Options for phase two of the high speed rail network

A report to Government by HS2 Ltd

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Preface to March 2012 reports

This report was submitted to Government by HS2 Ltd at the end of March 2012 and is part of a suite of documents produced to provide preliminary advice to Government on potential options for phase two of the high speed rail network.

For details of the initial preferred scheme selected by Government, please see the Command Paper[1]. The initial preferred scheme will form the basis of further engagement. A preferred scheme will be published in 2013 that will form the basis of full public consultation.

Anyone reading the March 2012 reports should be aware of the following:

- The reports describe the development of options. The base proposition referred to is not a recommended or preferred scheme.

- The reports describe route and station options serving Heathrow T5. The options do not reflect an initial preferred scheme. The Government has announced its intention to suspend work on high speed rail options to Heathrow until the Airports Commission has reported.

- Where the Ordnance Survey Licence Number is shown on maps it should read 100049190.

[1] *High Speed Rail: Investing in Britain's Future*
Phase Two: The route to Leeds, Manchester and beyond

Foreword

In January 2012 the Government announced its decision to embark on the most significant transport project since the building of the motorways, the development and delivery of a new national high speed rail network.

The announcement marked a significant point for HS2 Ltd coming three years after we were established to advise the Government about the case for high speed rail and provide proposals for the phase one development of a new high speed rail line between London and the West Midlands.

This report is the first step in the development of phase two of the high speed rail network. In the proposals for the Y network we set out options for the onward legs from the West Midlands to Manchester and Leeds with stations in South Yorkshire and East Midlands and a direct high speed line serving a station at Heathrow. We also describe options for serving cities beyond the network, direct trains serving cities such as Liverpool, Newcastle, Glasgow and Edinburgh.

Since being given our remit by Government for phase two, we have developed and refined the options described in this report adopting the same approach as we did for phase one. We have made use of expert analysis in engineering, sustainability and analytical fields and benefited from the involvement, in confidence, of our regional stakeholders. Their views have contributed significantly throughout the process and we are grateful for their input.

The successful delivery of phase two, opening in 2032/33, will create a truly national high speed rail network. It will bring cities and regions of the north and south closer together as never before. It offers the opportunity to change the way people travel making high speed rail the mode of choice for long distance journeys. It is a once in a lifetime transport project that has the potential to deliver real economic growth across the country. The benefits must be balanced with the potential costs, and the financial and sustainability impacts have been crucial in the choices made and the options identified.

This report begins the development of phase two of the high speed rail network. It provides the Government with the evidence and advice it needs to engage and take decisions on its preferred scheme. We look forward to continuing to work with the Government on the future development of high speed rail.

Sir Brian Briscoe
Chairman

High Speed Two (HS2) Limited
March 2012

Contents

Executive summary		**1**
Chapter 1	**The context for high speed rail**	**10**
1.1	Rationale and specific remit	10
1.2	HS2 Ltd's remit and scope	12
1.3	The status of HS2 Ltd	13
1.4	The Government's policy goals	15
Chapter 2	**Our approach**	**17**
2.1	Establishing the case – our approach	17
2.2	Design and appraisal – specification and assumptions	20
2.3	Our assumptions	21
Chapter 3	**Methodology**	**25**
3.1	Tackling our remit	25
3.2	Option generation and sifting	25
Chapter 4	**West Midlands to Manchester**	**29**
4.1	Introduction	29
4.2	Geographic overview	31
4.3	Routes between Lichfield, the Manchester outskirts and Golborne	34
4.4	Intermediate station options on the route to Manchester	70
4.5	Routes to Preston and interchange option	75
4.6	Approaches into Manchester city centre	89
4.7	Manchester city centre stations	106
4.8	Interchange station options in the Manchester area	126
4.9	Routes and stations: Key decisions for Government	144
Chapter 5	**West Midlands to Leeds**	**146**
5.1	Introduction	146
5.2	Geographic overview	148
5.3	Routes between Water Orton and East Midlands	153
5.4	East Midlands stations	176
5.5	Routes between East Midlands and South Yorkshire	196
5.6	South Yorkshire stations	225
5.7	Routes between South Yorkshire and Leeds	245
5.8	Leeds city centre station	263
5.9	Connecting to the ECML and interchange station options	284
5.10	Routes and stations: Key decisions for Government	296
Chapter 6	**Heathrow**	**298**
6.1	Introduction	298
6.2	Demand for international high speed rail services from Heathrow	311
Chapter 7	**Maintenance and stabling infrastructure**	314
7.1	Introduction	314
7.2	Maintenance depots - approach	314
7.3	Proposed depot options and alternatives	321

Chapter 8	**Base proposition**	**332**
8.1	Introduction	332
8.2	Base proposition	333
References		**343**
List of supporting documents		**345**
List of acronyms		**346**
Glossary of terms		**347**

Maps and images

HS2 Ltd recommends that readers print high quality colour versions of this report to view the maps and images.

On the maps and images contained within, where high speed route options appear to overlap with existing rail lines, this represents the high speed option running alongside the existing railway, not on top or in place of it.

List of figures

Figure 1.1	How HS2 proposals for phase one have developed	10
Figure 2.1	HS2 Ltd decision making process	17
Figure 3.1	The relationship between the sifting process and the development of options	25
Figure 4.1	Geographic overview of the Manchester leg corridor	31
Figure 4.2	Routes between Lichfield, the Manchester outskirts and Golborne long listing stage	36
Figure 4.3	Routes between Lichfield, the Manchester outskirts and Golborne short listing stage	39
Figure 4.4	Routes between Lichfield, the Manchester outskirts and Golborne selecting options for refinement stage	42
Figure 4.5	Routes between Lichfield, the Manchester outskirts and Golborne final options	46
Figure 4.6	Lichfield to Newcastle-under-Lyme northern route option with variant	47
Figure 4.7	Lichfield to Newcastle-under-Lyme southern option route	51
Figure 4.8	Newcastle-under-Lyme to Crewe western route	53
Figure 4.9	Liverpool, Crewe and other intermediate markets – demand for long distance travel	55
Figure 4.10	Newcastle-under-Lyme to Sandbach M6 route	58
Figure 4.11	Crewe to Golborne western route	60
Figure 4.12	Sandbach to Golborne M6 route	64
Figure 4.13	Sandbach to Golborne via Airport route	66
Figure 4.14	Demand for long distance travel in south Cheshire and north Staffordshire	71
Figure 4.15	Manchester leg intermediate station options	72
Figure 4.16	M6 Junction 16 intermediate station	73
Figure 4.17	Routes to Preston long listing stage	76
Figure 4.18	Routes to Preston short listing stage	77
Figure 4.19	Routes to Preston selecting options for refinement stage	79
Figure 4.20	Route from Golborne to Preston	81
Figure 4.21	Preston interchange station options	85
Figure 4.22	Preston M55 interchange option	86
Figure 4.23	Approaches to Manchester long listing stage	90
Figure 4.24	Approaches to Manchester short listing stage	91
Figure 4.25	Approaches to Manchester selecting options for refinement stage	92
Figure 4.26	Approaches to Manchester final approach route options	93
Figure 4.27	Airport and south Manchester tunnel route to Manchester	94
Figure 4.28	Mersey and tunnel approach to Manchester	97
Figure 4.29	M62 approach route to serve a station at Salford	100
Figure 4.30	Chat Moss corridor approach to Salford	102
Figure 4.31	Manchester and Metrolink area – demand for long distance travel	106
Figure 4.32	Manchester city centre station area options	109

Figure 4.33	Manchester city centre station long list to final options	112
Figure 4.34	Selecting the final options for Manchester city centre station	113
Figure 4.35	Proposed Manchester Piccadilly station layout	115
Figure 4.36	Manchester Piccadilly indicative station illustration	116
Figure 4.37	Proposed Salford Central Middlewood station layout	118
Figure 4.38	Salford Central Middlewood indicative station illustration	119
Figure 4.39	Proposed Salford Central combined station layout	121
Figure 4.40	Salford Central combined indicative station illustration	122
Figure 4.41	Manchester, Stockport and Macclesfield – demand for long distance travel	127
Figure 4.42	Manchester interchange station options	129
Figure 4.43	Manchester interchange station long list to final options	131
Figure 4.44	Proposed Manchester Airport Davenport Green interchange station option	133
Figure 4.45	Proposed Manchester Airport north-south interchange station option	136
Figure 4.46	Proposed Manchester Airport east-west interchange station option	138
Figure 4.47	Proposed Knutsford – Sandbach to Golborne M6 route interchange option 5	140
Figure 4.48	Proposed Knutsford – Sandbach to Golborne M6 route interchange option 5a	141
Figure 4.49	Manchester leg final options	144
Figure 5.1	Geographic overview of West Midlands to Leeds	148
Figure 5.2	Broad line of route options for serving the East Midlands	151
Figure 5.3	Generation of initial ideas and sifting down to a long list for route options to the East Midlands	154
Figure 5.4	Creation of a short list of routes to the East Midlands	157
Figure 5.5	East Midlands routes selecting options for refinement stage	160
Figure 5.6	Water Orton to Toton via north of Measham	164
Figure 5.7	Water Orton to Toton via south of Measham	166
Figure 5.8	Water Orton to Toton avoiding River Mease SAC	168
Figure 5.9	Water Orton to Derby Midland	172
Figure 5.10	East Midlands three cities sub-region – demand for long distance travel	176
Figure 5.11	East Midlands station options sifting process	179
Figure 5.12	East Midlands station long list to final options	182
Figure 5.13	East Midlands stations final options	185
Figure 5.14	Derby Midland station layout	186
Figure 5.15	Derby Midland indicative station illustration	187
Figure 5.16	Toton station layout	189
Figure 5.17	Toton station indicative station illustration	190
Figure 5.18	Demand changes in East Midlands – Derby station	191
Figure 5.19	Demand changes in East Midlands – Toton station	192
Figure 5.20	South Yorkshire route options long listing stage	197
Figure 5.21	South Yorkshire route options short listing stage	199

Figure 5.22	South Yorkshire route options selecting options for refinement stage	201
Figure 5.23	Derby to South Yorkshire via the A38	205
Figure 5.24	Toton to Sheffield via the Erewash Valley	208
Figure 5.25	Toton to Sheffield via the M1	214
Figure 5.26	Sheffield Victoria loop	220
Figure 5.27	South Yorkshire – demand for long distance travel	225
Figure 5.28	South Yorkshire station options sifting process	227
Figure 5.29	South Yorkshire station long list to final options	230
Figure 5.30	South Yorkshire stations final options	234
Figure 5.31	Proposed Sheffield Victoria station layout	235
Figure 5.32	Sheffield Victoria station indicative illustration	236
Figure 5.33	Proposed Meadowhall station layout	238
Figure 5.34	Meadowhall station indicative illustration	240
Figure 5.35	Leeds route short listing stage	247
Figure 5.36	Leeds route options for refinement stage	250
Figure 5.37	Cold Hiendley to south facing Leeds station via Woodlesford	253
Figure 5.38	Cold Hiendley to Lofthouse (Transpennine) route	256
Figure 5.39	Cold Hiendley to Leeds city centre via Woodlesford route	259
Figure 5.40	Leeds and surrounding area – demand for long distance travel	263
Figure 5.41	Leeds city centre station options sifting process	265
Figure 5.42	Leeds station long list to final options	268
Figure 5.43	Proposed Leeds city centre station final options	271
Figure 5.44	Leeds station north layout	273
Figure 5.45	Leeds station north indicative illustration	274
Figure 5.46	Proposed Sovereign Street South station layout	276
Figure 5.47	Sovereign Street South indicative station illustration	277
Figure 5.48	Proposed New Lane station layout	279
Figure 5.49	New Lane indicative station illustration	281
Figure 5.50	Connections to the East Coast Main Line short listing stage	285
Figure 5.51	Connections to the East Coast Main Line selecting options for refinement stage	287
Figure 5.52	Cold Hiendley to Church Fenton via Garforth	290
Figure 5.53	Cold Hiendley to Church Fenton via Castleford	293
Figure 5.54	Leeds leg final options	296
Figure 6.1	Heathrow east to west station layout	302
Figure 6.2	Heathrow east to west indicative station illustration	303
Figure 6.3	Heathrow north to south station layout	304
Figure 6.4	Heathrow north to south indicative station illustration	305
Figure 6.5	Heathrow spur east surface route	310
Figure 7.1	Manchester leg infrastructure maintenance depot options sifting process	317
Figure 7.2	Leeds leg infrastructure maintenance depot options sifting process	318
Figure 7.3	Manchester leg rolling stock maintenance depot options sifting process	319

Figure 7.4	Leedsleg rolling stock maintenance depot options sifting process	320
Figure 7.5	Crewe infrastructure maintenance depot option	322
Figure 7.6	West Alsager infrastructure maintenance depot option	323
Figure 7.7	Staveley infrastructure maintenance depot option	324
Figure 7.8	Golborne rolling stock maintenance depot option	325
Figure 7.9	Barton rolling stock maintenance depot option	327
Figure 7.10	Eccles rolling stock maintenance depot option	328
Figure 7.11	New Crofton rolling stock maintenance depot option	329
Figure 7.12	Carrington rolling stock maintenance depot option	330
Figure 8.1	Base proposition phase two	335

List of tables

Table 1.1	Consultants engaged by HS2 Ltd	14
Table 4.1	Manchester city centre station – options not progressed to long list	110
Table 4.2	Manchester interchange station options not progressed to the long list	130
Table 5.1	East Midlands three cities: population and rail trips	177
Table 5.2	East Midlands station options not progressed to long list	180
Table 5.3	South Yorkshire station options not progressed to the long list	228
Table 5.4	Leeds city centre stations not progressed to the long list	266
Table 8.1	Full Y network cost estimate	339
Table 8.2	Phase two cost estimate	340
Table 8.3	London to West Midlands phase one cost estimate as announced	341

List of text boxes

Text box 1	Tatton Park, Rostherne Mere and the Dunham Massey Estate	37
Text box 2	Pasturefields Salt Marsh SAC	48
Text box 3	Serving Liverpool, Crewe and other intermediate markets	55
Text box 4	Cheshire and Warrington Local Enterprise Partnership – The case for an intermediate station	57
Text box 5	The Manchester Ship Canal and the surrounding area	61
Text box 6	Serving Scotland in phase two	87
Text box 7	The Northern Hub	107
Text box 8	Salford Central options – delivery partner views on impacts on development	120
Text box 9	Transport for Greater Manchester's work on city centre options	124
Text box 10	Route and station options in the Manchester Airport Area	128

Text box 11	Transport for Greater Manchester’s work on interchange options	135
Text box 12	River Mease SAC	158
Text box 13	City centre or interchange	177
Text box 14	East Midlands Parkway and Toton – connecting to classic rail	184
Text box 15	Hardwick Hall, Sutton Scarsdale and Bolsover Castle	212
Text box 16	Sheffield Victoria Loop – Rotherham Metropolitan Borough Council views	223
Text box 17	Through, loop or spur	231
Text box 18	Sheffield City Region and SYPTE work on economic impacts	242
Text box 19	Development in Leeds – Leeds South Bank	270
Text box 20	Leeds interchange and serving York and the North East	289
Text box 21	Southern facing connection to HS2 main line	306
Text box 22	Base proposition – sustainability performance	336

Executive summary

The context for high speed rail

1. In January 2012, the Government announced its decision to develop a new national high speed rail network. High Speed Two (HS2) will be built in two phases. Phase one from London to the West Midlands, via Old Oak Common and the West Coast Main Line (WCML), and connecting to High Speed One (HS1), is expected to open in 2026. Phase two, the onward legs to Manchester and Leeds, with stations in the East Midlands and South Yorkshire and a direct connection to Heathrow Airport, is expected to open in 2032/33.

2. This report covers line of route and station options and associated infrastructure for phase two. It sets out all the options we considered and describes our process of analysing and refining them. We then describe the final station and route options that we have developed to the greatest level of detail at this stage. We also set out a 'base proposition', a high speed rail network that meets the requirements of our remit set by Government, and which we used as the basis for our analysis of the business case. There are many alternative options for phase two depending on Government's choices and the base proposition we describe is not a preferred scheme.

3. The report offers Government some choices for the future development of the phase two network. It provides the underpinning evidence to facilitate future engagement and decision making.

Supporting documents

4. This report covers the principal engineering design and sustainability performance issues of various route, station and depot options. More detail can be found in our supporting documents (see *List of supporting documents* at the end of this report). The main supporting reports are:
   - *Options for phase two of the high speed rail network – approach to design;*
   - *Engineering options report – West Midlands to Manchester;*
   - *Engineering options report – West Midlands to Leeds;*
   - *Engineering options report – Heathrow;* and
   - *Options for phase two of the high speed rail network – Appraisal of Sustainability* ('AoS options report').

5. The engineering options reports provide a more detailed description of how routes and stations would be constructed and their principal features. The AoS options report provides detail on our appraisal of potential sustainability performance and impacts. In addition, documents are available that provide more detail on our approach to cost and risk and on our approach to engagement with key stakeholders. We have also submitted to Government the

submissions and analysis that our delivery partners have provided and which are referenced in a number of places in this report.

6. Our appraisal of the updated economic case for the Y network, and of the potential released capacity benefits, are set out in documents which will be provided separately to Government.[1]

Our approach and methodology

7. Our approach to developing this report has followed the same process and model for high speed rail that we adopted to produce our report to Government on phase one.[2] Since being given our remit for phase two,[3] we have undertaken a process of generating options and developing and sifting them. Our assessment of options has been based on four key sifting elements covering engineering, sustainability, demand and cost. We have sought to balance these criteria in our assessment and also ensure that the potential impact on people and their communities has been properly considered and mitigated as far as possible at this stage in our design process. As our analysis developed, the depth of assessment increased as the number of options decreased.

8. An integral part of the development of our station options has been the involvement, in confidence, of our regional delivery partners - representatives of local authorities, passenger transport executives, the Highways Agency and Network Rail. Where we refer to the contribution of our delivery partners throughout this report it should be noted that those discussions have been confidential to minimise unnecessary blight and uncertainty from the untimely release of information. Their views and advice have informed the development of our station options though this report, and any recommendations we make are ours alone.

9. We have used the same technical and design assumptions that underpinned the Secretary of State's announcement on phase one in January 2012.[4] This report describes the additional operational requirements with the full network in service. As with phase one the infrastructure is designed for speeds up to 250 miles per hour (mph) or 400 kilometres per hour (kph) with a maximum operating speed of 225mph (360kph) at opening. Achieving the maximum speeds consistently requires long uninterrupted distances. While this is achievable on phase one and on the leg to Manchester, on the Leeds leg, with two intermediate

[1] These documents were published in August 2012.

[2] See HS2 Ltd, 2010, *High Speed Rail London to the West Midlands and Beyond – a report to Government by High Speed Two Limited,* http://webarchive.nationalarchives.gov.uk/+/http:/www.dft.gov.uk/pgr/rail/pi/highspeedrail/hs2ltd/hs2report/

[3] Our current and earlier remit letters covering phase two can be found at HS2 Ltd, *Governance documents,* http://www.hs2.org.uk/governdocs

[4] See *Oral Statement – High Speed Rail,* 10 January 2012, http://www.dft.gov.uk/news/statements/greening-20120110a/

stops en route to Leeds, achieving maximum speeds between stations would require more aggressive acceleration and deceleration. We therefore recognise the benefits of having a more consistent speed profile operating below maximum operating speeds. Our approach to costs is the same as phase one.

Developing our options – key challenges

10. Developing our route and station options for phase two required a number of difficult trade-offs. The principal challenges we faced are briefly described below and are expanded upon in the relevant sections of this report.

11. A fundamental issue for phase two was developing proposals that would give the best performing overall Y network balanced with developing the optimal options for serving our remitted cities and regions. This was a particular consideration on the Leeds leg where we had to balance serving the largest market of Leeds with the best possible journey times whilst seeking to ensure that the South Yorkshire and East Midlands markets were effectively served.

12. One of our key considerations for the development of our station options for East Midlands and South Yorkshire was the choice between city centre and interchange stations. City centres offer densely populated markets to which high capacity, high speed lines are well suited. As the centres of commerce and business, city centres offer high value development opportunities meaning that high speed rail potentially supports significant economic growth. However, city centre stations are more likely to have a comparatively low speed approach introducing a journey time penalty for any services heading northwards. Construction in a city centre is likely to have additional cost and sustainability impacts due to the need to develop a route approach through densely populated city suburbs.

13. Interchange options tend not to be as well-located for city centre passengers but, if good public transport and road access can be provided, potentially serve a wider region. By being accessible to a wider region rather than a specific city centre, the benefits can be spread to a wider market. Interchange stations are more likely to have a high speed approach and enable HS2 trains to move on at high speed, reducing the overall journey time to onward travellers. However, they are more likely to have lower value businesses around them or no development at all. With less existing development, it is harder to judge the extent to which a HS2 station would drive or contribute to economic growth. Constructing an interchange station is also not without sustainability impacts as they may be built in open countryside.

