High Speed Two Phase 2b South Yorkshire Parkway & Connectivity Study

HS2 Ltd's advice to Government

July 2017

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Department for Transport

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1 Executive summary

1.1.1 Building on a recommendation from David Higgins in his Sheffield and South Yorkshire Report (July 2016), High Speed Two (HS2) Ltd has investigated the scope for enhancing HS2 services to South Yorkshire via either a parkway station; or by extending HS2 services stopping at Sheffield Midland station to travel onward to other destinations on the classic network.

1.1.2 In assessing whether there is sufficient demand to warrant offering an additional service to the broader South Yorkshire region, the work has two main focuses:

- to consider the best location for a parkway station, how this could be best served, and the case for this to be delivered as part of the HS2 scheme; and
- to consider the options for extending terminating HS2 services beyond Sheffield Midland.

1.1.3 The study takes as its starting point the HS2 route as set out in the preferred Phase 2b route announcement in November 2016. Under this proposal, HS2 services would use the M18/Eastern route to serve Sheffield Midland by running high speed 'classic compatible' trains into Sheffield via a dedicated link (spur) off the main high speed line. This would allow services to join the Midland Main Line (MML) south of Chesterfield at Clay Cross, and travel on to Sheffield Midland. This route also assumes a junction at Clayton, to the north of Sheffield.

1.1.4 It is noted that decisions on the final Phase 2b route through South Yorkshire are still to be taken by the Secretary of State, following the recent public consultation between November 2016 and March 2017.

1.2 Assessing rail demand in the South Yorkshire region

1.2.1 Our high level assessment of potential demand across the region has considered a range of factors. These include where people currently live and work, the location of businesses, past and future growth patterns, key strategic Growth Areas identified by the Sheffield City Region HS2 Programme Board, and patterns of rail demand.

1.2.2 In considering these factors, our work has revealed that the polycentric nature of the region, with a wide spread of people, means that no single location for rail services is likely to best serve all areas.

1.2.3 Sheffield is the largest urban centre and area within the region in terms of population. However, most (more than two-thirds) people in South Yorkshire live outside this area. Our analysis therefore suggests that there is likely to be a strong desire for long-distance travel, including by rail, outside this area.

1.2.4 The issue, however, is that this potential demand is spread widely across the region, in a combination of urban centres and towns. As such, a compromise would be required on where best to target rail services. This aligns with one of the conclusions of the

Sheffield and South Yorkshire Report, which stated that no single high speed station option in South Yorkshire benefits all areas equally.

1.3 Potential parkway station locations

1.3.1 In our approach to identifying and sifting potential parkway station locations we considered our standard sifting criteria, such as likely demand for travelling to and from each station, constructability, accessibility, environmental impacts, and cost. Alongside our standard criteria, we considered the fit with wider strategic developments in the region. We also undertook a range of population and travel time analyses to understand how well different options supported regional development plans.

1.3.2 We considered eight longlisted potential parkway station locations. These were made up of almost all the locations on the M18/Eastern route where there is an interface between the HS2 route and a major road, or the existing rail network. We were able to shortlist the parkway station locations to four potential options at:

- Wales
- Bramley
- Mexborough
- Hemsworth

1.3.3 However, our work did not indicate a clear standout location from this shortlist. Based on our initial train service specification (TSS) modelling tests, there were similar results across all four shortlisted parkway locations on aggregate economic grounds and demand, making it difficult to determine the best station location on these results alone.

1.3.4 Our appraisal of the constructability and sustainability issues associated with each parkway option resulted in a slight preference for Bramley over Hemsworth. Wales and Mexborough would cost significantly more, being more challenging to construct and having more sustainability impacts.

1.3.5 It is also important to note that there are some qualitative differences between the shortlisted parkway station options that need to be considered – most notably, the potential for synergy between a potential parkway station site at Hemsworth – and future Northern Powerhouse Rail (NPR) services, with the Hemsworth site being located north of the proposed M18 northern loop connection at Clayton.

1.3.6 Our further modelling work to assess a range of TSS scenarios to representative parkway station locations at Mexborough and Bramley shows that a South Yorkshire parkway station on the M18/Eastern route could significantly increase the number of South Yorkshire HS2 passengers (possibly by more than 30 per cent), with a net increase also in overall HS2 passengers.

1.3.7 However, our work also suggests that a parkway station may not deliver large additional benefits to the overall value for money assessment of the HS2 business case. Additionally, this analysis does not take into account the estimated cost (approximately £200 million–£300 million) of building a parkway station.

1.3.8 While not delivering large additional benefits to the overall HS2 business case, it should be noted that some options did show a small positive impact on benefits, and any overall impact is likely to be small (generally between -0.3 per cent and +0.1 per cent). Further options may yield more positive changes in benefits and this would need to be explored further.

1.3.9 Our work demonstrates that stopping HS2 services at a parkway station may have an impact on other destinations, mainly in terms of longer journey times for those services. Further fine tuning of the TSS may help to offset this impact and its disbenefits for other markets on the HS2 network. However, it is important that decision makers consider this wider context alongside the regional issues we discuss in this report.

1.3.10 Nonetheless, given the distributed demand in this area, the wider strategic context, and the long-term development and investment plans, there may be a wider case for the possible future development of a parkway station. Some options showed high numbers (+3,700) of new boarders. This indicates that a station could enable large numbers of new passengers to access HS2 services and, arguably, meet the aim of serving South Yorkshire more effectively.

1.3.11 The populations that would be served vary according to the location of any parkway station, which again reflects the distributed nature of demand in the region. However, regardless of any decision on whether to build a parkway station and its location, the results of our tests demonstrate that serving Sheffield Midland remains an important part of the service offer.

1.3.12 We therefore recommend undertaking further engagement with the region to understand whether it is possible to come to an agreed position in terms of location, strategic fit and funding. As referred to above, decision makers should also bear in mind that the benefits to new passengers in South Yorkshire are of course offset by impacts on other passengers, notably in terms of additional journey times.

1.3.13 Incorporating a parkway station in the HS2 scheme would require changes to the HS2 mainline to accommodate platform loops. If there were a desire to leave the option of a parkway open for the future, some future-proofing, in the form of mainline realignment, would be required. Accordingly, this would need to be instructed for inclusion into the design as part of the Phase 2b hybrid Bill preparation.

1.4 HS2 service extensions

1.4.1 Our work to consider possible service extensions built on existing work to consider the potential opportunities. This work provided an indicative view on the cost and infrastructure implications of extending HS2 services to different locations north of

Sheffield Midland. We considered the operational and demand impacts of service extensions to locations in South Yorkshire where such extensions would offer improvements over existing journey times. However, we did not consider in detail the wider context of train services in the region.

1.4.2 We looked at a number of service extension destinations, including Meadowhall, Barnsley, Rotherham, Wakefield and a new station on the existing railway network near Goldthorpe/Thurnscoe.

1.4.3 The boarding and benefits results presented in our report for parkways and extensions of services are not directly comparable, due to modelling differences. Nonetheless, our work shows clearly that service extensions drive a significantly lower level of increases in passenger numbers than a parkway station on the HS2 mainline.

1.4.4 Our analysis indicates that, based on the assessed options, South Yorkshire passenger numbers could increase by up to a maximum of six per cent (in the case of extending two HS2 trains per hour (tph) to Meadowhall and Rotherham). Whereas we saw evidence that parkway stations could potentially improve the HS2 service offer to a range of locations across South Yorkshire, the impact of extending HS2 services beyond Sheffield Midland was more local and tended to deliver benefits mainly to the specific location served. The lower level of increases in passenger demand for service extensions reflects the relatively lower improvements in journey time delivered by service extensions, and the more limited markets being served.

1.4.5 Extending more than one service brought a disproportionate increase in benefits. However, this would also require additional investment in rolling stock and infrastructure. We estimated the overall benefit of impacts to be small (at most 0.3 per cent). While this was of similar magnitude to the best case scenarios tested for a parkway, as described above, the boarding and benefits impacts presented in our report for parkways and extensions of services are not directly comparable, due to modelling differences.

1.4.6 It should also be noted that the costs we have used to assess the infrastructure required to extend an HS2 service between Sheffield Midland and the terminating location are based on an extension of one tph. The benefits associated with extending two tph to Rotherham or Meadowhall do not take into account the full costs of doing this. Further work would be required to understand the full extent of costs associated with extending two tph, with regards to additional infrastructure requirements and additional operational implications.

1.4.7 Taking into account the caveats applied above, there is some evidence for a case to extend services to turn round at Meadowhall, rather than at Sheffield Midland – especially if this can be accommodated within the time that these services would otherwise occupy platforms at Sheffield Midland. Network Rail has identified this as a potential opportunity to manage capacity constraints at Sheffield Midland.

1.4.8 The opportunity may also exist for services travelling on the South Yorkshire loop to stop at a new location in this area. At the moment, we understand that Network Rail is considering what works would be required to enable HS2 services to operate on a loop basis. Once this work has generated recommendations, we can give further consideration to whether there are more opportunities to stop looped services elsewhere.

1.4.9 As with the parkways part of this study, more work is required to consider the implications of extending HS2 services, particularly the operational and cost impacts of existing and planned classic services and infrastructure requirements. It may be that a 'hub-and-spoke' model using Sheffield Midland delivers better connectivity across the region. However, given the relatively limited amount of infrastructure change required to facilitate this, there is a longer horizon for this work than for the parkways work as it may not be necessary to incorporate these changes within a Phase 2b hybrid Bill.

2 Structure of report

2.1.1 Following this section, the report adopts the following structure:

2.1.2 **Section 3** sets out the context for our advice. It contains the study remit; the policy context for the study; and the approach, methodology and overarching assumptions that have underpinned our work.

2.1.3 **Section 4** appraises demand in the study area. It assesses who wants to travel in South Yorkshire; current demand; future demand; and the strategic growth aspirations of the South Yorkshire local authorities.

2.1.4 **Section 5** reports on the outcomes of our work to assess eight potential high speed parkway station locations. This section addresses the question of whether there are any factors, including demand, which could help us determine a preferred location for a parkway station.

2.1.5 **Section 6** takes the work done in Section 5 to examine further the potential train service specification (TSS) for the parkway station to provide a deeper appraisal of the demand implications.

2.1.6 **Section 7** looks into the possibility of extending classic compatible HS2 services north of Sheffield to locations further north on the classic rail network.

2.1.7 **Section 8** summarises the findings and conclusions of the study.

3 Setting the context

3.1 Remit

3.1.1 The Sheffield and South Yorkshire Report[1], published in July 2016, noted that if the HS2 Phase 2b route were to serve South Yorkshire via a connection to the existing Sheffield Midland station, there may be scope to consider other opportunities for further developing services in South Yorkshire. The report recommended that HS2 Ltd should undertake a study for a potential parkway station along the M18/Eastern route that could serve the South Yorkshire area as a whole.

3.1.2 Following the announcement of the preferred HS2 Phase 2b route from Derbyshire to West Yorkshire in November 2016, and confirmation that this route would serve South Yorkshire via a connection to the existing Sheffield Midland, HS2 was issued with a formal remit by the Department for Transport (DfT) to provide advice on the options that exist to serve demand in the wider South Yorkshire region.

3.1.3 In fulfilling this remit, this advice covers the following questions:

- Is there sufficient demand to warrant a parkway station in the wider South Yorkshire region?
- What is the best location for such a parkway station on the HS2 mainline serving the wider South Yorkshire region?
- What train service would be suitable to serve the parkway station?
- What benefit would the parkway station deliver to HS2, and at what cost?
- Are there alternative means of serving this South Yorkshire demand?
- What implications do these alternative means have for the existing train services and the network?

3.1.4 In fulfilling this remit, and producing this advice, it is noted that decisions on the final Phase 2b route through South Yorkshire are still to be taken by the Secretary of State, following the recent publication between November 2016 and March 2017.

[1] HS2: Sheffield and South Yorkshire Report 2016: https://www.gov.uk/government/publications/hs2-sheffield-and-south-yorkshire-report-2016

3.2 Developing HS2 in South Yorkshire

2013 consultation route

3.2.1 HS2 Ltd consulted on a proposed route for Phase Two of the scheme from July 2013 to January 2014. As part of this route, South Yorkshire was served via a station at Meadowhall. Responses to the consultation demonstrated that there were different opinions in the region about whether Meadowhall was the right location for an HS2 station.

3.2.2 Sheffield City Region (SCR) recognised that the region is polycentric in nature and that the city centre generated a larger business count than any other location within the region. Countering this argument, other stakeholders felt that the widespread nature of the larger population throughout the region justified a station location outside the city centre.

3.2.3 The Phase Two 2013/14 consultation route was further refined and developed on the feedback and intelligence gathered through the Phase Two consultation, and through ongoing engagement with stakeholders and communities. In South Yorkshire, HS2 Ltd revisited the Meadowhall and Sheffield Victoria station options, taking into account responses from local stakeholders.

3.2.4 In October 2014, the report Rebalancing Britain[2] outlined the challenges of poor connectivity and overdependence on roads in the north of England and suggested that this was leading to an imbalance in productivity and business opportunities compared to other parts of the UK. The report called for HS2 to:

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

3.2.5 In March 2015, the Government and Transport for the North (TfN) published a joint Northern Transport Strategy. 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 (Manchester Airport), with the right connections to the wider network.

3.2.6 This strategy set out clear plans for developing the northern rail network in the future, with the aim of improving connectivity between key urban centres in the north of England. As improving connectivity and growth are central to the case for HS2, synergies with the Northern Transport Strategy and, in particular, Northern

[2] Rebalancing Britain: From HS2 towards a national transport strategy: https://www.gov.uk/government/publications/rebalancing-britain-from-hs2-towards-a-national-transport-strategy

Powerhouse Rail (NPR), are an important consideration. The technical practicalities of this for HS2 are reflected in this report.

The Sheffield and South Yorkshire Report

3.2.7 Since 2013, opinion among local stakeholders about the HS2 station location has remained divided, for the reasons set out above. This has made the decision about where best to locate an HS2 station in South Yorkshire very challenging. During this time, HS2 Ltd reviewed options for South Yorkshire in light of these challenges and in the context of ambitions set by TfN for NPR. The results of this were detailed in the Sheffield and South Yorkshire Report published by David Higgins in July 2016.

3.2.8 This report reviewed the options for a station in South Yorkshire, taking into account five key factors: demand (from South Yorkshire and markets further north); the needs of Sheffield and the wider region; connectivity with the existing rail network and the wider transport network; topography, urban density and the environment; and cost.

3.2.9 In particular, the report sought to ensure that any decisions balanced the need to serve South Yorkshire effectively with the need to avoid significant disbenefits to larger markets further north. The developing strategic context of the NPR project led us to reconsider how HS2 could improve connectivity between city centres in the north of England.

3.2.10 The report laid out the options for serving South Yorkshire, making two key recommendations:

- That HS2 services should serve Sheffield Midland in Sheffield city centre by running high speed classic compatible trains into Sheffield via a dedicated link (spur) off the main high speed line. Under this proposition, the report stated it would be possible to provide up to two trains per hour (tph) into Sheffield city centre and a new high speed service to Chesterfield.
- That the high speed mainline be moved further east, initially running parallel to the M18. This alignment avoids the complexities and risks associated with the Meadowhall route, and provides journey time savings for services heading to Leeds, York and Newcastle.

3.2.11 The report also noted that using the existing Sheffield Midland station for HS2 services opened up the possibility of running high speed trains from Sheffield to Leeds by building a link back onto the main HS2 line north of Sheffield. This link could deliver TfN's ambition for a frequent 30-minute journey time between Leeds and Sheffield; it might also be used by Birmingham–Leeds HS2 services, allowing them to route through Sheffield. TfN are considering the Sheffield–Leeds corridor alongside other NPR schemes.

3.2.12 The report also recommended that HS2 Ltd should undertake a study for a potential parkway station along the M18/Eastern route that could serve the South Yorkshire area as a whole.

3.3 Scope of the study

3.3.1 This study takes as its starting point the HS2 route as set out in the Phase 2b route announcement in November 2016, with a junction at Clayton to the north of Sheffield.

3.3.2 We explain throughout the report where we have made assumptions about additional road or rail connectivity beyond that available today.

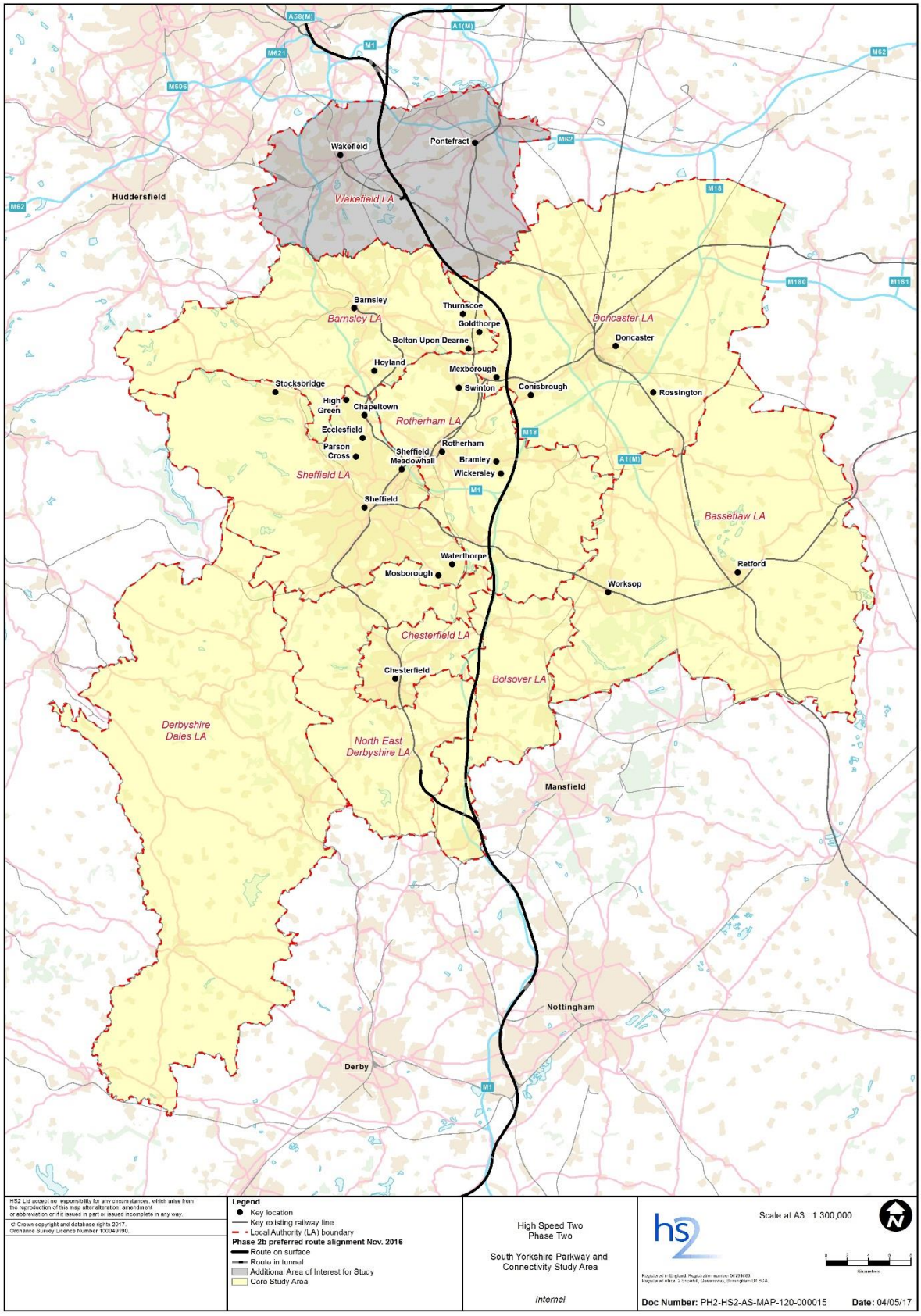
3.3.3 In considering how HS2 can serve the wider South Yorkshire region beyond that served by a spur to Sheffield Midland, we have considered the following options:

- the provision of a parkway station on the M18/Eastern mainline route serving the South Yorkshire region; and
- the extension of classic compatible terminating HS2 services beyond Sheffield Midland to locations further north.

3.3.4 The geographical area covered by the study is shown in Figure 1. The extents of the study area are defined by the SCR Local Economic Partnership (LEP) boundary. While the primary focus area for the study is South Yorkshire and the SCR, the study has also considered some areas just beyond the region, particularly Wakefield, but also Pontefract, Scunthorpe and Grimsby to the east and Kirklees to the west.

3.3.5 In conducting this study, it is noted that decisions on the final route through South Yorkshire are still to be taken by the Secretary of State, following the recent public consultation between November 2016 and March 2017.

Figure 1: South Yorkshire Parkway & Connectivity Study area.



3.4 Approach, methodology and overarching assumptions

3.4.1 HS2 Ltd uses a standard sifting process when considering route and station options to ensure that our comparisons can be undertaken on a consistent basis.

3.4.2 We have built on our sifting standards to use the criteria set out in Table 1 to assess potential options as part of this feasibility study. The criteria for assessing options was approved by both the HS2 Ltd Phase 2b Board and the SCR HS2 Programme Board, which comprises representatives from the SCR local authorities and from the West Yorkshire Combined Authority.

Table 1: Criteria for assessing parkway station and HS2 service extension options.

Criteria	Parkway station	Extension of HS2 services
Demand	- Population and employment across South Yorkshire - Daily HS2 boardings at station - Total daily HS2 passenger boarders in South Yorkshire - Net Present Value (NPV) and impacts on total HS2 benefits (v. reference case) - SCR Integrated Infrastructure Plan (IIP) Growth Areas	- Population and employment across South Yorkshire - Daily HS2 boardings at station - Total daily HS2 passenger boarders in South Yorkshire - NPV and impacts on total HS2 benefits (v. reference case) - SCR IIP Growth Areas
Cost	- Providing the station and approaches - Changes to HS2 mainline (Note cost assessed on point-to-point basis against HS2 M18/Eastern route HSL14/16)	- Infrastructure costs, including: extension of existing platforms; provision of platform loops; turnback sidings; and electrification
Constructability	- Constructability of station, including viaducts, cut-and-cover tunnels and embankments - Length of HS2 mainline change and platform loops required	- Constructability of infrastructure required to enable service extension, including extension of existing platforms, provision of platform loops, turnback sidings, electrification
Accessibility and connectivity	- Highways access - Rail interchange - HS2 journey time to key destinations	- Existing rail station - Station location (in relation to wider transport network) - HS2 journey time to key destinations
Journey times to key destinations	- Compared against local urban areas - Compared against SCR IIP Growth Areas	
Sustainability	- Key sustainability features, including landscape and visual impacts, watercourse diversions, heritage impacts, flood risk, impact on ecology, environmental features and planning sites - Demolitions	N/A
Strategic fit	- Alignment with SCR connectivity vision (SCR IIP Growth Areas)	
Operational implications	- Impact on operation of HS2 mainline	- Timetabling - Additional rolling stock required - Capacity at terminating locations

3.4.3 Our sifting process followed the prescribed HS2 Ltd approach. Options were sifted to increasing levels of detail (described as initial sift, longlist, shortlist). This enabled us

to prioritise the more promising options and work them up at progressive levels of detail. Reflecting the increasing level of detail, we made our recommendations for which options should be taken forward by using increasing levels of scrutiny.

3.4.4 We have used the SCR HS2 Programme Board to engage with South Yorkshire local authorities throughout the delivery of the study, updating them on progress and getting their input into the criteria we should assess options against. The board was also involved in reviewing the longlist of parkway station options, and the options we have considered for extending HS2 services.

3.4.5 More detail on the methodology applied during each stage of the study is contained within the relevant sections of the report.

Overarching assumptions

3.4.6 The study assumes that South Yorkshire is served by the M18/Eastern route from Derbyshire to West Yorkshire of Phase 2b of HS2. In undertaking the study, we note that decisions on the final route through South Yorkshire are still to be taken by the Secretary of State, following the recent public consultation between November 2016 and March 2017.

3.4.7 The reference case for the study work is the M18 loop route as set out in the Phase 2b Economic Case[3]. This assumes that:

- Following consultation, it is agreed to take forward a junction between HS2 and the existing network north of Sheffield, to enable HS2 services to loop through Sheffield Midland. This junction is currently assumed to be at Clayton.
- HS2 is able to use the existing network between Sheffield Midland and Clayton without additional investment being funded from the HS2 budget.

3.4.8 More detailed assumptions that have been applied to each stage of the work are explained throughout the report.

[3]HS2 Phase 2b Crewe to Manchester and West Midlands to Leeds: Economic Case https://www.gov.uk/government/publications/hs2-phase-2b-crewe-to-manchester-west-midlands-to-leeds-economic-case

4 Potential rail demand in South Yorkshire

4.1.1 A key question for this work is to ascertain if there is sufficient demand to warrant an additional HS2 service offering to the broader South Yorkshire region – either through a parkway station or by extending services currently planned to terminate at Sheffield Midland.

4.1.2 This section takes a closer look at the South Yorkshire region. It considers where people currently live, work and travel, to provide a high-level assessment of the potential for demand for HS2 services across the region, and where this might occur.

4.1.3 As described above, while the primary focus area for the study is South Yorkshire, as defined by the SCR LEP boundary, the study also considers some areas just beyond the region, such as Wakefield, Pontefract, Scunthorpe and Grimsby to the east and Kirklees to the west.

4.1.4 This assessment lays the groundwork for assessing the potential for additional HS2 service options to the region: whether demand might exist for these services, what improvements in rail service they might offer, and how well they might fit with the region's needs.

4.2 Methodology

4.2.1 In seeking to understand potential rail demand, it is important to explore a range of indicators, as one alone may present an incomplete picture. Current patterns of rail use, for example, may under-represent potential rail demand as they may partly reflect the level of existing rail services that are offered (i.e. some people may want to travel but have no access to rail services). In contrast, population levels across the region may overestimate potential demand, as desire to travel by rail is likely to be affected by a range of factors including, for example, local employment, cost of travel and car ownership. Looking at current patterns alone may also mask future trends in demand.

4.2.2 As such, this high-level assessment of potential demand across the region has considered:

- where people currently live and work;
- the location of businesses;
- past and future growth patterns;
- key strategic Growth Areas identified by the SCR LEP; and
- current patterns of rail demand.

4.2.3 An assessment of each of these has been used to identify whether there might be potential for rail demand across South Yorkshire and where this might be. Based on this assessment, and in consultation with the SCR HS2 Programme Board, we have

developed a list of 'focus areas' to use within the study to allow the assessment of possible additional HS2 service options.

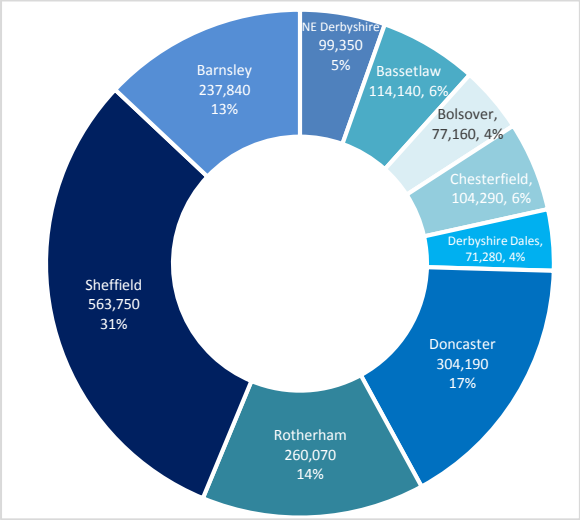
4.3 Population, employment and businesses in South Yorkshire

Population

4.3.1 Over 1.8 million people live within the SCR LEP region (2014). The region is polycentric in nature, with its population spread widely across the region in a mixture of larger urban areas and smaller towns.

4.3.2 Figure 2 shows the share of population across the nine local authority areas in the region. Between them, the local authority areas of Sheffield (31%), Doncaster (17%), Rotherham (14%) and Barnsley (13%) make up three-quarters of total population (just under 1.4 million people). The largest local authority area, Sheffield, makes up less than one-third of the total population.

Figure 2: Population in SCR LEP Region 2014 (by local authority area)[4].

