Brighton Main Line

Emerging Capacity Strategy for CP6

Pre-Route Study report for DfT

NetworkRail

Contents

Front Cover: Trains pass on the southern approaches to Windmill Bridge Jn, from the left is the Up Fast, Fast Reversible, Down Fast, Up Slow and Down Slow. The complicated flat junction for the fast lines to/from Victoria (heading to the left) and London Bridge/ the Thameslink Core can be seen beyond the signal.

Executive Summary

This report covers a wide range of issues that shape the capacity challenge on the Brighton Main Line (BML). In every case, initial conclusions only are offered and the Route Study for Sussex due to be published in draft in late 2014 will present further developed options for funders.

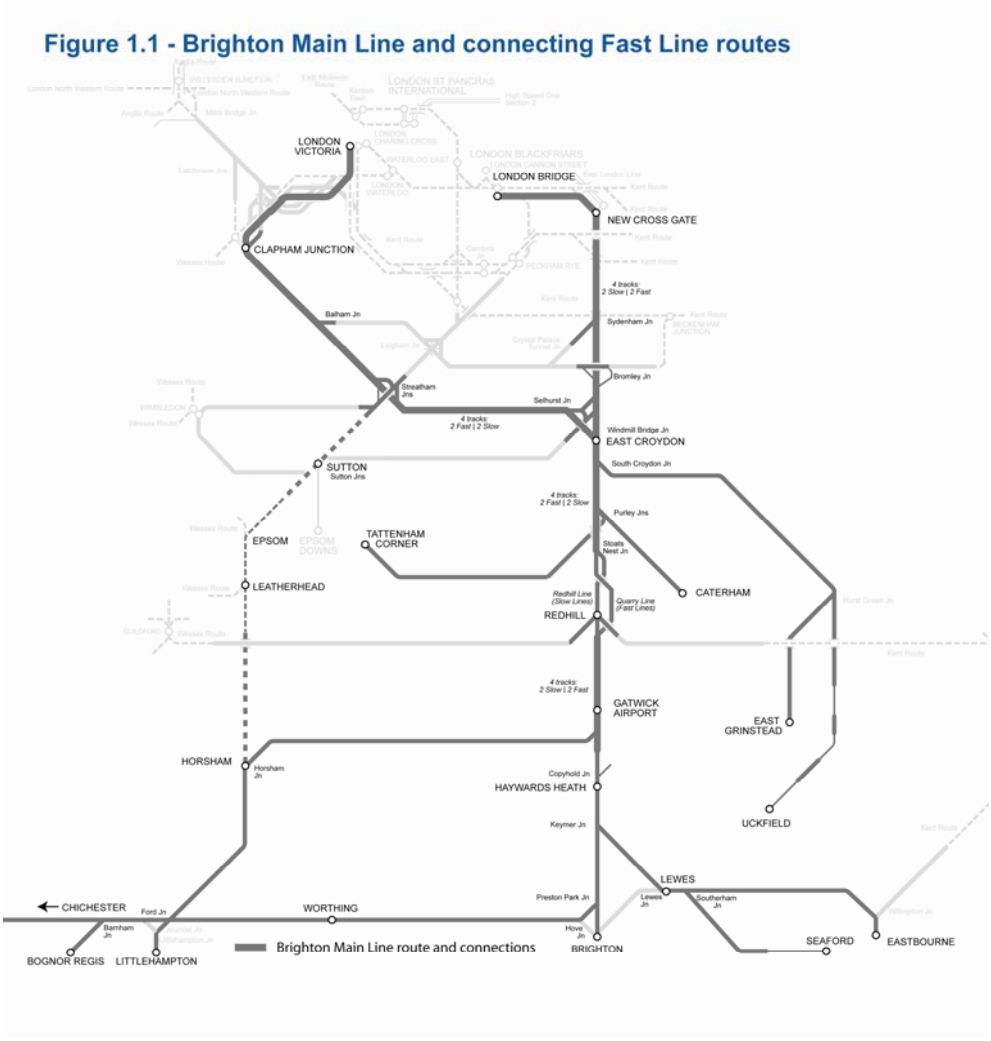
Until further work can be completed to support that process, the following conclusions set out in Section B of this Executive Summary must be regarded as preliminary only.

Section A: Context

Figure 1.1 outlines the area that falls within the scope of this report. The purpose of the report is to outline the emerging capacity strategy for the route in CP5 (2014-19) and CP6 (2019-24) with a particular emphasis on the latter Control Period given the fixed nature of most CP5 plans.

This report has been produced in response to a direct request from the Department for Transport for an update in advance of the Route Study process.

Figure 1.1 - Brighton Main Line and connecting Fast Line routes



Section B: Key conclusions of this report:

- Already committed capacity interventions in CP4 (2009 -2014) and CP5 (2014-2019) will have a significant impact in decongesting some peak trains, in particular those that serve London Bridge.

- The key constraints to unlocking a further increment of capacity on the BML are the flat junctions and the number of fast line platforms at key stations. These constraints are not only limiting capacity on the route but are now a day-to-day part of the reliability challenge of delivering the existing timetable.

- The density of traffic on plain line sections is also an issue but this is because of the uneven spacing of services on these sections driven by the complexity of the origin and destination of services plus the flat junctions and platform availability described above.

- Future signalling technology advances such as ERTMS are likely to provide marginal capacity benefits on plain line sections, but will not remove the key constraints of flat junctions and available fast line platforms.

- The most heavily utilised flat junctions, platform faces and plain line sections are in the inner area of the route i.e. from Stoats Nest Junction (north of Redhill) inwards to London, and it is here that the main focus of effort needs to be in CP6. These locations are acting as a bottleneck for the whole route. Most of these inner locations are also likely to see increased usage from December 2018, when the Thameslink programme is completed.

- There is no single intervention that can free up capacity on the route, but the planned renewal of much of the Three Bridges area signalling interlocking in 2020 potentially represents a one-off opportunity to ease several further key constraints, primarily at East Croydon, and Windmill Bridge Junction but possibly also at Stoats Nest and Keymer.

- Initial work suggests that, should they prove affordable and feasible, improvements at the above locations as enhancements on Three Bridges re-signalling renewal will release some valuable additional capacity into Victoria on the BML, but this is also contingent on relieving some localised constraints in the Clapham area (also due for re-signalling in CP6).

- The interventions that could take place in CP6 would also have some capacity benefits for main line traffic via London Bridge although it is unlikely a significant number of additional main line paths will be released on this route.

- It is absolutely critical that any interventions to improve capacity also address reliability issues on the route. Consequently, the focus of

development work in CP5 and, subject to the outcome of that work, investment in CP6, will be interventions that improve reliability as well as releasing some remaining incremental capacity on the BML[1].

- Network Rail will continue to work closely with DfT and the winning bidder for the TSGN franchise to deliver the optimal timetable from a performance and capacity perspective, in the meantime, in December 2018.

- Given the above conclusions with respect to critical bottlenecks on the inner section (London end) of the BML, large scale investment in alternative routes on the outer area of the BML such as Lewes – Uckfield, is likely to be of very limited value in the short to medium term, although Network Rail remains of the view that protection of that alignment is still the correct policy for the long term.

Next Steps

In preparation for the publication of the Sussex Route Study in draft in late 2014, Network Rail is proposing to undertake the following workstreams over the course of this year.

- Further development of our understanding of the outputs, in terms of train paths and performance improvement, that the interventions outlined in this report could deliver. This process will also include the impact of any other interventions that come to light as part of the Route Study process.

- Further development of the feasibility of the infrastructure options outlined in this report. The extent of development will depend on available funding.

[1]To this end the Sussex Route study will continue to be developed alongside work recently completed by NR for RSSB on BML performance, as well as ongoing industry workstreams on Traffic Management Systems and ERTMS.

