
HS2 Phase Two

Sheffield and South Yorkshire

Options Report



Department for Transport

High Speed Two (HS2) Limited has been tasked by the Department for Transport (DfT) with managing the delivery of a new national high speed rail network. It is a non-departmental public body wholly owned by the DfT.

High Speed Two (HS2) Limited,
One Canada Square,
Canary Wharf,
London E14 5AB

Telephone: 020 7944 4908

General email enquiries: HS2enquiries@hs2.org.uk

Website: www.gov.uk/hs2

High Speed Two (HS2) Limited has actively considered the needs of blind and partially sighted people in accessing this document. The text will be made available in full on the HS2 website. The text may be freely downloaded and translated by individuals or organisations for conversion into other accessible formats. If you have other needs in this regard please contact High Speed Two (HS2) Limited.

© High Speed Two (HS2) Limited, 2016, except where otherwise stated.

Copyright in the typographical arrangement rests with High Speed Two (HS2) Limited.

This information is licensed under the Open Government Licence v2.0. To view this licence, visit www.nationalarchives.gov.uk/doc/open-government-licence/version/2 **OG**L or write to the Information Policy Team, The National Archives, Kew, London TW9 4DU, or e-mail: psi@nationalarchives.gsi.gov.uk. Where we have identified any third-party copyright information you will need to obtain permission from the copyright holders concerned.



Printed in Great Britain on paper containing at least 75% recycled fibre.

Contents

Executive summary	2
Summary of technical options	4
High speed services to Meadowhall Station	4
High speed services to Sheffield Midland Station	4
High speed services to Sheffield Victoria Station	4
Classic-compatible spur	5
Structure of this report	5
1 Policy background and demand context	6
1.1 Timeline	6
1.2 Policy background for HS2 in South Yorkshire	7
1.3 Regional demand	8
Demand in Sheffield City Region	9
Implications for station selection	10
1.4 Phase Two route consultation	11
1.5 Northern Powerhouse Rail (NPR)	11
HS2 in the context of NPR	11
Emerging conclusions about what NPR means for HS2 plans	12
Implications for HS2 route and stations in South Yorkshire	13
2 Serving South Yorkshire with high speed stations	14
2.1 Introduction	14
2.2 South Yorkshire Hub: Meadowhall	14
Route and location	15
Key facts	17
Assessment	17
Sheffield Meadowhall – constructability	20
2.3 Sheffield Midland high speed station options	20
Route and location	21
Key facts	21
Assessment	21
2.4 Sheffield Victoria high speed station	24

	Route and location	24
	Key facts	26
	Assessment	26
3	Serving South Yorkshire with classic-compatible services	30
3.1	Route and key facts	30
3.2	Assessment of classic-compatible services via the Erewash Valley line	30
	Wider connectivity	32
3.3	Assessment of the HS2 Eastern leg – the 'M18 / Eastern Route'	32
	Key facts	33
	Route	33
	Assessment	33
4	Summary	37

List of figures

Figure 1: Population and employment maps for the Eastern leg	9
Figure 2: Rail demand in South Yorkshire	10
Figure 3: Current journey times and TfN journey time targets	12
Figure 4: Meadowhall high speed station location	14
Figure 5: Meadowhall consultation route	16
Figure 6: Sheffield Midland high speed station route	23
Figure 7: Sheffield Victoria high speed station location	24
Figure 8: Sheffield Victoria route	25
Figure 9: M18/Eastern Route including classic-compatible services via the Erewash Valley line	31
Figure 10: M18/Eastern Route including Sheffield to Leeds link	35
Figure 11: Alternative classic-compatible services via the Wales spur	36

Executive summary

This report provides the technical background to the four options presented in the report on Sheffield and South Yorkshire 2016. These options are summarised below:

- a high speed rail station at Meadowhall
- a high speed rail station at Sheffield Midland
- a high speed rail station at Sheffield Victoria
- a classic-compatible spur serving Sheffield Midland station.

Responding to the demand for HS2 in South Yorkshire is particularly complex. Engineering challenges like South Yorkshire's industrial legacy, environmental constraints such as settlements and landscape features, and the distributed pattern of demand mean that no single option so far suggested is clearly preferred.

Whatever route HS2 takes through South Yorkshire and whatever station the new services stop at must also work for the other regions that HS2 serves. One of HS2's strategic goals is to contribute to rebalancing the UK's economic geography. Therefore any solution we develop needs to drive economic growth, support regeneration, and run as far as possible with the grain of local aspirations for development.

In March 2015, the Government and Transport for the North (TfN) published a joint Northern Transport Strategy. This sets out clear plans for developing the northern rail network in future years. Northern Powerhouse Rail (NPR) will connect major cities in an east-west axis. As another of HS2's strategic goals is connectivity with the existing rail and wider transport network, synergies with NPR are an important consideration and the technical practicalities of this for HS2 are reflected in this report.

Any technical proposal we make must deliver value for taxpayers' money, recognising that HS2 is a very substantial investment. We have sought to develop a solution within the budget envelope for HS2 established in the recent Spending Review.

Station location	Route	Journey time London - Sheffield	Journey time London - Leeds (non-stop)	Estimated cost impact
Meadowhall (high speed)	via Don Valley / M1	68 mins to Meadowhall c.78 mins to Sheffield Midland	81 mins to Leeds + stopping time for services that stop at Meadowhall	BASE CASE
Sheffield Midland (high speed)	via city centre	66 mins to Sheffield Midland	81 mins to Leeds	+£2bn
Sheffield Victoria (high speed)	via city centre	69 mins to Sheffield Victoria + c.10 mins walk to Sheffield Midland	84 mins to Leeds	+£700m
Sheffield Midland Station (classic)	Main line via M18 / Eastern Route; spur to Erewash Valley line	83 mins to Sheffield (incl. stop at Chesterfield)	80 mins to Leeds (with no intermediate stop in South Yorkshire for through services)	- £1bn ¹

¹ This is for the southern connection into Sheffield Midland only and includes efficiencies and optimism bias. The recent NAO report quotes £768m savings (excludes efficiencies and optimism bias), which includes both the southern connection and northern connection between Sheffield and Leeds.

Summary of technical options

Each of these options needs to be measured against the following criteria:

- demand and transport benefits across HS2
- the needs of Sheffield and the wider region
- connectivity with existing rail and integration into the wider transport network
- topography, urban density and environment
- affordability.

High speed services to Meadowhall Station

We consulted on a new station at Meadowhall in July 2013, and after continued consideration this report reflects the difficulties of delivering a high speed line into Sheffield city centre. Although delivering a station at Meadowhall would have some major impacts on significant local employers and development sites, and there are some engineering challenges at this location, our work to date suggests that this is a constructible option. Meadowhall offers good connections to Sheffield city centre and other regional centres thanks to strong tram and rail connectivity.

Although effective as an interchange station, the scope for Meadowhall to drive local regeneration is likely to be lower in comparison to a city centre station. A station at Meadowhall does not provide connections to the city centre of Sheffield in line with the aspirations of the Northern Powerhouse Rail programme.

High speed services to Sheffield Midland Station

In theory, connecting to the existing city centre station, Sheffield Midland, with a new high speed alignment could provide fast services that are well integrated with local and regional rail networks, supporting national and regional connectivity, as well as driving growth in Sheffield city centre.

The engineering challenges of constructing a new railway through the middle of Sheffield and the significant risk of flooding means that HS2 Ltd does not believe this city centre option to be cost-effective or sustainable.

High speed services to Sheffield Victoria Station

Recognising the strong preference of Sheffield City Council and some other local stakeholders for a station in Sheffield city centre, HS2 Ltd has developed technical plans for an alternative option on the site of the disused Victoria Station. This has the advantage that it offers greater opportunity for local regeneration than Meadowhall, but the disadvantage that Sheffield Victoria is a significant distance from Midland station and is not connected to the existing rail network. Linking effectively with the Northern Powerhouse Rail programme would require an additional station on the classic network. Our work suggests that it is technically feasible to deliver this route and station. However this option comes at a significantly higher cost than the Meadowhall option.

Classic-compatible spur

Serving South Yorkshire with a spur to the classic network represents a different approach from the three considered above. The challenges in South Yorkshire that we have already mentioned make it feasible to look at separating the issues of providing a core HS2 service to South Yorkshire from the HS2 route going north.

A spur to Midland Station via the Erewash line would provide classic-compatible high speed services into Sheffield city centre (with an option to stop at Chesterfield), and the scope for these services to extend past Sheffield to serve the wider region. This would link in with Transport for the North's aspirations of better connecting the cities of the North to the wider network. The additional scope to reconnect into the HS2 network north of Sheffield and create a loop is explored in Section 3.

When combined with an alternative route alignment through South Yorkshire, this classic-compatible option could reduce the cost of the overall scheme – at the same time as enabling people from the East Midlands and further south to reach markets in Leeds and further north more rapidly.

Structure of this report

Section 1 sets out the policy background and demand context for the Sheffield and South Yorkshire Report 2016.

Section 2 sets out the technical details for the three high speed station options, with the Meadowhall option set alongside the two options in Sheffield city centre (Midland and Victoria).

Section 3 sets out the options for meeting the multiple connectivity demands in South Yorkshire with classic-compatible services.

Section 4 presents a comparison of all four options in a summary table.

1 Policy background and demand context

1.1 Timeline

2010

Secretary of State for Transport, Andrew Adonis, outlines -in a series of letters to the HS2 Ltd chairman- a remit for developing high speed 'Y-network' from West Midlands to Manchester and to Leeds.

Part of the remit is to develop proposals for an Eastern leg serving the East Midlands, South Yorkshire, and Leeds.

October 2010

New Secretary of State for Transport, Philip Hammond, instructs HS2 Ltd to continue developing *"route proposals between the West Midlands and Leeds including options for serving the East Midlands and South Yorkshire."*

February - July 2011

The Government runs a national consultation setting out its proposed strategy for a national high speed rail network for Britain.

It receives almost 55,000 responses - from UK individuals, businesses and organisations.

Findings published in: [High Speed Rail: Investing in Britain's Future-The Government's decisions.](#)

End of 2011

After reviewing the evidence, the Government concludes that a national high speed rail network between Birmingham, Manchester, Leeds and London (the 'Y network') would be the best solution for enhancing rail capacity and performance on these key north-south corridors.

Delivery to be in two phases: Phase One from London to West Midlands; and Phase Two from West Midlands to Manchester and Leeds.

2012

HS2 Ltd generates initial options on how to serve South Yorkshire; for details see: [Options for phase two of the high speed rail network](#)

Early work on developing options for serving South Yorkshire with high speed rail looks at the best location for a station - taking into account demand and accessibility, and how to design the line of route to connect the network to the station.

2013

The Government selects Meadowhall as its preferred South Yorkshire station, given the wider context of delivering the best-performing Phase Two network and considering the issues and challenges associated with the city centre options.

July 2013 – January 2014

Public consultation on Meadowhall as the HS2 station in South Yorkshire.

February 2014

HS2 Ltd revisits Meadowhall and Sheffield Victoria options, taking into account responses from local stakeholders.