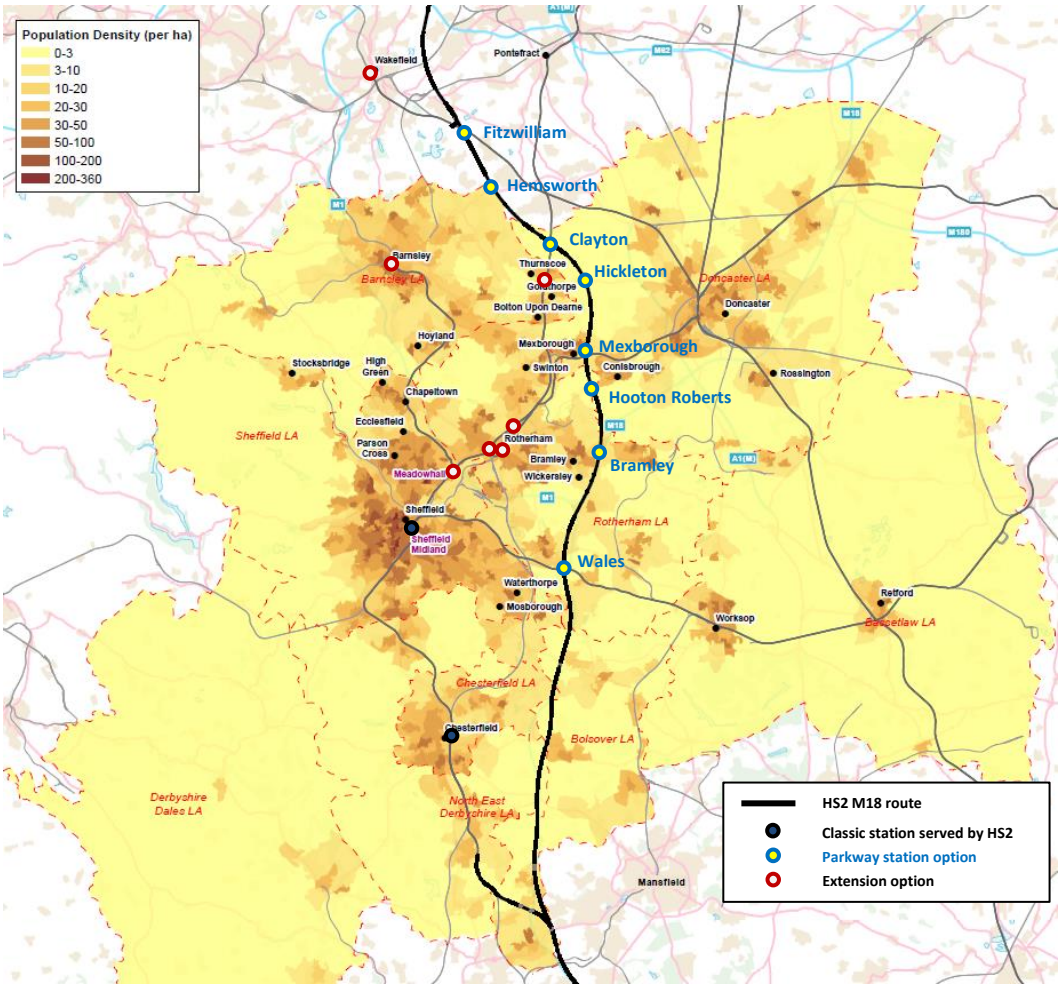


Source: ONS, Population Statistics 2014

4.3.3 Figure 3 shows that the population is further spread within the local areas of the SCR LEP region. While there are large populations within major urban areas (the cities of Sheffield, Doncaster, Rotherham and Barnsley), the population nonetheless spreads from outer areas of these conurbations to nearby towns. Figure 3 also shows the M18/Eastern route, together with longlisted parkway station locations (presented in Section 5) and service extension locations (presented in Section 7).

[4] There were 331,000 people living in the Wakefield local authority area in 2014 (not shown).

Figure 3: Population density (per hectare (ha)) – SCR LEP Region (2014).



Source: ONS, Population Statistics 2014

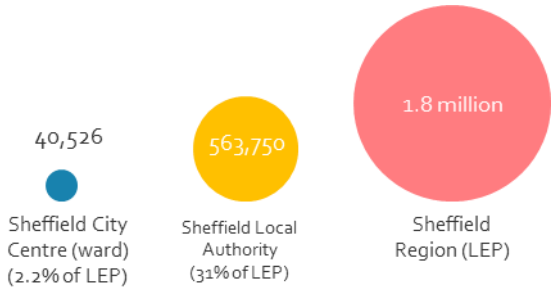
4.3.4 Importantly, the vast majority of the population live outside urban city centres, for example[5]:

- Sheffield city centre is home to 41,000 residents – seven per cent of the Sheffield local authority area and 2.2 per cent of total SCR LEP population.
- Doncaster town centre is home to 18,000 people – six per cent of the Doncaster local authority area and one per cent of total SCR LEP population.

[5] Based on 2011 Census figures of population for Sheffield Central ward and Doncaster Central ward boundaries.

4.3.5 Figure 4 further presents this point, showing the relative size of population within Sheffield city centre, Sheffield local authority area and the total SCR LEP region.

Figure 4: Relative size of population in the SCR LEP region (2014).



Source: ONS population estimates (2014)

4.3.6 That the Sheffield city centre represents only 2.2 per cent of the South Yorkshire population suggests a high potential for rail demand outside this area. Further, while it is the largest area in the region, the Sheffield local authority area comprises less than one-third of the region's total population, suggesting relatively high levels of potential for rail demand from the other two-thirds.

4.3.7 It is clear from the map in Figure 3 that the majority of the population in the region resides to the north and east of Sheffield, including in a mix of:

- major urban areas and their surrounds (Sheffield, Doncaster, Rotherham, Barnsley); and
- a large number of smaller towns to the north and east of Sheffield, generally along rail and road corridors, such as:
  - a cluster around Mexborough, Conisbrough and Swinton (approximately 60,000 people)
  - the Dearne valley (Thurnscoe, Goldthorpe, Bolton-upon-Dearne etc.)
  - the east/south-east of Sheffield towards Worksop and Retford
  - the north of Sheffield and towards Barnsley
  - Chesterfield to the south of Sheffield.

4.3.8 In addition, there are some larger cities just outside the South Yorkshire region that potentially use or benefit from rail services to the region, including:

- the cities of Wakefield and Pontefract to the north, with a combined population of more than 100,000 people[6]; and
- the cities of Scunthorpe and Grimsby to the east of Doncaster, with a combined population of more than 150,000 people.

4.3.9 The wide spread of the population across the South Yorkshire area has important implications for considering the location for rail services, as no single location is likely to be best for all people in the area. The concentration of people outside city centres also has implications for assessing station options.

Population growth

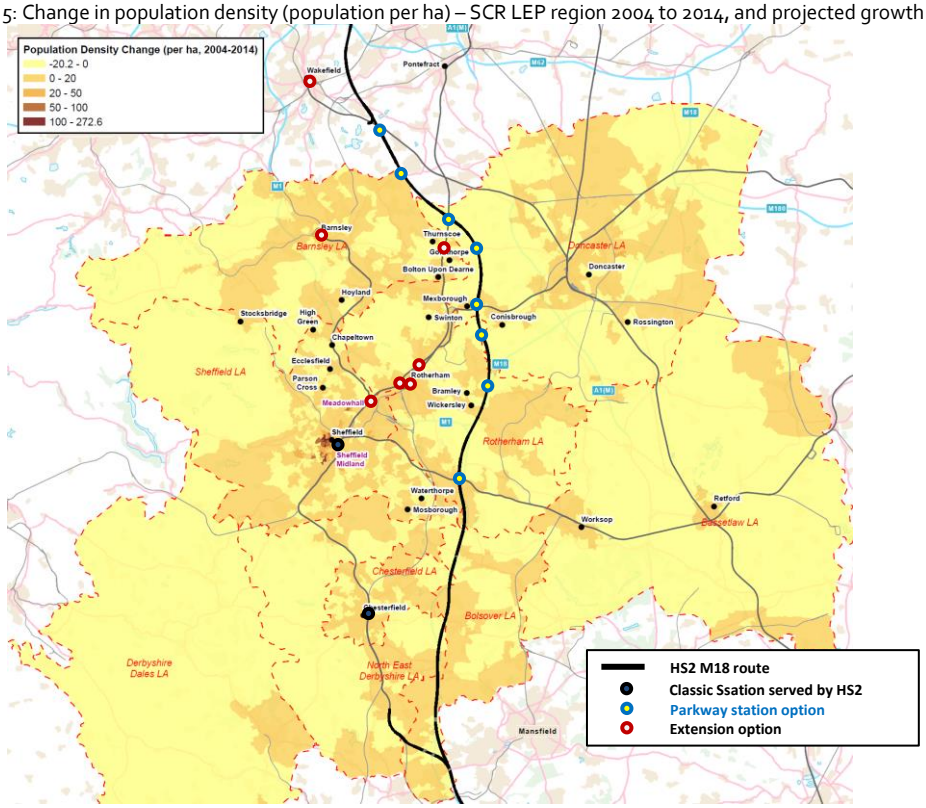
4.3.10 The population across the SCR LEP region grew by 5.6 per cent between 2004 and 2014. Figure 5 shows that population growth has occurred across the region. In percentage terms, this has been fastest in Sheffield (8.5 per cent) and Barnsley (7.5 per cent), and around four per cent in Doncaster, Bolsover and Bassetlaw (although these last two are smaller in absolute terms).

4.3.11 In terms of contribution to overall regional population growth, the main areas have been Sheffield (45 per cent of total growth), Barnsley (17 per cent), Doncaster (14 per cent) and Rotherham (nine per cent). Looking at future projected growth over the next two decades, these trends are forecast by the Office of National Statistics to continue (see Figure 5)[7].

[6] The Wakefield local authority area (within which the cities of Wakefield and Pontefract are located) had a total population of around 330,000 in 2014 (ONS).

[7] ONS Sub-National Population Projections (2014)

Figure 5: Change in population density (population per ha) – SCR LEP region 2004 to 2014, and projected growth 2014 to 2037.



Local authority	Population: % change 2004 to 2014	Population: % contribution to growth in SCR LEP	Population: projected growth 2014 to 2037 (%)
Barnsley	7.5	17.0	11.3
Bassetlaw	3.7	4.2	7.6
Bolsover	4.8	3.7	8.5
Chesterfield	3.7	3.8	6.1
Derbyshire Dales	2.5	1.8	9.6
Doncaster	4.6	13.7	3.8
NE Derbyshire	1.9	1.9	7.8
Rotherham	3.3	8.6	6.5
Sheffield	8.5	45.3	12.3
TOTAL LEP	**5.6**	**100.0**	**8.8**

Source: ONS Small Area Population Estimates (mid 2014), and ONS Sub National Population projections (2014)

Employment and businesses

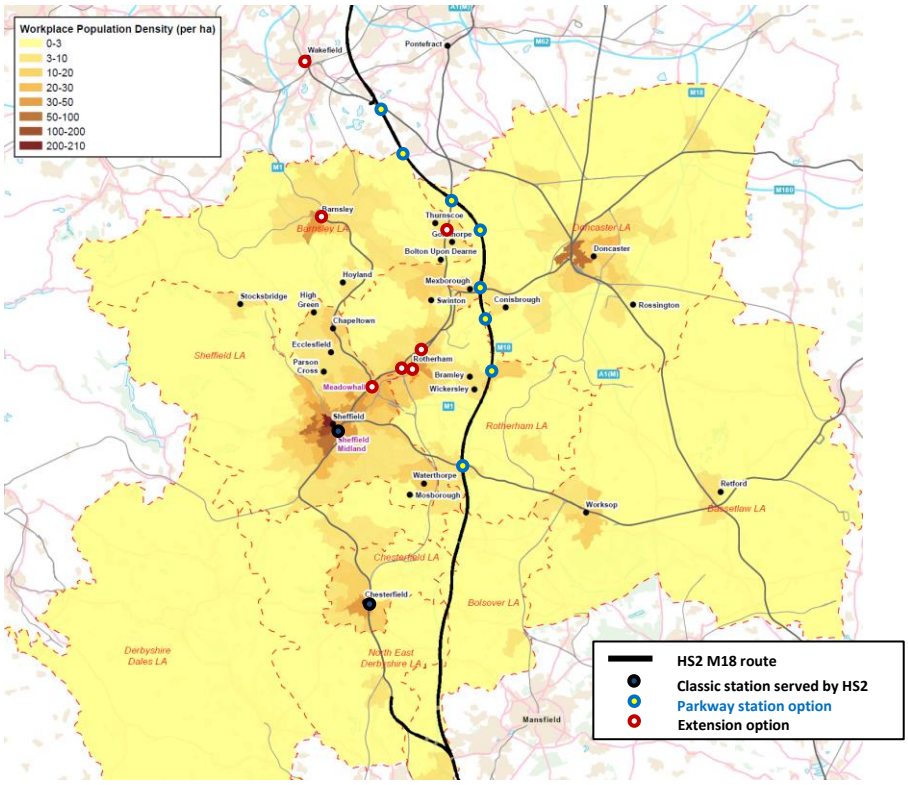
4.3.12 The location where people work within the SCR LEP region closely follows the patterns for population, albeit more concentrated within larger urban areas and with less spread away from city centres (see Figure 6).

4.3.13 Of the 825,000 jobs across the region, 32 per cent are located in the Sheffield local authority area (1.2 per cent in Sheffield city centre)[8]. Together with the local authority

[8] A further 150,000 jobs are located in the Wakefield local authority area, just outside the study area.

areas of Doncaster (16 per cent), Rotherham (14 per cent) and Barnsley (13 per cent), these make up three-quarters of all jobs in the region.

Figure 6: Employment density by place of work (per ha) – SCR LEP Region (2011).



Local authority	Employment (2014)	% LEP total	Business count (2015)
Barnsley	109,200	13.2	5,770
Bassetlaw	47,600	5.8	3,775
Bolsover	32,500	3.9	2,440
Chesterfield	44,600	5.4	3,190
Derbyshire Dales	34,500	4.2	4,550
Doncaster	132,200	16.0	8,090
NE Derbyshire	46,600	5.6	3,235
Rotherham	115,600	14.0	6,390
Sheffield	262,200	31.8	14,555
TOTAL LEP	**825,000**	**100**	**51,995**
*Sheffield Central Ward**	*9,890*	*1.2*	*N/A*

Sources: ONS Small Area Population Estimates (mid-2014); *ONS Census 2011; ONS UK Business Count (2015)

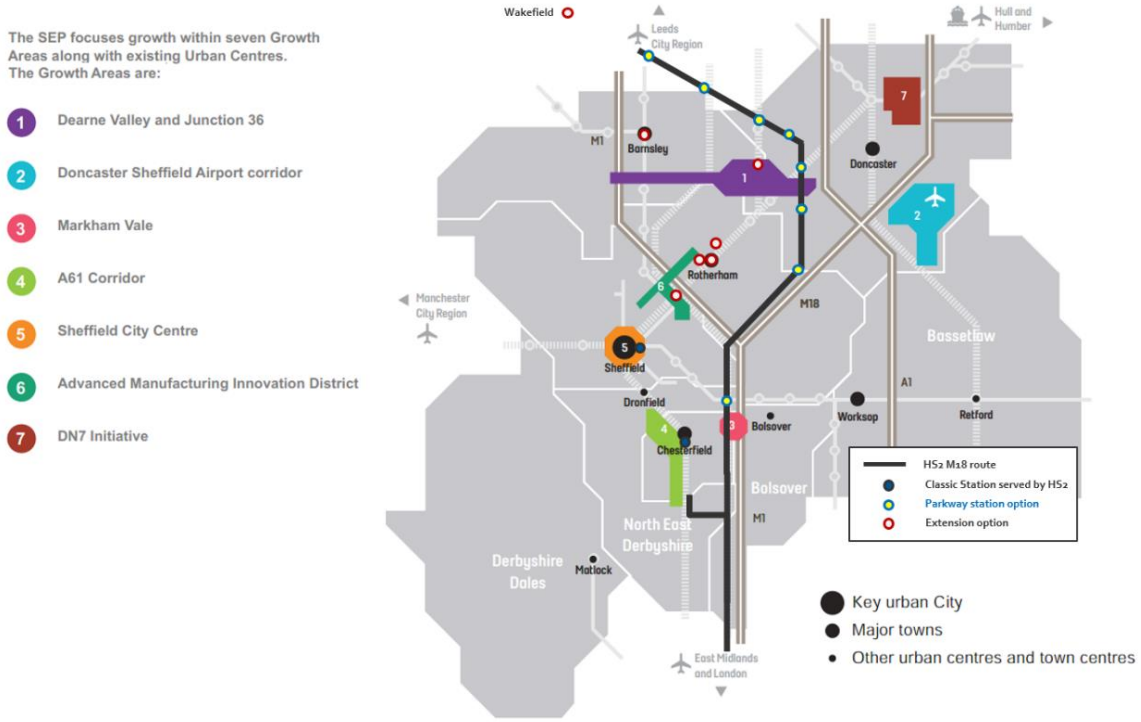
4.3.14 A similar pattern also exists for the location of business, with 28 per cent located in the Sheffield local authority area.

4.4 Sheffield City Region Integrated Infrastructure Plan Growth Areas

4.4.1 As part of this study, HS2 Ltd discussed the above analysis with the SCR LEP in January 2017. The LEP supported our assessment, but also requested that we consider a number of additional areas of strategic importance to the region. Their recent

Sheffield City Region Integrated Infrastructure Plan (SCR IIP) outlines seven Growth Areas in addition to key urban centres across the region (see Figure 7). These Growth Areas also form part of the LEP's Strategic Economic Plan.

Figure 7: SCR IIP Growth Areas (map shows possible additional HS2 service options) and FLUTE Growth by Local Authority Area



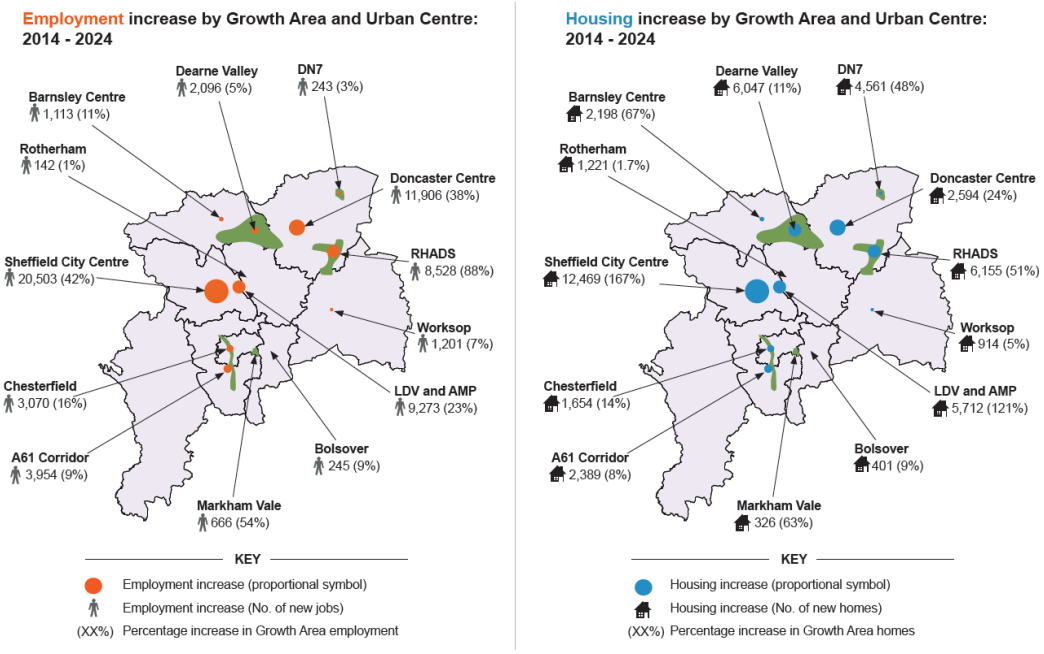
Local authority area	Employment		Homes	
	Change	%	Change	%
Sheffield	29,269	11	19,627	8
Rotherham	8,939	8	12,937	12
Doncaster	19,734	15	20,687	16
Barnsley	7,016	8	15,243	15
Chesterfield	6,604	13	3,525	7
NE Derbyshire	-1,440	-5	2,057	5
Bolsover	5,852	20	2,669	8
Bassetlaw	5,147	9	6,976	14
Derbyshire Dales	1,627	5	3,596	11
SCR TOTAL	**82,748**	**10**	**87,317**	**11**

Source: SCR IIP. ◯ = Top 4 areas

4.4.2 These Growth Areas relate in large part to business and enterprise parks or clusters, such as the Advanced Manufacturing Innovation District and the Robin Hood Airport corridor.

4.4.3 The SCR IIP also presents a set of forecasts for employment and housing across the region. This expects the four fastest growing areas over the next decade (in absolute terms) to be the local authority areas of Sheffield, Rotherham, Doncaster and Barnsley, across both urban centres and Growth Areas (see Figures 7 and 8).

Figure 8: SCR IIP – projected growth in employment and housing across SCR Growth Areas and Urban Centres.



Source: SCR IIP

4.5 Rail demand in South Yorkshire

Current long-distance rail services to South Yorkshire

4.5.1 Rail travel in the South Yorkshire region includes local, regional and long-distance services. All major towns and cities in the region have their own local rail station.

4.5.2 At present, the majority of long-distance rail services in South Yorkshire are from Sheffield Midland and Doncaster railway stations. These stations offer the most frequent, direct and fastest services to long-distance destinations such as London, the Midlands and the North East.

4.5.3 In many cases, these two stations (together with Wakefield) are the only stations in the region to offer direct services to London and Birmingham. They also provide the fastest current journey times to these destinations and Leeds (see Table 2).

Table 2: Current rail services – summary of selected rail destinations available from South Yorkshire.

	Direct services (trains per hour)			Current fastest journey time (mins)		
	London	Birmingham	Leeds	London	Birmingham	Leeds
Urban areas within Sheffield City Region						
Sheffield city centre	2–3	2	5	121	63	40
Meadowhall	✖	✖	4	124*	86*	48
Rotherham	✖	✖	1	136*	92*	56
Barnsley	✖	✖	3	156*	107*	32
Doncaster	4 – 5	1	3	94	88	29
Worksop	✖	✖	✖^	112*	108*	88*
Urban areas outside Sheffield City Region						
Wakefield	2 –3	1	8–9	114	99	11
Pontefract	✖	✖	1	167*	127*	30
Scunthorpe	✖	✖	✖	134*	139*	77*

Source: National Rail Enquiries (April 2017). ✖= no direct services. * = interchange required. ^There are two (slow) direct services per day from Worksop to Leeds, which run via Sheffield Midland.

4.5.4 This means that people living outside these areas must choose between:

- travelling (by road or public transport) directly to a larger station, such as Sheffield, Doncaster or Wakefield;
- travelling (most likely by road) to their own local station to take a regional service and interchanging at Sheffield, Doncaster or Wakefield; and
- avoiding rail travel and using road only.

4.5.5 In making such decisions, people are likely to consider factors such as the total door-to-door journey time, waiting and interchange time, convenience, cost, road congestion and parking. For example, a possibly quicker rail journey from Sheffield may be weighed up against driving into the city centre and finding parking.

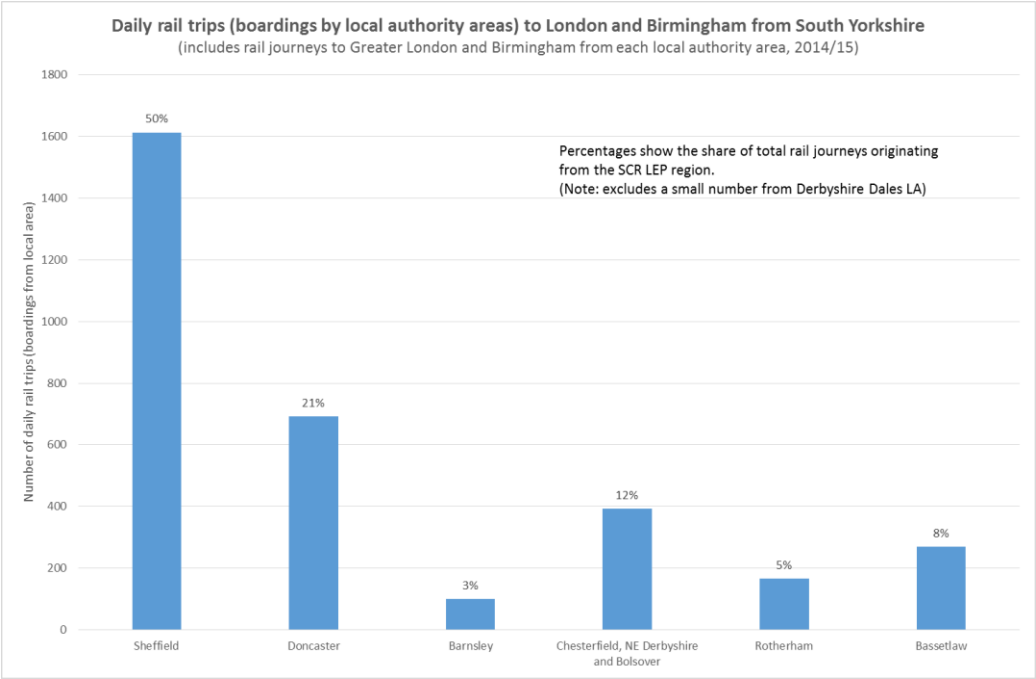
Current long-distance rail demand in South Yorkshire

4.5.6 As such, it is unsurprising that the Sheffield and Doncaster areas currently make up the largest proportion of long-distance rail journeys. At present, more than 70 per cent of daily boardings to London and Birmingham are from these two areas (see Figure 9)[9]. In comparison, these areas make up 47 per cent of the total population within the SCR LEP region.

[9] London and Birmingham have been used as a proxy for overall long-distance rail travel.

4.5.7 In contrast, there are much fewer rail journeys to London and Birmingham commencing from the other areas (e.g. Barnsley and Rotherham make up only eight per cent of these journeys, despite comprising 27 per cent of the population).

Figure 9: Daily rail trips (boardings by local authority areas to London and Birmingham) – SCR LEP Region 2014/15.



Source: HS2 Ltd

4.5.8 This information is based on rail tickets and location of boardings (rather than the location of residence of passengers). Therefore, it is unclear whether the higher level of demand observed for Sheffield and Doncaster represents a greater desire for rail travel from passengers residing in these areas; or whether it might also be the result of passengers from other areas travelling to these stations to commence their rail journey.

4.5.9 This is an important consideration, as currently observed travel patterns may, in part, be the result of the existing rail service offer rather than local variation in the desire for such travel.

4.5.10 Barnsley, for example, has no direct rail services to London at present. Current rail journeys from Barnsley station to London can generally take more than an hour longer than those from Sheffield Midland, and require one or two interchanges. As such, passengers from this area may choose to drive to a station outside their area (e.g. Sheffield Midland, Meadowhall, Wakefield or Doncaster) to board a more favourable rail service, as opposed to starting their rail journey from Barnsley station.

Comparison with road demand

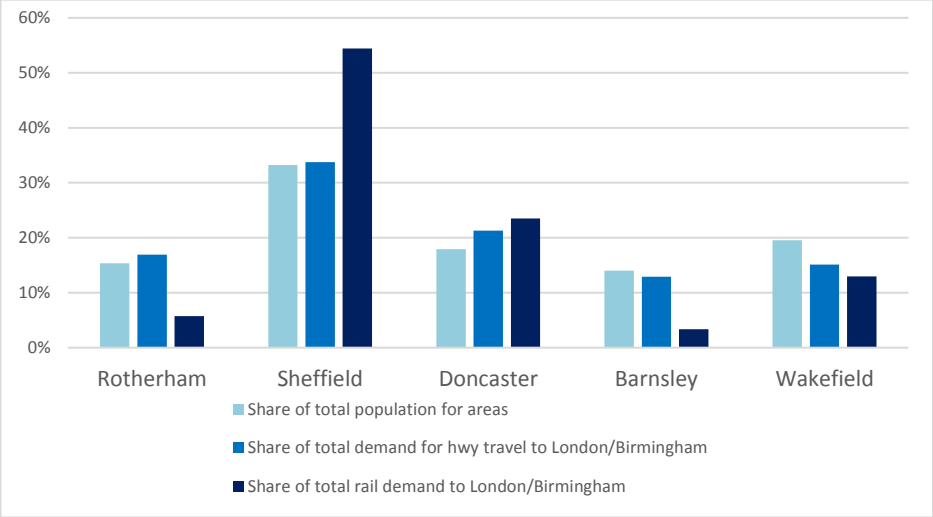
4.5.11 In comparison with the information on rail demand presented above, much less variation in the demand for long-distance road travel appears between areas in the

SCR. Long-distance road travel is also closely correlated with population and where people live.

