1. Introduction

1.1 HS2 Ltd has been asked to provide a high level assessment of the comparative business cases of:

(a) A network extending from the West Midlands to Manchester and then across the Pennines to Leeds; and
(b) A network incorporating separate legs from the West Midlands to each of Manchester and Leeds[1]

As part of this assessment we have also been asked to consider the consequences of each option for capacity on the major conventional routes to London from Yorkshire and the West Midlands.

1.2 Of the two networks described in 1.1: (a) is commonly referred to as a 'reverse S' and (b) as a 'Y'. This paper will refer to the two corridors as the 'S' and the 'Y' throughout.

1.3 This paper provides the high level comparative analysis. We have considered only the two different options noted above. Our assessment is made at a broad corridor level using approximate service patterns (set out at Annex A), and we have not defined specific routes. In making this comparative assessment we have not carried out a detailed analysis of the wider network options from either core corridor, limiting ourselves to observing possible implications only where these are clear cut. We recognise that the ultimate high speed network could be based on either the S or the Y or a combination of the two; but our focus here is on which looks the best prospect for early development.

1.4 The Executive Summary below sets out the main conclusions from our assessment. Section 3 provides a short explanation of the two corridors being assessed. Section 4 provides more detail on the S and Y describing, at a high level, our broad assessment of the engineering feasibility, infrastructure costs and headline sustainability features of both corridors. Section 5 then considers the potential released capacity on the conventional existing railway lines resulting from either high speed corridor being taken forward. Section 6 sets out the relative business case for both options, comparing and contrasting, at a high level, the forecast passenger demand as well as examining the indicative costs and benefits. And in Section 7 we have set out a short summary of external opinion on the merits of both options.

[1] Remit letter from the Secretary of State for Transport to Sir Brian Briscoe, Chairman of High Speed Two Ltd (11 June 2010) http://www.hs2.org.uk/publications/HS2-Ltds-remit-of-11-June-2010-56111

2. Executive Summary

2.1 Our high level comparative analysis of the two wider network options concludes that the benefits offered by the Y are likely to be substantially greater than the S. The Y has the potential to deliver in the order of £15bn[2] more in wider transport benefits and as much as £10bn[2] more in revenue through faster city to city journey times and by capturing sizeable additional markets.

2.2 We estimate that the cost of the Y (over and above the London to West Midlands route) is £11.2bn, compared with £10.4bn for the S. However, this is comfortably outweighed by the additional benefits of the Y. Moreover the per mile build costs of the Y would be around a third lower given the longer network created and its likely more straight forward construction.

2.3 The operating costs of the Y are likely to be in the region of a third higher than the S though this reflects in part the more significant high speed rail network offered by the Y and therefore assumes a higher number of services than on the S and higher rolling stock costs.

2.4 Whilst the S would provide significant benefits for passengers between the North West and Yorkshire and Humberside this market is comparatively smaller than the market accessible by the Y which could serve the East Midlands and South Yorkshire as well as Leeds. Serving these areas is forecast to enable in the region of 40,000 or more trips per day on the rail network in 2033 than under the S.

2.5 Reduced journey times from city centre to city centre with frequent services were the major source of benefits in the business case we presented for high speed rail. As the table on page 4 shows the journey time to Leeds on the S is potentially some 15 minutes slower than on the Y and over 20 minutes slower to Newcastle. Whilst the S offers the prospect of faster journey times between Leeds and Manchester our high level assessment suggests that this would be outweighed by the more sizeable market between London and Leeds and the faster journey times offered by the Y.

2.6 Both the S and Y would also have a positive effect on releasing capacity on existing conventional routes and, subject to available capacity, both could enable fast conventional services to run on parts of the high speed line where it is not fully utilised. Both would have the same effect on the West Coast Main Line, potentially enabling local, inter-urban passenger and freight services to be improved. The key differences between the S and the Y are:

[2] Present Value 2009

- With the S, depending on technical evaluation, some or all of the Trans-Pennine Express services might share a high speed route between Leeds and Manchester. This would release capacity and facilitate the growth of local passenger and freight traffic on this busy regional corridor.

- The Y would release more capacity on the East Coast Main Line from south of York to London, potentially benefiting local and long distance passengers and freight services.

- The Y would release capacity on the Midland Main Line at the southern end of the corridor which could be used for additional Thameslink services for the growing market from Bedford and Luton through Central London.

- The Y would also release some cross country capacity between Birmingham and the East Midlands and South Yorkshire which would facilitate the development of additional inter-urban services.