14. We also looked at the extent to which an interchange station on the western leg to Manchester city centre would benefit the business case; as part of this we looked at serving Manchester Airport. We found that developing route options to serve an interchange station at the Airport would have potentially significant

sustainability impacts. Options at or near to the Airport were the best location for an interchange station, but at a significant additional cost.

15. Though not part of our remit, we also explored options for an additional intermediate station between Lichfield, where phase one ends, and Manchester city centre. Additional intermediate stations capture new markets but have an associated infrastructure cost. Whilst it is possible not to stop all trains at an intermediate station, those that do will have a journey time penalty on passengers wanting to head further on. The market therefore needs to be sizeable to outweigh the infrastructure costs and potential journey time penalty.

16. The development of phase two also has the potential to deliver wider transformational change to cities and regions beyond the high speed network. We have therefore also considered how best to serve the cities and regions of the North West and the North East by classic compatible services, high speed trains which can also run on existing rail lines. There are trade-offs here too between ensuring that the largest markets are captured at a proportionate cost and making the best use of the number of train paths available.

17. Our work developing phase two route proposals also had significant implications for serving Scotland. The trade-off here is relatively straightforward: the further the high speed line is constructed northwards, the faster the potential journey time to Scotland. However, constructing additional high speed line comes at a higher cost and with additional sustainability impacts. Therefore in our work considering potential connection points to the West Coast Main Line (WCML), we assessed the costs and benefits of a range of options noting the significant additional cost of the more northerly connections. In addition to this we considered whether Scotland should be served via the connection to the WCML or the East Coast Main Line (WCML).

18. We expand on these challenges throughout this report. At the end of each section we summarise the main trade-offs between options.

Summary of our options

19. Taking the key challenges described above, the following final options are presented in this report.

Station options

20. We describe three final options for a station serving Manchester city centre. We conclude this section by noting that one of these, a proposed HS2 station alongside the existing Manchester Piccadilly station, is the best performing option across our analysis and is strongly supported by our delivery partners and their analysis. It is not the lowest cost option but the differential with the two other options, integrated or near the existing Salford Central station, is small and the benefits significantly greater.

21. Our remit includes consideration of serving major airports. We looked at a number of options that would serve Manchester Airport and a wider set of options for an interchange type station in the area surrounding Greater Manchester. The case would be strongest for a station option near to Manchester Airport called Manchester Airport Davenport. However, the costs of providing the station and associated line of route would be significant and in addition to our £33 billion cost envelope. We describe the benefits and costs of including such a station.

22. Three final options for a station serving Leeds city centre are described. Here, the choices are finely balanced. We describe two options with fast approaches from the south. The two stations would be located in an area which Leeds City Council has identified for development and with some schemes already coming forward. Leeds City Council was therefore concerned that one of these options in particular would conflict with development plans, blighting the area in the short to medium term. The second option would be more peripheral to development sites. The third option would be alongside the existing Leeds central station. This would have a slower journey time, as a result of its longer approach, but would have seamless connectivity with the existing rail and would be well placed for the established city centre. Its costs would be higher, though and it would make any future Network Rail expansion of the existing Leeds station very difficult and costly to achieve. Nevertheless, as this option would not conflict with city development plans, would be located alongside the existing Leeds station and would be well placed for access to the established city centre, it was favoured by Leeds City Council.

23. We describe two final options for serving South Yorkshire: one city centre station and one interchange station near the Meadowhall Shopping Centre. Our analysis suggests that serving central Sheffield would bring greater benefits than Meadowhall, but this would come at a significant cost. The proposition would be for a station at Sheffield Victoria on a loop from the main high speed line, capturing the largest market in the region by serving the city centre. The extra track would cost significantly more and also incur additional sustainability impacts. Indeed at around £1 billion more expensive than the proposed Meadowhall station, it would add significant pressure on the overall costs for phase two. Our analysis suggests that the costs would not outweigh the benefits, whilst Sheffield City region delivery partners have carried out work to suggest that the benefits could. The interchange station at Meadowhall, on the main high speed line would give lower benefits than Victoria, but would have good connectivity, capturing the South Yorkshire market effectively at a lower cost. We are also mindful that, though important, the South Yorkshire market is smaller than the markets further north. This reinforces the need to capture the important market but to do so at a proportionate cost.

24. We also describe our two final options for serving the East Midlands: one a city centre station and the other an interchange. The costs of these are reasonably close. We conclude that there are benefits from capturing the Derby city centre market with HS2 integrated into a re-developed Derby Midland station. This

particularly benefits Derby and Derbyshire but would not serve the wider region effectively. The interchange station option, on the site of the existing freight, maintenance and goods yard at Toton, would serve the wider region and capture a greater overall market. It would require work to be connected to the existing railway to maximise these benefits and we describe our analysis of how this could be achieved.

Route options

25. On the western leg, we describe two principal route options from the West Midlands to the outskirts of Manchester, the approaches to each of the final station options and two options for connections to the WCML.

26. At the southern end of the route we need to identify the best solution for avoiding or minimising the impact on Pasturefields Salt Marsh Special Area of Conservation (SAC). Beyond that the decision on how best to serve Liverpool and the North West markets will influence the choice of route, with one route offering a connection to the existing rail network at Crewe providing a good balance of journey time to Liverpool and Warrington with the ability to serve intermediate markets including Crewe itself. We also describe a single option for an intermediate station off Junction 16 of the M6, including the costs and benefits of this option noting that it would add little overall to the economic case. The decisions of which city centre station is preferred, whether to serve Manchester Airport directly, for which we describe route options, and where to connect to the WCML, will dictate the remaining choices on the overall preferred route.

27. On the eastern leg our route options are aligned to the intermediate station options that they would serve from the East Midlands and South Yorkshire. We describe route options to serve the stations at either Derby Midland or Toton. The decision at the southern end, as with the western leg, is dependent on identifying the best solution for avoiding or minimising any impact on the River Mease, a SAC.

28. From the East Midlands to South Yorkshire the route choice will depend on the preferred station choice. We describe one route option from the station at Derby Midland and two options from Toton. The line of route choice for serving South Yorkshire will be dependent on which station is selected. Similarly the choice of station in Leeds city centre will dictate the choice of the approach to Leeds. We also describe two alternative route options for connecting to the ECML offering slightly different journey times and benefits to classic compatible services north. Within this section we also briefly describe the benefits of capturing the York and North East markets.

29. We also developed route options to serve a high speed station in the vicinity of Heathrow Terminal 5 (T5) as part of phase two. We describe a single proposed station option with some potential variants to how it is served.

Routes and stations: Key decisions for Government

30. Therefore, subject to future confidential consultation, we describe below the decision making process that Government will go through to arrive at a decision on preferred route and station choices. This is based on the route and station options we describe in this report and does not preclude the Government asking HS2 Ltd to undertake further work and analysis or potentially develop new proposals in support of that decision making.

Western leg to Manchester

31. The decision making on this leg is as follows:
    i) HS2 Ltd will need to advise Government, following further analysis, the most appropriate route to avoid or minimise any impact on Pasturefields SAC. Following this the Government will need to consider and confirm its route choice at the southern end.
    ii) Government to consider the merits of providing a connection at Crewe for services to Liverpool and the North West. An alternative option will be to consider the merits of an intermediate station. This will influence route choice.
    iii) Government to consider the merits of an interchange station which, if a Manchester Airport interchange is selected, will influence route and approach choice.
    iv) Government to select a preferred city centre station option which, in addition to the interchange station decision at (iii), will influence the selection of the approach.
    v) Government to select a preferred connection to the WCML and consider how Scotland would best be served from phase two.

Eastern leg to Leeds

32. The decision making on this leg is as follows:

    i) Government to select a preferred East Midlands station.

    - *If* Derby Midland is selected then Government to consider the proposed route option described in this report. We would need to engage further with Natural England and the Environment Agency about the proposed crossing of the River Mease SAC.

    - *If* Toton is selected, subject to us engaging further with Natural England and the Environment Agency and providing further advice, Government to select a preferred route from the proposed options.

    ii) Route selection from the East Midlands to South Yorkshire will also be dependent on the choice of East Midlands station.

- *If* Derby Midland is selected then Government to consider the proposed route option following the A38.

- *If* Toton is selected then Government to consider the route options following the Erewash Valley or M1. We intend to undertake further design work on these routes to advise Government further about their relative merits.

iii) Government to select a preferred station option for South Yorkshire. The final options in this report are a HS2 station at Meadowhall or at Sheffield Victoria (served by a loop from the main high speed line).

iv) Government to consider the case for classic compatible services in the East Midlands and/or South Yorkshire.

v) Government to confirm the route from South Yorkshire to Leeds and select a preferred Leeds city centre station. This will confirm the choice of approach.

vi) Government to select a preferred route, and connection, to the ECML.

Heathrow

i) Government to confirm a preferred route choice and associated station.

Base proposition

33. In the final section of this report we set out a base proposition, a high speed rail network that meets our remit set by Government. The base proposition was used as the basis for our analysis of the business case. The routes and stations that form it are taken from the detailed options we describe in the main body of the report and summarised above. We also describe the potential costs and benefits of making some alternative choices or additions to the base proposition albeit at an additional cost. This base proposition enables us to assess the costs and benefits of the scheme at this stage in the design and development process. There are many alternative options for phase two depending on Government's choices and the base proposition we describe is not a preferred scheme.

Further work

34. The Government has indicated that it intends to hear the views of delivery partners in the cities proposed to receive HS2 stations. We will support that process as requested by Government. In addition, we set out in this report a number of issues or areas which we believe warrant further work to ensure that we can advise Government fully. These issues are briefly set out below and explained in the relevant section of this report:

- we indicate a small number of route options which we believe will benefit from further refinement and assessment before routes are presented for consultation;
- dependent on the route options selected by Government, we will need to engage Natural England and the Environment Agency, and carry out relevant studies, on Pasturefields SAC and the River Mease SAC;
- if the Government wishes to consider the potential merits of Manchester Airport Davenport further, we would propose that we undertake some additional work to understand fully its effect on the overall business case and consider with delivery partners how best to integrate it with the Airport;
- we expect to engage further with our delivery partners on specific issues around station options once the Government has indicated its likely preferences;
- we will need to develop our maintenance and stabling options further and engage with relevant delivery partners; and
- we will carry out any further work or analysis requested by Government in support of the selection of a preferred scheme.

Chapter 1 –The context for high speed rail

1.1 Rationale and specific remit

1.1.1 In January 2012 the Government announced its decision to develop a new national high speed rail network for Britain. High Speed Two (HS2) will be built in two phases. Phase one from London to the West Midlands, via Old Oak Common and the West Coast Main Line (WCML), and connecting to High Speed One (HS1), is expected to open in 2026. Phase two, the onward legs to Manchester and Leeds with stations in the East Midlands and South Yorkshire and a direct connection to Heathrow Airport is expected to open in 2032/33.

1.1.2 This report covers line of route options for the two onward legs to Manchester and Leeds and for stations in those city centres. The report also includes options for stations in the East Midlands and South Yorkshire as part of the leg to Leeds. Connections to the West Coast Main Line (WCML) and East Coast Main Line (ECML) would allow direct trains to run to the North West and North East and to Glasgow and Edinburgh. This will be phase two of the high speed network known as the Y network because of its shape. The report also covers a direct connection to Heathrow built as part of phase two as a spur off the phase one route.

1.1.3 The timeline in figure 1.1 describes how our work on phase one has developed since we were originally remitted. This report covers the first stage of the process for phase two. We describe the process we have gone through in developing detailed station and line of route options. We cover all of the options we identified for line of route and stations. We developed station options together with our regional delivery partners, mainly local authorities and passenger transport executives and with regional representatives of Network Rail and the Highways Agency. We also set out the additional analysis we have done on options beyond the high speed rail network potentially serving wider conurbations by running on the existing rail network using our so-called classic compatible trains, which are trains that can operate on both the high speed and existing rail network.

Figure 1.1 - How HS2 Ltd proposals for phase one have developed

Source: HS2 Ltd

1.1.4 We describe how options were assessed and refined down to a small number. These options are described in detail in this report and in our supporting documents. Our work developing proposals for a direct link to serve Heathrow as part of phase two is also explained, building on our earlier published work.

1.1.5 Having described all the options we considered and developed, we then describe a base proposition for phase two and some of the additional choices which underpin our analysis of the business case. The base proposition formed the basis of our economic appraisal. There are many alternative options for phase two depending on Government's choices and the base proposition we describe is not a preferred scheme.

1.1.6 This report and its supporting documents set out the detailed development and analysis of options we have done for phase two of the high speed rail network. The report will provide the Government with evidence on which to engage and ultimately as a basis for its future decisions.

1.2 HS2 Ltd's remit and scope

1.2.1 Our remit for phase two has been set out in a number of publicly available remit letters from the Government.[5]

1.2.2 In this report we meet our remit by setting out:

- station options for each of the remitted cities and regions and Heathrow;
- consideration of providing access to the major airports in these regions with Manchester Airport the most significant consideration;
- line of route options from the West Midlands to Manchester and the West Midlands to Leeds and a spur from the phase one route to Heathrow;
- connections to the WCML and ECML including how Scotland will be served from the phase two connections which we describe in more detail in text box 6;
- options for serving cities and regions off the base high speed rail network;
- proposed locations for train maintenance facilities and stabling;
- appropriate engineering, sustainability, economic and social appraisals; and
- a re-confirmation of the technical specification for high speed rail.

1.2.3 The economic case for the Y network has been submitted to Government separately.

[5] See our remit letters which are available at HS2 Ltd, *Governance documents*, http://www.hs2.org.uk/governdocs

1.3 The status of HS2 Ltd

1.3.1 HS2 Ltd was created as a Government company in 2009 initially to examine the case and develop proposals for a new high speed rail line between London and the West Midlands (phase one) and potentially beyond. Following the Government's decision to proceed with this phase, and to seek powers for construction through the hybrid bill process, HS2 Ltd became the scheme promoter.

1.3.2 Our role for phase two has, so far, been to carry out an objective analysis against our remit and to present options and recommendations to Government to support decision making and the future consultation process. We have followed this through to this report.

1.3.3 We have worked closely with a number of 'delivery partner' organisations whose specialist and local knowledge has helped inform our investigation. These organisations include representatives of local authorities, passenger transport executives, the Highways Agency and Network Rail. Their views and advice have been invaluable throughout the process and have been an integral part of our evidence base. Moving forward we will work with them in more detail on how stations can integrate into cities and regions. We call them delivery partners because they are essential to the delivery of the railway.

1.3.4 Where delivery partners have commissioned additional analysis, with our full support, particularly to look at the specific regional costs and benefits of options, we reflect key findings here and have submitted their analysis to Government as part of the evidence that should underpin decisions. For more detail about who our delivery partners are then please see our *Record of stakeholder engagement for phase two of the high speed rail network*, which accompanies our report.

1.3.5 Whilst delivery partners have been an integral part of our process, this report is ours alone and the support of the organisations we have consulted should not be automatically assumed.

1.3.6 We have engaged with a number of statutory authorities, particularly Natural England, English Heritage and the Environment Agency. This has been to discuss sustainability appraisal processes and when we have identified the potential for our route and station options to impact specific features. The status of those discussions is reflected in the relevant sections of our report. We are clear though that this is only the first stage in the design process and we will seek to continue to engage with all relevant statutory authorities going forwards to ensure that our route and station proposals as far as possible avoid impacting on nationally or internationally important sites.

1.3.7 We have also employed specialist consultancy support and advice throughout this process. The firms that have advised us are listed in table 1.1 and their reports make up several of the supporting documents which we have submitted to Government. The reports listed in our *List of supporting documents* underpin all of our evidence in this report and include further technical detail on our approach, methodology and options presented. We take full responsibility for the findings and recommendations we present.

Table 1.1 - Consultants engaged by HS2 Ltd

Arup Group Ltd	Engineering – West Midlands to Leeds
Mott McDonalds, Scott Wilson and Grimshaw (MSG)	Engineering – West Midlands to Manchester
MVA & Mott McDonald	Demand modelling and appraisal
WS Atkins	Demand modelling and appraisal
Temple ERM	Appraisal of Sustainability
CB Richard Ellis Ltd	Land and property
Davis Langdon	Cost modelling

Source: HS2 Ltd

1.4 The Government's policy goals

1.4.1 As we developed our options for phase two, we had in mind the wide range of benefits which high speed rail can potentially offer:

- a significant increase in capacity; a new network able to carry up to 18 trains per hour (tph) and key to tackling the capacity constraints on the UK's north-south inter-city rail routes;
- released space on the existing rail network for new commuter, regional and freight services;
- improved intercity connections and direct international connections without having to change trains;
- better end to end journeys by ensuring good connections with local networks;
- faster rail journeys offering an alternative to many domestic aviation and car journeys;
- better rail links between regional cities, significantly reducing journey times between cities and regions and supporting regional economic development;
- improved links for business travellers, providing access to wider markets and enabling productivity and growth; and
- the creation of significant numbers of new jobs and the regeneration of areas around stations.

Benefiting passengers

1.4.2 This is a technical document which provides route and station options for achieving phase two. However, it is worth reflecting that the realisation of the Y network offers the opportunity to truly change the way that people travel, making high speed rail the mode of choice for long distance journeys. Journey time savings for passengers heading to and from each of the cities served will be very significant with further savings compared to phase one for services to Scotland. Just as crucially, connectivity between major cities will vastly improve with fast services between important markets like Sheffield and Leeds. The Y network will also serve cities and regions beyond the core network as well, bringing benefits to even more passengers. It will also free up further capacity on the existing rail network for new and different services.

Released capacity

1.4.3 We have undertaken work to investigate the potential of released space on the existing rail network, termed 'released capacity'. Our first step was to model demand for existing rail services with the assumption of HS2 phase two being in place. We optimised the service patterns of the existing services to meet the changed demand levels. We were then able to analyse how best to meet the wider range of demand requirements, making use of released capacity and flexibility on the existing network.

1.4.4 We expect phase two to result in some released capacity on the WCML, Midland Main Line (MML), ECML and CrossCountry services north of Birmingham. With HS2 catering for the longer distance inter-city market, services on these routes could be reconfigured to better meet the needs of shorter distance markets. In addition, fast links could be maintained and enhanced to or from destinations which would not be direct beneficiaries of HS2. Detail of this work will be reported in the supporting *Options for phase two of the high speed rail network - demand and appraisal analysis* document which sets out the results of our demand and appraisal work. This is due to be provided to Government in Spring 2012.

Chapter 2 – Our approach

2.1 Establishing the case – our approach

2.1.1 In this chapter we describe our approach to developing our analysis and our design specifications and assumptions. This first section sets out how we have approached developing options for phase two. Our approach has been consistent with the approach we took at the same stage of our development of phase one options.

2.1.2 Our work on our remit for phase two began in 2010 and has been conducted in parallel with the ongoing phase one work programme. A dedicated team was set up to develop and progress options. The hierarchy of the decision making process in HS2 Ltd, during the period in which this report was being prepared, is shown in figure 2.1.

Figure 2.1 - HS2 Ltd decision making process

Source: HS2 Ltd

2.1.3 The process for developing options for meeting the remit and narrowing these down to the set of final options that are presented for consideration in this report can be described as a 'sifting' process. This reflects that we started with a significant and varied number of options for each section of the remit and through a thorough process we removed options that did not perform favourably (sifted them out). Chapter 3 sets out the stages of this process and how we went about sifting out options in more detail.

External input and challenge

2.1.4 In order to ensure the validity of our approach and results we sought to involve external stakeholders and advisors wherever appropriate. We involved location specific stakeholders on a regular basis in the development and assessment of options. These stakeholders are our delivery partners. Our engagement with them focussed principally on the development of station options, though we also spoke at a high level about route approaches to stations with them. We also engaged confidentially with statutory environmental bodies, both generally on the sustainability appraisal process, and specifically in relation to advice on certain features.

2.1.5 We did not engage externally on the development of line of route options due to the potential risk of blight to large parts of the country if multiple route options were placed in the public domain. Much of this blight would be unnecessary as many of the lines of route identified at an early stage in the process were not taken forward. Going forward we would intend to have discussions with local authorities as route proposals are developed and refined and at a stage when the risk of uncertainty or unnecessary blight can be appropriately managed and avoided.

2.1.6 Our second group of key stakeholders were external peers and experts to challenge and feed into our approach. We introduce the role and make-up of these types of stakeholders below.

