



OAKERVEE

REVIEW

Contents

1. Chair's Foreword.....	3
2. Introduction.....	5
3. Executive summary.....	11
4. What is HS2.....	19
5. Review of the objectives for HS2.....	24
6. The HS2 design and route.....	41
7. Cost and schedule.....	55
8. Contracting and HS2 specifications.....	66
9. HS2 stations.....	72
10. Capability, governance and oversight.....	80
11. Economic assessment of HS2.....	93
12. Alternative Options.....	107
Annex A: Glossary.....	116
Annex B: Terms of Reference.....	121
Annex C: Meetings and Evidence.....	125

1. Chair's Foreword

Shortly after Prime Minister The Rt Hon Boris Johnson took up office, he invited me to lead a quick review of High Speed Two (HS2) to better allow the government to consider whether and how to proceed with HS2 ahead of the Notice to Proceed decision for HS2 Phase One. I was privileged to accept this challenging task upon appointment by the Department for Transport acting on behalf of the Secretary of State for Transport, The Rt Hon Grant Shapps. I appointed a Deputy Chair, Lord Berkeley, and a panel to support me. The Panel consisted of John Cridland, Michèle Dix, Stephen Glaister, Patrick Harley, Sir Peter Hendy, Andrew Sentance, Andy Street, and Tony Travers. My Terms of Reference can be found in Annex B.

The short duration of the review meant we did not conduct a formal call for evidence but instead canvassed the views of a wide variety of interested parties all with different perspectives, both for and against the HS2 project. I am grateful to the MPs, peers, regional mayors and leaders, local government officers, community and business/industry leaders, civil servants, HS2 Ltd and Network Rail staff, all of whom have provided a wealth of evidence. Likewise, we are grateful to the many organisations and individuals who have written to us expressing their views. All this information has strengthened this report and my recommendations.

Given the limited time available, the Review has faced a major challenge to undertake a deep examination of all the areas included in its Terms of Reference. I believe the Review has, though, provided views on the key issues.

I am extremely grateful to the time and insights the panel members and the Deputy Chair have given to the Review. I have endeavoured to ensure all the conclusions and recommendations are based on the evidence provided to the Review.

Throughout this report I refer to the conclusion and recommendations of the Review – these conclusions are mine and I reached them with the

support and recommendations of my Deputy Chair and panel members. Discussions with my Deputy Chair and panel members were constructive and challenging. All the panel members, with the exception of the Deputy Chair, have confirmed they support the approach taken in the report.

Without the support of an independent secretariat (sourced from the Department for Transport but reporting to me), it would not have been possible to complete the task in the time available. I am extremely grateful for their hard work.

Any errors or omissions in this report are all mine.

Douglas Oakervee CBE, FREng

December 2019

2. Introduction

2.1 Much of the debate surrounding HS2 has presented the project as a dichotomy: whether to, on the one hand, cancel HS2 in its entirety or, on the other hand, recommend that the project should seemingly proceed at any cost. The Review has seen evidence for both extremes, but in reality the position is much more nuanced.

2.2 In an attempt to break down this dichotomy, the Review has looked at the project from multiple perspectives. These include:

- the case for high speed rail as part of the GB rail network (including how it has evolved over time)
- how HS2, as currently proposed, links the existing GB rail network and other transport systems, including those currently being proposed by Midlands Connect and Transport for the North and Network Rail's Enhancements Programme
- the places on the GB rail network that are not on the HS2 network but are nonetheless potentially affected (negativity or positively) by a new line
- the environmental case for and against HS2, particularly in light of the government's recent commitment to net zero carbon emissions by 2050 and the impact of the construction of HS2 itself on the environment
- the design and specification of the project
- the impact of the construction and operation of HS2 on communities and individuals
- the capability of High Speed Two Limited (HS2 Ltd) as a company to deliver the project, including whether appropriate levels of governance, oversight and transparency are in place

- how a new national high speed rail could benefit the economy of the UK
- how the UK government currently appraises large transport schemes
- the costs of the project and the certainty of current estimates
- the impact of cancelling part or all of the scheme, including the impact on the UK construction industry, rail supply chain and confidence in UK infrastructure
- alternative schemes for railway investment and how HS2 and other proposed rail investments fit into a robust plan for the GB rail system as a whole

2.3 In addition, it is important to note that any examination of the project does not start from a blank sheet of paper. Phase One of the project has had 10 years of design, public consultation and lengthy debates in Parliament. Phase Two is at an earlier level of maturity and here the focus is on finalising route design, station locations and integration with other transport projects.

2.4 It should also be noted that, given the instruction to report in the autumn, there was a limited amount of time to carry out the review. Evidence was considered by the Review largely over the course of September 2019. Following this period, HS2 Ltd, the DfT and others may have further refined and built on the evidence originally provided to the Review.

2.5 In respect of costs, although the Review did not have enough the resources or the time to develop its own robust, bottom-up estimate of costs, it has examined cost estimates for the HS2 project. The Review has used, as a starting point, the cost estimates provided in the Chairman's Stocktake. In order to cross-reference the cost information provided, the Review has looked at cost benchmarking done by HS2 Ltd and the DfT.

The Review also examined a cost estimate developed by an external consultant for consideration by the Review.

- 2.6 At the time of writing this report, the latest cost baseline for Phase One has been going through governance and assurance. It is vital that the DfT, with the support of HM Treasury and the Infrastructure & Projects Authority (the IPA), should properly scrutinise and, where appropriate, challenge any cost baselines developed by HS2 Ltd. The Review also notes that cost estimates for Phase One will need to be updated if the government agrees to and succeeds in getting the private sector to contribute towards funding the development of HS2 stations.
- 2.7 The next section sets out an executive summary of the report's conclusions and recommendations. The below paragraphs set out some of the Review's thinking in a number of key areas along with some thoughts on issues of wider relevance to other major projects.
- 2.8 In coming to its view on whether and how to proceed with the HS2 project, the Review, in particular, considered the following key points:
- the impact of cancelling HS2 would be significant. Costs incurred amount to approximately £9bn, though some of these costs may be recovered with around £2bn to £3bn of land and property costs potentially recoverable, and additional direct costs of cancelling the project estimated at around £2.5bn to £3.6bn. There would also be significant detrimental consequences for the supply chain and the fragile UK construction industry and confidence if HS2 was cancelled
 - the full network is needed to realise the benefits of the investment in HS2. Phase One as a standalone scheme makes little sense
 - substantial changes to specifications and design requirements, which could reduce costs on Phase One, would require changing the Phase One Act (The High Speed Rail (London - West Midlands) Act 2017). Amending the Phase One Act would substantially delay the

opening of Phase One, causing further uncertainty and blight to local communities on the route

- HS2 could help deliver the government's commitment to bring all greenhouse gas emissions to net zero by 2050. This net zero commitment was only made in June 2019 – well after HS2 was initially proposed and indeed after the Phase One Act achieved Royal Assent in 2017.

2.9 The Review has also considered the ongoing affordability of the HS2 project including how, if the HS2 project is to proceed, costs need to be kept under control. The Review has set out in this report a series of conclusions on how costs on the project can be controlled and how savings for taxpayers could be delivered including:

- getting the private sector to contribute towards funding the development of HS2 stations
- removing 'gold-plating' on HS2 and optimising the design. This could deliver substantial savings especially on later phases
- altering the procurement and contracting model used by HS2 Ltd
- HS2 Ltd making substantial improvements in its performance especially in the area of cost management
- overhauling the governance of the HS2 project, ensuring that the government has proper oversight into what is happening on the project and control over costs

2.10 While delivering savings to the taxpayer and controlling costs on HS2 is vital, the Review notes that the upgrading of the Victorian railway network is both challenging and costly. This was evidenced by the West Coast Main Line (WCML) upgrade between 1998 and 2008 which cost considerably more than originally estimated. The investment required to deliver not only HS2 but the Northern Powerhouse Rail (NPR) and Midlands Engine Rail strategies, along with the Network Rail's

Enhancements programme, seems to be huge. However, when considered over a potential spend period of 20 to 30 years, this investment is not only more acceptable but is also necessary in order to transform the nation's economy by providing connectivity between our major cities along with improved rail links across the Midlands and the North of England.

- 2.11 As indicated in the report, the Review considers that more needs to be done to ensure that the Midlands and the North of England get the improved rail services, which these regions are rightly demanding, well ahead of HS2 Ltd's view of opening Phase 2b as currently designed in 2035-40. The Review is clear that such improvements need to be made on an ongoing, annual basis. The Review has, therefore, recommended establishing a further study to develop an integrated railway plan embracing Phase 2b alongside an integrated railway investment programme, with a regular, planned annual spend, for the Midlands and the North of England. Any further study should look at how to quickly bring forward rail improvements for the Midlands and the North of England.
- 2.12 The conclusions set out in this report may be applicable and relevant to how government develops and implements projects in other areas. Similarities exist for example between the challenges on HS2 and problems experienced by Railtrack in upgrading the WCML in the early 2000s, which also experienced significant cost and schedule overruns. The DfT, working with the IPA, has taken steps in the past year to learn lessons on major projects and ensure risks are managed more effectively. However, the government needs to continue to ensure lessons are fully embedded at all stages including in project design and delivery.
- 2.13 Further, the Review considers that the use of 2015 prices in presenting the cost of HS2 has not helped the public understand the project's cost. Going forward, the government should reconsider how it presents the costs of major infrastructure projects with a view to helping Parliament and the public better comprehend the costs of these projects.

2.14 More generally, the government needs to consider how it can better reflect uncertainty in cost estimates for projects that are at an early stage in their development. The initial budget for a project, which may for example be provided to Parliament at the start of a hybrid Bill process, needs to be updated including in light of the latest prices, and greater certainty around scope. The government should consider how it can better involve Parliament in setting realistic budgets for major infrastructure projects.

3. Executive summary

Overall conclusions

The choice of “whether and how we proceed” with HS2 is the responsibility of the government. The latest economic appraisal indicates that the net cost to the transport budget in proceeding with HS2 is around £62bn to £69bn (present values, 2015 prices). In providing its view to government, the Review considers that, on balance, Ministers should proceed with the HS2 project, subject to the following conclusions and

- 3.1 In coming to its view on “whether and how we proceed” with HS2, the Review has considered whether the original rationale for HS2 still holds and, if so, whether alternative rail investments could deliver that rationale. Following careful consideration, the Review has concluded as follows:
- the original rationale for HS2 still holds. There is a need for greater capacity and reliability on the GB rail network as a whole (**conclusion 1 in section 5**)
 - there are no shovel-ready alternative investments in the existing network that are available: if HS2 were to be cancelled, many years of planning work would be required to identify, design and develop new proposals. The upgrading of existing lines would also come at a high passenger cost with significant disruption (**conclusion 62 in section 12**)
 - there would be serious consequences for the supply chain, the fragile UK construction industry and confidence in UK infrastructure planning if HS2 were to be cancelled at this late stage (**conclusion 22 in section 7**)

- accordingly, the Review strongly advises against cancelling the HS2 scheme (**conclusion 63 in section 12**)

3.2 The following conclusions apply to all phases of HS2 and to where HS2 interfaces with the conventional rail network:

- the primary need is for capacity; speed although an important factor in economic benefits should not be in and of itself the primary driver of decision making (**conclusion 1 in section 5**)
- the government should recommit to the principle of the full Y-shaped network, serving both sides of the Pennines (**conclusion 10 in section 6**)
- the full network is needed to realise the highest value for money economic return on the investment of HS2. Phase One as a standalone scheme does not represent value for money, nor does building Phase Two without building Phase One (**conclusion 54 in section 11**)
- it is hard now to stop Phase One and start HS2 in the North of England. The quickest way to deliver long-distance inter-city connectivity to the Midlands and the North of England is to continue with Phase One, and to fully commit to subsequent phases (**conclusion 61 in section 12**)
- the government should deliver service improvements in the Midlands and the North of England as soon as possible – before HS2 Ltd’s view of opening Phase 2b as currently designed in 2035-40 (**conclusion 11 in section 6**)
- HS2 should be planned as part of the national rail network. This includes links to existing railways but also to new investment proposals from Midlands Connect and Transport for the North and Network Rail’s Enhancements Programme (**conclusion 2 in section 5**)

- HS2 can be part of transformational economic change, but only if properly integrated with other transport strategies, especially those seeking to improve inter-city and intra-regional transport, and also with national, regional and local growth strategies. Transport investment alone will not ‘rebalance’ the UK economy (**conclusion 4 in section 5**)
- the cost estimates for HS2 have escalated for a number of reasons including the procurement strategy and contracting model for the Phase One Main Works Civils. Cost controls will be key to ensuring that costs remain at or below the levels set out in the Chairman’s Stocktake (**conclusion 15 in section 7**)

Phase One and Corporate level recommendations

3.3 The key decision for Phase One is ‘Notice to Proceed’ (NtP): the government authorisation for HS2 Ltd to finalise the contracts for major construction works for Phase One alone. In essence, NtP is a go/no-go for the entire HS2 project as the Review has concluded that it only makes sense to do Phase One if continuing with the northern phases. Before issuing NtP, the government should as soon as possible ensure:

- HS2 Ltd achieves a satisfactory position with each of the Main Works Civils contractors in order to obtain acceptable Stage 2 prices¹ and a reasonable level of value engineering. If HS2 Ltd cannot achieve a satisfactory position with the Main Works Civils contractors, then HS2 Ltd, subject to further discussions with the DfT and HM Treasury, may have to consider re-procuring some or all of these contracts (**conclusion 25 in section 8**)
- an updated business case for Phase One, approved by HM Treasury, is published and a revised funding envelope is set for Phase One with appropriate levels of contingency to be held by the DfT/HM

¹The Main Works Civils contracts are based on a two-stage design and build strategy with the aim of fixing final target prices (‘Stage 2 prices’) at Notice to Proceed.

Treasury (**conclusion 21 in section 7** and **conclusion 59 in section 11**)

- the DfT updates and publishes a revised business case for the project as a whole. This should include the latest cost and benefits for the project (**conclusion 59 in section 11**)

3.4 The economic case does not currently fully align with the strategic case. Economic rebalancing, one of the primary drivers in the strategic case for HS2, is not currently reflected in the economic case. (**conclusion 48 in section 11**). Further work is needed on understanding the potential impact of HS2 on the number and location of homes and jobs. Work is needed by the DfT and HS2 Ltd for future HS2 business cases to review and quantify the level 3 impacts² in the benefit-cost ratio given the prominence of these impacts in the strategic case (**conclusion 49 in section 11**). Further work is also needed on understanding why reducing crowding doesn't play a greater role in the quantified benefits (**conclusion 50 in section 11**).

3.5 In addition to NtP:

- HS2 Ltd and the DfT should seriously look at reducing the specifications of HS2 Phase One within the limits of the High Speed Rail (London - West Midlands) Act 2017 (hereafter referred to as the Phase One Act) and in finalising detailed designs. This should include reducing the central planning assumption for HS2 to a more realistic 14 trains per hour (tph), while future proofing the scheme for 16tph, and noting the loss of assumed benefits (**conclusions 6 and 7 in section 6 and conclusion 23 in section 8**)

² Level 3 impacts include analysis in which either land use change is explicitly quantified (structural impacts) or supplementary economic modelling has been conducted. Source: DfT, Transport Analysis Guidance, May 2018 ([link](#))

- a frequency of 14tph, with passive provision for 16tph, needs to be considered in future business case work (**conclusion 7 in section 6 and conclusion 58 in section 11**)
- milestones to be set against which HS2 Ltd's management should be held to account in respect of their period in office (**conclusion 35 in section 10**)
- HS2 Ltd should demonstrate how it intends to improve its performance in a number of key areas including cost estimation, management and control (**conclusions 40 and 41 in section 10**)
- HS2 Ltd's governance arrangements need to evolve to reflect the project's complexity and scale (**conclusion 37 in section 10**)
 - systems integration needs to be strengthened now and maintained throughout the life of the project and beyond into asset management, with a single point of accountability for systems integration (**conclusion 38 in section 10**)
 - HS2 Ltd should continue to mitigate the impact on communities of the construction of HS2 and needs to demonstrate improvements in stakeholder engagement (**conclusion 9 in section 6, and conclusion 42 in section 10**)
 - the government should consider making changes to the scheme to remove the Handsacre connection, and investigate how best to maintain or improve services on the WCML to Stoke-on-Trent, Stafford and Macclesfield (without HS2). The Review considers that the Handsacre connection would only be needed if it was decided not to proceed with Phase 2a to Crewe (**conclusion 13 in section 6**)
 - the DfT should set out its plan for improving how it functions including how it will improve its internal expertise in key areas (**conclusion 45 in section 10**).

Phase 2a recommendations

3.6 The government should continue to support the High Speed Rail (West Midlands to Crewe) Bill (hereafter referred to as the Phase 2a Bill) through Parliament. Given the revised schedule forecasts set out in the Chairman's Stocktake³, the government should consider merging the construction of Phase 2a with that of Phase One (**conclusion 18 in section 7**). In addition, the government and HS2 Ltd should:

- investigate the potential to optimise the design and reduce costs within the constraints of the Bill currently in Parliament (**conclusion 27 in section 8**)
- look again at the size, phasing and contracting model for Phase 2a construction contracts (**conclusion 26 in section 8**)

Phase 2b recommendations

3.7 In respect of Phase 2b, the key decision is when and how to introduce a hybrid Bill to gain further powers for HS2. Here the government should:

- establish a further study to be completed by summer 2020 to develop an integrated railway plan embracing Phase 2b alongside an integrated railway investment programme for the Midlands and the North of England. The economic appraisal of this integrated rail plan and investment programme should be assessed in addition to individual projects and phases of schemes. Any further study needs to look at how to quickly bring forward rail improvements for the Midlands and the North of England – before HS2 Ltd's view of opening Phase 2b as currently designed in 2035-40 (**conclusion 11 in section 6 and conclusion 55 in section 11**)

³ HS2 Ltd, Chairman's Stocktake, August 2019 ([link](#))

- await the outcome of this study and pause the preparation of materials for the Phase 2b Bill as currently designed (**conclusion 12 in section 6**)

HS2 stations

3.8 A key decision is whether to make Old Oak Common the London terminus, at least for a period. Here the government should:

- continue with the section from Old Oak Common to Euston. Euston station is an important part of realising the benefits of HS2 (**conclusion 60 in section 12**)
- Old Oak Common should act as the temporary London terminus for HS2 services until Euston station is complete. Time taken to get Euston right should not delay the start of HS2 services (**conclusion 60 in section 12**)

3.9 In comparison with the other Phase One HS2 stations, the construction at Euston is very challenging. Here the government should:

- carry out a study, looking into the efficiency of the future station as a whole including considering options to simplify the HS2 approach to Euston (**conclusion 33 in section 9**)
- develop and set out a single plan for the overall Euston project, with one organisation responsible for the overall development and governance of the Euston project. Given the complexity of the Euston project, this organisation should not be HS2 Ltd (**conclusion 34 in section 9**)

3.10 More generally, in respect of HS2 stations, the government and HS2 Ltd should:

- ensure commercial opportunities are maximised (**conclusion 28 in section 9**);

- engage with the private sector, in association with local government, to develop HS2 stations. There may be opportunities for local authorities or combined authorities, in partnership with the private sector, to take on HS2 Ltd's role in funding and developing stations (**conclusion 29 in section 9**).

4. What is HS2

History of High Speed Rail in the UK

- 4.1 In the 2000s, studies explored the potential for further application of high speed technology, such as work by the Strategic Rail Authority in 2003⁴, which made the case for relieving capacity on the West Coast, East Coast and Midland Main Lines. In 2009, Network Rail's study on new lines⁵ set out key areas on the GB rail network requiring increased capacity to cope with forecast demand, a key example being on the WCML south of Rugby. It concluded for the high peak hour that, by the end of the next decade, "the route that will become full first is the corridor to Birmingham and the north west, with no spare capacity for more trains or passengers". The study proposed a new high speed line to serve WCML destinations including Birmingham, Liverpool, Manchester and Glasgow/Edinburgh. The ambition for high speed rail was also driven by the potential to reduce the demand for domestic aviation capacity.
- 4.2 The Network Rail study was completed shortly after upgrades to the WCML between 1998 and 2008: work that was seen as disruptive, took longer than expected and cost many times more than originally estimated.⁶
- 4.3 Meanwhile, the development of high speed rail in the UK started with High Speed One (HS1) connecting London to the Channel Tunnel and Kent. Plans were developed in the early 1990s, receiving powers for construction in 1996. HS1 has been operating, in part, since 2003 and along its entire route length since 2007. Initially services ran into Waterloo on classic lines, with the high speed rail section ending south of London. The second phase was then completed, including the

⁴ Strategic Rail Authority, The Strategic Plan, January 2003 ([link](#))

⁵ Network Rail, Meeting the capacity challenge, The case for new lines, August 2009 ([link](#))

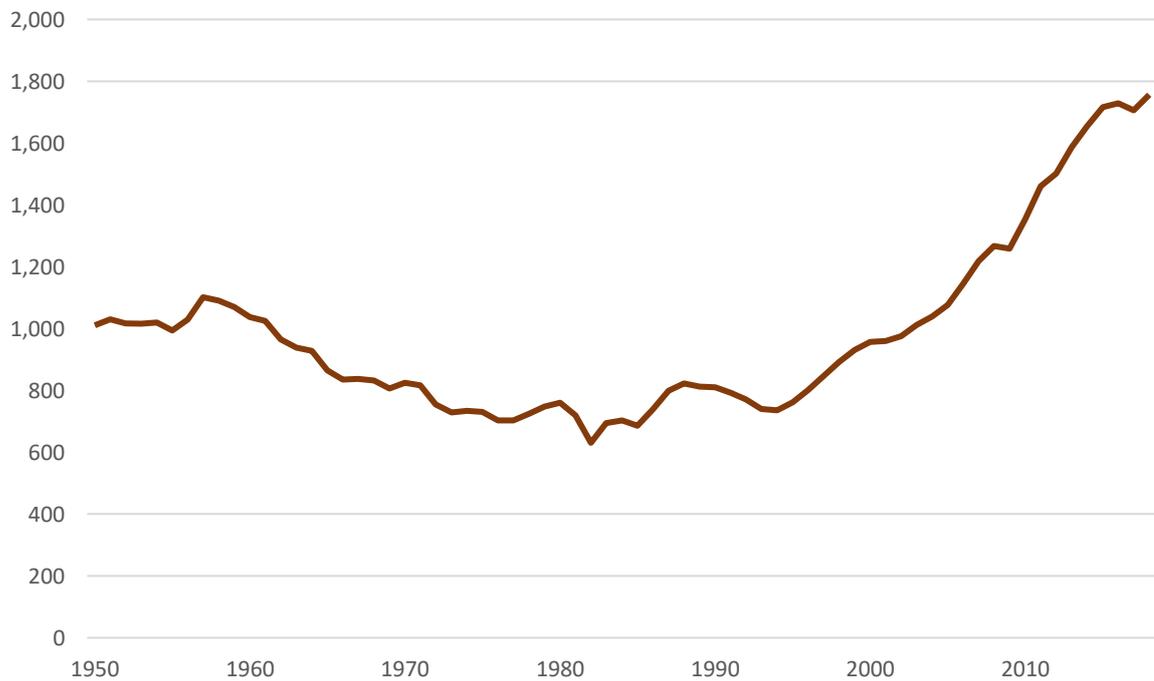
⁶ House of Commons, The Modernisation of the West Coast Main Line HC 189, June 2007 ([link](#))

redevelopment of St Pancras, allowing full high speed services into central London.