1: Introduction

1.1: Report scope

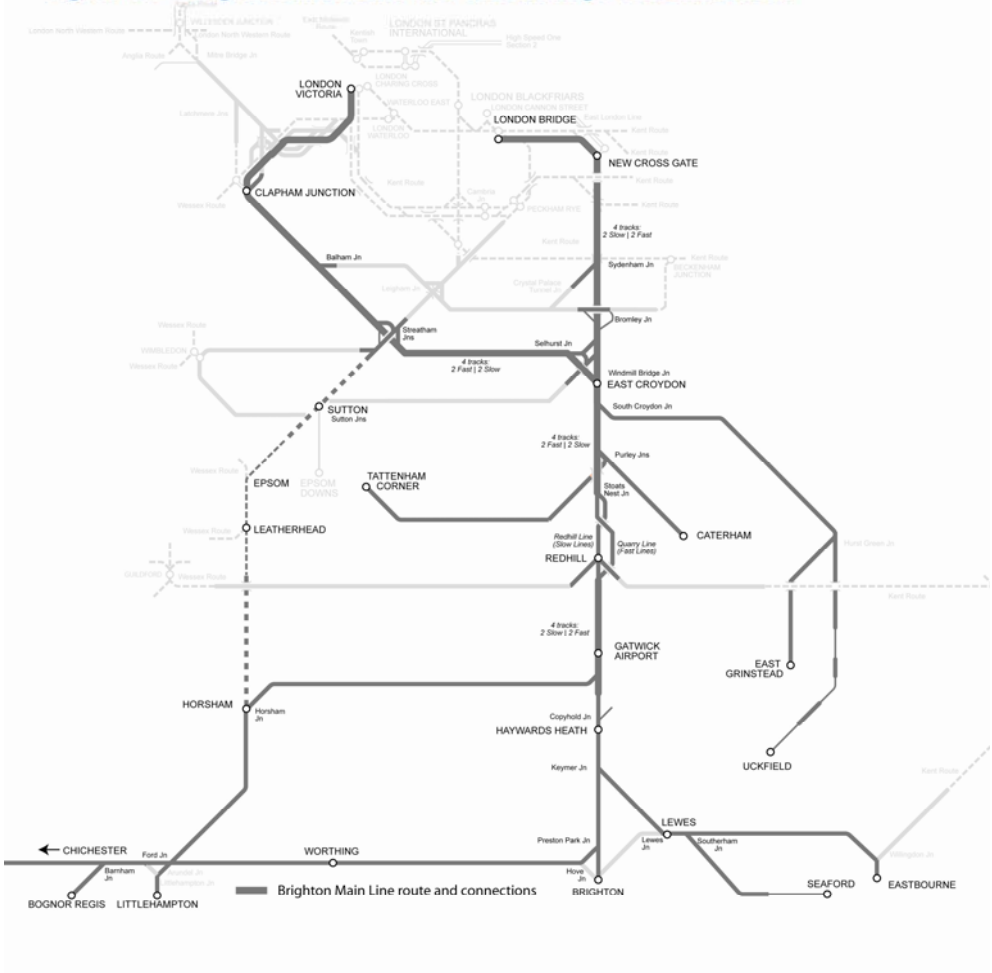
This report focuses on Network Rail's emerging capacity strategy for the Brighton Main Line (BML) in advance of the Route Study to be published in draft in late 2014 and as a final document in summer 2015. The Route Study is being put together by an industry working group and will be publically consulted. The conclusions of that study will supersede the initial analysis outlined in this report.

The service groups considered in this report include all services that operate on the Fast Lines from East Croydon/ Norwood Junction/ Selhurst inwards to London Bridge and London Victoria.

Figure 1.1 outlines the area that falls into the scope of this report.

The purpose of the report is to outline the emerging capacity strategy for the route in CP5 (2014-19) and CP6 (2019-24) with a particular emphasis on the latter Control Period given the fixed nature of most CP5 plans.

Figure 1.1 - Brighton Main Line and connecting Fast Line routes



When considering the BML it is difficult to convey simply the scale and complexity of the railway operation currently in place on this route.

Table 1.1 below sets out the number of daily train movements through the hub of the Brighton Main Line[2] (the Windmill Bridge – East Croydon area), and compares the volume to a selection of key rail hubs around the country, some of which will be more familiar to many readers.

Table 1.1: BML trains per day throughput – a comparison

Location	**Total weekday trains 2014**
East Croydon	1,195
West Croydon	625
Croydon Combined (Windmill Bridge Jn)	1,820
Manchester Piccadilly	1,249
Reading	1,027
Paddington	834
Euston	752
Kings Cross	590

1.2: The industry planning process

Following the 2005 Railways Act, the Office of Rail Regulation (ORR) modified Network Rail's Network Licence in June 2005 (further amended in April 2009) to require the establishment of Route Utilisation Strategies (RUSs) across the network. This process gave Network Rail responsibility for ensuring efficient and effective use of current route capacity and developing plans, with the industry and funders, to cater for future demand.

Under this process Network Rail has produced Route Utilisation Strategies for the area the Brighton Main Line passes through as follows:

2008: South London RUS: focused primarily on inner suburban services in South London, but covered the outer suburban routes to East Grinstead, Tattenham and Caterham that operate on the fast lines from Croydon inwards.

2010: Sussex RUS: covered the whole length of the BML as well as outer and inner suburban services.

[2] Table includes suburban as well as main line services, and empty stock/ shunt moves

2011: London and South East RUS: covered the whole length of the BML plus outer and inner suburban services but re-stated the conclusions of the Sussex RUS.

The Sussex RUS conclusions provided a clear set of capacity recommendations for Control Period 5 (CP5) for the Brighton Main line.

These are listed in Table 1.1 below. This table also provides a reminder of the likely outputs of the Thameslink Project. This project was assumed as in the baseline for the RUS analysis, but it should be remembered that it potentially provides significant additional capacity between the BML and London Bridge in the peaks by the end of CP5.

Network Rail has made good progress in identifying the funding needed for the projects in Table 1.1 and in some cases has already delivered CP5 outputs early. For the purposes of this report it is assumed as in the baseline that the recommendations in Table 1.1 will be implemented in late CP4 and during CP5 as planned.

When considering the capacity challenge on the BML it is important that stakeholders realise the changes that are already planned in CP5 and understand that they are targeted at resolving some of the most acute crowding problems the route currently has.

Table 1.2: Reminder of Sussex RUS/ LSE RUS conclusions + likely Thameslink Outputs impacting the BML

Recommended scheme	Output	Expected completion date
Thameslink Key Output 1	12-car rather than 8-car operation of Brighton <> Thameslink core services	Infrastructure completed, rolling stock due in 2016/17 (small number of diagrams already operating at 12 car)
Thameslink Key Output 2	4 tph Brighton <>Thameslink core via London Bridge in the peak (rather than current 3/4 tph predominantly via Elephant & Castle)	December 2018
CP4 Inner Suburban train lengthening and associated platform lengthening works: CP4	8- to 10-car on peak suburban services via Balham. 8- to 10-car on Sydenham slow line services into London Bridge. 8- to 12-car on East Grinstead services	December 2011 (delivered) December 2013 (delivered)
CP5 infill train lengthening: Caterham and Tattenham, and associated platform	8- to 10-car in peak on Caterham and Tattenham services north of Purley	Brought forward from CP5. Delivered December 2013

lengthening works		
CP5 infill train lengthening: West London Line	4- to 8-car on some peak West London Line services operated by Southern	Works brought forward from CP5. Spring/ Summer 2014 delivery targeted.
Infill train lengthening CP5: Uckfield line 10 car	4/6/8- to 10-car operation on peak services to/from Uckfield	To be delivered in CP5
Redhill Platform 0	Additional platform at Redhill, to aid splitting and joining of 12 car length trains for London and help toward increase of Reading/ Guildford <> Gatwick frequency	December 2017
Gatwick Airport remodelling	Additional platform on fast line side of the station. Removal of fast to slow line moves of Gatwick Express services	February 2014

The above interventions will help to relieve crowding throughout the inner and outer suburban areas of the BML and also on some main line services from the outer areas to London Bridge.

It should also be noted that in addition to the above investments on the route, the DfT has recently indicated a significant government contribution to the upgrade of Gatwick Station is to be made available.

Despite the significant impact of the above recommendations, Network Rail now recognises it is time to start putting together firm capacity plans for Control Period 6 (CP6, 2019 -2024) for the Brighton Main Line. From a renewals perspective CP6 will see replacement of much of the signalling and associated interlocking equipment on the BML and this presents a clear opportunity.