4.5.12 Figure 10 compares the population share across five areas in the region with their share of road and rail demand to London and Birmingham. The share of road trips closely mirrors population share, suggesting the overall propensity for long-distance road travel is similar across the region. In comparison, demand for rail travel is quite mixed:

- rail share is well above the population share for Sheffield, and slightly above the population share for Doncaster (these areas currently have high levels of rail service);
- rail share is slightly below the population share for Wakefield; and
- rail share is well below the population share in Rotherham and Barnsley.

Figure 10: Share of highway (hwy) and rail demand to London and Birmingham (% share of five areas shown).

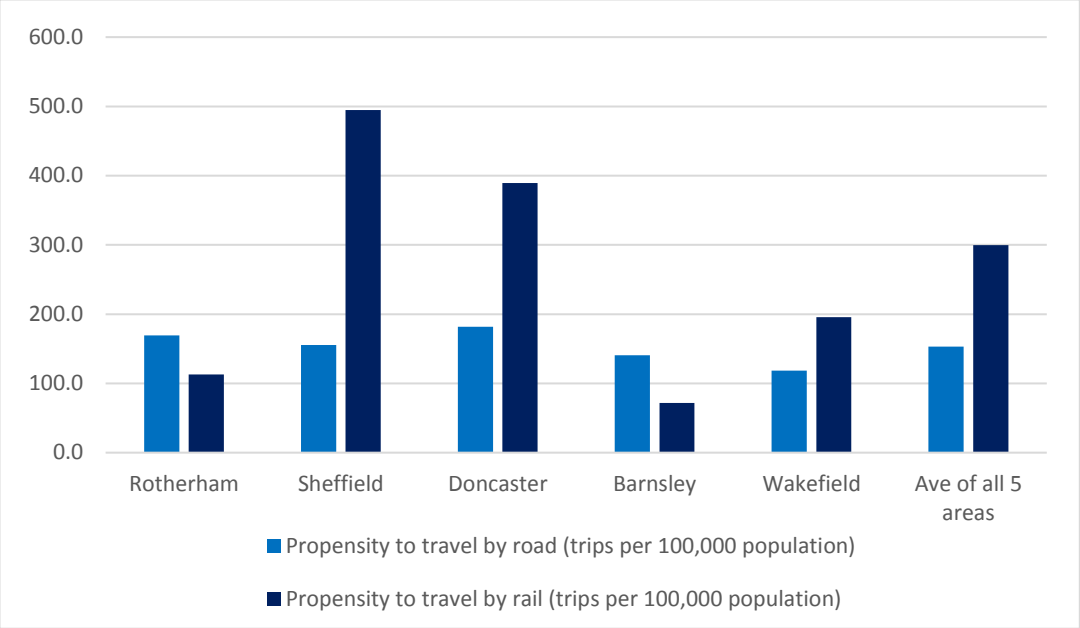


Source: HS2 Ltd

4.5.13 This is further evidenced by comparing the propensity to travel (trips per 100,000 population) across these areas for both road and rail (see Figure 11). The propensity to travel to inner London and Birmingham by road remains broadly similar across all five areas, suggesting a similar level of desire for such journeys.

4.5.14 In comparison, rail propensity is much higher than the average for Sheffield and Doncaster; and lower for Rotherham, Wakefield and Barnsley. It may be, therefore, that the currently observed rail patterns understate the desire for rail travel in locations such as Rotherham, Wakefield and Barnsley.

Figure 11: Propensity to travel by road (highway) and rail to (inner) London and Birmingham (trips per 100,000 population).



Source: HS2 Ltd

4.5.15 There may also be a number of explanations for why we observe similar levels of road demand but substantially different levels of rail demand across the region. These explanations may not be exclusive:

- The actual desire for long-distance rail journeys varies across the region, with greater demand from those people living in Sheffield and Doncaster (i.e. they have different behaviours and desires).
- Related to the above point, rail may be the preferred mode of choice for long-distance business travel, while long-distance leisure travellers may be more willing to travel by road. Employment in the SCR is more concentrated than the population within larger urban areas and with less spread away from city centres, which suggests that business trips are more likely than leisure trips to originate in larger urban areas.
- The current levels of rail demand reflect the current level of rail services provided.
- The residents of areas with lower observed rail demand (e.g. Barnsley and Rotherham) travel to other areas (e.g. Sheffield, Doncaster or Wakefield) to commence their rail journeys. This would understate rail demand observed in their areas and overstate the rail demand observed in the areas that they travel to.

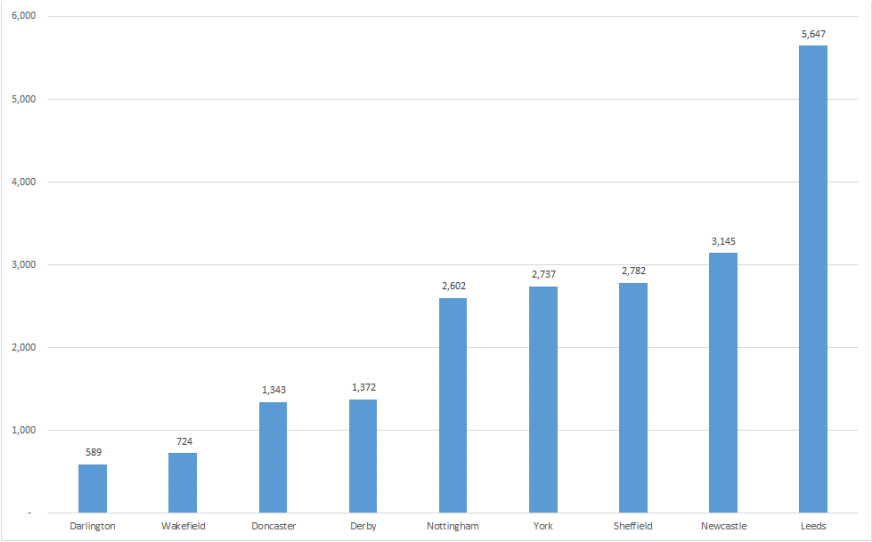
4.5.16 While it is not possible to deduce why we have observed substantially different levels of rail demand across the region without further examination, it is likely that this is a combination of the above explanations. It would, however, appear likely that the current levels of observed rail demand presented above understate the true level of demand for long-distance rail travel in some areas where there are lower levels of rail service provided.

Rail demand in South Yorkshire and on the rest of the eastern leg

4.5.17 Options to alter the HS2 service offer to South Yorkshire may impact on other regions served by the eastern leg of Phase 2b of HS2. It is therefore important to understand South Yorkshire rail demand in context with other regions, such as the East Midlands, Leeds, York and the North East.

4.5.18 Figure 12 shows daily rail trips, or boardings, to and from London for major destinations on the eastern leg. Leeds is by far the largest market, with other large markets from Newcastle, Sheffield, York and Nottingham.

Figure 12: Daily rail trips (boardings) to/from London.

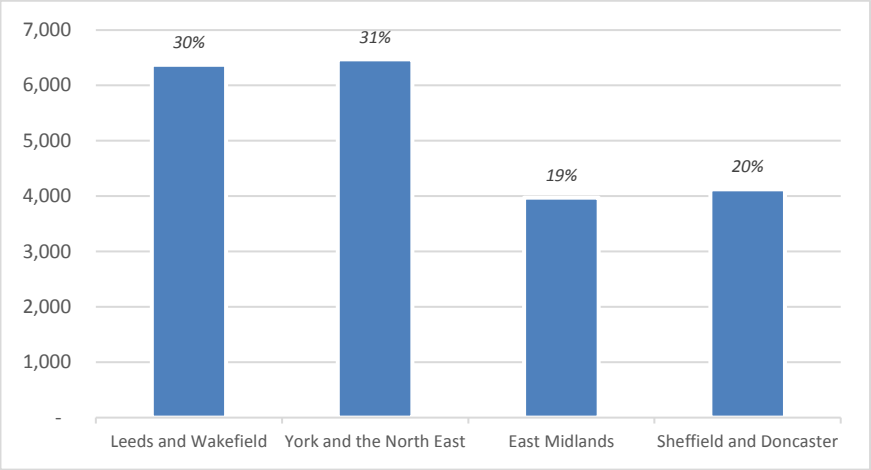


Source: HS2 Ltd

4.5.19 This becomes even clearer when grouping these into broader regions. The South Yorkshire area comprises about one fifth of this current rail travel[10].

[10] It is noted that this does not include South Yorkshire rail travel commencing from areas outside of Sheffield and Doncaster (e.g. Barnsley, Rotherham). As shown previously, this comprises about 30 per cent of the total demand in the region.

Figure 13: Daily rail trips (boardings) to/from London (grouped) in 2014/15.



Source: HS2 Ltd

4.6 Focus areas in South Yorkshire

4.6.1 Our assessment above has considered the location of population, employment, business and current rail demand in South Yorkshire. The polycentric nature of the region, with a wide spread of people, means that no single location for rail services is likely to best serve all areas, something that reflects the previous discussions among South Yorkshire stakeholders regarding the HS2 route and station location in the area.

4.6.2 While Sheffield remains the largest city and area within the region in terms of population, the majority of people (more than two thirds) in South Yorkshire live outside this area. Similarly, only a small proportion (2.2 per cent) live within Sheffield city centre. Current travel patterns for road travel suggest that there may be just as strong a desire for long-distance travel outside these areas. This strongly suggests that there may be potential for rail demand outside the Sheffield area.

4.6.3 The issue, however, is that this potential demand is widely spread across the region, in a number of urban centres and towns. As such, this suggests a compromise would be required on where best to target additional rail services. This may also require policy consideration as to whether the objective is to target specific areas within the SCR or to maximise overall demand in the region.

4.6.4 Based on our assessment of population and employment, it is necessary to narrow down and identify key focus areas within the South Yorkshire study region in order to assess the impact of possible HS2 service options.

4.6.5 Based on our analysis of trends in population, employment, business numbers, and rail demand, together with consultation with the SCR HS2 Programme Board, we have identified 15 locations to focus our study on.

4.6.6 These include six urban areas within South Yorkshire, six Growth Areas identified by the SCR IIP, and three urban areas just outside the South Yorkshire region (see Table 3).

Table 3: Focus areas identified for the study.

Type of area	Focus areas identified
Urban areas/local authorities within South Yorkshire Region	Sheffield (city centre) Sheffield (Meadowhall) Rotherham Barnsley Doncaster Worksop
Growth Areas from SCR IIP[11]	Advanced Manufacturing Innovation District (AMID) Robin Hood Airport/business park (south east of Doncaster town) Dearne Valley (East) Dearne Valley (West) Markham Vale (East of Chesterfield) DN7 initiative (north east of Doncaster town)
Urban areas outside South Yorkshire	Wakefield Pontefract Scunthorpe/Grimsby

4.6.7 A number of city centre locations have been used for this assessment. This has been done out of necessity to identify central locations and to reduce the focus areas to a manageable number. It is worth reiterating, however, that the vast majority of people live outside these city centres. Any conclusions would need to be mindful of this and their relevance to the surrounding areas.

4.7 Potential options for serving South Yorkshire with additional HS2 services

4.7.1 As identified in Section 3, the study has broadly considered two possible ways in which it might be possible to enhance the HS2 service offering to the above focus areas:

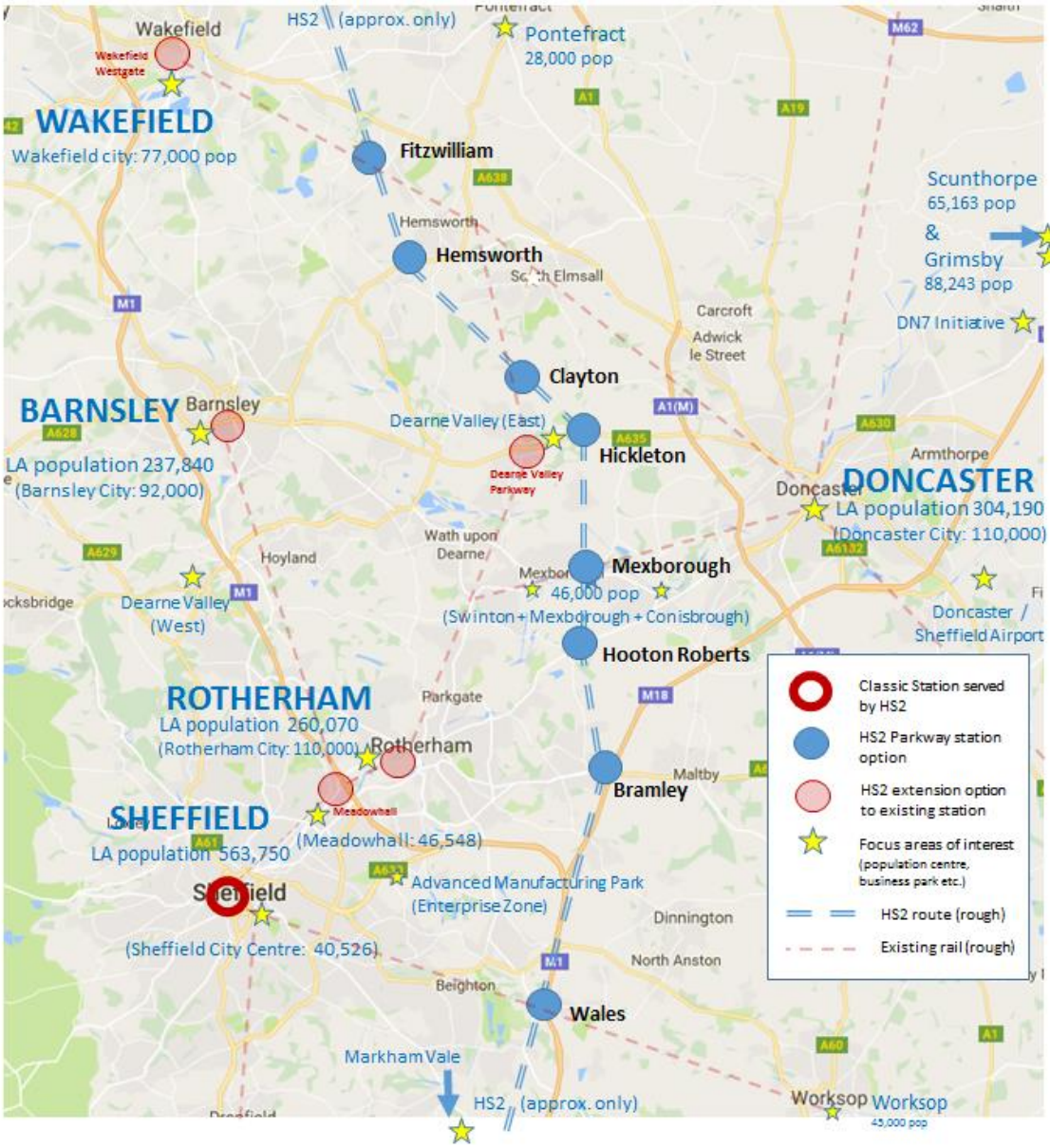
- a parkway station on the HS2 mainline between East Midlands and Leeds; and
- extending HS2 services beyond their currently planned terminus at Sheffield Midland.

4.7.2 Each of these approaches is considered in detail in Sections 5, 6 and 7 of this report.

4.7.3 We have considered eight possible locations for a parkway station, and five locations for the extension of HS2 services. These are shown in relation to the key focus areas in Figure 14.

[11] Given the size of the Dearne Valley area, we have split this area into two locations (East and West), based on the Thurnscoe and Gladman business parks respectively. Two of the SCR IIP Growth Areas have not been included (Sheffield City Centre and the A61 Corridor) as these are already served by existing planned HS2 services to Sheffield Midland and Chesterfield.

Figure 14: Presentation of study focus areas and possible additional HS2 service options.



5 Serving South Yorkshire with a high speed parkway station

5.1.1 The provision of a parkway station on the M18/Eastern mainline route serving the South Yorkshire region would complement the HS2 services currently proposed to and from Sheffield Midland, Chesterfield and Leeds.

5.1.2 A parkway station is a railway station that does not directly serve a major urban centre. It is an out-of-town station, providing long-distance and inter-urban rail journeys to the region. The essential features of a potential HS2 parkway station are deemed to be good road access, expansive car parking facilities and an attractive HS2 rail service. A key objective of a parkway station is to increase accessibility to the rail network – in this instance to the HS2 network – and to ultimately increase the number of passengers in South Yorkshire using HS2.

5.2 Methodology

5.2.1 In addition to the overarching methodology set out in Section 3.4, our parkway station work has been developed using the following methodology:

- delivery of a full appraisal of parkway station options, to Sift 3 level of detail;
- designs for parkway stations have been undertaken considering the Deliverable Approach Statement (2014), ensuring compliance to key spatial requirements consistent with current Phase 2b methodology;
- parkway station designs have used the latest agreed digital terrain model and environmental datasets (January 2014);
- costs are based on a node-to-node comparison (using the HS2 Phase 2b eastern leg route sections HSL14 and HSL16);
- costs are undertaken using the 1Q15 cost model, which includes an optimism bias of 40 per cent and is validated against Treasury guidance; and
- noise calculations are consistent with the 2016 train service specification.

5.3 Engineering assumptions

5.3.1 The engineering assumptions that have underpinned our work to assess the provision of a parkway station on the HS2 mainline are as follows:

- two station platform loops will be provided (in addition to the baseline of two through lines);
- a station loop length (4-tracking section) of a minimum of 3km (1.9 miles);
- station loop turnouts at a minimum of 130kph (82 mph);

- the concourse area for the station is a minimum of 4,250m² (13,943² feet);
- car parking is provided for 1,700 spaces and a station forecourt is included for drop-off, pick-up and transport interchange;
- there is road access to the station and a new roundabout/junction is provided to the existing highway network; and
- the aim is to avoid slowing the design speed of through lines so there is no impact on non-stopping services, as this would reduce the level of benefits delivered by the scheme as a whole.

5.3.2 Our work has considered the design and location of parkway stations, but more broadly, has also considered how the mainline might need to change to accommodate a parkway station.

5.4 Appraisal of sustainability

5.4.1 The HS2 Ltd Phase 2b Sifting Standards include a summary of the environmental topics that are considered when undertaking a sustainability appraisal of route and station options on Phase 2b. We carried out an appraisal of sustainability for a number of topics based on GIS datasets, with specialist inputs as required. For this study, these topics have included:

- landscape and visual;
- built heritage;
- archaeology;
- ecology;
- water;
- noise; and
- property.

5.4.2 We have also assessed whether each shortlisted parkway station would have an impact on any major development sites.

5.5 Benefits and impacts of a potential parkway station

Benefits

5.5.1 A parkway station strategically located to serve the wider South Yorkshire region could provide benefits in accessibility for areas of population outside Sheffield city centre and improve connectivity towards London, Birmingham, Leeds, the East Midlands and the North East. It could provide an alternative option for users who may otherwise have driven by car, or travelled by train and interchanged to board HS2 services at Sheffield Midland or Chesterfield.

5.5.2 To deliver these benefits, the location of the parkway station would need good highway access to and from it. It would also need to be well connected to major and local urban centres across the SCR.

5.5.3 To realise the benefits associated with a parkway station that is located on a site that has the potential for interchange with the classic railway network, the interchange between high speed and classic services should be as effective as practicable, to enable a swift onward connection to major and local urban centres.

Impacts

5.5.4 Providing a parkway station on the M18/Eastern route may require changing the HS2 mainline alignment. Straight sections of track are required to implement the turnouts for the platform loops for a parkway station. The majority of the M18/Eastern route is not straight in alignment, mainly to avoid the various settlements and environmental features as the route passes through South Yorkshire. A new alignment to introduce a parkway station could increase the environmental impacts of the route.

5.5.5 The introduction of a parkway station may result in a reduction in speed on the mainline. Reducing the speed of the mainline will have an effect on the journey times and the business case for services that continue northwards towards Leeds and the North East.

5.5.6 A parkway station would require a large area alongside the mainline to provide a concourse and car parking. The car parking and concourse for the station will have local visual, landscape and noise impacts on any potential locations that are close to existing areas of conurbation.

5.5.7 It would be necessary to remodel the existing highway network to provide access to and from the parkway station. Some locations may have poor highway access to the station and will require modifications to the existing highway network for the station to be effective.

5.5.8 Implementing a parkway station will also increase the footprint and width of the corridor required for the HS2 route through South Yorkshire. This is due to the platform loops and station facilities that would be required.

5.5.9 Interface issues may arise where a parkway station location has been identified at, or near to, a grade separated junction to a depot, spur or connection to the existing mainline. Similarly, the ongoing development of the Phase 2b route may mean that our engineering and route assumptions are valid for this report, but may not reflect future iterations of the Phase 2b route.

5.6 Parkway station longlist

5.6.1 A longlist of potential parkway station locations was compiled following discussions between Hs2 Ltd, Department for Transport (DfT) and local stakeholders from both the SCR and the West Yorkshire Combined Authority (WYCA).

5.6.2 The longlist covers almost all locations on the M18/Eastern route where there is an interface between the HS2 route and a major road or the existing rail network.

5.6.3 The longlist of potential parkway station locations is shown below, and in Figure 15.

- Wales (Rotherham, South Yorkshire);
- Bramley (Rotherham, South Yorkshire);
- Hooton Roberts (Rotherham, South Yorkshire);
- Mexborough (Doncaster, South Yorkshire);
- Hickleton (Doncaster, South Yorkshire);
- Clayton (Doncaster, South Yorkshire);
- Hemsworth (Wakefield, West Yorkshire); and
- Fitzwilliam (Wakefield, West Yorkshire).

Figure 15: South Yorkshire parkway station longlist.

5.7 Assessing our longlist

5.7.1 In sifting our longlist, we used the following criteria:

- the likely demand for travelling to and from the station and where this might come from (using the focus areas identified in Section 4);
- the constructability of the station, taking into account the length of the HS2 mainline change that would be required, reduction in speed of the mainline as a result of this change, and the length of the platform loops that would be required;
- the environmental and sustainability impacts, including the station location setting (i.e. whether this was urban or rural) and what the station might look like (i.e. whether it would be on a viaduct, embankment or in a cutting);
- the accessibility and connectivity to the station, including highway accessibility to the station and any interchange with the existing rail network;
- an approximate cost of building the station and any associated change to the mainline; and
- the HS2 journey time to London and Leeds.

5.7.2 In assessing our longlist, we agreed with the HS2 SCR Programme Board to categorise options on a geographical basis, splitting them into options in the north (Fitzwilliam, Hemsworth and Clayton), centre (Hickleton, Mexborough and Hooton Roberts) and south (Wales and Bramley).

5.7.3 We agreed with stakeholders that a reasonable approach to sifting the longlist would be to take forward at least one location in each area for further work.

Likely demand and journey times

5.7.4 We undertook a high-level assessment of likely demand that considered:

- how accessible each parkway station option is to our focus areas across South Yorkshire (e.g. by road or rail, and including journey time);
- a comparison of total door-to-door journey times that might be possible from each of the focus areas using each of the parkway options; and
- the relative size of each focus area and the potential demand from each.

5.7.5 Table 4 summarises this assessment for London as a destination. This shows current journey time from each focus area, together with a comparison of door-to-door journey times using both the current best HS2 service offer (from either Sheffield

Midland, Leeds or Chesterfield), as well as from each of the eight shortlisted parkway station options[12]. The table has been colour coded to assist interpretation:

- the cells highlighted in green or yellow indicate that the parkway station option would provide better door-to-door HS2 travel times to the focus area, and potentially result in demand from passengers in this location;
- the yellow cells present the best overall option, i.e. where a particular parkway option provides the best (fastest) overall door-to-door travel time for that area;
- the orange cells indicate where the parkway option is better than the current fastest journey time available, but would be less favourable to the area than using an existing HS2 offer (i.e. from either Sheffield Midland, Leeds or Chesterfield); and
- the red cells suggest the parkway option would be slower than current journey times – this option is unlikely to result in demand from this area.

[12] Combining time to access the station from the focus area (by either road or rail), interchange time, and HS2 journey time from the station to final destination.

Table 4: Travel times to/from London (mins) – by fastest access mode (rail*/road).

Focus areas	Population	Current fastest rail time (mins)	Best Existing HS2 option – Sheffield Midland unless otherwise marked	Wales	Bramley	Hooton Roberts	Mexborough	Hickleton	Clayton	Hemsworth	Fitzwilliam
SCR urban areas/local authorities (LAs)											
Sheffield (city centre/Midland)	Sheffield (LA): 563,750 Sheffield city centre (ward): 40,526	121	85	91	96	105	110* / 110	113	115*	125	129*
Sheffield (Meadowhall)	Sheffield (LA): 563,750 Sheffield Meadowhall (wards): 46,548	124	100*	92	95	100	101* / 106	110	108*	116	121*
Rotherham (Rotherham)	Rotherham (LA): 260,070 Rotherham (city): 110,000	136	107*	94	95	93	96*	106	101*	113	115*
Barnsley (Barnsley)	Barnsley (LA): 237,840 Barnsley (city): 92,000	156	116*	108	110	111	109	103	105	99	107
Doncaster (Doncaster)	Doncaster (LA): 304,190 Doncaster (city): 110,000	94	116*	100	98	98	92*	95	102	108	104*
Bassetlaw (Worksop)	Bassetlaw (LA): 114,140 Worksop (city): 45,000	112	125*	93*	94	108	111	109	118	119	125
SCR IIP Growth Areas											
Advanced Manufacturing Innovation District	(Advanced Manufacturing Park)	139 (SHF)	103	90	90	98	103	107	113	119	125
Doncaster/Sheffield Airport corridor	(Robin Hood Airport)	120 (DON)	125	102	100	102	107	103	118	114	120
Dearne Valley (West)	(Gladman Business Park)	155 (SHF)	119	98	102	104	103	101	105	108	120
Dearne Valley (East)	(Thurnscoe Business Park)	171 (THC)	125	104	100	98	93	86	92	100	107
Markham Vale		129 (CHD)	97 (CHD)	85	94	102	109	109	118	119	125
DN7 Initiative		149 (HFS)	123	98	98	102	105 / 108*	103	113	114	120
Areas outside South Yorkshire											
Wakefield (City)	Wakefield (LA): 331,400 Wakefield (city): 77,000	114	102 (LDS) /120* (SHF)	118	120	125	125	119	104*	109	95
Pontefract	Wakefield (LA): 331,400 Pontefract (city): 28,000	167	113 (LDS) /135* (SHF)	128	128	110	115*	107	94*	104	103
Scunthorpe	North Lincolnshire LA: 169,200 Scunthorpe (city): 65,163	134	155*	128	128	120	126	123	128	134	140

Key / notes

Fastest journey time option for this location		Faster than current time but slower than, or equal to, existing HS2 option	
Faster than current time and faster than existing HS2 option (SHF/CHD/LDS)		Slower than current journey time	

SHF = Sheffield Midland; CHD = Chesterfield; LDS = Leeds; DON = Doncaster; THC = Thurnscoe; HFS = Hatfield & Stainforth

An interchange assumption of 10 minutes has been applied for changes between rail/HS2 and road/HS2

Times marked (*) relate to access via conventional rail

Current times from Growth Areas are from nearest railway station (shown with station code), assuming road access

Source: HS2 Ltd analysis. Current fastest journey times from National Rail Enquiries (Jan 2017)

5.7.6 We can draw a number of conclusions from this:

- The Sheffield Midland HS2 proposition remains the best option for Sheffield city centre. No parkway option is able to improve on this time.
- A parkway would provide faster door-to-door journey times for all other focus areas, including the Sheffield Meadowhall area. This suggests the potential for demand from these areas.
- No single parkway would be the best for every focus area, although many of the parkway options present an improvement for a large number of focus areas.
- All parkway options represent an improved journey time for Barnsley, the best being Hemsworth.
- The fast current journey time from Doncaster to London means that only the Mexborough Parkway would deliver some (slight) journey time improvement to Doncaster town centre[13]. This is not necessarily the case for the areas immediately outside Doncaster centre, however.
- The four most southerly options generally provide the best travel times for the greatest number of focus areas (and also those areas with greatest population mass).
- The northern-most options provide some advantage to Wakefield and Barnsley but provide the least benefit to the majority of focus areas further south.

5.7.7 In general terms, parkways that are physically closer to a focus area are generally better – although this is not always the case, as consideration needs to also be given to available access arrangements (e.g. highway, rail) and HS2 times offered. For example, the best options for the DN7 Growth Area (north east of Doncaster) are Wales and Bramley, the most southerly options, which fare better than driving to the nearby Doncaster station.

5.7.8 A similar assessment was also done for Birmingham, Leeds, York and East Midlands as destinations.

[13] Although all parkway options do provide an improved travel time to other destinations, such as Birmingham.

