak times with existing infrastructure.	Not recommended as increasing services beyond 24tph is not considered operationally robust.
<b>Option D2</b>	Run 28tph at peak times with enhanced infrastructure.	28tph recommended by 2031 for peak capacity reasons, with 26tph as an interim step in the early 2020s.  Implementation requires remodelling of Bow Junction, additional turnback infrastructure in the Chelmsford area and at Wickford and additional capacity to stable rolling stock in the Orient Way area (on the Stratford – Tottenham Hale route).

### **Fenchurch Street route capacity**

Capacity enhancements on the route corridor to London Fenchurch Street are planned, with increasing 12-car operations. The RUS considers that this approach will provide sufficient additional peak capacity to match demand on this line. By the end of the RUS timescale it is anticipated that all peak services on this route will need to be operating with 12-car formations.

### **Kent route capacity**

As previously recommended by the South London and Kent RUSs, additional capacity in the South East London suburbs will be required through a programme of train and platform lengthening. The carriages to facilitate this are not committed at present, but many of them are anticipated to be provided by the major rolling stock cascade that can be expected upon completion of the Thameslink Programme. The platform lengthening programme has now commenced, with the main work initially being on the various routes to Dartford, followed by the more complex remodelling work at Gravesend, with further work anticipated at locations such as Rochester and potentially London Charing Cross in CPS.

Whilst full 12-car suburban operations would provide significant extra capacity where most needed, there remain significant operational issues to resolve, including the 11-car length of platforms 4 – 6 at London Charing Cross, operational constraints in that area and around New Cross/Lewisham, platform lengths at Woolwich Dockyard and power supply constraints. The RUS advises that further work is needed to resolve these issues.

A limited peak capacity gap will also exist on High Speed 1 (HS1) services between East Kent and London St Pancras International. The Kent RUS recommended an option for lengthening and extension further back into Kent of the current Ebbsfleet peak shuttle service and this remains the recommended approach. This would build on the recent implementation of peak services between Maidstone West and London St Pancras International via Strood. The RUS also emphasises the importance of the fare pricing structure in

Kent, to encourage North Kent coast passengers in particular to transfer to capacity which is available on HS1.

The potential extension of the London Underground Bakerloo line onto the Hayes branch, as described later, also remains a potential long term means of providing increased capacity into London Charing Cross from other routes.

### **Sussex route capacity**

Significant additional capacity is now being provided on Network Rail's Sussex route – the Brighton Main Line (BML) and branches, plus the South London suburban area – through an extensive train lengthening programme and the implementation of the Thameslink Programme. This is in response to recent growth and current crowding problems on these lines.

The committed extra capacity includes train lengthening on Brighton to Bedford services (which will be lengthened from eight-car to 12-car and peak trains rerouted to run via London Bridge), the Redhill Line (more 12-car operations), the East Grinstead Line (where platform lengthening works to lengthen from eight-car to 12-car have now commenced), the Sydenham Line (where lengthening is planned from eight-car to 10-car) and all routes via Balham to London Victoria (lengthening from eight-car to 10-car). In addition to this a small number of additional trains are planned to run upon completion of the Thameslink Programme, though this can only be to a very limited degree as the major constraint through the East Croydon area will remain.

The Sussex RUS recommended further train lengthening which is not currently committed. This included running 10-car trains on the Uckfield Line and running additional longer trains on the Purley corridor (now anticipated to be combined 10-car Caterham/Tottenham Corner trains to London Victoria, with 12-car later). Inserting Clapham Junction calls in certain peak Gatwick Express services was also recommended to provide improved connectivity from Brighton to this area and spread loadings more evenly between peak trains. This RUS re-emphasises the need for these changes, shown below.

### **Sussex route – further recommendations (in addition to current plans)**

<b>From Sussex RUS</b>	Uckfield line train lengthening to 10-car.	Recommended.
	Caterham/Tottenham Corner lines to Victoria 12-car (services to join at Purley).	Recommended (with 10-car as an interim stage).
	Call certain peak Brighton/Gatwick Express services at Clapham Junction.	Recommended.