- 4.4 The development of new rail lines in the UK has been against the background of large and sustained increases in UK rail demand. Passenger numbers have more than doubled in the last 25 years. As reported in 2018 by the Independent Transport Commission⁷, this is not down to population growth alone (an increase of 15% over the period). Structural changes in the British economy have resulted in strong job growth for sectors that have a high proportion of rail commuters, and a decline in manufacturing where rail commuting is lowest. Further, recent job and residential growth has mainly been concentrated at high densities in urban centres. These structural changes along with company car taxation changes have also affected business trips.

⁷ Independent Transport Commission, Wider Factors affecting the long-term growth in Rail Travel, November 2018 ([link](#))

Figure 4.1: Office for Rail and Road data on total franchised passenger journeys from 1950 to 2018 in Great Britain (millions)⁸



Development of HS2

4.5 In January 2009 the government set up HS2 Ltd as the organisation responsible for developing and then delivering new high speed rail infrastructure: HS2. It was instructed by the then government to draw up detailed designs for a new route between London and the West Midlands, and to explore options for extending this on to Greater Manchester and Scotland – and to Leeds, West Yorkshire and the north-east. This was a broader proposal than in the initial Network Rail study.

4.6 Since 2009, key milestones for HS2 include:

- 2010: Formal proposals for a route between London and the West Midlands were published, which became Phase One. Following work

⁸ Figures to 1984 are per calendar year; from 1985 per financial year beginning. Office of Rail and Road, Passenger rail usage 2019-20 Table 12.5, December 2019 ([link](#))

on alternative shapes for the high speed network, the government's Command Paper⁹ committed to a 'Y-shaped network' serving Manchester and Leeds conurbations, South Yorkshire and the East Midlands, which became Phase Two

- 2011: Public consultation on Phase One proposals
- 2012: Government decision on the Phase One route
- 2013: Phase One hybrid Bill deposited in Parliament; public consultation on plans for Phase Two
- 2014: Sir David Higgins, the then Chairman of HS2 Ltd set out the need to improve links between northern cities (*Rebalancing Britain*)¹⁰ and to accelerate the section of high speed route to Crewe and make Crewe a hub station (*HS2 Plus*)¹¹
- 2015: Government decision to accelerate the Phase 2a section of HS2 to Crewe
- 2017: Phase One achieved Royal Assent; the Phase 2a hybrid Bill was deposited in Parliament; and the Phase 2b route, from Crewe to Manchester and the West Midlands to Leeds and beyond, was confirmed
- 2018: Enabling works for Phase One started

4.7 This Review has come at a relatively late stage of the development of HS2 project. Decisions on routes and destination for the whole HS2 project have been made with Phase One being prepared for the start of construction with the key decision now on NtP to sign the Main Works Civils Contracts, Phase 2a being considered by Parliament, and Phase 2b,

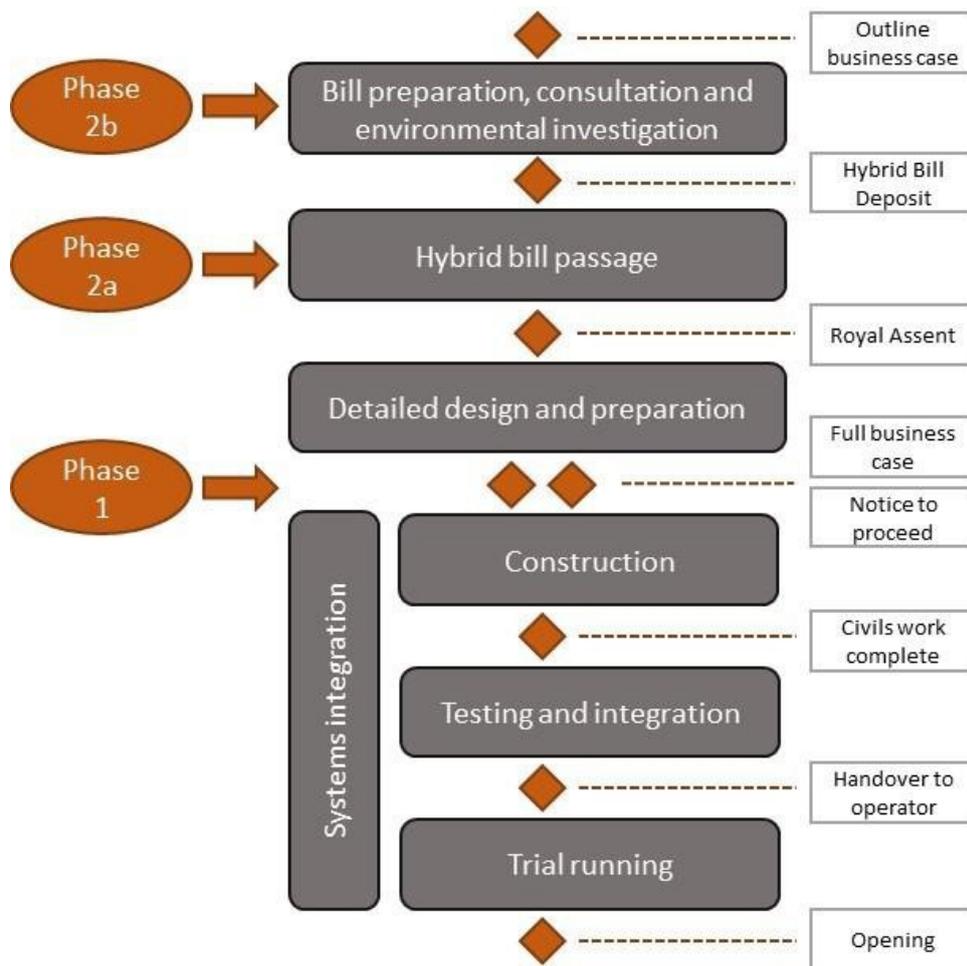
⁹ DfT, High Speed Rail Cm 7827, March 2010 ([link](#))

¹⁰ David Higgins, *Rebalancing Britain: From HS2 Towards a National Transport Strategy*, 2014 ([link](#))

¹¹ David Higgins, *HS2 Plus*, 2014 ([link](#))

as currently designed, safeguarded with legislation being prepared. The Review is therefore not starting with a blank sheet of paper.

Figure 4.2: Current stages of HS2 programme



5. Review of the objectives for HS2

5.1 Throughout the development of HS2, the government and HS2 Ltd have set out strategic objectives for the project. These have consistently focused on increasing capacity, improving connectivity and supporting economic growth. The Review observed that the emphasis or primacy of each of these objectives has varied over time, and certainly the project's name as 'High Speed' has meant that the public perception of the railway has been about fast journey times. HS2 Ltd focussed on speed in its early years which gave rise to the specification of a 400 kilometres per hour (kph) railway, dictating the horizontal alignment to be as straight as possible at very gradual gradients.

Capacity

5.2 The Review has attempted to look at the capacity need through different lenses, mainly train paths and seat capacity, and the evidence is not always easy to decipher. Capacity of the GB rail network can be measured in several ways:

- train paths – the ability to run a fixed number of trains over a section of track. This is important when looking at the ability to add new destinations or increase the frequency of passenger or freight services
- reliability and resilience – it can be beneficial to run fewer trains than the theoretical maximum to allow for recovery from delays or incidents
- train lengths and seat numbers – the ability to get more people or freight into each train path available, particularly at peak times
- station and throat capacity – terminal stations often limit capacity, in the number of tracks in the approach to a station, the number of

platforms and in the ability to transport passengers to their final destinations

Train path capacity

- 5.3 HS2 as currently envisaged is designed to provide capacity for the GB rail network as a whole by creating new lines for fast inter-city services and thereby releasing capacity on the conventional network. It then becomes possible to use these paths released on the conventional network to improve capacity and connectivity across the network differently: putting additional stops in long distance services, providing services to new destinations or increase levels of service on commuter routes or to destinations that currently have only infrequent or irregular services.
- 5.4 By removing or reducing the need to mix non-stopping with stopping trains on the same line it is possible to increase the total number of train paths that can be accommodated each hour, or indeed leave more time between trains to improve service reliability.
- 5.5 The paths freed up on the conventional network could be used to provide additional freight capacity, in addition to improving passenger services. The demand for rail freight is clearly affected by changes in the logistics and ports industries and, unlike passenger trains, freight demand may vary from day to day and week to week as well as seasonally, since freight trains (unlike passenger trains) do not usually operate unless they have customers. Proposals from the DfT on how to use capacity released by HS2 suggest one additional freight path each hour could be released on the WCML, although the benefits of this are not quantified in the economic appraisal. Capacity for freight services clearly needs to be considered in integrated planning for the whole GB network, particularly in the context of the government's pledge for net zero greenhouse gas emissions by 2050 (discussed below in paragraphs 5.30 to 5.40).
- 5.6 At a high level, looking at the constraints on the current network, HS2 broadly appears to create new paths in the places needed: an additional two tracks for a high capacity service for WCML destinations of London,

Birmingham and Manchester, in addition to new capacity into Leeds and to the East Midlands. The alternative would be to provide this capacity by investing in the existing rail network, providing additional tracks, station platforms and other upgrades. The pros and cons of this are discussed in more detail in section 12.

- 5.7 However, in some places HS2 trains appear to increase pressure on parts of the existing network: for example, north of York planned HS2 services coming onto the existing network are proving challenging to fit with future planned services and could potentially result in costly upgrades or interventions on Network Rail track and/or a worsening of existing services. HS2 Ltd and Network Rail need to continue to plan and timetable the mix of HS2 and conventional rail services as part of an integrated rail plan for the whole GB rail network.

Passenger capacity

- 5.8 In addition to track path capacity (the ability to run trains), it is important to consider on-train capacity (the ability to carry passengers). Since the 2009 Network Rail study on new lines, passenger growth on the WCML has been significantly higher than anticipated. The study predicted passenger growth on services arriving at Euston during the busiest hour of the weekday peak of 30% between 2007 and 2020, equivalent to a compound annual growth rate of 2.0%.¹² However, demand has exceeded expectations. Equivalent passenger numbers between 2007 and 2017 have grown by around 55%, approximating a 4.5% compound annual growth rate.
- 5.9 Evidence for 2018¹³ shows that there was regular standing across the 3-hour AM and PM peak period for West Midlands Train services to and from Euston. There was a lower level of standing for passengers using

¹² Evidence provided by Network Rail to the Review

¹³ Evidence provided by the DfT to the Review

Virgin Trains West Coast with standing isolated for specific services in the peak period. Capacity issues are projected for passengers in the early 2030s without further intervention.¹⁴ Unless there were changes in fares to discourage peak travel, standing would be a regular occurrence on the WCML under central growth projections in the early 2030s, and substantial crowding issues are projected if the high case growth projection materialises.

5.10 As well as providing greater city-to-city capacity, HS2 also provides released capacity on the conventional network to provide an uplift in seat capacity and reliability improvements for regional and local services.

5.11 Alternative ways to provide additional seat capacity (instead of running more trains) would be to lengthen existing services or even abolish first class. In many places train lengths are limited by lengths of platforms at stations, so could still drive additional infrastructure spend in constrained locations, although selective door opening can also be used to overcome this. The abolition of first class may also only result in a marginal increase in seat capacity. Peak demand issues can also be dealt with using fares to discourage peak travel. This was examined by Atkins in 2013 on behalf of the DfT¹⁵, concluding that large price rises would be needed and that this solution would not deliver connectivity or economy growth improvements. The Review does not support these alternatives to building HS2, but notes that they could be required in the short-term to deal with crowding issues at peak times before HS2 services are operational in around 10 years' time.

¹⁴ Evidence provided by the DfT to the Review

¹⁵ Atkins for the DfT, HS2 Strategic Alternatives, October 2013 ([link](#))

Conclusion 1: Notwithstanding changes that have occurred since the 2009 Network Rail study, its principal conclusion – and original rationale for HS2

– still holds: there is a need for greater capacity (both more trains on tracks and more seats on trains) and reliability on the GB rail network. The primary need is for capacity; speed although an important factor in economic benefits should not be in and of itself the primary driver of decision making. HS2 should be thought about as a new railway that enables fast inter-city services to be on segregated lines to free up capacity for commuter and freight services – and should be designed, built and operated with this in mind. It is essential that all future analysis for the business case for HS2 captures the latest evidence and projections for crowding on the conventional network, with the projections accounting

Connectivity

5.12 The second stated objective of the full HS2 network is to improve connectivity. Business case documents produced by the DfT show the large journey time reductions forecast between London and core UK cities.¹⁶ While these journey times appear impressive, some of the greater changes to connectivity are the non-London connections, as shown in Table 5.1. Regional authorities told the Review that these journeys are relatively poor by rail today and many will choose to drive, so here HS2 or improvements to existing rail infrastructure could provide new rail travel opportunities. This would support the government commitment to reduce carbon emissions, discussed below.

¹⁶ HS2 Ltd, Phase Two Strategic Case, July 2017 ([link](#))

Table 5.1: Forecast connectivity improvements between UK cities with HS2¹⁷

Journey	Fastest Regular Journey Time Today	Fastest HS2 Phase 2b Journey Time – Phase 2b as currently envisaged	Percentage Reduction with HS2
London to Birmingham	1h 21min	45min	44%
London to Manchester	2h 04min	1h 11min	43%
London to Leeds	2h 11min	1h 21min	38%
Birmingham to Manchester	1h 26min	41min	52%
Birmingham to Leeds	1h 52min	49min	56%
Birmingham to York	1h 52min	57min	49%

5.13 It is also important to consider places that are not served by HS2 trains. Some places that are currently served by fast long-distance services are concerned they will lose out, either by losing their fast London service or other connectivity, or that they will be made comparatively worse off by others around them getting the direct benefits of HS2. These concerns have arisen in part because HS2 was considered in isolation from the conventional network. Again, the solution to this is an integrated rail plan for the whole GB rail network, to understand how to best serve places across both HS2 and conventional services and ensure places not on the core route maintain or improve on current connectivity.

5.14 HS2 business case documents do not clearly show the total potential connectivity improvements across a large number of destinations on both HS2 and the conventional rail network. Buried in technical modelling documentation, HS2 Ltd sets out a potential ‘released capacity network’

¹⁷ Evidence provided by the DfT to the Review

used in business case modelling.¹⁸ This shows that, for example, Milton Keynes could greatly benefit from the introduction of HS2, with an increase of 5 trains in the morning peak hour to London Euston modelled compared to the May 2019 timetable, 2 of them ‘fast’¹⁹ services. Evidence from sources such as Network Rail and Steer Davies Gleave on behalf of the DfT²⁰ suggest different opportunities for improving connectivity on the conventional network as a result of HS2:

- on the WCML, opportunities include increased connectivity between the North of England/the West Midlands and Milton Keynes and potential links to East-West Rail proposals;
- the Eastern Leg of HS2, according to evidence provided by Network Rail to the Review, provides opportunities for improving connectivity that cannot be met currently such as Bedford and Northamptonshire northwards and between the Midlands and Luton Airport, and on the East Coast Main Line (such as between Doncaster and Leeds, and south of Peterborough).

Without question further work is needed to explore this in more detail to design the best services for passengers – and freight – across both HS2 and the conventional rail network, as part of an integrated plan for the GB rail network.

¹⁸ HS2 Ltd, Plant Framework Model: PFMv7.1 Assumptions Report, 2017 ([link](#))

¹⁹ With one or no stops between London and Milton Keynes

²⁰ DfT, HS2 Released Capacity Study, July 2017 ([link](#))

Conclusion 2: Inter-city connectivity is important, but so too is regional and commuter connectivity. HS2 clearly delivers inter-city improvements, but also frees capacity for regional and commuter services to be improved. There is no overarching strategy and analysis to optimise the allocation of released capacity on the basis of the project's objectives. Given that this is a core rationale for the HS2 scheme, much more work needs to be done jointly between HS2 Ltd, the DfT, Network Rail and the Shadow Operator in an integrated GB rail plan to maximise these benefits and articulate them clearly. HS2 should be planned as part of the national rail network. This includes links to existing railways but also to new investment proposals from Midlands Connect and Transport for the North and Network Rail's Enhancements Programme.

HS2 has the potential to stimulate economic growth

- 5.15 The third broad objective of HS2 is to help the government's role of building a stronger and more balanced economy through improving rail capacity and connectivity.
- 5.16 Transport for the North, Midlands Connect and other regional organisations made it clear in evidence they provided to the Review that they believe improving inter-city connectivity within the North of England and the Midlands and from there to London is vital for their economies, citing agglomeration effects from knowledge-sharing between cities, improved matching of high skills to appropriate jobs, and access to finance and international connectivity via London.²¹ This has the ultimate aim of creating more high-value jobs in the regions and for people to be confident in building a career outside of London, as stated in regional strategies.

²¹ Transport for the North, Submission to the Review, September 2019 ([link](#)); Midlands Connect, Submission to the Review, September 2019 ([link](#))

- 5.17 The Northern Powerhouse Independent Economic Review (NIER)²² highlighted that poor transport connectivity, reliability, quality, and inadequate capacity are all acting as a constraint on productivity and economic growth in the North of England. There can be significant barriers to new development, so if wider economic benefits are to be maximised and form a significant element of the overall HS2 business case then it will be crucial that a range of policies are used to enable growth and development where HS2 creates new opportunities. Planning policies that reflect the potential new opportunities will be critical to success.
- 5.18 In his Stocktake, Allan Cook identified that HS2 could support significant regeneration around stations.²³ The Review has seen evidence that local authorities across the areas which see a connectivity improvement as a result of HS2 are developing growth strategies to help maximise the scale of redevelopment and regeneration. HS2 has the potential to cause a spatial change of economic activity and open opportunities for new jobs and businesses.
- 5.19 The Review saw evidence from places where it was stated that business activity had already begun since the announcement of HS2. Examples cited to the Review included that coincident with announcing Royal Assent to Phase One in 2017, organisations such as Deutsche Bank, HSBC UK, PwC and HM Revenue and Customs have chosen to either relocate or expand their presence in Birmingham, creating thousands of jobs.²⁴ Both office and residential development in the city centre has been at a record high. However, it is not possible to verify that these changes have been the result of the promise of HS2 and would not have occurred anyway as a result of broader economic regeneration either in these locations or

²² The Northern Powerhouse Partnership, HS2 NORTH: Redesigning our railways, October 2019 ([link](#))

²³ HS2 Ltd, Chairman's Stocktake, August 2019 ([link](#))

²⁴ Midlands Connect, Submission to the Review, September 2019 ([link](#))

elsewhere, and therefore whether this is additional economic activity but simply displaced.

5.20 As discussed in more detail in section 11 on the Economic assessment of HS2, it is surprising that the business case for HS2 does not attempt to estimate these potential benefits to the UK economy in the benefit-cost ratio, although the Review recognised the difficulties in developing robust estimates of these benefits. Business case modelling depends on historical data, using past trends to predict future growth, which often means that infrastructure lags behind the demands of economic growth and in fact limits growth. This has typically only been overcome by political decision-making. The classic example of this is the Jubilee Line Extension to Canada Water, Canary Wharf, North Greenwich and Stratford: during its development the proposal did not have a strong economic case, but a political decision allowed it to be constructed and the commercial and residential development in all these locations has grown far beyond expectation. In Hong Kong, Singapore and many other countries overseas infrastructure drives growth and development by being in place in advance of need.

Evidence on high speed rail stimulating economic growth

5.21 Academic literature on this subject is mixed, with opinions that improving inter-city connectivity, or HS2 in particular, may benefit the regions more than London or could conversely benefit London more than the regions.

5.22 Eddington's Review of the link between transport and productivity in the UK economy, published in 2006, concluded that targeted new infrastructure would be most likely to provide high returns on investment, rather than large projects where benefits could be considered 'speculative'.²⁵

²⁵ Sir Rod Eddington, The Eddington Transport Study: Main Report: Volume 1, December 2006 ([link](#))

5.23 The HS1 initial evaluation in 2015²⁶ found no conclusive evidence of HS1 changing the economy in the south-east. The assessment recognised that this may be due to the UK-wide economic downturn and although there was no evidence at the time, it does not mean that HS1 will not have a positive impact on economic growth in the future. One positive outcome from HS1 is that passenger numbers on domestic services using the HS1 network have grown significantly. From 2010/11 to 2016/17 demand on domestic high speed services has almost doubled, increasing by 93% to 15 million. This growth is now leading to increased pressure on the capacity of high speed trains during peak hours. The evidence shows that over 20% of journeys using domestic high speed services are new rail passengers and the highest concentrations of the starting points for journeys are around Ashford, Canterbury and the Medway Towns. The use of domestic high speed services is strongly dominated by journeys into and out of London, which makes up 79% of the total trips.

5.24 The HS1 evaluation noted that the original plans for Ebbsfleet included housing development of 10,000 units, however at the time of the evaluation only around 300 were completed. In September 2019 a report for HS1 Ltd²⁷ set out that Ebbsfleet Garden City, adjacent to Ebbsfleet International, is planned to deliver 15,000 homes by 2035; to date just over 1,500 of these homes have been built. The failure to deliver planned housing growth around the station has likely contributed to lower passenger numbers using HS1 services than would have been expected had Ebbsfleet been developed as planned. The experience of HS1 demonstrates the need to deliver joined-up housing and transport plans. It is clear that transport is necessary but not sufficient on its own to promote economic growth.