March 2014

The Higgins report, [Rebalancing Britain: From HS2 towards a national transport strategy](#), outlines challenges of poor connectivity and over-dependence on roads in the north of England, leading to imbalance in productivity and business opportunities compared to other parts of the UK; and it calls for HS2 to:

- make cities and regions in the north more competitive by improving connectivity to global markets and to each other.
- integrate with existing transport networks and improve connectivity within the Midlands and the North.

April 2014 – July 2016

Ongoing work on options for the Eastern leg of HS2 to serve the people of East Midlands, South Yorkshire, and Leeds; and to serve important markets in the northeast, including York and Newcastle.

March 2015

The Government and Transport for the North publish a joint Northern Transport Strategy.

1.2 Policy background for HS2 in South Yorkshire

1.2.1 The region of South Yorkshire stands to be one of the biggest beneficiaries of HS2. High speed services will help South Yorkshire by:

- improving connectivity to global markets and other regions of UK;
- almost halving current London to Sheffield journey times;
- improving journey times between Birmingham and Sheffield as well as between Nottingham and Sheffield;
- serving South Yorkshire at the same time as the large markets further north;
- driving economic growth, supporting regeneration and going with the grain of local aspirations for development as far as possible; and
- adding all the above capacity in a sustainable way.

1.2.2 The preferred technical proposal for the Eastern leg has to ensure the best overall solution for the cities and regions served including the impact on services to the North and the best use of the available capacity.

- 1.2.3 As set out in Section 2, the main demand in the region of South Yorkshire is from Sheffield city centre and Doncaster, along with Barnsley and Rotherham, which has led to us developing technical options for stations at Sheffield Victoria and Meadowhall.
- 1.2.4 Both options have now been revisited, with different route alignments, to find the right strategic fit in light of the evolving Northern Powerhouse Rail programme and HS2's overall business case.
- 1.2.5 We have also looked at serving the existing Sheffield Midland Station with classic-compatible HS2 services. Constructing a new spur to connect HS2 with the existing classic rail route to Sheffield Midland, on which classic-compatible services would be able to run, could enable HS2 to serve Sheffield city centre, reduce journey times and maintain synergies with future NPR development.
- 1.2.6 The consideration of new high speed stations, including city centre options, is set out in Section Two.
- 1.2.7 Proposals for serving Sheffield city centre with classic-compatible services into Sheffield Midland Station are set out in Section Three.
- 1.2.8 The rest of this section considers the three main issues underpinning our further optioneering work:
- regional demand
 - the Phase Two route consultation
 - Northern Powerhouse Rail (NPR).

1.3 Regional demand

- 1.3.1 A key part of the business case for HS2 rests on the Eastern leg being used by trains serving destinations including Leeds, York and Newcastle as well as Sheffield. The population and employment maps in Figure 1 suggest that the size of the market in Tyneside is comparable to that of Leeds, the market for Leeds and York combined is approximately double that of Sheffield City Region, and Sheffield is a significant market in its own right.
- 1.3.2 For every two passengers projected to alight at Sheffield, a further seven are travelling through the city to other destinations served by HS2.
- 1.3.3 A balance can be struck between serving South Yorkshire's needs and serving the needs of other regions to its north and south. From a technical point of view, we aim to balance siting a station to suit the greatest regional concentration of demand with overall journey times across the Eastern leg of HS2.

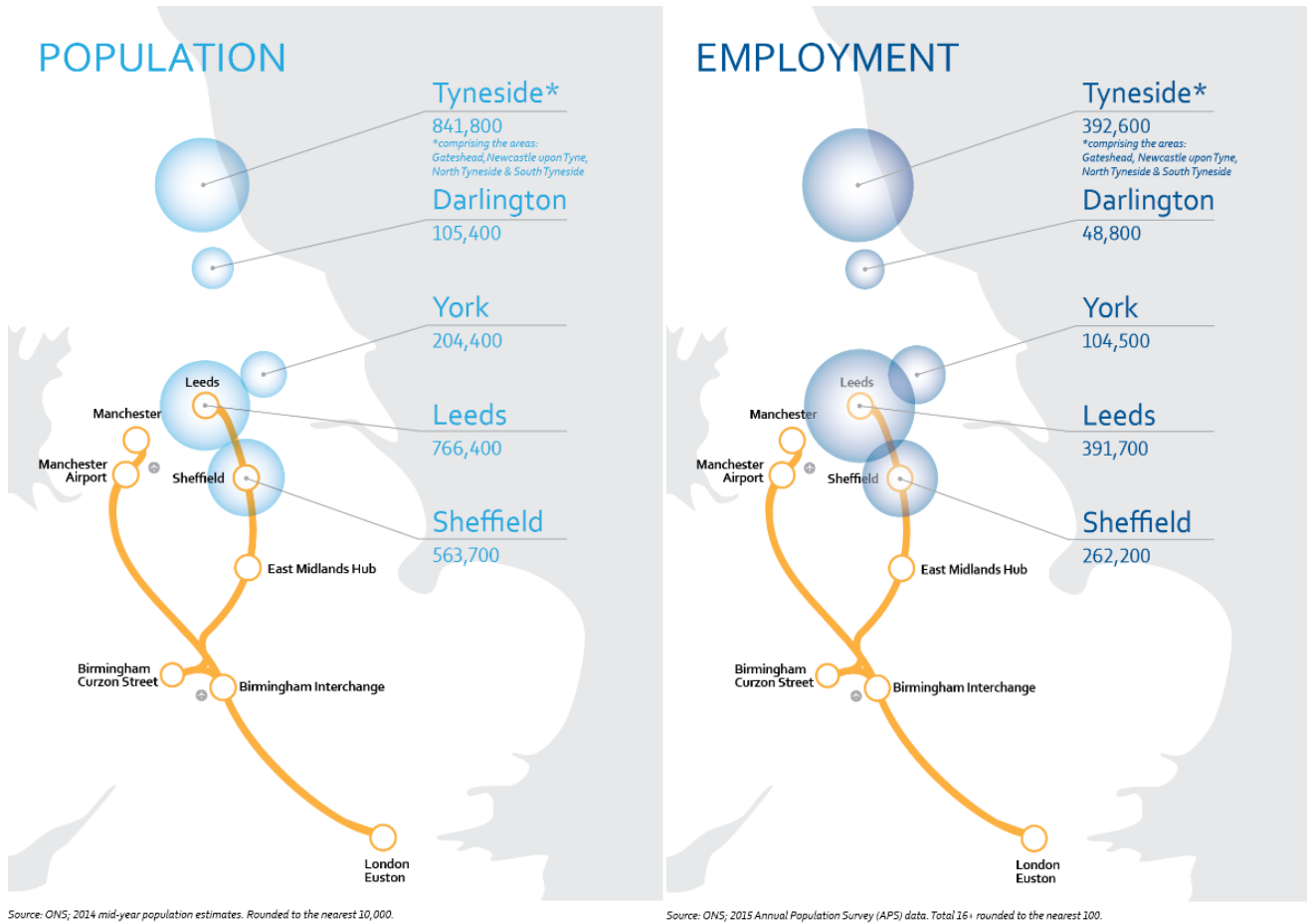


Figure 1: Population and employment maps for the Eastern leg

- 1.3.4 For these reasons, the options in the following sections include journey times between London and Sheffield as well as London and Leeds, to help illustrate the different impacts of different options to destinations beyond Sheffield.

Demand in Sheffield City Region

- 1.3.5 As already mentioned, one of the key drivers for choosing a station location is its alignment with regional centres of demand.
- 1.3.6 In our technical consideration of where to locate a station in South Yorkshire, we have also taken into account the patterns of potential demand for the service within the Sheffield City Region.
- 1.3.7 This section provides an overview of the current demand, future demand and passenger numbers that we took into consideration when comparing route and station option locations.

- 1.3.8 We looked at where the demand comes from, as well as considering the overall level of demand. The figure below illustrates variations in demand across the South Yorkshire region for long-distance rail travel.

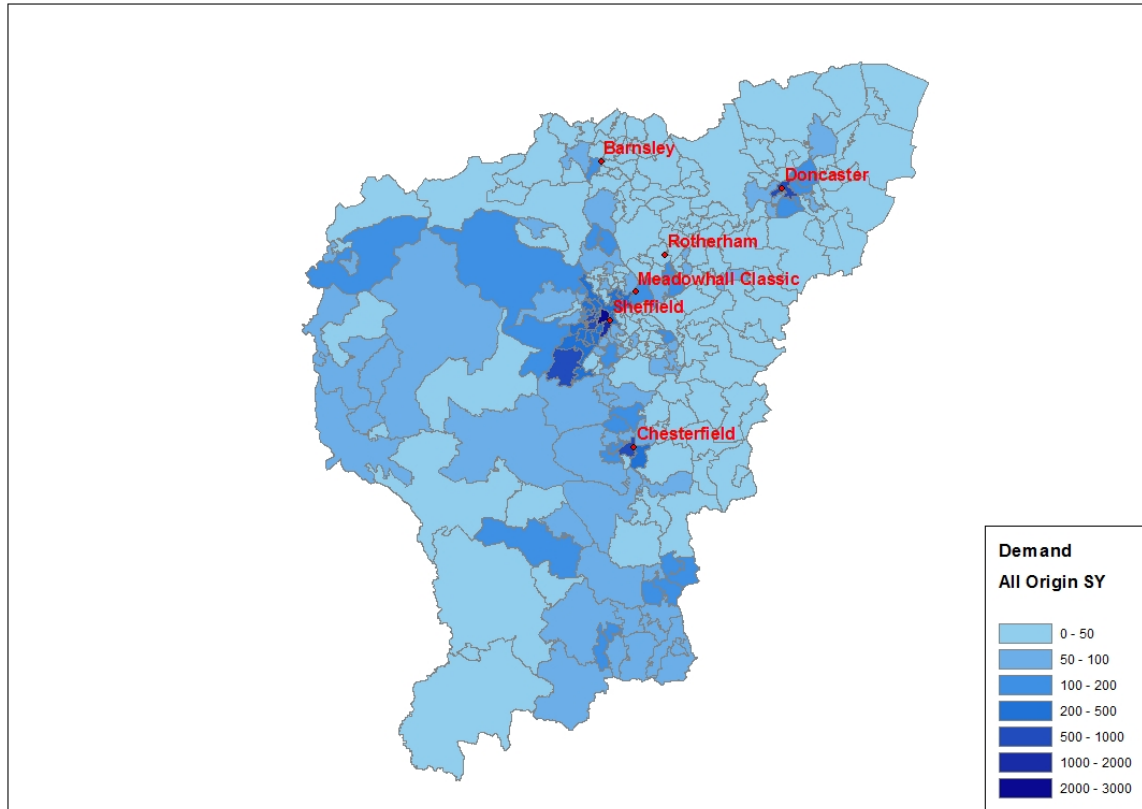


Figure 2: Rail demand in South Yorkshire
Source: HS2 Ltd

- 1.3.9 Within the region of South Yorkshire, Sheffield has the largest current level of demand for HS2, with a population of around 550,000; and demand to Leeds and London is expected to increase significantly over the next 30 years. There is high demand from Chesterfield and Doncaster too, and from south-west of Sheffield. There is also demand from the nearby towns of Barnsley and Rotherham, which have a combined population and labour market of similar size to Sheffield.
- 1.3.10 The rail demand figures suggest that, although a station in the centre of Sheffield could meet the greatest concentration of demand for long-distance travel, we also need to consider how HS2 can serve the wider distributed demand across the region.
- 1.3.11 The benefits of designing a route to meet this concentration of demand have to be weighed against the cost, and also against the impacts on those passengers seeking to travel through South Yorkshire.