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Assuming that the above strategy is implemented this RUS still forecasts a peak capacity gap on the BML in 2031 of some 3,000 passengers in the busiest peak hour, principally to London Victoria. There is an existing capacity gap on this route today, with peak standing regularly occurring as far as Haywards Heath. The RUS strategy is therefore heavily reliant on the new 12-car Thameslink rolling stock, which will be configured internally to maximise on-train capacity. Whilst overcrowding on the BML is not forecast to be fully resolved by this approach, the most heavily loaded trains will be alleviated.

The RUS has been unable to identify workable options to resolve the remaining capacity gap in a cost effective way. Ongoing reviews will be required by operators to optimise service patterns, fare structures and rolling stock allocation, to minimise the numbers of standing passengers and the duration of such standing on a train-by-train basis. Significant levels of spare capacity will exist during 'shoulder peak' times, partly due to the fixed-formation nature of vehicles using Thameslink routes, and effectively utilising the opportunity this provides is likely to be a key consideration in the future.

In the inner suburban area further train lengthening from 10-car to 12-car, as recommended by the South London RUS, could be required at some stage to alleviate high levels of standing on the Sydenham route and possibly routes via Balham. Demand forecasts on these routes are subject to uncertainty, so these conclusions should be kept under review.

### **South West Main Line capacity**

The most significant scheme at present on the South West Main Line (SWML) is 10-car inner suburban operations, a recommendation of the South West Main Line RUS and now fully committed. As a result the modelling for this RUS does not indicate a peak capacity gap on inner suburban services in 2031, with the additional carriages providing sufficient on-train space. During the consultation period a number of stakeholders expressed views that passenger numbers in the suburban area will grow faster than suggested by the modelling. Whilst this is not the forecast in this RUS it is recognised that further lengthening to 12-car under **Option F1** would be needed in such a scenario and it is recommended that no work is undertaken which precludes this.

However the current train lengthening project only directly benefits suburban passengers, given that main line trains are generally already full length and no additional timetable slots can be found on the route for extra trains, regardless of capacity at London Waterloo. With respect to longer distance services the RUS therefore notes that a significant peak capacity gap may arise, with a forecast shortfall in capacity for some 7,000 passengers in the busiest peak hour; this figure includes capacity required on today's already overcrowded trains, along with the 3,500 resulting from future growth. The gap could potentially be reduced slightly with additional lengthening, for example on the Salisbury line and on semi-fast services from Guildford via Cobham (given that some of the latter run fast from Surbiton at peak times), and these are considered



robust tactical level interventions but this would then only marginally reduce the gap to 6,100 passengers.

The RUS has now considered seven options in significantly more detail than was presented in the Draft for Consultation. **Option F2** involves double-deck trains and work has identified that this is potentially achievable at high cost for a small number of services, but such an approach would result in significant operational complexities and is not capable of providing sufficient additional capacity. **Option F3** involves running significantly longer domestic trains than those in operation anywhere else on the UK network into the former International Platforms at Waterloo. However again this also involves major operational restrictions in where such trains would originate, it requires complex grade separation works in the Clapham Junction area for the SWML to pass over or under the Windsor lines approaches to London Waterloo, and is also not capable of providing sufficient additional capacity to fully resolve the gap.

As neither double-deck trains nor trains longer than 12-car appear to represent a robust way forward the remaining options are therefore additional services on either the existing or a new route. **Option F4** would therefore involve increased peak service frequency through an additional four trains per hour from a location such as Basingstoke, potentially requiring additional infrastructure such as a new flyover at Woking and enhancements between Clapham Junction and London Waterloo. However, stakeholders have significant concerns regarding whether the resulting 28 trains in the busiest peak hour over the Surbiton – Waterloo section is operationally viable, so further work would be needed to determine if such a level of service could be robustly delivered by future signalling technology. Even if it were achievable this approach would still only provide just over 50 per cent of the capacity needed to resolve the gap, so crowding would remain broadly at current levels.

As a result of the above the RUS has investigated a new **Option F5**, which would involve providing a fifth track from Hampton Court Junction (south of Surbiton) inwards. This appears to be broadly achievable within the existing railway boundary, but detailed engineering design work will be required to confirm viability. The RUS recommends further consideration of such a project towards the latter years of its timescale. In the meantime the land on this corridor and at London Waterloo should be protected from any development which precludes this occurring. However, the high cost of this intervention suggests that this route should be a priority for investigating the extent to which demand management interventions can be used to mitigate overcrowding before turning to major infrastructure schemes, for example through smartcard technology to encourage season ticket holders to work from home once a week.