Delivery partner station working groups

2.1.7 These groups contributed to the identification and assessment of station options and comprised a small number of stakeholders with specific local transport and planning responsibilities from Manchester, Leeds, South Yorkshire and the East Midlands. There was also bilateral confidential contact with relevant district/borough authorities where appropriate, for example to gather information on planning proposals. The membership of these groups comprised of:

- top tier local authorities whose jurisdiction was included in our remit or additional considerations;
- local passenger transport executives;
- regional Highways Agency representatives;
- regional Network Rail representatives; and
- Regional Development Agencies and Government Offices (up until 2011 when they ceased to be operational).

2.1.8 We also had meetings with BAA Airports Limited, Network Rail, Transport for London (TfL) and the Highways Agency in relation to the station at Heathrow Airport. Here the station site was fixed, by the decisions already taken by Government, but it was helpful to discuss how the station could work in the context of the Airport and of existing rail and road networks.

Rolling stock and infrastructure maintenance depot stakeholders

2.1.9 We drew on stakeholder knowledge as part of the option generation for depot locations. These stakeholders were the top tier local planning authorities in areas where there were potential depot location options. This was not a formal group. Going forward it will be important to have discussions with local authorities where a depot is being proposed to aide our understanding of the sites and potential further mitigation of any impacts.

Regional briefing meetings

2.1.10 In addition to these geographic based groups we held a small number of regional briefing sessions with selected local and regional planning authorities, business groups and other interests in the Midlands, north of England and Scotland. Throughout our work on phases one and two, ongoing discussions with industry and national stakeholders were held in relation to the HS2 technical specification.

External peer groups

2.1.11 Following the approach taken for phase one, we held external challenge groups comprising experienced industry experts to provide independent scrutiny. This report is ours alone and these groups were not accountable for the proposals we have developed. The groups have instead provided independent advice and critique of our work at a high level. Members were asked to be involved based on their individual experience. They did not represent any organisation or lobby. The two groups that provided input and challenge were:

- Strategic Challenge Group – this focussed on offering an overall view and sense check of the programme as a whole and on providing an independent perspective on our overall approach; and
- Analytical Challenge Group – this focussed on the appraisal and modelling of options, scrutinising the relevant evidence base and providing technical advice on key methodologies.

2.1.12 In addition, to support the sustainability process, an Appraisal of Sustainability Reference Group was formed which included stakeholders from central government departments and statutory agencies. It provided useful input and challenge of our sustainability appraisal methodology.

2.1.13 The names of all members of these groups during the development of proposals for phase two can be found in the *Record of stakeholder engagement for phase two of the high speed rail network* which accompanies our report.

2.2 Design and appraisal – specification and assumptions

2.2.1 This section explains our assumptions and specification that we used in the design, development and appraisal of the options. These reflect the assumptions and specification used for our work on phase one. Any adjustments to this have been to accommodate the fact that we have been developing the second phase of proposals or where the lessons we have learned from the first phase have resulted in additional considerations.

The concept of HS2

2.2.2 We set about the development of our proposals guided by the following principles:

- HS2 rail services will serve long distance, city-to-city journeys;
- HS2 will be used by high speed trains only;
- benefits will be extended to destinations further north by running trains off HS2 onto the existing rail network; and
- HS2 must be well integrated with other transport networks so that door-to-door journey time savings are delivered.

The key requirements for HS2

2.2.3 Our Technical Appendix contains our main technical, operational and sustainability requirements.

2.2.4 The main driving factors in the design of HS2 are:

- providing a safe and secure network for passengers, those who operate and maintain it and third parties who may otherwise come into contact with it;
- ensuring compliance with the EU Directive and Technical Specifications for Interoperability[6] to benefit from standard, proven, competitively sourced high speed rail equipment, systems and trains;
- providing internationally recognised levels of availability, reliability and speed with a high level of capacity;
- ensuring that high speed trains can run onto the existing rail network; and
- harnessing the principles of sustainable development, where possible avoiding or otherwise minimising and mitigating sustainability impacts.

[6] Europa, 2008, *Technical harmonisation,* http://europa.eu/legislation_summaries/internal_market/single_market_for_goods/technical_harmonisation/index_en.htm

2.3 Our assumptions

Key design assumptions

2.3.1 The key design assumptions for the development of phase two are set out below:

- HS2 will be a two track railway (one northbound and one southbound track);
- up to 18 trains per hour could run in each direction on the opening of the full Y network;
- we will use a mixed fleet of high speed trains, known as 'captive trains', and specially designed classic compatible trains which could run on both HS2 and the existing rail network;
- trains of up to 400m long will run on HS2 which will have up to 1,100 seats. Stations therefore need to be designed to cope with high volumes of people. Station design at this stage is indicative of the size of station options only. The pictures of stations used in this report should not be taken as representations of how stations will eventually look;
- we include specific structure specifications across the design, such as the use of grade separated junctions;
- there will be a separation of maintenance activity from train operations, and the automation of inspection and mechanisation of maintenance activities as far as possible;
- sustainable design aims were used in our option development and design process[7]; and
- our line of route design work seeks to follow existing transport corridors where practicable.

Speed

2.3.2 The route will be designed for speeds up to 250mph (400kph), though on opening, a maximum train speed of 225mph (360kph) would be assumed. Achieving maximum speed requires relatively long distances of high speed track. On the eastern leg, with several intermediate stops en route to Leeds, achieving speeds of 250mph (400kph) would potentially require aggressive acceleration and almost immediate deceleration on the approach to stations. We therefore consider the benefits of a more consistent and flatter speed profile. In some built-up areas or to avoid major impacts in other key areas, line speed could be lower.

Tunnelling

2.3.3 Tunnels are typically used where there is no practical option for a route above ground due to population density or in some cases to mitigate sustainability

[7] See Department for Environment, Food and Rural Affairs, *Sustainable Development in Government – Who does what,* http://sd.defra.gov.uk/gov/approach/who/

impacts. Tunnels designed for HS2 would allow up to 200mph (320kph) and in some cases 250mph (400kph). Tunnels cost about five to six times more per kilometre than building on the surface through open countryside. Long tunnels, greater than 1.2 miles (2km), require cross-passages which provide emergency exits and intervention shafts which provide pressure relief, ventilation and access for emergency services. Tunnelled route section locations are currently indicative. They would be subject to change based on the location of shafts when this is determined in the future.

Power

2.3.4 A high level check of power supply availability has been performed, including discussion with the National Grid. We can confirm that the route options that are presented in this report could all feasibly be supplied with the correct level of power (both traction power at 25 kilovolts AC and other types of power that are required).

2.3.5 More generally we are working on the design and logistics of all types of power that would be required by a complete Y network. For example: traction power, non-traction power and locally sourced power. This continues to be a work in progress and covers both phases one and two. Our work includes consideration of how the carbon impact of the power consumption could be minimised, in line with the Government’s low carbon agenda.

2.3.6 The detail of what powering the network would involve will be developed now that the Government announced its decision to go ahead with high speed rail and the detailed design of phase one. As this work needs to consider the Y network as a whole, more details on the proposed strategy to power a high speed rail network including phase two will be released in the future at the point of public consultation on the Environmental Impact Assessment.

Phase two operational requirements

2.3.7 The current operational requirements are described in detail in our Technical Appendix and reflect the work we have undertaken since we began in 2009.

2.3.8 Our work developing phase two route and station proposals has continued to support the operational model and station concept. In particular, our route design takes into consideration the need to operate both a captive and classic compatible fleet in order to serve additional markets in the North West, North East and Scotland.

2.3.9 The proposed HS2 service pattern from London Euston to the North West in phase two would consist of 8tph serving Manchester, Liverpool, Preston, Glasgow and Edinburgh. Manchester would have a total of 6tph consisting of 3tph from London Euston, 1tph from Heathrow and 2tph from Birmingham. This service pattern to Manchester, combined with an average turn around time of 28 minutes would require four platform faces at the Manchester station.

2.3.10 The proposed service pattern from London Euston to the North East in phase two would consist of 6tph serving the East Midlands, South Yorkshire, Leeds, York and Newcastle. Leeds would have a total of 6tph consisting of 3tph from London Euston, 1tph from Heathrow and 2tph from Birmingham. This service pattern combined with platform occupancy would require five platform faces at the Leeds station.

2.3.11 An overall operational assessment of the proposed network has been undertaken. This assessment has drawn on experience of other high speed networks and applied a number of recognised measures to establish the robustness of the proposed services and flexibility of the network. The assessment confirmed the network was operable and confirmed areas where the network was under stress and further detailed consideration required. In particular for the northern terminals the platform occupancy measures were higher than recommended. In response to this we have assessed the practicality of an additional platform at each terminal. Our current proposal is to provide an additional platform at Leeds, the more stressed location.

2.3.12 The additional sections of the network are each supported with rolling stock and maintenance depots. Sites have been selected in accordance with the criteria set out in the Technical Appendix. Our current assumption is that the full network will also require some extension to the facilities at the Washwood Heath depot required for phase one.

Mitigating the impacts of HS2

2.3.13 Chapter 3 sets out the stages of development of our proposals. Throughout the development of our options we have sought to identify how people and the communities they live in could be potentially affected and wherever possible sought to avoid or minimise the impact. The AoS options report describes the early key mitigation we have applied at this stage of the process. For example, once options had been developed to the above technical and design principles we took time to consider whether we could further mitigate any negative impacts for example through changes in the vertical and/or horizontal alignment.

2.3.14 Going forward, as the design becomes more developed further mitigation will be built in. At this stage we have made provision in our cost estimates for the type of mitigation, for instance for noise or visual impacts, that tend to be brought in at the more detailed design stages.

2.3.15 The results of the strategic noise appraisal have highlighted a number of settlements in close proximity to the route which will require careful consideration during the project development to protect them from potential noise impacts. The planning and design of stations would aim to protect areas from potential adverse noise impacts. The assessment of potential noise impacts, at this stage of the design process, can be found in the AoS options report.

The economic appraisal of our proposals

2.3.16 Part of our work to date has been to carry out an economic appraisal of the proposed scheme which enables us to compare its costs and benefits. We have undertaken this for phase one alone and more recently for phase one and two combined – the Y network. The economic appraisal of a transport scheme seeks to include the full economic costs and benefits of a scheme and to quantify these in monetary terms. We approach this on the basis of the HM Treasury Green Book and of Department for Transport's (DfT) web based Transport Appraisal Guidance (WebTAG).[8,9]

2.3.17 These guidelines ensure that we make proper provision for value for money assessment, whole life costs and risks. The DfT's WebTAG is designed to ensure comparability and consistency across proposed transport schemes for all modes of transport. In line with DfT practice, we have assessed the full economic benefits and costs over a 60 year period of operation, the 'appraisal period'.

2.3.18 We have regularly updated our economic appraisal to reflect the ongoing development of our work, our development of an increasingly sophisticated transport model, and external factors such as gross domestic product (GDP) forecasts which are used as assumptions in the model. As we have begun to appraise phases one and two combined, we have not reported on the results of our most up to date appraisal in this document. Instead, a stand-alone summary of the latest appraisal figures, including benefit-cost ratio (BCR) will be published by Government in due course.

[8] See HM Treasury, 2003, *The Green Book*, chapter 5, http://www.hm-treasury.gov.uk/data_greenbook_index.htm
[9] See Department for Transport, 2011, *Transport Analysis Guidance – WebTAG,* National Trip End Model, http://www.dft.gov.uk/webtag/documents/expert/unit3.15.2.php

Chapter 3 – Methodology

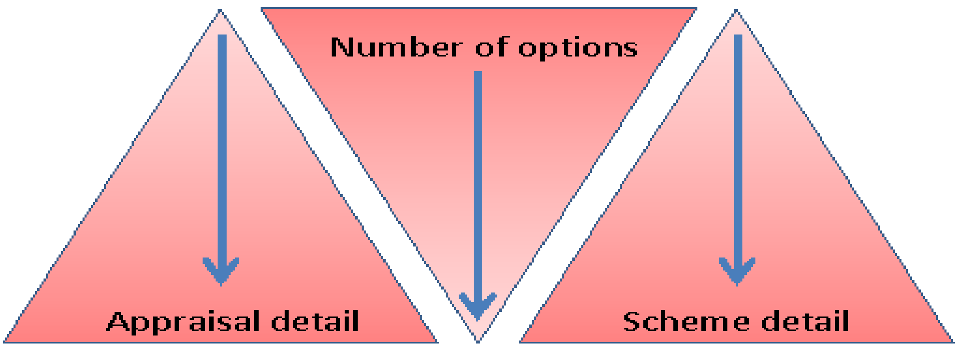
3.1 Tackling our remit

3.1.1 This chapter describes our approach to developing and sifting options. Our remit and other considerations were separated into a number of distinct elements. The majority were defined geographically, with some general requirements for the whole network being dealt with separately. The design and mitigation process was undertaken for each aspect of the remit separately, before bringing them together to form a base proposition for phase two described in chapter 8 to enable an appraisal of the scheme at this stage of the design process to be made.

3.2 Option generation and sifting

3.2.1 For each of the elements above, we undertook a separate process generating options and developing and sifting them. This follows the same approach as for phase one of HS2. This section sets out the four stages we went through which were generally common to each component. In early stages of the sifting process, options were considered against only the highest priority issues to establish relative preferences between different options. In later stages the scope and depth of appraisal increases. As less favoured options fall away, the remaining options were worked up in greater design detail and are appraised at a correspondingly increasing level of detail. Figure 3.1 represents this process in a diagram.

Figure 3.1 - The relationship between the sifting process and the development of options



Source: Temple ERM

3.2.2 As with the process that we went through for phase one of HS2, the development of options was based around the four main sifting criteria:

- engineering and construction feasibility;
- sustainability;
- demand considerations including journey times; and
- cost.

3.2.3 Our appraisal of options was therefore structured around these four overarching headings with progressively more detailed analysis and specialist knowledge utilised within each category as the options were narrowed down through the sifting process.

3.2.4 For stations, at every stage of the process delivery partners were involved in confidence. They provided an important source of information, particularly on local planning and transport policy and emerging strategies.

The generation of initial options and the sifting down to a long list

3.2.5 Supported by our consultants, we reviewed existing information, land use policies and documentation from delivery partners and used knowledge of the remitted areas to generate initial ideas for routes (in sections at this stage) and potential station locations. We invited options for stations from our delivery partners and checked our initial ideas with their knowledge. A template was used to record each option generated and we gathered an initial set of high level information for each.

Long listing

3.2.6 We used high level indicators to identify those options that appeared feasible, and had potential based on the high level indicators, and took them forward for further development. Where we did not have enough information about an option, it was taken forward to the next stage in order to explore it in more detail. Options that would not be feasible, or would perform notably worse than comparable options, were not taken forwards.

3.2.7 In addition, for sifting our station options, as well as monthly working groups, two stages of discussion were held with delivery partner working group members: a presentation of the information held on each of the options; and a formal sifting meeting that preceded the HS2 Ltd decision on which options would be taken forward to the long list.

The creation of a short list

3.2.8 Options taken forward were developed in more detail with further more detailed analysis including forecast passenger demand, impact on each type of transport infrastructure of route and station options, information affecting dispersal and access to stations. A full footprint and visualisation for station options was also developed. This allowed for a more accurate appraisal of the sustainability impacts of route and station options.

3.2.9 Short listing followed the same approach as long listing, including the involvement of delivery partners for station meetings. The process of 'pair-wise' comparison was used more significantly at this stage. This involved comparing two or more station options that were in close proximity or route sections with similar characteristics. The purpose of this was to compare all the details of the options on an equal basis and establish their advantages and disadvantages. The most favourable options were taken forwards leaving a small number of options for each component area – the short list.

Selecting options for refinement

3.2.10 At this stage options were designed by the engineering team to the full extent that is required by our remit. A detailed appraisal of the sustainability impacts of these designs was undertaken. We also compared route options on the basis of their journey time and access time to stations and demand. Costs were calculated from the designs on a bottom up basis.

3.2.11 A sift of the options took place and for stations, as with other stages, delivery partners fed into the information gathering stage and a sifting meeting with us to put across their views.

3.2.12 Our internal line of route analysis used pair-wise comparisons, firstly, for various sections of routes with common start and end points and then for whole routes from the West Midlands to the remitted locations.

3.2.13 At the end of this stage two or three station options or a small number of route options remained in most cases. The next stage of the process looked at how these options could be improved from all perspectives, but with a particular emphasis on sustainability.

Finalising our options

3.2.14 Refinement to minimise impacts was an integral part of each stage of the development of options. In this final stage the engineering and sustainability teams worked on the remaining options to mitigate the predicted impacts by refining the vertical or horizontal alignments and by introducing certain structures such as green tunnels, viaducts or cuttings with retained walls. In this way, the route development process has ensured that mitigation is inherent within the designs from the outset and the impact on people and communities avoided or minimised as far as possible even at this early stage in the design process.

3.2.15 This stage of the process allowed for options to not be taken forward if they proved to perform notably worse than the other main options. However, this stage was less about the sifting out of options, but about discussion of the issues that the changes to the design dealt with. For each component, a comparison of the design at the previous stage and the new design was made, to ensure that overall any changes led to improvements.

3.2.16 At this stage there was opportunity for additional information on demand and benefits to passengers to be taken into consideration. Costs were re-calculated based on the agreed final design. We continued to keep delivery partners informed of our development of station options, and they expressed their preferences and presented the conclusions of their work to date on how each option would impact their area.

3.2.17 The next chapters of this report present a summary of the results of the sifting process and describe our final options in more detail for each element of our remit and the additional work we have undertaken.

Chapter 4 – West Midlands to Manchester

4.1 Introduction

4.1.1 Our remit in chapter 1 asks us to develop route proposals and options for a high speed line between the West Midlands and Manchester with a link onto the WCML. We are asked to provide station options to serve Manchester city centre. A relevant aspect of our remit for the leg to Manchester is also to consider providing access to major airports. In this regard, Manchester Airport warrants proper analysis, being the largest airport outside London in terms of passengers served. We have also considered a wider set of options for serving an interchange station in the area surrounding Greater Manchester.

4.1.2 We also describe in this chapter a number of additional pieces of further analysis we have carried out to determine the likely best performing Y network. We have examined whether an additional intermediate station, between Lichfield and Manchester, would add to the overall business case. We have particularly focussed this work on the areas around Crewe and Stoke-on-Trent. We have also considered how best to serve the cities and regions off the high speed rail network by classic compatible trains, serving Liverpool and key North West centres in particular. With the high speed line connecting to both the WCML and ECML as part of phase two we have also examined how best Scotland should be served. We have considered a number of connection points to the WCML including the case for connecting as far north as Preston.

4.1.3 In this chapter we describe our process of sifting our route options between Lichfield and the outskirts of Manchester, approaches into our Manchester city centre station options and route options for connecting with the WCML. We explain the key issues we faced seeking to identify the best performing direct and high speed routes between Lichfield and Manchester; these included the presence of key environmental features such as the Pasturefields Salt Marsh Special Area of Conservation (SAC), and the constraints deriving from existing transport arteries and features such as the Dunham Massey estate.

4.1.4 In describing our final station options we note that Manchester is a significant rail hub. We explain how we considered the trade off between a HS2 station close to Manchester Piccadilly which would benefit from excellent connectivity and access to the city centre but with route approaches from the south to Manchester Piccadilly presenting significant sustainability constraints. We therefore needed to balance the potential benefits of a Manchester Piccadilly station over its higher costs resulting from its potentially more challenging approach.

4.1.5 This chapter is structured as follows:

- section 4.2 provides a geographic overview;
- section 4.3 covers the route options between the point at which the phase one route ends near Lichfield and the route to the southernmost option for connecting to the WCML. This is split into three geographic sections to reflect flexibility between combinations of whole routes. We also describe in this section our analysis of options for serving Crewe, Liverpool and other North West centres (text box 3);
- section 4.4 explores the case for any intermediate stations on the routes set out;
- section 4.5 covers the route option to Preston and interchange station options. In this section we also describe our analysis of serving Scotland from the West or East Coast Main Lines (text box 6);
- section 4.6 covers the options for the approaches into Manchester;
- section 4.7 covers the options for a Manchester city centre station; and
- section 4.8 covers the options for a Manchester interchange station.