²⁶ Atkins, Evaluation of the Impacts of High Speed 1, October 2015 ([link](#))

²⁷ HS1 Ltd, Delivering for Kent: The Economic Impact of HS1, September 2019 ([link](#))

- 5.25 The evidence on spatial distribution of economic growth enabled by high speed rail is also mixed. Evidence for the Transport Select Committee in 2012 from Professor John Tomaney²⁸ showed that, based on international experiences, a likely outcome of HS2 is an increasing concentration of economic activity in London. In addition, it was noted that investments in intra-urban and intra-regional transport systems may provide more local benefits than high speed north-south links, a view which has been supported by others including the Centre for Cities.
- 5.26 HS2 alone may be unlikely itself to take benefits beyond city centres to help the more deprived areas in the North of England and Midlands. With the released capacity created by HS2 though, local and intra-city transport improvements, together with inter-city improvements, will help support economic growth across the country.
- 5.27 The National Infrastructure Commission in July 2018²⁹ indicated that government should commit to £43bn of long-term transport funding for intra-city improvements, in addition to funding national inter-city networks. This figure is often misrepresented as an additional cost of HS2. However, the Commission's report is clear this sum should be committed as part of a wide-ranging package of investments to support the UK economy. This has also been confirmed in discussions with the Chair of the National Infrastructure Commission, Sir John Armit.
- 5.28 The Review supports investment by government in delivering inter-city and intra-regional transport improvements including in the Midlands and the North of England – such transport improvements, in addition to HS2, are key to supporting regional economic growth.
- 5.29 Transport investment alone will not rebalance the UK economy. National, regional and local growth strategies that address issues such as

²⁸ Professor John Tomaney, The Local and Regional Impacts of High Speed Rail in the UK, May 2011 ([link](#))

²⁹ National Infrastructure Commission, National Infrastructure Assessment, July 2018 ([link](#))

education, the business environment and innovation are also important. This aligns with the government's Industrial Strategy which sets out five foundations of productivity: Ideas, People, Infrastructure, Business Environment and Places.³⁰

Conclusion 3: Given that supporting regional economic growth and a more balanced UK economy is a core objective of HS2, further work should be done by HS2 Ltd, the DfT and wider government to understand these impacts. It has been hard for this Review to assess the likely size of impacts on regional economic growth that will result from HS2 or other transport improvements.

Conclusion 4: HS2 can be part of transformational economic change, but only if properly integrated with other transport strategies, especially those seeking to improve inter-city and intra-regional transport, and also with national, regional and local growth strategies. Transport investment alone will not 'rebalance' the UK economy.

Wider environmental considerations

5.30 In June 2019 the UK government committed to bring all greenhouse gas emissions to net zero by 2050.

5.31 In the short to medium term, the construction of HS2 is forecast to add to carbon emissions. The most recent estimates from HS2 Ltd on emissions from construction of the full HS2 network are at between 8m and 14m tonnes of CO₂e (carbon dioxide equivalent) over the construction period³¹, around 0.1% of current UK emissions on an annual basis. This is driven by the construction of tunnels, earthworks, bridges, viaducts and underpasses. The decisions to adopt straight alignments and very gradual gradients to reduce noise and visual pollution has led to the need for

³⁰ Department for Business, Energy & Industrial Strategy, Industrial Strategy, November 2017 ([link](#))

³¹ HS2 Ltd, HS2 Sustainability Statement including Post Consultation Update Volume 1, November 2016 ([link](#))

large excavations with bigger local impacts and the use of higher volumes of concrete – the production of concrete is carbon-intensive.

- 5.32 It is though important to consider the carbon impacts of HS2 against alternative ways of managing increased demand for travel. The Review notes that HS2 could in fact be less carbon intensive than other non-rail alternative transport schemes which deliver similar transport outcomes. This includes, for example, the construction and operation of new motorways, and of new runways or airports.
- 5.33 Over the longer term, HS2 could be promoted to encourage modal shift from both road and domestic aviation. Transport is a major contributor to the UK's emissions: 33% of CO₂ emissions were from the transport sector in 2018.³² Research by Eurostar has shown for example that a Eurostar journey from London to Paris emits 90% less greenhouse gas emissions per passenger than the equivalent short haul flight.³³ Nevertheless, the Review notes that the whole rail network needs to be decarbonised if the government is to deliver its net zero target. HS2 should be considered carefully in the role it could play in helping meet this target.
- 5.34 The Review looked at effects in both the short to medium term and the longer term. The operational footprint of the full HS2 network is estimated by HS2 Ltd at saving circa 11-12m tonnes of CO₂e over the first 60 years of operation, taking into account requirements for operation, tree planting, modal shift and freight uptake of released capacity.
- 5.35 On modal shift:
- HS2 may encourage people to travel by rail instead of car. HS2 has greater potential to encourage modal shift from car where the new track can be used for regional NPR or Midlands Engine Rail services and where capacity relieved on the conventional network can encourage more shorter-distance trips by rail, which is likely outside

³² BEIS, UK Greenhouse Gas Emissions 2018, March 2019 ([link](#))

³³ Eurostar, Our Community and Environment Programme and our new Tread Lightly 10 point plan, 2018 ([link](#))

of London. It should, however, be noted that the relative carbon benefits of rail compared with car travel will diminish as cars electrify.

- another important feature of modal shift from road to rail is that of freight. If HS2 can release conventional rail capacity for freight paths – and freight operating companies make use of these paths – this could help reduce not only road congestion but the significant emissions from road haulage. Given that road haulage may electrify in due course, rail freight paths would need to also be electrified in order to deliver carbon savings. Rail freight emits on average 76% less carbon emissions than the equivalent road journey.³⁴ Italian government figures report that the Mercitalia *Fast* high speed freight service has taken approximately 9,000 trucks a year off the road and has reduced carbon emissions by approximately 80%.³⁵ While HS2 is unlikely to be used for high speed freight trains, this gives an indication of the potential benefits a shift to rail freight could bring.
- HS2 may encourage people to travel by rail instead of flying. Analysis suggests around an 11% reduction in domestic flights after the introduction of HS2, half of which is from a reduction in people flying between London and Scotland.³⁶ Modelling for the Committee on Climate Change Aviation review in 2009³⁷ suggested a new high speed rail line could significantly increase the rail market share on Anglo-Scottish routes: the London-Edinburgh market share could increase from around one third today to over 80% in 2050. Aviation demand management is likely to be needed to meet the 2050 net zero emissions target, and rail travel is more carbon efficient than air travel. Public pressure to reduce carbon emissions, as shown in

³⁴ DfT, Rail Freight Strategy, September 2016 ([link](#))

³⁵ FS Italiane Group, Integrated Mobility for Sustainable Transport, February 2019 ([link](#))

³⁶ Evidence provided by the DfT to the Review

³⁷ Committee on Climate Change, Meeting the UK Aviation Target – options for reducing emissions to 2015, December 2009 ([link](#))

recent demonstrations by Extinction Rebellion, may prove HS2 Ltd's forecasts to be an underestimate of the potential for modal shift from air.

5.36 To achieve significant modal shift from both road and air to rail, HS2 should be part of an integrated government strategy to induce this behaviour change, implemented alongside other measures to dissuade passengers from carbon-producing transport modes.

5.37 On balance, taking into account both the construction and operation of HS2, it appears that HS2 is likely to be close to carbon neutral, though it is not clear whether overall HS2 is positive or negative for greenhouse gas emissions. Based on the current assessment, if the low end construction emissions are achieved, HS2 will reduce carbon emissions by 3-4m tonnes of CO₂e; at the high end, the project will contribute 1-3m tonnes of CO₂e over the assessment period of construction and 60 years of operation. It is therefore important for HS2 Ltd to continue to look for ways to be more carbon efficient, particularly in construction in the short-medium term.

Conclusion 5: The government's 2050 target has placed a new emphasis on the design, build and operation of the HS2 network. The ability to reduce carbon emissions in the construction of Phase One may be limited so focus should be placed on improving plans for Phase Two in this regard in particular. HS2 Ltd should look to drive innovation in construction and delivery of the project to reduce its forecast greenhouse gas emissions. Over the longer term HS2 should form part of an integrated government strategy to encourage people to shift to greener transport

5.39 Further, it is understood that climate change may increase the risk of flooding in the UK. HS2 Ltd has confirmed to the Review that HS2 has been designed to be resilient to flooding and also to ensure there is no detrimental material impact in terms of flood risk to third parties from HS2 infrastructure. It is understood that:

- HS2 infrastructure has generally been designed to be resilient to a 1 in 1,000 year return period flood event and that this is broadly in line with the requirements for critical infrastructure
- watercourse crossings associated with HS2 are designed to ensure that they can convey a 1 in 100 year return period event with an allowance for climate change effects over the 120 year design life of the HS2 scheme
- appropriate mitigation will be provided to ensure there are no material increases in flood risk to third parties from HS2 infrastructure.³⁸

In light of recent flooding events and the increased risk of flooding arising from climate change, the Review notes HS2 Ltd's work on flood resilience and would encourage HS2 Ltd to ensure it delivers a flood-resilient railway.

5.40 HS2 Ltd will also need to consider the impacts of climate change in ensuring that HS2 infrastructure, including track, is able to cope with extreme temperatures. It is understood that HS2 slab track, where deployed, should be resilient to high temperatures³⁹ but this is an issue that needs to be kept under review.

³⁸ Evidence provided by HS2 Ltd to the Review

³⁹ Evidence provided by the DfT to the Review

6. The HS2 design and route

HS2 specifications

- 6.1 The Review considered whether the specification for HS2, in particular the frequency, speed and alignment, is appropriate including examining how much this specification has driven the cost of the project.
- 6.2 HS2 has been designed for the ultimate capacity of 18tph in each direction. Current plans are to start phased entry into service with 10tph once Phases One and 2a have fully opened, with then 17tph in Phase 2b, as set out in the latest business case assessments.
- 6.3 The Review expressed concern about whether HS2 could reliably run 18tph. This is a higher frequency than is currently delivered on high speed lines anywhere in the world, as shown in Table 6.1 below. The maximum number of high speed trains currently running is 14-15tph in peak periods in Japan and China; frequency is typically lower in Europe. However, trains run does not necessarily indicate maximum line capacity, since operators will run services to cater for demand and paths may be left free for reliability. The Review understands there are plans to upgrade the Paris-Lyon line to carry up to 16tph using the latest signalling technology in 2030.
- 6.4 The Review has also focussed on the speed specifications for HS2. Phase One civils infrastructure has been designed to a 400kph alignment, to allow future rolling stock to operate at these speeds. However, the planned operating infrastructure and rolling stock is designed to operate at a commercial operating speed of 330kph, with a maximum speed of 360kph to allow service resilience (to recover late-running services), although only around 60% of the Phase One route, and probably less on the Phase 2b route, is capable of operating at 360kph. An operating speed of 330kph is faster than is currently achieved internationally apart from China. China's high speed rail network accounts for about two thirds of the world's high speed rail and is the most heavily used. Other

countries, including Italy with the Frecciarossa, have trains capable of operating at 360kph though they do not in practice operate at these speeds.

Table 6.1: International examples of high speed rail lines⁴⁰

Country	Route		Frequency (tph)		Max Speed km/h
			Off-Peak	Max Peak	
United Kingdom	HS1	London-Ebbsfleet*	8	12	230
		Ebbsfleet-Ashford*	6	8	300
France	LGV Sud-Est: Paris-Lyon/Dijon/Macon		8	10	300
	LGV Atlantique:	Paris-Le Mans/Tours	6	11	300
		Tours-Bordeaux	2	4	320
Germany	ICE Frankfurt-Cologne		3	5	300
Spain	AVE: Zaragoza-Barcelona		2	5	300
Italy	Trenitalia + NTV: Florence-Bologna		6	9	300
Japan	JR Central Shinkansen: Tokyo-Nagoya		14	15	285
	JR East Shinkansen:	Tokyo-Omiya	12	14	240
		Omiya-Sendai	8	8	320
China	CRH: Beijing-Tianjin via Langfang		8	10	350

***HS1 Services:**

London-Ebbsfleet 8tph average off-peak comprises 2tph Eurostar, 6tph South Eastern High Speed
 London-Ebbsfleet 12tph max peak comprises 3tph Eurostar, 9tph South Eastern High Speed
 Ebbsfleet-Ashford 6tph average off-peak comprises 2tph Eurostar, 4tph South Eastern High Speed
 Ebbsfleet-Ashford 8tph max peak comprises 4tph Eurostar, 4tph South Eastern High Speed
 The busiest hour London-Ebbsfleet and the busiest hour Ebbsfleet-Ashford are at different times of day

⁴⁰ Evidence provided by the DfT to the Review

- 6.5 As confirmed by evidence provided to the Review by rolling stock manufacturers, the Review concluded that the requirement for rolling stock to have maximum speeds of 360kph along with other capacity and tonnage specifications has not added cost to the rolling stock cost estimates. The specification for speed would have to be reduced to 250kph in order to deliver reductions to the rolling stock cost estimates.
- 6.6 There would likely be an impact on benefits from reducing the speed of HS2 services. Reducing the speed to say 320kph could increase journey times by a few minutes, and although in reality passengers may not be too concerned by this journey time impact, journey time benefits make up a large part of the estimated benefits from HS2, as shown in section 11.
- 6.7 This high capacity, high frequency and high speed network has influenced decisions such as:
- the number of platforms required
 - junctions between lines are often required to be grade separated, due to the large number of services from different locations – the approach to Euston station is particularly challenging
 - the requirement of slab track, as opposed to ballasted track, on Phase One and the power requirements and other equipment
- 6.8 However, the Review saw little evidence of regular design review to check whether these standards were driving disproportionate costs into the HS2 project, and whether a less ambitious scope could have kept costs within budget.
- 6.9 The Review acknowledges, up to a point, the need to use infrastructure assets, especially high cost assets such as HS2, in an intensive fashion. However, evidence suggests that super high speed, high capacity requirements have led to infrastructure costs in the order of magnitude 10% higher than if HS2 had been designed at more internationally

comparable standards.⁴¹ If starting from a blank sheet of paper, the cost impacts from reducing the speed and frequency of the design could have the potential to be quite wide-ranging: different alignments could be found, stations could need fewer platforms, junctions like the approach at Euston station could be de-scoped, and structures could be cheaper. Lowering the speed and frequency could have also resulted in ballast instead of slab track being used on Phase One – although this could move capital costs to higher ongoing maintenance costs, worse for whole life cycle costs for HS2.

6.10 However, to achieve these cost reductions would require revising the route alignment and designs. For Phase One, this would require changing the Phase One Act which, depending on the amount and scale of changes required, would require new environmental impact assessments, consulting with newly impacted communities and enacting new legislation. This could significantly delay the forecast opening date of Phase One, causing further uncertainty and blight to local communities on the route.

6.11 Relatively few changes, therefore, can be made to Phase One at this stage given the limited deviation of the alignment possible within the Phase One Act's powers. However, opportunities to make changes, and therefore savings, would be greater for Phase 2b.

6.12 The key question is whether to build HS2 now with the maximum capability for 18tph at 360kph, or reduce requirements now and risk in the future wanting to add in this capability, which would be much more expensive to do. One example of this 'future-proofing' is the Euston station approach, where an expensive 'dive-under' junction has been included in Phase One scope to accommodate 18tph, and could be avoided at 14tph. The Review also notes that such a 'dive-under' junction

⁴¹ European Court of Auditors, A European high-speed rail network, June 2018 ([link](#))

exposes significant risks to the existing railway and services during construction.

6.13 The Review concluded that even if infrastructure scope is not changed, it would be prudent to have a core assumption of 14tph on HS2 infrastructure and understand the marginal impacts of increasing beyond this in the future. How best to use these 14 HS2 trains per hour should be explored by the West Coast Partner (the Shadow Operator), Network Rail, Midlands Connect and Transport for the North in the further study on Phase 2b recommended below. It is though expected by the time that HS2 is operational that signalling technology will have progressed, with ERTMS2 or potentially ERTMS3 throughout the GB rail network. Such improvements in signalling technology should enable 16tph on HS2.

Conclusion 6: On balance the Review considered that reducing the specifications of HS2 Phase One should be looked at, but only within the limits of the Phase One Act powers. This is due to the significant costs of making changes to these powers, both in terms of time and monetary costs, and the benefits of future-proofing the scheme for future service enhancements.

Conclusion 7: The specification for HS2 is ambitious compared to current international experience. A more prudent assumption of 14tph should be used as a central planning assumption for train service planning, future-proofing for 16tph, and future business cases should be updated accordingly.

Localised environmental impacts

6.14 In addition to carbon emissions (described in section 5 above), it is also important to note other environmental considerations, including impacts on woodland, landscape, biodiversity and more broadly on built and natural environments. Though such impacts are, in many ways, unavoidable on a project like HS2, it is vital that appropriate mitigation and compensatory measures are implemented by HS2 Ltd.

6.15 Although the evidence submitted to the Review has been mixed, HS2 Environmental Policy aims for HS2 to be an exemplar project:

- no net biodiversity loss; minimising carbon footprint, reinstating agricultural land, etc.
- ideally it will avoid environmental impact by design; where impact is unavoidable, the project will work to reduce and abate the impact, and where this is not possible repair and compensation measures will be used.

6.16 The Review recognised the loss of habitats and potential impacts on certain species, for example barn owls, from HS2. It is understood that HS2 Ltd is seeking to implement mitigation and compensatory measures to address such impacts. Given the duration of the project, the Review considers that it is vital that environmental impacts, and mitigation and compensatory measures are kept under review to ensure such measures are effective.

6.17 One example of environmental impacts is the impact on woodlands, for which HS2 Ltd have put in place repair and compensation measures. On Phase One, this includes the planting of 112.5 hectares of woodland in response to the direct loss of 29.4 hectares of ancient woodland. For Phase 2a, compensation measures to address the direct loss of 10.2 hectares of ancient woodland include the planting of 77.1 hectares of woodland. Similar figures are not yet available for Phase 2b given its current lack of maturity, although the Review has seen evidence to suggest that at least 10 ancient woodlands will be affected. The Review recognised however that planting new woodland is not a direct replacement for removing areas of ancient woodland.

6.18 The Review also noted that mitigating some negative impacts had caused a worsening of others: proposing deep cuttings or tunnels to avoid visual impacts and noise pollution from HS2 trains has, in the case of the deep cuttings, resulted in needing to transport large amounts of spoil during construction, with associated impacts on communities. It is not clear how

well this issue (needing to move large amounts of spoil) and its impacts are understood by HS2 Ltd.

6.19 Ground investigations have also revealed that the quality of earth removed from cuttings and tunnels is unlikely to be of good enough quality to be re-used as originally planned for embankments elsewhere, further increasing the transport and storage impacts.

6.20 The current scheme prescribed by the Phase One Act and its strict limits results in there only being approximately 8 minutes on the journey between Euston and Birmingham Curzon Street when passengers have a view.⁴² The vast majority of the journey is within tunnel or cuttings or behind concrete noise barriers.

6.21 More generally, disruption from the construction of HS2 will severely impact on communities up and down the line route. As indicated in section 10 below, HS2 Ltd needs to significantly improve how it treats individuals and communities affected by HS2 especially as it moves into the main construction phase. Further, in the design of Phase 2b, there may be opportunities to avoid, reduce or mitigate negative impacts – this should be looked into as a priority.

Conclusion 8: The Review recognised the impact of HS2 on woodland, landscape, biodiversity and more broadly on built and natural environments. Given the duration of the HS2 project, such impacts, along with any accompanying mitigation and compensatory measures, need to be kept under review.

Conclusion 9: The Review recognised the impact on communities of construction of HS2, and HS2 Ltd should continue to mitigate these. There are opportunities in the design of Phase 2b to avoid, reduce or mitigate negative impacts.

⁴² Evidence provided by the DfT to the Review

The full Y-shaped network

- 6.22 Phase 2b of HS2 is currently planned to be deposited as one hybrid Bill in June 2020, with the latest assessment from Allan Cook's report that it could be delivered and operational between 2035 and 2040. Given its large scope and that it is still in a design phase, before the Bill has been deposited, there may be opportunities for changes to be made to the Phase 2b scheme to increase benefits or deliver them sooner, and potentially reduce costs and negative impacts.
- 6.23 Phase 2b is the largest section of HS2, currently designed at 53 miles for the Western Leg from Crewe into Manchester and to the WCML south of Wigan, and 123 miles for the Eastern Leg from Phase One into Leeds and connections to the MML south of Chesterfield and ECML south of York. Phase 2b is designed to serve multiple destinations in different ways: building new tracks directly into the city centres of Manchester and Leeds; serving Sheffield and towns and cities in the north-east and north-west via connections to the conventional network; and building 'parkway-style' stations in the East Midlands (Toton) and at Manchester Airport.
- 6.24 Northern and Midlands leaders have made it clear in submissions to the Review that the full Y-shaped network is needed to help transform the economies of the North of England and Midlands. The Review agrees and considers that the government should recommit to the full Y-shaped network.

Conclusion 10: The government should recommit to the full Y-shaped network, linking Phase One to Manchester, the East Midlands, Yorkshire, and beyond. It only makes sense to do Phase One if continuing with northern phases to deliver transformational benefits to the North of England and Midlands.