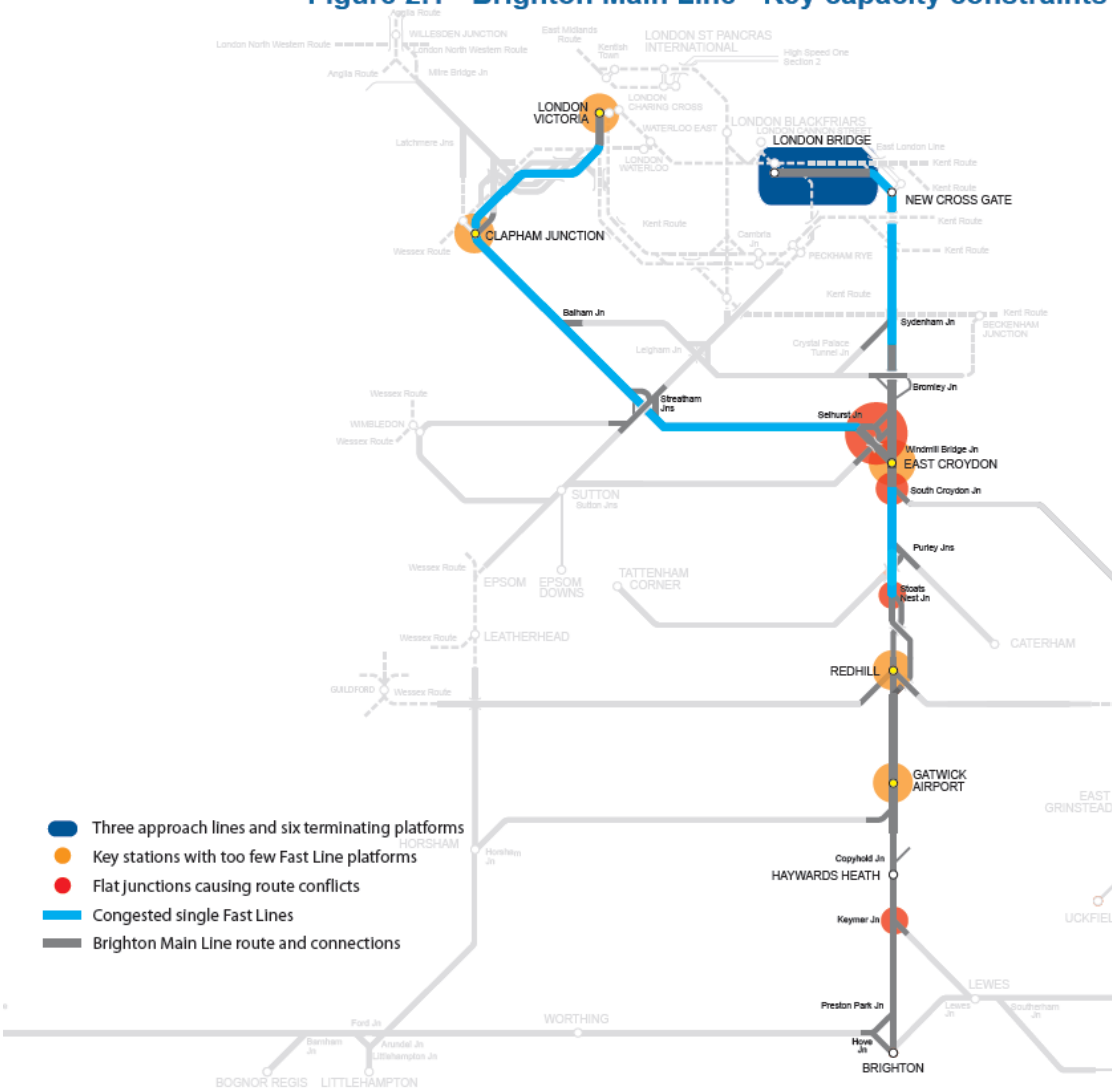
A new process to succeed the Route Utilisation Studies (RUSs) – the Long Term Planning Process (LTPP) – is underway. This has seen Market Studies (covering high level demand issues on the BML) published in late 2013 and a full Sussex Route Study, which will set out the interventions likely to be necessary in CP6 and beyond, to be published in 2015 (draft in late 2014). Importantly, the Route Study will also seek to identify options that are compatible with further expansion of Gatwick Airport. This report is a preliminary indication of the issues and options the Route Study will consider in more detail.

2: The railway we have today: key constraints

Figure 2.1 highlights the current key capacity constraints on the BML Fast Lines. The key constraints can be divided into 3 general areas:

- **Flat junctions:** leading to conflicting moves between Up and Down services and fast and slow lines. Indicated in Red
- **Key stations with too few Fast Line Platform faces:** Indicated in Orange
- **The presence of a single Fast Line in each direction:** where traffic density is 17tph or above in the peak. Indicated in Blue

Figure 2.1 - Brighton Main Line - Key capacity constraints



Taking each of these challenges in turn:

2.1: Key flat Junctions

2.1.1: Background

Figure 2.1 marks the key flat junctions on the Fast Lines in red.

Some of the key junctions on the Brighton Main Line have not seen significant alteration – in terms of layout – since the 19th Century. There are a number of reasons for this. In the highly constrained environment of the railway in London and the South East, most grade separation of railway junctions occurred either at the time of construction or in the late 19th century to pre-World War 2 period, before major development had occurred around the sites in question.

The London and South Western Railway, which operated today's Wessex Route area for example, was able to grade separate almost all of its major junctions between London and Basingstoke in the Victorian era. The London, Brighton and South Coast Railway which operated the Brighton Main Line was unable to fund grade separation at key junctions. Even when further opportunities presented themselves for remodelling with stimulus funds in the 1930s, the by then amalgamated Southern Railway, despite developing plans for several grade separations, chose to prioritise the South West Main Line (delivering the grade separation of slow and fast lines north of Wimbledon).

The investment that has occurred in key junctions on the Brighton Main Line has typically been focused at the time of re-signalling, most notably the Three Bridges area re-signalling of 1983/84. This re-signalling put significant funds into junction re-modelling at a time of relative austerity on the railway and succeeded in grade separating many of the conflicting moves at Windmill Bridge Junctions (marked as the largest red circle on Fig 2.1). Not all of the conflicts were removed however and the remaining issues that impact the Fast Lines are covered below.

2.1.2: The junctions

Windmill Bridge Junction:

Remaining flat junction conflicts are as follows:

- Up London Bridge Fast with Down Victoria Fast
- Up London Bridge Slow with Down Victoria Slow
- Up Slow to Up Fast crossing moves at Selhurst

South Croydon Junction

- Up Oxted (ex Sanderstead) with Down London Bridge/Victoria slow moves toward Purley

Stoats Nest Junction

- Moves from Up Slow to Up Fast conflict with Down Fast

Gatwick North

- Down Fast to Platforms 1-3 conflicts with Platform 4-6 to Up Fast moves. Many of these conflicting moves will be removed from February 2014 with the completion of the remodelling at Gatwick.

Keymer Junction

- Up moves (ex East Coastway) with Down moves toward Brighton

2.2: Key stations

A number of key stations on the BML have fewer fast line platforms than would be desirable to handle current and projected traffic. The main examples are:

Victoria

The terminus of the BML, Victoria has seven terminating platforms available to Fast Line services although two of these are dedicated to the 4tph Gatwick Express service to simplify access for airport passengers. This leaves the remaining platforms to handle a higher volume of traffic. Development either side and above the station means the options for building additional platforms at the terminus are extremely limited.

The current practice of splitting trains down in the platforms at Victoria in the morning peak is also driving platform utilisation down and leading to additional conflicting moves in the station throat, reducing capacity. There are a number of reasons for this activity taking place at present and these are referenced further in section 5.

London Bridge

The remodelled 'Low Level' terminating station at London Bridge will have a six platform/ three approach track arrangement. This is likely to restrict capacity in the Low Level at up to about 20tph, constrained further by the need to mix outer suburban and Fast Line services from the coast with inner suburban services from both the Sydenham and Tulse Hill corridors. Room does not exist to add additional platforms or approach tracks.