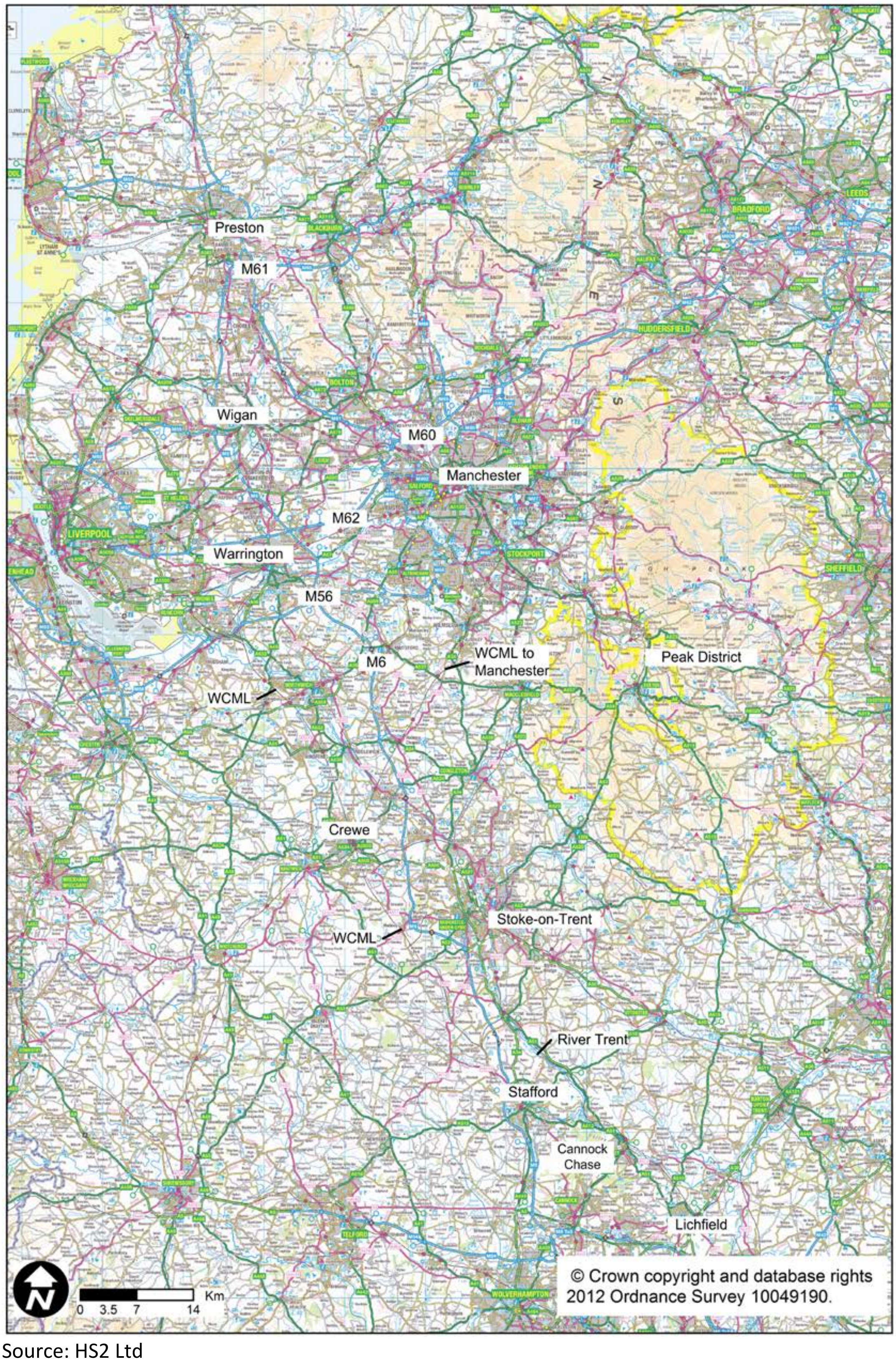
4.1.6 In each section we describe:

- the process that we went through to narrow down and develop options; and
- an overview of the route or station proposals that we developed as final options.

4.1.7 In section 4.9 we provide an overall summary of our final route and station options and the key decisions that Government will need to take to select a preferred scheme.

4.2 Geographic overview

Figure 4.1 – Geographic overview of the Manchester leg corridor



Source: HS2 Ltd

4.2.1 A short geographic overview of the broad corridor in which we developed our route and station options is set out below. This is to provide some context to the areas through which we developed our route options and proposed station locations. Figure 4.1 shows the broad corridor.

4.2.2 The land between Lichfield and the North West is broadly bounded to the east by the hills of the Peak District National Park and with flatter terrain to the west until it begins to rise again towards Wales. Several important international and national environmental features occur within this corridor, including SACs, significant wetland areas and major parks and gardens.

4.2.3 There are also a number of Registered Parks and Gardens and associated listed structures throughout Staffordshire, Cheshire and Lancashire. We have paid particular attention to these through the development of route options.

4.2.4 Where the phase one route ends in South Staffordshire the terrain is relatively flat, with the River Trent Valley forming a lowland corridor to the south of the Peak District National Park and to the north of the slightly hillier West Midlands conurbation. Between the end of the phase one route and Stafford lies the Cannock Chase Area of Outstanding Natural Beauty (AONB). Towards Stoke-on-Trent the terrain rises to form hills, with the river cutting a valley though this area. This area presents challenges for developing our route options. To the east of Stoke-on-Trent the terrain is hilly, whilst to the west it gradually becomes lower.

4.2.5 North of here lies the Cheshire Plain which consists of low-lying land. The Peak District continues northwards to the east of this area, and also bounds the eastern side of the Manchester conurbation. The Cheshire Plain is bounded to the north by the Manchester Mosses SAC (peat bog). To the west of the Manchester Mosses lies Warrington and to the north the terrain becomes hillier again. Much of this area of southern and central Lancashire is populated with small and medium sized settlements. The settlements become more concentrated into a narrower corridor between the north-east of Manchester and Preston. The rural area to the east of these settlements is hillier and to the west it is flatter as it approaches the Lancashire coast.

4.2.6 Two major transport corridors run between Lichfield, Manchester and Preston. The WCML runs from London northwards connecting Birmingham, Manchester, Liverpool (via Crewe) and Glasgow. From the West Midlands the M6 heads directly north, passing Stoke-on-Trent, Manchester and Preston.

4.2.7 Two east–west motorways form major corridors into Manchester: the M56 from north-west Cheshire joining the southern side of the M60, and the M62 from Liverpool, joining its western side. To the south-east of Preston the M61 splits from the M6 and heads south-east towards Manchester, joining with the M60 (Manchester's orbital motorway).

4.2.8 There are a number of urban areas that must be taken into consideration when developing route options. In South Staffordshire there are a number of towns spaced relatively far apart including Rugeley, Uttoxeter, Stafford and Stone. The major urban area between Lichfield and Manchester is Stoke-on-Trent and its immediate neighbours (known as The Potteries). Crewe sits to the north-west of The Potteries with an area of countryside in between. A number of small and medium sized towns are scattered in the mainly rural area between here and the Manchester conurbation, for example Congleton, Knutsford and Northwich.

4.2.9 The Manchester conurbation spreads considerably, particularly to the south and north. Settlements such as Altrincham, Cheadle, Bolton and Bury merge with it to form the Greater Manchester urban area. In the corridor between this and Liverpool lies Warrington and then further north Wigan and Preston, with the areas in between them built up with smaller settlements.

4.3 Routes between Lichfield, the Manchester outskirts and Golborne

4.3.1 It is within the broad corridor described in section 4.2 that we have developed line of route options to Manchester. The route options between Lichfield and where the route might connect to the WCML can be described as forming the main line of the Manchester leg of HS2. Options for approaches into Manchester city centre branching off this are described as spurs because they spur from the main high speed line to one of our Manchester city centre station options.

4.3.2 We set out in this section how we arrived at our two main route options between Lichfield, the Manchester outskirts and Golborne where the high speed line would potentially connect with the WCML. Subsequent sections present the option for HS2 to continue on from Golborne to provide an alternative connection to the WCML further north. Options for a spur into Manchester to serve our Manchester city centre station options are described in section 4.7.

4.3.3 In describing the final two main route options we explain the principal engineering and sustainability features. We highlight the key issues we faced, seeking to identify direct and high speed routes between Lichfield and Manchester and beyond but balanced with the need to avoid or minimise impacts as far as possible.

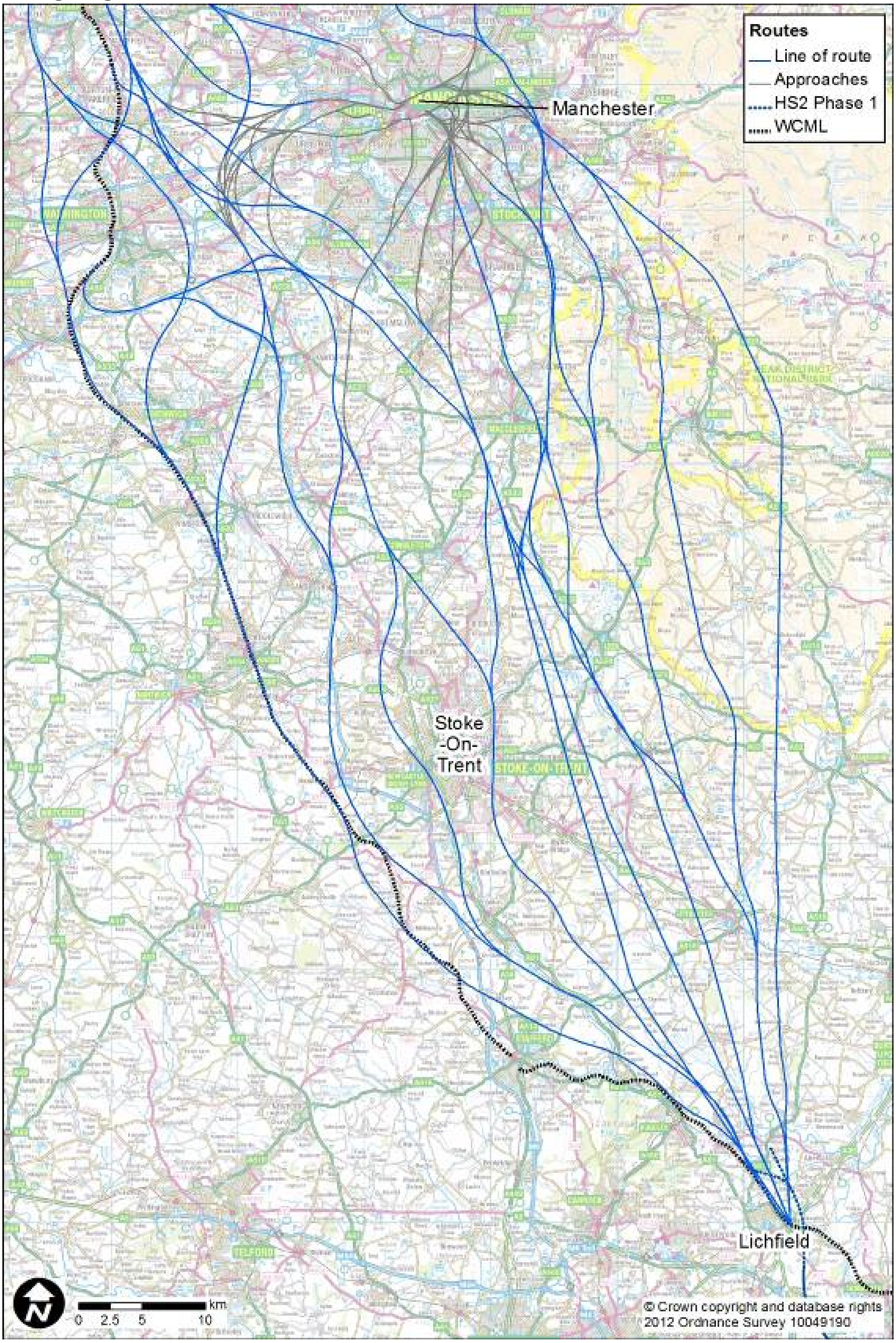
4.3.4 We explain the key aspects of our route choices such as route issues around Pasturefields Salt Marsh SAC at the southern end of the route, consideration of the potential intermediate markets including how the North West would be best served off the main high speed line and how we designed the route options to serve our final station options. In the subsequent sections, we explain how our work was further developed, analysing whether an additional intermediate station would add to the business case influences route choices. We also describe how the connection to the WCML influences the length of high speed line being built and the trade off between cost, journey time and markets served.

The generation of initial ideas and the sifting down to a ‘long list’

4.3.5 The generation of ideas for routes led to a large number of route options being initially developed, including those which would follow the M6 and WCML corridors and a ‘straight line’ broadly following the overhead power lines between Lichfield and a point in Manchester city centre.

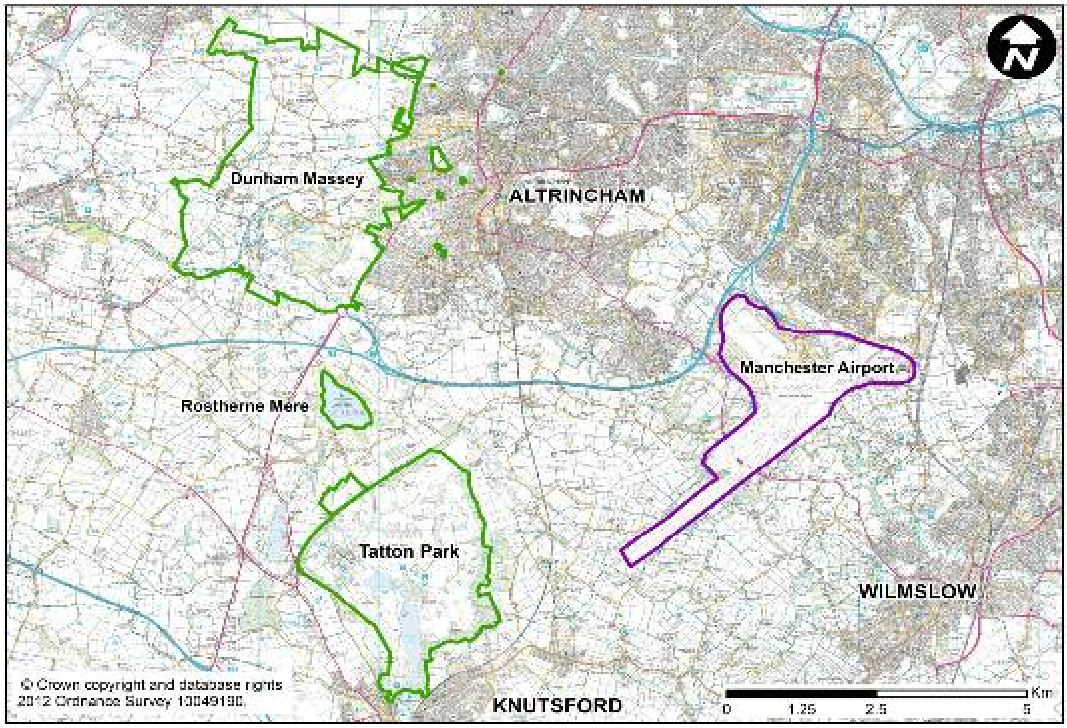
4.3.6 It was more complex to develop the route sections at the northern end of this corridor, than the southern section. At the northern end, route options had to serve at least one Manchester city centre station option and offer a way to connect with the WCML. The corridor of land that routes must pass through, either before or after a spur into Manchester, is also constrained by three sensitive sites in particular (see text box 1). At this stage, not enough information was known about the route options to enable sifting so all options were developed further. Figure 4.2 shows the initial list of options with all options progressing.

Figure 4.2 – Routes between Lichfield, the Manchester outskirts and Golborne long listing stage



Source: HS2 Ltd

1. Tatton Park, Rostherne Mere and the Dunham Massey estate



Source: HS2 Ltd

A number of features to the south-west of the Manchester conurbation present a particularly complex restriction to the engineering of a new railway line through this area. As the map highlights the principal features are, Manchester Airport and its runways, the extensive Tatton Park (a Registered Park and Garden containing listed structures), Rostherne Mere nature reserve (a Ramsar site and a Site of Special Scientific Interest (SSSI)) and the Dunham Massey estate also containing listed structures and surrounding National Trust land. There are also a number of settlements in the area which we aimed to avoid where possible.

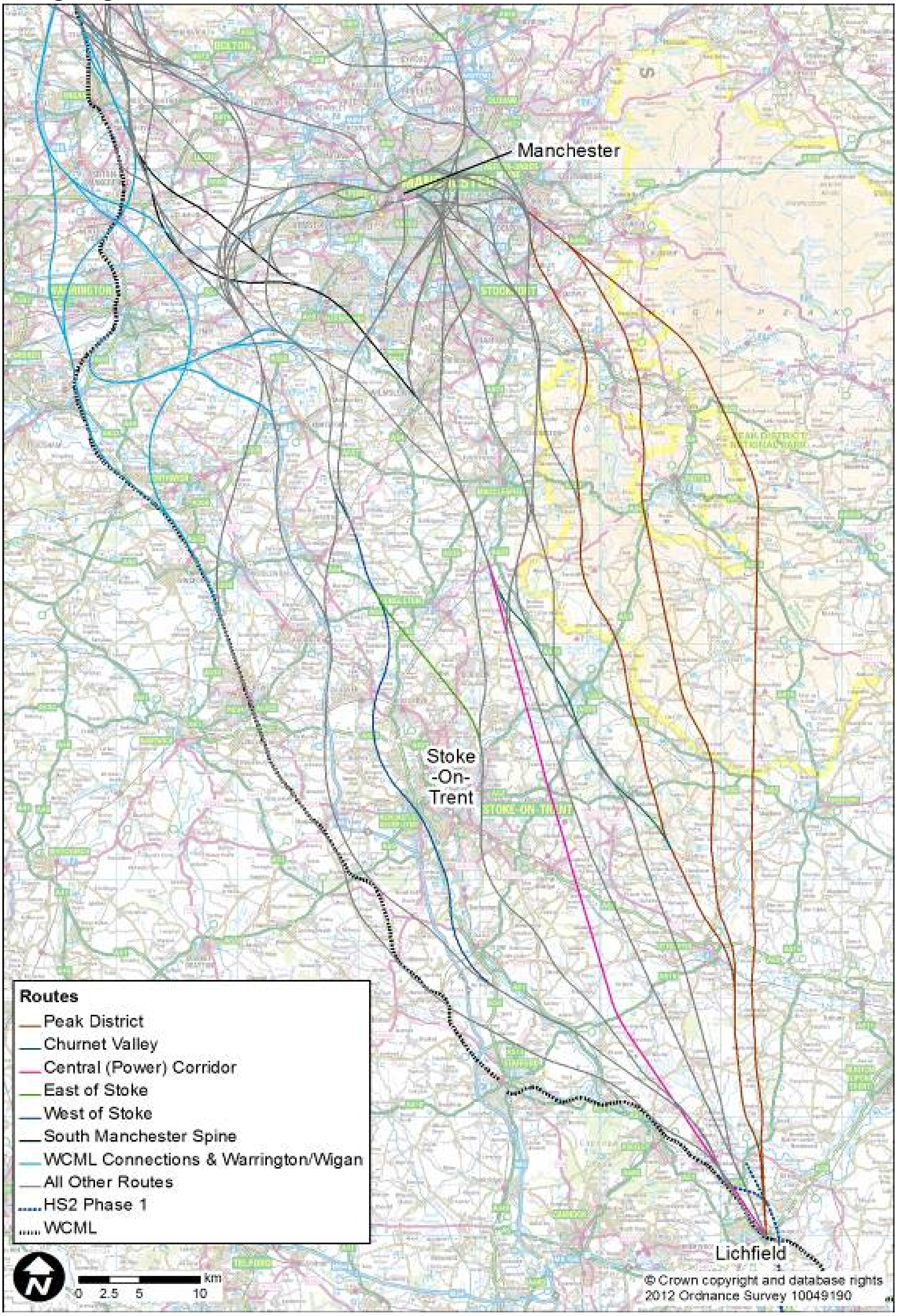
Any route which is to serve both a station near Manchester Piccadilly and a link to the WCML would need to pass through the very narrow corridor between the north side of Tatton Park and Rostherne Mere and the edge of the Altrincham urban area (bounded by the M56), followed by the Dunham Massey estate. In addition, any line of route that would serve an interchange station near to or at Manchester Airport would need to pass through the narrow corridor between the Airport and Tatton Park.

Rostherne Mere is listed under Ramsar (an international designation that promotes the conservation of wetlands) because it is one of the deepest and largest of the meres (lakes) of the Shropshire-Cheshire Plain. The key interest features which qualify the site for Ramsar status are the extent of natural standing open water habitat and the large areas of water-fringe vegetation including fen, marsh and swamp habitats.

We aimed to avoid impacting on all of these sites where possible. Where this has not been possible we have sought to minimise impact on these important sites. As our design work continues we will consider whether route options through this sensitive area can be further refined.

The creation of a short list

Figure 4.3 – Routes between Lichfield, the Manchester outskirts and Golborne short listing stage



Source: HS2 Ltd

4.3.7 Figure 4.3 shows the options presented for sifting at this stage, including any changes to the alignment of options that were developed as part of the further work. Those not short listed for further development are coloured and grouped on these maps.