Need for an integrated rail plan

- 6.25 HS2 trains are planned to run off HS2 track onto the current network. This is akin to the French system in which TGV trains run off high speed onto conventional lines particularly as high speed trains approach major cities to allow them to serve existing stations. The Japanese system, in contrast to the French system, is largely separate from the conventional speed network. The French system, not the Japanese system, would have therefore been the better comparator and model for HS2 Ltd to follow.
- 6.26 However, evidence on how HS2 has been developed suggests the Japanese model has typically been followed by HS2 Ltd, with HS2 designed largely in isolation from the conventional network and HS2 services being planned without proper consideration of existing or future planned services on the conventional network. Going forward, the Shadow Operator, appointed in August 2019 with their role on HS2 having commenced in late 2019, will help ensure HS2 services are planned with full consideration of services on the conventional network.
- 6.27 Further important considerations are regional transport strategies from Midlands Connect and Transport for the North. Much of the Phase 2b scope provides key infrastructure for the proposed NPR and Midlands Engine Rail networks directly as well as releasing capacity for local service improvements. NPR and Midlands Engine Rail strategies are being or will be developed after HS2 has reached a relatively advanced stage of design, and as such HS2 Phase 2b is currently having scope and design changes to help ensure that it is 'future-proofed' for these schemes.
- 6.28 Current plans for NPR services make use of up to around 110km of the proposed HS2 Phase 2b tracks. Midlands Engine Rail plans would also make use of the Eastern Leg of HS2 for proposed Birmingham-Nottingham and Bedford-Leeds connectivity, as well as making use of

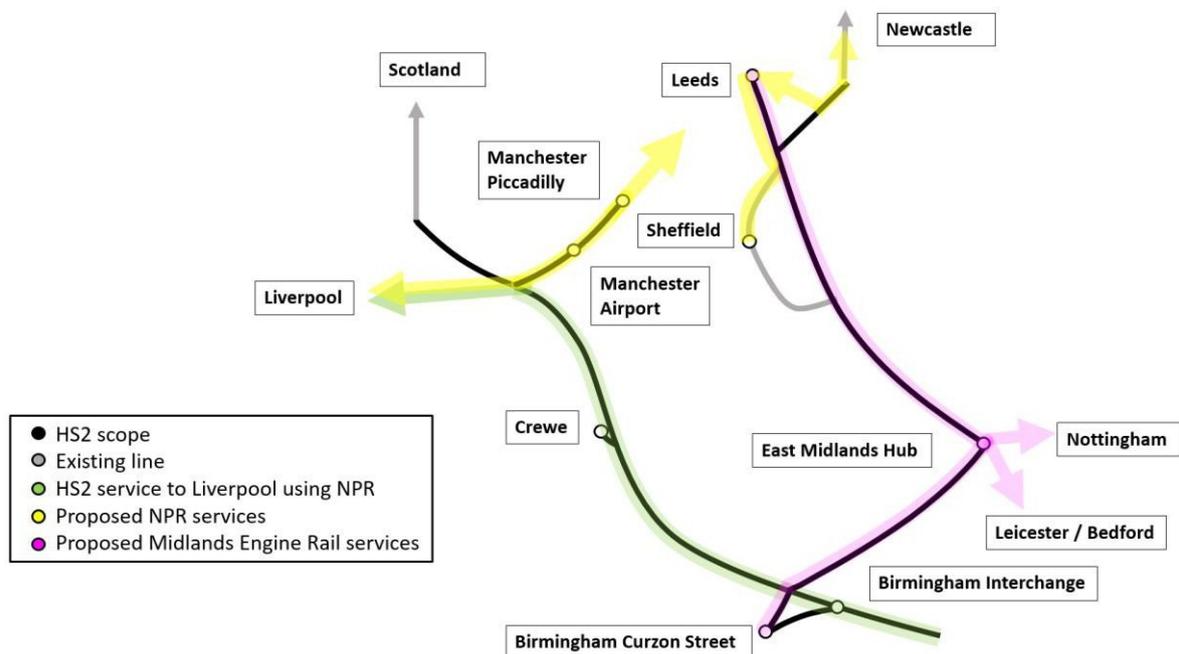
released capacity in the Midlands to improve local connectivity such as the Midlands Rail Hub proposal.⁴³

6.29 It is essential to integrate HS2 Phase 2b and the existing rail network. It is unlikely that an optimal solution providing maximum benefits to the Midlands and the North of England will be possible unless the various plans (NPR, Midlands Engine Rail and HS2) are developed in an integrated way. As described in conclusion 11 below, a further study is needed in order to determine an integrated rail plan for the North of England and the Midlands. Transport for the North and Midlands Connect, together with Network Rail, should contribute to the design development of Phase 2b. The aim should be to maximise the benefits of Phase 2b and ensure an optimised delivery model. Further, the study should consider how to deliver service improvements as soon as possible – before HS2 Ltd’s view of opening Phase 2b as currently designed in 2035-2040.

6.30 If the further study to determine an integrated rail plan for the North of England and the Midlands goes ahead, then the budget allocated towards Phase 2b, along with other relevant funding allocations, should be used in developing an integrated railway plan alongside an integrated railway investment programme for the Midlands and the North of England. A regular, planned annual spend could then be used in the delivery of the integrated rail plan, helping ensure greater consistency in funding and providing certainty for the supply chain. Any integrated rail plan for the North of England and the Midlands, including its on-going management and funding, will need to be aligned with the recommendations of the Williams Review including in respect of any new bodies established by government following the Williams Review.

⁴³ Evidence provided by the DfT to the Review; evidence provided by Transport for the North to the Review; Midlands Connect, Midlands Engine Rail, September 2019 ([link](#))

Figure 6.1: HS2 infrastructure proposed to be shared with NPR and Midlands Engine Rail



- 6.31 With the limited time available for the Review, optioneering was not examined in detail – nor, importantly, did the Review feel it would be appropriate to determine any scope changes to Phase 2b.
- 6.32 The Review understands that the delay in delivering Phase 2b would not enable the economic transformation that the Midlands and the North of England, and indeed the government, wish to see, and that it would not be acceptable for the Midlands and the North of England to wait for Phase 2b to open between 2035 and 2040.
- 6.33 However, the Review considered it would be beneficial to pause the preparations of the Hybrid Bill for Phase 2b. It would be worthwhile considering how best to break the current proposal down into parts and deliver sections sequentially as they become ready such as to deliver a phased programme of improvements, integrated with the conventional rail network and with NPR and Midlands Engine Rail proposals.
- 6.34 The Review noted that there is not currently full agreement between HS2 Ltd, Network Rail, the DfT and regional authorities about the appropriate

mix of new high speed line and upgrades of conventional network to improve reliability and service frequency, and the sequencing of these to deliver service improvements as soon as possible.

Conclusion 11: Transport for the North and Midlands Connect, together with Network Rail, HS2 Ltd and the DfT, should develop a plan to maximise the benefits of Phase 2b and ensure an optimised delivery model. This could be the first step in an integrated rail plan for the GB rail network. This Review recommends a further study of circa 6 months of Phase 2b scope in the context of Midlands Engine Rail and NPR proposals. The study should consider the appropriate mix of new high speed line and upgrades of conventional network to improve reliability and service frequency, and the sequencing of these to deliver service improvements as soon as possible – before HS2 Ltd’s view of opening Phase 2b as currently designed in 2035-2040. The budget allocated towards Phase 2b, along with other relevant funding allocations, should be used in developing an integrated railway plan alongside an integrated railway investment programme for the Midlands and the North of England.

Conclusion 12: Preparation of materials for the Phase 2b Bill as currently designed should be paused and await the outcome of this study. Given experience on Phase One, having smaller Bills/phases may be better to allow easier scrutiny of proposals in Parliament and faster construction.

6.35 The Review recognised this could leave uncertainty and blight for the current Phase 2b design, and mean that some of the preparatory work undertaken on Phase 2b would no longer be required. However, the Review felt it was important to ensure plans for the Midlands and the North of England are optimised and that service improvements are delivered as soon as possible – before HS2 Ltd’s view of opening Phase 2b as currently designed in 2035-2040.

Other route considerations

- 6.36 Further, the Phase One Act includes a connection to the WCML at Handsacre, originally designed for where HS2 Phase One services north of Birmingham join the conventional network. With the Chairman's Stocktake forecasting that both Phases One and 2a will open in 2028-31⁴⁴, the sole use of this connection is to be able to serve Stafford, Stoke-on-Trent and Macclesfield with one HS2 train per hour. The Review did not see a good rationale for this connection now given the revised schedule and the relatively limited benefits derived for the cost of the connection. Network Rail also raised concerns about the disruption the connection would cause during construction.
- 6.37 The Review recognised that not including the Handsacre connection in HS2 scope would mean Stoke-on-Trent and Stafford would not see the promised HS2 services. The Review thought if government were to remove the connection it would be important for the West Coast Partner and Network Rail to maintain and/or improve the service on the conventional line, likely at lower cost and to greater benefit to passengers in Staffordshire and Stoke.
- 6.38 The Review also heard evidence from a number of informed stakeholders suggesting there should be a new station near Calvert, where HS2 would cross East-West Rail proposals to improve connectivity along the Oxford-Cambridge corridor. Previously, due to the impact on speed, no interim station had been planned between London and Birmingham Interchange. The Review concluded that the DfT should consider making passive provision for a future HS2 station near to Calvert. If it is decided that a HS2 station should be built near to Calvert, passive provision will help prevent any disruption to HS2 services. There could be merit in developing an HS2 station in the future here if local plans support a significant residential and commercial development in this region, and if

⁴⁴ The Review understands that the schedule ranges currently being considered by HS2 Ltd and the DfT are wider than the forecasts set out in the Chairman's Stocktake.

there is passenger demand to justify the cost of developing a station here. Without this coordinated planning, the experience of HS1 stations risks being repeated. The Review notes that the cost of developing a future station near Calvert could be shared with others including potentially the East West Rail Company.

Conclusion 13: The Review recommends removing the Handsacre connection from HS2. At the same time, Network Rail and the DfT should maintain or improve services on the WCML to Stoke-on-Trent, Stafford and Macclesfield. The Review considers that the Handsacre connection would only be needed if it was decided not to proceed with Phase 2a to Crewe.

Conclusion 14: The DfT should consider making passive provision for a future HS2 station near to Calvert. There could be merit in developing a HS2 station near Calvert if local plans support a significant residential and commercial development in this region, and if there is passenger

7. Cost and schedule

- 7.1 The Review has examined the current cost assessments provide by HS2 Ltd and the associated risk and contingency analysis. In order to cross-reference the cost information provided, the Review has also looked at cost benchmarking done by HS2 Ltd and the DfT, and evidence submitted to the Review which provided external estimates of cost.
- 7.2 The Review had neither the time nor the resources to develop its own bottom-up estimate of costs on the HS2 project, and has used, as a starting point, the cost estimates provided in the Chairman's Stocktake. During the course of the Review, HS2 Ltd has been working on the latest cost baseline for Phase One (Baseline 7). Baseline 7 has been going through governance and assurance – this includes assurance by an external financial consultant (one of the big 4) and the Independent Assurance Panel. Following further development and consideration of Baseline 7 by HS2 Ltd's board and the DfT, it is understood that Phase One cost estimate ranges could be higher than those set out in the August 2019 Stocktake and the schedule ranges currently being considered are wider.

Latest cost estimate

- 7.3 The Chairman's Stocktake sets out a cost estimate for the HS2 project in **2015 prices (Q1)**:
- Phase One is estimated to cost in the range of £36.1bn to £38.4bn. This is made up of a point estimate of £28.9bn and contingency of £7.2bn to £9.5bn. The overall figure for Phase One is £8.9bn to £11.2bn higher than the Phase One funding envelope set in 2013 and revised in 2015. These figures include the cost of developing the HS2 stations which, as described in section 9 below, the Review considers could be funded by the private sector

- Phase 2a is estimated to cost in the range of £3.6bn to £4bn. This is made up of a point estimate of £2.7bn and contingency of £0.9bn to £1.3bn. The Phase 2a funding envelope, which was confirmed in 2015, is £3.7bn
- Phase 2b is estimated to cost in the range of £32.4bn to £36bn. This is made up of a point estimate of £24bn and contingency of £8.4bn to £12bn. This is £7.6bn to £11.2bn higher than the Phase 2b funding envelope which was confirmed in 2015
- the HS2 project (Phases One, 2a and 2b) is therefore estimated to cost in the range of £72.1bn to £78.4bn. This is £16.4bn to £22.7bn more than the funding envelope set in 2013 and revised in 2015

7.4 If adjusted to 2019 prices, the figures set out in the Chairman's Stocktake are as follows:⁴⁵

- Phase One: £40.4bn to £43bn, against a budget equivalent of £30.4bn
- Phase 2a: £4bn to £4.5bn, against a budget equivalent of £4.2bn
- Phase 2b: £36.3bn to £40.3bn, against a budget equivalent of £27.8bn
- total for HS2 project: £80.7bn to £87.7bn, against a budget equivalent to £62.4bn

7.5 The Review considers that the use of 2015 prices in presenting the cost of HS2 is problematic. It has not assisted either Parliament or the public to understand the HS2 project's current costs. However, the government should consider carefully when is the appropriate time to fix funding and cost envelopes, and present costs.

⁴⁵ Figures provided by the DfT at Q3 2019 prices

Latest estimate of schedule

7.6 The revised schedule forecasts for the HS2 project set out in the Chairman's Stocktake are as follows:

- Phase One: a staged opening between 2028 and 2031 instead of a target delivery date of December 2026
- Phase 2a: delivery to the same timescale as Phase One instead of delivery in 2027; and
- Phase 2b: delivery between 2035 and 2040 instead of a target delivery date of 2033

7.7 As indicated at paragraph 7.2 above, the Review understands that the schedule ranges currently being considered by HS2 Ltd and the DfT are wider than the forecasts set out in the Chairman's Stocktake.

Phase One

7.8 A greater proportion of the cost estimates on Phase One are now derived from contractor pricing compared to previous baselines.⁴⁶ However, unless rigorous cost controls are put in place, there is considerable risk that the prices for Phase One will not remain at the levels set out in the Chairman's Stocktake. This is primarily because of the Phase One procurement strategy and contracting model for the Main Works Civils (see section 8 below) which has, in hindsight, proved to be unsuccessful.

Phase Two

7.9 Estimates of costs and schedule on Phase Two are less mature than that of Phase One.

⁴⁶ HS2 Ltd, Chairman's Stocktake, page 17 (2019) says that baseline 7 for Phase 1 is based on contractor input (50% by value), professional services / design consultant input (23%) and client-led estimates (27%). Previous cost estimates for Phase 1 were, in contrast, based, to a very large extent, on HS2 Ltd's own estimates and also suffered from a lack of information about ground conditions along the route ([link](#))

7.10 The Review considers that, if Phase 2a proceeds as currently planned, the cost estimate may need to be revised upwards including, it is understood, in light of emerging estimates for land and property, systems and indirect costs. A higher cost contingency could be used on Phase 2a cost estimates. However, if more ground investigations take place and the design for Phase 2a matures, it may be possible to bring this cost contingency down.

7.11 The estimate of cost and schedule on Phase 2b is the least mature. A realistic cost envelope should be set for Phase 2b and, in terms of schedule, an evidenced range of opening dates, instead of a target date, should be used. Given Phase 2b's relatively early stage of development, there are opportunities to make the design more efficient. If, however, Phase 2b proceeds as currently planned without the further study described in section 6 above, the Review considers that the cost estimate may need to be revised including for the following reasons:

- there are opportunities to change or refine the Phase 2b route, and choices on route have cost implications – accordingly, the cost estimate in the Chairman's Stocktake cannot be relied upon
- the Phase 2b Hybrid Bill has not gone through Parliament – obligations placed on HS2 Ltd and the DfT, during any Hybrid Bill process, may result in cost increases
- further cost pressures including in respect of land and property costs
- assumed efficiencies and value engineering savings may not be achievable
- a lack of information on ground conditions – the Chairman's Stocktake has cited ground conditions as a reason behind cost increases on Phase One. This issue, a lack of information on ground conditions, needs to be remedied on Phase Two.

Conclusion 15: Phase One: The Review has examined HS2 Ltd cost estimates. There is considerable risk that the prices for Phase One will not remain at the levels set out in the Chairman's Stocktake unless rigorous cost controls are put in place. Cost controls will be key to ensuring that costs remain at or below the levels set out in the Chairman's Stocktake.

Conclusion 16: Phase Two: There is far less certainty on the costs and schedule for Phase Two. It would be unwise to commit a specific cost number for Phase Two given the choices on Phase 2b route that are still to be made, the design maturity and the level of ground investigations. Accordingly, costs and schedule for Phase Two should continue to be expressed as a range. For Phase Two cost estimates, higher contingency levels are appropriate including in order to avoid the issues that Phase One has faced. As described in section 6 above, preparations of materials for the Phase 2b Bill as currently designed should be paused.

Conclusion 17: While the Review has not been able to develop its own bottom-up estimate of costs on the HS2 project, it considers that costs on the HS2 project could be around 15 to 20 per cent higher than those set out in the Chairman's Stocktake. Critically, this assumes, amongst other things, that Phase 2b proceeds as currently planned – as indicated at conclusion 23 in section 8 below, there are real opportunities to reduce costs on Phase 2b by removing gold-plating including through alignment redesign.

Conclusion 18: Given the revised schedule forecast for Phase One and Phase 2a set out in the Chairman's Stocktake, the government should consider merging the construction of Phase 2a with that of Phase One.

Benchmarking

7.12 Benchmarking is a useful tool for checking that cost estimates for major projects are reasonable and are broadly comparable with those of other projects.

- 7.13 The Review considered a cost estimate of the HS2 project that has been developed by an external consultant. This estimate sets out a total cost of £106.6bn in Q4 2015 prices for the HS2 project.⁴⁷ The Review commissioned a comparative analysis of this external consultant's cost estimate and the cost estimates developed by HS2 Ltd for Phase One. Evidence provided by Network Rail to the Review indicated that major rail infrastructure cost plans generally exhibit certain characteristics. Such characteristics were not evident in the estimate developed by the external consultant in that it seemed to the Review that the amounts allocated towards major construction works were too low, and the amounts allocated towards rail systems seemed too high. This view was confirmed by evidence provided to the Review by Network Rail.
- 7.14 Benchmarking, developed by the DfT, was designed to compare HS2 cost estimates to comparable cost elements from other UK major projects. This shows that the current HS2 Phase One cost estimates are comparable with, though at the upper end, of the costs of other UK infrastructure projects – see table 7.1 below. The below table shows for Phase One of the project the application of a benchmark ('Multi-project benchmark') developed by the DfT to HS2 Phase One.⁴⁸ The DfT has confirmed, in respect of the 'multi-project' benchmarking approach, that it draws on a range of recent, mainly outturn comparator rates from UK rail and non-rail data sources on an asset class basis (e.g. tunnelling, earthworks etc).
- 7.15 The table below also shows the application of a benchmark based on the costs of HS1, the UK's only high-speed rail route, to HS2 Phase One ('HS1 benchmark'). The DfT has confirmed, in respect of the HS1 benchmark that the single-project (HS1) benchmark was developed using a deconstruction of HS1 costs by works type, and re-based to Q1 2015

⁴⁷ Evidence provided by Michael Byng to the Review.

⁴⁸ The DfT also notes, in respect of this multi-project benchmark, that: (i) the comparator data forms the basis for a three-point estimates of cost rates, which are subsequently applied to HS2 quantities and aggregated to

derive a total benchmark cost range; and (ii) totals in the table also include any 'non-benchmarked' costs (e.g. land and property), which are extracted from HS2 Ltd's estimates.

prices. Costs were subsequently re-scaled in accordance with HS2 design quantities and specification to demonstrate what Phase One would cost if built with an efficiency equivalent to that of HS1. The range shown is based on different inflation indices and captures inflation uncertainty.

Table 7.1 Cost benchmarking of HS2 Phase One

Funding envelope (£, 2015 prices)	Cost estimate set out in the Chairman's Stocktake (£, 2015 prices)⁴⁹	Multi-project benchmark (£, 2015 prices)	HS1 benchmark (£, 2015 prices)
27.2bn	36.1-38.4bn	34.3 – 37.9bn	31.7-35.0bn

7.16 Benchmarking, commissioned by HS2 Ltd, was designed to compare HS2 cost estimates to high speed rail lines in other countries. This demonstrates that the cost of HS2 is substantially higher than the cost of high speed rail lines in other countries. However, the analysis also showed there are explainable differences in cost including:

- UK-specific factors including, amongst other things, the fact that the construction industry in the UK is more fragmented than in other countries and relies on many tiers of subcontractors; and
- the higher specifications which HS2 is being built to. For example, the Chairman's Stocktake cites, amongst other things, HS2's higher frequencies, speed and resulting tonnages.

7.17 While the benchmarking is welcome, it seems that benchmarking has not been used by HS2 Ltd and the DfT on a consistent or uniform basis across the project. The Review considers there is more that HS2 Ltd and the DfT

⁴⁹ HS2 Ltd, Chairman's Stocktake, August 2019 ([link](#)). The figures used in the Chairman's Stocktake are outturn figures (i.e. inclusive of contingency)

could do to ensure that benchmarking is used more consistently and uniformly on the HS2 project.

7.18 As part of this benchmarking work, there is a need to monitor the market to check that cost estimates align with current market prices. The original cost estimate for the HS2 project would have been influenced by market prices at the time of estimation. As discussed in paragraph 10.15, following that cost estimate, there have been rises in market prices. Proper monitoring of market prices will help ensure there is early warning of any price rises.

Conclusion 19: HS2 Ltd and the DfT need to deploy benchmarking more consistently and more uniformly. The DfT, with the support of the IPA, should build on the useful multi-project benchmark which the DfT has developed. Any benchmarking should be UK-specific where relevant, but look to include and learn from international examples as well. As part of this benchmarking work, there is a need to monitor prices on the market to check that cost estimates align with current market prices.

7.19 Further, the Review has considered evidence provided by Network Rail on cost estimating methodologies. This evidence has confirmed that HS2 Ltd and Network Rail should work more closely together and use cost estimating methodologies that are consistent.

Conclusion 20: HS2 Ltd and Network Rail to engage with each other to ensure that cost estimating methodologies are used in a consistent fashion including on an ongoing basis for future projects. There is an opportunity to learn from each other.

7.20 In terms of cost estimating more generally, there is a need to properly consider and reflect the different stages of a project from concept design through to Royal Assent. A budget should be set for delivering a concept design, and, for any hybrid Bills, it is important for Parliament to understand how much the Bill process itself is costing in terms of time and money. Any cost and schedule estimate should be confirmed

following Royal Assent and before authority is given to proceed and commence procurements.

Overall affordability

7.21 The HS2 project as currently scoped is no longer affordable within its present funding envelope which was set in 2013 and revised in 2015. Therefore, it is legitimate to ask whether proceeding with the project is a good way to use taxpayer money.

7.22 While HS2 Ltd and the DfT need to ensure that costs are properly controlled on the project, it is important to put the spend on HS2 into context: it is estimated that the costs of the HS2 project, if spread over 25 years (2015-2040), will amount to approximately 0.2% of the UK's GDP.⁵⁰ Affordability also needs to be considered alongside the project's benefits including those described in section 11, wider issues such as the need for capacity on the GB rail network, and the potential for HS2 to be part of transformational economic change. Further, as described in section 11, it is also worthwhile noting that there will be revenues generated by HS2.

Conclusion 21: Given the cost position outlined in this section, HS2 as currently scoped is not affordable within its present funding envelope which was set in 2013 and revised in 2015. As previously indicated at conclusion 10 in section 6 above, the Review considers that the government should commit to the full Y-shaped network. If the government commits to the full Y-shaped network, it will need to commit significant additional funding to make the scheme affordable including providing a realistic funding envelope for Phase Two. Before issuing NtP, a revised funding envelope should be set for Phase One – the funding envelope should have appropriate levels of contingency, to be held by the DfT/HM Treasury, and should be realistic.