Constructability, sustainability and accessibility

5.7.9 We undertook a high-level constructability, sustainability and accessibility assessment for each parkway station location, assessing the following factors:

- the constructability of the station, including length of the HS2 mainline change, reduction in speed of the mainline and length of platform loops required;
- the sustainability impacts, including the station location setting and what it might look like;
- the accessibility and connectivity of the station, including highway and rail accessibility to the station; and
- the indicative and approximate cost of building the station.

5.7.10 In the north area, Fitzwilliam and Clayton present difficulties based on our high-level assessment of the associated constructability, sustainability and accessibility issues. A station at Fitzwilliam would require an extensive footprint on the HS2 mainline, while a station at Clayton would require a new road access and new mainline route alignment. A station at Clayton would also have potential interface issues with the proposed northern connection junction back onto the HS2 mainline.

5.7.11 A parkway station at Hemsworth could limit the visual impact of a station (given its relatively isolated location), has good road access and also has the strategic potential to serve services using the loop north of Sheffield Midland.

5.7.12 In the central area, Hickleton and Hooton Roberts would both require new mainline route alignments. The station at Hooton Roberts would be located on a viaduct.

5.7.13 Mexborough, while set in an urban location and needing to be built on a viaduct, has good connectivity links, especially with the existing rail network.

5.7.14 In the south, Bramley and Wales both have good transport connectivity. Both would require 4-tracking near urban areas, potentially resulting in greater visual impact. The station at Wales would be on a mix of embankment and viaduct; at Bramley, the station would be in a mix of embankment and cutting.

Summarising our assessment of longlisted parkway stations

5.7.15 A summary of our longlisting sift work is shown in Tables 5, 6 and 7.

Table 5: Summary assessment of longlisted parkway station options – north area.

North area	Fitzwilliam	Clayton	Hemsworth
Length of mainline change	~7 miles (~11.5km)	~10.5 miles (~17km)	~5 miles (~8km)
Reduction in speed of mainline?	No	Yes to 300kph (was 340kph)	No
Length of platform loops	~2.5 miles (~4km)	~2 miles (~3km)	~2.2 miles (~3.5km)
Station location setting	Rural on embankment and viaduct	Rural on embankment and viaduct	Rural on embankment and in cutting
Station location impacts	Close to Nostell Priory and Parkland, National Trust	Closer to Ancient Woodland and Grade II Listed Building	Greater visual impacts from Hemsworth
Highway access to station	Close to A638	No main road	A628
Indicative cost	Higher	Higher	Comparable
Likely demand (RAG rated, Red = poor Amber = ok Green = good)	Sheffield (city) Sheffield (Meadowhall) Rotherham Barnsley Doncaster Wakefield	Sheffield (city) Sheffield (Meadowhall) Rotherham Barnsley Doncaster Wakefield	Sheffield (city) Sheffield (Meadowhall) Rotherham Barnsley Doncaster Wakefield
HS2 journey time to London	76 mins	73 mins	75 mins
HS2 journey time to Leeds	10 mins	12 mins	11 mins
Interchange with existing rail	Yes	Yes	No

Table 6: Summary assessment of longlisted parkway station options – central area.

Central area	Hooton Roberts	Mexborough	Hickleton
Length of mainline change	~6 miles (~9.5km)	~4.3 miles (~7km)	~5 miles (~8km)
Reduction in speed of mainline?	No	No	Yes to 250kph (was 340kph)
Length of platform loops	~2 miles (~3km)	~2.5 miles (~4km)	~2.5 miles (~4km)
Station location setting	Rural on embankment and viaduct	Urban on viaduct	Rural in cutting
Station location impacts	Greater impacts on ancient woodland and two Grade II listed buildings.	Residential development, industry and local nature reserve	Closer to ancient woodland and Grade II listed building
Highway access to station	A630	A6023	A635
Indicative cost	Higher	Higher	Higher
Likely demand (RAG rated Red = poor Amber = okay Green = good)	Sheffield (city) Sheffield (Meadowhall) Rotherham Barnsley Doncaster Wakefield	Sheffield (city) Sheffield (Meadowhall) Rotherham Barnsley Doncaster Wakefield	Sheffield (city) Sheffield (Meadowhall) Rotherham Barnsley Doncaster Wakefield
HS2 journey time to London	71 mins	72 mins	73 mins
HS2 journey time to Leeds	14 mins	14 mins	13 mins
Interchange with existing rail	No	Yes	No

Table 7: Summary assessment of longlisted parkway station options – south area.

South area	Wales	Bramley
Length of mainline change	~4.3 miles (~7km)	~5 miles (~8km)
Reduction in speed of mainline?	No	No
Length of platform loops	~2.5 miles (~4km)	~3 miles (~5km)
Station location setting	Rural and urban on embankment and viaduct	Urban on embankment and in cutting
Station location impacts	4-tracking near urban areas, greater visual impacts	4-tracking near urban areas, greater visual impacts from Bramley
Highway access to station	A57, A618 and M1 Junction 31	M18 Junction 1 and A631
Indicative cost	Comparable	Comparable
Likely demand (RAG rated Red = poor Amber = okay Green = good)	Sheffield (city) Sheffield (Meadowhall) Rotherham Barnsley Doncaster Wakefield	Sheffield (city) Sheffield (Meadowhall) Rotherham Barnsley Doncaster Wakefield
HS2 journey time to London	68 mins	71 mins
HS2 journey time to Leeds	17 mins	15 mins
Interchange with existing rail	Yes	No

5.7.18 As a result of this first stage of work, we recommended that the list of eight longlisted station locations was reduced to a shortlist of four:

- Wales (Rotherham, South Yorkshire);
- Bramley (Rotherham, South Yorkshire);
- Mexborough (Doncaster, South Yorkshire); and
- Hemsworth (Wakefield, West Yorkshire).

5.7.19 A very high-level summary of the rationale underpinning this recommendation is shown in Table 8.

Table 8: High-level rationale for shortlisting of potential parkway station locations.

Parkway longlist		Recommendation	Rationale and notes
North area:	Fitzwilliam	Parked at longlist	Requires extensive footprint on mainline; interface issues with proposed New Crofton depot; upgrades required to the road network for access.
	Hemsworth	Taken forward to shortlist	Has potential for minimising visual impacts for station; good road access to both Barnsley and Wakefield; could serve M18 loop services.
	Clayton	Parked at longlist	Requires a new road network for access to South Yorkshire; requires new mainline route alignment with a reduced mainline speed; has less of a strategic fit with the wider South Yorkshire aspirations (given this is also the location of the northern connection for the M18 loop).
Central area:	Hickleton	Parked at longlist	Requires new mainline route alignment with a reduced mainline speed; new alignment increases environmental impacts.
	Mexborough	Taken forward to shortlist	Has good connectivity; likely demand from South Yorkshire region; good access to road network; good access for local communities along the Dearne Valley region and the wider South Yorkshire region.
	Hooton Roberts	Parked at longlist	Requires new mainline route alignment; new alignment increases environmental impacts; station located on viaduct.
South area:	Bramley	Taken forward to shortlist	Has good existing transport connectivity; likely demand from the South Yorkshire region; situated near to the SCR IIP Growth Areas
	Wales	Taken forward to shortlist	Has good existing transport connectivity; likely demand from the South Yorkshire region; situated near to the SCR IIP Growth Areas

5.8 Assessing our shortlist

5.8.1 To assess the shortlisted parkway station options, we have undertaken more detailed work against our assessment criteria. The aim of the shortlisting work was to identify, if practicable, whether any of these options could represent a preferred location for a parkway station.

5.9 Modelling potential demand

5.9.1 We have undertaken modelling to assess the impact of the four shortlisted options in terms of:

- the likely demand for the station, including who will use it and where they are likely to travel;
- the likely impact on the total number of passengers using HS2 in the South Yorkshire region (combined passengers at Sheffield Midland and parkway);
- the impact on the overall estimate of (national) benefits in the HS2 business case;
- the impact on other HS2 passengers (e.g. boarding or alighting at Leeds); and
- the impact on the rest of the rail network.

5.9.2 This modelling has sought to provide insight into two aspects of the study:

- Where is the best location for a parkway station?
- What train service would best serve a parkway station?

5.9.3 This was undertaken as a two-stage process. The first assessed all four shortlisted parkway station options against a consistent train service specification (TSS). In the second stage, a range of TSSs were tested for a representative parkway location. This second stage of work is covered in Section 6.

5.9.4 We undertook this modelling work using HS2's PLANET Framework Model (PFM, version 7.0), which is used to assess the HS2 value for money appraisal[14].

5.10 Assessing demand at shortlisted parkway station locations

5.10.1 Our initial assessment sought to model the four shortlisted parkway options against the HS2 Phase 2b M18 loop reference case (i.e. the Phase 2b route without a parkway station), as modelled in the November 2016 Economic Case for Phase 2b.

5.10.2 The HS2 TSS was selected for our initial assessment to ensure consistency and comparability between options, rather than to necessarily maximise benefits. In particular, it has been specified so that it does not affect the existing HS2 service to Sheffield Midland or Chesterfield, making comparisons with the reference case across

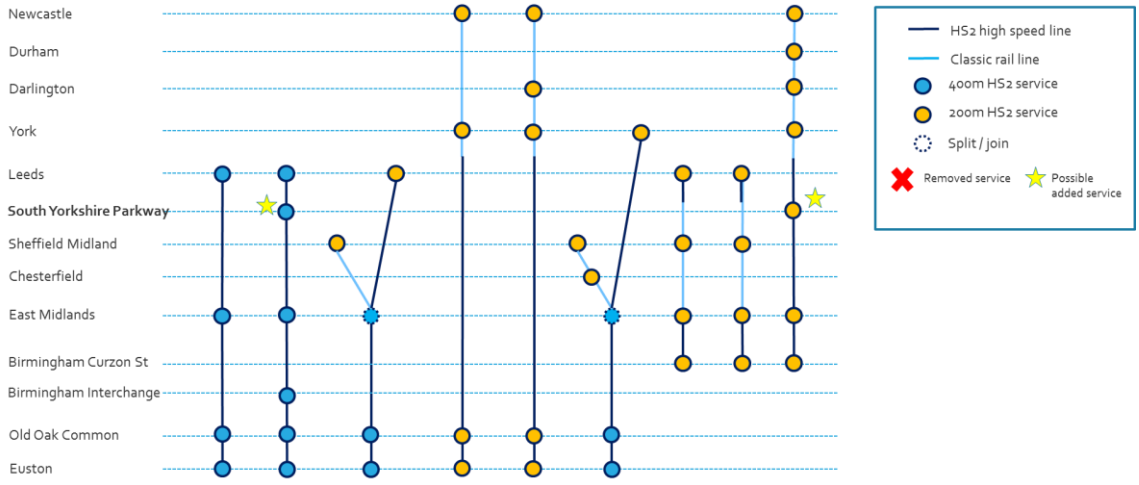
[14] It is noted at the outset that there are a number of assumptions, limitations and caveats associated with the modelling of these services. These are covered in Section 6. The interpretation of any results should be mindful of these before drawing conclusions from the results presented.

South Yorkshire straightforward. This is important, as mixing up these services initially would cloud the comparison. Keeping the other HS2 services in South Yorkshire unchanged means that any impacts are not the result of changing the HS2 service offer to Sheffield Midland or Chesterfield.

5.10.3 The tested service specification is outlined in Figure 16, showing that the only change to the M18 loop service pattern has been to:

- stop one London–Leeds service per hour in each direction at the parkway[15]; and
- stop the one Birmingham–York and North East service per hour in each direction at the Parkway[16].

Figure 16: Initial train service specification used in testing shortlisted parkway locations (Test 2 – M18 loop plus parkway).



Source: HS2 Ltd.

HS2 passengers

5.10.4 Under this initial test, each of the shortlisted parkway station locations results in a growth in HS2 boarders within South Yorkshire. Figure 17 shows that overall South Yorkshire passenger numbers on HS2 services (Sheffield Midland + parkway) increase by between 1,200 and 1,700 per day in 2037.

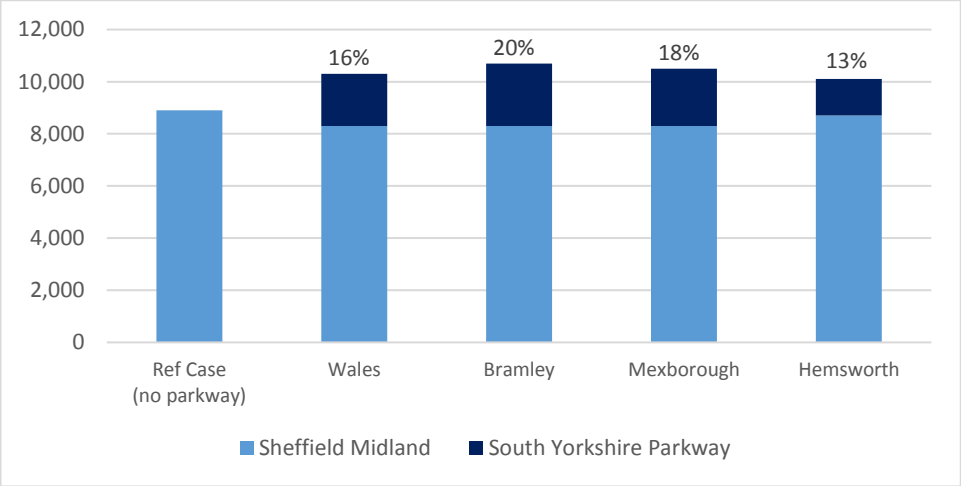
5.10.5 As illustrated in Figure 17, the number of new passengers boarding at the new parkway more than offsets the slight reduction in Sheffield Midland passengers. The

[15] Chosen to be the service which calls at Birmingham Interchange in order to provide this connection back to the South Yorkshire area (lost in moving from the old Meadowhall route to M18 loop).

[16] This similarly re-provides a connection between South Yorkshire, York and the North East that has been lost in moving to the M18 loop.

best performing stations are Bramley and Mexborough, with a 20 per cent and 18 per cent increase in total South Yorkshire HS2 boardings respectively.

Figure 17: Total daily HS2 boarders in South Yorkshire in 2037 (Sheffield Midland + parkway) (Initial test: M18 loop + parkway).



5.10.6 Table 9 summarises HS2 boarders at each parkway option under the initial test. The Wales, Bramley and Mexborough options are expected to see between 2,000–2,400 boardings per day in 2037. For comparison, this is similar to the number of HS2 passengers expected to board at Stafford, Warrington or Wigan; and around three times more than expected at Chesterfield. The Hemsworth option is expected to see slightly fewer boardings (1,400 daily).

Taking into account both Sheffield Midland and the parkway options, there is an expected increase in overall HS2 boarders for all the parkway options (of between 1,200–1,400 per day for Wales, Bramley and Mexborough). This is somewhat lower for Hemsworth (500 additional passengers).

Table 9: HS2 boarders at each parkway station under the initial test.

2037 HS2 daily boarders (no.)	**Ref case**	**Wales scenario**	**Bramley scenario**	**Mexborough scenario**	**Hemsworth scenario**
Sheffield Midland	8,900	8,300	8,300	8,300	8,700
South Yorkshire parkway	0	2,000	2,400	2,200	1,400
Leeds	20,400	19,700	19,800	19,600	19,500
York	9,900	10,100	10,100	10,100	10,100
All other stations	298,900	299,200	299,400	299,300	298,800
Total HS2 passengers	338,100	339,400	339,900	339,500	338,600
Total South Yorkshire (Midland + parkway)	*8,900*	*10,300*	*10,700*	*10,500*	*10,100*
2037 HS2 daily boarders (no.) (change compared to ref case)		**Wales scenario**	**Bramley scenario**	**Mexborough scenario**	**Hemsworth scenario**
Sheffield Midland		-600	-700	-600	-200
South Yorkshire parkway		2,000	2,400	2,200	1,400
Leeds		-700	-600	-800	-900
York		300	300	200	200

All other stations		200	400	300	-100
Total HS2 passengers		1,300	1,800	1,400	500
Total South Yorkshire (Midland + parkway)		*1,400 (+16%)*	*1,700 (+20%)*	*1,600 (+18%)*	*1,200 (+13%)*

5.10.7 The impact of stopping at the parkway results in a slight (approximately three per cent) reduction in the number of HS2 passengers boarding at Leeds, relative to the reference case (the result of slowing one HS2 service per hour in each direction between London and Leeds). Other HS2 stations, such as York, also gain passengers, possibly due to providing new services to South Yorkshire that were not feasible previously[17].

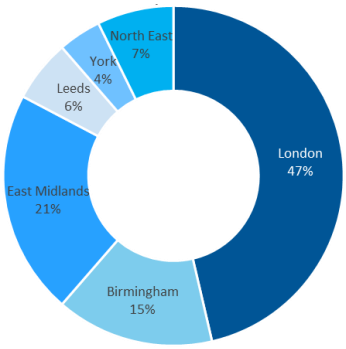
5.10.8 Under this initial specification, just under half of the boarders of the parkway station travel to London, with a similar travel pattern across all four parkway options. This is shown in Table 10, and by way of example for Mexborough in Figure 18. Birmingham and the East Midlands are also popular destinations, perhaps unsurprising, considering the service specification being tested.

Table 10: Destinations of HS2 daily boarders from each of the four parkway station locations. *Total numbers to Leeds likely to be underrepresented – see text below.

2037 daily passengers	Wales scenario	Bramley scenario	Mexborough scenario	Hemsworth scenario
Euston	500	650	600	430
Old Oak Common	330	390	420	260
Birmingham International	100	90	110	60
Birmingham Curzon Street	180	180	220	130
East Midlands (Toton)	440	480	470	280
Leeds*	210	250	130	100
York	130	150	90	60
Darlington	30	40	30	20
Durham	20	30	20	10
Newcastle	100	140	110	80
Total	**2,000**	**2,400**	**2,200**	**1,400**
% to London (Euston + Old Oak Common)	**42%**	**43%**	**47%**	**49%**

[17] It may also be possible that some increases in HS2 boardings at York could be by passengers who previously chose to travel by HS2 from Leeds now switching to York (particularly where choices between them were previously marginal).

Figure 18: Passengers using Mexborough parkway station by destination.



5.10.9 It is noted that these figures are likely to underrepresent the number of passengers travelling from South Yorkshire to Leeds, as a result of the way in which the PFM model is constructed to focus on long-distance travel. A further investigation would be required to better understand the possible size of this, particularly if these results were to be used in isolation, in forming policy decisions around services between these locations.

Who uses the parkway station?

5.10.10 The results above suggest that all four options for parkway station locations generate additional HS2 demand across South Yorkshire. The level of this is somewhat similar between options (with slightly lower numbers likely at Hemsworth), at least with this initial TSS test.

5.10.11 However, under these aggregate figures lie differences between the options in terms of who makes up that demand. Figures 19 and 20 show a breakdown of these boardings by location. Unsurprisingly:

- the northern-most parkway station option (Hemsworth) experiences a larger number of boarders from other northern areas (Barnsley and Wakefield);
- the central parkway options (Mexborough and Bramley) experience the highest number of passengers from Doncaster, and, to some degree, Rotherham; and
- the southern-most parkway options (Bramley and Wales) have the highest number of passengers from Sheffield, Rotherham and Bassetlaw.

Figure 19: Daily HS2 boarders at shortlisted South Yorkshire parkway station locations – by origin of boarders (2037).

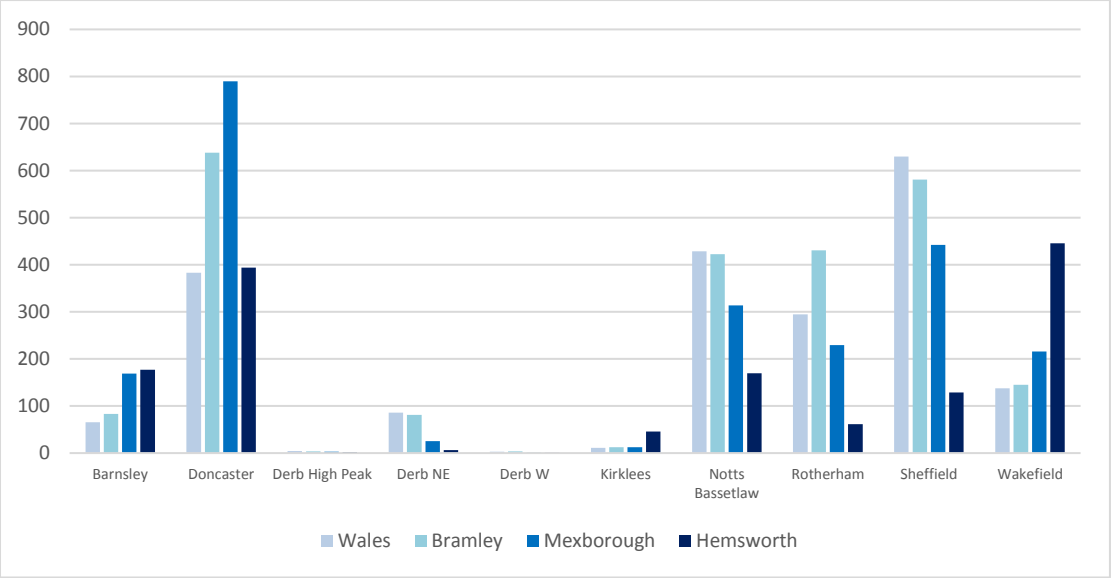
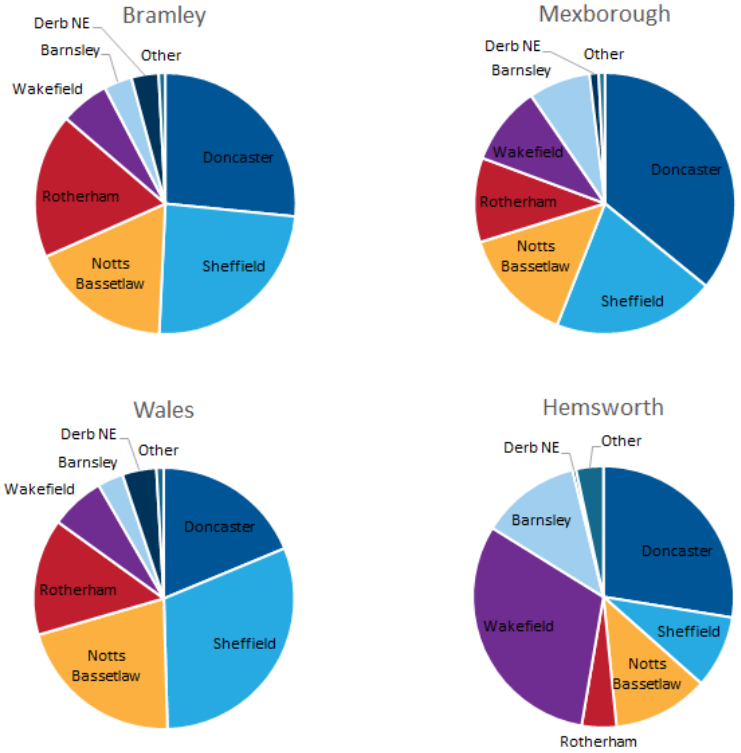


Figure 20: Proportion of daily HS2 boarders at shortlisted South Yorkshire parkway station locations – by origin of boarders (2037).



Total boarders across the rail network

5.10.12 Looking across both HS2 and classic rail services, the introduction of the new parkway station is estimated to reduce overall rail boardings (an indicator of rail demand) very slightly, compared with the M18 loop reference case. Table 11 shows that (at least for this initial TSS test) a parkway station has only a very slight reduction in rail boardings across the entire network (less than 0.1 per cent)[18].

Table 11: Impact of a parkway station on the rest of the rail network (change in total daily rail boardings relative to reference case).

2037 daily boarders (change relative to ref case)	**Wales scenario**	**Bramley scenario**	**Mexborough scenario**	**Hemsworth scenario**
HS2	1,300	1,800	1,400	500
Virgin East Coast	-700	-900	-900	-400
Cross Country	-500	-400	-300	-200
Trans Pennine Express	-300	-300	-100	-300
Northern	-400	-1,000	-600	-800
Other	-400	-200	-200	-200
Total	-1,000	-1,000	-700	-1,400

5.10.13 It is not possible to deduce from these figures whether the reduction in boardings also represents an overall reduction in trips, fewer interchanges (boardings per trip), or a combination of both.

5.10.14 However, consideration of passenger kilometres (as opposed to boarders) suggests that there is likely to be very little change in overall trips (close to zero). It is therefore possible that the slight reduction in boardings across the network may in fact be a positive outcome – the result of people making fewer interchanges (and therefore boardings) for the same number of trips.

Economic appraisal

5.10.15 We have used the PFM model (Version 7.0) to estimate the impact on the value-for-money appraisal of the overall HS2 business case.

5.10.16 Table 12 shows that, compared with the M18 loop reference case, this initial test estimates a slight reduction in overall benefits (between 0.2 and 0.4 per cent, or £100 million–£230 million), with similar results across all four shortlisted parkway station options.

[18] For example, for the best case of the Mexborough parkway station option, a reduction of 700 in total demand across the network represents about a 0.08 per cent reduction overall from a base of almost one million daily boardings.

5.10.17 The reduction is largely due to the six additional minutes added to journey times between London and Leeds on one hourly service, and the high value of time assumed for business passengers on this route.

Table 12: Assessment of value-for-money appraisal for HS2 business case across the four parkway station locations (under initial TSS test).

£m 67-year Net Present Value (NPV)	Ref case	Wales scenario	Bramley scenario	Mexborough scenario	Hemsworth scenario
Transport benefits (business)	53,470	53,280	53,340	53,300	53,240
Transport benefits (other)	15,100	15,120	15,100	15,070	15,080
Other quantifiable benefits	330	330	330	330	330
Loss to Government of indirect taxes	-3,640	-3,630	-3,630	-3,630	-3,630
Net transport benefits	65,250	65,100	65,150	65,070	65,020
Revenues	38,950	38,810	38,840	38,810	38,790
£m 67-year NPV (change relative to reference case)		**Wales scenario**	**Bramley scenario**	**Mexborough scenario**	**Hemsworth scenario**
Transport benefits (business)		-190	-130	-170	-230
Transport benefits (other)		20	20	-20	-20
Other quantifiable benefits		0	0	0	0
Loss to Government of indirect taxes		10	10	10	10
Net Transport Benefits		-160 *(-0.2%)*	-100 *(-0.2%)*	-180 *(-0.3%)*	-230 (-0.4%)
Revenues		-140	-110	-130	-160

Conclusions from initial modelling tests of shortlisted parkway station locations

5.10.18 These initial tests to compare the four shortlisted parkway station locations suggest that:

- all parkway stations increased the overall number of South Yorkshire HS2 passengers (by 13–20 per cent) and also total HS2 passengers;
- almost half of passengers boarding the parkway stations travel to London;
- there were similar results across all four locations on aggregate economic grounds and demand (making it difficult to determine the best station location on these results alone);
- each of the parkway station options demonstrates a different mix of passengers across South Yorkshire; and
- none of the options showed a net positive economic case on this initial TSS test – all had very slight reductions in aggregate terms of around 0.2–0.4 per cent, compared to the M18 loop reference case.

5.11 Constructability and sustainability

5.11.1 As detailed above, there were similar results for all four potential parkway station locations on economic grounds and demand, making it difficult to determine the best station location on these results alone.

5.11.2 We have also undertaken detailed work to assess the constructability and sustainability issues associated with each parkway station. This is described in the following sections. Each shortlisted parkway station location was appraised against the sustainability topics set out in Section 5.41. This has been undertaken using our Sift 3 level of appraisal. The appraisal focuses on the impacts of each proposed new parkway station, as well as on any additional impacts on the HS2 mainline as a result of the introduction of each station.

Wales

5.11.3 A parkway station at Wales would be located at the interface between the HS2 route and the classic railway line between Sheffield and Worksop. The site would lie to the north-west of Wales and to the west of the M1.

Figure 21: Wales parkway station location.

5.11.4 Highway access to the station would be from the nearby roundabout connecting the A57 and A618. The A57 provides access to Sheffield to the west and to the M1 Junction 31 to the east. The A618 runs north towards Rotherham.

5.11.5 There would be a rail interchange with classic rail platforms below the parkway station platforms. The interchange would provide connectivity to local classic rail services along the Worksop to Sheffield railway line.

5.11.6 The station at Wales would be located on a combination of viaduct and embankment. The 210-metre-long viaduct over Pigeon Bridge Brook floodplain and the existing railway would be up to 21 metres high. To the north of the station, the viaduct over a tributary of Pigeon Bridge Brook and the A57 would be 440 metres long and up to 26 metres high. The station would require the diversion of Pigeon Brook, a major river.