2.7 Therefore, whilst both the S and Y have a positive impact on releasing capacity from conventional lines our broad assessment is that the Y would offer greater opportunities. At this high-level stage, the potential benefits of released capacity gained by either corridor have not been included as part of the overall comparative analysis but could increase the return of both options.

2.8 Both corridor options are feasible from an engineering viewpoint and this comparative analysis does not seek to rank either option. Both would incorporate a route between Birmingham and Manchester to the west of the Peak District. For the S it is clear that a corridor across the Pennines would create major engineering complexities coupled with a potentially significant impact on the natural environment. Whilst tunnelling could be used to mitigate the impact on the landscape and respect the topography, it would come at a high cost and with the additional vents and shafts necessary for longer tunnels. The Y would potentially encounter engineering complexities between East Midlands and Leeds but we consider that there is greater scope than with the S to mitigate the impact on the natural environment during the more detailed route design phase.

2.9 We have not sought wider external views during the creation of this comparative analysis. We have set out in the final section the views expressed during our earlier work on the London to West Midlands. This largely supported a configuration consistent with the Y rather than the S.

Summary Comparison Table

Journey Times (hrs:mins)		
Route	**S**	**Y**
London – East Midlands*	N/A	0:53
London – South Yorkshire*	N/A	1:15
London – Manchester	1:20	1:20
London – Leeds	1:35	1:20
London – Newcastle	3:00**	2:37
London – Glasgow / Edinburgh	3:47	3:47
Birmingham – Manchester	0:54	0:54
Birmingham – Leeds	1:17***	1:05

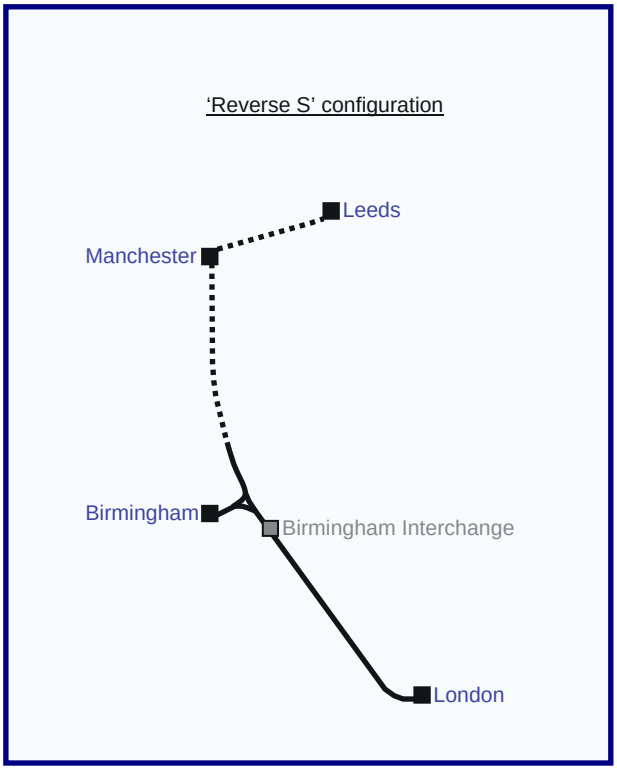
*The times on the 'Y' are the equivalent to new East Midlands and South Yorkshire stations the location of which would be defined if this corridor option is selected.
** Included for information only and not modelled
*** Includes the assumption that high speed trains starting at Birmingham would include Manchester as an intermediate stop on the way to Leeds.

3. Corridor Description

3.1 This section describes both corridors:

(a) A network extending from the West Midlands to Manchester and then across to Leeds.

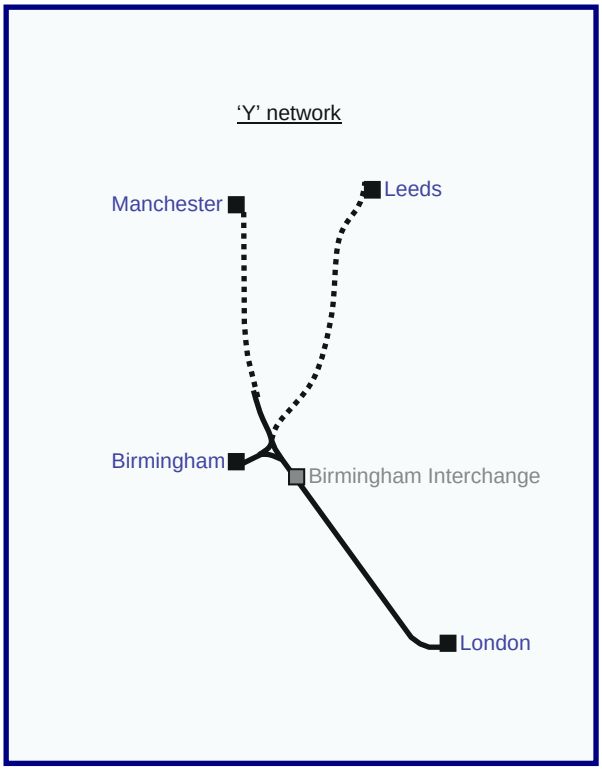
This configuration is known as the ‘Reverse S’ and is referred to in this paper simply as the ‘S’:



Similar network configurations have been the subject of past investigation. Beyond Birmingham the route would connect first Manchester and then across the Pennines to Leeds. Beyond Manchester and Leeds this network could potentially connect with the East and West Coast Main Lines to serve the North and Scotland.

(b) A network incorporating separate legs from the West Midlands to each of Manchester and Leeds

This configuration is known as the ‘Y’ and has been referred to in this way throughout this paper:



The ‘Y’ shaped network links London to Birmingham and beyond to Manchester and Leeds by way of two separate legs. The eastern leg could also serve the East Midlands and South Yorkshire. Beyond Manchester and Leeds this network could potentially connect with the East and West Coast Main Lines to serve the North and Scotland.

4. Engineering, Infrastructure Costs & Sustainability

4.1 This section sets out, for analytical purposes, route corridors for both the S and the Y that would be broadly feasible in engineering terms. No detailed engineering analysis has taken place at this stage. If remitted to do so, we would work to propose a specific route to the same level of detail, and using the same methodology, as the London to West Midlands report.

4.2 In describing broad corridors we have made assumptions for the purposes of producing realistic cost estimates and getting an overall impression of the environmental challenges. We have kept in mind that in our earlier work we have proposed an infrastructure designed for speeds up to 250mph (225mph at opening). In order to achieve maximum speeds the preferred position for the physical track would be at ground level ('at grade') or just below ground level ('in cutting') which would also serve to minimise the visual impact. A normal maximum gradient of 2.5% (1 in 40) would still enable maximum speed to be maintained and was used in sections of our design for London to the West Midlands.

4.3 Our assessment seeks to describe some of the most significant natural environment areas that the corridors could encounter. At this stage we have not conducted a detailed analysis against the four sustainability criteria which, if remitted, we would do as part of our detailed analysis to come forward with a preferred route in the future. In making an assessment here, we have made high level assumptions about potential ways to mitigate or reduce the potential impact on the natural environment, such as through the use of tunnels. Our potential future work designing a specific route, and coming forward with a preferred approach, would include a comprehensive assessment of how to limit the impact on, or avoid, key natural environment areas such as Sites of Special Scientific Interest (SSSI), wetland areas, Special Protection Areas (SPA) and Special Areas of Conservation (SAC) as well as meeting wider sustainability criteria.

4.4 Tunnels are often presented as the best way to minimise the impact of new routes. As highlighted in our earlier work, whilst tunnels potentially mitigate the impact on landscape and property, or provide a topographical solution, they are not without engineering complexities and environmental impact of their own. Our previous work has shown that in order to maintain the maximum design speed of 250mph, larger tunnel diameters, up to 9.5m are needed. Tunnels also cost about five to six times more per mile than building at ground level. Therefore tunnel diameter and associated cost needs to be considered in each case against the benefits of achieving these maximum speeds. In this assessment, for both the Y and S configuration north of the West

Midlands, we have used a maximum speed in tunnel of 200mph. Additional factors to be considered, depending upon tunnel length and speed, are requirements for cross passages and intervention shafts for emergency use; ventilation to relieve pressure in the tunnel and avoid both passenger discomfort and excessive noise as a train emerges from the tunnel. Tunnel design would also take account of ground conditions in order to mitigate any potential settlement.

The S Corridor

Lichfield to Stoke/Stafford

4.5 The high level natural and cultural features map (attached) shows the region and the main natural environment features highlighted below.

4.6 Starting from Lichfield, the end-point for the London to West Midlands route, the S corridor would head in a north westerly direction broadly towards Stafford and Stoke on Trent. It would be naturally constrained by two barriers; the Peak District National Park to the east and the Cannock Chase Area of Outstanding Natural Beauty and associated SSSIs to the south west. The landscape that the corridor would pass through is predominantly flat and therefore we assume, for cost estimate purposes, that the line would either be at grade or in cutting.