Implications for station selection

- 1.3.12 The demand case for South Yorkshire is strong, but deciding how to serve this demand is complex. See [Options for Phase Two of the high speed rail network – demand and appraisal report](#) for details.

1.3.13 We have considered the following four questions from a technical point of view:

- What is the impact of the station options on Eastern leg journey times?
- How do the station options affect connectivity to key demand centres in South Yorkshire?
- What is the impact of the South Yorkshire station options on the business case for and affordability of HS2 as a whole?
- How does any solution align with the wider strategic picture in the north of England?

1.4 Phase Two route consultation

1.4.1 In 2011–2013 we canvassed the aspirations and expectations of regional stakeholders by:

- establishing station city working groups to help inform the location of stations; and
- consulting on the proposed route from July 2013 to January 2014 (10,000 responses).

1.4.2 Ipsos MORI produced a summary of the issues raised as part of the consultation in [High Speed Rail: Investing in Britain's Future: Consultation on the route from the West Midlands to Manchester, Leeds and Beyond](#), which was published by the Department for Transport in November 2015.

1.4.3 There were 1,983 respondents who provided comments about a proposed South Yorkshire station at Sheffield Meadowhall, and eight campaigns commented on the proposals.

1.4.4 543 respondents agreed with the proposal. The main positive comment was that it would be sensible and a good idea to build the station as proposed.

1.4.5 935 respondents disagreed with the proposal. The main negative reasons given were to do with the inconvenience for passengers to access a station at Meadowhall from Sheffield's existing station (Sheffield Midland).

1.4.6 The outcome of the consultation is that no consensus was reached amongst the stakeholders in the Sheffield City Region. That position has prevailed over the last two years - unlike in the East Midlands, Leeds and Manchester, where a local consensus has developed around sites for HS2 stations.

1.5 Northern Powerhouse Rail (NPR)

HS2 in the context of NPR

1.5.1 The Government and Transport for the North (TfN) published a joint Northern Transport Strategy in March 2015. The strategy is to better connect the north of England's six major cities (Hull, Leeds, Liverpool, Manchester, Newcastle and Sheffield) and the North's biggest airport, with the right connections to the wider network.

TfN's aspirations for Sheffield to Leeds is six trains every hour with a journey time of 30 minutes or less.

1.5.2 Northern Powerhouse Rail's focus is specifically on city centre connectivity, with the aim of driving agglomeration benefits through better connecting the markets and population centres of the north of England.

1.5.3 Figure 3 illustrates the current journey times between these cities and the journey time targets set by TfN:

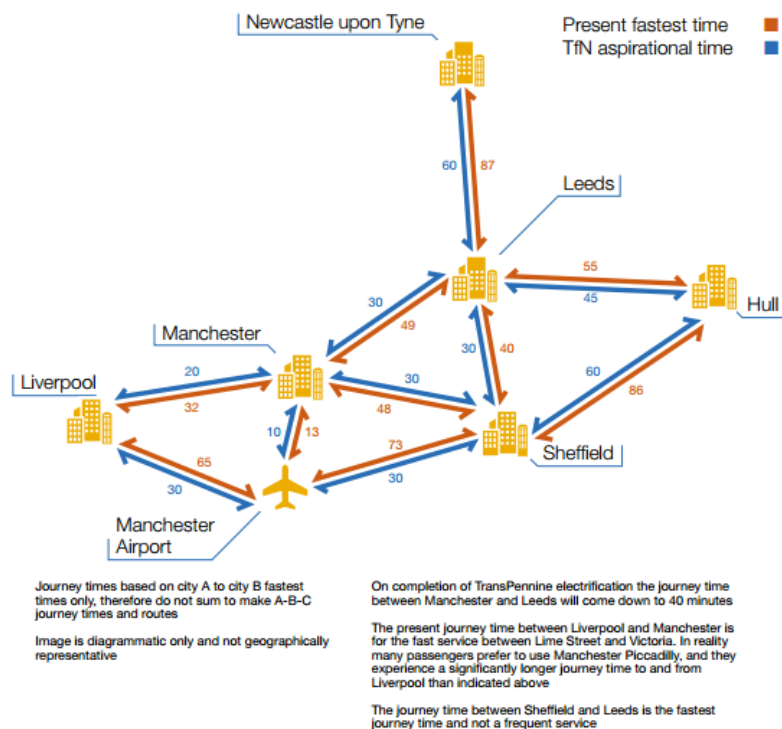


Figure 3: Current journey times and TfN journey time targets

Source: National Rail timetable correct at time of publication

1.5.4 Plans include delivering the full HS2 network as soon as possible alongside upgrades to the classic network.

1.5.5 There is further information on this in the Department for Transport's command paper [High Speed Two: East and West: The Next steps to Crewe and Beyond](#).

Emerging conclusions about what NPR means for HS2 plans

1.5.6 NPR feasibility studies have found that combining their service aspirations with HS2 means:

- there is only capacity for an added four trains per hour on the HS2 alignment between South Yorkshire and Leeds.
- for operational reliability, junctions onto HS2 and Network Rail generally

require 3km of plain line track to ensure space between handover power, signalling and communications.

- design that provides maximum flexibility in terms of the origin and destination of services is vital, as through trains require much less station infrastructure (and therefore land take).
- whilst the northern throat to Sheffield Midland station is a constraint on the network, we believe that the solution to increasing this capacity is to provide a tunnelled connection to the east of the current throat, but this would be extremely difficult to link to the Sheffield Victoria station because of existing railways, highways, the tram network and the River Don.

Implications for HS2 route and stations in South Yorkshire

- 1.5.7 The aim is for HS2 and NPR to complement each other in enabling new and improved journeys. Both want to make the most of the potential synergies between the two networks – most significantly (on HS2’s Eastern leg) in the connections between Sheffield and Leeds.
- 1.5.8 As mentioned above, NPR’s focus is on city centre connectivity. One of the developing considerations for HS2’s station and route selection in South Yorkshire is how we can support NPR at the same time as delivering the benefits of the HS2 programme.
- 1.5.9 In light of these considerations, we have looked again at the route and station options for HS2 in South Yorkshire. Our technical appraisal of the options does not include looking at how costs could be apportioned between the HS2 and NPR schemes to reflect interactions and benefits between these.

2 Serving South Yorkshire with high speed stations

2.1 Introduction

2.1.1 HS2's original recommendation of a station at Meadowhall (our base case) meant:

- linking into the classic network to provide good connections across South Yorkshire; and
- avoiding significant costs and reducing the impacts of delivering a new high speed route into a city centre.

2.1.2 We have now considered the Meadowhall option alongside city centre high speed routes (in this section) and city centre classic-compatible routes (in Section 3).

2.2 South Yorkshire Hub: Meadowhall

2.2.1 A new high speed station in the Meadowhall area, serving the South Yorkshire region, is the option the Government took forward to public consultation in 2013-14.

2.2.2 Following consultation, HS2 Ltd undertook further design development work to refine this option. This included considering alternative alignments through Meadowhall station, to understand whether we could increase the speed of the route through Meadowhall, or reduce the cost.

2.2.3 The discussion below is based on a 190kph alignment through Meadowhall Station, similar to that presented at consultation with some minor amendments to reflect lessons learned from Phase One.

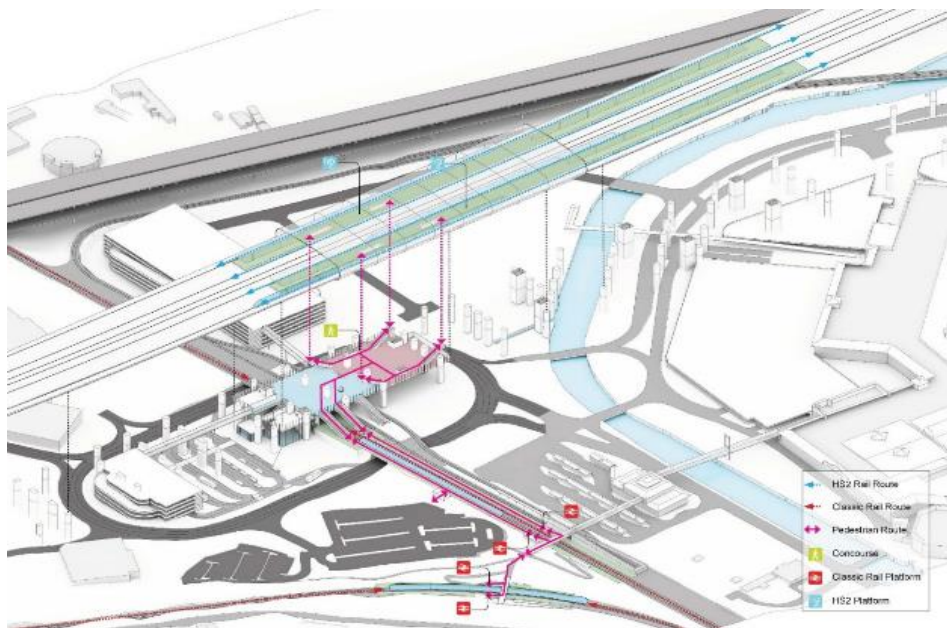


Figure 4: Meadowhall high speed station location

Route and location

- 2.2.4 The route to serve a South Yorkshire Hub station at Meadowhall would approach from the south, running along the Rother Valley, past Rother Valley Country Park. The route would bear northwest and rejoin the M1 corridor in the Orgreave area. It would run on a 4km viaduct alongside the M1 across the transport corridor between Sheffield and Rotherham.
- 2.2.5 A South Yorkshire hub high speed station at Meadowhall would be located on a 4km viaduct on the high speed main line between Meadowhall shopping centre to the west and the M1 on the Tinsley viaduct to the east. The viaduct would be up to 22m high and at a similar level to the M1. Meadowhall is in the Lower Don Valley, north-east of Sheffield and south-west of Rotherham. The site is easily accessible from Sheffield city centre and nearby towns and cities, including Rotherham, Barnsley and Doncaster, by a range of transport modes.
- 2.2.6 North of the station, the route would continue to follow the M1 corridor, diverging from the M1 in the Chapeltown area and heading north to the east of Barnsley.