5.11.7 Three separate viaduct structures would be required due to the lie of the land, the design speed requirements of the mainline, the existing railway corridor below and complex geometry between the through mainlines and platform loops. The trace width for the route through the station is up to approximately 75 metres.

5.11.8 The length of change required to the M18/Eastern route in order to implement a parkway station at Wales would be five miles (8km), while the 4-track section of route

for the station platform loops would be 2.6 miles (4.2km), beginning to the south-west of Wales and ending to the north-east of Aston.

5.11.9 As part of the five-miles (8km) change to the mainline, the route would move 45 metres closer to the M1 to the north-east of Aston in order to facilitate the turnouts for the platform loops.

5.11.10 At this point in time, we estimate that the new infrastructure and changes required to the M18 / Eastern route alignment to provide for a parkway station in Wales would cost in the region of £323m.

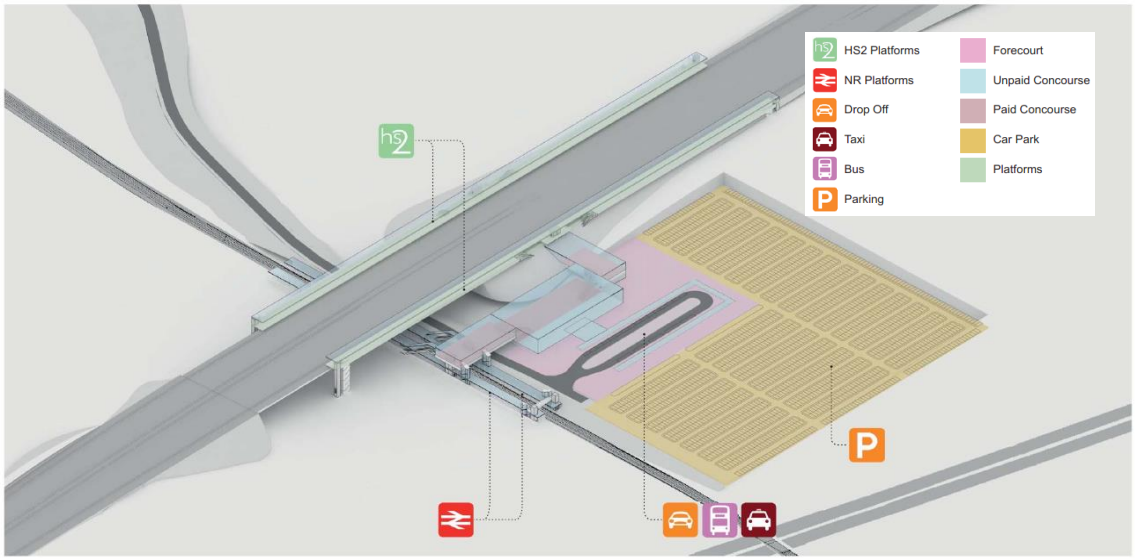
5.11.11 There would be major landscape and visual impacts due to the station being set within a sensitive rural landscape with an association to Capability Brown at Aston Park. The raised station platforms and access would adversely affect recreational users of local footpaths and ponds. They would also interrupt the scenic views towards the Rother Valley Country Park. As a result of changes to the mainline there would also be increased visual impacts to the area south of Aston, with greater land take and loss of woodland.

5.11.12 There would be an increased impact on the setting of the Aston Conservation Area, with the additional demolition of the Grade II listed farm buildings associated with the Grade II listed Nickerwood Farmhouse, which is already directly impacted by the HS2 mainline. Additional residential demolitions would be required.

5.11.13 Noise impacts would remain similar to those predicted for the HS2 mainline (without a parkway station) at Wales.

5.11.14 A visualisation of the potential parkway station at Wales is provided in Figure 22.

Figure 22: Visualisation of a potential parkway station at Wales



Bramley

5.11.15 A parkway station at Bramley would be located alongside the M18 Junction 1, between the motorway and town of Bramley (see Figure 23).

Figure 23: Bramley parkway station location.

5.11.16 Highway access to the station would be from the M18 Junction 1, also connecting to the A631. The A631 provides access to Rotherham to the west and towards Maltby and the A1 (M) to the east.

5.11.17 The station would be located on embankment and in cutting at either end of the station. The station would be situated over a tributary of Maltby Dike, with the platforms on an embankment up to 7 metres high.

5.11.18 To the south of the station, the route would be in a retained cutting between the Broadlands Estate and the M18, before crossing under the M18 Junction 1. In order to construct the crossing under the M18, the platforms would not be parallel at the station. The trace width for the route through the station is up to approximately 50 metres.

5.11.19 The length of change required to the M18/Eastern route to implement a parkway station at Bramley would be 5.8 miles (9.3km). A 4-track section of route for the station platform loops would be 3.7 miles (6km). The 4-track section of route would begin where the route crosses over the M1 joining the M18, to the west of Thurcroft and end to the north-east of Bramley.

5.11.20 At this point in time, we estimate that the new infrastructure and changes required to the M18 / Eastern route alignment to provide for a parkway station in Bramley would cost in the region of £301m.

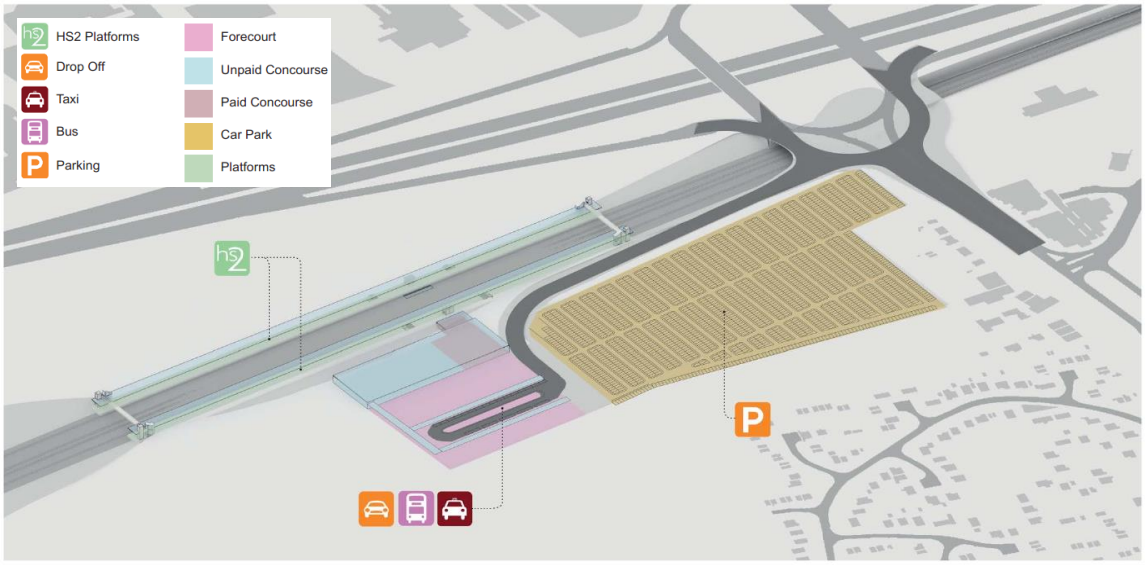
5.11.21 As part of the 5.7-mile (9.3km) change to the mainline, the route would move 50 metres to the west to the north-east of Bramley in order to facilitate the turnouts for the platform loops. The route would also move 75 metres to the east at the intersection with the A630, to ensure the existing mainline speed is not reduced.

5.11.22 There would be moderate landscape and visual impacts as a result of the station, particularly for residents on the eastern edge of Bramley. No new impacts on heritage assets would be expected and, as a result of changes to the mainline there would be a small reduction in land take from Old Denaby Wetland Local Nature Reserve. The station would potentially result in additional residential and commercial property demolitions.

5.11.23 Noise impacts would remain broadly similar to those predicted for the HS2 mainline (without a parkway station) at Bramley. There would be a slight increase in noise as the cutting is wider, reducing screening to nearby dwellings.

5.11.24 A visualisation of the parkway station at Bramley is provided in Figure 24.

Figure 24: Visualisation of a potential parkway station at Bramley.



Mexborough

5.11.25 A station at Mexborough would be located at the interface between the HS2 route and the classic railway line between Sheffield and Doncaster. The station would lie between the towns of Mexborough and Conisbrough.

Figure 25: Mexborough parkway station location.

5.11.26 Highway access to the station would be from the A6023, which provides access to Mexborough and Swinton to the west; and Conisbrough and Doncaster (via the A630) to the east.

5.11.27 There would be a rail interchange with classic rail platforms below the HS2 parkway station platforms, providing connectivity to local classic rail services along the Doncaster to Sheffield railway line, including to locations such as Rotherham.

5.11.28 The station would be located on a 780-metre-long viaduct. The station viaduct would be up to 21 metres high over Denaby Lane, the existing railway, the River Don, the Sheffield and South Yorkshire Navigation, the A6023 and Pastures Road.

5.11.29 Three separate viaduct structures would be required for the station due to the lie of the land, the design speed requirements of the mainline, environmental and existing transport features below, and complex geometry between the through mainlines and platform loops. The trace width for the route through the station is up to approximately 75 metres. The construction of the station in and over the existing floodplain would increase engineering complexity and have significant environmental impacts on the floodplain.

5.11.30 The length of change required to the consulted M18/Eastern route to implement the station would be five miles (8.1km). A 4-track section of route for the station platform loops would be 2.6 miles (4.2km). The 4-track section of route would begin just south of the intersection with the A630 and end to the north-east of Mexborough.

5.11.31 As part of the five-mile (8.1km) change to the mainline, the 2.6-mile (4.2km) 4-track section of route would increase the trace width to up to 50 metres outside the station footprint due to the geometry of the route through this section.

5.11.32 At this point in time, we estimate that the new infrastructure and changes required to the M18 / Eastern route alignment to provide for a parkway station in Mexborough would cost in the region of £339m.

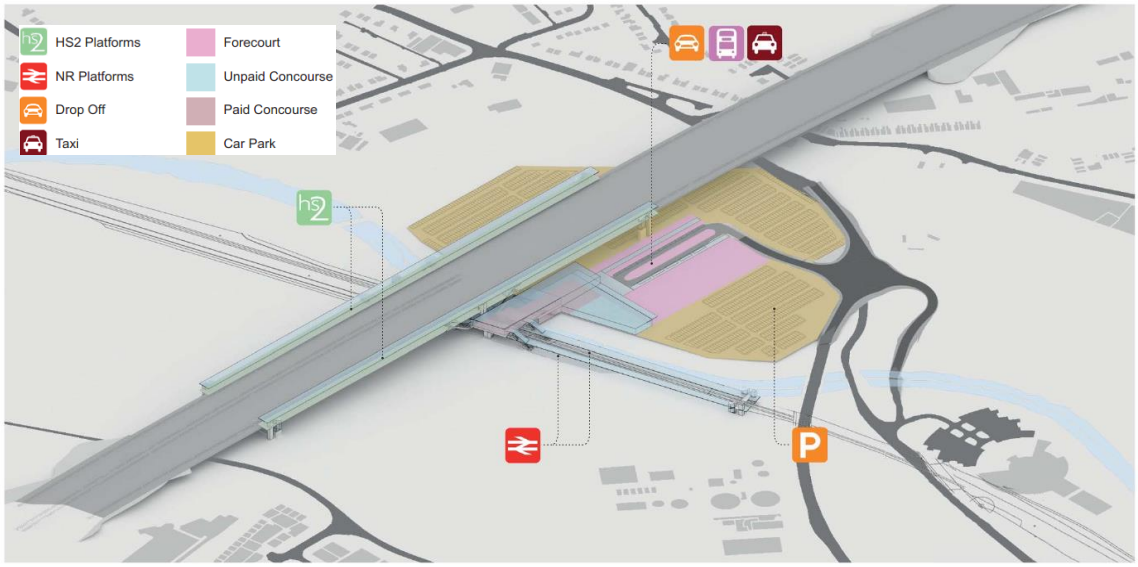
5.11.33 The siting of the station at Mexborough in the Don Valley, and its elevated platforms, would have considerable landscape and visual impacts. It would impact on the landscape character of the valley with visual impacts for recreational users of the Dearne Way and Castle Hill as well as for residents of Mexborough.

5.11.34 There would also be an increased impact on the Shimmer Major Development Site (with a significantly increased number of demolitions on the Estate from those already required by the mainline), plus other additional residential and commercial demolitions required. The station would also increase impacts at the Old Denaby Wetland Local Nature Reserve and two additional Habitats of Principal Importance (HPI) sites within the station footprint, with increased land take also associated with changes to the mainline resulting in additional loss of woodland.

5.11.35 The noise appraisal indicates that there would be a reduction in noise impacts at Mexborough (from the base case which includes the HS2 mainline without a parkway station). This would be due to additional screening provided by station earthworks. The HS2 mainline would form the centre line with parkway station lines on the outside. Earthworks from these station lines would provide screening as the station is raised.

5.11.36 A visualisation of the parkway station at Mexborough is provided in Figure 26.

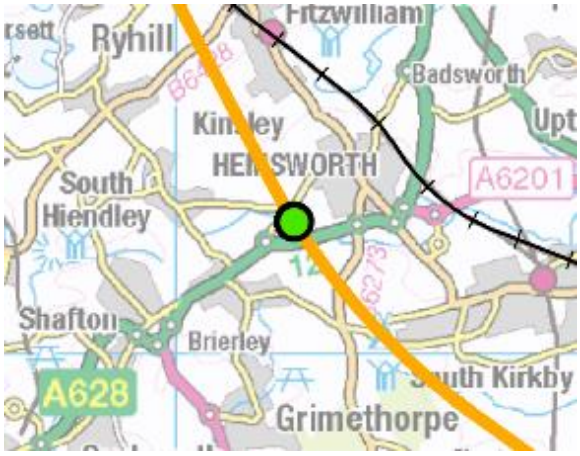
Figure 26: Visualisation of a potential parkway station at Mexborough.



Hemsworth

5.11.37 A parkway station at Hemsworth would be located off the A628 to the south-west of the town of Hemsworth.

Figure 27: Hemsworth parkway station location.



5.11.38 Highway access to the station would be from the nearby roundabout connecting the A628 and Barewell Hill Road. The A628 provides access to Barnsley to the south-west and Pontefract to the north.

5.11.39 The station would be located in cutting and on embankment at the southern end of the station. The station platforms would be situated between the route crossing over the A628 and crossing under Barnsley Road.

5.11.40 The crossing over the A628 would be up to 17 metres high and the section of station on embankment would be up to 10 metres high. The trace width for the route through the station is up to approximately 50 metres.

5.11.41 The length of change required to the M18/Eastern route to implement a station at Hemsworth would be 5.6 miles (9.1km). A 4-track section of route for the station platform loops would be three miles (4.9km). The 4-track section of route would begin to the south of South Kirkby and end to the south of Kinsley.

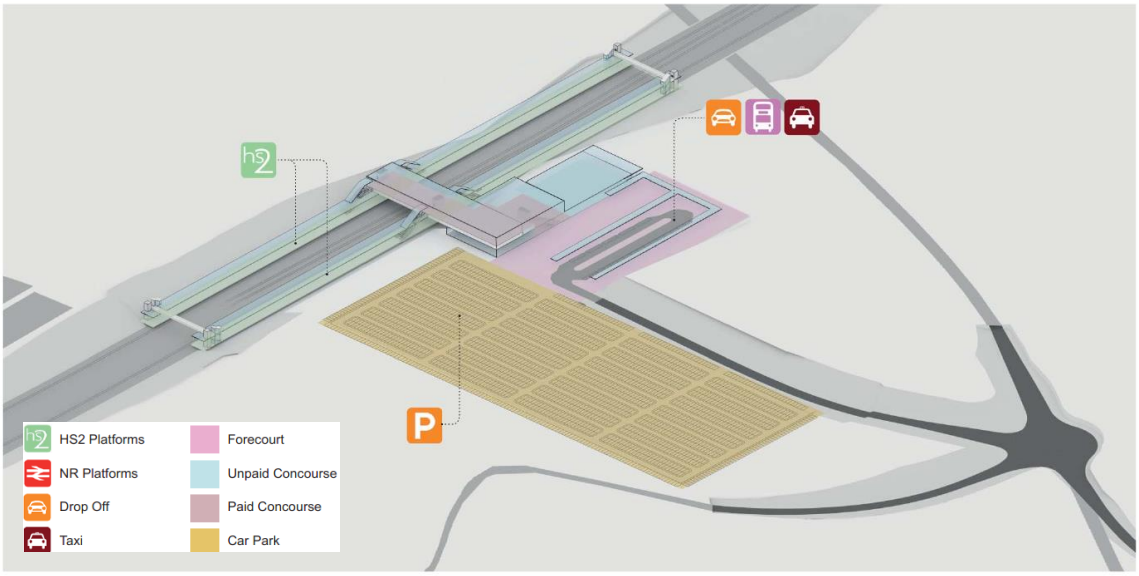
5.11.42 At this point in time, we estimate that the new infrastructure and changes required to the M18 / Eastern route alignment to provide for a parkway station in Hemsworth would cost in the region of £266m.

5.11.43 As part of the 5.6-mile (9.1km) change to the M18/Eastern route, the route would move up to 30 metres to the south at the intersections with the A628 and B627 to facilitate the turnouts for the platform loops.

5.11.44 The station would have moderate landscape and visual impacts with its setting within an open rural landscape, with visual impacts on residents of Robin Lane and users of the local footpath network. Changes to the mainline to accommodate the station would have minimal additional landscape impacts. When compared against the base case (the HS2 mainline without a parkway station), there would be a slight increase in noise impacts at Kinsley.

5.11.45 A visualisation of the parkway station at Hemsworth is provided in Figure 28.

Figure 28: Visualisation of a potential parkway station at Hemsworth.



Conclusions from the constructability and sustainability assessment of shortlisted parkway station locations

5.11.46 The key issue associated with the constructability of a parkway station is that, wherever the station may be located, there would be changes required to the M18/Eastern route alignment.

5.11.47 The constructability of any of the four shortlisted station locations is complex due to the geometry of the M18/Eastern route and the topography of South Yorkshire. Where one option may be complex due to issues associated with the constructability of the station and less complex in terms of the change required to the mainline alignment, the opposite can be said for another option.

5.11.48 The slightly less complex stations in terms of constructability are Bramley and Hemsworth. Both Wales and Mexborough are located on viaducts at the station and embankments, where the route would require 4-tracking.

5.11.49 The costs of providing a station at Bramley and Hemsworth are similar, but are both less than the stations at Wales and Mexborough. However, the parkway stations at Wales and Mexborough do include for a classic railway interchange, with the provision of two classic railway platforms. The cost of the route refinement associated with implementing a station is also less for Bramley and Hemsworth.

5.11.50 From a cost estimate perspective, it is important to consider the following:

- All of the shortlisted parkway station options are located in either Phase 2b M18/Eastern route sections HSL14 or HSL16. For cost comparison purposes, each of the cost estimates includes the full cost of the station and its associated external works.
- Land and property costs for the line of route are common to each shortlisted parkway station option.
- The property cost estimates for each parkway station location include for the additional land take and compensation payments.
- The parkway station design at Mexborough, located on an island site surrounded by rivers, does not take into account any flood protection measures at this stage of the feasibility design. There are, therefore, no costs within the Mexborough estimate for flood protection measures. If this option were to be taken forward, further work during more detailed design would be required to evaluate and understand the extent of work for flood protection.
- If any of the parkway station options were to be taken forward, further work would be required to fully develop cost estimates.

5.11.51 From a sustainability perspective, Bramley is a slightly better option than Hemsworth, and both of these outperform Wales and Mexborough. The changes required to the current alignment to implement a station at Bramley would lead to a reduction in environmental impacts on ancient woodland near Hooton Roberts.

5.11.52 The station at Bramley would be relatively well sited with no new impacts on heritage assets or local planning development proposals in the area. There would be additional residential and commercial property demolitions.

5.11.53 Both Bramley and Hemsworth station locations are similar with regard to the increase in localised visual and landscape impacts. Hemsworth station would have a slightly greater impact as this location is positioned in a more open rural setting.

5.11.54 There would be significant landscape and visual impacts associated with the elevated structures at Wales and Mexborough. At Wales, there would also be increased heritage impacts, with direct impacts on the Aston Conservation Area and the demolition of a Grade II listed structure. A station at Mexborough would likely involve increased ecology impacts on the Old Denaby Wetland Local Nature Reserve and ancient woodland at Hooton Roberts. There would also be additional property demolitions associated with Mexborough (in addition to those already occurring as a result of the impact of the mainline on the Shimmer Major Development Site), along with complex river crossings and floodplain issues.

5.11.55 Noise impacts at Hemsworth, Bramley and Wales are broadly similar to those experienced as a result of the M18/Eastern route at their respective locations. There

would be a reduction in noise impact at Mexborough due to additional screening provided by station earthworks. The station at Hemsworth performs the best of all options from a noise perspective due to the rural setting of Hemsworth, followed by Wales, Mexborough and Bramley which are all located adjacent to residential properties. Bramley has the highest noise impact due to the proximity of dwellings adjacent to the station.

5.11.56 A high-level summary of our sustainability impact assessment for each parkway station location is shown in Table 13. The impacts presented are those over and above those impacts already associated with the HS2 mainline route. All demolition figures represent additional demolitions to those that will be required for the HS2 mainline route in each area.

Table 13: Summary of sustainability impacts associated with each shortlisted parkway station location.

	Wales	Bramley	Mexborough	Hemsworth
Landscape and visual	Existing major impacts worsened by mainline change. Elevated station creates landscape and visual impacts.	Station relatively well sited but would generate localised visual effects. Mainline may generate significant effect at King's Pond.	Slight worsening of existing mainline impacts. Elevated station has a considerable landscape and visual effect.	Few additional effects of mainline Station and car park on an exposed site – moderate impact.
Heritage	Aston Conservation Area – greater impact and demolition. Listed building demolition.	No new impacts.	Listed mile marker – limited impact.	Increased impact on Vissitt Manor listed building but no change on impact score.
Water and flood risk	Diversion of Pigeon Brook (Environment Agency Main River).	No new impacts.	Construction in and over the floodplain – significant impact.	No new impacts.
Ecology	Slight increase in impact on woodland.	Reduction in woodland loss at Hooton Roberts.	Increased impact on Old Denaby Wetland LNR and ancient woodland at Hooton Roberts.	Small peripheral impact on woodland.
Planning	No new impacts.	No new impacts.	Impact on Shimmer Major Development Site (MDS)	No new impacts
Property (est. additional demolitions above those required for mainline)	10 residential demolitions.	5 residential demolitions. 6 commercial demolitions.	15 residential demolitions (+ Shimmer). 5 commercial demolitions.	No new impacts.
Noise (Net Present Value[19] of change in noise)	-£1,935,377 (£287,073)*	-£8,638,855 (-£351,512)*	-£3,498,482 (£3,696,908)*	-£466,411.95 (-£34,234)*
	* Figures (in brackets) represent changes in noise performance compared to noise impacts from HS2 mainline			

[19] Change in Net Present Value (NPV) is calculated as required as per DfT's Transport Analysis Guidance. It is the estimated total NPV of the change in noise discounted over the 60-year appraisal period. The NPV costs are not included in the cost model that HS2 has developed. For NPV of change in noise, a negative figure in brackets indicates a greater noise impact than the base case. The guidance is available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/487684/TAG_unit_a3_envir_imp_app_dec_15.pdf

5.12 Conclusions of parkway station shortlisting work

5.12.1 The work we have done to assess the four shortlisted parkway locations is summarised in Tables 14 and 15. This includes the work on strategic fit and journey time discussed in Section 4.

5.12.2 Our economic and demand modelling assessment indicates no clear preference for a particular location, and that none of the options shows a net positive impact on aggregate scheme benefits using the initial train service specification test.

5.12.3 Our engineering and sustainability assessment results in a slight preference for Bramley over Hemsworth, with Wales and Mexborough costing significantly more. This is because they are more challenging to construct and have significantly more sustainability impacts.

5.12.4 There are also some qualitative differences between the options that need to be considered, most notably the potential for synergy between a potential parkway station site at Hemsworth, and future NPR services, with the Hemsworth site being located north of the proposed M18 northern loop connection at Clayton.

5.12.5 It should also be noted at this stage that any parkway station would require us to change the alignment of the mainline for the M18/Eastern route.

5.12.6 Based on the work undertaken to date, we cannot conclusively recommend a single preferred location for a parkway station. Given the inconclusive results at this stage of the study work, we have undertaken further modelling work to consider a range of train service specifications to one of the parkway locations to better understand the impact of different service patterns on potential demand and whether this affects the viability of a parkway station. This work took the Mexborough parkway option as a representative station, without seeking to pre-empt the decision on any preferred station location. The results of this work are detailed in Section 6.

Table 14: Summary analysis of parkway station shortlist – accessibility, journey time, strategic fit and modelling.

Parkway station shortlist summary: Accessibility, journey time, strategic fit and modelling analysis		**Wales**	**Bramley**	**Mexborough**	**Hemsworth**
Accessibility and connectivity	**Highway access**	A57 (M1) and A618	M18 Junction 1 and A631	A6023	A628
	Rail interchange	Yes (Worksop–Sheffield)	No	Yes (Doncaster–Sheffield)	No
	HS2 journey time to London	68 mins	71 mins	72 mins	75 mins
	HS2 journey time to Leeds	17 mins	15 mins	14 mins	11 mins
Journey times to London (RAG rated compared with existing offer: Red = poor Amber = okay, Green = good) Underlined = overall best for location	**Urban areas**	**Sheffield (city)** **Sheffield (Meadowhall)** **Rotherham** **Barnsley** Doncaster **Wakefield** **Worksop**	**Sheffield (city)** **Sheffield (Meadowhall)** **Rotherham** **Barnsley** Doncaster **Wakefield** **Worksop**	**Sheffield (city)** **Sheffield (Meadowhall)** **Rotherham** **Barnsley** **Doncaster** **Wakefield** **Worksop**	**Sheffield (city)** **Sheffield (Meadowhall)** **Rotherham** **Barnsley** **Doncaster** Wakefield **Worksop**
	SCR IIP Growth Areas (Strategic fit with SCR Growth Areas)	Advanced Manufacturing Park (AMP/AMID Robin Hood Airport Dearne Valley (West) Dearne Valley (East) Markham Vale DN7	AMP/AMID Robin Hood Airport Dearne Valley (West) Dearne Valley (East) Markham Vale DN7	AMP/AMID Robin Hood Airport Dearne Valley (West) Dearne Valley (East) Markham Vale DN7	AMP/AMID Robin Hood Airport Dearne Valley (West) Dearne Valley (East) Markham Vale DN7
Strategic fit		High	Medium	High	Low
Modelled demand (initial TSS test only – 1tph to London)	Daily HS2 boardings at Parkway station	2,000	2,400	2,200	1,400
	Daily HS2 passenger boardings in South Yorkshire (increase compared with ref. case)	+ 1,400 (+16%)	+ 1,700 (+20%)	+ 1,600 (+18%)	+ 1,200 (+13%)
	Impact on total HS2 benefits (relative to ref case) £m (%)	-160 (-0.2%)	-100 (-0.2%)	-180 (-0.3%)	-230 (-0.4%)

Table 15: Summary analysis of parkway station shortlist – constructability, sustainability and cost.

Parkway station shortlist summary: Constructability, sustainability, cost		Wales	Bramley	Mexborough	Hemsworth
Constructability (engineering)	**Features**	Station requires three separate viaduct structures because of the lie of the land, existing railway below and complicated geometry between mainline and platform loop.	In order to construct narrow 4-tracks cut-and-cover tunnel under A631 road, platforms are not parallel at station.	Station requires three separate viaduct structures because of the lie of the land, River Don and floodplain, existing railway and the distance between platform loops and mainline.	Southern end of station exposed and on embankment before mainline and platform loops (4-track) crosses over the A628.
	Length of mainline change	5.0 miles (8km)	5.8 miles (9.3km)	5.0 miles (8.1km)	5.6 miles (9.1km)
	Platform Loops	2.6 miles (4.2km)	3.7 miles (6.0km)	2.6 miles (4.2km)	3.0 miles 4.9km
	Station setting	Viaduct/embankment	Embankment/cutting	Viaduct	Embankment / cutting
Sustainability (environment)	**Features**	Landscape and visual impacts worsened by mainline change. Watercourse diversion. Heritage impacts. Increase in impact on woodland	Localised visual and landscape impacts. Reduction in woodland loss at Hooton Roberts	Landscape and visual impacts. Residential demolitions. Flood risk. Increased impact on ecology. Impact on Shimmer MDS	Visual and landscape impacts. Small impact on woodland
	Demolitions (net additional)	10 residential demolitions	5 residential demolitions. 6 commercial demolitions	15 residential demolitions (+ Shimmer). 5 commercial demolitions	No new impacts
	Noise (NPV of change in noise)	-£1,935,377 (£287,073)	-£8,638,855 (-£351,512)	-£3,498,482 (£3,696,908)	-£466,411.95 (-£34,234)
Cost (£m). Figures based on 1Q15. Includes optimism bias (OB) at 40%.	**Estimated incremental increase against emerging estimate for this section of M18 / Eastern route.**	323	301	339	266

6 Examining a suitable train service to serve a potential South Yorkshire parkway

6.1.1 Section 5 of the report examined the issues related to the location of a possible HS2 parkway station on the Phase 2b HS2 mainline in South Yorkshire. This section further extends the modelling presented in Section 5, to consider what train service specification (TSS) might be suitable for serving such a parkway station.