As a further consideration a variant on **Option A5** has been developed, based on some of the additional services to London Paddington starting at Basingstoke. This **Option F6** may be a sensible way forward, though it requires infill electrification.

From the above it can be seen that a full conventional capacity solution to the SWML gap would require expensive and significantly disruptive infrastructure upgrades over a wide area. An alternative way to increase capacity on the route would be to increase the number of tracks from the Surbiton area to central London from four to six, but this is only realistically achievable by means of tunnelling over a long distance. Such a tunnel would need to fit into a cross-industry strategy for future underground lines in the capital in general. The RUS has therefore worked closely with Transport for London to identify a variant of the currently safeguarded Crossrail line 2 route, and this forms **Option F7** in this RUS.

The SWML conclusions are summarised in the table which follows:

<i>Options for the South West Main Line</i>		
<b>From SWML RUS</b>	Run all main line trains at maximum length.	<p>This involves lengthening all peak fast trains into London Waterloo to the maximum number of carriages readily achievable without major infrastructure changes.</p> <p>This means either:</p> <ul style="list-style-type: none"> <li>• 12-car length (routes with 20m vehicles) or</li> <li>• 10-car length (routes with 23m).</li> </ul> <p>This approach particularly applies to semi-fast services from Guildford via Cobham and peak services on the Salisbury route. The RUS considers this will need to be implemented as a priority, though it will only partially resolve the gap.</p>
<b>Option F1</b>	Implement 12-car inner suburban operations.	Modelling has not indicated that this option will be required, but this conclusion should be kept under review.



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<b>Option F2</b>	Run double-deck trains on SWML outer services.	<p>Detailed analysis has indicated that only a limited number of double-deck trains would be viable, even with major infrastructure works for gauge clearance on both the Southampton and Portsmouth routes to London Waterloo. The additional capacity provided would therefore be insufficient to resolve the gap.</p> <p>This option is therefore not recommended due to high cost and not providing sufficient additional capacity.</p>
<b>Option F3</b>	Run 16-car trains on SWML outer services into London Waterloo International.	<p>Detailed analysis has indicated that only a limited number of 16-car trains would be viable, even with major infrastructure works in the Clapham Junction area for a grade-separated junction from the main SWML tracks into the former London Waterloo International Platforms. The additional capacity provided would therefore be insufficient to resolve the gap.</p> <p>This option is therefore not recommended due to high cost and not providing sufficient additional capacity.</p>
<b>Option F4</b>	Run 28tph SWML outer (4tph additional) with additional infrastructure at key pinchpoints.	<p>This option would involve running additional trains in the high peak on the main lines into London Waterloo, potentially with infrastructure enhancements such as the grade separation of Woking Junction and changes between Clapham Junction and London Waterloo.</p> <p>However, even with these enhancements the option has not been shown to be operationally viable on the number of lines currently available from Surbiton inwards, so it is highly dependant on future signalling technologies.</p> <p>In addition, this level of service would only provide just over 50 per cent of the capacity needed to resolve the gap, so further interventions would still be required to fully resolve the gap.</p>
<b>Option F5</b>	Run 32tph or more SWML outer with additional infrastructure at key pinchpoints and provision of five tracks between Hampton Court Junction and Clapham Junction.	<p>This option further develops the major infrastructure enhancements from <b>Option F4</b>.</p> <p>In order to fully resolve track capacity from Surbiton inwards it also includes an additional main line track from around that point to Clapham Junction, which is potentially viable within the existing railway corridor. The remodelling of the London Waterloo approaches would then convert a current Windsor Line track for use by main line services.</p> <p>This option is therefore recommended for further development, with the land on the route corridor and at London Waterloo station protected from alternative uses which would render it impractical.</p>
<b>Option F6</b>	Run services from Basingstoke into London Paddington via Reading.	<p>This would be a variant of <b>Option A5</b> as described earlier, with some of the Thames Valley peak services to London Paddington commencing from Basingstoke, to which additional electrification would be provided. This option provides new journey opportunities and appears to have significant merit in the context of a 20tph peak GWML main line service, but would not resolve the SWML capacity gap in isolation.</p>
<b>Option F7</b>	Free up SWML main line capacity by running inner services into a variant Crossrail line 2 route.	<p>This would require the Crossrail line 2 route to eventually be constructed in tunnel out to at least the Wimbledon area (with branches towards Kingston and Epsom).</p> <p>As a result existing SWML stopping services would utilise the new tunnel, running via Central London rather than to London Waterloo. This would free up capacity on the existing surface level railway for additional fast trains.</p> <p>Further consideration is recommended as part of the planning process for Crossrail line 2.</p>

### Windsor Lines capacity

The starting point for this RUS includes reopening of the currently unused former International Platforms at London Waterloo, to enable the planned service increase on routes via Putney (the 'Windsor Lines') from the current 15 to a future 16 trains in the busiest peak hour. This is the only train service frequency increment currently committed.