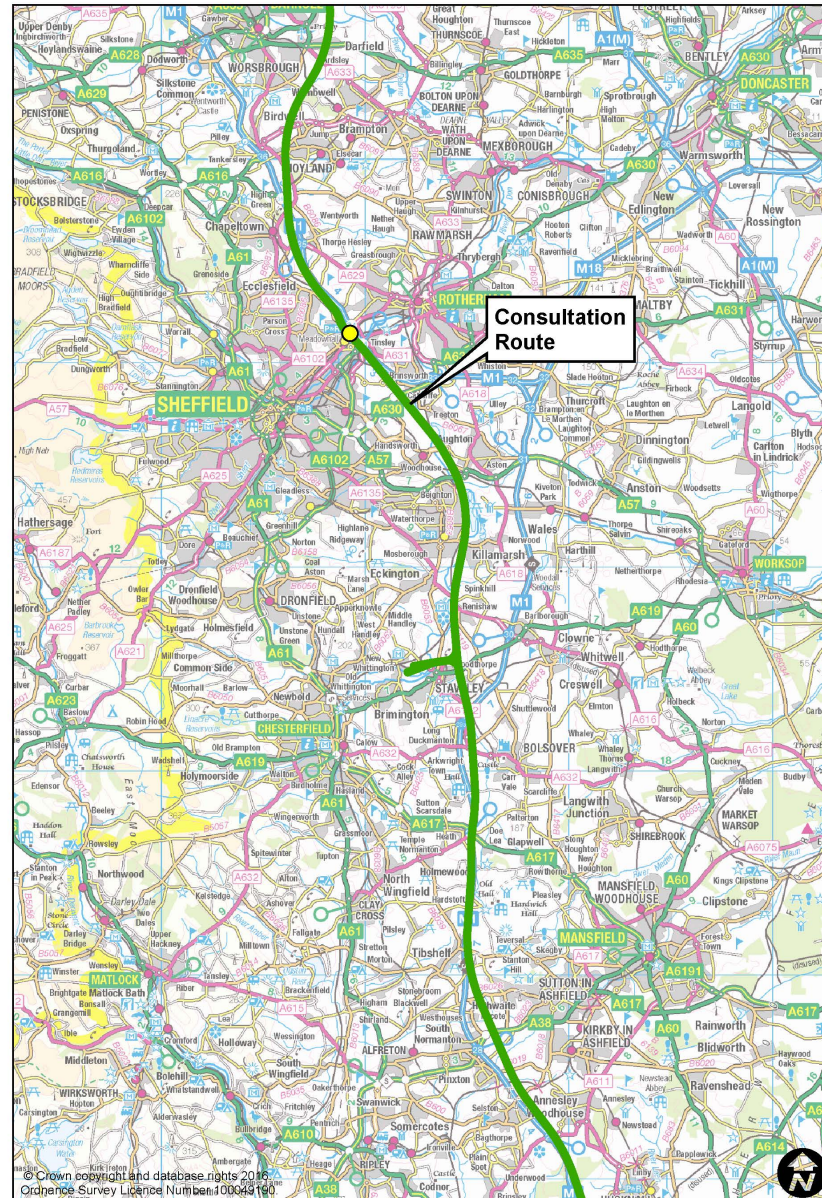


Figure 5: Meadowhall consultation route

Key facts

Station Location	Route	Journey time London - Sheffield	Journey time London - Leeds (non-stop)	Estimated cost impact
Meadowhall Station (High Speed)	Route via Don Valley / M1	68 mins to Meadowhall c. 78 mins to Sheffield Midland	81 mins + stopping time for those services stopping at Meadowhall	Base case

Assessment

Benefits

- 2.2.7 A station at Meadowhall would offer good intermodal connectivity, serving the South Yorkshire market effectively. The high speed station would interchange with other modes of transport for passengers to complete their journeys to Sheffield city centre and the surrounding areas. Meadowhall is well served by buses, trains and the Supertram network at Meadowhall Interchange. Access to the station would be designed for public and private transport. There would be a pedestrian link to the existing Meadowhall Station on the classic network, which provides heavy rail connections to destinations including Sheffield Midland, Rotherham and Barnsley.
- 2.2.8 We consider that a station at Meadowhall would have fewer construction constraints than high speed city centre options, particularly given the hilly topography of Sheffield. There would also be fewer direct impacts on property at Meadowhall. Hence we consider this option to be less costly.
- 2.2.9 Although an HS2 station at Meadowhall would cross the classic lines to Rotherham and Barnsley, the route would not share a corridor with Network Rail. This means there would be few complex interactions with the classic network.
- 2.2.10 The station would likely support a number of jobs and housing opportunities. For example, the high level analysis suggests the station could support around 4,000-5,400 jobs and possibly support 250-300 residential units. This analysis does not take account of the wider transformative effects a new high speed station could have in this location and the wider region.

Demand

- 2.2.11 A hub station at Meadowhall could serve the wider city region well, and this is reflected in the demand and benefits generated by the station from across the region. However, although it is well connected by tram and heavy rail to central Sheffield, a station at Meadowhall is less well connected to the main long-distance travel market in the region, located in south-west Sheffield.
- 2.2.12 The journey time from London to Meadowhall Station would be 68 minutes. The onward journey to Midland Station would depend on interchange with services on the

classic network from Meadowhall Station to Sheffield Midland Station. We estimate that, at best, this would be around ten minutes (including interchange time).

- 2.2.13 The headline journey time for services from London to Leeds would be 81 minutes. There would be an additional journey time penalty for passengers travelling through South Yorkshire on services that stop at the South Yorkshire Hub. Owing to the need to thread through the industrial area, the route slows to 190kph for a short section north of Meadowhall Station, requiring all services to slow on their way through South Yorkshire.

Impacts

- 2.2.14 The proposed route to Meadowhall would pass along the Rother Valley between Renishaw and Catcliffe, crossing the River Rother at a number of locations, particularly between Beighton and Treeton, where some degree of diversion or major channel works would be required. The Sheffield Meadowhall Station footprint may also require in-channel works of the River Don.
- 2.2.15 The station would occupy an area already characterised by large-scale development. The viaducts north and south of the station would affect the townscape setting of the Meadowhall Centre as well as views from the M1, the residential area of Wincobank and the Trans Pennine Trail that runs along the valley, although the M1 viaduct is already a strong influence on views. There would also be some potential loss of woodland and trees along the route in this area.
- 2.2.16 Extensive remodelling of the existing highway network would be required to make space for the HS2 route and station. The area already experiences significant traffic congestion so we would need to ensure that the capacity of the local roads is not compromised. In addition, the area is part of the Sheffield City Air Quality Management Area. Any additional road traffic generated at these places, either during construction or operation, has the potential to exacerbate local pollution levels if no air quality improvements have been implemented by local authorities by that time.
- 2.2.17 The HS2 Ltd Design Panel, an independent advisory body, noted that there is limited scope for regeneration in the area immediately surrounding the station. They had concerns about the constraints at Meadowhall, including the highways infrastructure, air quality, microclimate and station design challenges. Were a Meadowhall option identified, the priority should be for it to be as effective an interchange as possible to enable swift onward connectivity to major urban centres.
- 2.2.18 In terms of synergies with NPR, direct services between Sheffield and Leeds city centres could be delivered by a new chord to the existing line into Midland. This would require a new 3.5km grade-separated junction near Darnall, south of Meadowhall Station. This junction has not been designed; however, based on other junctions, we expect the cost to be in the region of £300m. Electrification of the Worksop line, which would provide the connection into Sheffield Midland, would also be required.

Property and development impacts

- 2.2.19 The station and associated line of route would have impacts on development and property, including significant regional employers, developments and enterprise zones.
- 2.2.20 The approach to Meadowhall would impact on an infilled open-cast mine that is now the site of the Waverley New Community development, a substantial mixed-use development for the Sheffield City Region. Alongside implications for part of the development, there would be a risk of ground movement affecting the railway.
- 2.2.21 Major business and property concerns include:
- Meadowhall Shopping Centre
 - Outokumpu
 - Sheffield Airport Business Park
 - Waverley New Community
 - Alcoa (formerly Firth Rixson)
 - SIRFT (M&S)
 - Morrisons Supermarket
 - IKEA.

Sheffield Meadowhall – constructability

A number of concerns have been raised about the constructability of a station at Meadowhall. At this stage of optioneering, HS2 Ltd has not undertaken detailed construction planning for the Phase Two route. However, in order to ensure that this issue was addressed, a review was carried out by the Phase One construction and technical specialists. The following table shows their conclusions:

ITEM	RAG	COMMENT	REQUIREMENT
Can a new viaduct be constructed at Tinsley	●	As there is a similar viaduct alongside constructed some 50 years ago it is assumed this is feasible.	Items to consider further are: <ul style="list-style-type: none"> - Further GI due to deep (50m) coal seams - Existing viaduct is a moveable structure on rollers and bearings – rail expansion requirement may preclude this design
Can a new station be incorporated into the design	●	Existing viaduct is a steel structure with minimal surface are. Station will increase point loads and wind resistance.	Items to consider further are: <ul style="list-style-type: none"> - Foundation design based on additional GI and increase in loading - Wind loadings imparted into structure from station building
Traffic Management and road design proposals	●	The road network is currently almost at capacity and parking is at a premium	<ul style="list-style-type: none"> - Traffic modelling is required prior to any further design in order to ensure capacity and traffic flow are managed. - Close liaison with Meadowhall and Network Rail will be required regarding traffic parking
Has the location got suitable access for construction deliveries	●	There are good road accesses to the location	Item to consider further <ul style="list-style-type: none"> - There is rail access to Meadowhall and potential space available within Tinsley sidings.
Construction worksite space	●	Has the location got sufficient space for all ground based construction activity	Item to consider further <ul style="list-style-type: none"> - The area has a number of roads and rail routes. Space will be limited for large plant and carnage to work.

2.3 Sheffield Midland high speed station options²

2.3.1 As part of our early route optioneering, we assessed four variant options for delivering high speed services to Sheffield Midland; a through route option, two loop options and a spur option with a terminus station. For more information about how HS2 Ltd generated initial options for stations in South Yorkshire, please refer to: [Options for phase two of the high speed rail network](#).

2.3.2 As part of our current work, we reviewed the through route option that serves Sheffield Midland on a through alignment so that it could be compared at a high level to the Meadowhall base case.

² A range of options in Sheffield city centre were developed as part of the original route optioneering in 2010-11. We have updated the cost to enable these to be compared. A high-level comparison has been undertaken against the route taken forward to consultation.

- 2.3.3 Midland would be the best location for a station in central Sheffield owing to its good connectivity to the Supertram and existing rail services, and its city centre location. However, the engineering challenges would be considerable, and this is reflected in our estimated cost impact. Hence we did not undertake further design for a route via Sheffield Midland.

Route and location

- 2.3.4 To reach a new HS2 station at Sheffield Midland, a high speed alignment would leave the consultation alignment in the Bolsover area and head north-west towards Sheffield. Owing to the topography and urban areas, this route would run through a series of tunnels to reach the centre of Sheffield.
- 2.3.5 The HS2 station would be located to the east of the existing station. It would sit partly in side of Park Hill and be below ground level.
- 2.3.6 North of the station, the route would use a long tunnel to leave Sheffield in order to initially avoid impacting existing infrastructure and thereafter owing to the urban areas and topography.

Key facts

Station location	Route	Journey time London - Sheffield	Journey time London - Leeds (non-stop)	Estimated cost impact
Midland Station (High Speed)	route via city centre	66 mins to Sheffield Midland	81 mins to Leeds	+£2bn

Assessment

Benefits

- 2.3.7 In terms of its location, Sheffield Midland has the highest demand in the region and greatest potential for local city centre employment growth. It would also support the aspiration set out by Transport for the North for fast, frequent services between Sheffield and Leeds city centres.