Peak district routes

('Peak District' on figure 4.3)

4.3.8 The most easterly groups of route options, the Peak District routes, would begin as two routes initially north of Lichfield, diverging to form three to the east of Uttoxeter. These three options were not short listed primarily because of the impact they would have on the Peak District National Park and other sustainability issues, such as potentially impacting up to 14 SSSIs. In addition, these routes would not perform favourably compared to more westerly options in terms of cost and journey time.

Churnet Valley routes

('Churnet Valley' on figure 4.3)

4.3.9 The section of route crossing the Churnet Valley from the Peak District was also not taken forward. This was because we had an alternative option from Lichfield passing to the west of Uttoxeter which performed more favourably in terms of cost and sustainability impact.

East of Stoke-on-Trent and Central Corridor routes

('East of Stoke' and 'Central (Power) Corridor' on figure 4.3)

4.3.10 In the central corridor to the east of Stoke-on-Trent a further option was not shortlisted because, compared to the option immediately to the east, this would be more expensive, have a longer journey time and a poorer sustainability performance.

Warrington and WCML corridor routes

('WCML connections and Warrington/Wigan' on figure 4.3)

4.3.11 The westernmost route sections around Warrington and Wigan were originally designed to follow the WCML corridor, however these were not taken forwards. Three of the four route variations would only serve Manchester from a spur diverging from the main route south of Northwich. This resulted in an increased total route length and hence a high overall cost. The remaining route sections not taken forward as they would perform worse from a cost, journey time and sustainability perspective compared to the shortlisted western route from Crewe to Golborne.

4.3.12 Also seen to the west of the map, are three options connecting to the WCML to the south of Warrington. These were not shortlisted for cost and sustainability reasons as they would present considerably long lengths of additional track to the route to the WCML compared to other options, and would therefore introduce unnecessary costs and sustainability and journey time impacts.

South Manchester 'Spine'

('South Manchester Spine' on figure 4.3)

4.3.13 The south Manchester 'Spine' route options would provide a link from Wilmslow (south of Manchester) in a long tunnel under Manchester Airport to two connection options to the WCML. Given the very significant cost of tunnelling and the potentially poor sustainability performance further north, these route options were not taken forward.

West of Stoke-on-Trent routes

('West of Stoke' on figure 4.3)

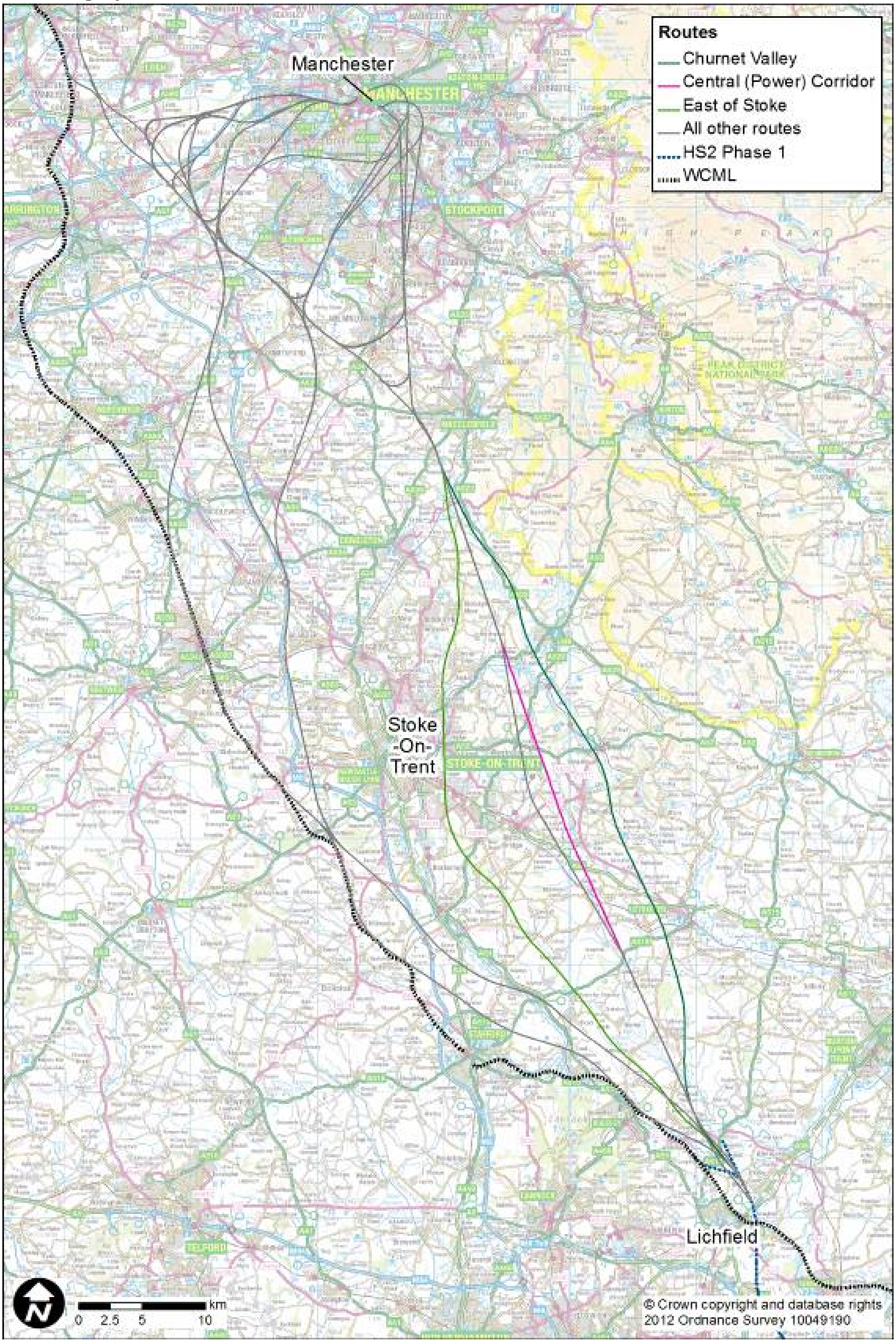
4.3.14 The route option that would pass through the west of Stoke-on-Trent was not selected for short listing. This route would have significant demolitions and noise impacts at Stone and Stoke-on-Trent in addition to a high cost tunnel. The short route section passing from the northeast of Stoke-on-Trent to Congleton was also not taken forward on similar grounds.

4.3.15 Following this stage of the process a single connection option to the WCML remained in the Golborne area. Other connection options remained further north and the development of these, plus the comparison to the connection in the Golborne area is dealt with in the section on routes to Preston later in this chapter.

Selecting options for refinement

4.3.16 Figure 4.4 presents the short listed route sections with those not taken forwards highlighted. The route options presented reflect the further development undertaken at this design stage.

Figure 4.4 – Routes between Lichfield, the Manchester outskirts and Golborne selecting options for refinement



Source: HS2 Ltd

East of Stoke-on-Trent and Churnet Valley routes

('East of Stoke' and 'Churnet Valley' on figure 4.4)

4.3.17 The route that would pass through Stoke-on-Trent was not taken forward because it would require long sections of tunnelling. This presented a high cost, further exacerbated by a very high level of engineering risk which may result in additional cost. The two easternmost routes remaining were also not progressed. This was predominantly due to higher cost of structures and tunnels required to negotiate the Churnet Valley and surrounding hills. The number of potential demolitions and other sustainability considerations were also higher compared to the remaining alternative route option to the east of Stoke-on-Trent.

4.3.18 Although the remaining route to the east of Stoke-on-Trent was identified as the best performing route to the east, it was not taken forwards for further development. This option was not developed primarily because of its higher cost compared to the final options. In addition, the sustainability and journey time improvements identified for this option did not justify the higher cost.

4.3.19 As this was the only remaining route option to the east we investigated in some detail, but did not develop fully as a final option. This route would run in a north-west direction from the junction with the phase one route, passing through mainly rural areas. Then it would pass between the Stoke-on-Trent conurbation and Cheadle, to the west of Leek. Remaining to the west of the Peak District and Macclesfield it would then curve to the west to pass south-west of Alderley Edge and Manchester Airport before connecting to the route of the other options to the south of Altrincham.

4.3.20 The route would require a mixture of high embankments and cuttings, some lengths of high viaduct, and several short sections of tunnel to pass through the hilly landscape. The route would run through areas of hard rock which could present difficulties for tunnelling construction, and unstable slopes. The considerable amount of structures and earthworks required for this route would generate an expensive route option, compared to the western route alternative. This option would also present a number of sustainability impacts, including potential water and ecology impacts on Blithfield reservoir, landscape and heritage impacts in relation to Congleton Cloud and landscape and heritage impacts on Gawsworth and Old Hall.

4.3.21 We therefore decided that the route options to the east were not viable and would not be progressed. If the Government wishes us to undertake further analysis on the eastern route options then this option would be reviewed.

Finalising our options

4.3.22 The emphasis at this stage was on design refinement and mitigation of all route options taken forward at the previous stage, not to reduce the number of options. However, if options were assessed not to be viable as a result of this work, they would have been sifted out. As design refinement and mitigation, generally in the form of avoidance of impacts was applied, a comparison was made with the route design from the previous stage. This was to ensure that further work had introduced an overall improvement with acceptable cost increments where necessary. In some cases it was found that despite a number of changes to deal with individual issues, the design presented at the previous sifting stage still performed better overall, however the majority of changes proposed were accepted.

4.3.23 At this stage we assessed the routes as whole route options. Up to this point shorter route sections had been assessed from one common point to another. We pieced together these remaining sections into all the combinations possible that would meet our remit and assessed these as separate full route sections.

4.3.24 These final main route options separated into three geographic sections are presented below. Figure 4.5 shows these full route options and variations on a map.

From Lichfield to Newcastle-under-Lyme:

- Lichfield to Newcastle-under-Lyme northern option with variant - Heading north-west from the junction with the phase one route, the route would pass Rugeley and to the south of Weston before heading to the west of Newcastle-under-Lyme. The variant would skirt to the south of Weston, following the same route for the remainder; and
- Lichfield to Newcastle-under-Lyme southern option - Heading north-west from the junction with phase one, the route would pass Rugeley and to the north of Cannock Chase and north of Stafford before heading north to Newcastle-under-Lyme.

From Newcastle-under-Lyme to Crewe and Sandbach

- Newcastle-under-Lyme to Crewe western route - This would join the route of the WCML north of Newcastle-under-Lyme to Crewe and would enter a tunnel to pass under the town, with a junction there to connect with the WCML; and
- Newcastle-under-Lyme to Sandbach M6 route - Following the M6 corridor, this route would head north from Newcastle-under-Lyme, passing to the north-west of Stoke-on-Trent and to the east of Sandbach.

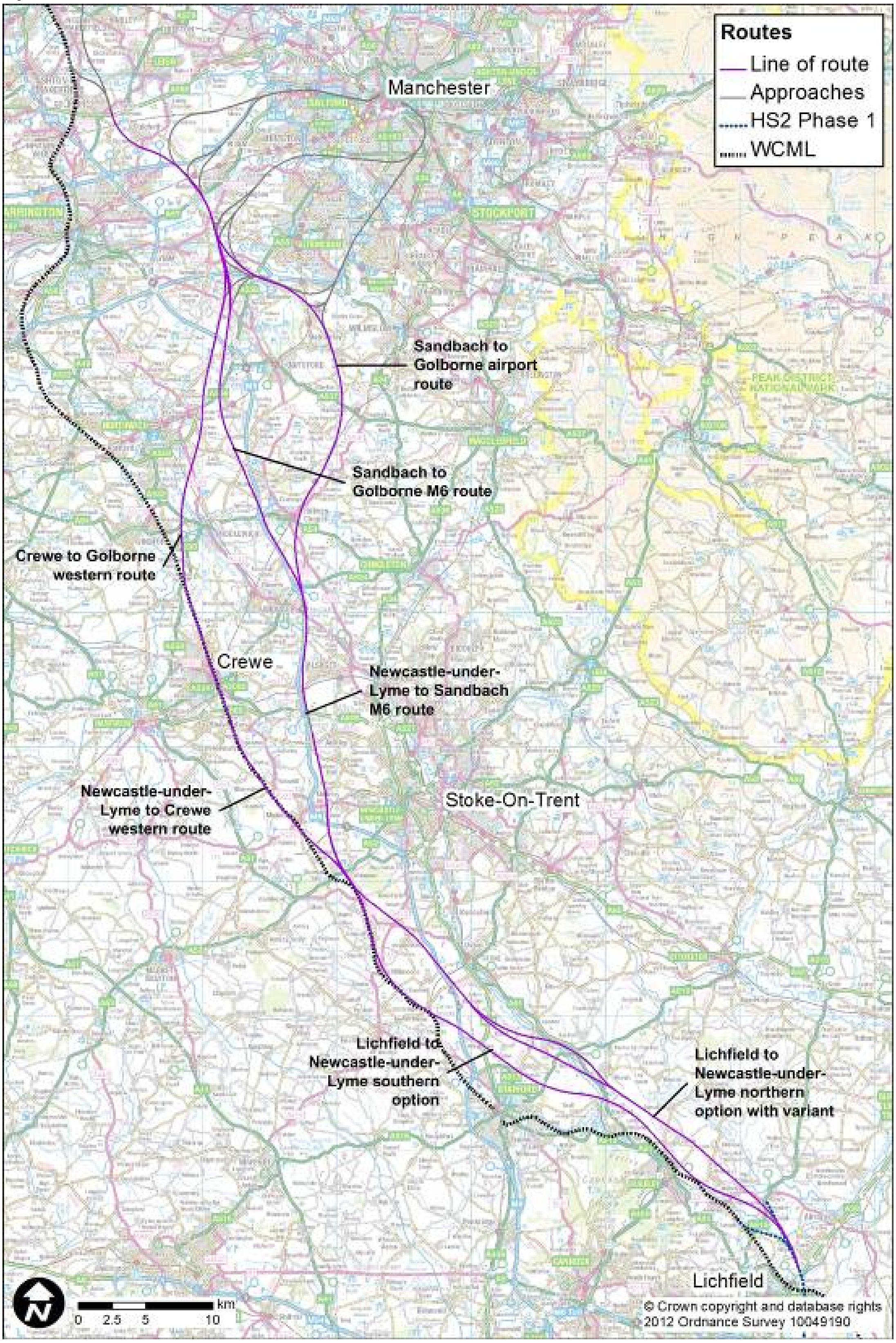
From Crewe and Sandbach to Golborne

- Crewe to Golborne western route - This would follow the WCML to the north of Crewe, and then head north-east across the Cheshire Plain to the south of Manchester, where connections could be made to city centre and interchange stations. It would pass to the west of Manchester and towards a connection to the WCML near Golborne;
- Sandbach to Golborne M6 route – This would continue along the M6 corridor passing to the west of Knutsford before connecting to a station in Manchester and also the WCML to the west of Manchester; and

- Sandbach to Golborne Airport route - This would pass to the east of Knutsford and to the south-west of the Airport before joining the path of the M6 route to the south-west of Manchester.

4.3.25 A summary of the design, impacts and factors that would influence costs and benefits is presented for each of these options in the following section.

Figure 4.5 - Routes between Lichfield, the Manchester outskirts and Golborne final options



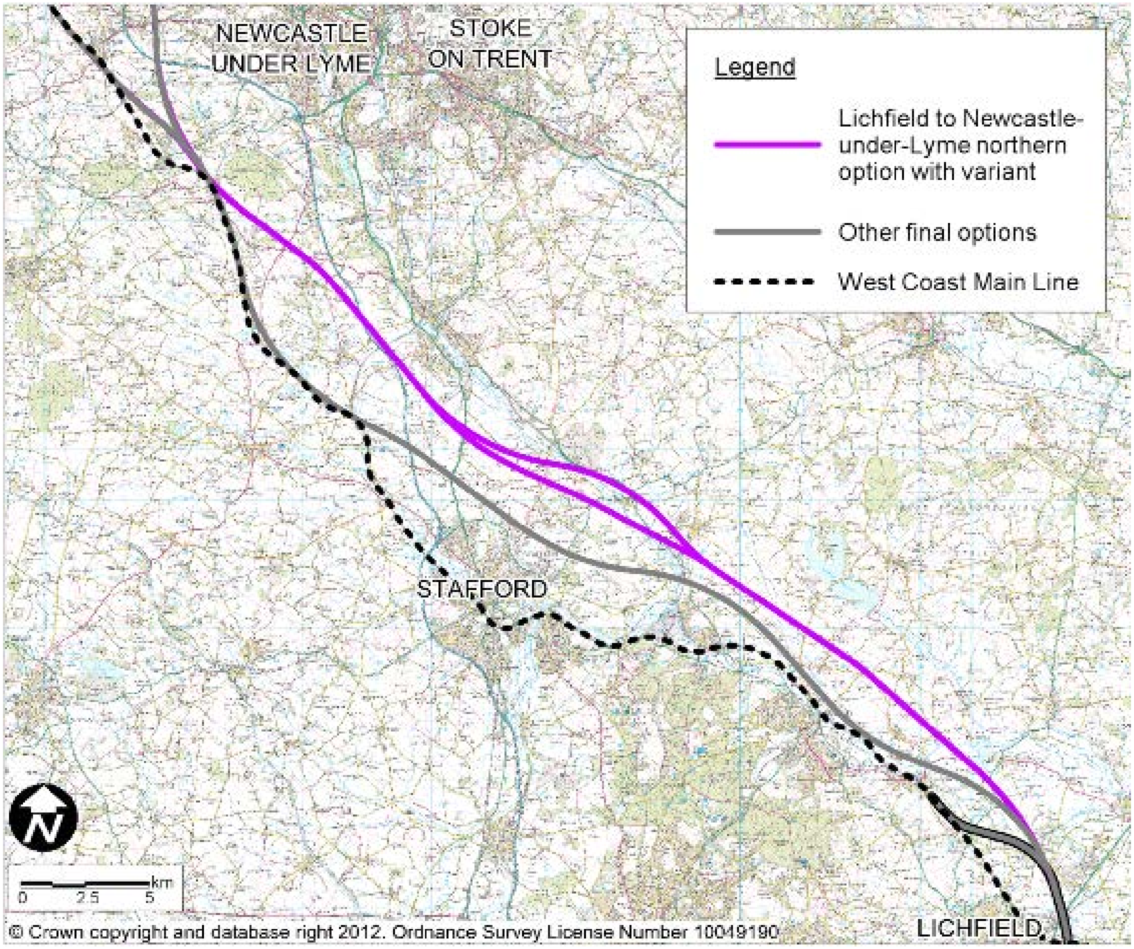
Source: HS2 Ltd

Proposed whole route options and alternatives

4.3.26 We now present a high level description of the final route options that are set out above. These options run up the western side of the corridor towards Manchester.

The area from Lichfield to Newcastle-under-Lyme: Lichfield to Newcastle-under-Lyme northern route option with variant

Figure 4.6 - Lichfield to Newcastle-under-Lyme northern route option with variant



Source: HS2 Ltd

Engineering

4.3.27 Figure 4.6 is a map of the Lichfield to Newcastle-under-Lyme northern route option with variant. The route would begin at a junction with the phase one route to the north of Streethay. The phase one junction with the WCML would be retained following the opening of the phase two route so that classic compatible trains could leave the HS2 route here to serve existing stations to the north. The northern option would be on an embankment in this area and would pass over the Trent and Mersey Canal on a bridge. Heading north-west the route would cross the A515 and the Bourne Brook floodplain on a viaduct, passing half-way between Handsacre and Kings Bromley to minimise potential noise impacts. Shortly afterwards the route would cross the River Trent and its floodplain on a long viaduct.

4.3.28 Continuing to run north-west on a mixture of cutting, embankment and surface level tracks to follow the terrain, the route would pass to the north-east of Hill Ridware and Colton. A succession of short viaducts would then be used to cross a valley, Moreton Brook floodplain and Bourne Brook.

4.3.29 As the route approaches Weston an alternative variant of this route has been developed. The option to the north of Weston would be expected to have greater impacts on Weston (which includes a conservation area) and Hixon as it would pass closer to these towns. The option to the south of Weston would however have the potential for a higher likelihood of impacting on the Pasturefields Salt Marsh SAC (see text box 2) as it would pass closer to it. We describe both variants below.

2. Pasturefields Salt Marsh SAC

The Pasturefields Salt Marsh SAC is a protected European site of particular importance because it is the only significant remaining example in the UK of a natural salt spring with inland saltmarsh vegetation. The salt is derived from natural deposits within the underlying rock, and is carried to the site by groundwater. It is currently understood that the local topography and orientation of below ground geology cause the salt water to rise to the ground surface to form the springs at Pasturefields Salt Marsh SAC.

Possible sources of information available to us at this stage have been consulted (including Natural England and the Environment Agency), but the hydrological processes that support the salt meadows are imperfectly understood.