Clapham Junction

Clapham Junction is the key platform-based constraint on the route into Victoria. The station has single Up BML Fast and Down BML Fast platforms, and the majority of Fast Line services call here. The platforms have a booked dwell time of one minute and a platform re-occupation time of two minutes[3]. This effectively pegs the maximum theoretical capacity of the BML Fast Lines

[3] The platform re-occupation time is the time period allowed in timetable planning, between a train departing from a stand in a platform and the next train being able to arrive at a stand in the platform. The allowed time window is calculated based on signal positions and line speed at that location, together with 12-car rolling stock formations and the performance capability of the train. The technical calculation is rounded up for planning purposes.

into Victoria at 20tph – although when combined with constraints elsewhere on the route it is effectively less.

East Croydon

East Croydon has three Fast Line platforms but their use is complicated by the track layout at the London end of the station that involves conflicting moves between Up London Bridge fast and Down Victoria fast services at Windmill Bridge (listed above), as well as requiring reversible use of Platform 2.

On the Slow Line side of the station, reversing moves in Platform 5 are complicated by the fact that setting the route in the Up direction from Platform 5 prevents trains arriving into Platform 4 at the same time.

Gatwick

The lack of terminating platforms on the fast lines for Gatwick Express services, leads to the need for those services to cross the slow lines in order to terminate at the station. This constraint has been resolved in CP4 (new layout and additional platform commissioned in February 2014). The opportunity was taken to resolve this constraint as part of the renewal of the signalling interlocking in this area in CP4.

Redhill

The presence of only two Up platforms in the morning peak to cater for a significant number of trains joining and the Guildford line trains reversing, as well as through train movements. This constraint is being resolved in CP5. A scheme for an additional platform is part of Network Rail's CP5 Delivery Plan.

2.3: The single Up and Down fast lines

Single Up and Down fast lines exist for most of the length of the BML. These sections include: Stoats Nest to East Croydon, Selhurst to Battersea Park and Norwood Junction to Bricklayers Arms Junction.

Without adding additional tracks on these sections, the through capacity of the route will always be limited by the realistic capability of a single Up and Down track. However if junction and platforming constraints detailed above can be resolved it is recognised that these plain line sections could deliver a higher throughput than today with or without ERTMS[4]. This issue is explored further in Section 5.

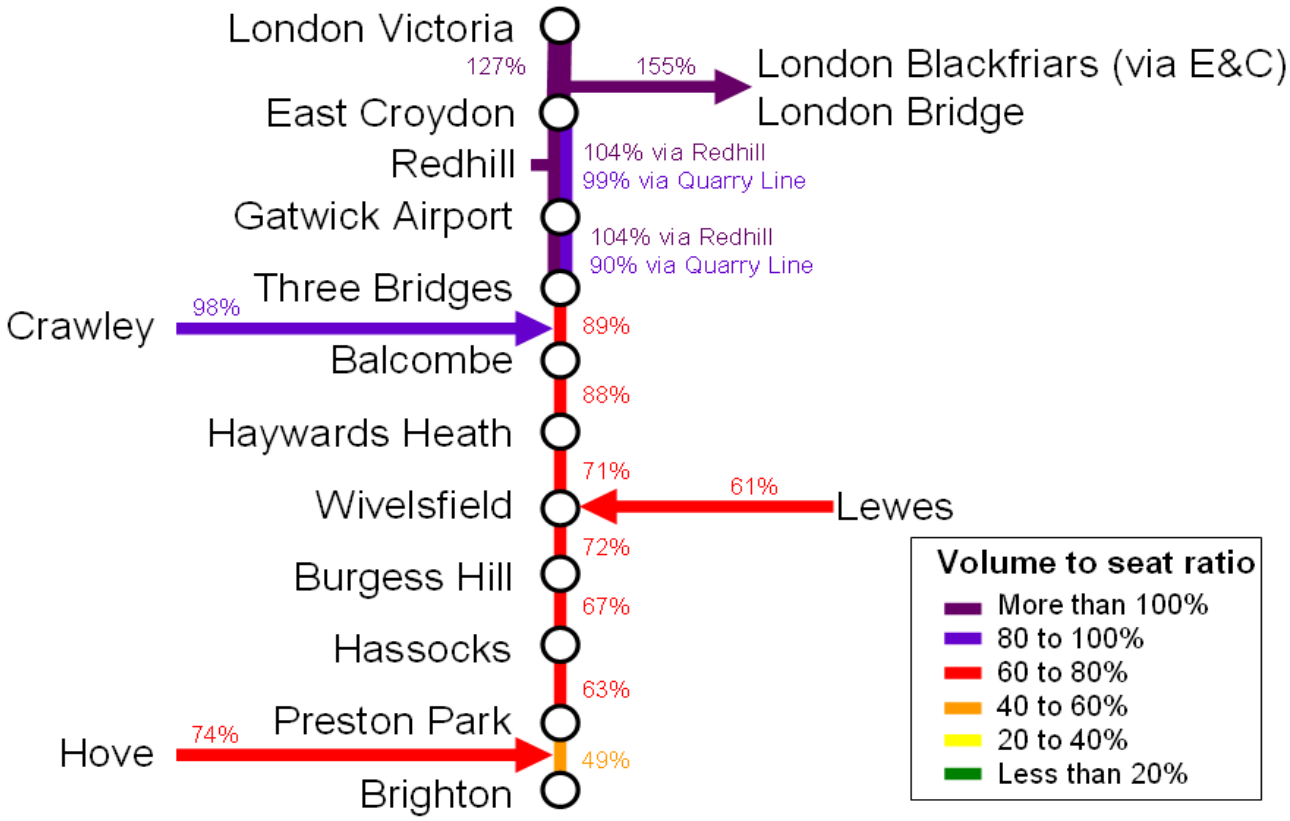
[4] Depending on its application ERTMS is likely to reduce slightly the actual technical headways on plain line sections. It is not yet clear whether this will be sufficient to reduce planned headways to the extent necessary to release additional through train paths on this particular route. Initial assessment of key sections suggests possibly not, but this conclusion needs to remain under review.

3: Demand

3.1: Current Demand

Figure 3.1 shows the passenger congestion levels taken in a sample in Spring 2013 from Southern Railway, Gatwick Express and First Capital Connect (FCC)[5] trains along the BML during the morning peak.

Figure 3.1: Brighton Main Line seat utilisation in the busiest hour of the morning peak, Spring 2013.



As shown in Figure 3.1, in the morning high peak hour (arrivals into London between 0800 and 0859), on average all seats are occupied north of Crawley and Three Bridges. Seat utilisation varies between services however, with passengers standing on some trains from as far out as Burgess Hill and Haywards Heath (45 to 50 minutes), whilst other services such as the Gatwick Express trains that start from the South Coast have available seats throughout. These disparities skew the data in Figure 3.1 to give the false impression that significant standing is only an issue in the inner area.

North of East Croydon, all trains that call, reach or exceed standing capacity. For services to Victoria, the busiest point on the route is Clapham Junction.

[5] First Capital Connect train loads have been estimated using the MOIRA model.

Services to or via London Bridge are busiest at London Bridge, whilst services to London Blackfriars or through the Thameslink core via Elephant and Castle are busiest at London Blackfriars.

3.2: Future Demand

The London and South East Market Study predicts an average of 26% demand growth on the Brighton Main line between 2011 and 2023. This forecast relates to passenger loads at the busiest points on the services, in the busiest hour of the peak. The largest growth (64%) is expected on Thameslink services, driven by the better peak connectivity to London Bridge.

In the longer term (over the next 30 years), demand on the route is expected to increase by 38%-53% compared to 2011.

In addition to the peak forecast of passenger growth into London, demand on the Brighton Main Line between stations such as Brighton, Gatwick and East Croydon is also expected to grow, especially in response to any expansion of Gatwick Airport, and proposed retail and commercial developments along the route (for example, the proposed Westfield retail centre at Croydon). Specific growth relating to a second runway at Gatwick is not included in the above forecasts – but is being considered as part of the Route Study.

As noted in section 1, the full implementation of the Thameslink programme in 2018 adds capacity on the most critically crowded London Bridge route with, amongst other changes, potentially four direct, 12-car trains per hour between Brighton and London Bridge, replacing the 8-car services that predominantly do not run via London Bridge in the peak.

The new rolling stock for Thameslink services has a layout designed for higher passenger density, with fewer seats and more standing room. In the short to medium term, the extra carriages will ease or at least match the current levels of standing on the route at peak times. Despite this, in the long term, it is likely that passengers will stand for greater distances unless further capacity is provided.