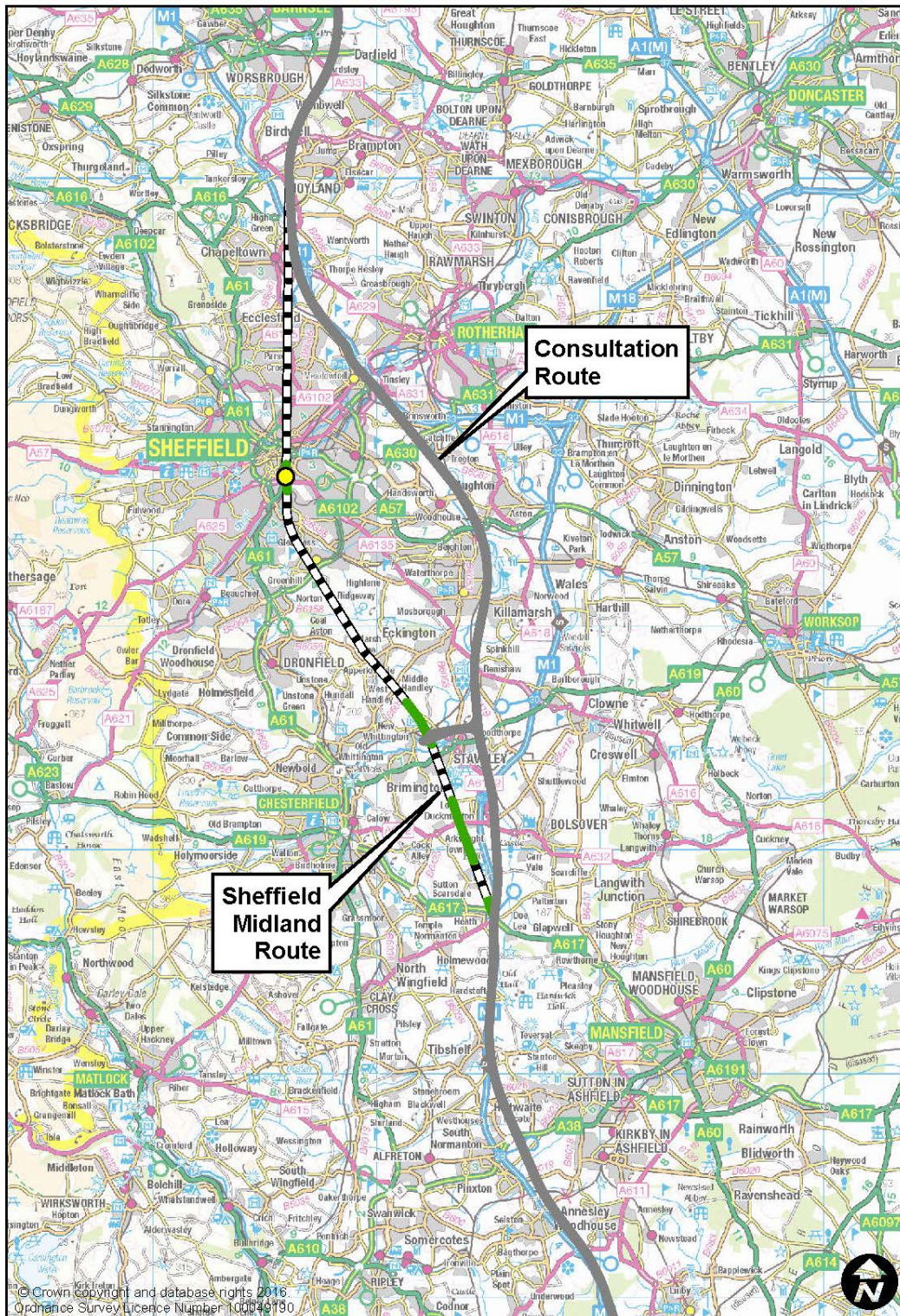
Demand

- 2.3.8 HS2 design standards generally require the route to be designed to enable services to operate at 360kph on opening, with the scope for 400kph services to be delivered later. If the route to Sheffield Midland were delivered to these standards, this would deliver fast services to South Yorkshire and beyond, with services reaching the Sheffield Midland Station in 66 minutes, and Leeds in 81 minutes. However, the impacts, as set out below, would be considerable.

Impacts

- 2.3.9 A route passing through Sheffield Midland would involve complex construction and phasing works as it would require the entire existing station and its approaches to be rebuilt. There would be major disruption at the station with an expected significant reduction of train services over several years.
- 2.3.10 Owing to topography and urban areas, a high speed route into Sheffield Midland would require a significant tunnelled approach from the south. The high speed line would need to enter a tunnel just south of the station, and both the station and the tunnel portal itself would be in the floodplain of the River Sheaf and Porter Brook. This would create a serious risk of flooding. Given that the station would be situated on the main line, any flooding would therefore affect HS2 services across the Eastern leg with implications for the long-term reliability of the service.
- 2.3.11 Delivering a new high speed station alongside the existing Midland Station would require significant realignment of local roads and it would also be necessary to extend the station footprint eastwards by excavating into the adjacent Park Hill. Constructing a new station alongside the existing station would constrain future expansion, which could in turn have an impact on the ability to deliver against wider Northern Powerhouse aspirations.
- 2.3.12 This extensive tunnelling and other engineering works outlined above would entail significant additional cost, which would have an impact of in excess of £2bn on the overall affordability of Phase Two.
- 2.3.13 Given the scale of the issues above, we do not think Sheffield Midland is a viable alternative.

Figure 6: Sheffield Midland high speed station route



2.4 Sheffield Victoria high speed station³

- 2.4.1 Our work to develop a route for consultation led us to the conclusion that a station at Sheffield Victoria is the most viable way of serving Sheffield city centre with a high speed line. Following the consultation, HS2 Ltd undertook further work to review and update this design in a similar way to the approach adopted with the Meadowhall option, so that it could be further considered and compared against alternative options.
- 2.4.2 The original proposition for a station at Sheffield Victoria was for it to be served via a loop from the main line, as the route through Victoria would involve significant journey time penalties for through services to destinations such as Newcastle, Leeds, Birmingham and London.
- 2.4.3 As a result of our further design work, we developed a faster alignment, with through services running through Sheffield Victoria at 200kph. This means that a loop would not be required, leading to a significant reduction in costs for the Victoria option.

Route and location



Figure 7: Sheffield Victoria high speed station location

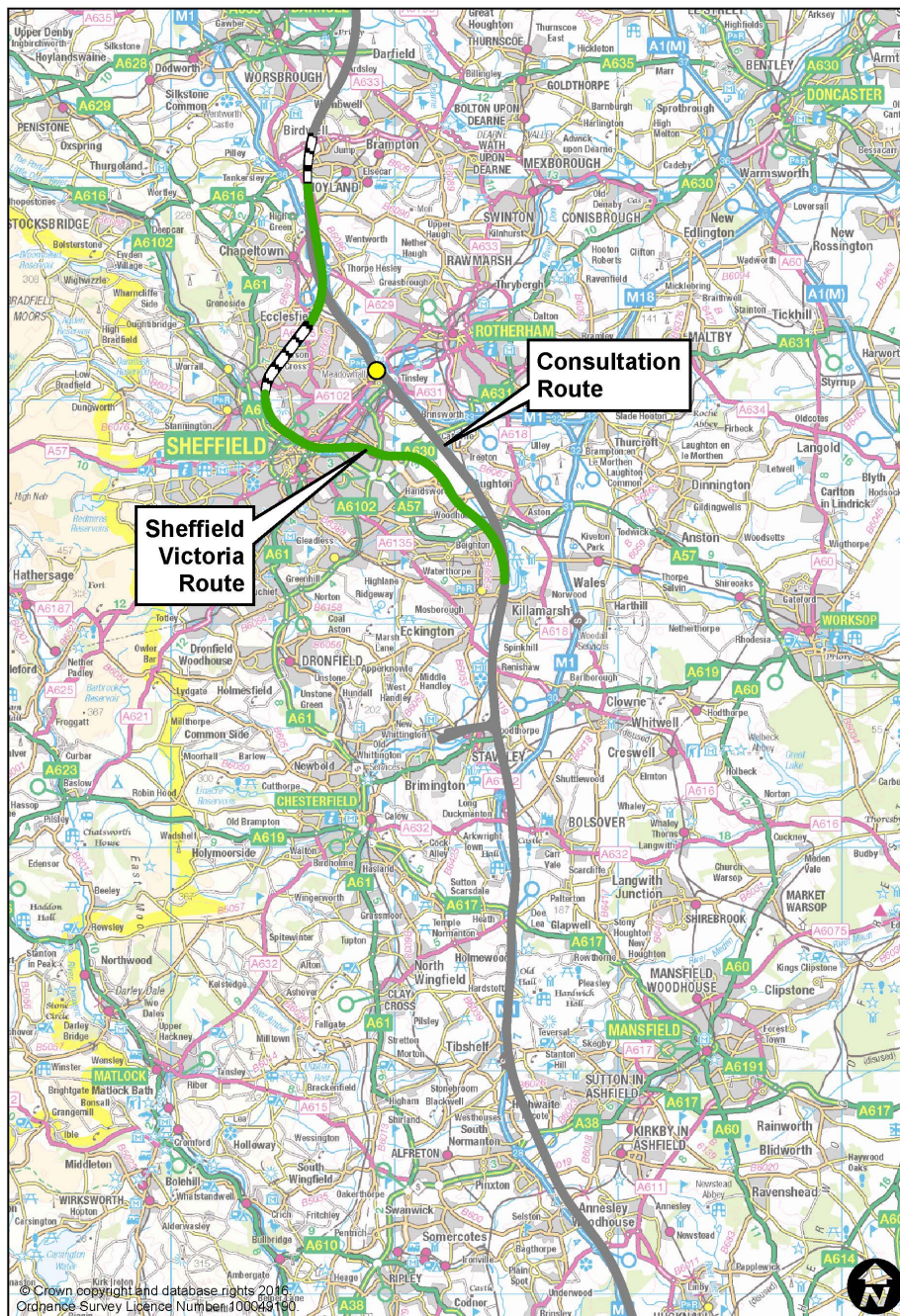
- 2.4.4 The HS2 route would approach Sheffield Victoria Station from the east. The route would follow the existing rail corridor on a 200kph alignment to reach the Victoria Station site. This would require some significant remodelling of the existing railway, as well as widening of the rail corridor.
- 2.4.5 The station site would lie to the northeast of the city centre, on the north side of the dual-carriageway A61 inner ring road (Derek Dooley Way) and over the River Don and Sheffield Tinsley Canal. The station was situated on an elevated structure (Grade II*

³The updated option at Sheffield Victoria was compared against the HS2 consultation route. Both routes were updated to reflect design lessons learned from Phase One.

listed Wicker Arch). It was closed to passengers in 1970, but a single track remains for freight services to the Stocksbridge Steel Works, northwest of Sheffield.

- 2.4.6 The new HS2 station would sit on a 12m high viaduct and would be 113m wide to accommodate four platforms and two curved through lines.
- 2.4.7 North of Sheffield Victoria Station the route would enter a tunnel, re-emerging to join the consultation alignment in the Chapeltown area.