6.1.2 We have not at this stage considered the detailed timetabling implications that may result from changes to the timing of services. This is an important operational consideration that would require appropriate analysis.

6.2 Informing a suitable train service specification to a parkway station

6.2.1 The modelling presented of the four shortlisted parkway stations in Section 5 sought to provide a better understanding of potential parkway station locations, in terms of demand and impact on the assessment of the HS2 value-for-money business case.

6.2.2 This was undertaken against an initial HS2 TSS. The objective of this phase of the modelling was to compare each of the shortlisted parkway stations consistently, to ascertain whether it could inform decisions on location.

6.2.3 This initial test provided a somewhat limited service to the parkway station, and did not seek to understand how best to serve a parkway station, or whether a better TSS could provide a better outcome in terms of demand and impact on the overall business case. We explore this further in this section of the report.

Approach and considerations

6.2.4 To limit the amount of modelling required, we initially limited the testing of TSS options to one representative parkway location option served by a range of TSS scenarios. We selected the Mexborough parkway as it had among the highest number of boarders in the initial parkway location tests, and also because it has the best classic rail connections. We complemented this work later by also testing scenarios using the Bramley parkway location, where the initial test showed positive results.

6.2.5 This approach does not, however, suggest we are recommending promoting these options over Wales or Hemsworth. We would need to consider further testing of favoured TSS options against all four parkway station options before recommendations could be properly formed.

6.2.6 There are potentially a large number of options and combinations for serving a parkway station. It was not possible within the limits of this study to assess all of

these. Instead, we considered a cross section of possible TSS options to provide information and evidence to inform further thinking.

Considerations for parkway service options

6.2.7 Ultimately, an ideal TSS must weigh up a number of often competing considerations, such as:

- the frequency of HS2 services calling at the parkway station, especially to key destinations such as London;
- finding the right mix of HS2 services to South Yorkshire as a whole – between the three possible HS2 stations at Sheffield Midland, Chesterfield and the parkway;
- an understanding of which destinations people wish to travel to;
- the likely impact on HS2 passengers travelling to destinations outside South Yorkshire – for example, by slowing services from Leeds or York to London due to stopping at the parkway;
- operational considerations, such as timetabling, to understand what is and is not technically possible (or understanding additional measures that need to be implemented[20] that are not considered here in our modelling and are assumed to be possible, but would need to be checked); and
- impacts in terms of costs (both capital and operating cost).

6.2.8 In seeking to understand how best to serve a possible parkway station, judgements must be made on the acceptable level of impact on other parts of the network to maximise benefits to South Yorkshire. Ultimately, the best service specification depends on the policy objective being sought. For example:

- stopping all HS2 services at a parkway station would likely maximise demand and benefits in South Yorkshire, but is also likely to have the largest impact on other markets such as Leeds, York and the North East by increasing their journey times; and
- at the other extreme, minimising the potential impact on other markets would suggest minimising the number of HS2 services that stop in South Yorkshire.

6.2.9 These are similar to the considerations that informed David Higgins' Sheffield and South Yorkshire report published in July 2016.

[20] This is not considered further below. No judgement has been made on this basis in this section, and our modelling assumes that all options are possible.

6.2.10 Determining the best service mix is therefore a question for policy decision makers, after weighing up these considerations. This study has tested a range of possible TSS options designed to inform such decisions. We are not proposing that these options are the only (or best) options available. Further work may be required to use the learning outlined below to construct an optimal TSS that meets the needs and values of decision makers.

The parkway train service specifications considered in the study

6.2.11 The tests we have undertaken as part of this study are summarised in Table 16, showing a mix of services (in trains per hour) between Sheffield Midland and a parkway station. These services are described in more detail below. Tests 1 and 2 relate to an M18 loop reference case (without a parkway station), and to our initial parkway test – the results of which are already described in Section 5.

6.2.12 In general terms, the tests considered here seek to provide additional understanding on the following:

- Whether options vary under an M18 loop or spur scenario to serve Sheffield Midland (Test 3). This helps us to understand whether a parkway station could better serve demand for travel between South Yorkshire and Leeds, compared to running HS2 loop services. It also provides useful evidence in the context of wider considerations about the scope for interaction with NPR aspirations.
- The mix of HS2 services serving South Yorkshire, i.e. between a parkway station and/or Sheffield Midland. We considered this by examining the extremes of only serving Sheffield Midland (Test 1), or only serving a parkway station (Test 4), giving further consideration to other patterns (e.g. Test 2).
- An understanding of the impact of serving a parkway station on other HS2 markets outside South Yorkshire, and exploring options that may be able to limit any negative impacts (Tests 5 and 6).
- Service frequency and the impact of a greater number of services (especially to key destinations) (Test 6).

Table 16: Overview of parkway station TSS scenarios tested.

Modelling test		Objective(s) of test	Sheffield Midland services (tph)	Parkway services (tph)	Total South Yorkshire services (tph)	Sheffield Midland services to London (tph)	Parkway services to London (tph)	Total SY services to London (tph)
1	M18 loop (no parkway)	Reference case (without parkway)	4	**0**	**4**	2	0	2
2	M18 loop plus parkway	Initial test of parkway locations	4	**2**	**6**	2	1	3
3	M18 spur plus parkway	Loop vs. spur	2	**4**	**6**	2	1	3
4	Parkway only (no spur)	Mix of South Yorkshire services between Sheffield Midland and parkway	0	**6**	**6**	0	3	3
5	M18 loop plus parkway (one fewer stop at Toton)	Options to reduce impact on other markets	4	**2**	**6**	2	1	3
6	M18 loop plus 3 tph parkway	Increase of parkway services to London. Options to reduce impact on other markets	3	**3***	**7**	2	2*	4

Note: * This specification, while increasing the number of London services to the parkway, also provides a different mix of how this is achieved (via the slower London–Leeds and York splitting services rather than faster London–Leeds service).

6.2.13 For the majority of these tests, a six-trains-per-hour service to South Yorkshire (including three trains per hour to London) in each direction is assumed to allow a consistent comparison between approaches of delivering this.

M18 loop versus M18 spur scenarios

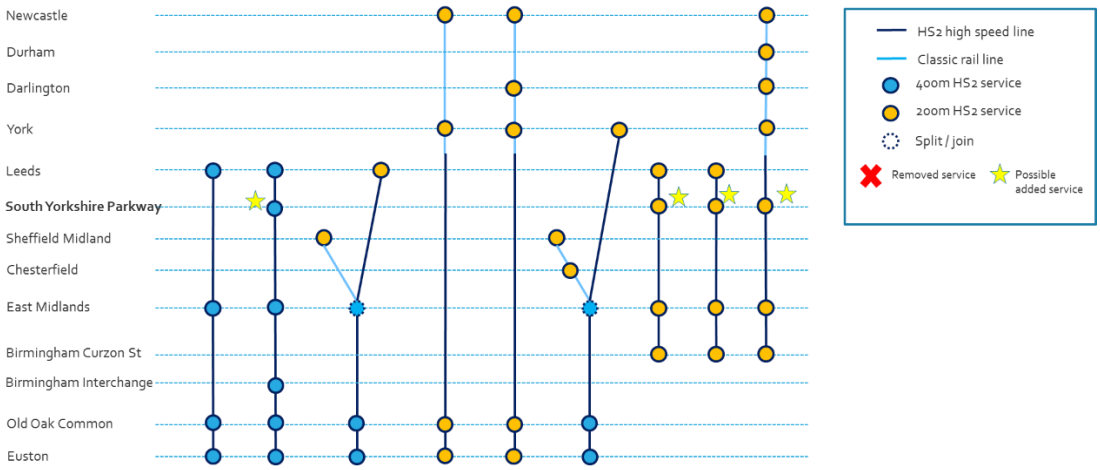
6.2.14 Test 3 (M18 spur plus parkway) seeks to understand how estimated demand and benefits from parkway options might differ under a M18 spur scenario, whereby Birmingham–Leeds services run on the HS2 mainline rather than on a classic rail loop through Sheffield Midland.

6.2.15 This TSS (see Figure 29) represents:

- six trains per hour (tph) to South Yorkshire (two to Sheffield Midland, four to a parkway);

- only one tph from the parkway to London;
- as per the M18 loop plus parkway test, but with a spur rather than loop: this shifts the two Birmingham–Leeds services to stop at a parkway station rather than Sheffield Midland, which wouldn't otherwise serve South Yorkshire under a spur scenario without a parkway; and
- As with other spur scenarios, this significantly speeds up the Birmingham–Leeds service, as this is now running via the HS2 mainline.

Figure 29: Test 3 – M18 spur plus parkway.



Mix of services to South Yorkshire

6.2.16 The reference case (Test 1) represents a scenario where South Yorkshire is only served by way of Sheffield Midland services (i.e. no parkway station)[21]. This was consistent with our 2016 business case. Test 2 (M18 loop plus parkway) provided an initial test of introducing parkway stops (four tph to Sheffield Midland and two tph to the parkway).

6.2.17 At the other extreme, Test 4 (parkway only) considers the case where South Yorkshire is only served by the parkway station (with no spur or service to Sheffield Midland). Our aim in running this test was not to advance this as an independent scenario, but to provide the extreme alternative to the reference case of four tph to Sheffield Midland, to understand the possible range of outcomes.

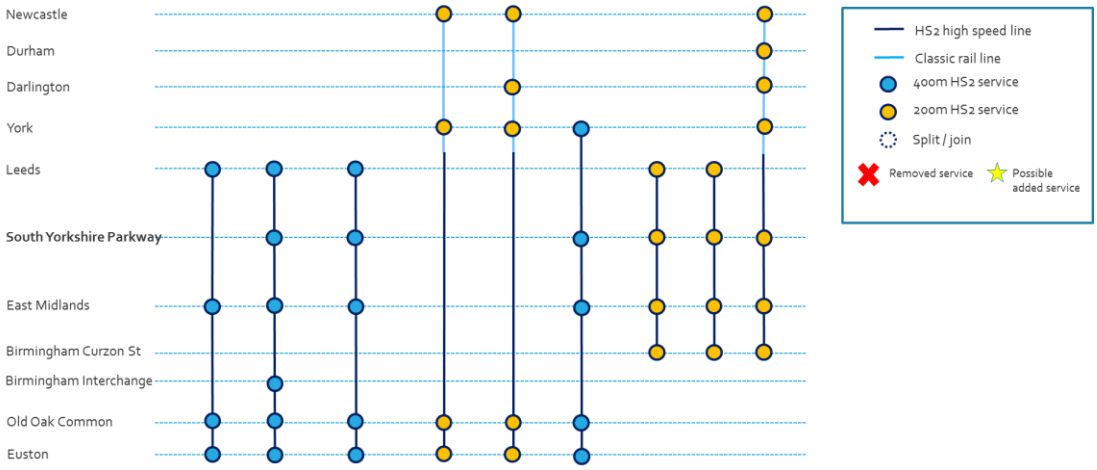
6.2.18 This TSS (see Figure 30) represents:

- six tph to South Yorkshire (none to Sheffield Midland, six to a parkway);
- three tph from the parkway to London;

[21] Chesterfield services also included.

- all services to South Yorkshire provided by parkway alone (no services call at Sheffield Midland or Chesterfield); and
- the splitting HS2 services in the reference case are removed (no longer needing to split at East Midlands in order to serve Sheffield Midland); this has the effect of reproducing a TSS similar to that used in the previous Meadowhall proposition (albeit with nine train paths used in this case to allow a consistent comparison)[22].

Figure 30: Test 4 – parkway only (no spur).



6.2.19 Other options that could be explored include:

- intermediate mixes, such as a balanced mix of services to both Sheffield Midland and the parkway (e.g. three tph each), allowing an additional London service to call at the parkway; and
- Test 6 (and also the extension of services tests) shows benefits of more than one tph in each direction to the station, which suggest other hybrid mixes between Sheffield Midland and the parkway may be worth exploring.

Options for limiting impact on other markets

6.2.20 In our initial test (Test 2 – M18 loop plus parkway), we observed large increases in South Yorkshire HS2 passengers, but small reductions in benefits in the nationwide overall HS2 scheme. This was predominately the result of slowing the London–Leeds service in order to stop at the parkway station, and the standard appraisal assumptions regarding the value of time for long-distance business travellers.

[22] The original Meadowhall TSS only used eight train paths.

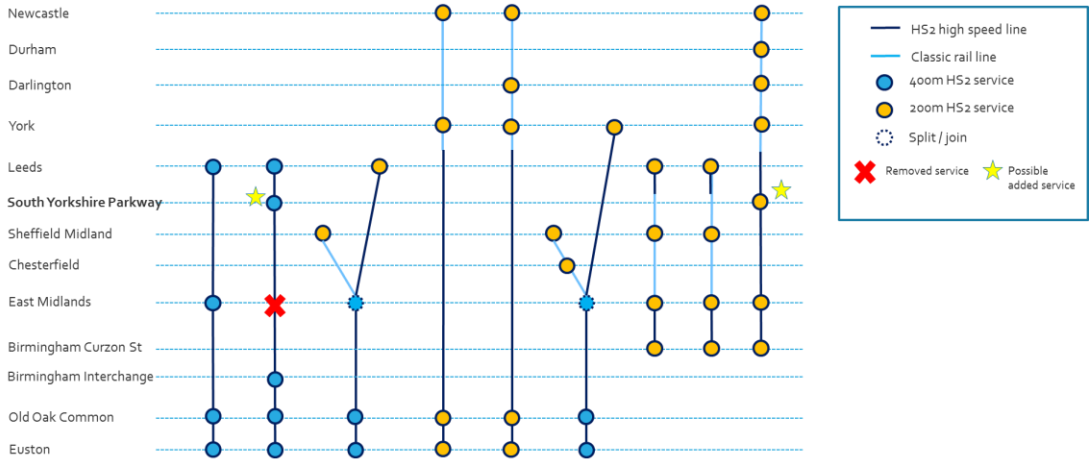
6.2.21 Stopping this service at the parkway station has the effect of adding about six minutes to the total London–Leeds travel time, which impacts benefits based on the assumptions employed in our model. There may be options to mitigate this, however.

6.2.22 One option to reduce this impact might be to drop a stop elsewhere on this service to counter this increase in journey time. Test 5 repeats the initial parkway test (Test 2 – M18 loop plus parkway), but removes a stop at the East Midlands Hub station at Toton to keep the total London–Leeds journey time unchanged[23].

6.2.23 This TSS (see Figure 31) represents:

- six tph to South Yorkshire (four to Sheffield Midland, two to a parkway);
- connection from the parkway to East Midlands is no longer possible; and
- total travel time from London–Leeds on this service remains unchanged from that in the reference case (M18 loop with no parkway).

Figure 31: Test 5 – M18 loop plus parkway (one less stop at Toton).



6.2.24 Other options that could be tested (but not explored here) include stopping the express London–Leeds service (which doesn't stop at Birmingham Interchange) at the parkway and removing the East Midlands stop from this service instead. This may provide a better option as it would maintain broader connections to Birmingham Interchange from East Midlands and its connecting services from the North East.

6.2.25 We considered a second option by taking the parkway stop off this faster London–Leeds service, and instead serving it via the slower splitting services. This has the

[23] Under the current HS2 M18 loop proposal the East Midlands Hub benefits from the highest number of HS2 services of any station outside London and Birmingham (seven tph in each direction, four of which are to London). As such, removing one service would still leave East Midlands with excellent connectivity.

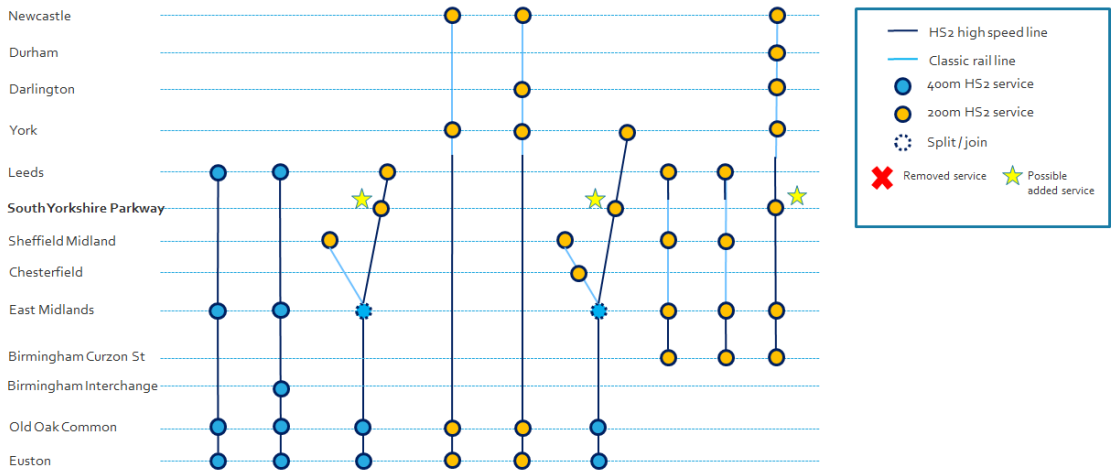
effect of keeping the London–Leeds times unchanged on the faster of those services, and keeping the same number of East Midlands stops.

6.2.26 Test 6 (M18 loop plus three tph parkway) considers a case where both of the London splitting services call at the parkway station, essentially splitting at East Midlands to serve Sheffield Midland and the parkway from the same services.

6.2.27 This TSS (see Figure 32) represents:

- seven tph to South Yorkshire (four to Sheffield Midland, three to a parkway);
- an increase in London services to the parkway (two versus one in the initial test);
- London services to the parkway made only via the slower splitting services;
- all East Midlands services unchanged; and
- slowing the slower London–Leeds and London–York splitting services (which stop at the parkway).

Figure 32: Test 6 – M18 loop plus three-trains-per-hour parkway.



6.2.28 Other options that could be explored further (but not tested here) include:

- stopping only one of the splitting services at the parkway (providing six tph to South Yorkshire); and
- a combination of stopping two London–Parkway services from a fast London–Leeds service and slower spitting London–Leeds or London–York service.

6.2.29 These options may be explored in combination with other options to increase the frequency of parkway services or vary the mix of Sheffield Midland/parkway services.

6.3 Results of parkway station modelling

6.3.1 Each of the above tests has been modelled using the PLANET Framework Model (PFM) (version 7.0), to ascertain an estimate of their impact in terms of passenger demand, benefits and the overall business case. Each of these has been initially tested against our representative parkway location of Mexborough. We have repeated Tests 5 and 6 against the Bramley parkway station location[24].

HS2 passenger numbers with a parkway

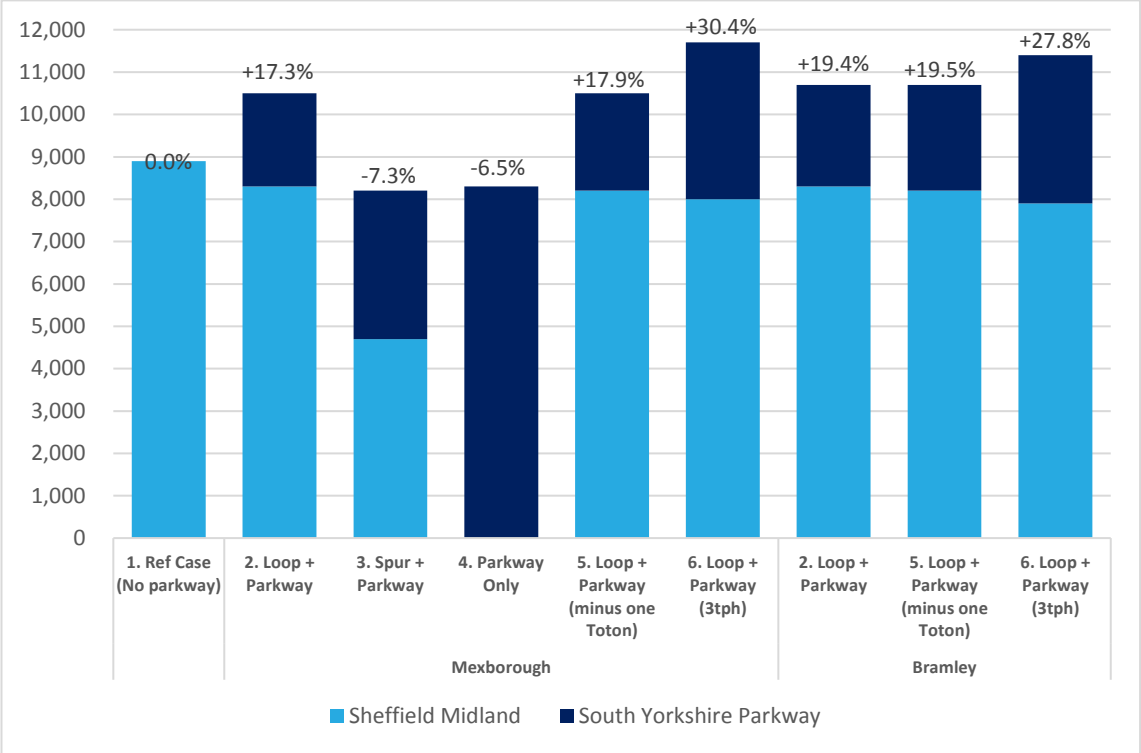
South Yorkshire HS2 passengers

6.3.2 Figure 33 shows the impact of each of these tests in terms of total HS2 passenger numbers (daily boardings) across South Yorkshire[25].

[24] As Tests 3 and 4 showed reduced passenger numbers and benefits for Mexborough, they were not considered for further testing for Bramley or other station location options.

[25] Chesterfield passenger numbers are not shown, to simplify the chart. These are shown in Table 18, and are roughly unchanged at around 750 passengers a day (at most, eight per cent of total South Yorkshire HS2 passengers), other than for the parkway-only test where these reduce to zero. On this basis, the parkway-only test would reduce South Yorkshire passengers (defined as Sheffield Midland, parkway and Chesterfield) by 13.8 per cent – making it the lowest performing option overall in terms of South Yorkshire HS2 passenger numbers.

Figure 33: Daily HS2 boarders in South Yorkshire (excluding Chesterfield) (2037)[26].



Source: HS2 Ltd. Percentages above bars represent percentage change in total South Yorkshire HS2 boarders compared with reference case.

6.3.3 The results of these tests suggest that for each of the M18 loop plus parkway scenarios:

- A parkway station can substantially increase overall HS2 passengers from South Yorkshire (by 15–30 per cent).
- The largest increase tested was 30 per cent for the M18 loop plus parkway (with three tph calling at the parkway and four tph calling at Sheffield Midland). This suggests that greater frequency (especially to London) supports greater demand from the parkway. For comparison, with boardings of around 3,500 a day, a parkway would handle similar numbers of HS2 passengers as we forecast at Runcorn; twice as many as stations like Wigan, Warrington and Darlington; three times more than Durham; and five times more than Chesterfield. It would have around half the number of passengers of Sheffield Midland.

[26] There is a similar pattern if we also include Chesterfield, as this stays fairly constant under all options – other than in the parkway-only test, where it also goes to zero. Chesterfield remains low (about 1/3–1/5th of total parkway passengers) and at most, eight per cent of total South Yorkshire passengers (in the reference case).

- These increases remain substantially higher than any increases achieved by the HS2 service extension options that have been tested (see Section 7).

6.3.4 The parkway-only test (with no HS2 services to Sheffield Midland) maximises the number of parkway passengers but significantly reduces the number of overall South Yorkshire passengers using HS2. This is despite the large number of services stopping at the parkway in this scenario. This demonstrates that a scenario that serves Sheffield Midland (without a parkway) is better than one that only serves a parkway. However, our work suggests that, if the policy objective is to maximise HS2 passengers in South Yorkshire, then a parkway in combination with some level of HS2 service to Sheffield Midland better meets this objective.

6.3.5 An M18 spur-plus-parkway scenario reduces the number of HS2 passengers from South Yorkshire (compared with the reference case). This is mostly due to removing access to the Birmingham–Sheffield Midland–Leeds services (i.e. moving from a loop to a spur is driving these results, rather than the addition of a parkway).

Overall HS2 passengers

6.3.6 Table 17 shows the overall impact on HS2 passenger numbers (including those outside South Yorkshire) under the various parkway scenarios tested for both the Mexborough and Bramley station locations. The number of total HS2 boardings increases in all M18 loop-plus-parkway options (by up to 2,100, representing a growth of up to 0.6 per cent compared to total forecast passengers on the HS2 network). These options also increase York passengers, while some reductions are observed for Leeds passengers – the lowest being in the option where the Toton stop is removed to keep London–Leeds times unchanged.

Table 17: Estimated daily HS2 boardings (2037) under tested parkway train service specifications[27].

		Mexborough					Bramley		
2037 daily HS2 boarders	**1. Ref case (no parkway)**	**2. Loop + parkway**	**3. Spur + parkway**	**4. Parkway only**	**5. Loop + parkway (minus one Toton)**	**6. Loop + parkway (3 tph)**	**2. Loop + parkway**	**5. Loop + parkway (minus one Toton)**	**6. Loop + parkway (3 tph)**
Sheffield Midland	8,900	8,300	4,700	0	8,200	8,000	8,300	8,200	7,900
S/Yorks parkway	0	2,200	3,500	8,300	2,300	3,700	2,400	2,500	3,500
Chesterfield	800	700	700	0	800	700	700	700	700
Leeds	20,400	19,600	18,300	18,000	20,000	19,500	19,800	20,200	19,900
York	9,900	10,100	9,900	9,400	10,100	9,400	10,100	10,100	9,600
All other stations	298,200	298,500	299,000	296,900	297,100	298,700	298,700	297,200	298,600
Total HS2 boardings	338,100	339,500	336,200	332,700	338,500	340,000	339,900	338,900	340,200
Total HS2 boardings in South Yorkshire (Sheffield Midland + parkway)	8,900	10,500	8,300	8,300	10,500	11,600	10,700	10,700	11,400
Total HS2 boardings in South Yorkshire (Sheffield Midland + parkway + Chesterfield)	9,700	11,200	9,000	8,300	11,300	12,400	11,400	11,400	12,100

[27]Although not shown in Figure 33, we have also included in this table an alternative South Yorkshire total passenger measure that includes Chesterfield, together with Sheffield Midland and the parkway.

(Change relative to reference case) 2037 daily HS2 boarders	1. Ref case (no parkway)	Mexborough 2. Loop + parkway	3. Spur + parkway	4. Parkway only	5. Loop + parkway (minus one Toton)	6. Loop + parkway (3 tph)	Bramley 2. Loop + parkway	5. Loop + parkway (minus one Toton)	6. Loop + parkway (3 tph)
Sheffield Midland		-600	-4,200	-8,900	-700	-900	-600	-700	-1,000
S/Yorks parkway		2,200	3,500	8,300	2,300	3,700	2,400	2,500	3,500
Chesterfield		-100	-100	-800	0	-100	-100	-100	-100
Leeds		-800	-2,100	-2,400	-400	-900	-600	-200	-500
York		200	0	-400	300	-500	200	200	-300
All other stations		300	800	-1,300	-1,100	500	500	-1,000	400
Total HS2 boardings		1,400 *+0.4%*	-1,900 *-0.6%*	-5,500 *-1.6%*	400 *0.1%*	1,900 *+0.6%*	1,800 *+0.5%*	800 *+0.2%*	2,100 *+0.6%*
Total HS2 boardings in South Yorkshire (Sheffield Midland + parkway)		1,600 *+17.3%*	-700 *-7.3%*	-600 *-6.5%*	1,600 *+17.9%*	2,800 *+30.4%*	1,800 *+19.4%*	1,800 *+19.5%*	2,500 *+27.8%*
Total HS2 boardings in South Yorkshire (Sheffield Midland + parkway + Chesterfield)		*1,500* *+15.8%*	*-700* *-6.8%*	*-1,300* *-13.8%*	*1,600* *+16.5%*	*2,700* *+27.7%*	*1,700* *+17.5%*	*1,700* *+17.8%*	*2,400* *+25.1%*

Source: HS2 Ltd. Note numbers may not add up due to rounding.