4: Current Route Capacity and Performance

4.1: BML: current and planned CP5 usage of critical sections

Table 4.1 sets out the current usage of the most heavily used sections of the Brighton Main Line in the morning peak (the time of the most concentrated load on these sections). The table indicates both usage today (from the May 2013 timetable change) and an estimate of possible usage from December 2018 when a new timetable will be in place to support the completion of the Thameslink project.

Table 4.1: Current usage of key BML sections and possible usage from December 2018[6]

Plain line section	Up Main usage morning peak – high peak hour 2013 (FL = Fast lines, SL = Slow lines, RVS = reversible)	Possible Up Main line usage post December 2018 (KO2 TLK implementation – DTT 2011)	Theoretical plain line maximum capacity – before junctions and other constraints (e.g. platforming) are factored in**
Keymer Junction – Balcombe Tunnel Junction	13	13	30
Stoats Nest - Purley	17 FL 3 SL	18 FL 6 SL	30 FL 30 SL
Purley – South Croydon	17 FL 6 SL	20 FL 10 SL	30 FL 30 SL
South Croydon – East Croydon	17 FL 13 SL 3 RVS	20 FL 12 SL 6* RVS	30 FL 30 SL 6 RVS
North of Norwood Junction – Bricklayers Arms Junction	14 FL 14 SL	20 FL 14 SL	30 FL 15 SL
Selhurst – Battersea Park (Measured at Wandsworth Common)	16 FL 15 SL	18 FL 16 SL	20 FL 15 SL

*Plus 2 in Down direction (2tph West London Line-South Croydon)
** It should be noted the theoretical plain line maximum capacity will never be achieved in terms of through pathing even if all junction and platforming constraints were removed, due to the complexity of origin and destination of service on the route.

A number of key points should be noted:

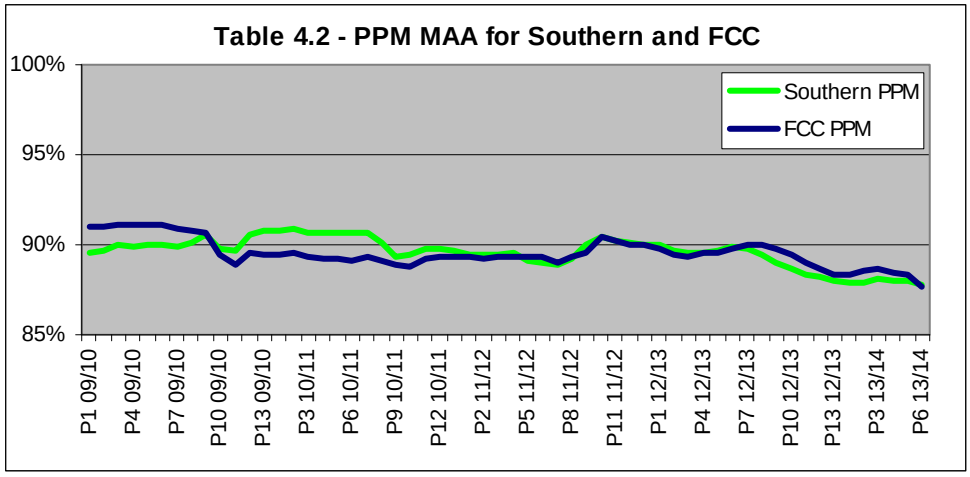
- The theoretical plain line capacity indicates that the issue is not necessarily providing extra tracks but relieving the key constraints at junctions and stations that is key
- It is sections of the inner area of the Brighton Main Line – Stoats Nest inwards – that are seeing the most intensive usage and which are the priority for relief.

[6] Estimated usage in 2018 is taken from DTT 2011 – an outline timetable produced by NR to test what may be possible post completion of Thameslink KO2. Whether this precise level of service transpires will depend on ongoing timetabling and performance analysis with the winning bidder for the TSGN franchise.

- Post December 2018 the usage of the Up Fast line into Victoria could be up to 18tph during the peak, just 2 trains short of the theoretical maximum that Clapham Junction Up Fast platform could handle given current signalling constraints (Section 5 explores this further).

4.2: Current Performance

Table 4.2 sets out current performance (as measured by the Public Performance Measure moving annual average) for the Sussex Route since the start of Control Period 4.



Both Southern and FCC PPM has fallen since the start of the control period. There are many factors that contribute to the performance challenge in the Sussex Route area and it is not possible to list and detail all of these in this report. The density of service and the track layouts and platform availability on the Brighton Main Line are the subject of this report but it is important to note they are just one factor.

Despite this, it is very clear that the intensive operation of the route and the current configuration of the infrastructure at key locations does have a daily impact on performance. Key drivers include:

- The volume of trains both peak and off peak that are currently being operated on the BML given its current capability
- The conflicting moves these services are making at key junctions such as Windmill Bridge which create the potential for delay to be passed between services that would otherwise have no connection
- The flat junction moves between slow and fast lines for example at Stoats Nest Junction which again create potential for delay to be passed between service groups that would otherwise have no direct connection

Table 4.3 below shows the top ten TRUST sections for weekday congestion delay for both Southern and FCC over the past year (Period 7 2012/13 to Period 6 2013/14 inclusive). Congestion delay is typically where a train loses time when following, or regulated behind, a preceding service. In this analysis,

the use of weekday congestion delay serves to highlight locations where the route is utilised most intensively.

Table 4.3: Top ten TRUST sections for weekday congestion delay

Table X – Southern Congestion delay

Rank	Trust section	Delay
1	Balham to Clapham Junction	17,068
2	London Victoria	15,577
3	**Purley to East Croydon**	**15,301**
4	Earlswood (Surrey) to Gatwick Airport	11,822
5	Balham to Selhurst	11,000
6	**Selhurst to East Croydon**	**10,680**
7	Clapham Junction to London Victoria	10,330
8	Selhurst to Balham	9,616
9	Battersea Park to London Victoria	9,446
10	**East Croydon to Selhurst**	**8,800**

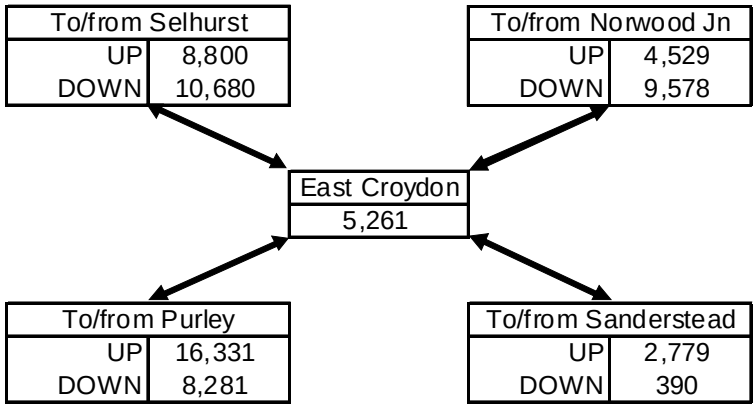
Table Y – FCC Congestion delay

Trust section	Delay
Earlswood (Surrey) to Gatwick Airport	4,239
West Hampstead Thameslink to St Albans City	2,758
Norwood Junction to East Croydon	**2,734**
Bricklayers Arms Jn to London Bridge	2,009
Keymer Jn to Preston Park	1,957
Flitwick to Bedford	1,810
Three Bridges to Gatwick Airport	1,623
East Croydon	**1,593**
Haywards Heath to Balcombe Tunnel Jn	1,589
St Albans City to Luton	1,560

As can be seen above, the TRUST sections in and around East Croydon (highlighted bold) are a significant factor and contribute a large proportion of congestion delay for both TOCs. In total, the relatively short sections at or adjacent to East Croydon represent 16% of all Southern congestion delays and 15% of FCC congestion delay over the past year.

A breakdown of the congestion delays in these sections is provided in Figure 4.1 below. Totals are aggregated for both TOCs.

Figure 4.1 – breakdown of congestion delay by TRUST section and direction



The majority of the congestion delay occurs to the north of East Croydon station, and the largest part of that is in the down direction through Windmill Bridge Junction.