Figure 8: Sheffield Victoria route



Key facts

Station Location	Route	Journey time London - Sheffield	Journey time London - Leeds (non-stop)	Estimated cost impact
Victoria Station (High Speed)	route via city centre	69 mins to Sheffield Victoria c.15 minute walk to Sheffield Midland	84 mins	+£700m

Assessment

Benefits

- 2.4.8 The main advantage of a station location at Sheffield Victoria is that it would provide a city centre location that would be an asset to city development. Sheffield City Council has stated that the area around Victoria presents a better prospect for regeneration-based growth than the same area around Meadowhall. The site has relatively good highway access and is already served by the local bus network.
- 2.4.9 A station at Sheffield Victoria could support an estimated 9,700-12,600 jobs and between 1,100 and 1,400 residential units. This analysis does not take account of the wider transformative effect a new high speed station could have on the city centre.
- 2.4.10 Although there would be a number of impacts in the city centre, which are detailed below, a through route via Sheffield Victoria does avoid the property impacts on strategic local employers and developments that are involved in delivering a route and station at Meadowhall. This includes Waverley New Community Development, Sheffield Airport Business Park, and Meadowhall shopping centre. This is reflected in the property cost estimate, which is around £140m less than the Meadowhall route largely due to using the existing railway corridor and 3.7km tunnelled section.
- 2.4.11 As a city centre option, Sheffield Victoria Station would also support the aspiration set out by Transport for the North for fast, frequent services between Sheffield and Leeds city centres.

Demand

- 2.4.12 Our appraisal work suggests that there would be an increase in inter-regional trips if a station were located at Sheffield Victoria rather than Meadowhall. We would expect a city centre station to generate greater demand and thus deliver greater benefits and revenue.
- 2.4.13 However, siting a station at Sheffield Victoria, even with the improved alignment that we have developed, would result in longer journey times for trips through South Yorkshire. We estimate that there would be a journey time penalty of around three minutes for passengers travelling through South Yorkshire, which would have an impact on the overall benefits delivered by this option.

- 2.4.14 Despite these increased journey times, our appraisal suggests that a high speed station at Sheffield Victoria would deliver more benefits overall than the Meadowhall base case. However, this increase in benefits would likely be offset by the additional capital cost explained above. In addition, as set out below, the scope to support wider Northern Powerhouse Rail connectivity is also limited.

Impacts

- 2.4.15 Sheffield Victoria presents significant constructability issues. These include the likelihood of major disruption to existing rail services including 7km of realigned track, the relocation of two stations, and the delivery of cut-and-cover tunnels under the existing railway in two locations.
- 2.4.16 The engineering challenges involved in delivering the route to a station at Sheffield Victoria are reflected in the costs. Delivering this route and station is estimated to cost at least £700m more than a route through Meadowhall (including land, property and risk). This is largely due to a 3.7km tunnel north of Sheffield Victoria and a 5km longer route. Construction costs also include:
- 21 additional highways interfaces
 - an additional 1.3km cut and cover tunnel (1.8km v 0.4km)
 - an additional 9.7km of classic railway modification.
- 2.4.17 Construction at the station would have a potentially major impact on townscape and local heritage owing to the demolition of three Grade II listed buildings, as well as potential major impacts during construction on an additional two Grade II listed buildings and the Grade II* listed Wicker Arches. There would also be setting impacts on a number of listed buildings in the area, including the Grade II listed Royal Victoria Hotel. The northern and southern viaducts and car park would have a potentially adverse effect on townscape character, resulting in visual intrusion.
- 2.4.18 The route serving Sheffield Victoria (station and line of route) would potentially require an additional four major river diversions compared to a route serving Meadowhall, and result in major flood risks associated with the River Don. The route serving Sheffield Victoria would also directly impact the Neepsend Railway Cutting Site of Special Scientific Interest.
- 2.4.19 There would be significant Network Rail interaction requiring widening of the existing rail corridor and possible closure of the Stocksbridge line during construction, for up to six months. In total, there would be an additional 9.7km of classic railway modifications at a significant cost.
- 2.4.20 Major property impacts include:
- Sheffield Energy Recovery Facility (Veolia);
 - Holiday Inn Royal Victoria Sheffield;

- Ross & Catherall – Killamarsh; and
- disturbance to the tram depot.

Regional connectivity and Northern Powerhouse Rail

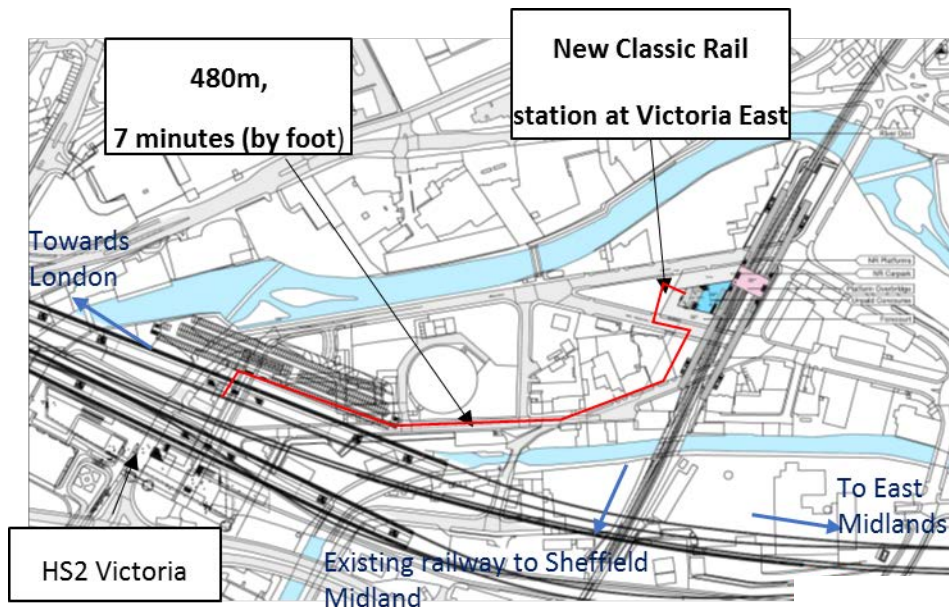
- 2.4.21 As noted above, a high speed station at Sheffield Victoria would provide the ability to link Leeds and Sheffield city centres and help to deliver the Northern Powerhouse Rail aspirations. This option does not work as well as others, as the Sheffield Victoria station site is constrained by the need to have the alignment on a curve; and the boundaries of the site itself are fixed by the river and the listed Victorian arches below the station. As such, there is insufficient space to turn back services at the station itself. As the Victoria site does not link into the main rail lines in the area, there is no obvious destination for the rolling stock to serve beyond this.
- 2.4.22 In order to operate Northern Powerhouse Rail services to Sheffield Victoria, it would be necessary to build either suitable turn back facilities remote from the station or a link to the classic network to allow the rolling stock to serve a suitable additional location. Either of these options would require a significant spend on infrastructure as well as increasing impacts, and would not appear to offer an optimum solution for Northern Powerhouse Rail rolling stock.
- 2.4.23 Although located in the city centre, Sheffield Victoria Station would not offer a good connection to the main classic network services in South Yorkshire. The station at Victoria would be 10 – 15 minutes' walk from the classic station at Sheffield Midland. Although options like an extension to the tram network (at extra cost) could be considered, this would remain a challenging interchange.
- 2.4.24 Whilst Sheffield Midland and Sheffield Victoria Stations are too far apart to allow for easy pedestrian interchange, they are too close to facilitate a heavy rail connection. The classic lines that pass through the Victoria Station site do not connect with the lines that serve Midland Station, and our work suggests that this area is too constrained to construct a new junction to provide this connectivity.
- 2.4.25 To deliver this classic network connectivity, a new station on the classic network would be needed. How this might work in practice is detailed below.
- 2.4.26 It is important to note that providing a second classic network station in Sheffield city centre would effectively split classic network services. In other words, if more services provide connectivity at Victoria East (the classic station), we would expect that fewer would serve Sheffield Midland station.

Victoria East Station – Connectivity to the classic network

A new classic station at Victoria could be positioned 400 metres north of Nunnery Junction, around a seven minute walk from the proposed site of the HS2 station at Victoria (480 metres). That would require an additional northern concourse at the HS2 station costing around £25 million.

A station could not be positioned closer to Sheffield Victoria without significant work to Nunnery Junction and the Sheffield ring road. This would be both expensive and disruptive, adding cost to a station in this location. If the original design were retained then walking time would be no better than between the HS2 station and Sheffield Midland.

HS2 Ltd's indicative estimate of the cost of a new station at Victoria East is an additional £54 million, assuming complementary works are undertaken on the classic network by Network Rail.



3 Serving South Yorkshire with classic-compatible services

3.1 Route and key facts

3.1.1 Consideration of classic-compatible options have taken account of a number of considerations:

- Planned electrification and upgrade investments by Network Rail in the Midland Main Line and Sheffield Midland Station.
- The developing Northern Powerhouse Rail programme, with its focus on services between city centres.
- The possibility of delivering efficiencies in the scheme, given growing concern about the cost of a station at Meadowhall.

3.1.2 Classic-compatible services are where an HS2 train leaves the HS2 network and travels on to serve other destinations via the classic network. It is proposed that HS2 will serve a number of destinations in this way, including Newcastle, Liverpool, Glasgow and Edinburgh.

3.1.3 Classic services could be provided by a spur that provides a connection to the classic network, or a loop that returns to the HS2 line. Both have been considered in South Yorkshire, and are described below. These options could also provide opportunities to deliver classic-compatible services to wider markets across South Yorkshire, such as Rotherham and Barnsley, by extending services beyond Sheffield Midland Station.

3.1.4 We have looked at a number of options for how HS2 could connect into the classic network, and how the region might be served. We present below the best of these options, via the Erewash Valley line; and then also describe an alternative we considered for a connection via the Worksop line.

3.2 Assessment of classic-compatible services via the Erewash Valley line

3.2.1 An option via the Erewash line would require a grade-separated junction from HS2 near the junction between the M1 and A38, and a 6.6km spur to connect to the Erewash Valley line. This option then requires 6km of electrification of the Erewash Valley line before it connects into the Midland Mainline. The additional impacts of constructing a spur would be limited when compared to the impacts of constructing an entirely new line into Sheffield city centre.