4.7 The corridor would potentially pass close to Blithfield Reservoir located only a few miles north of Lichfield. Therefore any route would have to divert around this feature. Continuing in a broadly north direction we assume for our cost estimates that it is unlikely that any of this section would need to be in tunnel.

Stoke/Stafford to Manchester

4.8 Several important international and national environmental features occur within this corridor including a number of SSSIs, significant wetland areas and major parks and gardens. These would all require particular attention through the design of any future specific route.

4.9 In this part of the region, the topography generally stays the same though the size of villages and towns starts to increase. This would require careful evaluation and planning in order to minimise the impact and retain as much of the proposed corridor as possible at grade.

4.10 Heading towards Manchester we assume that the corridor might follow the main road arteries. As much of the route as possible would be in cutting or at grade though the closer the route gets to urban hubs the more likely the need for tunnelling.

4.11 As this corridor approaches Manchester Airport, offering opportunities to pick up an interchange, and the larger urban areas around Manchester, it would be likely to need longer sections of tunnel; in some cases three to four miles in length. Tunnelling would minimise disruption to the local urban environment and reduce the physical impact, however, it does add an additional level of complexity and risk due to changing geological strata, buried services and ground water. However, the areas that the corridor would potentially pass through predominantly consist of mudstone, gritstone and boulder clay, and would be considered a good medium to tunnel in.

4.12 Creating a suitable alignment into the centre of Manchester, to serve a possible range of central station options, would be challenging. Although existing transport corridors would potentially offer practical and realistic options. Following the methodology adopted between London and Birmingham, the proposed approach would most likely be a combination of tunnel, grade and elevated running using existing transport corridors.

4.13 As the corridor approaches Manchester a high speed junction and connecting spur towards Warrington could be constructed in order to route trains to the North via the West Coast Main Line (WCML) and to locations served by the classic network.

Lichfield to Manchester route and costs

4.14 Table 1 shows the assumed route lengths for the proposed corridor between Lichfield and the centre of Manchester[3] (paras 4.5 – 4.13):

Table 1

From	To	Rural Flat (mile)	Rural Hilly (mile)	Urban length (mile)	Tunnelled length (mile)	Total (mile)
Lichfield	SW Manchester	28	30	0	1	59
SW Manchester	Central Manchester	0	0	5	6	11
SW Manchester	WCML (Warrington)	8	5	3	0	16
	Total (miles)					**86**

4.15 Table 2 shows the high level costs for the Lichfield to Manchester corridor. These costs have been developed using the rates for delivery as published in our 2009 report on the London to West Midlands route

[3] Route lengths and cost estimates in Tables 1 to 6 include rounding.

and include allowances for risk (including a 66% optimism bias), contingency and scheme management. Provision for land purchase and compensation are not included in these figures.

Table 2

From	To	Rural Flat (£bn)	Rural Hilly (£bn)	Urban length (£bn)	Tunnelled length (£bn)	Total (£bn)
Lichfield	SW Manchester	0.8	1.4	0	0.3	2.5
SW Manchester	Central Manchester	0	0	0.3	1.3	1.6
SW Manchester	WCML	0.2	0.2	0.2	0	0.6
Manchester Central Station						0.4
Potential additional station						0.3
	Cost (£bn)					**5.4**

Manchester to Leeds

4.16 From Manchester we have assumed that the corridor would initially head north east and then east close to existing transport corridors in a mix of tunnel and elevated structures. Tunnelling has been assumed beneath the South Pennine Moors designated as a Special Protection Area, Special Area of Conservation and an SSSI; the potential impact of tunnelling would need to be carefully considered in detailed design.

4.17 Continuing, the corridor would have to contend with steeper gradients, possibly to the maximum permitted 3.5% (1 in 28.5), in order to get across the Pennines. This would add to the tunnelling complexity and challenge. Where practicable the corridor would probably run close to the existing motorway network; however the topography would require a high proportion to be in tunnel. The geological make up of the Pennines is a mix of limestone, sandstone and shale which erodes easily in wet environments. Tunnelling in this environment would be considerably harder and more complicated and is seen as a higher risk and expensive due to the weak and changeable geology.