A far larger volume of additional capacity is currently planned through the operation of 10-car services, which will provide 25 per cent extra vehicles on many trains. However, the committed CP4 platform lengthening programme only extends as far out as Virginia Water, so the South West Main Line RUS recommendation for full 10-car operations, involving further platform lengthening to Reading is carried forward into this RUS. As with other routes, additional rolling stock would be required to enable all trains on this corridor to be lengthened.

Once the above are implemented a limited peak capacity gap is forecast on the Windsor Lines by 2031.

The RUS has therefore considered two variants for running 18 trains in the peak on the Windsor lines as a whole, both of which would address the gap. The options have sought to minimise the impact on level crossing downtimes, by routeing the additional trains where practical via the Hounslow line, rather than the congested route via Richmond. The need for two options was influenced by the potential construction of a new route between Staines and Heathrow Terminal 5, with implementation as part of the BAA Heathrow Airtrack scheme, since this would have resulted in significant changes to the future train service structure. However, the Transport and Works Act (TWA) Application for this scheme has been withdrawn, with an alternative proposal now provided under **Option J3** later for accessing the Windsor Lines from Heathrow.

Whilst the additional peak trains under **Option G1** are operationally viable without additional infrastructure there is a degree of interaction with the TfL Piccadilly Line upgrade scheme in the Hounslow area, which, if implemented as planned, could delay the growth in demand on the Windsor lines as some passengers would switch modes.

Windsor Lines options		
From SWML RUS	Run all trains at maximum length.	This requires platforms extensions to 10-car on the Virginia Water to Reading route and is recommended for implementation in CP5.
Option G1	Run 18tph at peak times, without an increase in the off-peak.	A timetable has been developed which enables two additional train paths in the busiest peak hour, both of which are routed via Hounslow. This option is operationally viable without additional infrastructure so is recommended for further consideration through the franchise process.
Option G2	Run 18tph at peak times on the Windsor Lines, including two trains an hour to Staines or Heathrow throughout the day.	A timetable has been developed which would also enable two additional train paths, but running throughout the day. In the peak the additional paths would be via Hounslow as above, but the increment would be via Richmond in the off-peak. Track remodelling on the approaches to the former London Waterloo International terminal would potentially have been required to maintain robust performance associated with the increased level of all-day service. In addition infrastructure enhancements would have been required at Queenstown Road to run this increased level of service in the contra-peak direction. Given that the BAA Heathrow Airtrack scheme is not being progressed no further development is anticipated in the near future.
Option G3	Implement 12-car Windsor Line operations.	Modelling has not indicated that this option will be required, but this conclusion should be kept under review.

### ***Elephant & Castle corridor to Blackfriars/Thameslink capacity***

Committed capacity increments on this route include the major impact of the Thameslink Programme. The completion of Key Output 2 of the Thameslink Programme will enable additional trains to operate into the new London Blackfriars bay platforms and capacity will be freed up over Herne Hill Junction by rerouting Brighton Main Line trains via London Bridge which will enable additional local services.

Consistent with the recommendations of the South London RUS, operational analysis indicates that services routed via Herne Hill will need to operate into the new London Blackfriars bay platforms, whilst services routed via Catford will need to operate through the Thameslink core. Given the track and station layout currently under construction at London Blackfriars, reversing this arrangement is not considered operationally viable.

Following the impact of the above the modelling forecasts a capacity gap of some 900 passengers in the busiest peak hour in 2031, primarily inner suburban services on the Herne Hill corridor.

The RUS has considered train lengthening on this route but this is considered highly complex due to track layouts at locations such as Herne Hill and Tulse Hill, where major works would be required. It is therefore anticipated that the use of higher density rolling stock is likely to be required at some stage for these services.