3.2.2 In order to appraise this option, we need to understand the impact on the classic network. A workshop was held with Network Rail, HS2 Ltd and DfT (including Rail Executive), which agreed the assumptions and infrastructure enhancements that would

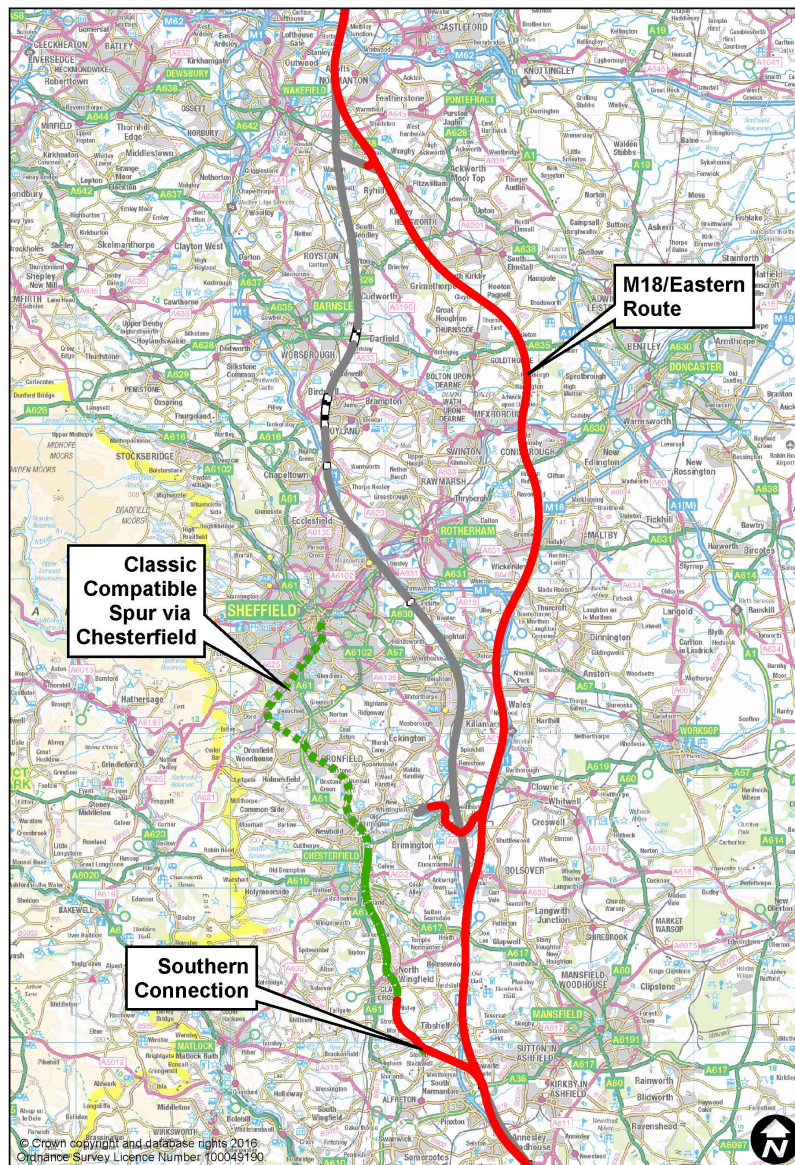
be completed prior to HS2 Ltd running a service. The outputs of this workshop informed the on-network costs for each of the classic-compatible options.

3.2.3 This estimate, and our assessment of the operational feasibility of this option, is based on these agreed assumptions. We have assumed that Network Rail will deliver a number of projects as part of their planned investment programme, including:

- electrification of the Midland Main Line
- signalling upgrades
- remodelling of Sheffield Midland Station.

3.2.4 One of the key considerations for this option is how well it can serve demand in the South Yorkshire region, and the impact on other services. This is considered further below.

Figure 9: M18/Eastern Route including classic-compatible services via the Erewash Valley line



Wider connectivity

- 3.2.5 This connection would enable HS2 services to serve Chesterfield, as well as Sheffield Midland station. The actual services that would run on such a spur would need be subject to agreement; however, work with Network Rail indicates that there would be capacity for up to four trains an hour to serve Sheffield Midland via such a spur.
- 3.2.6 Our work suggests that, even with a stop at Chesterfield, the journey time to Sheffield Midland via this connection would be comparable to the journey time for passengers travelling to Midland Station via the South Yorkshire Hub at Meadowhall. In addition, because there is the opportunity to avoid the need to include a station on the main line, those services using the main HS2 line could benefit from additional journey time savings.
- 3.2.7 The possibility also remains for services to run beyond Sheffield Midland station and serve other destinations such as Meadowhall, Rotherham or Barnsley.
- 3.2.8 There would also be scope to deliver synergies with the NPR aspirations for Sheffield – Leeds connectivity by providing a northern connection back to the HS2 network. This means a journey time of around 30 minutes - considerably quicker than the current journey times as well as meeting TfN's aspirations.
- 3.2.9 As noted above, we also considered a loop option based on the above spur. We believe that upgrading the signalling system would provide enough capacity for up to four trains per hour along the loop. Trains would run on the classic network beyond Wincobank for another 20km to South Kirby where they would rejoin the HS2 line.
- 3.2.10 As well as the upgrades involved in delivering the spur, the loop option also requires a grade-separated junction to the north near South Kirby. These present reliability challenges to be considered as the trains going onto the HS2 route will need to present on time from the classic-compatible loop to the HS2 main line.
- 3.2.11 However, we recognise that it is vital we maximise the value of the HS2 project by delivering synergies with complementary projects. This link could deliver the NPR ambition for a frequent 30-minute journey time between Sheffield and Leeds. This link might also be used by Birmingham-Leeds HS2 services, allowing them to route through Sheffield. It is being considered by TfN as part of their work on Northern Powerhouse Rail.
- 3.2.12 We will continue to work with partners, including TfN and DfT, to consider how best to meet the strategic aim of an integrated network.

3.3 Assessment of the HS2 Eastern leg – the 'M18 / Eastern Route'

- 3.3.1 The HS2 route is determined by the need to connect high speed stations as effectively as possible. Serving South Yorkshire with a classic-compatible connection means that the high speed mainline no longer follows the route through Meadowhall.
- 3.3.2 Accordingly, this has allowed us to consider whether a better route may be possible through South Yorkshire. We have developed an alternative option that broadly

follows the M1 and M18 transport corridor before heading west across country to rejoin the M1 near Wakefield. This is referred to as the 'M18 / Eastern Route'.

Key facts

Station Location	Route	Journey time London - Sheffield	Journey time London - Leeds (non-stop)	Estimated cost impact
Midland Station (classic)	main line via M18 / Eastern Route; spur to Erewash Valley line	83 mins to Sheffield Midland (including stop at Chesterfield; excluding performance allowance)	80 mins. No intermediate stop in S Yorks for through services	-£1 bn (2015 prices, including cost of spur) but not including the cost of the loop ⁴

Route

- 3.3.3 The M18 / Eastern Route diverges from the consultation route to the north of Bolsover and heads north along the line of the M1 and M18. The route turns north to head between the towns of Mexborough and Conisbrough. After crossing the A635 to the east of Goldthorpe, the route heads northwest and re-joins the consultation alignment after passing to the east of the proposed rolling stock depot at New Crofton, which is proposed to remain in the same location as proposed in consultation.

Assessment

Benefits

- 3.3.4 This route avoids the complex challenges involved in threading a route along the line of the M1 between Sheffield and Rotherham. Whereas the consultation alignment to Meadowhall required around 6km of viaducts to pass along this corridor, and includes a six-track station on a widened viaduct, the M18 / Eastern Route passes largely through open country and does not require such complex structures.
- 3.3.5 Similarly, our work to date leads us to expect fewer geotechnical challenges on the M18 / Eastern Route alignment. This includes the risks introduced by passing over old mine workings, landfills and other former industrial sites.
- 3.3.6 This is reflected in the cost estimate. With a classic-compatible spur as described above, this option could save an estimated £1bn over the Meadowhall route, even with the cost of a spur to the Erewash line taken into account.
- 3.3.7 The M18 / Eastern Route passes through countryside, rather than a more densely populated urban area. Accordingly, it is expected there would be fewer direct impacts on residential and commercial property. The route would avoid the property impacts associated with a station at Meadowhall, including impacts on the Waverley New Community Development, Sheffield Airport Business Park, and Meadowhall shopping centre.

⁴ This is for the southern connection into Sheffield Midland only and includes efficiencies and optimism bias. The recent NAO report quotes £768m savings (excludes efficiencies and optimism bias), which includes both the southern connection and northern connection between Sheffield and Leeds.

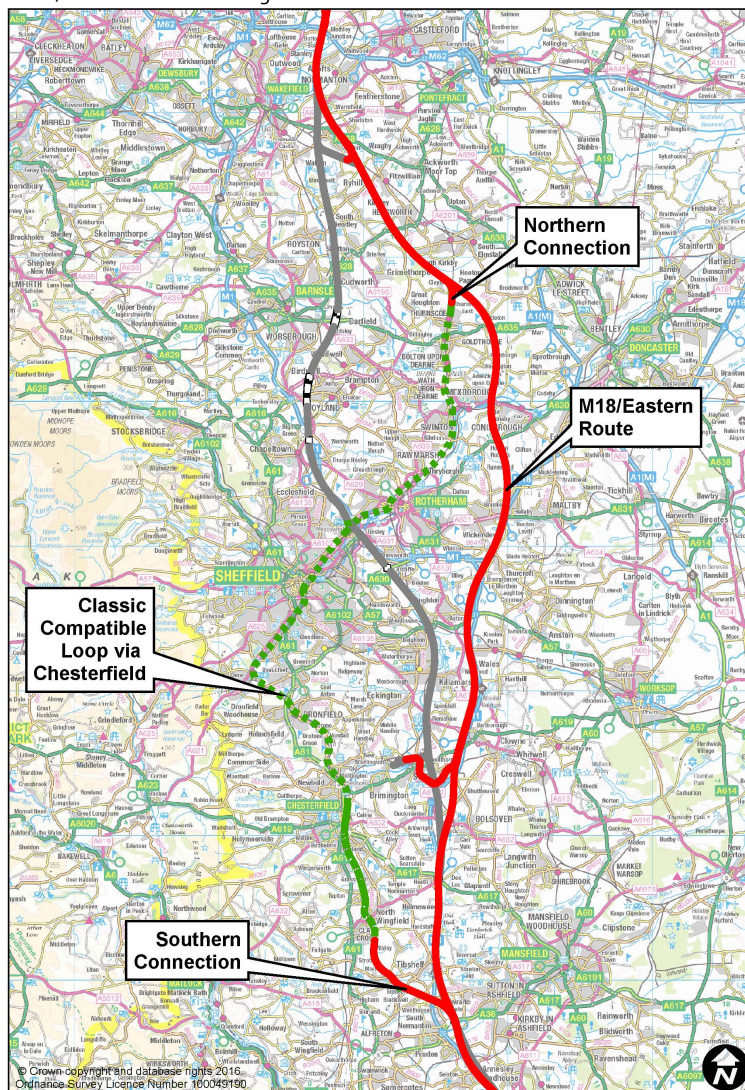
- 3.3.8 There would also be a reduction in the potential noise impacts and the route would be unlikely to require any major watercourse diversions.
- 3.3.9 We note below the specific implications for benefits and regional connectivity that could come as a result of adopting this route.