4.18 Both due to the distances involved, gradients and, as discussed in section 4.4, use of tunnels on this section, the maximum speed would be limited to 200mph rather than 250mph. Any tunnelled route across the Pennines would also have to incorporate ventilation shafts, tunnel

cross passages every one mile and access roads for maintenance and emergency services.

4.19 Exiting Leeds the corridor could reconnect with the East Coast Main Line (ECML) to route trains to the North and to locations served by the classic network.

Manchester to Leeds route length and cost

4.20 Table 3 shows the assumed route length between central Manchester and central Leeds:

Table 3

From	To	Rural Flat (mile)	Rural Hilly (mile)	Urban length (mile)	Tunnelled length (mile)	Total (mile)
Manchester	Leeds	0	13	16	15	44

4.21 Table 4 shows the estimated cost for this section of the S. A standard cost for tunnelling has been used. No assessment has been made of the effect of the complexity of tunnelling (see paragraph 4.17) on cost:

Table 4

From	To	Rural Flat (£bn)	Rural Hilly (£bn)	Urban length (£bn)	Tunnelled length (£bn)	Total (£bn)
Manchester	Leeds	0	0.6	1.0	3.0	4.6
Leeds Central Station						0.4
	Cost (£bn)					**5.0**

The 'Y' corridor

Lichfield to Manchester

4.22 The Y would follow the same broad corridor as the S westwards to Manchester set out in paragraphs 4.5 to 4.13. The high level natural and cultural features map (attached) shows the region and the main natural environment features highlighted below.

Birmingham to East Midlands (Derby/Nottingham)

4.23 Heading north east from the West Midlands, Coleshill area, we assume that this corridor could broadly follow the M42 motorway and A42 to limit the impact on people and to avoid the Peak District National Park.

4.24 There are a number of additional significant environmental features in this area including several SSSIs and woods, parks and gardens.

4.25 The corridor would likely be predominantly at grade or in shallow cuttings. Where practicable the line would pass under existing trunk and motorways, however if this is impracticable bridges would be required. This type of route infrastructure would be low risk.

4.26 As the corridor turns north it would have the opportunity to pick up an interchange close to East Midlands Airport or a well connected station facility for the Nottingham and Derby area, with Leicester being further away to the South East.

East Midlands to Leeds

4.27 Northwards the corridor could follow the existing M1 motorway though the natural topography would make this more challenging. There are a number of important cultural and environmental features in the region which would need to be carefully considered in any detailed design.

4.28 As the line heads north, it is likely that parts would have to be tunnelled. The tunnelled sections would be short, no more than one or two miles in length and in soft ground. Keeping them short would also minimise the requirement for cross passage tunnels and ventilation shafts although the speed through them may need to be restricted. The region's historic mining heritage would require careful consideration and allowances made for any remedial work to such locations.

4.29 Heading towards South Yorkshire, the route would become more complicated as there are no direct transport corridors to follow. Careful consideration would need to be given to the location of mine workings, regional SSSIs and parks and gardens as these could have a serious effect on any proposed line. The high speed line would potentially need to be a mix of at grade and tunnelled section.

4.30 The approach to Leeds would require detailed analysis during design. Where practicable we assume that the line would run alongside the existing transport system. However, as it approaches the centre of Leeds it might have to incorporate some tunnelling in order to access possible alternative city centre station locations and to limit the effects on property, people and businesses and local environmental and cultural sites.

4.31 As the corridor approaches Leeds a high speed junction could be constructed in order to route trains to the North via the East Coast Main Line (ECML).

Birmingham (Coleshill) to Leeds route and costs

4.32 Table 5 shows the assumed route lengths for the proposed leg between Birmingham (Coleshill) and the centre of Leeds.

Table 5

From	To	Rural Flat (mile)	Rural Hilly (mile)	Urban length (mile)	Tunnelled length (mile)	Total (mile)
Birmingham (Coleshill)	Leeds Centre	69	21	8	5	103
South Leeds	ECML	6				6
	Total (miles)					**109**

4.33 Table 6 shows the high level costs for the Coleshill to Leeds route. These costs have been developed using the rates for delivery as published in our report on the London to West Midlands route and include allowances for risk (including a 66% optimism bias), contingency and scheme management. Provision for land purchase and compensation are not included in these figures.