⁵⁰The fiscal remit set by government for the National Infrastructure Commission provides a long-term funding guideline for gross public investment in economic infrastructure of between 1.0% and 1.2% of GDP in each year between 2020 and 2050. Remit Letter for National Infrastructure Commission, November 2016 ([link](#))

The cost of cancellation

- 7.23 The Review has also examined evidence on the cost of cancelling the whole HS2 scheme. Estimates from HS2 Ltd and the DfT indicate that, to date, the HS2 programme has spent approximately £9bn. These have been described to the Review as ‘sunk costs’. It has, however, been confirmed by HS2 Ltd and the DfT that some of these costs could be recovered with around £2bn to £3bn of land and property costs potentially recoverable.
- 7.24 In addition to the amount already spent, HS2 Ltd and the DfT have estimated that the direct costs of cancelling the HS2 project are around £2.5bn to £3.6bn. This estimate of additional direct costs includes amongst other things the costs of continuing to fund HS2 Ltd until it is wound down and costs relating to the making good of construction sites.
- 7.25 The costs cited in the paragraphs above do not include the wider impacts resulting from cancellation. For example, it is estimated there are around 2,000 companies, employing over 9,000 people, in the direct supply chain working on HS2. It is understood, therefore, that cancelling HS2 would have significant negative impacts not only on the UK construction industry but the wider supply chain. It is important to note that there appear to be no other ‘shovel ready’ transport infrastructure projects of a similar scale to HS2. Therefore, it is not clear whether the government or the private sector could mitigate the negative impacts for the construction industry and the UK rail supply chain arising from any decision to cancel HS2.
- 7.26 The cancellation of HS2 is also likely to result in significant negative impacts on the UK’s reputation for planning and delivering major infrastructure. This, in turn, would have a detrimental impact on the confidence of companies and investors, including those based overseas, in the UK and its ability to deliver major projects. An overseas company is a key member of each of the winning consortiums on the HS2 Phase One Main Works Civils. Many of the companies involved in HS2 are ultimately

owned by entities based overseas and/or are multinational organisations that could, if HS2 was cancelled, focus their interest outside the UK. This could, in turn, result in these organisations reducing, in respect of their UK offices, the quantity and quality of apprenticeships, spaces on training schemes and overall headcount.

7.27 Further, it is understood that public investments have already been made locally ahead of the arrival of HS2.⁵¹ The impact of cancelling HS2 on these investments is unclear but could be detrimental. More generally, the cancellation of HS2 could hinder attempts to create an economic transformation across the UK.

Conclusion 22: There would be serious consequences for the supply chain, the fragile UK construction industry and confidence in UK infrastructure planning if HS2 were cancelled at this late stage. Cancellation of HS2 could also hinder attempts to create an economic

⁵¹ Evidence provided by the DfT to the Review

8. Contracting and HS2 specifications

8.1 The Review has looked at why costs have escalated over time, the impact of the contracting model and how the design and specification have influenced the pricing HS2 has received from contractors.

Design standards and specifications in HS2 contracts

8.2 There has been considerable over-specification and 'gold-plating' in HS2 contracts with much of the design seemingly done on a worst-case, risk-averse scenario. The Review considers this has been a key driver behind the inflated prices on Phase One. The Review concluded that these design standards and specifications could be reduced to be less severe without major risk, for example the slopes of embankments and need for extensive piling. These should be reconsidered to provide engineering in a more efficient manner, in the next and final stage of detailed design by the contractors for Phase One.

8.3 The Review has considered if there is a trade-off to be made between cost and schedule on Phase One especially whether a significant redesign of Phase One could lead to reduced costs. As set out in section 6, a significant redesign would involve changes to the limits of deviation or to environmental obligations which would in turn require amending the Phase One Act. Therefore, although a major revision to the design could bring about savings, they would be lost in the cost of delay. This is where the constraints of the Phase One Act, and the difficulty in changing it, do not assist the taxpayer. There are, however, greater opportunities on Phase 2b to remove gold-plating and over-specification including redesigning alignments.

8.4 Nevertheless, as part of its work to finalise detailed designs and prices with the Phase One Main Works Civils contractors, there could be opportunities for HS2 Ltd to make the design more efficient within the limits of the Phase One Act.

8.5 Further, there may be further opportunities to reduce costs by allowing the schedule to flex and changing milestones within the Phase One Main Works Civils contracts. It is understood that this issue is being explored by HS2 Ltd. It needs to be progressed in respect of all milestones within the Phase One Main Works Civils contracts.

Conclusion 23: On balance the Review considered that reducing the specifications of HS2 Phase One should continue to be looked at, but only within the limits of the Phase One Act powers. This is due to the significant costs of making changes to these powers both in terms of time and monetary costs, and the benefits of future-proofing the scheme for future service enhancements. The next stage of design development for Phases One and 2a should look at efficient and economic design standards, and this should form part of the work to finalise detailed designs and prices. HS2 Ltd should thoroughly examine what gold-plating of standards can be removed on Phase 2b to reduce costs, including alignment redesign if considered appropriate.

Conclusion 24: There needs to be a full review of the milestones within the Phase One Main Works Civils contracts with a view to keeping costs down

Procurement and contracting approach

8.6 Evidence provided to the Review has indicated that HS2 Ltd's procurement and contracting approach has inflated prices on the Phase One Main Works Civils contracts. The Review considers that, especially in relation to the allocation of risk, this approach has, in hindsight, proved to be unsuccessful.

8.7 The procurement model for the Phase One Main Works Civils contracts was based on a target cost model with pain and gain elements. These pain and gain elements are designed to help ensure there are incentives for all parties to perform their potential contractual obligations. The main issue with the approach used on the Phase One Main Works Civils contracts was that, initially, all the risk was placed on the contractors.

The better and more normal approach, whereby **those who are able to manage risk should carry risk**, was not followed. Further, given the fragile state of the UK construction industry, especially following the collapse of Carillion and others, the contractors have behaved in a risk adverse manner and hence priced the potential risks very highly. HS2 Ltd's approach meant that the initial draft target prices received from contractors were excessive and significantly above the company's expectations.

- 8.8 As a consequence, HS2 Ltd has given further consideration to risk allocation. Even so, the current position is that HS2 Ltd is carrying most of the risk, with little gain, and the contractors are not. The relatively modest reductions in price are not thought to reflect the full value of the saving that could be achieved.

Proposed next steps on the Phase One Main Works Civils contracts

- 8.9 In respect of the Main Works Civils contracts, the Review considers that, ahead of issuing Notice to Proceed for Phase One, the government should ensure that HS2 Ltd achieves a satisfactory position with each of the Main Works Civils contractors in order to obtain acceptable Stage 2 prices and a reasonable level of value engineering. The Main Works Civils contracts are based on a two-stage design and build strategy with the aim of fixing final target prices ('Stage 2 prices') at Notice to Proceed. Stage 1 was intended to develop maturity in design, schedule, cost and risk before agreeing a target price to move into Stage 2 detailed design and build. This report does not set out what would constitute acceptable Stage 2 prices or a reasonable level of value engineering. This should be determined by HS2 Ltd with the DfT, HM Treasury and the IPA.
- 8.10 If HS2 Ltd cannot achieve a satisfactory position with the Main Works Civils contractors, then HS2 Ltd, subject to further discussions with the DfT and HM Treasury, may have to consider re-procuring these contracts. A re-procurement of some or all of these contracts would introduce some

delay to the programme but could potentially result in a reduction in costs.

Conclusion 25: ahead of issuing NtP for Phase One, the government should ensure that HS2 Ltd achieves a satisfactory position with each of the Main Works Civils contractors in order to obtain acceptable Stage 2 prices and a reasonable level of value engineering. If HS2 Ltd cannot achieve a satisfactory position with the Main Works Civils contractors, then HS2 Ltd, subject to further discussions with the DfT and HM Treasury, may have to consider re-procuring some or all of these

Future HS2 procurements

- 8.11 Lessons from the Phase One Main Works Civils contracts, and indeed from Crossrail and other major transport projects⁵² including the WCML upgrades, need to be learnt and applied by HS2 Ltd.
- 8.12 Revised procurement and contracting models should be considered especially for any future HS2 construction contracts. HS2 Ltd, along with the DfT, HM Treasury and the IPA, should review alternative procurement models including, for example, the approach used by Heathrow Airport in developing their terminals at Heathrow in recent years and the revised contract adopted for the A14 project. It should be noted that, while the contracting models used in these examples are not dissimilar to that used by HS2 Ltd for the Main Works Civils, they have been implemented more effectively in these instances. Given the substantial interfaces that HS2 Ltd needs to manage on the project, the Review considers that it may be more efficient for HS2 Ltd, rather than the contractors, to carry and manage risk.
- 8.13 This approach to risk is especially sensible when comparing the capitalised values or balance sheets of many of the companies against the size of exposures under those construction contracts. Such exposures

⁵² DfT, Lessons from transport for the sponsorship of major projects, April 2019 ([link](#))

mean that this risk may ultimately be carried by government in any event. Accordingly, the Review considers that it would be preferable for HS2 Ltd, and not the construction contractors, to carry and manage all risk save for those risks covered by the contractors' normal insurances. This approach could enable prices to be brought back to acceptable commercial levels.

- 8.14 In addition, in considering the scope and size of procurement packages, there needs to be greater consideration of the interfaces on the project, i.e. smaller work packages may be more deliverable but this would require robust management by HS2 Ltd of the interfaces.
- 8.15 Evidence from overseas has been submitted to the Review which indicates that there could also be benefit in HS2 Ltd, in addition to the project insurance that it has already obtained, procuring some of the construction contractors' normal insurances on their behalf on a project wide basis. HS2 Ltd could obtain lower rates for these insurances than any individual contractor could obtain. The cost of the contractors' normal insurances will be part of the contractors' prices and so will be passed on to HS2 Ltd. This approach, whereby HS2 Ltd procures, at a lower rate, some of the contractors' normal insurances on their behalf on a project wide basis, could therefore result in project savings.
- 8.16 Further, the contracting model used to engage design consultants on the Phase One Main Works Civils contracts, with designers working for the construction contractors as opposed to working for HS2 Ltd, has potentially resulted in risk-averse designs that are not cost-effective. This contracting model needs to be reconsidered for future procurements. There could, for example, be value in HS2 Ltd developing the preliminary design to a more advanced stage from that required during the Phase One Hybrid Bill process prior to going to the market. HS2 Ltd could then allow the contractors' detailed design to be developed. Further, HS2 Ltd should consider whether there could be benefit in adopting an asset based procurement strategy in future procurements.

Conclusion 26: Lessons from the Phase One Main Works Civils contracts, and indeed from Crossrail and other major transport projects, need to be learnt and applied by HS2 Ltd. Revised procurement and contracting models should be considered, especially for any future HS2 construction contracts including on Phase 2a. In any future procurements, HS2 Ltd needs to consider how it can ensure: (i) an optimised approach to risk allocation is used; (ii) there is robust management of interfaces on the project; and (iii) efficient designs are developed.

Proposed next steps on Phase 2a

8.17 There are, as with Phase One, significant earthworks on Phase 2a. Such earthworks are again apparently dictated by the 400 kph track alignment. Within the constraints of the Phase 2a Bill, there may be potential ways of optimising the design and reduce costs on Phase 2a. This could include using tunnelling or modifying the earthworks, providing the environmental impact is either lessened or is no worse.

Conclusion 27: Within the constraints of the Phase 2a Bill, HS2 Ltd and the DfT should investigate the potential to optimise the design and reduce costs on Phase 2a.

9. HS2 stations

9.1 Stations are a core part of the HS2 project including acting as gateways for passengers into city centres. It is vital that the integration of HS2 stations with the existing transport networks and local areas they serve is at the forefront of their design. The stations have the potential to be a catalyst for change and they will be key in the success of local growth ambitions.

9.2 Stations also have an important role in driving commercial value and contributing to the funding of rail projects. Over site development and private sector contributions have been used for Crossrail and innovation in this area needs to continue for funding future infrastructure projects.⁵³

9.3 Phase One includes stations at:

- Birmingham Curzon Street, located in the Eastside district on the edge of the city centre
- Birmingham Interchange, located in Solihull and will be part of a new public transport interchange serving Solihull, the West Midlands, Birmingham Airport and the National Exhibition Centre
- Old Oak Common, located in west London and will combine HS2 with the Elizabeth Line and the Great Western Main Line (GWML)
- Euston, with HS2 increasing the station footprint and adding additional services to the existing station

9.4 This section focusses on the design and governance of the Phase One stations. Section 12 examines alternative options including the case for

⁵³ Crossrail, OSD Collaboration and Property Value Capture, July 2018 ([link](#))

a station at Old Oak Common and Euston, and concludes that both stations are important to the project.

Commercial opportunities

- 9.5 Designs are being developed for each Phase One station and the construction partners for Old Oak Common and Euston are now in place. Although each station is at a different level of maturity, all Phase One Stations are working toward RIBA 3 and schedule 17 submission.⁵⁴
- 9.6 The Review considers that more needs to be done to drive further value from the stations. This is vital to ensure that the economic and social value from the opportunities presented by the stations are maximised.
- 9.7 A substantial amount of work has been undertaken to maximise the land around and above Euston station, in terms of both the HS2 station and Euston conventional station, following the appointment of Lendlease as the development partner in 2018. The latest masterplan in Euston has a gross developable area of 10 million square feet⁵⁵ and it has been claimed that it is the largest over site development in Europe. It also contains 21 acres of public green space and a focus on ensuring the development enhances the innovation district, promoted by Camden Council, emerging in the ‘Knowledge Quarter’ around King’s Cross, the Euston Road and Bloomsbury. Delivering economic and social value has been at the centre of the design. This needs to continue and further opportunities need to be explored for commercial and residential development at the other stations along the route.
- 9.8 The assumption that HS2 Ltd should build all HS2 stations at public expense should be challenged. HS2 Ltd is not properly incentivised to

⁵⁴ In respect of Euston, this wording applies to the plans for building the HS2 station.

⁵⁵ Evidence provided by Lendlease to the Review

maximise over station development at HS2 stations. Further, given the complexity and scale of the HS2 project, HS2 Ltd may not have the capacity to properly focus on over station development. If the current arrangements for station development are left in place, there is a significant risk that economic value from HS2 station developments will not be maximised, and that there will be cost and schedule overruns. At present, the total capital cost for developing the HS2 stations, including any cost overruns, will be picked up by the public sector.

9.9 There may be opportunities for local authorities or combined authorities, in partnership with the private sector, to take on HS2 Ltd's role in funding and developing stations.⁵⁶ There is also potential for private sector funding to be used to pay for railway works into and at stations. It is estimated that, if all stations for Phase One were delivered in this manner (i.e. funded and developed by the private sector in association with local government), this would lead to capital cost savings amounting to potentially several billions of pounds.⁵⁷

9.10 While there are very limited UK examples of this approach being used, there are numerous international examples. A bespoke, specific commercial model may need to be developed to deliver this approach. This new model could seek to build on the approaches used by London and Continental Railways on major development projects. Any model which is developed will need to ensure that profits from commercial development are used to pay for the station.

9.11 There could also be opportunities to capture value created in land close to HS2 stations especially at Euston and Birmingham Curzon Street. This value would normally accrue to freeholders, but, if captured, could defray some of the cost of developing the HS2

⁵⁶ The Review has heard evidence that local authorities, in conjunction with the private sector, could be interested in developing HS2 stations

⁵⁷ Evidence provided by the DfT to the Review

stations. There needs to be further consideration around whether and how such value could be captured.

9.12 The governance arrangements for the development of the HS2 stations need to be streamlined. The current arrangements often involve complex, ineffective and loose partnership arrangements with the DfT, HS2 Ltd, Network Rail, local government and transport authorities, and private sector partners.

9.13 In addition, the HS2 stations to date have been considered as a stand-alone system. However, it is vital for the success of the project that the HS2 stations are closely integrated with the existing transport network, especially intra-city transport networks, and the urban fabric of the local area. The Review considers that, if local government, in partnership with the private sector, takes on HS2 Ltd's role in funding and developing stations (see paragraph 9.9 above), this should help ensure HS2 stations are well integrated with the existing transport network and the local area.

Conclusion 28: Work needs to continue to ensure that commercial opportunities are maximised at HS2 Phase One stations.

Conclusion 29: HS2 Ltd and the DfT should continue, where feasible and appropriate, to engage with the private sector, in association with local government, to develop HS2 stations. There may be opportunities for local authorities or combined authorities, in partnership with the private sector, to take on HS2 Ltd's role in funding and developing stations. If the current arrangements for station development are left in place, there is a significant risk that economic value from HS2 station developments will not be maximised. A bespoke, specific commercial model may need to be developed to deliver specific elements in and around stations.

Conclusion 30: There needs to further consideration around whether and how value created in land close to HS2 stations could be captured.

Conclusion 31: Governance arrangements for the development of the HS2 stations need to be streamlined with HS2 stations closely integrated with the existing transport network and the local area.

Conclusion 32: Until the issues set out in conclusions 28 to 31 above are sufficiently progressed, procurements for the development of HS2 stations should be paused.

Euston station: costs, options and governance

9.14 In comparison with the other Phase One HS2 stations, the construction at Euston is very challenging. Accordingly, the Review has looked at the Euston design in further detail.

9.15 Euston station is a complex site with four different projects being developed or planned for development within a confined space. As well as the HS2 Euston project there is the redevelopment of the conventional Network Rail Euston station, regeneration above and on the land around Euston station and proposed plans for Crossrail 2. There is also the challenge of undertaking the work alongside

maintaining the operation of the existing railway and underground services as well other local transport provision such as buses and taxis.

- 9.16 Euston station has been designed to the HS2 requirements established by the Phase One Act, as amended in additional provisions, and has been through several iterations since the Bill was laid. The latest design is delivered as a two-stage build and seen as separate to the conventional station. The two-stage build prolongs the construction of the HS2 station which is seen to increase costs and does not meet the aspirations of the key stakeholders. The Review concludes that the existing design is not satisfactory.
- 9.17 The plans for HS2 tunnels running from Old Oak Common to Euston have provided major challenges due to the potential conflict with the existing railway entering Euston. There are different options for the approach, ranging from a diaphragm wall cofferdam or open cut box alongside the existing operational railway housing the tunnel portals to a tunnelled dive-under beneath the existing operational railway. The existing planned construction of the approach has taken the form of a tunnelled dive-under which is likewise expensive and exposes major risks to the existing railway and services during construction.
- 9.18 The driving force behind the current designs for Euston is the HS2 specification relating to speed, gradients and track curvature, and future proofing for an 18 tph service. The Review considered the potential to reduce the specification, remove some HS2 platforms, and redesign the approach to produce savings. These changes could initially impose a limit on HS2 capacity of 14tph though this could be enhanced with future upgrades.
- 9.19 Historically, there has been limited joined up thinking between HS2 Ltd and Network Rail to optimise the railway design to minimise both risk and cost. Euston should be viewed as one station and not the two at present to ensure that it is delivered in a cost-efficient and passenger-friendly way. At the time of writing this Report, meaningful discussions

are ongoing to arrive at a sensible solution. HS2 Ltd and the DfT, together with Lendlease and Network Rail, have been exploring options for amending the design of Euston station to potentially reduce the size and number of platforms and encourage a single build.

9.20 An in-depth study needs to be undertaken to improve the efficiency of the future Euston station as a whole. This should seek to avoid the complicated HS2 approach to Euston station and minimise risk, and also look at the construction and movement of passengers. The Review strongly recommends that this is undertaken under the leadership of the Senior Responsible Owner (SRO) together with Network Rail, the DfT, HS2 Ltd, Lendlease, the Shadow Operator, Camden Council (without undermining their role as a planning authority) and appropriate independent experts.

Conclusion 33: The existing design for the HS2 station at Euston is not satisfactory. For the future Euston station, there should be a study led by the SRO, looking into the efficiency of the future station as a whole including considering options to simplify the HS2 approach to Euston station.

9.21 The management of the whole Euston project is muddled and the current governance arrangements for Euston station need to be changed. It is helpful that Euston is now under a single SRO at the DfT to bring together all four of the projects at Euston that are currently being developed or planned for development.

9.22 Discussions with stakeholders involved in the Euston project – the DfT, Camden Council, HS2 Ltd, Network Rail, Lendlease and Transport for London – have demonstrated that there is a need for better integration and coordination. In essence, there needs to be a single plan for the overall Euston project and a single organisation which is responsible for the overall development of the Euston project to capture the views of the stakeholders.

9.23 This single organisation should be responsible for delivering the three business cases relating to the development of Euston station: (i) the redevelopment of the Network Rail station – this is at present unfunded; (ii) the building of the HS2 station; and (iii) the works which will be used to support development above and alongside the HS2 station and track approaches. This organisation should also consider the onward distribution of HS2 passengers arriving at Euston in collaboration with Transport for London. In light of the challenges presented by the development of Euston station, along with the complexity and scale of the HS2 project itself, the Review considers that this single organisation, which is responsible for the development of Euston station, should not be HS2 Ltd.

Conclusion 34: There needs to be a single plan for the overall Euston project. In order to help deliver this single Euston plan, one organisation should bring together all the stakeholders and be responsible for the overall development and governance of the Euston project. Given the complexity of the Euston project, this organisation should not be HS2

10. Capability, governance and oversight

10.1 The Review examined evidence from a variety of sources relating to whether HS2 Ltd is in a position to deliver the project effectively.

10.2 This section also considers:

- the governance of the project as a whole
- the role of the government, primarily the DfT but also others in government including HM Treasury and the IPA, in ensuring the project is delivered effectively and within an agreed **fixed** budget

Accountability on mega-projects

10.3 It has to be appreciated that, if the government decides to proceed with HS2, the life of this mega-project will have been at least thirty years when complete, having started in 2009. Given the timescales involved in such a project, no one single person can be truly accountable for its delivery. Already the project has had seven Secretaries of State for Transport, six HS2 Ltd Chairmen, and many other leaders and sponsors. During the course of the next twenty years, there will almost certainly be dozens more. Therefore, the governance structure needs to withstand this change in officers and personnel, and remain stable throughout and not subject to constant changes in direction. Further, while the timescales for the HS2 project present difficulties in ensuring there is accountability, more needs to be done including by setting milestones against which HS2 Ltd's management will be held to account.

Conclusion 35: Milestones to be set against which HS2 Ltd's management should be held to account in respect of their period in office.