### ***Orbital routes capacity***

The RUS has identified a significant capacity gap on orbital routes, which are increasingly used by passengers on journeys not requiring travel into Central London. For example on the West London Line (WLL) by 2031 the forecasts suggest a capacity gap of some 3,000 passengers in the busiest peak hour on this route, a figure which does not include the potential major impact of the proposed HS2 station at Old Oak Common.

Two of the recommendations for orbital routes relate to the WLL. As presented in the Draft for Consultation a particular problem at present is the 73-minute gap in the morning peak on otherwise

hourly direct services from the WCML to the WLL. Stakeholders have indicated significant support for this to be increased to half-hourly, at least at peak times (**Option I1**). This requires a timetable recast on the WLL to match WCML paths, though this is likely to be needed anyway due to the general recast south of London following completion of the Thameslink Programme. The RUS therefore recommends detailed consideration, once sufficient dual voltage rolling stock which is needed to implement this option is cascaded from elsewhere following the introduction of new-build Thameslink trains. In advance of this during CP5, the RUS also recommends platform lengthening to allow eight-car Southern services to call at stations on the WLL (**Option I2**), which would provide a significant increment in capacity over the critical Clapham Junction/Croydon to Shepherds Bush link. The RUS also notes that development plans for the Earl's Court area can be expected to exacerbate existing crowding problems on the WLL in the absence of additional capacity.

Beyond the above other capacity solutions for orbital routes involve London Overground services. NLL trains are already configured at a high standing density, but are considered for lengthening by **Option I3**, with lengthening under **Options I4** and **I5** also addressing London Overground capacity on the ELL and Gospel Oak – Barking line respectively. Stakeholders have suggested additional trains on orbital routes as an alternative but the RUS considers this unlikely to be consistent with the important role these have with respect to freight.

The RUS also notes that the NLL and WLL routes run very close to the proposed HS2 station at Old Oak Common, so providing increased capacity and journey opportunities to this area on these routes will be an important factor.

On the South London Line service changes as part of the London Overground extension to Clapham Junction are planned, and the RUS considers that the post-Thameslink Programme timetable is likely to provide the opportunity for a four trains per hour all day service to/from London Victoria at Denmark Hill and Peckham Rye without impacting on journey times for longer distance passengers.

### ***Options for orbital routes***

<b>Option I1</b>	Increase West London Line – Watford Junction (or beyond) peak service to 2tph.	Requires timetable recast on WLL.  Recommended for detailed consideration once sufficient dual voltage rolling stock becomes available.
<b>Option I2</b>	Lengthen Southern WLL services to eight-car.	Recommended.
<b>Option I3</b>	Lengthen London Overground NLL/WLL services to six-car.	Recommended for further development.
<b>Option I4</b>	Lengthen London Overground ELL services to five-car.	Recommended for further development.
<b>Option I5</b>	Lengthen London Overground Gospel Oak–Barking services to three-car or four-car.	Recommended for further development, potentially linked to electrification.

### Potential new lines

The RUS notes several strategic connectivity gaps (ie potential major flows where journey opportunities by rail do not currently exist) in the London area. It has only sought to consider gaps in this category related to major drivers of demand and recognises that other smaller-scale gaps and options exist at a more local level.

#### Improving access to Heathrow Airport

The RUS considers that the difficulty in accessing Heathrow Airport by rail (except from Central London) is a strategic gap. The options shown in the table below for new lines are described:

More detailed development of potential new rail routes to serve Heathrow airport is recommended, initially focussing on a detailed study regarding a new western access to allow through-running services. Such a link would provide connections at Reading to the West Country, South Wales and the West Midlands. This further analysis would need to be undertaken jointly between DfT, the rail industry, BAA and local stakeholders.

In addition implementation of **Option A5** described earlier would involve a ten rather than four trains per hour service from the Central London Crossrail tunnels running to Heathrow Airport. This significantly increased frequency would be a major improvement for Crossrail users from Central London, though some of the features of the existing Heathrow Express operation would be lost.

**Option K1** below would provide new journey opportunities between Heathrow Airport and stations at the south end of the WCML, with one change of train.