Table 6

From	To	Rural Flat (£bn)	Rural Hilly (£bn)	Urban length (£bn)	Tunnelled length (£bn)	Total (£bn)
Birmingham (Coleshill)	Leeds Centre	1.9	1.0	0.5	1.0	4.4
South Leeds	ECML	0.2	0	0	0	0.2
Leeds Central Station						0.4
East Midlands and South Yorkshire						0.8
	Cost (£bn)					**5.8**

Operating Costs

4.34 The operating and maintenance costs of the S are likely to be significantly lower than the Y for a number of reasons:

- The service specification for the S assumes fewer trains running over very long distances, particularly London to the North East – which would remain quicker on the existing ECML
- The S is likely to be a shorter route, resulting in lower track maintenance costs
- The S is assumed to have fewer stations (with lower operating and maintenance costs)

4.35 Our cost estimates are approximate, based on average utilisation of trains and the total distance travelled under the assumed service specifications (outlined in Annex A). Further optimisation of operating patterns and maintenance regimes may change these costs, but should provide a reasonable view for the purposes of comparing the networks.

4.36 The operating costs of the S are likely to be around two thirds the costs of the Y. The annual operating cost for the S would be around £830m (£350m on top of the London-West Midlands scheme), with the Y costing almost £1.25bn a year (an extra £770m).

4.37 Table 7 provides a breakdown of operating costs. It is clear that the biggest difference in costs is between rolling stock costs – reflecting the lower number of services assumed on the S. This is likely to be the most uncertain element of the operating costs as further optimisation may find more (or less) scope for high speed rail services between different locations.

Table 7: Estimated Operating and Maintenance Costs

	S	Y
Rolling stock		
Operating costs	390	600
Maintenance	290	460
Track		
Maintenance	120	150
Stations		
Operating costs	30	30
Maintenance	10	10
Total (rounded)	830	1240

4.38 Operating and maintenance costs are included in our analysis of the wider business case at section 6. Operating and maintenance costs are off-set by passenger revenues. The analysis in section 6 shows that, since the S delivers less revenue, the net costs would be slightly higher.

5. Released Capacity

5.1 Railway line capacity is used most efficiently when all trains have the same operating characteristics such as acceleration, maximum speed, braking and stopping patterns. Where a route has to cater for a wide range of traffic types (ranging from long-distance fast passenger trains to metro-style stopping trains and freight of varying speeds) the route capacity is quickly exhausted and the punctuality and reliability of the route tends to be poor. Therefore removing the fastest trains from such a route would not only release paths but would also enable a more homogenous service pattern to be developed, which would increase reliability.

5.2 The degree to which capacity on the existing rail network could be released by a high speed line varies according to the shape of the high speed network and the service pattern it offers. The following sections describe potential released capacity that might be achieved from either the S or Y high speed line. Whilst this would have economic benefit, this has not been included in our assessment of the relative business cases at this stage.

The S Corridor

5.3 As set out in the previous section, this network would consist of the core HS2 line from London to Birmingham and then onwards past Lichfield to Manchester and across the Pennines to Leeds. For the purposes of this comparison it is assumed that there would be a branch off this corridor south of Manchester to link back onto the West Coast main Line (London to Glasgow) in the vicinity of Warrington and indirectly to Liverpool.

West Coast Main Line

5.4 Creation of this high speed line would release capacity on the West Coast Main Line south of Warrington. This could be used to improve local and inter-urban passenger services and for freight traffic. North of Warrington there could be a net increase in fast trains to and from Scotland. This would require additional infrastructure works, which are as yet undefined. Diversion of some Birmingham to Manchester Cross Country flows onto the high speed line would also release capacity on the Birmingham – Wolverhampton – Stafford – Manchester route, which would particularly benefit West Midlands local services.

Trans-Pennine

5.5 The S also creates a high speed link between Leeds and Manchester. The northernmost trans-Pennine route (via Hebden Bridge) would be unlikely to see any significant change in capacity or journey patterns, as journeys on this route are of a predominantly local nature, which would not be changed by the introduction of a high speed link.

5.6 The main route between Leeds and Manchester is via Huddersfield and Stalybridge (known as the Diggle route). The existing TransPennine Express (TPE) services which run between Leeds and Manchester on this route form the central section of a network linking Newcastle, Middlesbrough, Scarborough, Hull, Manchester Airport and Liverpool.

5.7 Reconfiguration of TPE services would result in the release of capacity on the Diggle route. This would facilitate the growth of local passenger and freight traffic on this busy corridor, which features strong commuting flows into both Manchester and Leeds from the intermediate communities, in addition to the longer-distance trans-Pennine flows.