HS2 Ltd's capability

10.4 The CEO, Mark Thurston, in conjunction with the board, has played a leading role in reshaping his executive team and in seeking to improve the capability of HS2 Ltd, including through the comprehensive HS2 Improvement Programme (HIP).⁵⁸ It seems that HIP has delivered some significant improvements in HS2 Ltd's capability. However, the company must ensure HIP is not merely a process-driven programme but follows through into delivery.

10.5 There is still much more to do for HS2 Ltd, especially its Phase One construction team, to be in a position to deliver a project of the scale and complexity of HS2 effectively. In particular, HS2 Ltd needs to demonstrate improvements in the areas described below in this section.

Board effectiveness

10.6 Since the arrival of Allan Cook as Chairman of HS2 Ltd, the performance of HS2 Ltd's board has been on an upward trajectory. Further, as a result of the actions of the board, including the HS2 Ltd Chairman and the senior non-executive Director, there have been significant improvements in corporate governance in HS2 Ltd. The most important improvement has been the re-establishment of the Audit and Risk Committee. This is a critical function and the absence of this function may have been a contributing factor to some of HS2 Ltd's previous difficulties.

10.7 The Review has determined that, although HS2 Ltd's board and corporate governance appear to be nearing substantial readiness for the next stage of the HS2 project, additional non-executive directors should be appointed. In coming to this assessment, the Review has engaged in discussions with HS2 Ltd's board, including its non-executive directors

⁵⁸ HS2 Ltd have confirmed to the Review that the objective of the HIP programme is to deliver the required capability improvements ahead of NtP with a focus on critical capability areas, such as People & Leadership.

and its executive team, and the Project Representative.⁵⁹ It has also considered reports on HS2 Ltd's capability including from the HS2 Independent Assurance Panel, jointly chaired by David Orr and Gordon Masterton.

10.8 The HS2 Independent Assurance Panel has recommended that additional non-executive directors should be appointed.⁶⁰ The individuals needed must be carefully considered for their skills. The Review agrees with this recommendation: additional non-executive directors will help the increase the board's capacity and, as indicated by the HS2 Independent Assurance Panel, ensure there is the right mix of skills and expertise on the board. If, as per paragraph 10.31 and conclusion 43 below, it is decided that the government should appoint non-executive directors to the HS2 Ltd board, it will be for the government to appoint directors with the appropriate skills and expertise.

Conclusion 36: While HS2 Ltd's board and corporate governance appear to be nearing substantial readiness for the next stage of the HS2 project, additional non-executive directors should be appointed. However, the board and the executive must not be complacent and will need to consider what further steps should be taken to improve the Company's performance.

10.9 Further, in order to help the board challenge HS2 Ltd's executive team, the Review considers that the HS2 Ltd technical assurance or challenge panels which are made up of experts, some previously involved with the design of the scheme, should be refreshed and reconstituted. Those appointed to any HS2 Ltd technical panels should be independent and the panels should report to the Chairman and non-executive board members rather than the executive. Any panels should stress-test and challenge HS2 Ltd proposals. These panels should also be fully authorised to have

⁵⁹ The HS2 Project Representative sits within HS2 Ltd and provides the DfT with independent assurance on the progress of the HS2 programme

⁶⁰ Evidence provided by the DfT to the Review

access to any documents whether internal or produced by contractors, design consultants or the supply chain. The Review considers that HS2 Ltd could set up technical challenge panels in the following areas: (i) Engineering (design & construction); (ii) Procurement & cost control; and (iii) Systems including integration.

10.10 The Review also considers that, if the government decides to proceed with HS2, HS2 Ltd's governance arrangements need to be reconsidered and strengthened to reflect the project's complexity and scale as it moves to the next phase in development. Any governance arrangements should also reflect the future integration of HS2 into the national railway network.

10.11 In terms of the functioning of HS2 Ltd's executive team, the Review considers that improvements could be made to reflect the evolution of the project. At the very least, the Review considers that the following need to be added to the executive team: a project director, a chief operating officer and a commercial director.

Conclusion 37: HS2 Ltd's governance arrangements need to evolve and strengthen to reflect the project's complexity and scale as the project moves through its various phases in the coming decades.

Company Capability

10.12 The Review has heard substantial and widespread concerns about the performance of HS2 Ltd over recent years. The HS2 Ltd board and government will need to judge capability across a range of areas. However, there are several the Review examined, specifically:

- systems integration
- network integration
- cost estimation, management and control

- company capability in key areas including in terms of commercial strategy, design management and construction management
- stakeholder engagement

Systems integration

10.13 Learning from other major transport projects⁶¹, including Crossrail, indicates that there needs to be a single point of accountability for systems integration: systems should be considered from the outset of the project and integration plans should be fully understood. This process needs to start with **all** contracts, including the major construction contracts, reflecting the importance of integration, and being clear about the interdependencies and requirements. HS2 Ltd and the DfT need to ensure the lessons from Crossrail are understood and incorporated. HS2 Ltd, as the system integrator, needs to fully understand the interfaces between the civil construction works, the oversite development and various contractors (including engineering, maintenance and systems contractors). Such an approach to systems integration needs to then be continued and taken forward into asset management.

Network integration

10.14 HS2 will be part of the national rail network. HS2 Ltd therefore needs to work closely with the Shadow Operator, appointed in August 2019 with their role on HS2 having commenced in late 2019, and with Network Rail, to ensure that its decisions consider and reflect the operational perspectives of both organisations. As part of this, HS2 Ltd should work with Network Rail to ensure, where possible, that existing rail services are not jeopardised or unduly disrupted. Before the appointment of the Shadow Operator, no operator had been properly involved in helping shape decisions on the HS2 project even though these decisions often had considerable operational implications. There is also some indication

⁶¹ DfT, Lessons from transport for the sponsorship of major projects, April 2019 ([link](#))

that the views or needs of Network Rail have not been sufficiently reflected in various aspects of the HS2 project. Closer working with Network Rail could result in cost savings and operational benefits including, amongst other things, avoiding the duplication of control rooms.

Conclusion 38: Systems integration in HS2 Ltd needs to be strengthened now and maintained throughout the life of the project and beyond into asset management. It also needs to be ensured there is a single point of accountability for systems integration. This is a vital lesson from Crossrail. Clear accountability for systems integration, along with an authority overseeing integration, will be key to ensuring HS2 services commence in a timely and smooth fashion.

Conclusion 39: HS2 Ltd should work closely with the Shadow Operator and Network Rail to ensure its decisions consider and reflect the operational perspectives of both organisations.

Cost estimation, management and control

10.15As described in section 7, costs for the HS2 scheme have escalated significantly. Prior to the Chairman's Stocktake report, the budget had not changed since 2013, merely being escalated to reflect 2015 prices. It is further understood that the budget for the 2013 Spending Review was prepared against industry rates and prices from comparative projects, including from Crossrail. At this time of course, prices dipped following the financial crisis. Contractor rates and prices have escalated greatly over the past ten years. However, the HS2 public estimates have not been updated in any way since then until the Chairman's Stocktake report. The Chairman's Stocktake report sets out a number of other reasons why the estimates have changed since the 2015 Spending Review, including ground conditions being more challenging than predicted.

10.16 The Review has also looked at the reasons behind the escalation in costs including the underestimation of certain cost elements, e.g. the budget for land and property purchases⁶², and the Phase One Main Works Civils procurement strategy and contracting model (described above in section 8).

10.17 Going forwards, HS2 Ltd and the DfT can make substantial improvements in how costs are estimated, managed and controlled. To ensure cost estimates are robust, there is a need for more consistent use of benchmarking by HS2 Ltd and the DfT (see section 7), better assessment of risk by HS2 Ltd and also that information on ground conditions is obtained at the earliest stage possible.

10.18 The management of contingency, effective risk management procedures and avoidance of scope creep are key to cost control on major infrastructure projects. The Review considers that the structure and processes for managing contingency on HS2 need to be reviewed. Better cost control could be achieved by more assiduously using the approach set out below:

- any internal HS2 Ltd spending envelope should be less than the spending envelope set for HS2 Ltd by the DfT
- any overall HS2 Ltd spending envelope, which is set by the DfT, should be significantly less than the funding envelope
- clear processes need to be established for dealing with situations where trends indicate there is a likelihood of a cost overrun. Proactive action is needed rather than reactive action when the damage may already have been done

⁶² The National Audit Office found that the property cost estimate had increased significantly - from £1,120 million in 2012 (2011 prices) to £3,295 million in 2017 (in 2015 prices). Source: National Audit Office, Investigation into land and property acquisition for Phase One (London – West Midlands) of the High Speed 2 programme, September 2018 ([link](#))

10.19 Going forwards, the DfT and HM Treasury should also seriously consider setting a fixed budget cap and rigorous cost controls within which HS2 Ltd will be tasked with delivering the HS2 project.

Conclusion 40: Going forward, HS2 Ltd needs to demonstrate improvements, to the satisfaction of HS2 Ltd's board, the DfT and HM Treasury, in cost estimation, management and control.

Commercial strategy, design management & construction management

10.20 As described in section 8, the procurement and contracting approach used by HS2 Ltd on the Phase One Main Works Civils contracts has, in hindsight, proved to be unsuccessful.⁶³ The Review considers that HS2 Ltd needs to continue to strengthen its commercial strategy in respect of future procurements.

10.21 The Review considers improvements in design management control in HS2 Ltd would be prudent. There is some indication that scope creep has played a part in the escalation of costs. Going forward, HS2 Ltd needs to ensure there are effective internal design management controls against a fixed budget.

10.22 The Review has not seen convincing evidence that HS2 Ltd, especially the Phase One construction team, have the level of control and management of the construction normally associated with major projects. The Review considers that significant progress is needed to ensure that HS2 Ltd is ready to manage the construction stage of Phase One.

10.23 Project Evolve is a HS2 programme that has been initiated to help transition the company into a new operating model for delivering the second stage of the Main Works Civils contracts and address some of the challenges observed by the Review. This programme could be key to ensuring that HS2 Ltd is ready to manage the construction stage of Phase

⁶³ It should be noted that this approach was approved and agreed by the DfT, HM Treasury and the IPA

One. However, this programme at present seems to focus on process rather than the delivery of proven capability.

Conclusion 41: Going forward, HS2 Ltd needs to demonstrate improvements in capability, to the satisfaction of both HS2 Ltd's board and the DfT, in a number of key areas including commercial strategy, design management and construction management.

Stakeholder engagement

10.24 HS2 Ltd says that it is committed to being a good neighbour, treating affected communities with respect and consideration. However, the Review has received much evidence from individuals, MPs and peers that in reality this is not and has not been the case for many.

10.25 HS2 Ltd's Residents' Charter sets out ten commitments to communities impacted by HS2.⁶⁴ The Review is supportive of the commitments set out in the Residents' Charter and the appointment of two independent commissioners⁶⁵ to help ensure the commitments in the Residents' Charter are delivered. The Review notes that the two independent commissioners should be provided with adequate resources to allow them to properly fulfil their duties and that their remits should cover any further Phases of the HS2 project.

10.26 Discussions with the independent commissioners have indicated that HS2 Ltd's performance has improved over at least the last 12 months. However, evidence provided to the review indicated that HS2 Ltd's treatment of residents in some cases has not met the standards set out in the Residents' Charter. There is also ample evidence that HS2 Ltd has failed to properly address the concerns of local authorities and local people affected by HS2 works. As a consequence, this would indicate

⁶⁴ HS2 Ltd, Residents' Charter, October 2019 ([link](#))

⁶⁵ As described in the Residents' Charter: (i) the Residents' Commissioner oversees and monitors the commitments made in the charter, producing a periodic report ([link](#)); (ii) the Construction Commissioner provides advice to members of the public on how to complain and, in respect of any unresolved construction related disputes, mediates ([link](#))

that, HS2 Ltd's stakeholder engagement is not adequate in its performance and strength, as well as not having people who are fully knowledgeable of the local areas affected by HS2. Further, the Review notes that contractors and HS2 Ltd need to work in harmony on these matters.

10.27 The Review acknowledges that neither HS2 Ltd nor its contractors will be able to fully satisfy many of those impacted by the construction and operation of HS2, especially those who have lost their homes or businesses. Nevertheless, HS2 Ltd needs to significantly improve how it treats individuals and communities affected by HS2. Better communications with affected communities will be key in achieving such improvements, particularly as it moves into the main construction phase.

10.28 Further, the Review considers that HS2 Ltd needs to ensure that when it has taken land for construction, the impact of the work sites are minimised and the land take is appropriate for the works being undertaken by contractors.

Conclusion 42: Going forward, HS2 Ltd needs to demonstrate improvements, to the satisfaction of both HS2 Ltd's board and the DfT in stakeholder engagement.

Governance and oversight by government

10.29 Government, and not HS2 Ltd alone, has a critical role to play in the delivery of the HS2 project.

10.30 The overall governance of the HS2 project within government needs to be strengthened to contribute, support and assist HS2 Ltd rather than be a burden. Therefore, structures across government and within the DfT may need to be changed to better reflect the mega-scale and complexity of the HS2 project.

10.31 The HS2 Ltd board at present only has the DfT's Director General as an observer. The DfT, as the sole shareholder of HS2 Ltd, has no

representation at board level, which the Review does not consider to be either appropriate or sensible, and is likely to create negative tensions. As a consequence, the Review would suggest that in addition to the current non-executive directors, there should be directors appointed by the DfT who could represent and protect the DfT's interests. The DfT should also consider offering HM Treasury and the IPA the opportunity to appoint non-executive directors to the HS2 Ltd board. This could then enable the principal government departments to have a better oversight into what is happening, proper control over the use of contingency, and provide swift decisions when needed by the board to allow for the commitment of contingency, thus avoiding unnecessary bureaucracy. The government should, as indicated at paragraph 10.8 above, appoint directors who have appropriate skills and expertise.

10.32 The Review also considers the government approvals processes on HS2 may have been overly, and potentially unnecessarily, lengthy. As indicated in the recent report *Lessons from Transport for the Sponsorship of Major Projects*, the government needs to ensure there is better join up across departments, especially the DfT, HM Treasury and Cabinet Office, for project approvals. This is especially the case when decisions relate to the commitment of contingency or material changes in scope or service.

10.33 For Phase One of HS2, the DfT also needs to move into project delivery mode. The Review is not clear whether the DfT, as sponsor, has the right project delivery skills and the expertise described in paragraph 10.34 below. While the DfT is supported by the HS2 Project Representative who provide independent assurance on the progress of the HS2 programme, the Review considers this alone is insufficient and it could be beneficial for the DfT to also draw on the expertise of a group of independent experts in reviewing HS2 Ltd's performance. This group could comprise experts from a wide variety of areas.

Conclusion 43: The government should appoint non-executive directors to the HS2 Ltd board. The government needs to ensure it has clear oversight into what is happening on the project and proper control over costs.

Conclusion 44: The DfT should draw on the expertise of a group of

10.34 The government needs to ensure that it provides efficient oversight of the HS2 project. In order to do this, the government needs to have the right number of people with the right skills, and it should avoid the temptation to micro-manage the project. In some areas, including in terms of cost management, the Review considers there has been too little control exercised by government. It also appears the lack of government control may have been exacerbated by a lack of expertise within government in key areas including in terms of engineering, construction and project management of large projects.

10.35 Further, as the project has developed, the government's interventions in the project seem to have also led to the project's scope being inflated with no extra corresponding funding or budget being provided.

Conclusion 45: As part of the decision around Notice to Proceed, the DfT should set out its plan for improving how it functions as a sponsor, client, funder and shareholder including how it will improve its internal expertise in a number of key areas.

10.36 Government needs to ensure that the overall governance of the HS2 project is considered and, if necessary, reframed in light of the recommendations of the Williams Review. Keith Williams, in a speech in July 2019, indicated that a wide range of organisations had argued in favour of a new arm's length body or bodies to act as a '*guiding mind*'. There will need to be close, formal links between any new body or bodies which are established by government following the Williams Review and HS2 Ltd. This could include having representatives from any new arm's length bodies on HS2 Ltd's board.

Conclusion 46: The overall governance of the HS2 project, including the future planning of Phase Two along with the delivery and operation of HS2, should be reframed in light of the recommendations of the Williams Review, including any new body or bodies that are established by government following the Williams Review.

Transparency

10.37 Government, along with HS2 Ltd, need to be more transparent and open about the progress of the project including on issues, such as cost challenges, that the project is facing. Parliament should be kept regularly informed on the project's progress and should be provided with sufficient information to be in a position to properly scrutinise the government on the project. It is vital that the lessons from Crossrail are learnt in this regard.

Conclusion 47: On a regular basis, the Secretary of State for Transport should, upon receipt of a report from the HS2 Ltd Chair, advise Parliament on the

11. Economic assessment of HS2

- 11.1 This section considers the evidence which has been shared with the Review on the economic benefits and costs of HS2.
- 11.2 The published evidence has considered the impacts of the full HS2 network in line with the HM Treasury Green Book and DfT's Transport Appraisal Guidance (TAG). This assessment captures the impacts until 60 years after the scheduled opening of the full HS2 network.
- 11.3 The economic assessment quantifies the benefits and costs of the scheme to produce an estimate of the return to taxpayers' money. The economic case is one of the five components of a business case as set out in the Green Book.

Methodology used

- 11.4 The 2017 published economic case⁶⁶, along with the latest economic assessment described in paragraphs 11.17 to 11.22 below, quantifies the benefits at levels 1 and 2 only. As set out in the DfT's TAG, level 1 represents the net transport benefits and level 2 also includes wider economic impacts that are driven by the changes in connectivity that HS2 provides. Both levels 1 and 2 assume that land-use is fixed and HS2 has no impact on the number or location of homes or jobs.
- 11.5 The 2017 economic case, along with the latest economic assessment described in paragraphs 11.17 to 11.22 below, does not currently fully align with the strategic case. The economic case does not capture the full view of the expected benefits of HS2 from transformational land-use change – this issue is described in greater detail at paragraphs 11.7 to 11.10 below. In addition, as described at paragraph 11.11 below, the Review is surprised, given the emphasis placed on the need for capacity

⁶⁶ HS2 Ltd, High Speed Two Phase Two: Economic case advice for the Department for Transport, July 2017 ([link](#))

in the strategic case, that the benefits associated with a reduction in crowding are not a larger share of the quantified impacts.

11.6 The Review also notes that, as set out in paragraphs 11.12 to 11.15 below, there are a number of impacts, both beneficial and adverse, which are currently not quantified and which are important to consider alongside the monetised benefit-cost ratio.

Conclusion 48: The economic case does not currently fully align with the strategic case. Economic rebalancing, one of the primary drivers in the strategic case for HS2, is not currently reflected in the economic

Wider economic impacts

11.7 Wider economic impacts have been quantified assuming that land-use is fixed which is in line with the 'level 2' benefits in the DfT's TAG. Productivity benefits through static agglomeration, by bringing existing businesses effectively closer together, are a substantial benefit of the scheme. At level 2 the wider economic impacts assume that the introduction of the scheme has no impact on the number or location of homes or jobs, just that the scheme alters the accessibility and connectivity between them. The existing analysis does not capture the full view of the expected benefits of HS2 given the prominence in the strategic case to deliver transformational land-use change.

11.8 The role of railways is not just about moving passengers and freight in a more efficient way, the benefits of which are captured in transport user benefits. Railways fundamentally change the structure of cities and can do so in a highly positive manner. Research undertaken for Crossrail during the development of its Business Case⁶⁷ found a strong relationship between employment density and productivity and the role of public transport to enable a higher density of employment.

⁶⁷ Colin Buchanan and Volterra Consulting, The Economic Benefits of Crossrail, October 2007 ([link](#))

11.9 As discussed in section 5, there is a range of outlooks on the potential for HS2 to enable transformational change and create new opportunities for jobs and businesses outside of London. On the one hand, there are views that HS2 will drive greater economic growth outside of London and across the country because of poor connectivity, reliability, quality and inadequate capacity acting as a constraint on productivity and economic growth. On the other hand, there are views, based on international experiences, that London could derive more benefits from HS2 than places outside of London.

11.10 The DfT released new guidance in 2018 to allow for the quantification of benefits that result from land-use change as a result of the transport intervention ('level 3' benefits). Such 'level 3' benefits are being quantified in the NPR and Crossrail 2 business cases that are being developed.⁶⁸ In the strategic case, the DfT and HS2 Ltd highlight the importance of HS2 changing land-use, i.e. the location of business and household activity. However, the benefits of changing land-use are not quantified in the HS2 benefit-cost ratio. This is a constraint of the appraisal that an estimate is not included, given the importance placed in the strategic rationale for HS2 being a driver for these transformational benefits.

Conclusion 49: Further work is needed on understanding the potential impact of HS2 on the number and location of homes and jobs. Work is needed by the DfT and HS2 Ltd for future HS2 business cases to review and quantify the level 3 impacts in the benefit-cost ratio given the prominence of these impacts in the strategic case.