#### Potential Crossrail extensions – maximising the benefits of the central London tunnels

The Draft for Consultation emphasised the desirability of optimising the usage of Crossrail tunnels, focusing on avoiding the need for services to terminate from the east in sidings at Westbourne Park (later at the proposed High Speed Rail station at Old Oak Common). This approach received a high degree of support from stakeholders and is considered to have potential to provide a high level of benefit at relatively low capital cost for major schemes of this nature.

The emerging scenario is of a 24 trains per hour peak Crossrail service (16 off-peak), all running to/ from locations west of Paddington. This would create a relatively simple service pattern, based on the following peak service level:

- 10tph semi-fast to (or via) Heathrow Airport
- 6tph semi-fast on the GWML
- 8tph via a new route to the WCML slow lines.

The WCML extension option appears to have a good business case and the RUS therefore now recommends detailed development. The benefits would compliment HS2 and the two schemes have synergies, including in the Old Oak Common area through which the necessary Crossrail alignment would run.

#### Options for new rail routes to Heathrow Airport

<b>Option J1</b>	BAA Heathrow Airtrack.	Transport and Works Act (TWA) is now not proceeding in the near future. An alternative means of providing access to Heathrow Airport from the Windsor lines is provided by Option J3.
<b>Option J2</b>	Heathrow Airport Western connection (North).	Would enable up to 4tph Crossrail semi-fast services to be extended to Reading via Slough over a new line. Recommended for detailed consideration.
<b>Option J3</b>	Heathrow Airport Western connection (South).	Would enable up to 4tph Crossrail semi-fast services to be extended to Staines over a new line. Recommended for detailed consideration, as an incremental step towards Option J1.
<b>Option J4</b>	New High Speed Rail station complex serving Heathrow Airport directly.	The Government's proposed High Speed Rail strategy includes a new station at Heathrow Airport, to be provided when the High Speed Rail network is extended beyond the West Midlands to Manchester and Leeds.

<b>Crossrail extension options</b>		
<b>Option A1</b>	Extend relief line services to Reading.	Recommended as described earlier, for implementation as part of the 2018 scheme.
<b>Option A5</b>	Additional Crossrail trains to Heathrow Airport.	As described earlier a potential future train service which appears likely to be required could involve 10 Crossrail tph, all running skip-stop from Paddington at peak times.  Under this option Crossrail would serve all Heathrow terminals, rather than just terminals 1-4 as planned.
<b>Option K1</b>	Crossrail extension onto WCML slow lines.	Recommended for detailed investigation, for several reasons: <ul style="list-style-type: none"> <li>to provide direct trains from this corridor to the West End, City of London and locations such as Canary Wharf, avoiding the need to change onto the London Underground system at London Euston</li> <li>to free up capacity on the London Underground system, both at Euston station and on the Northern and Victoria lines</li> <li>to improve access to Heathrow Airport, by providing the WCML corridor with access to Heathrow Airport with a single change at Old Oak Common</li> <li>to improve access to orbital routes from the WCML, with potential for a single change at Old Oak Common</li> <li>to enable full benefit to be made of the Central London Crossrail tunnels, with 24tph arriving from key corridors to the west and none needing to start at Old Oak Common/Westbourne Park.</li> </ul> The case for this option is strengthened by HS2 proceeding. The option would reduce the number of trains and passengers needing to be accommodated at London Euston during HS2 construction works, and in the longer term.
<b>Options J2/J3</b>	Crossrail extensions west of Heathrow.	Recommended for detailed consideration as described above.
<b>Kent RUS option</b>	Crossrail extension to Gravesend.	Safeguarded scheme to improve connectivity to Dartford area, subject to business case.

The combination of **Options A1, A5 and K1** would lead to all the peak 24 trains per hour trains from the west into the Crossrail core coming from further afield, rather than 14 Crossrail trains per peak hour starting their journey at London Paddington as currently planned.

### High Speed 2

Proposed Government strategy for HS2 is consistent with the strategy outlined in this RUS. This will involve providing additional north – south capacity through the construction of a new line from an expanded London Euston to the West Midlands, running via a major new station at Old Oak Common. Later stages involve future extensions to Manchester and Leeds, together with a station at Heathrow Airport.

Whilst the strategic business case for HS2 is much wider than the peak London commuter flows that are the focus of this RUS, there are significant transport planning issues to consider in the London

area. The RUS therefore recommends further development with respect to both the London Euston and Old Oak Common areas. This includes potential local links (eg between Old Oak Common and the NLL and WLL routes), capacity as a whole at London Euston and detailed consideration of which, if any, GWML fast line trains should call at Old Oak Common.