Given the above it was not a surprise when performance modelling on the December 2018 end KO2 timetable, completed by the Thameslink Programme team at Network Rail, indicated the flat junctions at Windmill Bridge, Stoats Nest and Keymer Junction are performance risks against the current timetable specification planned for the BML from 2018. This specification loads a few more trains through East Croydon, Windmill Bridge and Norwood Junction during the peak than presently operate. Section 5 considers this issue further.

5: Developing the railway in CP6 and beyond

5.1: Options under consideration on existing infrastructure

As sections 1-4 detail, the infrastructure as presently configured on the BML is essentially full during the peaks, due to the capability of junctions, station platforming and the complicated range of origin and destination flows that reduce the flexibility of how trains can be pathed. As a result the number of constraints to further additional train paths being operated in the high peak is significant.

Despite this, the re-signalling of the Three Bridges interlocking area planned for CP6, offers a once in 40 years opportunity to remodel some of the junctions and station areas referred to as key constraints in section 2. Figure 5.1 below identifies the area of signalling up for renewal in the Three Bridges interlocking area (+ the Clapham interlocking), mapped against the key constraints identified in Section 2.

Figure 5.1 - Brighton Main Line - Key capacity constraints/CP6 resignalling opportunities

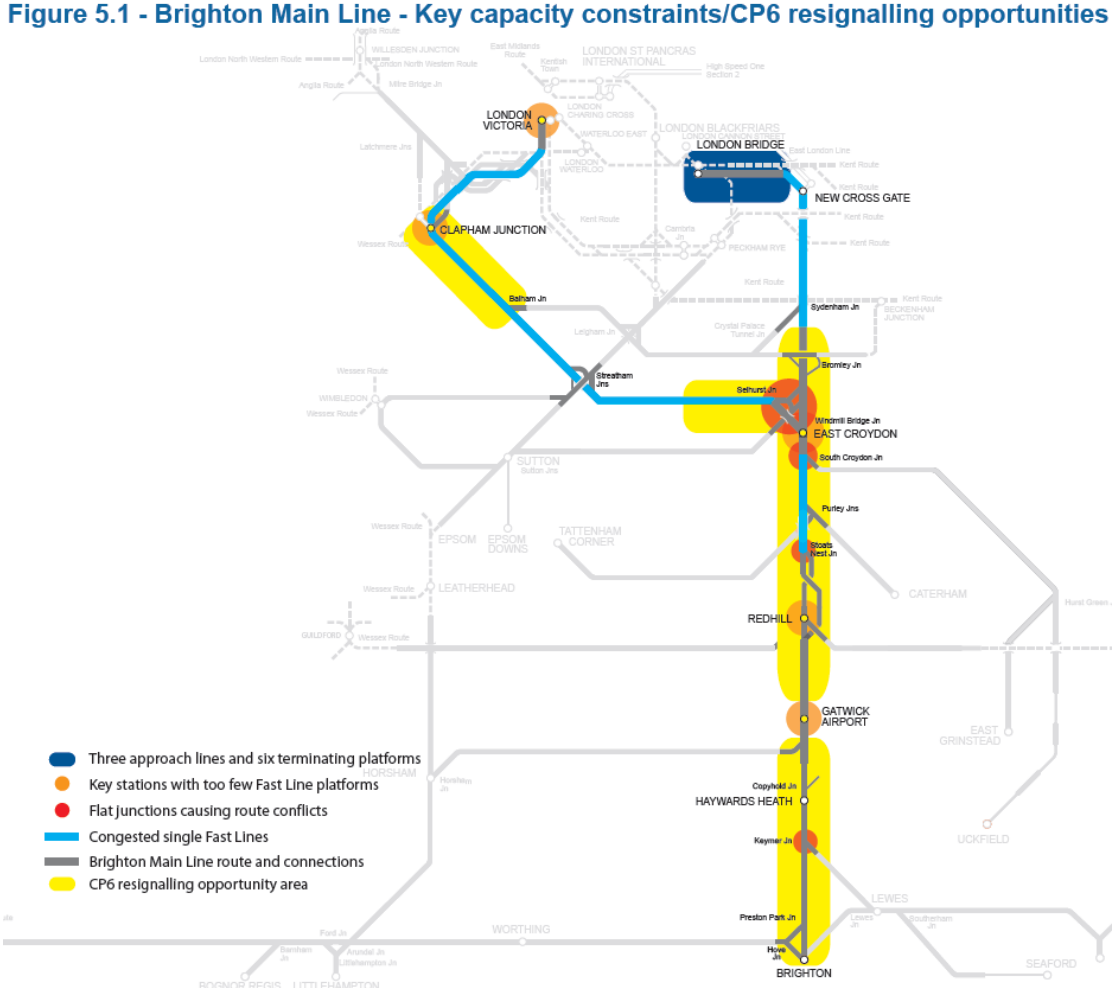


Table 5.1 below details each constraint described in Section 2 and the potential solution where one has been identified either as part of Three Bridges re-signalling or a separate scheme:

Table 5.1: Key constraints and possible solutions:

Constraint	Area due for re-signalling in CP6?	Possible solution (in each case further work is required to prove case)
1. Keymer Junction	Yes	Several options under consideration from grade separation to a third track option – case yet to be proven and would not be required if reliability and capacity uplift was focused on Gatwick inwards only.
2. Stoats Nest Junction	Yes	A grade separation option for Up Slow to Up Fast moves under development.
3. South Croydon Junction	Yes	No viable solution currently available. Relief of other constraints may allow current layout to remain, as the flat junction constraint predominantly affects Slow Line services (although potentially constrains the pathing of services that use the Fast Lines north of Croydon).
4. Windmill Bridge Junction	Yes	Grade separation of remaining flat junction conflicts (Down Victoria Fast with Up London Bridge Fast) and Up London Bridge slow with Down Victoria slow) under development.
5. Victoria Main Line platforms	No	a) Transfer of Platform 8 from South Eastern side into South Central side of station. Associated alteration of S&C on approaches/ shifting over by 1 platform of all suburban services to create 1 additional Fast Line Platform. b) Better utilisation of platforms in the peak by a reduction in the number of train sets split down in the platforms themselves and sent back out in the contra-peak direction.[7]

[7] The current practise of splitting stock down in the morning peak is driven by a range of requirements including the need to send vehicles to depot for maintenance, stock positioning for the off and evening peaks and the fact that it is the most sensible place to split down some contra-peak moves.

		c) Investigate changes to Up and Down Brighton Fasts between Battersea and Victoria to potentially make them reversible and offer a more flexible 3 track main line approach to Victoria (current reversible is on the Up side, leading to conflicting moves to get to the Down). d) Greater use of (and associated alterations to) the Pouparts Junction – Battersea Reversible – Victoria Eastern Route.
6. Clapham Junction Main Line platforms	Yes (or end CP5)	a) Conventional signalling alterations and ERTMS to be looked at to ascertain potential to reduce platform re-occupation time but this may well not be feasible. b) Options for an additional platform face for Fast Line usage being reviewed It should be noted a reduction in stopping of fast services at Clapham would relieve this location as the ruling constraint on the route – but is unlikely to be feasible from a demand point of view.
7. London Bridge Low Level platform availability and approach tracks	No	The configuration of 6 platforms and 3 approach tracks is likely to be fixed for the long term. Not considered feasible to add additional platforms or approach tracks. Balance of suburban vs Fast Line services that operate into the low level post December 2018 may be important.
8. East Croydon Main Line platforms and associated track layouts	Yes	Scheme providing an additional 1 or 2 platforms under development. Scheme would also provide additional track East Croydon to Windmill Bridge Junction and track layout and signalling changes in the immediate East Croydon area including to relieve platform 4 and

		5 constraints outlined in section 2.
9. Gatwick Airport Main Line platforms	No (resignalled in CP4)	Solution to be completed in CP4 (February 2014). Additional Main line Platform to be commissioned. Station footprint will be tested in the Route Study for long term compatibility with traffic growth.
10. Single Up and Down Main Lines Stoats Nest – South Croydon	Yes	No obvious solution, other than continued assessment of marginal gain new signalling technology can deliver in terms of headway. Not yet a ruling constraint though.
11. Single Up and Down Main Lines Norwood Junction – Bricklayers Arms Junction	No	No obvious solution, other than continued assessment of marginal gain new signalling technology can deliver in terms of headway. Not yet a ruling constraint though.
12. Single Up and Down Main lines Selhurst – Battersea Park	No	No obvious solution, other than continued assessment of marginal gain new signalling technology can deliver in terms of headway. Not yet a ruling constraint though as the capacity of the section is governed by constraint 6.