East Coast Main Line

5.8 The S would make little, if any, improvement for journey times to York and further north on the East Coast Main Line (ECML) (London Kings Cross – York – Newcastle – Edinburgh). Therefore only a limited amount of capacity is potentially released on this route by the withdrawal of one or two London Kings Cross – Leeds services in each hour with the likelihood that one service would be retained to provide a link between Leeds and Wakefield and intermediate stations to Kings Cross. This could enable the introduction of a small number of alternative services on the ECML of either a local or long-distance nature.

The Y network

5.9 The Y would be identical to the S for the London to Manchester / Warrington route. However, with no trans-Pennine link to Leeds, there is no released capacity effect there. Instead, the eastward line diverging from the core HS2 route terminating at Leeds should offer released capacity on other routes. A spur off this final section would run to the east of Leeds to reconnect onto the East Coast Main Line, notionally south of York (for the sake of this comparison).

West Coast Main Line

5.10 Capacity release would be identical to that noted in paragraph 5.4 for the S option.

Midland Main Line

5.11 The Midland Main Line (London St Pancras – Leicester – Derby / Nottingham – Sheffield) could see a significant reconfiguration of the service frequency and stopping pattern, as most passenger flows to the East Midlands and South Yorkshire would transfer to the new high speed services. Midland Main Line fast line capacity would be released which could be used for either additional Thameslink services

for the growing market from Bedford and Luton through Central London, or to develop improved services to intermediate station serving the Milton Keynes South Midlands Growth Area south of Leicester, or to provide a strategic freight corridor as has been proposed elsewhere.

Cross Country

5.12 The Cross Country route from Birmingham New Street via Derby to Nottingham and to Sheffield should also see passenger flows removed from the existing line and using the high speed line instead. This would facilitate development of inter-urban services, particularly on the Derby – Birmingham section, for which a requirement has already been identified.

East Coast Main Line

5.13 In addition to the diversion of London-Leeds passenger flows onto the high speed line, journey times to locations north of Leeds would be 20 minutes faster with the Y than the current fastest East Coast Main Line services. Therefore, through high speed services could operate to York and intermediate stations to Newcastle and possibly onwards to Edinburgh. This would release significant amounts of capacity on the ECML south of York as well as south of Leeds, facilitating a total re-specification of service patterns to meet the growing needs of commuting and regional passengers as well as freight customers.

Conclusion

5.14 Both the S and the Y would potentially have a positive impact on releasing capacity from conventional lines. Our broad assessment is that the Y should provide more opportunities and, in the case of capacity release on the Midland Main Line, additional capacity around the Southern corridor that might be considered valuable. The potential benefits of released capacity gained by either corridor has not been included in our assessment of the relative business cases at this stage.

6. Passenger Demand and Economic Benefits

Context

6.1 In this section we set out, at a high level, a comparative analysis of the potential passenger demand and relative benefits of the S and Y. We have used an indicative service pattern to consider the potential differences between both. This is not a detailed analysis but provides a realistic basis for comparison.

6.2 The demand and benefits of any new high speed line are broadly driven by the scale of the benefits in journey time offered between different locations, as well as the scope for reduced crowding and improved frequency of service.

Market access and journey time comparison

6.3 With a high speed trans-Pennine line, the S would provide substantially better connectivity between the North East, North West and Yorkshire and Humberside. The key conurbations of Leeds and Manchester would see journey times improve by over thirty minutes over current performance.

6.4 However, the Y would offer better links to London across a wider area, offering up to an hour off existing journey times to the East Midlands, South Yorkshire, and the North East. The Y would also offer faster journey times from Leeds to London due to the more direct route and inter-regionally between Leeds and South Yorkshire. The overall journey time comparison for existing rail services, the S and the Y is in Table 1 on the next page.

Passenger Demand

6.5 The S or the Y networks could as much as double the impacts on modal shift of the London to West Midlands scheme, reducing domestic air passengers by a further 5-10,000 trips per day and 10-20,000 trips off the road.

6.6 The two networks lead to different patterns of trips between regions – reflecting the different connectivity and journey times. In particular:

- The S would be forecast to deliver up to 10,000 more trips per day between the North West and Yorkshire and Humberside.
- However, the Y would be forecast to deliver up to 30,000 more trips per day between London and the East Midlands, South Yorkshire and Leeds as a result of faster journey times.
- The improved inter-regional connectivity offered by the Y would also additionally mean in the region of 15,000 non-London trips per day with over a third being trips within Yorkshire and Humberside.

6.7 Overall the Y is forecast to have in the region of 40,000 or more trips per day using the rail network than forecast under the S – potentially delivering as much as £10bn more revenue.