6.3.7 If the policy objective is to maximise HS2 passenger numbers, then our demand analysis suggests that a parkway station option would be beneficial. This is especially the case in South Yorkshire where sizable increases in the number of people using HS2 are possible.

6.3.8 In terms of the rest of the rail network and other operators, overall boardings varied by only a very small amount (a change of less than +/- 0.2 per cent for all cases). Further assessment of passenger kilometres (a potentially more meaningful indicator of the number of trips) showed even lower impacts on classic rail (typically less than +/- 0.03 per cent), well within the margins of uncertainty in the model. This suggests that any reduction observed in boardings may indicate a shift to more direct trips with fewer interchanges.

6.3.9 However, while the overall impact on classic rail demand is likely to be negligible in terms of overall passengers, our analysis suggests the impacts may vary between classic rail franchises.

Impact of a parkway on HS2 value-for-money analysis

6.3.10 Table 18 shows the impact of the range of TSS options on benefits that feed into the overall value-for-money assessment in the HS2 business case. It should be noted that a full value-for-money assessment would also consider the impact on capital and operating costs. We have not assessed these impacts here (Section 5 of the report discusses some of the relevant cost impacts).

6.3.11 In all tests (other than the parkway-only scenario), the addition of a parkway is likely to have only a very small impact on overall benefits (between -0.3 per cent and +0.1 per cent), compared with the reference case.

6.3.12 The option that shows the largest positive impact on overall scheme benefits (whereby the impact on London–Leeds times are mitigated by removing one East Midlands stop) shows positive benefits of about £70 million (or +0.1 per cent).

Table 18: Estimated impact on value-for-money assessment of parkway station options tested.

		Mexborough					Bramley		
Benefits (£m)	1. Ref case (no parkway)	2. Loop + parkway	3. Spur + parkway	4. Parkway only	5. Loop + parkway (minus one Toton)	6. Loop + parkway (3 tph)	2. Loop + parkway	5. Loop + parkway (minus one Toton)	6. Loop + parkway (3 tph)
Transport benefits (business)	53,470	53,300	53,450	52,740	53,500	53,360	53,340	53,540	53,420
Transport benefits (other)	15,100	15,070	15,040	14,880	15,050	15,090	15,120	15,090	15,140
Other quantifiable benefits	330	330	330	320	330	330	330	330	330
Loss to Government of indirect taxes	-3,640	-3,630	-3,640	-3,590	-3,640	-3,630	-3,630	-3,640	-3,630
Net Transport Benefits	65,250	65,070	65,180	64,340	65,240	65,150	65,150	65,330	65,260
Revenues	38,950	38,810	38,910	38,450	38,910	38,830	38,840	38,930	38,850

	Mexborough					Bramley		
Change in benefits relative to reference case (£m)	2. Loop + parkway	3. Spur + parkway	4. Parkway only	5. Loop + parkway (minus one Toton)	6. Loop + parkway (3 tph)	2. Loop + parkway	5. Loop + parkway (minus one Toton)	6. Loop + parkway (3 tph)
Transport benefits (business)	-170	-20	-730	30	-110	-130	80	-50
Transport benefits (other)	-20	-60	-220	-50	0	20	-10	50
Other quantifiable benefits	0	0	-10	0	0	0	0	0
Loss to Government of indirect taxes	10	0	50	0	10	10	0	10
Net Transport Benefits	-180	-80	-920	-10	-100	-100	70	10
(% change)	*-0.3%*	*-0.1%*	*-1.4%*	*0.0%*	*-0.2%*	*-0.2%*	*0.1%*	*+0.0%*
Revenues	-130	-40	-490	-40	-120	-110	-10	-90

6.3.13 It is noted that all of these estimates for changes in benefits are very low and need to be considered within the context of significance of results and underlying uncertainties of the PFM model. Our modelling of these TSS scenarios, however, does indicate that it may be possible to specify a parkway service that could marginally increase overall benefits in the HS2 value-for-money business case.

6.3.14 The analysis above considered only a limited number of TSS options. It may be possible to increase these benefits further by exploring options for service specification beyond those tested here; and by also further considering all four of the shortlisted parkway location options.

6.3.15 The parkway-only scenario shows the largest reduction in overall benefits (1.4 per cent, or £920 million). This is consistent with the findings of our work to assess changes in passenger numbers above.

6.4 Conclusions of parkway modelling

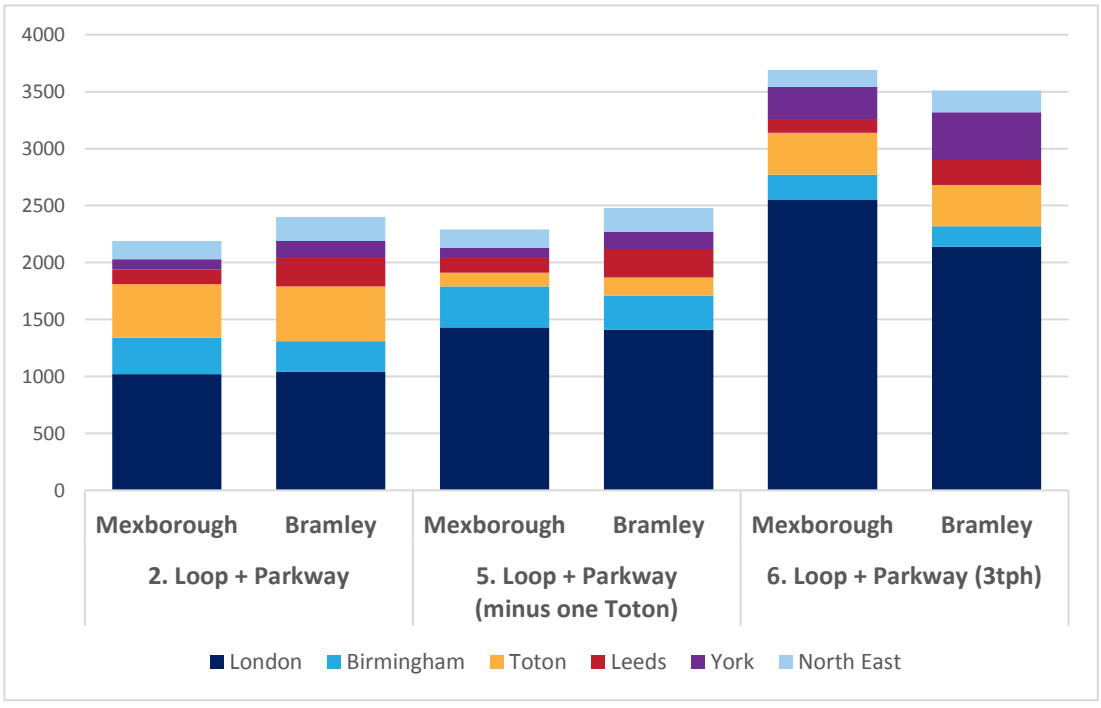
6.4.1 Our modelling shows that a South Yorkshire parkway station on the M18/Eastern route could significantly increase South Yorkshire HS2 passengers' numbers (possibly by more than 30 per cent), with a net increase also in overall HS2 passengers.

6.4.2 It also suggests that the likely overall impact on benefits that feed into the value-for-money assessment of the HS2 business case is likely to be small (generally between -0.3 per cent and +0.1 per cent change in scheme benefits), and in some cases might be slightly positive. Further options may yield more positive changes in benefits and this would need to be explored further.

6.4.3 Specifying how HS2 services might operate would require a judgement on the overall policy objectives and careful balancing between providing services to South Yorkshire and the impact on the benefits of other markets (in particular, slowing the London–Leeds services). Our analysis suggests that options which seek to offset or minimise disbenefits to HS2 passengers travelling between London and Leeds can show positive benefits overall to the HS2 business case.

6.4.4 Only one of our M18 loop-plus-parkway tests included more than two HS2 services an hour to the parkway (and only one of these connected to London). The M18 loop plus three-trains-per-hour parkway test considered a second London service to the parkway, albeit via the slower splitting services. These tests provided the greatest number of HS2 passengers from South Yorkshire, reflecting greater frequency in London connections (see Figure 34).

Figure 34: Estimated daily HS2 parkway boardings – by destination, 2037.



6.4.5 This suggests that other TSS options to serve a parkway with greater frequency (especially to London) may provide even higher HS2 passengers from South Yorkshire. These may include options, which provide frequency and use of the faster London (non-splitting) services. These would need to be explored further to understand their benefits and impacts to both passenger numbers and overall benefits.

6.5 Limitations, considerations and caveats regarding our modelling assessments

6.5.1 We undertook the modelling work for this study using HS2 Ltd's PFM, the same model used to appraise the overall HS2 value-for-money business case.

6.5.2 Modelling the movement and benefits of passengers of a large transformative national scheme like HS2 is inherently complex. The PFM has been built with the primary purpose of assessing large strategic investment decisions (the HS2 scheme as a whole), and less so for smaller regional and local transport decisions.

6.5.3 It is important, therefore, to understand the limitations, caveats and assumptions in seeking to model differences at the level of detail involved in this work. For example, comparing parkway station location options which are closely located to one another, relative to the geographic zoning employed in the model.

6.5.4 The modelling presented is intended to form only one part of the analysis undertaken for this study and, as such, caution should be exercised and further investigation undertaken before forming decisions on the basis of these results alone.

6.5.5 This is particularly important to consider given the relatively small size of variation between a number of the test results presented. These results must be considered in the context of the overall level of uncertainty in the model. Further investigation of each result would be required before forming policy decisions on these results alone.

6.5.6 Specific considerations and limitations to be aware of in this work include:

- Access to the parkway stations has only been considered and specified at an initial high level within the model. This is a complex and time-consuming task to consider fully, fairly and consistently within the model. As such, the results of station location are indicative and designed to provide initial insights on station location only, alongside the other analysis presented. Further investigation would be required – such as promoting or discounting a particular shortlisted station option – before making decisions of location on the basis of these results alone.
- No sensitivity or risk analysis has been undertaken to test the robustness of the results. This is particularly relevant given the small variations between results.

- An assessment of wider impacts or distributional impacts has not been undertaken.
- In general, it is assumed that there are no significant changes made to the rest of the transport network in response to the introduction of a parkway or extension of service[28]. We have not considered reconfiguring local and regional transport arrangements to optimally respond to and maximise the benefits of either a HS2 parkway or extension of HS2 services.
- Demand results from the model (boardings and passenger kilometres) are derived from the long-distance component of the PFM model. This has limitations when considering shorter distance journeys from parts of South Yorkshire to destinations such as Leeds (a major market for the region). In particular, this may not be consistent for all areas within South Yorkshire and is likely to significantly underestimate rail demand between Leeds and those areas of South Yorkshire outside Sheffield. Similarly, this means that significant care should be given when comparing demand between Leeds to/from different South Yorkshire locations.
- Only a small number of TSS options for a parkway station have been considered in modelling. This was intended (within the cost and time constraints of the modelling) to provide a broad range of initial evidence of how different specifications might affect passenger numbers and benefits. After considering these initial results, other TSS options could be considered to ascertain if these results could be improved further. These options would need to balance the mix of serving South Yorkshire between the parkway and Sheffield Midland with suitable frequency, while also seeking to manage the impact on the rest of the HS2 network.
- As noted elsewhere in this report, the modelling of parkways and extension of services has been undertaken using two different versions of the PFM model (version 7.0 and 6.2 respectively). These model versions include significant differences in both the reference and test cases for demand and benefits, meaning that the results cannot be directly compared. Further modelling would be required using a consistent model version to undertake a direct comparison between possible parkway and extension of service options. Section 7 contains details of the extension of services modelling that has been done as part of this study.

[28] Other than those changes assumed generally for the reference case (do minimum), the inclusion of a small number of express bus services from major urban centres to parkway locations, and a limited consideration to stopping some classic rail services at parkway locations with rail connections.

7 Serving South Yorkshire with classic compatible HS2 service extensions

7.1.1 A classic compatible service extension would extend the current proposals for the HS2 London to Sheffield Midland service to locations further north on the classic railway network. This would be analogous to HS2 services elsewhere on the classic network, which continue their journey on this network to spread the benefits of HS2 more widely.

7.2 Methodology

7.2.1 Network Rail commissioned work in 2016 in response to the DfT wider South Yorkshire remit. This work (and the associated report) identifies the infrastructure requirements necessary to facilitate provision of the HS2 London to Sheffield Midland classic compatible services. It also identifies opportunities for these classic compatible services to be extended beyond Sheffield Midland to various other South Yorkshire stations. The opportunities for extending HS2 services looked at the following locations:

- Meadowhall;
- Barnsley;
- Rotherham;
- Wakefield; and
- a new station on the existing railway network.

7.2.2 Two options were included in this existing work for a new station on the existing mainline railway that bypasses Rotherham. These options are Rotherham Masborough and Rotherham Parkgate.

7.2.3 We have undertaken further feasibility work on providing a classic compatible service extension beyond Sheffield Midland, with the existing work forming the basis of the further work we have undertaken as part of this study.

7.2.4 Having liaised with local authority stakeholders from the SCR and the WYCA regarding the work to look into extending HS2 services, we have included a new station on the existing railway network in the Dearne Valley area (called Dearne Valley Parkway) in our study work. For the purposes of this study, the new station is assumed to be located between the existing railway stations of Thurnscoe and Goldthorpe.

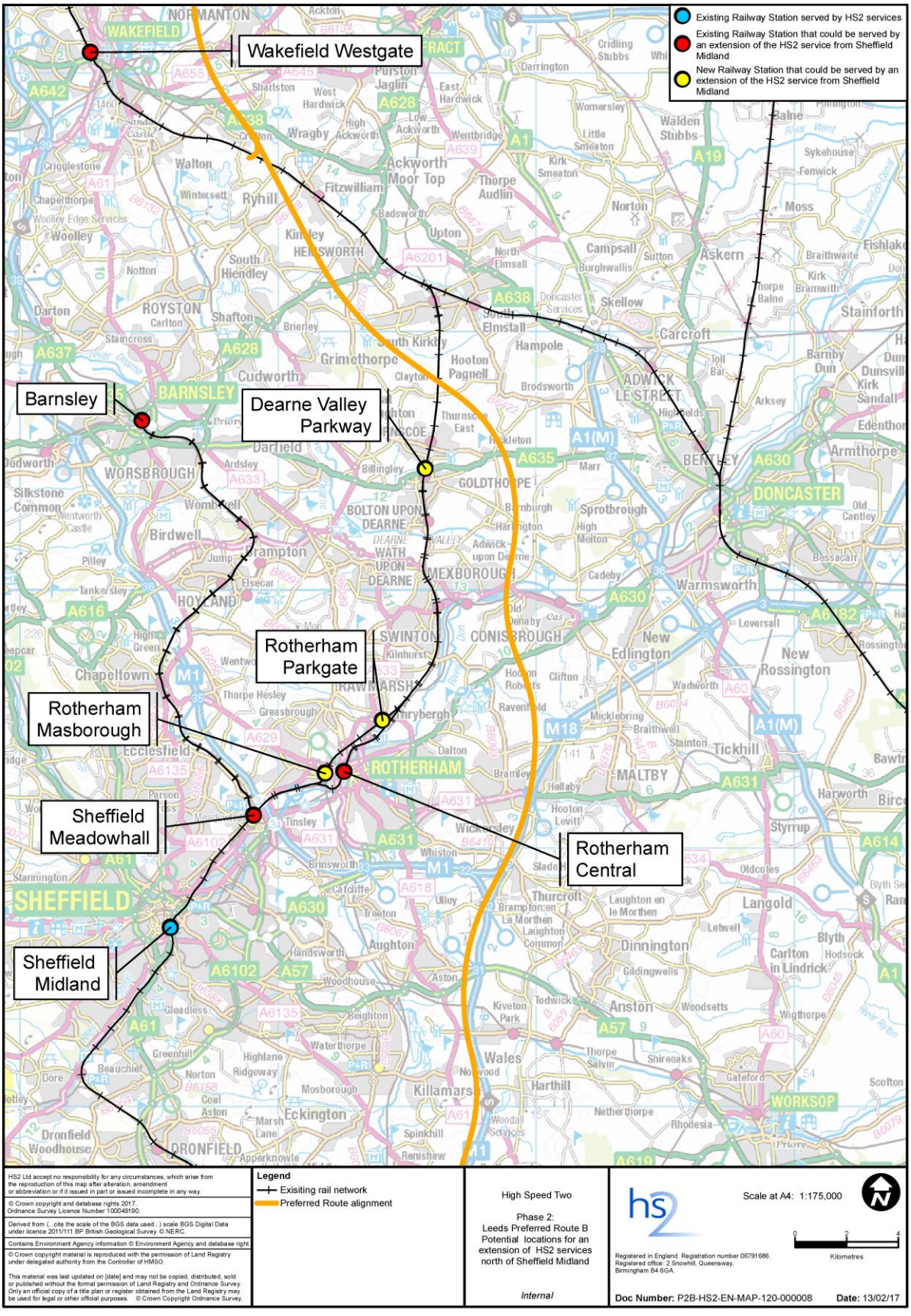
7.2.5 We did not take forward work to consider the extensions of HS2 services to locations where there is no opportunity for HS2 services to improve journey times to London over the existing network performance or the modelled HS2 performance. This means that we have not further considered the scope to extend HS2 services on the classic

network to Leeds, which receives direct HS2 high speed services. Nor have we further considered the scope to extend HS2 services on the classic network to Doncaster, where journey times that are already fast and will be further improved by the future roll out of the Intercity Express Programme on the East Coast Main Line.

7.2.6 The locations considered for an extension of the terminating HS2 service are listed below and shown in Figure 35:

- Sheffield Meadowhall (Sheffield, South Yorkshire);
- Barnsley (Barnsley, South Yorkshire);
- Rotherham Central (Rotherham, South Yorkshire);
- Rotherham Masborough (Rotherham, South Yorkshire);
- Rotherham Parkgate (Rotherham, South Yorkshire);
- Dearne Valley Parkway (Rotherham, South Yorkshire); and
- Wakefield Westgate (Wakefield, West Yorkshire).

Figure 35: Assessing potential extension of terminating Hs2 services beyond Sheffield Midland.



7.3 Classic railway network assumptions

7.3.1 The assumed state of the existing railway network in South Yorkshire when HS2 is operational in 2033, is as follows:

- a train path(s) will be available to accommodate the extension of HS2 services and European Rail Traffic Management System signalling will be fitted on all routes included in this study;
- the Midland Main Line up to Sheffield will have been electrified;
- the railway north of Sheffield up to the proposed northern junction at Clayton with HS2 will have been electrified; and
- all line speeds on existing routes north of Sheffield will be unchanged from the current line speeds.

7.4 Benefits/impacts of potential HS2 service extensions

Benefits

7.4.1 An extension of HS2 services north of Sheffield Midland to serve the wider South Yorkshire region could provide benefits and improvements to the region in accessibility towards London. The current classic railway service provision from many locations north of Sheffield does not provide direct services to London, with an interchange required at Sheffield, Wakefield or Doncaster.

7.4.2 An extension of HS2 services would provide an alternative option for users that may have driven by car, or travelled by train, and interchanged to board HS2 at Sheffield Midland or Chesterfield. To deliver the benefits of a service extension, the final destination for the service would therefore require good highway access to and from the destination, and an integrated transport system (or the potential for such a system) to the local urban areas. Similarly, the interchange between high speed and classic services should be as effective as practicable to enable a swift onward connection to other local urban centres.

Impacts

7.4.3 The options for an extension of the HS2 service need to consider the classic railway network-wide capacity and the consequential impacts. The classic railway network is more constrained to the north of Sheffield than the south, due to the greater number of routes which connect with Sheffield Midland: these come from Worksop, Barnsley, Rotherham, Doncaster and Wakefield.

7.4.4 In common with the wider HS2 scheme, further work will be required to understand how services on the classic network could change to enhance the benefits delivered by HS2.

7.4.5 The assumption that a train path(s) will be available to accommodate the extension of HS2 services is a risk to the existing network capacity of the classic railway. It should

be noted that we have not undertaken a detailed impact assessment on the capacity and capability of the classic railway network between Sheffield Midland and the final destination of the extension of service as part of this study. This could have additional ramifications for cost, which again have not been assessed.

7.4.6 Implementing an extension of the HS2 services north of Sheffield Midland could have an impact on the classic railway network capacity and capability to provide loop services as well as on any additional services on the loop proposed as part of TFN's aspirations for the NPR project. This wider context would need to be investigated further.

7.4.7 On the other hand, extending HS2 services may provide an opportunity to relieve certain capacity constraints. For example, extending HS2 services to run beyond Sheffield Midland could reduce platform occupation times at Midland station by enabling these services to turn round elsewhere.

7.5 Assessing demand for an extension of HS2 services

7.5.1 As with our assessment work for parkway station locations, we have undertaken a high-level assessment of likely demand for an extension of HS2 services. This considered:

- how accessible each option is to our focus areas across South Yorkshire (e.g. by road or rail, including journey time);
- a comparison of total door-to-door journey times that might be possible from each of the focus areas using each of the extension options; and
- the relative size of each focus area and the potential demand from each.

7.5.2 A summary of this analysis shows door-to-door journey times to London from each of our focus areas using the extension of service. This is shown in Table 19. These times assume that HS2 runs from Sheffield Midland to the extension station consistent with the current fastest journey times to that location. In some cases, it may be possible to improve these times further, should opportunities exist to run direct, non-stopping services. This would be conditional on being able to further optimise regional rail services to allow this to occur.

7.5.3 We have also undertaken an assessment of direct, non-stop service extensions. The journey time results for London Euston to the terminating location (via Sheffield Midland) are:

- London to Sheffield Meadowhall – 92 mins;
- London to Barnsley – 105 mins;
- London to Rotherham Central – 95 mins;
- London to Rotherham Masborough – 94 mins;

- London to Wakefield Westgate – 112 mins; and
- London to Dearne Valley Parkway – 99 mins.

7.5.4 In general, an extension of an HS2 service only benefits the location it calls at (e.g. an extension to Rotherham only benefits Rotherham), compared with the existing HS2 service offer at Sheffield Midland or the current journey time[29]. Also, the benefit is at most a maximum of eight minutes compared with the existing planned HS2 Sheffield Midland service[30].

7.5.5 This suggests that each of the extension of service options is unlikely to derive much demand from areas outside the local area. As such, the size of that local area is pertinent to whether or not this would potentially derive additional demand.

Table 19: Travel time to/from London (mins) (access by fastest of road or rail) – extension times assume current fastest rail time to Sheffield Midland.

Focus area	Population	Current fastest rail time (mins)	Best existing HS2 option – Sheffield Midland unless otherwise marked	Meadowhall extension	Rotherham extension	Barnsley extension	Wakefield extension	Dearne Valley extension[31]
SCR urban areas/local authorities (LAs)								
Sheffield (city centre/Midland)	Sheffield (LA): 563,750 Sheffield city centre (ward): 40,526	121	85	107	121	139	147	157
Sheffield (Meadowhall)	Sheffield (LA): 563,750 Sheffield Meadowhall (wards): 46,548	124	100*	92 (equal best with Wales parkway)	114	132	150	149
Rotherham (Rotherham)	Rotherham (LA): 260,070 Rotherham (city): 110,000	136	107*	107	99	140	152	143
Barnsley (Barnsley)	Barnsley (LA): 237,840 Barnsley (city): 92,000	156	116*	116	131	108	137	145

[29] The one exception to this rule is an extension of an HS2 service to Meadowhall, which would also provide a journey time advantage to Dearne Valley (West) Growth Area.

[30] This represents the difference between taking a conventional train from the location to Sheffield Midland (incurring a 10-minute interchange time) and an extension service (incurring a two-minute dwell time at Sheffield Midland).

[31] Goldthorpe was used as a proxy for journey times to an indicative new station to serve the Dearne Valley area and is based on current journey times.

Doncaster (Doncaster)	Doncaster (LA): 304,190 Doncaster (city): 110,000	94	116*	121	132	159	139	145
Bassetlaw (Worksop)	Bassetlaw (LA): 114,140 Worksop (city): 45,000	112	125*	130	137	158	172	157
SCR IIP Growth Areas								
Advanced Manufacturing Innovation District	(Advanced Manufacturing Park)	139 (SHF)	103	112	119	142	157	155
Doncaster/Sheffield Airport Corridor	Robin Hood Airport	120 (DON)	125	132	139	158	172	155
Dearne Valley (West)	(Gladman Business Park)	155 (SHF)	119	116	125	132	144	145
Dearne Valley (East)	(Thurnscoe Business Park)	171 (THC)	125	128	129	136	157	133
Markham Vale		129 (CHD)	97 (CHD)	124	131	153	167	157
DN7 Initiative		149 (HFS)	123	132	137	158	167	151
Areas outside South Yorkshire								
Wakefield (City)	Wakefield (LA): 331,400 Wakefield (city): 77,000	114	102 (LDS) /120* (SHF)	130	139	133	112	151
Pontefract	Wakefield (LA): 331,400 Pontefract (city): 28,000	167	113 (LDS) /135* (SHF)	136	136	154	137	148
Scunthorpe	North Lincolnshire LA: 169,200 Scunthorpe (city): 65,163	134	155*	148	177	200	186	205

Key/notes			
Fastest journey time option for this location		Faster than current time but slower than, or equal to, existing HS2 option	
Faster than current time and faster than existing HS2 option (SHF/CHD/LDS)		Slower than current journey time	
SHF = Sheffield Midland; CHD = Chesterfield; LDS = Leeds; DON = Doncaster; THC = Thurnscoe; HFS = Hatfield & Stainforth			
An interchange assumption of 10 minutes has been applied for changes between rail/HS2 and road/HS2			
Times marked (*) relate to access via conventional rail			
Current times from Growth Areas are from nearest railway station (shown with station code), assuming road access			
Source: HS2 Ltd analysis. Current fastest journey times from National Rail Enquiries (Jan 2017)			

Modelling HS2 service extension options

7.5.7 As with our approach to the analysis of the potential parkway stations, we have modelled these extension of HS2 services using our PLANET Framework Model (PFM) (version 6.2)[32]. The results of this are summarised in Table 20, for extensions to:

- Meadowhall only;
- Meadowhall and Barnsley;
- Meadowhall and Wakefield; and
- Meadowhall and Rotherham.

7.5.8 Providing these extensions at one train per hour (tph) in each direction (on the London–Sheffield Midland service) yields only a small increase in benefits and revenue; and at most, 115 additional HS2 boardings per day (for Meadowhall and Rotherham).

Table 20: Benefits, revenue and daily passengers from extending HS2 services to destinations north of Sheffield Midland (change relative to reference case).

Extension of HS2 London–Sheffield Midland services to:	Change in benefits (£m)	Change in benefits (%)	Change in revenue (£m)	Change in HS2 passengers (daily HS2 boarders)
1 tph tests				
Meadowhall	33	+0.0%	7	61
Meadowhall and Barnsley	47	+0.1%	12	89
Meadowhall and Wakefield	40	+0.0%	15	94
Meadowhall and Rotherham	53	+0.1%	13	115
2 tph tests				
Meadowhall and Rotherham	238	+0.3%	100	844 (of which 602 in SY)
Meadowhall only	201	+0.2%	77	710

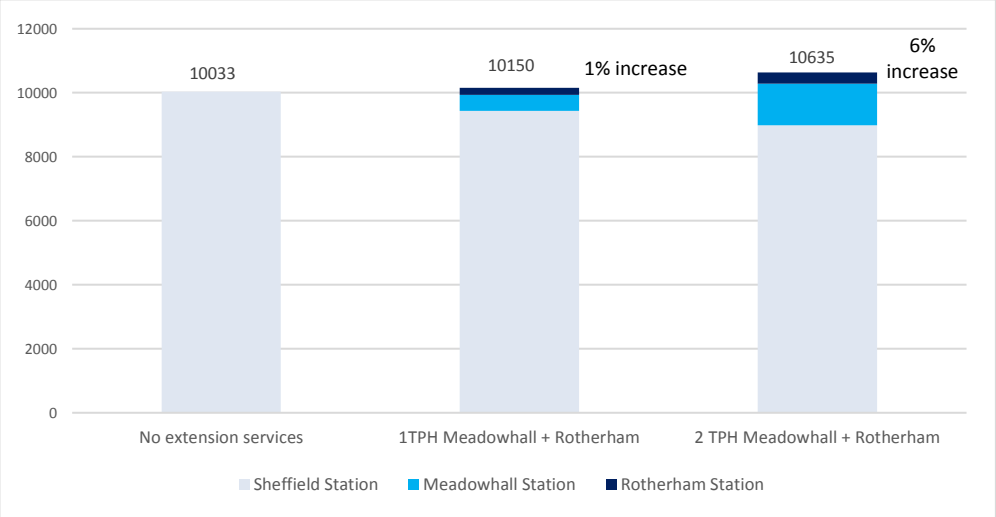
7.5.9 The PFM is highly sensitive to frequency (at small numbers of train services), owing to modelling assumptions made around wait times and passengers arriving randomly at

[32] Note that the extension of HS2 services have been modelled in a different version of the PFM than was used for the parkway analysis. As such, the results are not directly comparable. Further, there are a number of assumptions, limitations and caveats associated with the modelling of these services. These are covered in Section 7.6. The interpretation of any results should be mindful of these assumptions and caveats before drawing conclusions from the results presented.

stations. As such, one tph is far less likely to show benefits. To consider this, we reassessed the Meadowhall and Rotherham extension with two tph to London. This yielded higher benefits (£238 million, or 0.3 per cent change compared with the reference case) and higher total numbers of HS2 passengers (844 a day, of which 602 are in South Yorkshire).