5.2: Potential outputs in CP6 if solutions are implemented

5.2.1: Capacity BML <> Victoria

Early in 2013 Network Rail undertook some initial timetabling work to assess whether extra high-peak and 3-hour peak paths could be achieved if some of the infrastructure solutions outlined above were implemented. The work concluded that if solutions to constraints 2, 4, 5a and 8 were implemented as described above, two additional 12-car paths per hour throughout the peak could operate in the Down direction during the evening peak between Victoria and Gatwick Airport. This is over and above the service improvements that could occur in December 2018 under the Thameslink Programme (DTT 2011 iteration).

The report also concluded that the same level of additional service could operate in the Up Direction in the morning peak between Gatwick and London Victoria – but only if constraint 6 at Clapham Junction was also tackled.

Further iterations of operational planning work are underway and will be reported in the Route Study. Work to date on these looks likely to confirm the capacity benefits of the Windmill Bridge and Croydon interventions and

suggests a greater capacity benefit may be achieved if a Clapham solution proves feasible. It is important to note though that detailed performance modelling has not yet been undertaken, and this will be an important part of further work – before any final conclusions can be drawn.

5.2.2: Capacity BML <> London Bridge

The current plans for services from the BML/ Sussex suburban area to/from the Thameslink core is for 14 or 16 tph during the high peak. DTT 2011, the outline development timetable produced by Network Rail, had 14tph to the core during the peak. DfT has since indicated it would like to see a specification of 16tph from the Sussex Route area. Network Rail has proposed that due to congestion during the peaks north of Stoats Nest the +2tph should be substitution for existing services that operate into the Low Level at London Bridge rather than + 2tph overall.

This issue will be considered further as bids for the new franchise are assessed. It is possible that if interventions 2, 4 and 8 are completed in CP6 this net +2tph overall could operate from that point onwards, but further work is required to pinpoint how this could happen and the origin points of services.

Linked to this is the specification for suburban services into the Low Level at London Bridge. Additional services, for example from the Wimbledon Loop into London Bridge, might compromise the opportunity to operate a few additional Fast Line services from the coast into the Low Level platforms in the future. This is driven by the capacity constraint of the Bermondsey Reversible line into London Bridge Low Level, meaning that any increase in service frequency on the Tulse Hill corridor is likely to drive greater use of Lines 10 and 11 on the approaches to London Bridge.

It may be a better strategy to lengthen suburban services on that route to 10-car operation (notwithstanding known issues at Tulse Hill) than use up additional train paths into the Low Level. This possible trade off will be investigated further in the Sussex Route Study and an option around this trade off presented to funders.

5.2.3: Performance

Some initial thinking has been undertaken identifying the possible performance benefits of undertaking solutions 2, 4, 5a and 8. The principal benefits arise from removing the remaining conflicting moves at Windmill Bridge Junction and Stoats Nest that currently result in delay being passed between different services that would otherwise be unlikely to impact each other. Further work on quantifying potential performance benefits of the interventions outlined will be undertaken prior to any submission for funds for later GRIP stage development of the infrastructure options referred to in this report.

The extra platform option at Clapham Junction has not yet been assessed for performance impact – as initial feasibility has not yet been completed – but if feasible this is likely to carry performance benefits.

Further work on the performance implications of the options set out in Table 5.1 will be taken forward in co-ordination with the Brighton Main Line Reliability Modelling work recently completed for RSSB by Network Rail.

5.3: The role of new line schemes / diversionary routes

5.3.1 General

As can be seen from the above analysis, the critical constraints to delivering the next increment of through capacity on the BML are predominantly at the London end of the railway i.e from Stoats Nest/ Croydon north. This is not to say that constraints do not exist on the Southern end of the route. For example, the flat Junction at Keymer is particularly restrictive and the single line sections on the Uckfield line lead to fixed paths and some limits to flexibility of pathing on the Fast Lines north of East Croydon.

Despite this, as Section 2 displays, significant crowding on Main Line services tends to exist from Haywards Heath and Gatwick inwards. The re-configuration of platforms at Gatwick during CP4 has raised the possibility that if constraints in the inner area were relieved or partly relieved, additional services from as far out as at least Gatwick might be able to operate – without significant expenditure in the outer areas.

Given the constraints outlined on the route in Section 2, it is clear a new line solution would have to relieve constraints inwards of Stoats Nest and Croydon to add any capacity value over what may be achievable anyway in CP6.

The Sussex RUS highlights this fact in conclusions published in 2010. The RUS concludes that long-term relief of the BML would require a new railway in tunnel from at least as far out as South Croydon in addition to any new line scheme in the outer area.

5.3.2 Lewes – Uckfield

5.3.2.1: 2008 Report

During 2008 Network Rail undertook a study on behalf of East Sussex County Council, assessing the likely cost of re-instatement of the Lewes – Uckfield line and assessing the likely business case.

The report concluded there was not a case for re-opening the route. The key points from the study were:

- The cost of route re-instatement exceeded benefits of all options tested
- Options tested were based on the extension of existing Uckfield services to Lewes, Seaford and Eastbourne
- The level of population and expected development around the line was an important factor in the weak business case

Despite this the Sussex RUS published two years later in 2010, recommended the continued protection of the alignment. The logic for this remains sound, namely that in the long term, if a large-scale new lines solution is found to the inner area (South Croydon and inwards), focus will again turn to how the outer areas of the BML can handle greater capacity.

Whilst the RUS and this report concludes that in the medium term there is limited value in large-scale investment in the outer areas – as the next increment of capacity can only be gained by investment in the inner areas – this long-term point remains correct.

5.3.2.2: A medium-term capacity case for Lewes – Uckfield?

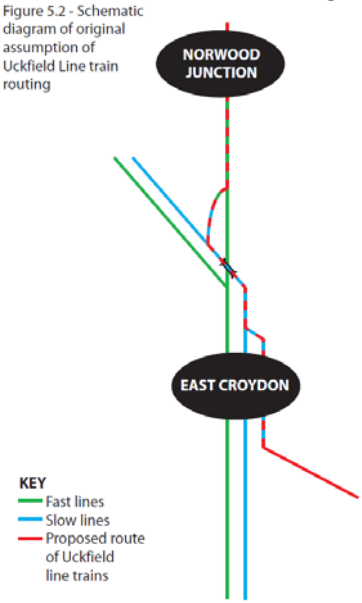
In the medium term it could be argued that the remaining relatively small levels of incremental capacity that may be squeezed out of the inner area by investment in CP6 could be put to running additional through services from a reopened Lewes – Uckfield route, rather than just extending existing Uckfield trains – as the original business case proposed. There are a number of reasons why this argument is unlikely to support a business case for early re-opening of Lewes – Uckfield.

- Allocating the last remaining freed up capacity that can be achieved from works in the inner area to services via the Lewes - Uckfield route may not be supported by evidence of where the largest peak demand is coming from. These services would not relieve Haywards Heath or serve Gatwick Airport for example.
- Running additional through services on the Uckfield line would trigger significant upgrade costs between Oxted and Uckfield including the need to double remaining single line sections, upgrade and put in new power supply equipment and re-signal parts of the route.

When plans were assessed for making use of the Lewes – Uckfield route as part of a capacity generating plan into London at the beginning of the last decade, some innovative ideas were put forward as to how re-opening the route could free up additional capacity all the way into London Bridge.

This was achieved by the tactic of keeping new additional Lewes – Uckfield London Bridge services 'on the right-hand side' through the congested East Croydon area (see Figure 5.2) meaning conflicts between additional Lewes – Uckfield – London Bridge Services and Fast Line services to and from Victoria would never occur – as they do today between Fast Line BML – London Bridge and BML – Victoria services.

Figure 5.2 - Schematic diagram of original assumption of Uckfield Line train routing



Unfortunately as table 4.1 in Section 4 indicates, since these proposals were floated the fast lines into London Bridge north of Norwood Junction have largely been filled up by other trains from the existing BML. In particular, by December 2018 the

lines will be operating at close to capacity once constraints at London Bridge in terms of platforming and approach tracks are factored in alongside the constraints at Windmill Bridge. The growth in use of these lines to 2018 is predominantly due to the re-routeing of BML to TLK core services via London Bridge during the peak - delivered as part of Thameslink Key Output 2.