Table 1 – Comparison Journey Times for existing rail services, the S and the Y.

Journey Times (hrs:mins)			
Route	**Existing Rail**	**S**	**Y**
London - Nottingham / East Midlands*	1:49	N/A	0:53
London - Sheffield / South Yorkshire*	2:09	N/A	1:15
London - Manchester	2:08	1:20	1:20
London - Leeds	2:20	1:35	1:20
London - Newcastle	2:52	3:00	2:37
London – Glasgow / Edinburgh	4:30	3:47	3:47
Birmingham - Manchester	1:30	0:54	0:54
Birmingham - Leeds	2:00	1:17**	1:05

* For 'Existing Rail' the current timetable times to Nottingham and Sheffield are quoted. The future high speed rail times on a 'Y' network are the equivalent to new East Midlands and South Yorkshire stations the location of which would be defined if this corridor option is selected

** Includes the assumption that high speed trains starting at Birmingham would include Manchester as an intermediate stop on the way to Leeds.

Appraisal of the S and Y

6.8 In summary, as set out in section 4 the operating and maintenance costs of the S would be two thirds the cost of the Y. The capital costs of the S, discounted over 60 years to give a present value, would also be around £2bn less than the Y.

6.9 However, our high level comparative analysis suggests that, compared to the S, the potentially greater number of trips on the Y would deliver as much as £10bn more revenue. In addition, over the 60 year appraisal period, the Y would deliver in the order of £15bn more benefits through faster services for a wider market, and greater relief of crowding on the classic network. Therefore whilst the S is less expensive to build and operate the benefits offered by the Y are likely to be substantially greater and would outweigh its higher costs.

6.10 This is not a detailed analysis at this stage and it has not included Wider Economic Impacts. These could add to both business cases – probably by £3bn to £6bn.

Assumptions

6.11 This is a high level assessment of the case for the two networks. With further optimisation it may be possible to improve the business case for both networks, but there may be slightly more scope to increase the benefits from the S. It is also possible that Wider Economic Impacts – the impact of transport on the productivity of cities – may be greater for linking Leeds and Manchester due to their size and proximity (though this is far from certain).

6.12 Against this, we have been relatively optimistic about the costs of rolling stock on the S – assuming that the purchase of significant numbers of (expensive) classic compatible trains could be avoided. In practice the scope for these savings may be limited by timescales and the commercial viability of these trains.

6.13 Whilst these may affect the relative attractiveness of the S compared to the Y, it is unlikely they would be of sufficient scale to make the overall business case better than the Y. For example greater optimisation of the service patterns on the S would need to add as many as 50% more passengers and deliver substantial time savings and crowding relief to make the S more attractive.

7. Summary of External Opinion

7.1 This section provides a short summary of external opinion which differentiates between the S and the Y. It covers high speed rail stakeholders, media and political comment. Most high speed rail stakeholders look to the potential longer term network, rather than the specific configurations that this paper compares.

High Speed Trans-Pennine

7.2 The challenge and cost of a trans-Pennine high speed line is seen as outweighing the benefits (at least in the short term) by several stakeholders, for example, Greengauge 21 and 4 North West (regional leaders' board). Greengauge 21 suggest upgrading the existing line as an alternative. This is also given high priority by other regional stakeholders, such as The Northern Way, who cite the Northern Hub proposal and electrification as taking priority.

East Midlands, Yorkshire and the North East

7.3 The fact that the S delivers a comparatively slower journey time to Leeds and Newcastle and does not serve East Midlands and South Yorkshire at all means that regional bodies, MPs and the local media in those areas tend to support the Y configuration.

7.4 Greengauge 21 reject the S for its relatively slow journey times to Leeds and Newcastle. They also cite the potential transformation, under the Y, of services to Sheffield which are very slow at present.

7.5 Some MPs and local politicians have also been lobbying for the Y to go ahead and this has been reflected in the local press, for example in the Yorkshire Post's 'Fast Track to Yorkshire' campaign and the recent letter from the Leeds and Sheffield city regions.

Overall views

7.6 Overall, two key themes are evident: the difficulty of building a dedicated high speed line trans-Pennine and the difference in the serving of cities on the East coast. Most articulated opinion is in favour of a configuration consistent with the Y, with the exception of the Bow Group, which supports the S. This may reflect the lower levels of awareness about the S publicly and, in particular, stronger levels of support for a Y type configuration in the East Midlands and South Yorkshire.