7.5.10 The effect of this is presented in Figure 36. This shows that with two tph in each direction, there is an overall increase in HS2 boardings in South Yorkshire of more than six per cent, comprising a shift in passengers previously boarding at Sheffield Midland to Meadowhall and, to a lesser extent, to Rotherham. In comparison, a one-train-per-hour service to the same destinations only increases South Yorkshire passengers by one per cent.

Figure 36: HS2 boardings in South Yorkshire – extension of HS2 services to Meadowhall and Rotherham.



Source: HS2 Ltd.

7.5.11 The boarding and benefits impacts presented above are not directly comparable with the boarding numbers and benefits presented for parkway stations in Sections 5 and 6, due to modelling differences. Nonetheless, it is clear that HS2 service extensions drive significantly lower increases in passenger numbers than a parkway station on the HS2 mainline. This reflects the relatively lower improvements in journey time delivered by extending HS2 services, and more limited markets being served, as discussed above.

Other locations

7.5.12 We also considered extending HS2 services to a new Dearne Valley Parkway station in the Thurnscoe/Goldthorpe area. Our high-level assessment of population, employment and demand suggests that this location is unlikely to perform as well in our model as the other options considered above. Given the operational and capital costs involved in extending HS2 services to other city centre destinations, the lack of existing infrastructure in the immediate area, and the time and resource that would be

required to build this location in our model, we decided that, at this stage, it would be more appropriate to focus on modelling two tph variants to other stations rather than introduce this location. Similarly, we have only undertaken modelling for Rotherham Central, and not for the potential new Rotherham station options at Masborough and Parkgate[33].

7.5.13 The opportunity may also exist for services travelling on the South Yorkshire loop to stop at a new location in this area. At the moment, we understand that Network Rail has been instructed to consider what works would be required to enable HS2 services to operate on a loop basis. Once this work has generated recommendations, we can further consider whether there are opportunities to stop looped services elsewhere.

7.6 Operational implications of extending HS2 services

7.6.1 We have assessed the operational implications for timetabling and HS2 rolling stock of extending HS2 service opportunities north of Sheffield Midland.

Timetabling implications

7.6.2 The current timetabling assumption for the London Euston to Sheffield Midland services is that both trains turning round at Sheffield per hour have a turnaround time of 43.5 minutes. Assuming a 30-minute turnaround time at Sheffield Midland, this provides an available excess turnaround time of 13.5 minutes.

7.6.3 For a one tph service extension, the timetable running time (including a dwell time at Sheffield Midland of two minutes) for all locations exceeds the 13.5 minutes. This therefore triggers the need for additional rolling stock to facilitate the extension of service.

7.6.4 For a two tph service extension, there are additional timetabling implications in the cross-formation of Hs2 services and overlap in turnaround time at the termination point. In other words, it may be necessary either to accommodate more than one HS2 train in any given location at the same time, or for services to operate different services in each direction. This cross-formation would arise where an extension service that originates from a Sheffield/Leeds splitting service would return to form a Sheffield/York splitting service. This would introduce additional operational and resilience risks.

7.6.5 An overlap between the services in turnaround time requires an additional platform or turnback siding for terminating a two tph service extension.

[33] These options would have required a substantial exercise to build new locations into the PFM.

Rolling stock implications

7.6.6 In the one tph service extension scenario, all locations for an extension of service would require one additional rolling stock. This is as a result of the timetable running time (including a two-minute dwell time at Sheffield Midland) exceeding the excess turnaround time at Sheffield Midland.

7.6.7 For a two tph service extension, Meadowhall, Rotherham and Dearne Valley would require one additional rolling stock for the same operational reasoning as extending one tph.

7.6.8 Barnsley and Wakefield would require two additional rolling stock for a two tph service extension because of the longer round trip running time to these locations.

7.6.9 It should be noted that if a 25-minute turnaround were accepted, rather than a 30-minute turnaround time, then the extension of service to Meadowhall and Rotherham Masborough would require no additional rolling stock. However, this should be regarded as high risk in terms of operation as there is no additional contingency time for incurring a delay to the service on the classic railway network.

Cost of operational implications

7.6.10 The operational expenditure (OPEX) and capital expenditure (CAPEX) costs for extension of HS2 services have not been assessed in detail, due to the complex operational implications stated above for each of the locations within the study. These would be additional to the total infrastructure costs identified in the section below.

7.6.11 A high-level assessment indicates that OPEX increases as the extension of service distance increases north of Sheffield Midland. OPEX will also increase with an increase in the number of services serving a location, i.e. a change between one and two tph.

7.6.12 The indicative CAPEX for one additional rolling stock is estimated at £30 million, with two additional rolling stock being approximately £60 million.

7.6.13 A more detailed assessment would be required for the cost of operational implications should further work be taken forward. It should be noted that such operational costs are not applicable to our assessment of parkway station options.

7.7 Infrastructure requirements for an extension of HS2 services

7.7.1 We have assessed the infrastructure requirements for the HS2 extension of service opportunities north of Sheffield Midland. Our work includes a high-level analysis of capacity at each of the potential service extension destinations.

Capacity and capability analysis

7.7.2 The study has assessed the infrastructure requirements that would be needed at the end terminating location to facilitate an extension of HS2 services. The infrastructure requirements are based on extending one tph.

7.7.3 The infrastructure needed to turnback an HS2 service at the terminating location for the extension of service can be either a new platform or a new turnback siding.

7.7.4 Should termination platforms or sidings involve conflicts between trains in opposite directions, there is a high risk that paths to suit the required timings will not be available.

7.7.5 We recommend that where a new platform is required at a terminating location, the classic railway station is configured so that the centre platform is the turnback platform for HS2. This would avoid further operational implications.

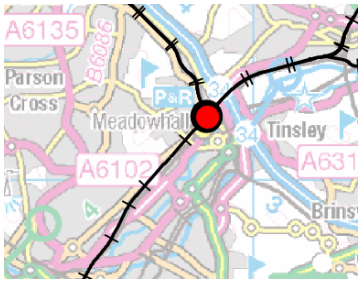
7.7.6 We have not completed a detailed impact assessment on the capacity and capability of the classic railway network between Sheffield Midland and the final extension of services location as part of this study. The study has assumed a train path(s) will be available to accommodate the extension of HS2 services – hence we have not included any infrastructure requirements to increase capacity between Sheffield Midland and the terminating location within the study.

7.7.7 We have also excluded electrification of the railway north of Sheffield up to the proposed northern junction at Clayton with HS2 from the below infrastructure requirements. We have assumed this route will have been electrified prior to the introduction of HS2 services to Sheffield Midland.

Meadowhall

7.7.8 Meadowhall is an existing railway station that currently has four platforms: two on the Sheffield towards Rotherham/Doncaster route and two on the Sheffield to Barnsley route.

Figure 37: Meadowhall station.



7.7.9 Meadowhall is located close to the M1 Junction 34 and all local rail services currently call at Meadowhall. Only long-distance rail services pass through the existing station without stopping. The station also connects with the Sheffield Super-Tram network.

7.7.10 The following infrastructure would be required to facilitate an extension of HS2 services for one tph to Meadowhall:

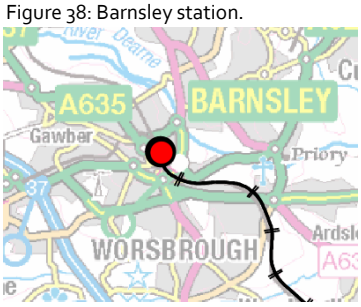
- a new down platform loop to accommodate the terminating service;
- extension of the existing platforms to 200 metres; and
- a new turnback siding and associated crossover north of Meadowhall station.

7.7.11 We estimate that this infrastructure would cost in the region of £64 million.

Barnsley

7.7.12 Barnsley is an existing railway station that currently has two platforms. It is situated on the Sheffield to Leeds via Barnsley route.

Figure 38: Barnsley station.



7.7.13 The station is located in the town centre with an existing bus interchange outside the railway station. All existing rail services call at Barnsley, connecting to local stations along the route.

7.7.14 The following infrastructure would be required to accommodate an extension of HS2 services for one tph to Barnsley:

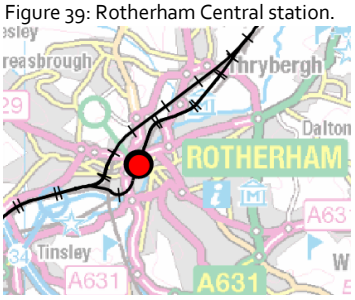
- electrification of the route from Meadowhall to Barnsley;
- existing platforms at Barnsley extended to 200m; and
- a new turnback siding and associated crossover north of Barnsley station.

7.7.15 We estimate that this infrastructure would cost in the region of £350 million.

Rotherham Central

7.7.16 Rotherham Central is an existing railway station that currently has two platforms. The station, located in the town centre, is situated on a loop off the mainline route between Sheffield to Wakefield and Doncaster routes.

Figure 39: Rotherham Central station.



7.7.17 Local rail services currently serve Rotherham Central. There is also a committed scheme to provide tram-train services to Rotherham Central from Sheffield using the Tinsley freight route as an extension to the Sheffield Super-Tram network.

7.7.18 The following infrastructure would be required to accommodate an extension of HS2 services for one tph to Rotherham Central:

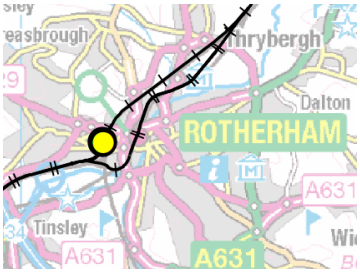
- electrification of the route from Holmes Junction to Rotherham Central junction;
- existing platforms at Rotherham Central extended to 200 metres;
- a new turnback siding and associated crossover to the north of Rotherham Central;
- new flyover at Holmes Junction to double-track the section of route between Meadowhall and Rotherham Central; and
- closure of Holmes Junction level crossing and provision of a new road bridge.

7.7.19 We estimate that this infrastructure would cost in the region of £224 million.

Rotherham Masborough

7.7.20 Rotherham Masborough is a former railway station on the mainline route from Sheffield to Doncaster and Wakefield. The station closed in 1988 and is located on the A629.

Figure 40: Rotherham Masborough station



7.7.21 The route through the station is used by long-distance rail services and some local services with the majority of local rail services being routed via Rotherham Central.

7.7.22 There is an opportunity to create a new railway station and rail interchange for Rotherham at Masborough, in close proximity to Rotherham Central. We have assumed that local rail services would serve Masborough to connect with the HS2 service.

7.7.23 The following infrastructure would be required to accommodate an extension of HS2 services for one tph to Rotherham Masborough:

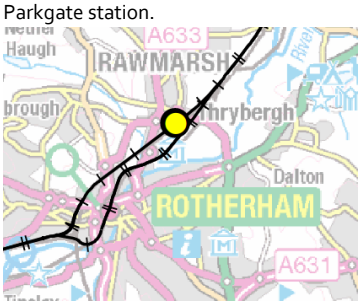
- the provision of a new station at Masborough with associated facilities and car parking;
- the station would be a three-platform station with a down platform loop required to accommodate terminating service; and
- the closure of Holmes Junction level crossing and provision of a new road bridge.

7.7.24 We estimate that this infrastructure would cost in the region of £142 million.

Rotherham Parkgate

7.7.25 Rotherham Parkgate would be a new railway station on the mainline route from Sheffield to Doncaster and Wakefield. Access to the station would be from the A6123 or A633.

Figure 41: Indicative location for Rotherham Parkgate station.



7.7.26 The route through the station is used by long-distance rail services and some local services with the majority of local rail services being routed via Rotherham Central.

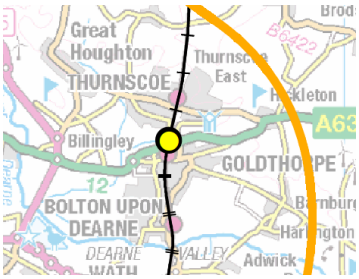
7.7.27 There is an opportunity to create a new railway station and rail interchange for Rotherham at Parkgate. The new station would be adjacent to the Rotherham Parkgate station where tram-train services from Sheffield and Rotherham Central would terminate. We have assumed that local rail services would serve Parkgate to connect with the HS2 service.

7.7.28 To accommodate an extension of HS2 services for one tph to Rotherham Parkgate, we have assumed that the same infrastructure would be required as that needed for Rotherham Masborough (at the same estimated cost).

Dearne Valley Parkway

7.7.29 Dearne Valley Parkway would be a new railway station on the mainline route from Sheffield to Wakefield. We have assumed that the new Dearne Valley Parkway station will be located between the existing railway stations of Thurnscoe and Goldthorpe. Access to the station would be from the A635.

Figure 42: Indicative location for a Dearne Valley Parkway station.



7.7.30 The route through the station is used by long-distance rail services and local rail services.

7.7.31 We have assumed that local rail services would serve Dearne Valley Parkway to connect with the HS2 service.

7.7.32 The following infrastructure would be required to accommodate an extension of HS2 services for one tph to Dearne Valley Parkway:

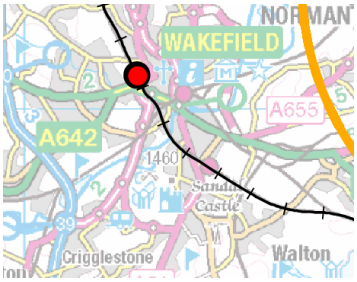
- a new station at Dearne Valley Parkway, associated facilities and car parking for parkway-type station;
- the new station would be a three-platform station with a down platform loop required to accommodate terminating services; and
- the closure of Holmes Junction level crossing and provision of a new road bridge.

7.7.33 We estimate that this infrastructure would cost in the region of £104 million.

Wakefield Westgate

7.7.34 Wakefield Westgate is an existing railway station that currently has two platforms. It is situated on the Doncaster to Leeds route, a spur off the East Coast Main Line.

Figure 43: Wakefield Westgate station.



7.7.35 The station is located in the city centre with an existing bus interchange outside the railway station. All existing rail services call at Wakefield Westgate, connecting to Leeds, Doncaster and Sheffield, as well as at local stations along the route.

7.7.36 To accommodate an extension of HS2 services for one tph to Wakefield Westgate, the following infrastructure would be required:

- enhancements to the existing signalling and turnback siding facilities; and
- the closure of Holmes Junction level crossing and provision of a new road bridge.

7.7.37 We estimate that this infrastructure would cost in the region of £94 million.

Infrastructure requirements for the extension of HS2 services for two trains per hour

7.7.38 The estimated costings for each service section that are shown above have been provided on the basis of one train per hour. It should be noted that if two HS2 trains per hour were to be extended, then all locations would need additional infrastructure due to the operational implications discussed in Section 7.6. This additional infrastructure would be either an additional platform or additional turnback sidings to facilitate the turnback of HS2 services.

7.7.39 We have not explored the additional cost of infrastructure requirements for extending two HS2 trains per hour in this study. Further work with Network Rail would be required to understand the infrastructure requirements for doing this.

7.8 Conclusions of work to assess extensions of Hs2 services

7.8.1 The work we have done to assess potential HS2 service extensions to destinations north of Sheffield has indicated that extending one tph to any of the destinations examined may not be viable. This is due to the limited demand, operational requirements and the additional infrastructure required.

7.8.2 However, based on our modelling work to assess the provision of two tph to Meadowhall and Rotherham, the initial indications are that further investigation of Meadowhall service extensions may provide a small increase in South Yorkshire passengers.

7.8.3 A summary of our work to assess each extension of service option is shown in Tables 21 and 22. Note that the costs shown in Table 22 are for the infrastructure required at the terminating location only, and are based on an extension of one tph. Further work would be required to understand the full extent of costs associated with extending two tph, with regards to additional infrastructure requirements. Further work would also be required to assess the costs of the operational implications of extending services.

Table 21: Summary assessment for extending HS2 services north of Sheffield Midland – accessibility, connectivity and journey time .

Extension of HS2 services summary: accessibility, connectivity, journey time		Meadowhall	Barnsley	Rotherham Central	Rotherham Masborough or Parkgate	Wakefield Westgate	Dearne Valley Parkway[34]
Accessibility and connectivity	**Existing station**	Yes	Yes	Yes	No	Yes	No
	Station location	M1 Junction 34	Town centre	Town centre	A629 (Masborough) or A6123 (Parkgate)	City centre	A635
	HS2 journey time to London (assuming non-stop)	92 mins	105 mins	95 mins	94 mins (Masborough as fastest)	112 mins	99 mins
Journey time to London **Red** = worse than current offer (HS2 Sheffield or current journey time) **Green*** = better than current offer **Underlined** = overall best option for location (inc. parkways)	**Urban areas**	**Sheffield (city)** **Sheffield (Meadowhall)*** **Rotherham** **Barnsley** **Doncaster** **Wakefield** **Worksop**	**Sheffield (city)** **Sheffield (Meadowhall)** **Rotherham** **Barnsley*** **Doncaster** **Wakefield** **Worksop**	**Sheffield (city)** **Sheffield (Meadowhall)** **Rotherham*** **Barnsley** **Doncaster** **Wakefield** **Worksop**	**Sheffield (city)** **Sheffield (Meadowhall)** **Rotherham*** **Barnsley** **Doncaster** **Wakefield** **Worksop**	**Sheffield (city)** **Sheffield (Meadowhall)** **Rotherham** **Barnsley** **Doncaster** **Wakefield*** **Worksop**	**Sheffield (city)** **Sheffield (Meadowhall)** **Rotherham** **Barnsley** **Doncaster** **Wakefield** **Worksop**
	SCR IIP Growth Areas	**AMP/AMID** **Robin Hood Airport** **Dearne Valley(W)*** **Dearne Valley (E)** **Markham Vale** **DN7**	**AMP/AMID** **Robin Hood Airport** **Dearne Valley(W)** **Dearne Valley (E)** **Markham Vale** **DN7**	**AMP/AMID** **Robin Hood Airport** **Dearne Valley (W)** **Dearne Valley (E)** **Markham Vale** **DN7**	**AMP/AMID** **Robin Hood Airport** **Dearne Valley (W)** **Dearne Valley (E)** **Markham Vale** **DN7**	**AMP/AMID** **Robin Hood Airport** **Dearne Valley (W)** **Dearne Valley (E)** **Markham Vale** **DN7**	**AMP/AMID** **Robin Hood Airport** **Dearne Valley (W)** **Dearne Valley (E)** **Markham Vale** **DN7**

[34] Goldthorpe was used as a proxy for journey times to an indicative new station to serve the Dearne Valley area and is based on current journey times.

Table 22: Summary assessment for extending HS2 services north of Sheffield Midland – infrastructure requirements, operational implications and cost.

Extension of services summary: infrastructure, operations, cost		Meadowhall	Barnsley	Rotherham Central	Rotherham Masborough or Parkgate	Wakefield Westgate	Dearne Valley parkway
Infrastructure requirements at terminating location for 1tph service extension		New down platform loop. Extend platforms to 200 metres. New turnback siding	Electrification from Meadowhall to Barnsley. Extend platforms to 200 metres. New turnback siding	Electrification from Holmes Junction (Jn) to Rotherham Central Jn. Extend platforms to 200 metres. New turnback siding. Holmes Jn flyover. Holmes Jn level crossing (LC) closure	New station including down platform loop. Holmes Jn LC closure. Car parking	Signalling and turnback siding facilities enhancements. Holmes Jn LC closure. Car parking	New station including down platform loop. Holmes Jn LC closure. Car parking
Infrastructure cost (£m) at terminating location – for 1tph service extension only		£64 (1tph only)	£350 (1tph only)	£224 (1tph only)	£142 (1tph only)	£94 (1tph only)	£104 (1tph only)
Infrastructure cost to allow 2tph (in addition to above)		Not assessed – additional to above					
Operational costs	**E.g. OPEX and rolling stock CAPEX**	Not assessed – additional to above					
Operational implications 1tph extension	**Timetabling**	The round trip running time for all locations exceeds the excess turnaround time at Sheffield Midland of 13 ½ mins					
	Additional rolling stock	1	1	1	1	1	1
Operational implications 2tph extension	**Timetabling**	Cross-formation between Sheffield services that split at East Midlands Hub Overlap at termination point requires additional platform or additional turnback siding					
	Additional rolling stock	1	2	1	1	2	1

8 Findings, conclusions and recommendations

8.1.1 Our work has involved a comprehensive assessment of the potential additional options to serve the wider South Yorkshire region that might not otherwise be well served by the proposed M18/Eastern route of Phase 2b of HS2.

8.1.2 We recognise that the demand for rail travel in South Yorkshire is complex and that observed demand in some areas may underrepresent actual desire for rail travel, particularly when compared with centres such as Doncaster and Sheffield that already have good rail connectivity. It is reasonable to argue that the demand picture is more nuanced than our modelling suggests; however, it is not possible to assert what this alternative picture might look like on the basis of the available evidence.

8.2 Parkway station options

8.2.1 In terms of the work to assess potential parkway station options, none of the work that we have undertaken provides a clear preference for a specific parkway location.

8.2.2 Based on our initial TSS tests, there were similar results across all four shortlisted parkway locations on aggregate economic grounds and demand. This makes it difficult to determine the best station location on these results alone.

8.2.3 Our engineering and sustainability assessment work resulted in a slight preference for Bramley over Hemsworth. Wales and Mexborough cost significantly more, being more challenging to construct and having significantly more sustainability impacts.

8.2.4 It is important to note that there are some qualitative differences between the shortlisted parkway station options that need to be considered. The most notable is the potential for synergy between a potential parkway station site at Hemsworth and future NPR services, with the Hemsworth site being located north of the proposed M18 northern loop connection at Clayton.

8.2.5 Our further modelling work to assess a range of TSS scenarios to representative parkway station locations at Mexborough and Bramley shows that a South Yorkshire parkway station on the M18/Eastern route could significantly increase South Yorkshire HS2 passengers (possibly by more than 30 per cent), with a net increase also in overall HS2 passengers.

8.2.6 The overall impact on benefits that feed into the value-for-money assessment of the HS2 business case is likely to be small (generally between -0.3 per cent and +0.1 per cent change in scheme benefits), and in some cases might be slightly positive. Our testing of a small range of service options generally produced only small variations in the overall benefits to the HS2 scheme at the national level. Although we observed an increase in the estimated benefits in certain cases, this was also small.

8.2.7 This does not suggest, therefore, that there is a clear-cut value-for-money case for a parkway *per se*, especially once the costs of delivering such a station are also considered. We note, however, that further TSS options may yield more positive changes in benefits and this would need to be explored further.

8.2.8 We recognise that while the value-for-money case is an important consideration for a parkway station, it is not the only issue. We also need to bear in mind questions of the wider strategic relevance of such a station, especially given longer-term development aspirations in the region. This is particularly relevant in the event that TfN advances proposals which might require further consideration in this context.

8.2.9 Similarly, we need to bear in mind that population, employment and demand for travel are distributed widely within the region, compared to regions such as Leeds City Region or Greater Manchester, where there is a large urban centre. Also, the distribution of travel demand in South Yorkshire might change over time. A parkway station may offer the opportunity to further future-proof the HS2 scheme against uncertainty over future patterns of rail demand in South Yorkshire, which may not closely resemble existing patterns.

8.2.10 Finally, we should reflect on commercial considerations. The case for a parkway station may look different if there is wider regional engagement in facilitating its delivery through agreements about future investment and development.

8.2.11 In this context, it is clear that a parkway station has the potential to significantly increase the number of people using HS2 in South Yorkshire, suggesting that it could contribute to improving the service delivered by HS2 to the region. The populations that would be served vary depending on the location of any parkway station, which again reflects the distributed nature of demand in the region. Regardless of any decision on whether to build a parkway station and its location, the results of our tests demonstrate that serving Sheffield Midland remains an important part of the HS2 service offer in South Yorkshire.

8.2.12 Our work also demonstrates that stopping HS2 services at a parkway station may have an impact on other destinations, mainly in terms of longer journey times for those services. Fine-tuning of the TSS may help to offset this impact and its disbenefits for other markets on the HS2 network. Nonetheless, decision makers need to consider this wider context alongside the regional issues discussed above.

8.2.13 We recommend, therefore, that this work forms the basis of further discussion with the region to identify:

- whether a proposed location for a parkway could be agreed;
- how this could interact with future development and investment across the region in housing, jobs and infrastructure; and
- wider strategic considerations, including consideration of commercial and funding issues.

8.2.14 The opportunity to include a parkway station in the HS2 Phase 2b scheme is time-limited. The timescale for delivery of a parkway is constrained by the need to amend the Phase 2b mainline were a parkway to be proposed. Even if a parkway were not proposed as a core part of the scheme, providing for its future delivery would require changes to the HS2 route presented in the Phase 2b hybrid Bill and would therefore need to be appropriately justified in business case terms.

8.3 HS2 service extension options

8.3.1 Whereas we saw evidence that parkway stations have the potential to improve the HS2 service offer to a range of locations across South Yorkshire, the impact of extending HS2 services beyond Sheffield Midland was more local and tended to deliver benefits mainly to the specific location served. Our work suggested that, based on the options assessed, South Yorkshire passenger numbers could increase by up to a maximum of six per cent (in the case of two tph to Meadowhall and Rotherham). In large part, the extended service shifted passengers already planning to board the HS2 service at Sheffield Midland to the local station.

8.3.2 The boarding and benefits results presented in our report for parkways and HS2 service extensions are not directly comparable due to modelling differences. Nonetheless, it is clear that HS2 service extensions drive a significantly lower level of increases in passenger numbers than a parkway station on the HS2 mainline. This reflects the relatively lower improvements in journey time delivered by service extensions, and the more limited markets being served.

8.3.3 However, our assessment is that in some locations, short distance service extensions could provide some benefits. In particular, the results of our initial analysis on extending the two HS2 Sheffield Midland-terminating services to Meadowhall and/or Rotherham suggests that this might deliver some benefits, particularly if two tph were extended. We note it may be possible to send services on to Meadowhall within the window available in the existing TSS.

8.3.4 It should be noted that the costs we have used to assess the infrastructure required to extend the HS2 service between Sheffield Midland and the terminating location are based on an extension of one tph. The benefits associated with extending two tph to Rotherham or Meadowhall do not take into account the full costs of doing this. Further work would be required to understand the full extent of costs associated with extending two tph, with regards to additional infrastructure requirements and additional operational implications.

8.3.5 All of these service extension options do require additional investment on the existing network. They may also increase the operational risk to HS2 if running on the classic network introduces additional reliability challenges. As we noted above, there may also be some opportunities to address existing constraints – notably at Midland Station – but these will come with their own challenges and further work will be needed to understand the balance of risk and opportunity.

8.3.6 Our initial assessment suggests that hybrid Bill powers may not be necessary to deliver the interventions required to facilitate these HS2 service extensions. Accordingly, decisions on this issue can be taken over a somewhat longer timescale, although we would still need to understand the likely level of service provision for the hybrid Bill process given the need to appraise the environmental impacts of the HS2 scheme and to establish a robust and credible case for the scheme.

8.3.7 One key issue is whether the extension of HS2 services represents the best use of a finite level of capacity on the existing rail network. This would need to be considered in liaison with Network Rail and the region, to understand the risks and opportunities of such proposals.

8.3.8 We therefore recommend that, if there is interest in pursuing this work further, the following work is required:

- further engagement with the region to understand the appetite regionally for potential HS2 service extensions and the most appropriate locations for these extensions;
- consideration with Network Rail, TfN and other stakeholders about the potential interaction between HS2 and other services in the region;
- further consideration about the operational risks and opportunities to HS2 and the classic network presented by service extensions; and
- more detailed work to understand the infrastructure and rolling stock implications of any such service extension.

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