All three final route options pass in the vicinity of the site at varying distances and each with different levels of potential risk to the designated site. In the surrounding area, there are also other pieces of infrastructure and sustainability considerations that have impacted on our route decisions. This includes Sandon Park Registered Park and Garden, the River Trent, the Trent and Mersey Canal and its associated Conservation Area and listed structure, the WCML and A51. Potential impacts on the nearby settlements of Hixon and Salt have also been limited as much as possible.

We have undertaken some initial appraisal of potential impacts to the site, and are discussing the findings with both Natural England and the Environment Agency. This work will continue as scheme designs are progressed and could involve some advance groundwater investigation if feasible and required.

The route to the north of Weston

4.3.30 After approaching Hixon mainly in cutting, the route would run on the surface through an existing industrial estate and the edge of an airfield. Pasturefields Salt Marsh SAC would lie to the south of the route at this point. Heading north-west alongside the existing railway line, the route would approach the north-east edge of Weston on a short viaduct over Amerton Brook.

4.3.31 The route, continuing alongside the existing railway line, would pass to the east of the A51 as it skirts past the northern side of Weston, before crossing this road and the Gayton Brook floodplain on a viaduct. Continuing to run parallel with the A51 and the railway line, the route would pass to the south of Sandon Park Registered Park and Garden and cross the River Trent and the Trent and Mersey Canal on a long viaduct.

4.3.32 The village of Salt would lie to the south of this viaduct. North of here the route would run in a deep cutting and then in a short tunnel under Sandonbank, followed by further deep cutting. After this the route would follow the terrain for approximately two miles on low embankment or shallow cutting. Whilst in cutting it would pass under the A34 before crossing a valley on a short viaduct to the west of Stone.

The variant route to the south of Weston

4.3.33 The variant option would approach the south of Hixon, mainly in cutting and then run on a high embankment to the south of an industrial estate. This option would be closer to Pasturefields Salt Marsh SAC however it would still lie to the south of the route. The route would then cross the railway line to Stoke-on-Trent and the A51 on bridges. A short viaduct would cross a floodplain, followed by a longer viaduct crossing the River Trent and the Trent and Mersey Canal. Weston would lie to the north of the route. The route would continue to run north-west with a series of shallow cuttings and embankments, passing to the north of Hopton Heath Historic Battlefield and crossing over the A34 as it approaches the south-west of Stone. This route would cross a valley to the west of Stone on a short viaduct then return to cutting.

The two options return to a common route at this point

4.3.34 The route would converge with the M6 corridor close to Stafford services then run in parallel with it for a short distance. The route would then cross the M6 and a floodplain on a viaduct. The route would pass Swynnerton to the east on an embankment and then run in a deep cutting and underneath the A51 and A519. To the north of here the route would run mainly in cutting and through a short section of a wood. It would pass to the south and west of Swynnerton Old Park and then pass through Springfield at the same point as the WCML. At the beginning of the floodplain to the north of Springfield the route would cross this and the A53.

Sustainability

4.3.35 The Lichfield to Newcastle-under-Lyme northern option would result in the demolition of an estimated 17 dwellings if taking the route to the north of Weston and 18 dwellings if taking the variant to the south of Weston.

If taking the route the north of Weston

4.3.36 The River Trent may need to be diverted in this area to accommodate the crossing. Four Grade II listed structures would be directly affected; these are the Grade II listed Salt road bridge over the Trent and Mersey Canal, where the route crosses this on a viaduct and Bentley Hall Farm House, Hamley House and its gate posts and attached garden wall.

4.3.37 The Trent and Mersey Canal Conservation Area would be crossed twice for short sections. The route would pass within a few kilometres of the Pasturefields Salt Marsh SAC (see text box 2). Four areas of BAP habitats would be crossed.

If taking the variant route to the south of Weston

4.3.38 There would be a potential major landscape impact in the Trent Valley north of Stafford, where the route would run parallel with the River Trent and the Trent and Mersey Canal, which is a conservation area. A further conservation area would be intersected by the route at Shirleywich. Four Grade II listed structures would be directly affected. These are the Wychdon Lodge and Outbuildings, Hamley House, gate piers and wall immediately south-west of Hamley House and Bentley Hall Farmhouse.

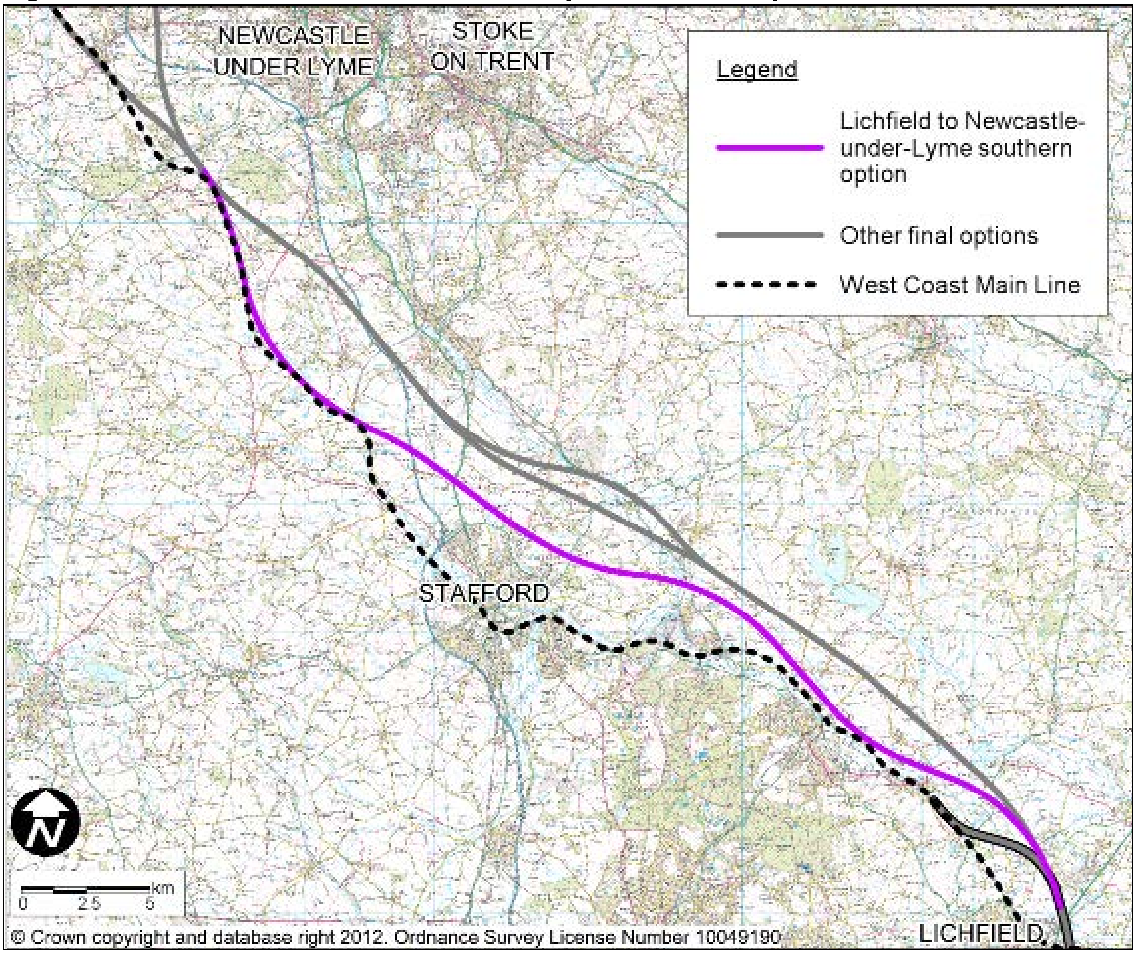
4.3.39 To the south of Salt the route would pass in close proximity to a Historic Battlefield and the Pasturefields Salt Marsh SAC (see text box 2). Eleven areas of BAP habitats would also be crossed. In relation to all sustainability considerations (excluding Pasturefields Salt Marsh SAC), this section of the route would perform better than the route to the north of Weston (above).

And for the remainder of the route after the two variants come together

4.3.40 Some of this section of the route would result in an impact on landscape character as well as visual impacts across surrounding areas of open countryside and on the nearby villages of Whitmore (a conservation area) and Baldwin’s Gate.

The area from Lichfield to Newcastle-under-Lyme: Lichfield to Newcastle-under-Lyme southern option

Figure 4.7 - Lichfield to Newcastle-under-Lyme southern option route



Source: HS2 Ltd

Engineering

4.3.41 Figure 4.7 is a map of the southern route option between Lichfield and Newcastle-under-Lyme. The route would begin at a junction with the phase one route to the north of Streethay. The phase one junction with the WCML would be retained following the opening of the phase two route such that classic compatible trains could leave the HS2 route here to serve existing stations to the north.

4.3.42 The route would be on an embankment in this area and would pass over the Trent and Mersey Canal and the A515 on bridges before crossing the Bourne Brook floodplain on viaduct. The route would pass to the north of Handsacre on a long viaduct across the River Trent floodplain and would be positioned to minimise noise impact on Hill Ridware, Handsacre and Armitage. This would result in the route passing close to Mavesyn Ridware.

4.3.43 For around 3.1 miles (5km) the route would follow the eastern side of the WCML as it passes east of Rugeley, moving from cutting to embankment and viaduct frequently as it passes through hills and crosses over floodplain. Heading north of Rugeley the route would follow the corridor of the overhead power lines in cutting, moving to the south of Hixon and the north of Cannock Chase, Shugborough Hall, Little Haywood and Great Haywood. The route would then rise on a viaduct to cross over the railway line to Stoke-on-Trent, the Trent and Mersey Canal and the River Trent. From here the route would follow the profile of the land through this area of countryside towards Stafford.

4.3.44 As the route passes Stafford it would be constructed with intermittent sections in deep cutting, on the surface and on embankment. It would cross over the A518 and under the A34 in a deep cutting rising to cross the M6 on a bridge northeast of Whitgreave. The route would then run alongside the corridor of the WCML from Norton Bridge for approximately 6.2 miles (10km).

4.3.45 The route would cross Meece Brook four times on viaduct, before diverging from the WCML to pass under the A51 in cutting to the east of Millmeece. From here the route would move back to the WCML corridor rising onto the surface following the Meece Brook Valley. The route would pass the villages of Cranberry, Stableford and Springfield, crossing the Brook and its floodplain four times on viaduct during this stretch. The route would continue to the north-west, diverging away from the valley and the WCML on an embankment and crossing over the A53.

Sustainability

4.3.46 The Lichfield to Newcastle-under-Lyme southern route would result in the demolition of an estimated 48 dwellings. Two conservation areas would be crossed by this route section: Mavesyn Ridware and the Trent and Mersey Canal. The setting of three listed structures would be impacted on. The route would cause visual impacts for a number of villages, including the Whitmore Conservation Area. Landscape impacts would be noticeable in some places, particularly viaducts over river valleys and where the route would need to cross canals and the transport arteries themselves.

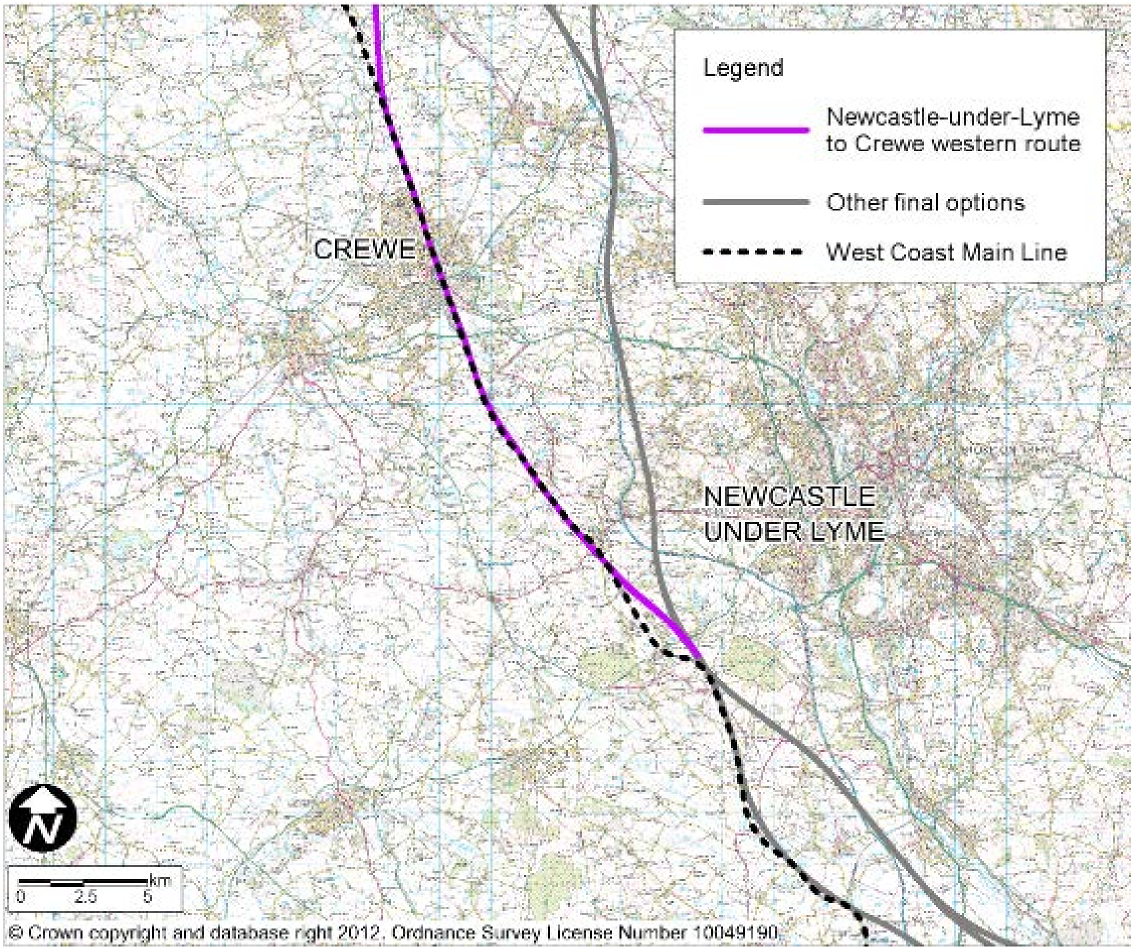
4.3.47 The route would also cross, and directly impact six areas of ancient woodland. Crossing the River Trent north of Great Haywood would seek to avoid direct impact on the Pasturefields Salt Marsh SAC (to the north of the viaduct). This route, located to the south of the SAC would be the lowest risk to Pasturefields Salt Marsh SAC of the three options passing it.

The area from Newcastle-under-Lyme to Crewe and Sandbach

4.3.48 The two route options set out above could then connect to either of the two route options described below, as the two sets of options intersect. This results in four route combinations two of which would go to Crewe and two which would go to Sandbach.

Newcastle-under-Lyme to Crewe western route option

Figure 4.8 - Newcastle-under-Lyme to Crewe western route



Source: HS2 Ltd

Engineering

4.3.49 Figure 4.8 shows the Newcastle-under-Lyme to Crewe western route option. After crossing the A53 the route would enter a deep cutting leading to a tunnel through the hillside. The route would emerge, again in cutting to pass Whitmore Heath and Wood and Hey Spink (a wood) before rising to cross over the existing railway line. The route would approach the WCML once again, running on a long viaduct to cross a floodplain and the WCML to the south of Madeley. Passing to the west of Madeley and on northwards, the route would follow the western side of the WCML, running mainly in cutting or at surface level.

4.3.50 Towards the point at which the WCML passes Wrinehill Hall the route would run on a series of embankments and at surface level before crossing the floodplain on a short viaduct and then continuing to follow the terrain northwards. After passing Wrinehill on the west of the WCML the route would cross under the existing railway in a deep cutting. The route would continue alongside the WCML towards Crewe sharing the corridor to the west of Chorlton. For this whole section the route would mainly run on the surface or in shallow cuttings, interspersed with short sections of embankment.

4.3.51 Approaching Crewe the WCML widens to form multiple tracks and cuts underneath the A500, which would need to be realigned to form a bridge over it. On entering Crewe, a grade separated junction would be provided to allow the option of connection to the WCML. The connection would require a viaduct to cross the other WCML branches and the main HS2 route immediately to the south of the Crewe urban area. After the junction the main route would descend into a retained cutting and then into tunnel to pass underneath the majority of the urban area of Crewe.

4.3.52 This connection to the WCML would allow for classic compatible services to exit the high speed network here and go on to serve Liverpool and other North West centres. A summary of our work on serving these markets is set out in text box 3. Alongside this, text box 4 summarises a report by Cheshire and Warrington Local Enterprise Partnership (LEP) on the case for a high speed rail hub at Crewe. We have also undertaken work on the possibility of an intermediate high speed station in the south Cheshire and north Staffordshire areas which includes an appraisal of demand for rail travel to London and the South East from this area. This can be found in section 4.4.

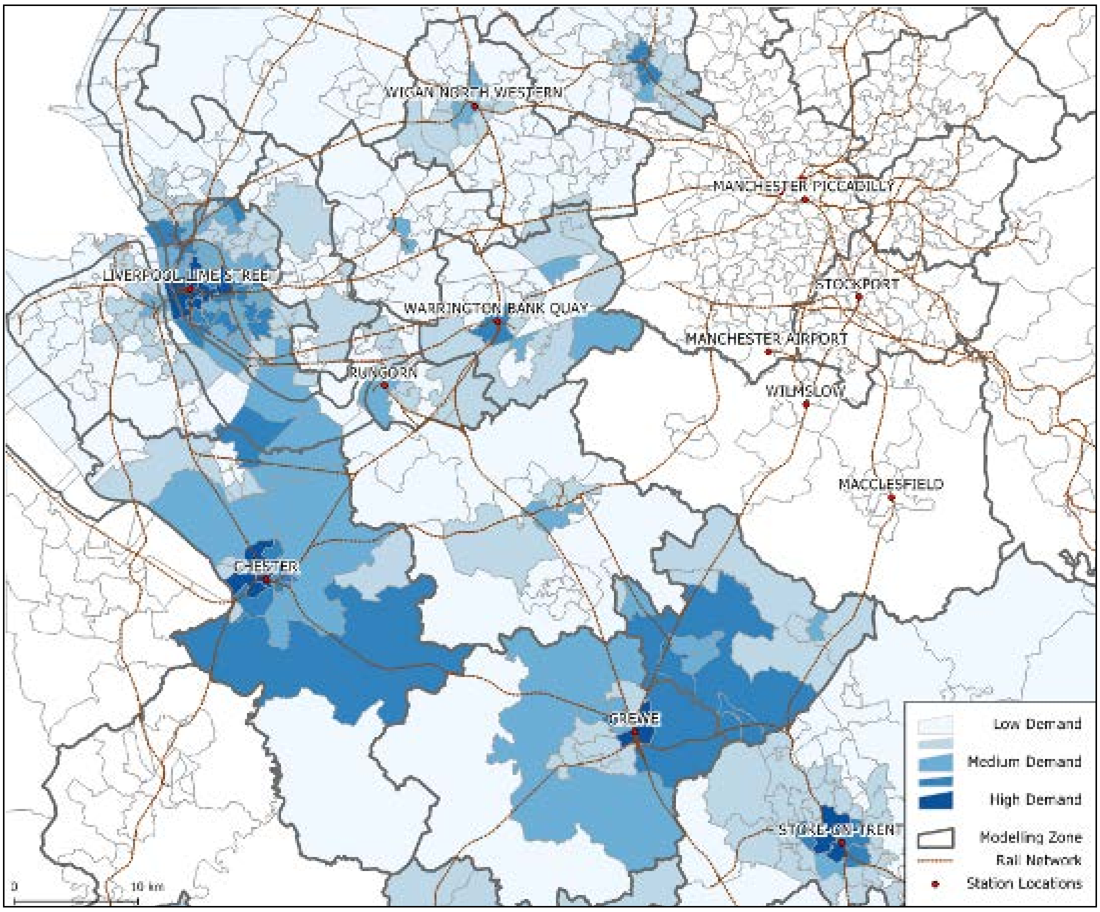
Sustainability

4.3.53 The Newcastle-under-Lyme to Crewe western route would result in the demolition of an estimated 15 dwellings. Some of this section would result in a high impact on the landscape as well as visual impacts across surrounding areas of open countryside; the route was also past close to the southern edge of Madeley Conservation Area. The route section would directly affect four ancient woodlands which are also wet woodland Biodiversity Action Plan (BAP) habitats.