In the short to medium term therefore the most likely use of Lewes - Uckfield could only be for the existing 2tph from Uckfield to be extended to run from Lewes or beyond. The 2008 study indicated this approach did not have a business case. Plans now exist to lengthen existing services on the Uckfield line to 10 car (Table 1.1, section 1) but this is just to meet current peak demand from the branch itself and locations inwards including East Croydon.

As section 5.2.2 indicates, if interventions 2, 4 and 8 are delivered in CP6, there is a possibility some incremental capacity into the Low Level at London Bridge could be released, but this is dependent on which of the services that currently operate into the Low Level are routed to the TLK core in the 2018 timetable change and the precise usage of the Low Level for suburban services as noted in 5.2.2.

The Sussex Route study will examine these trade offs in more detail and present options for funders.

5.3.2.3: Diversionary benefits

It is correct that at times of planned or unplanned prolonged disruption on the Brighton Main Line south of the Croydon area there would be some diversionary benefit in having the Lewes – Uckfield route open. However under the scheme assessed in the 2008 report, diversionary benefits would be predominantly for East Coastway passengers, with any passengers from Brighton only able to use the route with services reversing at Lewes, and passengers from the West Coastway and any stations north of Brighton on the BML receiving no benefit.

Regardless of the direction and layout of future connections at Lewes (and alternatives have been proposed that would allow through running from Brighton without reverse), capacity limitations north of Uckfield mean that it is unlikely at times of diversion that more than 1tph additional to the existing Uckfield service could be diverted this way without doubling the single line sections of the existing branch and associated re-signalling. Electrification would of course also have to be completed.

5.3.2.4: Lewes – Uckfield conclusions

In conclusion there remains a long-term case for protecting Lewes – Uckfield but this may rely on a longer-term new lines solution for the inner area of the BML.

The medium-term case for re-opening is not strong as the 2008 report established and is further hampered by the lack of additional peak paths likely to be available from South Croydon inwards for trains from a re-opened route. Most of all, the case is compromised by the fact that paths that can be freed

up by any Network Rail enhancements in the Croydon/ Windmill Bridge and Stoats Nest areas in CP6 would be under pressure to be allocated to main line flows from Gatwick/ Haywards Heath and the West Coastway/ East Coastway via the existing BML, rather than being allocated to the East Coastway via Uckfield.

Despite this, the Route Study will identify any freed up capacity from the enhancements outlined for CP6 for the inner area and it will be for funders to decide how that capacity is ultimately used.

5.3.3: Diversion via the Arun Valley/ the Arundel Chord

5.3.3.1: Diversionary benefits

During engineering works on the BML, trains can currently be diverted into Victoria via the Arun Valley and back onto the BML at Three Bridges, or alternatively via the Arun Valley and back onto the slow or fast lines of the BML London side of Streatham Common.

Presently trains diverted by this route have to go into Littlehampton to reverse. This adds to the journey time and makes the routing generally unattractive. Table 5.2 below outlines indicative journey times that might be achievable were an Arundel chord in place and compares them to existing options and the Ford turnback option.

Table 5.2: Diversionary route estimated journey time comparison

Brighton to	Victoria via Gatwick		London Bridge		Victoria via Sutton	
via	Mins	Stops skipped	Mins	Stops skipped	Mins	Stops skipped
Fast direct train	51		56			
Semi-fast direct train	59		68			
Lewes & Keymer Junc	83	3	80	3		
Ford	118	6	115	6	139	9
Littlehampton	125	6	122	6	146	9
Arundel Chord	105	6	102	6	126	9

As can be seen from the analysis, the route with the chord would offer better diversionary journey times than reversing at Littlehampton or Ford. Journey times from Brighton would still be significantly extended but less so for the Worthing market. For Brighton passengers the journey time penalty, even with the Chord, is at least 50 minutes.

Nevertheless the potential of the option to increase maintenance access to the two-track railway south of Balcombe and provide a faster diversionary route for passengers at times of unplanned disruption means it is currently being assessed in more detail as part of the Route Study. High level costings and operational planning work to establish the number and quality of diverted paths is being undertaken and options to funders will be presented in the Route Study.

5.3.3.2: Possible capacity benefits

One of the key issues with the capacity-generating case for constructing an Arundel Chord is the number of through train paths to London that could actually be achieved via this route during the peak on a weekday – as opposed to at weekends or late at night/ in the early morning when diversions for maintenance access are most likely.

The Arun Valley itself will be re-signalled by the late spring of 2014. This means ruling headways of around four minutes will replace some of the existing long block sections. Paths as far as Horsham therefore are likely to be available. However, to run additional trains into London via this diversion during weekday peaks, trains would then have to continue via the Horsham – Dorking – Epsom – Sutton route and rejoin the BML slow or fast lines London side of Streatham Common.

Threading additional paths via this routing will be very difficult. As part of the Route Study an assessment will be completed as to whether any additional through peak paths could be found via this routing from the Worthing area but this may not yield positive results.

6: Conclusions and next steps

6.1 Key conclusions

- Already committed capacity interventions in CP4 (2009 -2014) and CP5 (2014-2019) will have a significant impact in decongesting some peak trains, in particular those that serve London Bridge.

- The key constraints to unlocking a further increment of capacity on the BML are the flat junctions and the number of fast line platforms at key stations. These constraints are not only limiting capacity on the route but are now a day-to-day part of the reliability challenge of delivering the existing timetable.

- The density of traffic on plain line sections is also an issue but this is because of the uneven spacing of services on these sections driven by the complexity of the origin and destination of services plus the flat junctions and platform availability described above.

- Future signalling technology advances such as ERTMS are likely to provide marginal capacity benefits on plain line sections, but will not remove the key constraints of flat junctions and available fast line platforms.

- The most heavily utilised flat junctions, platform faces and plain line sections are in the inner area of the route i.e. from Stoats Nest Junction (north of Redhill) inwards to London, and it is here that the main focus of effort needs to be in CP6. These locations are acting as a bottleneck for the whole route. Most of these inner locations are also likely to see increased usage from December 2018, when the Thameslink programme is completed.

- There is no single intervention that can free up capacity on the route, but the planned renewal of much of the Three Bridges area signalling interlocking in 2020 potentially represents a one-off opportunity to ease several further key constraints, primarily at East Croydon, and Windmill Bridge Junction but possibly also at Stoats Nest and Keymer.

- Initial work suggests that, should they prove affordable and feasible, improvements at the above locations as enhancements on Three Bridges re-signalling renewal will release some valuable additional capacity into Victoria on the BML, but this is also contingent on relieving some localised constraints in the Clapham area (also due for re-signalling in CP6).

- The interventions that could take place in CP6 would also have some capacity benefits for main line traffic via London Bridge although it is unlikely a significant number of additional main line paths will be

released on this route unless a re-balancing of other suburban workings into London Bridge Low Level is considered.

- It is absolutely critical that any interventions to improve capacity also address reliability issues on the route. Consequently, the focus of development work in CP5 and, subject to the outcome of that work, investment in CP6, will be interventions that improve reliability as well as releasing some remaining incremental capacity on the BML[8].

- Network Rail will continue to work closely with DfT and the winning bidder for the TSGN franchise to deliver the optimal timetable from a performance and capacity perspective, in the meantime, in December 2018.

- Given the above conclusions with respect to critical bottlenecks on the inner section (London end) of the BML, large scale investment in alternative routes on the outer area of the BML such as Lewes – Uckfield, is likely to be of very limited value in the short to medium term, although Network Rail remains of the view that protection of that alignment is still the correct policy for the long term.

Next Steps

In preparation for the publication of the Sussex Route Study in draft in late 2014, Network Rail is proposing to undertake the following workstreams over the course of this year.

- Further development of our understanding of the outputs, in terms of train paths and performance improvement, that the interventions outlined in this report could deliver. This process will also include the impact of any other interventions that come to light as part of the Route Study process.

- Further development of the feasibility of the infrastructure options outlined in this report. The extent of development will depend on available funding.

[8]To this end the Sussex Route study will continue to be developed alongside work recently completed by NR for RSSB on BML performance, as well as ongoing industry workstreams on Traffic Management Systems and ERTMS.