The RUS also recommends further consideration of the proposal for connecting HS1 to HS2, focusing on reducing the impact on other elements of this strategy. The current proposal involves significant interaction with London Overground and freight on the NLL in the Primrose Hill/Camden Road area. Additional infrastructure in this area is likely to be required to provide a robust solution.





### **Crossrail line 2 (Chelsea – Hackney Line)**

The RUS supports the continued safeguarding of the alignment of a new cross-London rail tunnel. This would improve connectivity on a south west to north east axis and alleviate London Underground congestion, consistent with the Mayor's Transport Strategy.

The RUS notes that a number of potential modifications to the proposed route appear appropriate, given other developments:

- firstly, the alignment has potential to provide significant additional dispersal capacity for the passengers from the High Speed Rail network at London Euston. This would alleviate crowding in Euston Underground station and on the London Underground Victoria Line, so further consideration is recommended by this RUS
- beyond this the RUS also considers that Crossrail line 2 may have potential to fully resolve the SWML peak capacity gap. This is potentially significant for the longer term, given that the alternative approach described in **Option F5** has not been confirmed as economically viable at this stage
- the resolution of the SWML peak capacity gap appears to require an alignment via Clapham Junction, an area which is a significant driver of demand in its own right. This approach is considered by the RUS to have more potential as a means of jointly alleviating London Underground and National Rail capacity issues than the currently safeguarded alignment via the Southfields route to Wimbledon, so further development is recommended

- finally the RUS notes that the West Anglia corridor may provide an eventual destination for trains using such a cross-London tunnel. This route would provide a ready-made destination corridor for services through the tunnel, which would relieve the constraints of London terminal capacity. Possible long-term four tracking of the West Anglia route, as considered under **Option C4** should be considered in this context.

The RUS recommends further development of Crossrail line 2 for the longer term, to alleviate both London Underground and main line congestion on trains, provide new journey opportunities and reduce journey times.

### **East – West Rail**

The RUS notes the potential for further development of the proposed East – West Rail link, promoted by a consortium of local authorities, which would run over the Oxford – Bletchley axis and potentially beyond. Any passenger connectivity gap addressed by this scheme is outside the scope of this RUS, but it is noted that reopening of this route would also provide a potential new freight routeing, in addition to those existing at present, which might assist with flows such as Southampton Docks to Daventry.

### **Other potential Transport for London schemes interacting with the National Rail network**

As described above the RUS supports the concept of a southern extension to the London Underground Limited Bakerloo line, providing new journey opportunities and alleviating crowding on rail routes into London Charing Cross, by means of taking over the Hayes route.

Other recent work by TfL has considered extending the Docklands Light Railway system. The principal interaction with this RUS would be any extension westwards of Bank, giving interchange to north-south National Rail routes at City Thameslink.

The RUS notes ongoing development work on the Croxley Link scheme, being promoted in conjunction with Hertfordshire County Council, which would enable the extension of London Underground Metropolitan Line services to Watford Junction, so improving connectivity.

Finally, extending the Tramlink system to Crystal Palace would involve the closure of the National Rail line via Birkbeck, with affected rail services diverted to Norwood Junction.

### Other routes

Various other new lines or reopenings are possible, mostly schemes of a local nature. Further work is planned by the appropriate scheme promoters in this respect.

### Freight in South East England

The RUS has considered capacity issues associated with the interaction between passenger and freight in South East England in detail, focussing on a main routeing strategy for key future flows. The principal capacity issue is the need to accommodate growing intermodal import traffic from the container ports, in addition to passenger growth on much of the network as discussed earlier. Most of this new traffic is heading for distribution centres which are generally located in the Midlands or north of England, rather than in the London area.

Given that the London railway network is heavily congested the RUS has therefore considered how routes avoiding London could best be improved such that traffic not serving the Capital directly can have alternative routeing options, whilst not incurring uncompetitive cost or journey time increases which would adversely affect rail freight companies and the industry in general. The approach of avoiding London received mixed views in the consultation, with freight operators seeking new routes for the growth element of traffic only, whereas those representing passenger services sought as much existing freight to be routed away from the Capital as possible.