3. Serving Liverpool, Crewe and other intermediate markets

This section focuses on the work done on the different ways to serve Liverpool and draws out important distinctions on how the options allow other important intermediate markets to be served. As can be seen from the map, Liverpool is an important market for HS2. Liverpool currently has a service of one train per hour from London via the WCML. Despite the constraints on the trunk of HS2 between London and West Midlands, our modelling suggests that it would warrant two trains per hour.

Figure 4.9 - Liverpool, Crewe and other intermediate markets - demand for long distance travel



Source: HS2 Ltd

We looked first at whether it would be possible to 'gauge clear' routes to Liverpool to allow running captive high speed trains there. To do so would be very disruptive to the existing railway. Our high level work found it to be prohibitively expensive, owing to the number of bridges and other structures on the railways into Liverpool, so we did not progress it.

We then looked at whether it would be possible to connect to the existing railways into Liverpool near Warrington, allowing classic compatible trains to run into Liverpool. This could allow a fastest London to Liverpool journey time of 1 hour 26 minutes. It could also allow Warrington to be served.

Our demand model analysis saw an increase in passengers from Liverpool and a near doubling of passengers coming from Warrington indicating the benefit of serving it by HS2. However, the level of benefits would only provide at best a marginal business case for a connection near Warrington because of the cost of the infrastructure to connect (between £390 million and £690 million). The sustainability impacts of a connection in that area would potentially be significant and would need further examination were it to progress.

If a higher frequency of service could be achieved the benefits to Liverpool and Warrington would be greater, but this would be at the expense of other intermediate markets. The map shows other key markets such as Crewe and Runcorn. There is also the potential to tap into markets of North Wales and West Cheshire by serving existing well connected stations. Crewe is a major rail hub for connecting these regions.

Our modelling showed that these other markets are important in terms of generating benefits and revenue. Crewe, for example, would warrant two trains per hour from London. Although we started looking at how best to serve Liverpool, it became clear that these other markets are an important part of the picture in choosing where to connect to the existing classic network and what stopping patterns to run.

We identified the potential to have a connection just south of Crewe. This could only be achieved if the route selected between West Midlands and Manchester were the western route via Crewe.

This connection could offer a faster journey time to Liverpool than the Lichfield connection: around 1hr 36 minutes from London to Liverpool. Importantly, it would also allow key markets, such as Crewe and Runcorn to be served, and we determined that the benefits of doing so would be even higher than those for a fast Liverpool service. This option would also allow Warrington to be served by HS2 which we identified as being important. There are some issues which would need closer examination such as crowding at places like Stafford, but we believe more detailed planning could resolve them. A connection just south of Crewe would give higher journey time benefits than the Warrington connection and would provide a highly positive business case.

It is clear that it is not only important where we connect to the WCML, but what services are run on HS2 and the existing network. We will work in partnership with Network Rail and regional stakeholders to understand what services should be run on a Y network and how best these would interact with the existing railway.

In summary, our analysis suggests that the strongest economic case would be for a connection at Crewe, giving a faster potential journey time to Liverpool and Warrington, but also allowing intermediate markets including Crewe to be served and bringing benefits to the wider area through its connectivity. The case for this is stronger than that for a connection further north near Warrington as the costs and sustainability impacts would be significant and intermediate markets could not be served by trains using such a connection. The loss of serving those markets would outweigh the incremental benefits to Liverpool and Warrington.

4. Cheshire and Warrington Local Enterprise Partnership – The case for an intermediate station

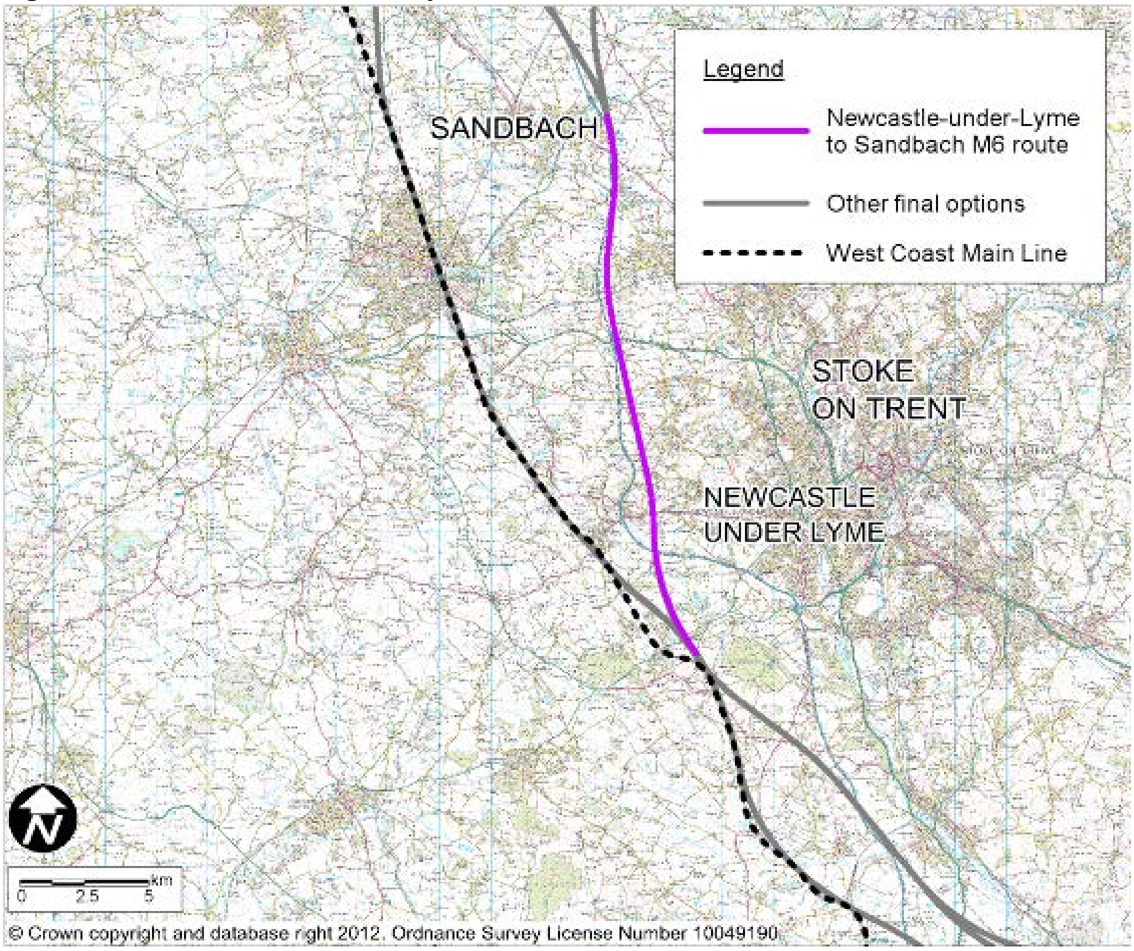
The Cheshire and Warrington Local Enterprise Partnership (LEP) and the Stoke-on-Trent and Staffordshire LEP strongly believe that a high speed rail Hub Station at south Cheshire or north Staffordshire would add significant value to the Government's high speed rail plans, strengthen the wellbeing of the adjoining economic sub-regions and to the wider economy of the North of England. Cheshire and Warrington LEP submitted a report to us and to Government. Below are key points from the report.

- A hub station in the area will boost the LEP areas, raise GVA per head in both and bring together a wide range of skills, employment and development opportunities. Including a hub station marries the strengths of these sub regional economies to provide a phenomenal platform for growth across a range of sectors.
- Both sub regions are well-connected, with strong functional economic linkages with the North's City Regions, north Wales, and the Midlands, all of whom stand to benefit from high speed rail. South Cheshire and North Staffordshire lie at the heart of this exciting wider economy and offer great potential to grow.
- High speed rail will allow both LEP areas to play a leading role in helping to drive forward the Government's agenda for rebalancing the economy, be this north-south, from public to private sectors, or across sectors and their trade patterns.
- We and our partners in the north-west and north Staffordshire are committed to working closely with Government and HS2 Ltd in delivering the growth potential that high speed rail would offer our economies given a Hub Station. High speed rail matters for you; it matters equally for us.
- To this end the strength of the transport and economic case for a Hub Station are clear as a catalyst to unleash the potential of both LEP areas and also deliver benefits across the North of England. Our assessment of the Hub Station and the proposed service connections adds over £1.3 billion of total transport benefits to the business case for high speed rail. We firmly believe this makes a compelling case.

We have submitted the report to Government.

The area from Newcastle-under-Lyme to Crewe and Sandbach: Newcastle-under-Lyme to Sandbach M6 route option

Figure 4.10 - Newcastle-under-Lyme to Sandbach M6 route



Source: HS2 Ltd

Engineering

4.3.54 Figure 4.10 shows the Newcastle-under-Lyme to Sandbach M6 route option. After crossing the A53 the route would pass in tunnel through a low hill west of Whitmore. It would emerge in cutting before rising onto embankments and viaduct in order to cross a valley, reaching a maximum height of 24m.

4.3.55 From here the route would cross the M6 to the west of Keele services before heading directly north, running on the east side of the motorway. The route would pass to the east of Madeley Heath using two viaducts to cross the terrain and the A525. Descending into a short tunnel under the hillside, the route would pass through a series of deep cuttings and embankments before moving to run adjacent to the M6 from Junction 16 (with the A500). At this point there is an option for an intermediate station (see section 4.4)

4.3.56 The route would pass over the A500 on a bridge on the eastern side of the M6. Continuing to follow the M6 corridor the route would run on embankment northwards, using viaducts to cross a floodplain, the Crewe to Kidsgrove railway and White Moss, an area of peat. At this point, still on embankment, the route would pass between the M6 and Alsager before moving to run immediately adjacent to the M6. The route would then rise onto viaduct to cross a floodplain before crossing the Trent and Mersey Canal and the A533 on bridges. Passing to the east through Sandbach motorway services the route would remain on the opposite side of the M6 from Sandbach.

Sustainability

4.3.57 The Newcastle-under-Lyme to Sandbach route option would result in the demolition of an estimated 19 dwellings. The Trent and Mersey canal Conservation Area would be crossed by the route. Despite running close to the M6 and WCML for a significant distance, landscape impacts would be noticeable in some places, particularly viaducts over river valleys and where the route would need to cross canals and the transport arteries themselves. The route would cross and directly impact on five ancient woodlands which are also BAP habitat; there would be one additional BAP habitat also impacted.

The area from Crewe and Sandbach to Golborne

4.3.58 There are three route options from Crewe and Sandbach to Golborne.

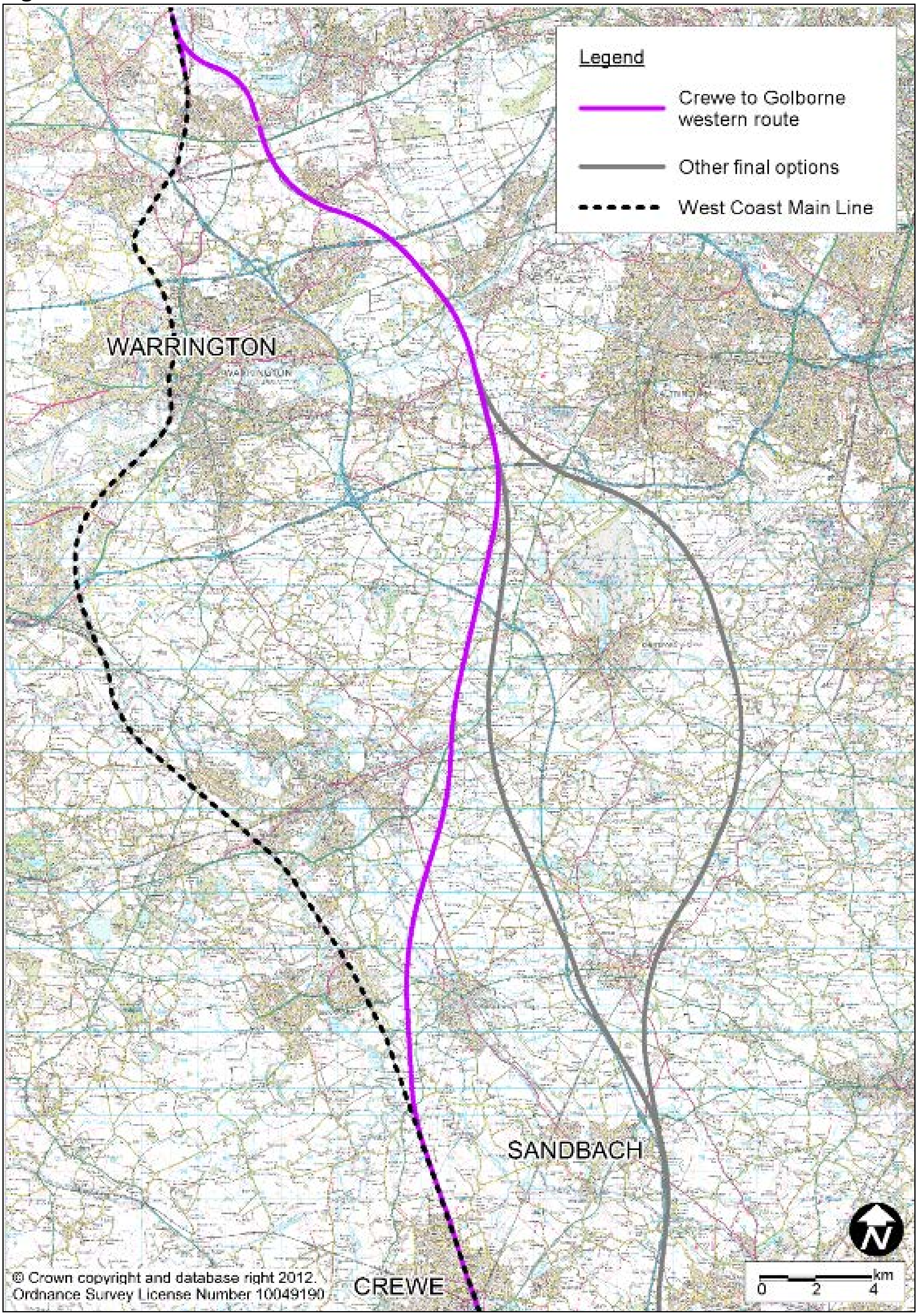
4.3.59 The first route option (Crewe to Golborne western route, Figure 4.11) is described from Crewe, passing to the east of Warburton and connecting to the WCML at Bamfurlong near Golborne. This route would continue on from the Newcastle-under-Lyme to Crewe western route.

4.3.60 The second route option (Sandbach to Golborne M6 route, Figure 4.12) would begin at Sandbach, following the route of the M6 motorway before connecting into a common route to the east of Warburton. This is one of two options that would continue on from the Newcastle-under-Lyme to Sandbach route.

4.3.61 The third route option (Sandbach to Golborne Airport route, Figure 4.13) would also begin at Sandbach and head in a northerly direction towards Manchester Airport. It would then move west to join the common route to the east of Warburton. This is an alternative option to continue on from the Newcastle-under-Lyme to Sandbach route. We now describe each of these options in turn.

The area from Crewe and Sandbach to Golborne: Crewe to Golborne western route

Figure 4.11 - Crewe to Golborne western route



Source: HS2 Ltd

Engineering

4.3.62 Figure 4.11 is a map of the Crewe to Golborne western route. When leaving the tunnel on the north side of Crewe, the route would remain in cutting as it passes the Barrows Green area. From here the route would run immediately adjacent to the WCML for 2.5 miles (4km), passing through open countryside at surface level. From this point it would begin to bear away from the WCML to head north-west.

4.3.63 The route would continue at surface level for a total of 3.7 miles (6km) as a result of the flat terrain. It would then rise to cross over the Shropshire Union Canal, before gradually descending to pass under the A530 and A533 in a long cutting. At this point the route would pass through the corridor between Middlewich and Winsford.

4.3.64 Northwards the route would then pass on viaduct over the Trent and Mersey Canal and the River Dane floodplain. This would be followed by a short section of cutting leading to a second viaduct over the Gad Brook floodplain before crossing over the Sandbach to Northwich railway line on a bridge. Bearing north-east the route would run mainly on embankment passing a few kilometres to the east of Northwich and providing some protection to Lostock Gralam by remaining on the east side of the A556.

4.3.65 The route would cross over the existing railway line, the A556 and the A559 on embankment before rising onto a series of viaducts to cross minor floodplains to the east of Higher Wincham and Pickmere. The route would then run in shallow cutting or on the surface for around 1.9 miles (3km) before rising onto embankment to cross over the M6 just to the north of Junction 19. After the M6 crossing, the route would descend gradually on an embankment and into a cutting under the A50 west of Hoo Green. The route would then continue to the east of High Legh as it approaches the M56 to pass under it in deep cutting.

4.3.66 Geographic constraints to the north of this point would require a reduction in design speed to 225mph (360kph) through this section. North of the M56 the route would rise onto an embankment, crossing over the A56 and the Bridgewater Canal to the west of Lymm. A short section of viaduct would follow as the route crosses the River Bollin then moves to the north-east in cutting between Warburton and Mossbrow, south of the Manchester Ship Canal.

5. The Manchester Ship Canal and the surrounding area

The route design through this area is constrained by a number of existing infrastructure features, settlements and areas of environmental importance. The Manchester Ship Canal, A57, Manchester to Warrington railway and the M62 all run into Manchester via the south-west part of the city, creating obstacles for a new route from the south-west of Manchester to the WCML further north.

Routes approaching the Manchester city centre from the west would need to cross an area known as the Manchester mosses. Carrington Moss, Barton Moss and Chat Moss are all examples of where the route would need to pass over areas of peat. In these locations a range of engineering solutions would be required to support the railway including low structures and the replacement of peat with appropriate material.

The Ship Canal is navigable by ships and as such a 23m clearance must be maintained by any structures that cross it. Given the significant structures required to achieve a 23m clearance, options were also explored to tunnel under the canal. However the need to cross the M56 to the south and the railway and M62 to the north, combined with the rising land profile would result in up to 3.1 miles (5km) of additional tunnelling. Given the significant cost this option was not pursued any further.

4.3.67 In this same location the route would be constrained on either side by the settlements of Mossbrow, Warburton, Hollins Green, Cadishead and Glazebrook. It is also necessary to avoid impacts wherever possible on Holcroft Moss SAC, Rixton Moss and Rixton Clay Pits SSSI. The settlements of Culcheth and Lowton and Risley landfill site would further constrain the route design to the north of the M62, resulting in a maximum train speed of 180mph (300kph).

4.3.68 As the route approaches the Manchester Ship Canal it would rise onto a long viaduct reaching 28m high. In addition to the canal the route would also cross the A57 and Manchester road between Hollins Green and Cadishead. As the route descends from viaduct onto embankment, it would cross over the Manchester to Warrington railway line, Glazebrook and the M62 with a bridge, avoiding Holcroft Moss to the east.

4.3.69 The route would then gradually descend, bearing to the west to pass across the north-east corner of Risley landfill site. It would then broadly follow a dismantled railway corridor skirting around Culcheth in a cutting before rising to surface level to cross over the existing railway line on a bridge. Heading northwards the route would descend back into cutting in the same dismantled railway corridor between Lowton and Lowton Common and would pass under the A580. At this point the route would then leave the corridor and head west passing to the north of Golborne, Byrom Hall and Lightshaw Hall.

4.3.70 The route would rise onto a long embankment, crossing over the A573 as it prepares to connect to the WCML using a grade separated junction to the south of Bamfurlong. This connection would require the eastern most WCML track to be realigned to the east so that the high speed line could pass over it before joining the existing tracks to form a six track railway for a short distance. At this point classic compatible trains would continue to various destinations in the North West and beyond to Scotland.

Sustainability

4.3.71 The Crewe to Golborne western route would result in the demolition of an estimated 21 dwellings. In addition the Grade II listed Newchurch old 'refectory' near Culcheth would need to be demolished. The Trent and Mersey Canal Conservation Area would be affected, where the route crosses this for a short distance. Whilst on the viaduct over the Manchester Ship Canal, the route would pass close to Partington, Cadishead and Hollins Green. Impacts would be mitigated as much as possible, however, there would be significant visual impact in this area.