⁶⁸ DfT, Transport Analysis Guidance, May 2018 ([link](#))

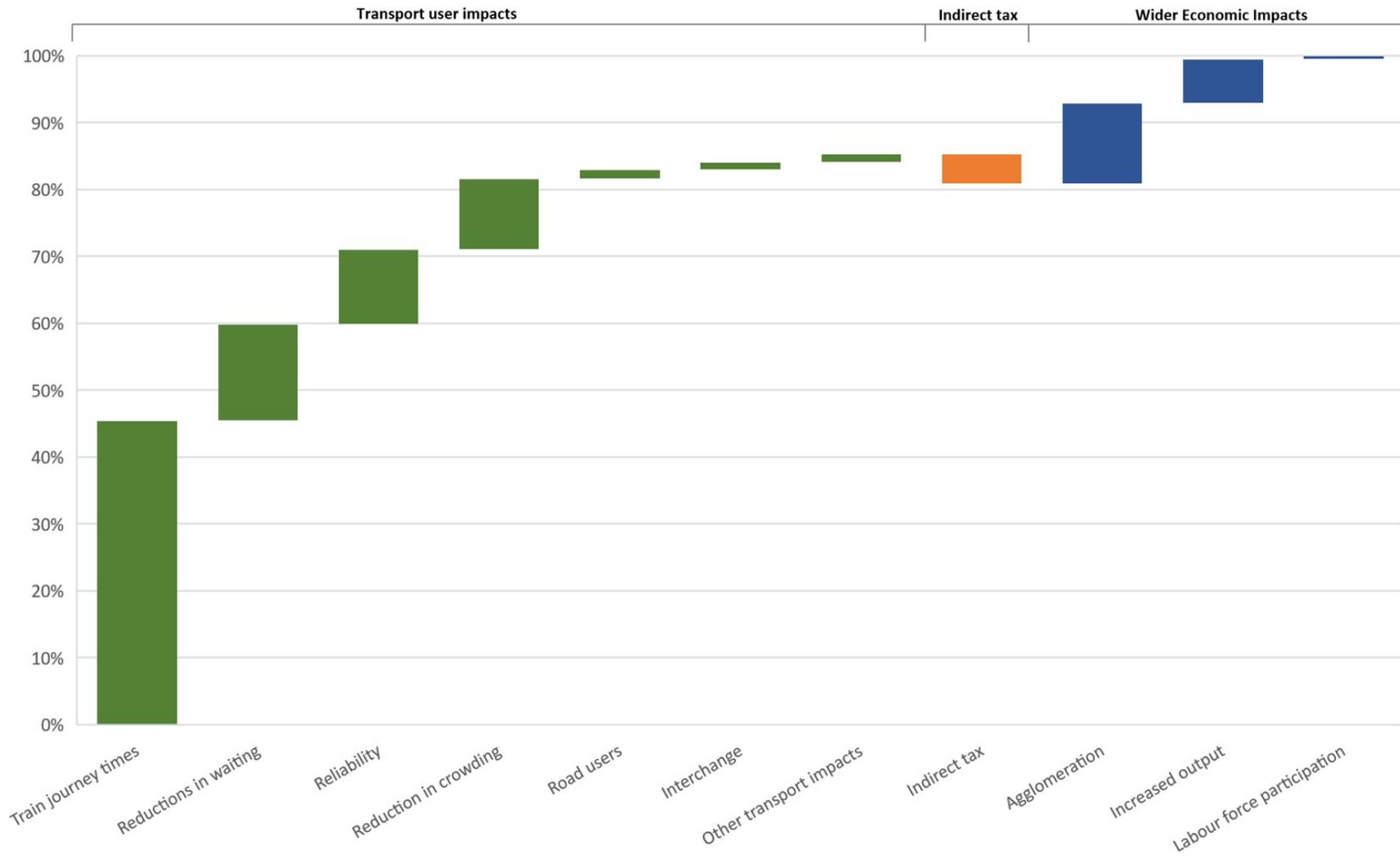
Composition of the full HS2 network benefits

11.11 The composition of the economic benefits from the full HS2 network are set out in Figure 11.1 below. The Review has made the following observations:

- the economic case concentrates on journey time and reliability benefits. The benefits breakdown from the published 2017 economic case shows that impacts on transport users constitute the majority of the benefits of the scheme. The reduction in journey times that HS2 enables, both directly and through the released capacity, represents 45% of the quantified benefits.
- in addition to benefits from greater reliability, HS2 enables benefits from reductions in waiting and crowding.
- given the large prominence placed on the need for capacity in the strategic case, it is surprising that the benefits associated with a reduction in crowding are not a larger share than circa 10% of the quantified impacts.

Conclusion 50: Further work is needed on understanding why reducing crowding doesn't play a greater role in the quantified benefits.

Figure 11.1: Share of the economic benefits (2017 Economic Case under fixed land-use)



Impacts not quantified in the appraisal

11.12 In addition to the potential transformational benefits from changing land-use in the towns and cities served by HS2, there are further impacts of HS2 which have been identified and qualitatively assessed in the business case to date.

11.13 The full extent of HS2's environmental and social impact is not captured in the benefit-cost ratio. Adverse impacts during construction in the form of increased carbon, noise and air quality as well as the permanent removal of ancient woodland and land and property are not captured either. Some of these impacts, such as train noise, will be mitigated by the commitments and undertakings set out during the hybrid bill process.

11.14 The economic assessment has focussed on a 60-year appraisal period after the full network opens. Given HS2 is being designed for 120 years, the Review notes that looking at the costs and benefits in the long-term should be an important consideration as part of the overall value for money of HS2.

11.15 HS2 Ltd and the DfT will need to ensure that they review the non-monetised impacts in the next business case to ascertain whether they are expected to have a material impact on the benefit-cost ratio of the scheme and attempt to monetise these impacts where possible.

Table 11.1: Impacts not monetised and therefore not included within the reported benefit-cost ratio

Beneficial	Adverse
Wider economic impacts under variable land-use	Impacts on noise, air quality and carbon during construction
Accessibility	Biodiversity from affecting species and habitats along the route
Option values by changing the availability of transport services	Construction works could affect groundwater quality which has the potential to temporarily affect public water supply
Journey quality impacts not considered elsewhere in the HS2 appraisal	The presence of new infrastructure in the rural environment
Land and property receipts such as over station development	Heritage from affecting Grade I and Grade II listed sites
Impacts beyond the 60-year appraisal period	The permanent severance of land
Potential for additional freight paths	Affecting views as a result of the construction and permanent infrastructure

Conclusion 51: There are impacts that are currently not quantified that are important to consider alongside the monetised benefit-cost ratio. This includes the potential transformational benefits that HS2 could unlock through changing land-use as well as the adverse environmental impacts from construction and the permanent land required for the railway.

2017 economic assessment of the full network

11.16 In the 2017 published economic case⁶⁹, the benefit-cost ratio for the full HS2 network was 2.3 when capturing the quantified benefits, including wider economic impacts, revenues, and costs. This means that for every £1 of cost to the taxpayer, £2.30 in benefits are generated over the 60 years after scheme completion. This, alongside a consideration of other impacts not captured in the benefit-cost ratio, suggested that the full HS2 network represented high value for money.

Table 11.2: The full HS2 network from the 2017 economic case

	Benefit-cost ratio components capturing the impacts 60 years after opening in line with TAG	Present Value (PV) £ billion, 2015 prices
1	Net transport benefits	74.6
2	Net benefits with wider economic impacts	92.2
3	Total costs (capital, operational and whole life costs)	83.4
4	Revenue (net of abstraction from other rail services)	43.6
5	Net cost to the transport budget = (3) - (4)	39.8
6	Level 1 benefit-cost ratio (no wider economic impacts) = (1)/(5)	1.9
7	Level 2 benefit-cost ratio (with wider economic impacts) = (2)/(5)	2.3

⁶⁹ HS2 Ltd, High Speed Two Phase Two: Economic case advice for the Department for Transport, July 2017 ([link](#))

Latest economic assessment of the full network

11.17 The latest economic assessment includes the most recent evidence on the costs, revenue and benefits of HS2. This is based on the existing scheme design to accommodate up to 18tph. As discussed in section 6, the Review recommends that future business cases should be updated for lower frequencies. An initial value for money assessment of a reduced frequency is included at the end of this section.

11.18 As covered in section 7, there have been updates to the cost and schedule estimates. In present value terms, the net cost to the transport budget ranges from £62bn to 69bn.⁷⁰ This draws on the capital costs from the Chairman's Stocktake⁷¹ and the latest internal view on operational and whole life costs, and revenue from the DfT and HS2 Ltd. The comparable figure from the 2017 economic case is £40bn.

Conclusion 52: The net economic cost to the transport budget, as valued by DfT TAG, of HS2 has increased from £40bn to £62-69bn (present values, 2015 prices).

11.19 The Review has examined the latest benefit-cost ratio of HS2 which is presented in Table 11.3 below. This work is based on initial results and has not been quality assured. The DfT and HS2 Ltd are in the process of updating the business case which will include the results following the quality assurance process.

11.20 This initial economic assessment, with the latest costs, indicates that the full HS2 network has a benefit-cost ratio of 1.5 under the low point of the Chairman's Stocktake capital cost range and 1.3 under the high point of the range. This is a material change from the 2017 published value for

⁷⁰ (1) calculated by the total cost (capital, operational and whole life costs) and revenue net of abstraction.

(2) these figures are in present values Q1 2015 prices with discounting to FY19/20.

(3) Present values are discounted to account for people preferring to consume goods and services now, rather than in the future even after accounting for inflation

⁷¹ HS2 Ltd, Chairman's Stocktake, August 2019 ([link](#))

money assessment where the full HS2 network was assessed as high value for money with a benefit-cost ratio above 2.

11.21 If the estimated benefits including wider economic impacts and revenues stay constant, the total cost (as set out in row 3 on table 11.3 below) would have to be over £138bn for the benefit-cost ratio to fall below 1.

11.22 The present values in table 11.3 capture a projection made in 2015 for construction cost inflation which has been used in the HS2 business case. The DfT and HS2 Ltd are reviewing outturn inflation, and the indication is that the outturn has been lower than what was projected in 2015. This would reduce the present value of capital costs in table 11.3 and therefore improve the benefit-cost ratio.

Table 11.3: The latest economic appraisal of the full HS2 network (presented in 2015 prices for consistency with the last published HS2 business case)

		PV £ billion, 2015 prices	
	Benefit-cost ratio components capturing the impacts 60 years after opening in line with TAG	Low Chairman's capital cost	High Chairman's capital cost
1	Net transport benefits	74.2	74.2
2	Net benefits with wider economic impacts	92.6	92.6
3	Total costs (capital, operational and whole life costs)	107.6	114.5
4	Revenue (net of abstraction from other rail services)	45.4	45.4
5	Net cost to the transport budget = (3) - (4)	62.2	69.1
6	BCR without wider economic impacts = (1)/(5)	1.2	1.1
7	BCR with wider economic impacts = (2)/(5)	1.5	1.3

Conclusion 53: The latest results indicate that the full Y-shaped HS2 network represents 'low-medium' value for money, using DfT TAG, when capturing the cost estimates in the Chairman's stocktake and benefits under fixed

Economic appraisal of phases of HS2

11.23 In economic appraisal, infrastructure schemes delivered incrementally can see later phases having higher benefit-cost ratios. This is as a result of using the infrastructure built in early phases to deliver the benefits associated with later phases.

11.24 The latest economic assessment indicates that Phase One alone has a benefit-cost ratio including wider economic impacts, under fixed land-use, of 1.0. This indicates that Phase One as a standalone scheme represents poor-low value for money. However, it does enable Phase Two, which if completed would provide an overall positive return. In addition, there is extra scope included in Phase One which is needed to deliver the full network. Moving the cost of these items into the appraisal of Phase 2b would improve the benefit-cost ratio of Phase One into the low value for money category. The link to London is important for the HS2 business case: around two-thirds of HS2 passenger journeys either start or end in London.

11.25 The full network is needed to achieve the highest value for money economic return on the investment of HS2. Phase One as a standalone scheme does not represent value for money, nor does building Phase Two without building Phase One. As discussed in section 6, a core recommendation is that an integrated rail plan and investment programme for the Midlands and the North of England is developed. The economic appraisal of this integrated rail plan and investment programme should be assessed in addition to individual projects and phases of schemes.

Conclusion 54: The evidence is clear that the full network is needed to realise the highest value for money economic return on the investment of HS2. Phase One as a standalone scheme does not represent value for money, nor does building Phase Two without building Phase One.

Conclusion 55: If an integrated rail plan and investment programme for the Midlands and the North of England is developed (see conclusion 11 in section 6 above), the economic appraisal of this integrated rail plan and investment programme should be assessed in addition to individual projects and phases of schemes.

Uncertainty in the economic appraisal

11.26As set out in the DfT's appraisal and modelling strategy⁷², the future of travel can be difficult to predict and uncertainty analysis is needed to support decision making. Robust uncertainty analysis is vital to assess whether HS2 delivers value for money across a range of plausible future outcomes.

11.27The Review considers that the quality of the previous risk analysis in the HS2 business case could be improved as the underlying statistical assumptions did not capture the full range of variability in risk factors and assumed that extreme events are unlikely.

11.28Internal analysis by the DfT and HS2 Ltd has been undertaken to test the value for money of HS2 in a low and a high demand outlook.⁷³ Combining this with the range of costs in the Chairman's stocktake suggests a level 2 benefit-cost ratio range for the full network of 1.0 to 2.1.

11.29The Review commissioned analysis from Oxera to understand the potential impact of changing key assumptions in the appraisal of HS2.

⁷² DfT, Appraisal and Modelling Strategy, April 2019 ([link](#))

⁷³ Demand in the core is reduced by 16% in the low test and increased by 16% in the high test

Several sensitivity tests were undertaken on the core economic appraisal outlined in Table 11.3 above.

11.30 The largest impact on the appraisal is seen by extending the period for which the benefits and costs are estimated. Ensuring that the long-term expectation of the costs and benefits of HS2 is considered in the appraisal is important in the context of the overall value for money assessment.

11.31 Evidence from both HS2 Ltd and Oxera suggests that extending the appraisal period to 100 years positively shifts the value for money category of HS2, with the benefit-cost ratio around 2 for the full network.

11.32 The DfT and HS2 Ltd should continue to look at uncertainty analysis and ensure that a sufficient range of scenarios are considered in the economic and strategic assessment.

Conclusion 56: The demand sensitivity analysis suggests that the full HS2 network has a benefit-cost ratio range of 1.0 to 2.1 and represents low-high value for money. Extending the appraisal period from 60 to 100 years after scheme opening has a material impact on improving the value for

Economic impact of a reduced frequency

11.33 The Review has considered the value for money implications of reducing the HS2 train frequency following concerns raised on whether a frequency above 16tph is achievable. It is difficult to assess the impact on value for money that reducing train frequency would have, since it requires redesigning both HS2 and conventional rail services from which the benefits, revenue and operating cost assessments are derived. The question of 'future-proofing' is also important, since if scope is left in HS2 to be able to run a higher-frequency service in future, infrastructure costs will remain similar while benefits will likely be lower than in the current assessment, thereby worsening the benefit-cost ratio.

11.34 Existing analysis of lower HS2 train frequencies includes:

- an example of a 16tph HS2 service which would remove the Stoke/Stafford/Macclesfield service from HS2. Analysis indicates that the cost savings from removing the Handsacre connection, which was previously discussed in section 6, would outweigh the reduction in benefits and therefore this would improve the benefit- cost ratio of HS2.
- an example of a 14tph HS2 service which would also defer the connection to the ECML at Church Fenton and therefore remove HS2 services to York and Newcastle. Analysis of this scenario indicates that while there would be cost savings, benefits and revenues would also fall, although the overall impact on the benefit-cost ratio for the full HS2 network would be relatively small (a reduction in the region of 0.1 to 0.2).

Conclusion 57: The benefit-cost ratio could be improved by removing the Handsacre connection and reducing the proposed frequency of HS2 services from 17 to 16tph.

Conclusion 58: Given the recommendation in section 6, a frequency of 14tph, with passive provision for 16tph, needs to be considered in future business case work. Initial analysis suggests that a move below 16tph would likely have a marginal negative impact on the benefit-cost ratio. However, the train service offer in this lower-frequency analysis has not been optimised. Further work is needed by the DfT, HS2 Ltd and Network Rail to ascertain the most suitable 14tph HS2 train service specification.

Conclusion 59: Before issuing NtP: (i) an updated business case for Phase One, approved by HMT, should be published; and (ii) the DfT should update and publish a revised business case for the project as a whole. This should include the latest cost and benefits for the project.

12. Alternative Options

12.1 In coming to conclusions and recommendations on whether and how HS2 should progress, the Review has at a high level sought to review and examine some of the strategic options and alternative rail investments that have been proposed. Options around scope and phasing are also relevant given the cost estimates set out in the Chairman's Stocktake which present questions regarding affordability (compared to the 2015 funding envelope set by government). In the short time available, the Review considered alternative options at a strategic level. The Review also received many detailed scheme proposals on alternative designs.

12.2 Overall the Review concluded that when considering the scope of HS2, options fell into three broad areas:

- 1) Continue with the full Y-shaped high speed network as currently proposed, but with the option to make changes to its specification and, where possible, its alignment
- 2) Changes to scope and phasing:
 - a. continue with the overall HS2 scheme but remove scope from Phase One
 - b. continue with the overall HS2 scheme but remove scope from Phase 2b
 - c. continue with the overall HS2 scheme but stop the current construction to change the order in which Phases One/2a and Phase 2b are built – 'Start in the north'
- 3) Stop the whole HS2 project and instead explore how the current network could be upgraded to meet capacity demands

12.3 For the options, the Review considered a range of high-level impacts on:

- costs
- value for money (costs compared to benefits)

- timescales
- deliverability, risk, other factors e.g. supply chain confidence, environment
- disruption to current rail users

12.4 The options that the Review is recommending should be taken forward by government are set out above in sections 6, 8 and 9. The Review sets out further detail in this section on some of the alternative options that it has considered including those options that it does not recommend should be taken forward.

Potential for scope reductions from Phase One

12.5 The Phase One scheme has undergone significant changes since it was first proposed in 2010, both in advance of depositing the Bill in 2013 and through the Parliamentary process, as a result of objections to the proposed scheme and its impacts. The government has made changes to the design e.g. longer/more tunnels and a revised Euston proposal. Scope changes have also been made, with some of the original elements of the Phase One proposal, including the HS2-HS1 link and the provision for a Heathrow Loop, already removed. As a result, the Review found limited further changes that could be made to Phase One without significantly changing the objective of the project.

12.6 However, the Review considered a number of options including the potential to extend HS2 from Old Oak Common via a South London through station to then connect with HS1 at Rainham. Two options though were explored in further detail and are considered below: terminating at Old Oak Common, and starting in the north.

Euston to Old Oak Common

12.7 The Review considered whether the scheme could save money by terminating at Old Oak Common. This was examined by the House of Lords Economic Affairs Committee, who recommended in May 2019 to

postpone the development of Euston until Phase 2b and have Old Oak Common as the London terminus for Phases One and 2a at least, and potentially for the full HS2 network. The Review also considered evidence submitted on alternative London station locations for HS2 and connecting with HS1 at Rainham.

12.8 For 18 HS2 trains per hour, the cost saving estimated by HS2 Ltd and the DfT is up to £2-2.5bn – a net impact of cost savings from removing the section from Old Oak Common to Euston station and the additional costs required to make Old Oak Common a terminal station for 18tph. For a lower train frequency, say 10-12tph, this saving would likely be higher (up to circa £5bn) as the size of Old Oak Common station would be reduced, potentially down to its currently planned size with relatively minor changes to the design for e.g. 10tph.

12.9 Analysis suggests that not going to Euston would have a significant negative impact on the business case for HS2: demand modelling by HS2 Ltd suggests that around two-thirds of London passengers prefer Euston station and the remaining one third prefer Old Oak Common, and that removing the section from Old Oak Common to Euston could reduce transport user benefits and revenues by £20-30bn.⁷⁴ However, others have pointed out that the time taken for passengers to reach central London locations from Euston or from Old Oak Common, via the London Underground network or Crossrail respectively, would be similar.

12.10 Evidence from Transport for London stated that Crossrail services would be extremely crowded if forced to disperse larger HS2 passenger numbers if Old Oak Common is the only London station – this is the case even if Old Oak Common is used as the London terminus on a temporary basis. Even a reduced frequency of HS2 service to say 10tph would likely cause crowding issues in rush hour east of Paddington. Crossrail was designed to relieve the Central line and provide additional

⁷⁴ Evidence provided by the DfT to the

capacity for East-West travel. It was not designed for the onward movement of

passengers from HS2. Crossrail services and their interchanges with the London Underground network would likely need to be enhanced to cope with the larger passenger numbers, or face significant crowding and disruption. The Mayor of London's submission to the Review was unequivocal that he/Transport for London did not believe terminating HS2 at Old Oak Common station permanently would be a viable option.

12.11 Current plans from HS2 Ltd and the DfT propose introducing a first phase of HS2 services with Old Oak Common as the London terminus for a few years so that delays to completing Euston station do not delay the start of HS2 services.⁷⁵ The Review supports this proposal for Old Oak Common to act as a temporary terminus station until Euston station is ready.

12.12 The Review also noted that the passenger experience at Euston could be enhanced by Crossrail Two proposals. Future HS2 business cases should include an assessment of passenger dispersal at Euston.

Conclusion 60: Euston station is an important part of realising the benefits of HS2, and the section from Old Oak Common to Euston should not be removed from the scope of the project. However, it is vital to get the Euston project right. Old Oak Common should act as the temporary London terminus for HS2 services until Euston station is complete, so time taken to get Euston right does not delay the start of HS2 services.

'Start in the north'

12.13 The Review has considered whether switching to building the northern parts of HS2 earlier would help to deliver benefits to the North of England and Midlands any sooner, given the strong desire to deliver improvements to rail connectivity in the North of England and the revised schedule forecast set out in the Chairman's Stocktake which indicates that Phase 2b may not open until 2040.

12.14 Although seemingly attractive, the Review does not believe starting HS2 with its northern sections would bring significant benefits to the North of England any sooner. In this scenario, the Review considered that it would not be possible to leave Phase One with many years' blight and uncertainty until a later phase while pressing ahead with Phase 2b, so if northern sections were a priority, this would mean cancelling Phase One permanently. Removing Phase One would then call into question the rationale for building other sections of HS2: Phase 2a would have limited benefit without Phase One, and sections of Phase 2b would also have less strategic rationale, such as the bottom of the Eastern Leg which would now not connect into anywhere. The likely remaining parts of HS2 would be those desired to deliver NPR proposals between Crewe and Manchester and between Leeds and Sheffield and the north-east – independent sections of new higher speed line, for which alternative investment in the existing network could be considered. Cancelling Phases One, 2a and parts of 2b would not deliver capacity improvements on the WCML. Therefore in this scenario the HS2 scheme quickly unravels to the option of cancelling the project in favour of alternative investment on existing lines, set out below.

Conclusion 61: It is now hard to stop Phase One and start HS2 in the North of England without years of blight given that powers have been taken for Phase One, a significant amount of work has been carried out on Phase One, and given the relative immaturity of northern sections and regional schemes. The quickest way to deliver long-distance inter-city connectivity to the Midlands and the North of England is to continue with Phase One, and to fully commit to subsequent phases.

Cancel HS2 in favour of alternative investment on the conventional network

12.15 Section 7 above set out the evidence on the cost of cancelling the whole HS2 project. In addition to the circa £9bn already spent on the project to date of which around £2-3bn may be recoverable, additional direct costs

of closure are estimated at £2.5bn to £3.6bn.⁷⁶ This does not include wider consequences of cancellation, such as the impact on the UK construction industry, supply chain and on local investments, or the impact on the UK's reputation for large infrastructure projects.

12.16 One reason cited for cancelling HS2 is to bring forward investment in NPR and Midlands Engine Rail schemes. The Review believes this argument is flawed: Transport for the North, Midlands Connect and northern and Midlands leaders have made it clear in submissions to the Review that for them it is not a question of either regional schemes or HS2. Both are needed to help transform the economies of the North of England and Midlands. Also, NPR and Midlands Engine Rail proposals are relatively early in their scheme development and any schemes requiring hybrid Bill powers are not yet ready so could not be progressed more quickly.