Demand

- 3.3.10 The options for how HS2 could serve Sheffield Midland Station via a classic-compatible spur, and any train service proposal, needs to consider network-wide capacity and impacts. In addition, as noted above, we would need to consider whether services to Sheffield Midland Station from London would terminate there, or travel on to serve other destinations in the region.
- 3.3.11 We have carried out a simple comparison to understand whether stopping a service at Midland and running the remaining services via the M18 / Eastern Route would deliver any increase in benefits over the base case of a station at Meadowhall. We started by looking at having an additional service that served Sheffield Midland Station via a connection to the classic network.
- 3.3.12 In this scenario, there was a marginal increase in benefits but a noticeable increase in revenue over the base case. Although there is an increase in operating costs as a result of introducing an additional service, this is offset by the capital cost savings from adopting an alternative route. This suggests that, with the right service proposition, this alternative option could deliver high value for money.
- 3.3.13 We continue to consider how South Yorkshire could be served if this route option were adopted. Overall, based on modelling undertaken to date, our assessment is that this option offers at least marginal benefits over the base case via Meadowhall and there could be a significant improvement to the economic case depending on the train service adopted.
- 3.3.14 Because a Sheffield station would no longer be on the main line, there is scope to deliver greater benefits across the Eastern leg through improved long-distance journey times.
- 3.3.15 In consultation, we assumed that of the eight trains passing through Meadowhall each hour in each direction, five would stop. Constraints in the South Yorkshire area mean that the alignment speed north of Meadowhall Station falls to 190kph. This means that all services passing through Meadowhall, whether or not they stop, are required to slow when they pass through this area.
- 3.3.16 By delivering an alternative route with no station on the main line, the M18 / Eastern Route offers improved journey times for travellers not stopping in South Yorkshire. We expect this to offer an improvement in the overall business case for the scheme, especially when combined with the significant cost saving that this route delivers.
- 3.3.17 This offers an effective balance between serving Sheffield city centre, whilst avoiding journey time penalties to other destinations on the HS2 route. The use of Sheffield Midland for HS2 services also opens the possibility of running high speed trains from

Sheffield to Leeds via a dedicated link to the main HS2 line, which could deliver the NPR ambition for a frequent 30 minute journey time between Sheffield and Leeds.

Figure 10: M18/Eastern Route including Sheffield to Leeds link



Impacts

- 3.3.18 Whilst at this stage in the design it is anticipated the M18 / Eastern Route would result in fewer demolitions than the consultation route, the route would pass through a new development between Mexborough and Conisbrough. There would therefore be a number of demolitions at this location.
- 3.3.19 The route would also result in major landscape and visual impacts as it runs through open green field land, in comparison to the more urban nature of the route via Meadowhall. In addition, the route would result in a number of major heritage impacts.
- 3.3.20 Further consultation would also be required to ensure that we understand the implications of the M18 / Eastern Route, and to ensure that newly affected individuals have the opportunity to give their views on the route.

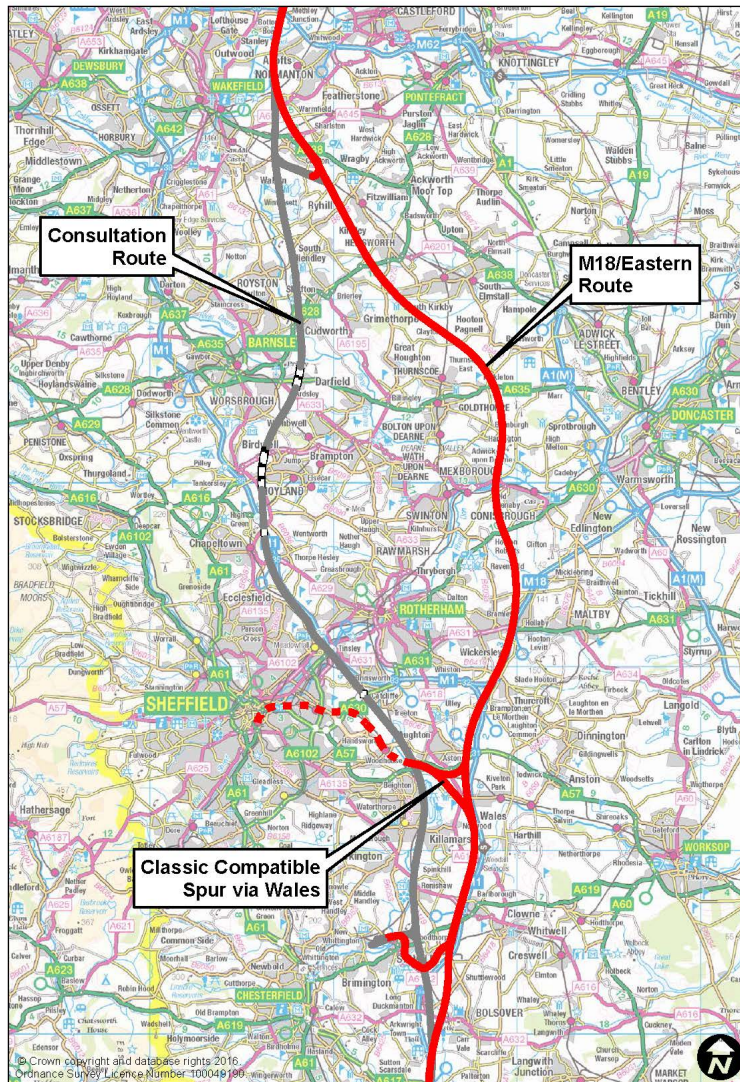
Alternative classic spur – Wales junction

As well as the spur option set out above, we considered an alternative classic-compatible spur via Wales, to the south-east of Sheffield.

In assessing this option, we made the same assumptions as those we made for the Erewash spur, so it is assumed that signalling enhancements and remodelling of Sheffield Midland Station would be undertaken by Network Rail before 2033. This option would require a grade separated junction and a 4km chord in the Wales area. It would also require the electrification of 8km of the Worksoy line.

A spur coming in from the Worksoy line is not well suited to serving Sheffield to Leeds as trains would enter Sheffield Midland from the north and facing south, although there could be synergies with a Sheffield to Manchester service that used the Hope Valley corridor. This option would require major enhancement works to Nunnery Junction if it were to be used for both north- and southbound. Given the limited scope for supporting NPR connectivity we decided not to take this option forward.

Figure 11: Alternative classic-compatible services via the Wales spur



4 Summary

- 4.1.1 The complexities of finding a solution for HS2 in South Yorkshire include:
- engineering challenges – like South Yorkshire’s industrial legacy
 - environmental constraints
 - a distributed pattern of demand.
- 4.1.2 We have set out the technical cases for four different HS2 service options, summarised in the table below.
- 4.1.3 We are aware that the HS2 programme is delivering connectivity for people, not just a technical solution to an infrastructure challenge – so whatever is decided must as far as possible run with the grain of local plans and aspirations.
- 4.1.4 For Sheffield City Council, this means services to the city centre to drive regeneration and growth.
- 4.1.5 For the wider region, this means connectivity to a fast, reliable service that can improve South Yorkshire’s access to the rest of the UK.

HS2 Sheffield and South Yorkshire Options Report

	Meadowhall Station route BASE CASE	Midland Station route	Victoria Station route	M18 / Eastern Route incl. c-c spur via Chesterfield
Journey time	London – M’hall: 68 mins London – Leeds: 81 mins	London – Midland: 66 mins London – Leeds: 81 mins	London – Victoria: 69 mins London – Leeds: 84 mins	London – Midland: 83 mins (incl. Chesterfield stop) London – Leeds: 80 mins
Connectivity	5tph serving Meadowhall HS2 station i.e. 3tph for London services and 2tph for regional services Serves wider South Yorkshire region well Well connected to M1 motorway Local road network is highly congested Frequent local rail service at Meadowhall Interchange	5tph serving HS2 city centre station Optimum location for rail connectivity Marginal reduction in ability to serve wider South Yorkshire region	5tph serving HS2 city centre station 1.1km from Sheffield Midland Station Poorly serves wider South Yorkshire region Well-connected to local bus network Significant issues providing expensive classic rail station and link to Sheffield Supertram Frustrates re-opening the Stocksbridge line	Up to 2tph for regional services - to Sheffield Midland (option of stopping at Chesterfield) Opportunity to turn back service at another South Yorkshire destination e.g. Meadowhall, Rotherham, Barnsley Does not provide Sheffield to Leeds HS2 service (see below for NPR) +3 mins journey time to Sheffield Midland than interchange at Meadowhall
NPR (incl. Sheffield – Leeds)	Requires new chord to Midland at additional cost to support Sheffield to Leeds NPR services	HS2 provides infrastructure to support Sheffield to Leeds service Future classic expansion constrained Junctions between HS2 and classic network likely to be extremely complicated	HS2 provides infrastructure to support Sheffield to Leeds service Junctions between HS2 and classic network likely to be extremely complicated Route and station frustrate re-opening of Woodhead route	Could provide northern junction to meet NPR aspirations - providing approx. 30 mins Sheffield to Leeds journeys
Demand	Serves more wider South Yorkshire region markets well Provides best national benefit : cost return of the pure HS2 options Main long distance travel market located SW Sheffield remote from Meadowhall	Highest demand due to existing connectivity Good potential for local city centre employment growth Lower demand from across the region No direct comparison with Meadowhall (as mentioned previously) as HS2 discounted this option at an early stage due flooding	More inter-regional trips on HS2, fewer trips and benefits from London to NE Added benefits no greater than added cost Good potential for local city centre employment growth No increase in standard wider economic impacts	New benefits from stopping in Chesterfield offset dis-benefits to wider region Provides best national benefit: cost return Benefits from faster journeys to the North Spur has potential to provide substantial benefits and revenue but with

HS2 Sheffield and South Yorkshire Options Report

		issues, disruption during construction and cost	due to regional losses offsetting Sheffield increases	additional operating costs to HS2
Sustainability	<p>Impact on a number of Major Development Sites associated with the Sheffield Enterprise Zone</p> <p>Noise impacts on a number of communities close to the route</p> <p>Cluster of 49 demolitions at South Tinsley</p> <p>Flood risk at station (concourse and car park)</p>	<p>Grade II* listed Park Hill flats adjacent to station require protecting</p> <p>Station and tunnels within floodplain</p> <p>Cumulative impact on listed buildings along Attercliffe corridor</p>	<p>Slower route means reduction in noise impact</p> <p>Greater direct impact on listed buildings and geological Site of Special Scientific Interest</p> <p>Greater interface with rivers and more watercourse diversions of major rivers</p>	<p>Reduction in impact on Major Development Sites</p> <p>Reduction in noise impacts</p> <p>Overall reduction in demolitions expected, although route would impact a new development site between Conisbrough and Mexborough</p> <p>Reduction in flood risk</p> <p>Greater heritage and landscape impacts.</p>
Risks and opportunities	<p>Geotechnical risks around station Meadowhall</p> <p>Major property impacts through northeast Sheffield</p> <p>Major highway modifications</p> <p>Impact on British Land car park</p>	<p>Lower geotechnical risk although significant tunneled north and south approaches required</p> <p>Operational risks with tunnel portal in flood zone</p> <p>Significant disruption during construction to Midland station and local highways to the north of the station</p>	<p>Greater local regeneration potential</p> <p>Greater potential for local employment growth</p> <p>Disruption to Network Rail and local roads as result of constructing along existing rail corridor</p> <p>Complex access to construct tunnelled route north of station</p>	<p>Route avoids known mining areas. Further investigation into hazards required</p> <p>Numerous highways impacts alongside M1/M18</p> <p>Opportunities for HS2 to serve other South Yorkshire destinations e.g. Chesterfield, Rotherham</p> <p>Performance risk of HS2 services</p>
Cost	BASE	+£2,000M	+£700M	-£1,000M (2015 price) ⁵

⁵ This is for the southern connection into Sheffield Midland only and includes efficiencies and optimism bias. The recent NAO report quotes £768m savings (excludes efficiencies and optimism bias) which includes both the southern connection and northern connection between Sheffield and Leeds.