A key short term objective is to increase train lengths and move from five to six-day working of key flows. This would reduce the number of additional paths needed on weekdays per tonne moved overall. However, the RUS emphasises that the needs of six-day operation and longer trains are likely to lead to a need for infrastructure interventions in several areas, and that these are not currently funded.

Beyond this the RUS recommends the main freight routeings for key flows as outlined below, based on optimising network capacity overall. Capability upgrades focussing on these routes, together with appropriate diversionary options (some of which are via London), for maximum efficiency in terms of loading gauge, speed and trailing loads are now being developed through the ongoing Strategic Freight Network workstream.

Key freight growth area	2010 average traffic	2031 traffic forecast	Proposed main routeing during normal operations
Felixstowe/ Bathside Bay	28tpd	58tpd	<p>Main route for current and future traffic recommended as being the cross-country route via Bury St Edmunds.</p> <p>To achieve this, the cross-country route will need to be progressively upgraded beyond current commitments, with services using this route needing to be just as efficient to operators as a London routeing.</p>
Southampton	20tpd	51tpd	<p>Main route for current and future traffic recommended as being via Oxford.</p> <p>Redoubling of sections of the Leamington Spa – Coventry line could assist with future growth, but would not in isolation resolve the need for freight traffic from the WCML to Southampton to make flat crossing moves at both Nuneaton (in the southbound direction) and Coventry.</p> <p>The RUS therefore notes that reopening of the East – West Rail corridor (promoted by a consortium of local authorities) is potentially a useful and faster new route for certain freight flows, enabling traffic for Southampton to leave the WCML at Bletchley. This is, however, subject to the major issue of paths on the WCML itself – but this is considered to be less of a concern post-HS2.</p>

Key freight growth area	2010 average traffic	2031 traffic forecast	Proposed main routing during normal operations
Essex Thameside (London Gateway etc)	8tpd	50tpd	<p>Main route for as much traffic as possible recommended as being the Gospel Oak – Barking line and the WCML.</p> <p>This would minimise the passenger/freight interactions in the Forest Gate/Stratford area.</p> <p>Electrification of the Gospel Oak – Barking line and the associated Thameshaven Branch and Ripple Lane Sidings was recommended in the Network RUS: Electrification.</p> <p>Further consideration has been undertaken regarding the forecast need for approximately 9tpd each way between London Gateway and the ECML, with the RUS analysis now identifying the availability of 5 paths in the daytime off-peak via Forest Gate/Stratford for this traffic, subject to the Felixstowe/Bathside Bay traffic running via the Bury St Edmunds route as above. The remaining 4tpd would need to run late in the evening or overnight.</p>
Channel Tunnel	6tpd	35tpd	Main route for current and future traffic envisaged as remaining via Maidstone East, Catford and the WLL to the WCML.
Kent Thameside (Isle of Grain, Medway etc)	9tpd	24tpd	Various routings via the London area, dependent on destination.

Note: tpd = trains per day.

In addition to the above, new domestic intermodal freight traffic serving the capital is expected to arise, though this requires the development of new terminal sites convenient to the flows concerned. This has potential to remove significant numbers of lorries from the highway network.

During the consultation stakeholders raised specific concerns regarding future off-peak freight capacity on the Midland Main Line following completion of the Thameslink Programme, as described later. Resolving these will potentially require changes to be made to future passenger services.

### South Hampshire and Solent

This RUS has provided the equivalent of a first generation RUS for this area, which was not covered in detail by the South West Main Line RUS. The key recommendations are:

- Brighton to Southampton Central service, to run as a loop service via Eastleigh and Southampton Airport Parkway, thence returning to Brighton via the Netley Line. This would effectively create a link between Southampton Airport and the West Coastway route in both directions
- targeting of journey time improvements wherever possible, either through infrastructure upgrades or timetable recasts

- small-scale infrastructure enhancements that might lead to further service changes, in particular redoubling of part of the Botley line and consideration of an additional platform 4 at Eastleigh. Other works may be needed linked to the growth in freight from Southampton Docks as described above.

The RUS has also investigated reopening of the Marchwood line to passenger traffic and potential conversion of the Netley Line to tram-train technology, but is unable to recommend either of these at this time.

### Next steps

This strategy will now be considered by the Office of Rail Regulation (ORR). Subject to the ORR not issuing an objection this RUS will then become Established. The strategy will then influence the future investment plans of Network Rail and its industry partners.