12.17 Further, NPR and Midlands Engine Rail proposals have all been designed on the premise that HS2 is going ahead as currently planned and use HS2 infrastructure, therefore cancelling the scheme or making significant changes to scope would most likely delay the NPR and Midlands Engine Rail, not bring it forward. Funding allocated to HS2 would not necessarily be repurposed for NPR or Midlands Engine Rail proposals, since as mentioned above funding allocated to HS2 has never been stated as available for alternative uses. If HS2 were cancelled at this stage, there may be limited confidence that these schemes would not also be cancelled at a later date when new calls for transport spending emerge.

Alternative rail investment

12.18 If the government were to cancel HS2, major alternative investment in the conventional rail network would be required, if the government was still determined to improve rail capacity and connectivity. The Review considered the alternatives work that has been undertaken by Atkins on behalf of the DfT at the time of each business case for each phase of the

⁷⁶ Evidence provided by the DfT to the Review

HS2 project (2013, 2015 and 2016), as well as other high level, strategic alternatives.

12.19 The alternative investments considered by Atkins aimed to improve capacity, speed and frequency of the existing network, and required a wide range of different types of upgrades and service changes across the WCML, ECML, MML, cross-country and enabling freight routes. In some instances, alternatives to HS2 on the existing network could also provide benefits to passengers from destinations well away from HS2 routes.

12.20 Network Rail's advice to the Review updating the previous strategic alternatives to HS2 is that these alternatives could cost in the region of £20-25bn, depending on the rate of inflation used to update previous estimates. However, this estimate does not take into account recent cost experience for both Network Rail projects and HS2 estimates. The previous work noted that upgrading the existing lines came at a high passenger cost of 10+ years of disruption in weekend closures. Network Rail also advised that the experience of WCML & GWML upgrades suggested disruption (line closures) would be greater than originally estimated.

12.21 Broadly speaking, the alternative investments that could provide additional capacity (but not to the same level of HS2), could include the following, noting that they would have to be justified on their own merits:

- between northern cities and Scotland, on both the ECML and WCML there are interventions that could improve capacity and provide some speed improvements. In any event there could be a case for improvements on these lines in addition to HS2, and to design a revised timetable, including allowing for growth in freight traffic.
- within the Northern Powerhouse area, without HS2 there is still a need for additional capacity on the routes HS2 would provide. Whether these are provided by four-tracking existing two-track railway or a new alignment the

purpose is the same – to segregate fast and slow services and therefore give an increase in capacity.

- within the Midlands Engine area, without HS2, extensive four-tracking of different lines would be required. The MML north from Derby and Nottingham could be upgraded with electrification and four-tracking. From Nottingham to Newark with a north-facing chord, an upgraded line coupled with upgrading of the ECML could give improved speed between Birmingham and Leeds and the North of England.
- for routes to and from London:
 - the capacity on WCML could be improved through signalling enhancement and infrastructure enhancements such as grade-separated junctions and adding in missing sections of four-tracking.
 - the MML's capacity and speed could be improved by completing electrification and four tracking to increase capacity.
 - on the ECML, upgrades in capacity and grade separation would be needed to provide more capacity and increased speed. In addition, alternative routes for freight could be upgraded to provide more passenger capacity on the main line.
 - the Chiltern Line could also be upgraded and electrified to improve journey times and capacity.
 - additionally, it may be possible to manage demand and/or give some shorter term increases in capacity through a combination of pricing policy, adjusting the train service, longer trains and train configuration.

12.22 It is important to note that there are no alternative schemes that are ready-to-go: if HS2 were to be cancelled, many years of planning work would be required to identify, design and develop proposals, and the earliest these could be funded to be delivered under the current rail enhancements system would be 2025-2029. All would need to have acceptable business cases and to adopt realistic cost, delivery and

disruption plans in the light of previous railway upgrades. The cost of upgrading existing lines should also not be underestimated.

Conclusion 62: There are no-shovel ready alternative investments in the existing network that are available: if HS2 were to be cancelled, many years of planning work would be required to identify, design and develop new proposals. The upgrading of existing lines would also come at a high passenger cost with significant disruption.

Conclusion 63: The Review strongly advises against cancelling the scheme.

Annex A: Glossary

Word	Definition
Alignment	The line followed by the track in both the horizontal and vertical planes. Features of the alignment include the elevation (above or below ground level), the gradient and the radius of curves (horizontal and vertical) and transitions
Ancient woodland	Any area that has been wooded continuously since at least 1600 AD
Ballast	Granite stone used to form the bed of a railway track
Benefit-cost ratio	An indicator showing the relationship between the relative costs and benefits of a proposed project
Chairman's Stocktake	Advice on the deliverability of the HS2 programme from HS2 Ltd's Chairman, Allan Cook. A redacted version of this advice was published in September 2019.
Cofferdam	A structure that retains water and soil that allows the enclosed area to be pumped out and excavated to enable work in a dry environment
Contingency (in the context of cost-estimates)	An amount of money that is included to cover potential events that are not specifically accounted for in a point cost estimate
Conventional network	The current operational network of UK railway lines owned and maintained by Network Rail
DfT	Department for Transport
Diaphragm wall	A continuous concrete wall constructed within the ground that facilitates subterranean construction activities in close proximity to other structures

Dive-under junction	A type of grade-separated junction where one set of rail lines tunnel under another set instead of crossing them on the level
Earthworks	Soil structures and soil-retaining structures that are subject to railway traffic loading
East Coast Mainline (ECML)	Railway connecting London and Edinburgh via Peterborough, Doncaster, York, Darlington, Durham and Newcastle
Enabling works	Works carried out to make a site ready for construction
Four tracking	Upgrading a section of railway line by increasing the number of parallel tracks from two to four. The upgraded line will then have two tracks in each direction, allowing faster trains to overtake slower trains, improving the capacity of the railway
Grade-separated junction	A junction where trains travelling in different directions are able to pass over/under each other, avoiding conflicting movements and therefore improving capacity and reliability
HMT	HM Treasury
HS2 Ltd	High Speed Two Limited is an executive non-departmental public body sponsored by the DfT and set up to deliver the HS2 project
IPA	Infrastructure & Projects Authority; the government's centre of expertise for major infrastructure projects
Main Works Civils	Main civil engineering works needed for an infrastructure project – for example embankments, cuttings and bridges
Midland Mainline	Railway connecting London to Sheffield via Leicester, Derby/Nottingham and Chesterfield

Midlands Connect	The sub-national transport body for the Midlands. Midlands Connect is a partnership of local authorities, local enterprise partnerships, Network Rail, Highways England and the business community
Midlands Engine Rail	Part of a wider proposal by Midlands Connect. A £3.5 billion programme of rail improvements proposed by Midlands Connect, deliverable in phases.
Midlands Rail Hub	A proposed £2bn programme of rail interventions that Midlands Connect believe could provide up to 10 additional trains per hour into/through Birmingham providing much greater east-west connectivity across the region
Northern Powerhouse Rail	Proposed strategic rail programme, co-cliented between the DfT and Transport for the North, designed to improve rail services across the North of England
Notice to Proceed (NtP)	The government authorisation for HS2 Ltd to finalise the contracts for major construction works for Phase One alone
Over site development	Over-station development – representing development at or above stations
Passive provision	Provision for the future construction of a physical extension to a structure (for example: increased platform length)
Phase One Act	The High Speed Rail (London - West Midlands) Act 2017
Phase 2a Bill	The High Speed Rail (West Midlands to Crewe) Bill
Piling	Usually concrete cylindrical structures in the ground of carrying diameters and depths to support the super structure

Project Representative	The HS2 Project Representative sits within HS2 Ltd and provides the DfT with independent assurance on the progress of the HS2 programme
Railway Systems	Elements of a railway's infrastructure (apart from the stations) that are installed once civil engineering works have been completed – for example track and signalling
RIBA Plan of Work	Definitive UK model for the building design and construction process
Schedule 17 submission	Schedule 17 in the Phase One Act puts in place a process for the approval of certain matters relating to the design and construction of the railway which must be submitted to the local authority for approval
Senior Responsible Owner (SRO)	A civil service term, the individual responsible for ensuring that a programme or project meets its objectives and delivers the projected benefits
Shadow Operator or West Coast Partner	The organisation which is to provide advice to HS2 Ltd and the government on HS2 from a Train Operating Company's perspective and will be involved in designing the future HS2 service
Slab track	A design of railway track where the rails are attached to a concrete slab, rather than being fixed to sleepers laid on ballast
Spatial distribution	Distribution of something across a physical area
Systems integration	The process (in engineering) of bringing together the component sub-systems into one system and ensuring that the subsystems function together as a system
Throat (station)	The area at the end of a railway station where running lines divide into platform tracks

Tonnage	The total weight of a train and its cargo passing over a railway line
Train path	An allocated slot in the railway timetable for a train to run all the way from its origin to its destination without conflicting with other scheduled train movements. The capacity of a particular route or section of railway may be defined as the number of train paths that are available per hour
Transport for the North	A sub-national transport body, formed in April 2018, involving local transport authorities and business leaders from across the North of England together with Network Rail, Highways England, and HS2 Ltd
West Coast Mainline (WCML)	Railway connecting London, Birmingham, Liverpool, Manchester, Edinburgh and Glasgow

Annex B: Terms of Reference

Purpose

The Prime Minister has stated his wish to review “whether and how we proceed” with HS2 ahead of the ‘Notice to Proceed’ decision for Phase 1 (London-West Midlands) due by the end of 2019. The review will assemble and test all the existing evidence in order to allow the Prime Minister, the Secretary of State for Transport and the government to make properly-informed decisions on the future of Phases 1 and 2 of the project, including the estimated cost and schedule position.

For the whole HS2 project, the review should rigorously examine and state its view on:

- whether HS2 Ltd is in a position to deliver the project effectively, taking account of its performance to date and any other relevant information
- the full range of benefits from the project, including but not limited to:
 - capacity changes both for services to cities and towns on HS2 and which will not be on HS2
 - connectivity
 - economic transformation including whether the scheme will promote inclusive growth and regional rebalancing
 - environmental benefits, in particular for carbon reduction in line with net zero commitments
 - the risk of delivery of these and other benefits, and whether there are alternative strategic transport schemes which could achieve comparable benefits in similar timescales

- the full range of costs of the project, including but not limited to:
 - whether HS2 Ltd's latest estimates of costs and schedule are realistic and are comparable to other UK infrastructure
 - why any cost estimates or schedules have changed since the most recent previous baselines
 - whether there are opportunities for efficiencies
 - the cost of disruption to rail users during construction
 - whether there are trade-offs between cost and schedule; and whether there are opportunities for additional commercial returns for the taxpayer through, for example, developments around stations, to offset costs
 - what proceeding with Phase 1 means in terms of overall affordability, and what this means in terms of what would be required to deliver the project within the current funding envelope for the project as a whole
- whether the assumptions behind the business case, for instance on passenger numbers and train frequencies, are realistic, including the location and interconnectivity of the stations with other transport systems, and the implications of potential changes in services to cities and towns which are on the existing main lines but will not be on HS2
- for the project as a whole, how much realistic potential there is for cost reductions in the scheme as currently planned through changes to its scope, planned phasing or specification, including but not limited to:
 - reductions in speed
 - making Old Oak Common the London terminus, at least for a period
 - building only Phase 1

- combining Phases 1 and 2a
- different choices or phasing of Phase 2b, taking account of the interfaces with Northern Powerhouse Rail
- the direct cost of reprioritising, cancelling or de-scoping the project, including but not limited to: contractual penalties; the risk of legal action; sunk costs; remediation costs; supply chain impact; and an estimate of how much of the money already spent, for instance on the purchase of land and property, could be recouped
- whether and how the project could be reprioritised; in particular, whether and, if so how, Northern Powerhouse Rail (NPR) (including the common sections with HS2Phase 2b) could be prioritised over delivering the southern sections of HS2
- whether any improvements would benefit the integration of HS2, NPR and other rail projects in the North of England or Midlands
- any lessons from the project for other major projects

Review team and support

The review will be chaired by Doug Oakervee. The deputy chair will be Lord Berkeley. There will also be a panel consisting of Michele Dix, Stephen Glaister, Patrick Harley, Sir Peter Hendy, Andrew Sentance, Andy Street, John Cridland and Tony Travers. Each will focus on a specific area of interest; they will feed in to and be consulted on the report's conclusions, without having a right of veto in the event that consensus cannot be reached.

Support will be provided by the Department for Transport. Sufficient support will be needed to allow a searching and rigorous review in a relatively short

time. The review team will be provided with any papers and persons they request. Undertakings of confidentiality will be entered into with the Chair, Deputy Chair, panel, and others as necessary.

Reporting and publication

The review will report to the Secretary of State for Transport with oversight from the Prime Minister and the Chancellor of the Exchequer. It should produce a written report suitable for publication.

Timing

The review should submit its final report in autumn 2019.

Annex C: Meetings and Evidence

Evidence was considered by the Review largely over the course of September 2019.

To carry out its work in the relatively short time available, the Review did not make a public call for additional evidence.

However, it visited and spoke with a wide range of interested parties, up and down the country. Many others, both for and against the project, also provided written evidence to the Review.

The Review also held two sessions in Parliament to hear views from MPs and peers – the first session taking place on 9 September 2019 and the second session taking place on 8 October 2019. The Review found that, broadly speaking, MPs with constituencies along the line of route in rural areas tended to oppose the scheme, while MPs with constituencies in the Midlands and the North of England were generally more supportive.

The Review would like to thank the following organisations, groups and parliamentarians who have contributed their views and evidence to the Review. In addition to those listed below a wide range of academics and individuals also submitted letters and evidence to the Review. We thank all of them for their time and contributions.

20 Miles More	Andrea Leadsom MP
Abbeywell Associates	Andrew Bridgen MP
Adam Smith Institute	Andrew Jones MP
Adrian Bailey MP	Andrew Mitchell MP
AECOM	Andy MacDonald MP
Alec Shelbourne MP	Andy Slaughter MP
Alex Norris MP	Angel Trains
Align JV	Antoinette Sandbach MP
Alstom	Arcadis
Amey	Argent
Andrea Jenkyns MP	Arthur Daily Trips

Artorius
 ARUP
 Association for Consultancy and Engineering
 Aston Against HS2
 Atkins
 Aylesbury Vale District Council
 Balfour Beatty VINCI JV
 Balsall and Berkswell Parish Council
 Barnsley Council
 Baroness Brown
 Baroness Randerson
 Baroness Ruby McGregor-Smith
 Baroness Young
 Birmingham City Council
 Birmingham City University
 Bob Seely MP
 Bombardier
 Bradford District Council
 Bramley Action Group
 British Chambers of Commerce
 Buckinghamshire County Council
 Build UK
 Built Environment Communications Group
 Camden Business Partnership
 Camden Council
 Camden Town Unlimited
 Campaign to Protect Rural England
 Warwickshire
 Capita Real Estate and Infrastructure
 CBI
 Chalfont St Giles Parish Council
 Chartered Institute of Highways & Transportation
 Chartered Institute of Logistics and Transport
 Chesham Town Council
 Cheshire & Warrington Local Enterprise Partnership
 Cheshire Business Leaders
 Cheshire East Council
 Chesterfield and Staveley Board
 Chesterfield Borough Council
 Chiltern and South Bucks District Councils
 Chiltern Ridges Action Group
 Chiltern Society
 Chilterns Conservation Board
 Civil Engineering Contractors Association
 Colmore Business District
 The Combined Campaign Groups for Yorkshire and North-East Derbyshire
 Connecting Britain
 Constellation Partnership
 Construcciones y Auxiliar de Ferrocarriles (CAF)
 Coventry City Council
 Core Cities UK
 Costain
 Hammersmith and Fulham Council
 Craig Tracey MP
 Craig Whittaker MP
 Crewe Partnership
 Crewe Town Council
 Crofton Against HS2
 Cross City Connect Ltd
 Cumbria County Council
 Cumbria Local Enterprise Partnership
 Dame Caroline Spelman MP
 Dame Cheryl Gillan MP
 Dame Rosie Winterton MP
 Dan Jarvis MP
 Datatrans

David TC Davis MP
Department for Transport
Department for Transport (Non-Exec)
Doncaster Chamber of Commerce
Doncaster Council
Earth Regeneration
East Coast Mainline Authorities
Consortium
East Midlands Airport
East Midlands Councils
East Midlands HS2 Partnership
East Midlands HS2 Strategic Board
East Midlands Local Enterprise
Partnership
Ed Miliband MP
Eiffage Kier
Esther McVey MP
Euston Design
Euston Town Business Improvement
District
Euston Town Limited
Expedition
Fabian Hamilton MP
Federation of Small Businesses
Fiona Bruce MP
First Group
First Trenitalia
Frank Field MP
Freightliner
Friends of the Earth
Gateshead Council
GB Railfreight
Great Missenden Village Association
Greater London Authority
Greater Manchester Chamber of
Commerce
Greater Manchester Combined

Authority

Greatworth Parish
Council Green Party
Greenguage 21
Greenpeace
Harriett Baldwin
MP
Heathrow Area Transport
Forum High Speed Rail
Industry Leaders High Speed
UK
Hilary Benn MP
Hillingdon Outdoors Activities
Centre Hitachi Rail
Hitachi-
Bombardier Holly
Lynch MP Homes
England HS1
HS2 (Phase 1) Planning
Forum HS2 Design Panel
HS2 Independent
Construction Commissioner
HS2 Independent
Residents Commissioner
HS2 Ltd
HS2 Ltd (non-
exec) Hull City
Council
Hyde Heath Village
Society Hypertunnel
Iain Stewart
MP Ian Austin
MP
Institute for High Speed Rail, University
of Leeds
Institute for Transport Studies,
University of Leeds
Institute of Directors West Midlands

Institute of Practitioners in Advertising
Institution of Civil Engineers
Integrated Project Delivery
Intermodality

Jack Brereton MP	Long Itchington Parish Council
Jacobs	Lord Adonis
Jeremy Lefroy MP	Lord Blencathra
Jeremy Wright MP	Lord David Rowe-Beddoe
Jess Philips MP	Lord Faulkner
John Baron MP	Lord Flight
John Grogan MP	Lord Forsyth
John Healey MP	Lord Framlingham
Joint Rural Parishes (JRP) Doncaster	Lord Haselhurst
Jon Trickett MP	Lord Hollick
Karlsruhe Institute für Technologie	Lord Hunt
Kelvin Hopkins MP	Lord Inglewood
Kenilworth Town Council	Lord Stevenson
Knowledge Quarter	Lord Stunell
L.E.K Consulting	Lucy Powell MP
Lach Dennis and Lostock Green Parish Council	Mace
Laing Murphy	Maggie Throup MP
Lancashire County Council	Manchester Airport Group
Lancashire Enterprise Partnership	Manchester City Council
Lancaster City Council	Margaret Beckett MP
Laura Smith MP	Mary Creagh MP
Lee Parish Council	Mary Robinson MP
Lee Rowley MP	Mayor of London
Leeds Chamber of Commerce	MBPC Infrastructure Limited
Leeds City Council	Melton Parish Council
Lendlease	Mesham Land Company
Liam Byrne MP	Michael Fabricant MP
Lilian Greenwood MP	Mid Cheshire Against HS2
Lisea	Midlands Connect
Little Missenden Parish Council	Midlands Economic Forum
Liverpool City Region Combined Authority	Midlands Engine
London Assembly, Conservative Group	Midlands Innovation and Midlands Enterprise Universities
London Borough of Camden	Mineral Products Association
London First	Ministry of Housing, Communities and Local Government
London Property Alliance	

Mott MacDonald
National Audit Office
National Farmers' Union
National Infrastructure Commission
National Skills Academy for Rail
National Union of Rail, Maritime and
Transport Workers
Naz Shah MP
Network Rail
New West End Company
Newcastle City Council
Nick Hurd MP
Nigel Adams MP
North & Western Lancashire Chamber of
Commerce
North East Local Enterprise Partnership
North Warwickshire Borough Council
Northern Powerhouse Partnership
Nottinghamshire County Council
Old Oak Common Development
Corporation
Owen Paterson MP
Oxford Economics
Parkway Residents Group
Passenger Transport Networks
Phil Wilson MP
Pinsent Masons
Plastic Omnium
Preet Gill MP
Preston City Council
RAC Foundation
Rachael Maskell MP
Rachel Reeves MP
Rail Delivery Group
Rail Forum Midlands
Rail Freight Group
Railfuture Yorkshire Branch
Railway Consultancy Ltd
Ramblers
Ramboll
Richard Burden MP
Richard Burgon MP
River Chess Association
Rotherham Council
Royal Automobile Club
RSPB
Scottish Association of Public Transport
Shabana Mahmood MP
Sheffield City Chamber
Sheffield City Council
Sheffield City Region
Sheffield Property Association
SHOUT2 - South Hampstead Opposition
to Underground Tunnelling HS2
Siemens Mobility
Sir David Lidington MP
Sir Keir Starmer MP
Sir Kevin Barron MP
Sir Patrick McLoughlin MP
Sir William Cash MP
Skanska Costain STRABAG JV
Solihull Council
South Bucks District Council
South Cheshire Chamber of Commerce
and Industry
SQW Ltd. and Cambridge Econometrics
Staffordshire Chamber of Commerce
Steer
Steve McCabe MP
Stoke-On-Trent City Council
Stop HS2
Stuart Andrew MP

Talgo
Tarmac
Tees Valley Combined Authority
Thelma Walker MP
Tom Watson MP
Tony Lloyd MP
Toton Delivery Board
Track 11 Transport Planning
Trades Union Congress
Transport Focus
Transport for Greater Manchester
Transport for London
Transport for the East Midlands
Transport for the North
Transport for the West Midlands
Transport Salaried Staff Association
Transport Scotland
Transport Watch
Tristan Fitzgerald Associates
Uniper
Valerie Vaz MP
Victoria Prentis MP
Welsh Affairs Select Committee
Wendover HS2
Wendover Parish Council
West & North Yorkshire Chamber
West and North Yorkshire Chamber of
Commerce
West Coast Rail 250
West Midlands Combined Authority
West Midlands Rail
West Yorkshire Chamber
West Yorkshire Combined Authority
WH Davies and Partners
Wigan Council
Wigan Metropolitan Borough Council
Wildlife and Countryside Link
Woodland Trust
World Wide Fund for Nature
WSP