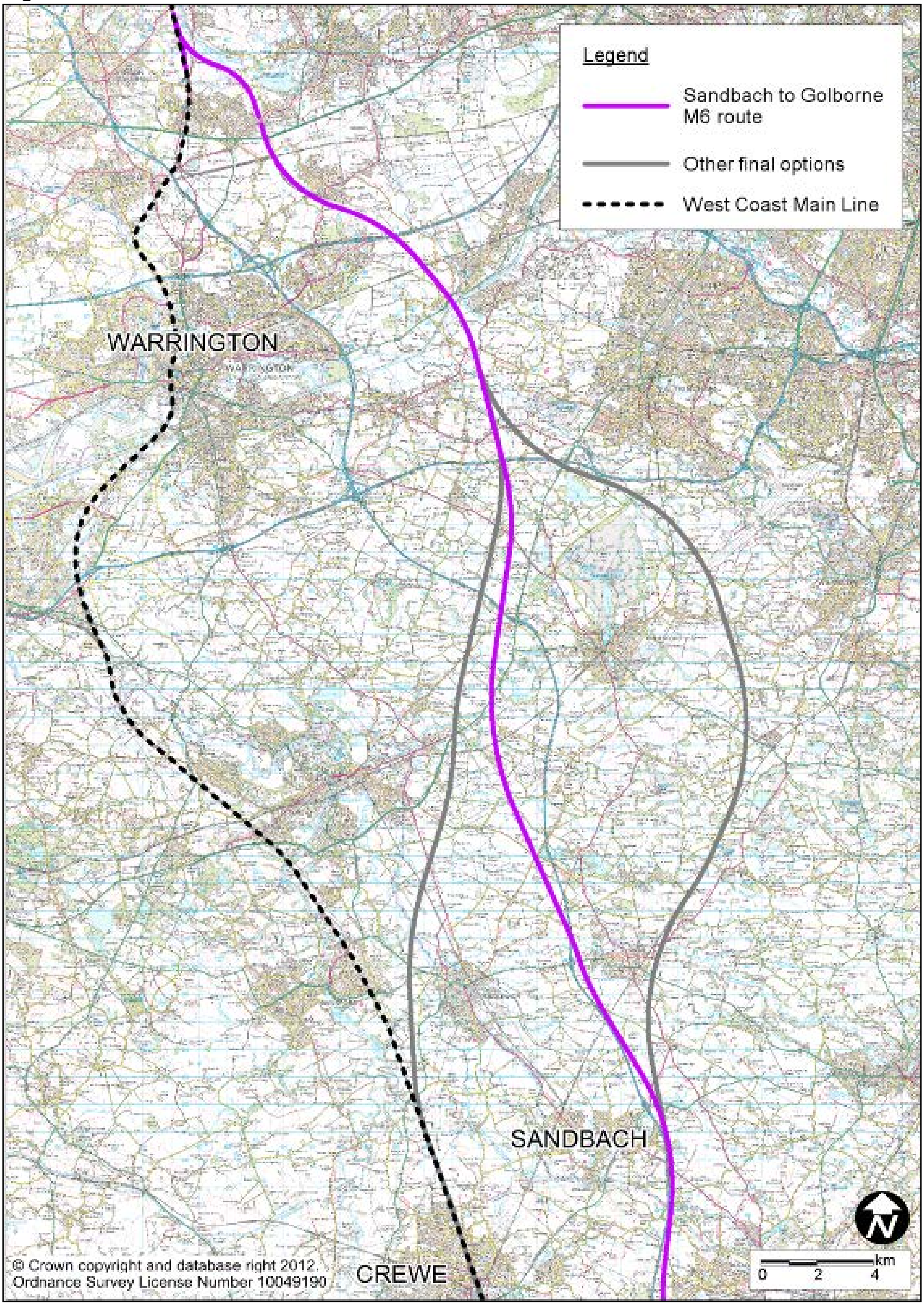
4.3.72 On descending from the ship canal viaduct, the route would run on embankment through the Manchester Mosses SAC. The route has been designed to avoid directly impacting on three Mosses areas. Further detailed work would be required to understand any potential impacts on groundwater flows and to design mitigation that would avoid any indirect impacts. Two ancient woodlands would be directly affected by the route as it would pass through them.

4.3.73 The Crewe to Golborne western route would allow a connection to any of the Manchester city centre station options presented in section 4.7. This would be via four possible approaches leaving the main route at four different points. The approach options and the point at which they would peel off the main route options are set out in section 4.6.

The area from Crewe and Sandbach to Golborne: Sandbach to Golborne M6 route

4.3.74 The Sandbach to Golborne M6 route is shown in Figure 4.12.

Figure 4.12 - Sandbach to Golborne M6 route



Source: HS2 Ltd

Engineering

4.3.75 After passing on viaduct to the south of Junction 17 of the M6 the route would descend to surface level. The route would run on embankment close to the M6 for 3.1 miles (5km) before crossing the existing railway line and a floodplain on a short viaduct. Passing Holmes Chapel to the east, the route would pass on very short sections of viaduct over two floodplains, followed by a stretch at ground level allowing the A54 to pass over the route on the eastern side of the M6 Junction 18. The route would then cross the River Dane on a viaduct followed by the M6 on a bridge before returning to ground level as the route heads north-west.

4.3.76 Avoiding Shakerley Mere, the route would leave the M6 corridor rising onto embankment and using a viaduct to cross the Crow Brook floodplain. To the north, the route would continue on embankment passing through part of Holford Moss, over the existing railway line and Peover Eye floodplain.

4.3.77 Short sections of embankment, viaduct and surface level track would take the route northwards and to the west of the A556 and Tabley Mere. After a section in cutting to the west of Knutsford, the route would rise onto embankment, using a series of viaducts to cross the M6 close to Junction 19 and Tabley Brook floodplain. There would be an option for an interchange station here (see section 4.4). After passing to the east of the Mere, the route would descend into cutting, crossing underneath the A50. After a short section at surface level the route would return into a deep cutting to pass underneath the M56 and then rise onto embankment to cross the A56 and the Bridgewater Canal on bridges. Passing Lymm to the west, the route would then pass over the River Bollin and its floodplain on a short viaduct. North of crossing the River Bollin, the route would continue along the same route to Golborne as the Crewe to Golborne western option.

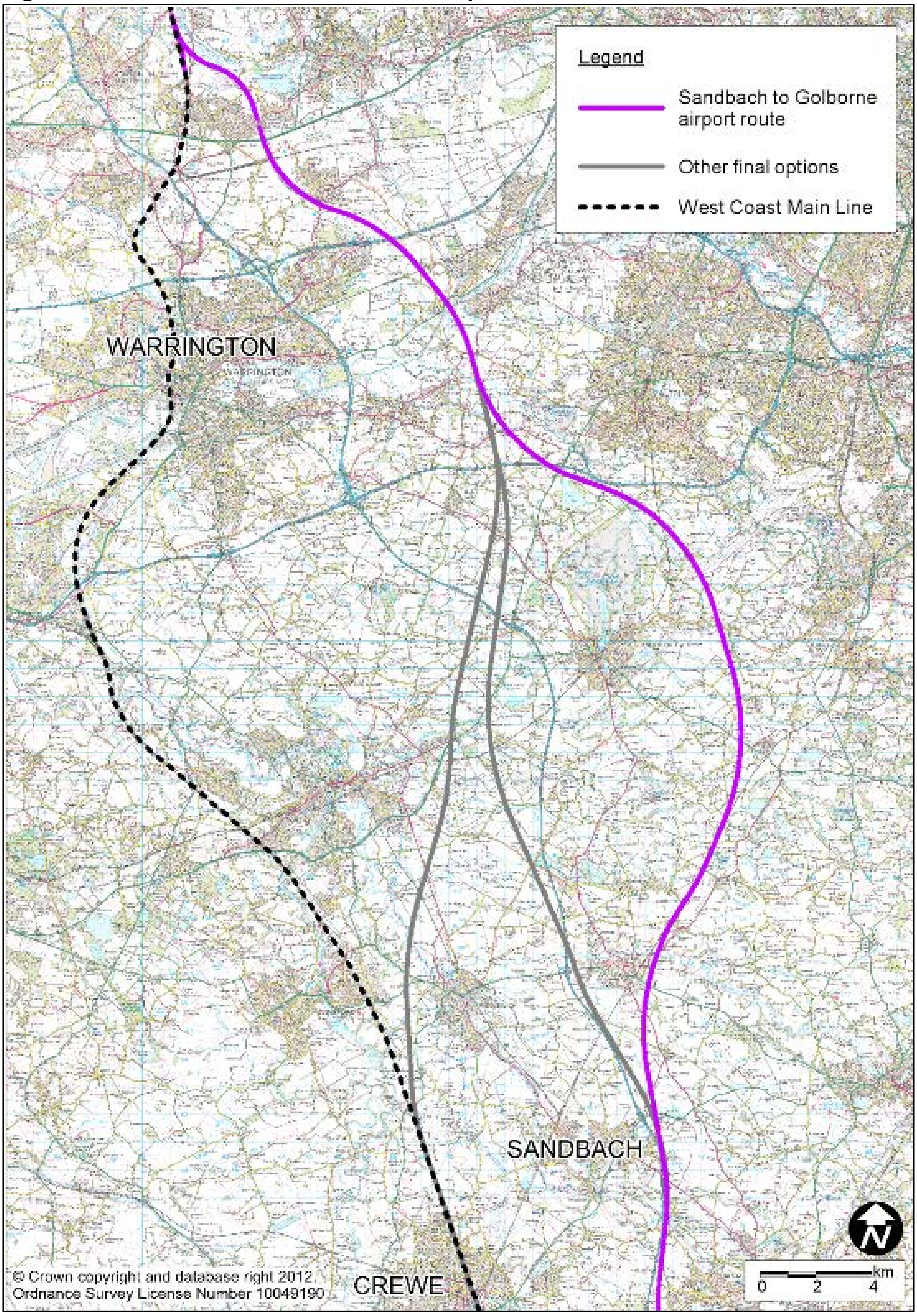
Sustainability

4.3.78 The Sandbach to Golborne M6 route up to the River Bollin would result in the demolition of an estimated 16 dwellings. This option would impact on the Grade II listed farmhouse at Brickhouse Farm, north of Sandbach. The route would affect the wider landscape setting of Tabley Park, which is a Grade II listed Registered Park and Garden. The Smoker Brook may require diversion. This option would directly impact on an area of ancient woodland, Round and Rinks Wood by cutting directly through it.

The area from Crewe and Sandbach to Golborne: Sandbach to Golborne via Airport route

4.3.79 The Sandbach to Golborne via Airport route is shown in Figure 4.13.

Figure 4.13 - Sandbach to Golborne via Airport route



Source: HS2 Ltd

Engineering

4.3.80 After passing Sandbach motorway services the route would cross a lake on a viaduct and the A534 would need to be diverted. For just over 3 miles (5km) the route would run at ground level, with the A5022 and A50 crossing over the route. A short viaduct would cross over the River Croco followed by a longer viaduct to cross the River Dane. Running to the east of Holmes Chapel the route would converge with the Crewe to Manchester railway line to run at ground level. Passing to the east of Goostrey the existing railway would be re-aligned to the east to allow the route to pass underneath in cutting. The route and the exiting railway would remain in the same shared corridor throughout this section and would pass to the west of the Jodrell Bank radio telescope.

4.3.81 The Sandbach to Golborne via Airport route would then diverge from the existing railway line, gently curving in a north-westerly direction towards Mobberley. The route would mainly run on the surface through this relatively flat area, to the west of Chelford. Moving north the route would cross the Pedley Brook floodplain on a viaduct before continuing on a series of shallow embankments and surface level track. The route would cross Mobberley Brook on a short viaduct before descending into cutting between Knolls Green and Mobberley.

4.3.82 Consideration has been given to the impact on Knolls Green and Mobberley and its Conservation Area. The significance of the impact in this area, particularly if accommodating a junction for a Manchester spur at this location, resulted in further investigation into two options to provide tunnels under Mobberley as alternatives to the surface route. One would be a bored tunnel and the other would use a green tunnel constructed from the surface and then covered. We would recommend the adoption of one of the tunnel options if this route was selected as a preferred option by Government.

4.3.83 The bored tunnel option would involve the route descending into cutting after crossing Pedley Brook. It would enter tunnel shortly before Mobberley Brook to the south of Knolls Green. The route would re-surface in cutting on the northern side of the Conservation Area, just south of where the spur to the Airport and south Manchester tunnelled approach would peel off. The green tunnelled option would not require such a deep cutting and would constitute a shorter tunnel, beginning just south of Mobberley Brook and ending just over half a mile (1km) later.

4.3.84 The route would bear north-west to pass the western end of the Manchester Airport runway. Continuing in cutting the route would then pass through the Sugar Brook floodplain using a concrete trough and siphon arrangement. At this point the maximum design speed of the route northwards would reduce to 225mph (360kph). North-west of the Airport, the route would rise onto embankment and cross the existing railway before bearing westwards and descending in the corridor between the M56 and Tatton Park. Whilst on the surface the route would pass over a floodplain, the River Bollin and Blackburn's

Brook on three low viaducts.

4.3.85 This route would enter a long cutting to pass Rostherne Mere, Dunham Massey and Little Bollington. Whilst in the cutting it would cross under the A556, the M56 and later the A56 and Bridgewater Canal, which would be placed in an aqueduct. The route would then rise to the surface as it approaches a viaduct crossing the River Bollin. Passing Lymm to the west, the route would then pass over the river and its floodplain. The Sandbach to Golborne M6 route and the Sandbach to Golborne Airport route would converge at this point. North of crossing the River Bollin, the route would continue along the same route to Golborne as the Crewe to Golborne western option.

Sustainability

4.3.86 The Sandbach to Golborne via Airport route up to the River Bollin would result in the demolition of an estimated 38 dwellings. The surface route and green tunnel options would be likely to require the demolition of three Grade II listed structures: Coppock House in the Mobberley Conservation Area; a Victorian milepost, which could alternatively be preserved by relocating it; and Toad Hall, a late 16th century cottage, though it is possible that future further route refinement could avoid this. The Mobberley Conservation Area would be crossed for a little over half a mile (1km) but would be mainly in cutting and would be positioned away from the historic cores of the conservation area, running instead between Mobberley and Knolls Green. The bored tunnel option would avoid some of these impacts.

4.3.87 It is likely there would be some visual intrusion associated with the high viaduct crossing of the River Dane near Holmes Chapel. Passing through the countryside around Altrincham which is well used, may result in moderate disruption to the landscape character where the route is raised above surface level (see text box 1). The route section would cross 600m of National Trust owned grazing land, classed as inalienable, west of Little Bollington, although this is some distance from the Dunham Massey Registered Park and Garden itself.

4.3.88 The route would directly affect four ancient woodlands: Bornish Wood and Ryecroft Wood, both of which are also wet woodland BAP habitats; and Hancocks Bank and Arden House Wood. Two areas of Lowland Bog BAP habitat would also be directly affected. The route section would pass close to the Rostherne Mere Ramsar site, also a SSSI and National Nature Reserve (NNR). We continue to appraise risks to the site, but are confident that impacts could be avoided.

Routes between Lichfield, the Manchester outskirts and Golborne: Section summary

4.3.89 Following the order of the geographic sections set out above, we now present a summary of the comparison of the route options. Between Lichfield and Newcastle-under-Lyme, the two route options would have similar costs and sustainability impacts, though the southern option would have over 30 more demolitions of dwellings. Both of these routes would link to either of the route options available north of Newcastle-under-Lyme. There are two slightly different routes for the northern option, one that would avoid some settlements, though this would pass closer to the Pasturefields Salt Marsh SAC, the sensitivity of which we described in text box 2.

4.3.90 The option from Newcastle-under-Lyme to Crewe and then northwards to Golborne would have the benefit of connecting to the WCML and Crewe station, providing connectivity to the North West and Liverpool. The Newcastle-under-Lyme to Sandbach route continuing onto Golborne via the M6 would have the option of adding a high speed intermediate station at Junction 16 of the M6. This is described in the next section, but would not bring as many benefits as the connection at Crewe and would of course have an additional cost attached.

4.3.91 Taking the alternative Airport route, between Sandbach and Golborne would have a significant impact on the village of Mobberely if the route were to run in cutting through this area. If the route were to pass through a bored tunnel in the area to avoid many of these impacts, this would add around £700 million to the cost of the route.

4.3.92 At this stage of our design process, a combination of the northern route between Lichfield and Newcastle-under-Lyme (which has the option of the variant) and from there to Crewe and on to Golborne using the western route (hence connecting to Crewe station) would therefore offer a combination of lower costs, similar sustainability performance and scope to serve wider markets.

4.4 Intermediate station options on the route to Manchester

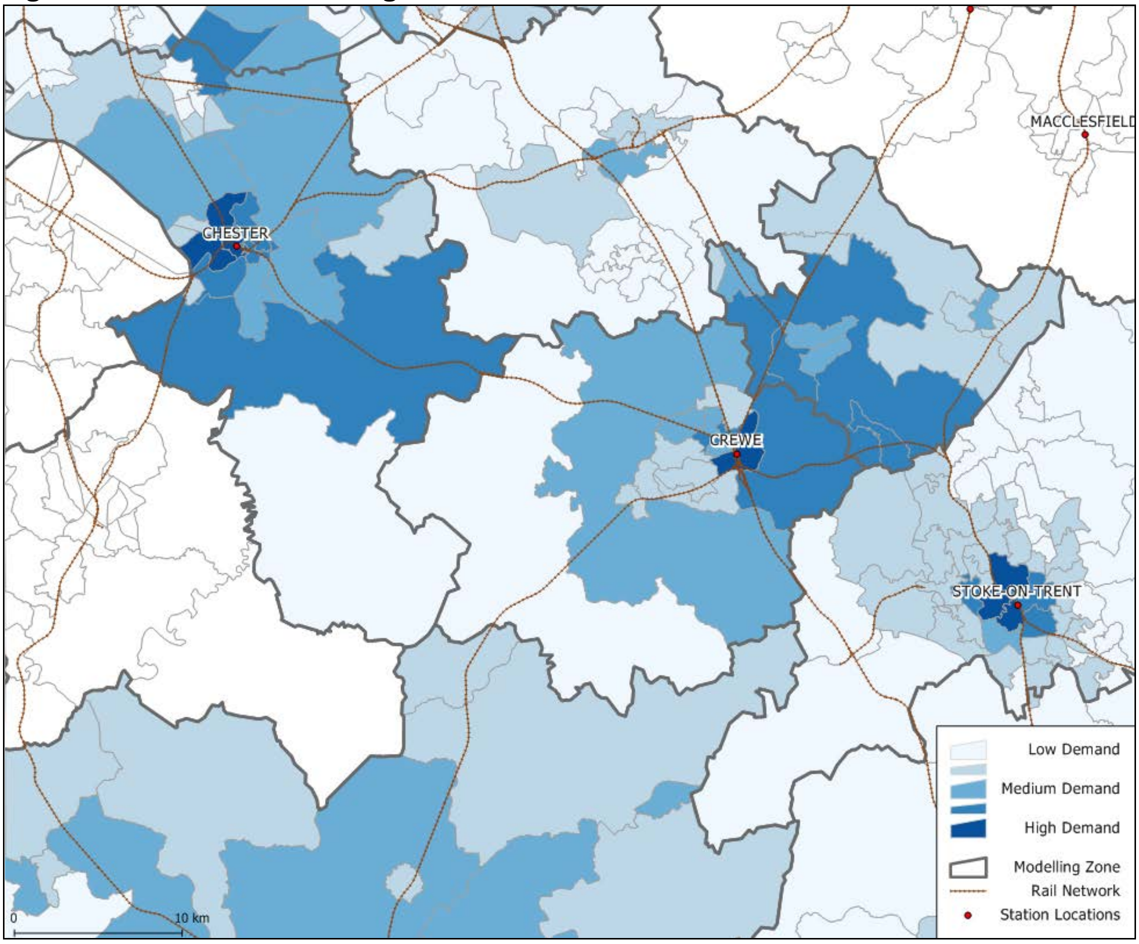
Introduction

4.4.1 As with interchange station options on the Manchester leg our remit does not ask us to provide an intermediate station on the Manchester leg of the Y network. It does ask us to consider interchange stations, and our consideration of stations at 'intermediate' points falls within this.

4.4.2 An intermediate station on the route to Manchester would aim to serve the main areas of demand for travel to London and the South East near the line of route, in this case south Cheshire and north Staffordshire. The urban parts of this area form the main source of this demand; however, there is a reasonable level of demand distributed outside the main urban areas to the north-east of Crewe as can be seen in figure 4.14. This more distributed demand means that there would be value in being near to good road connections to provide access to this demand. The greater level of demand is still situated in the urban centres, and therefore good access to these is also important.

4.4.3 The good rail connectivity at Crewe has the ability to provide a rail interchange location for HS2 passengers. Figure 4.14 shows the proximity of areas of high demand for travel to London and the South East from Chester. There are good rail links between Crewe and Chester which could allow some of this market to be captured by HS2, were classic compatible services to call at Crewe.

Figure 4.14 - Demand for long distance travel in south Cheshire and north Staffordshire



Source: HS2 Ltd

4.4.4 The location of any intermediate station would need to be on a viable route option that we were progressing as part of the development of our route options. Our demand work shows that no market is significant enough to dictate route choice. Therefore the presence of a route option was a key determinant of whether station options were developed.

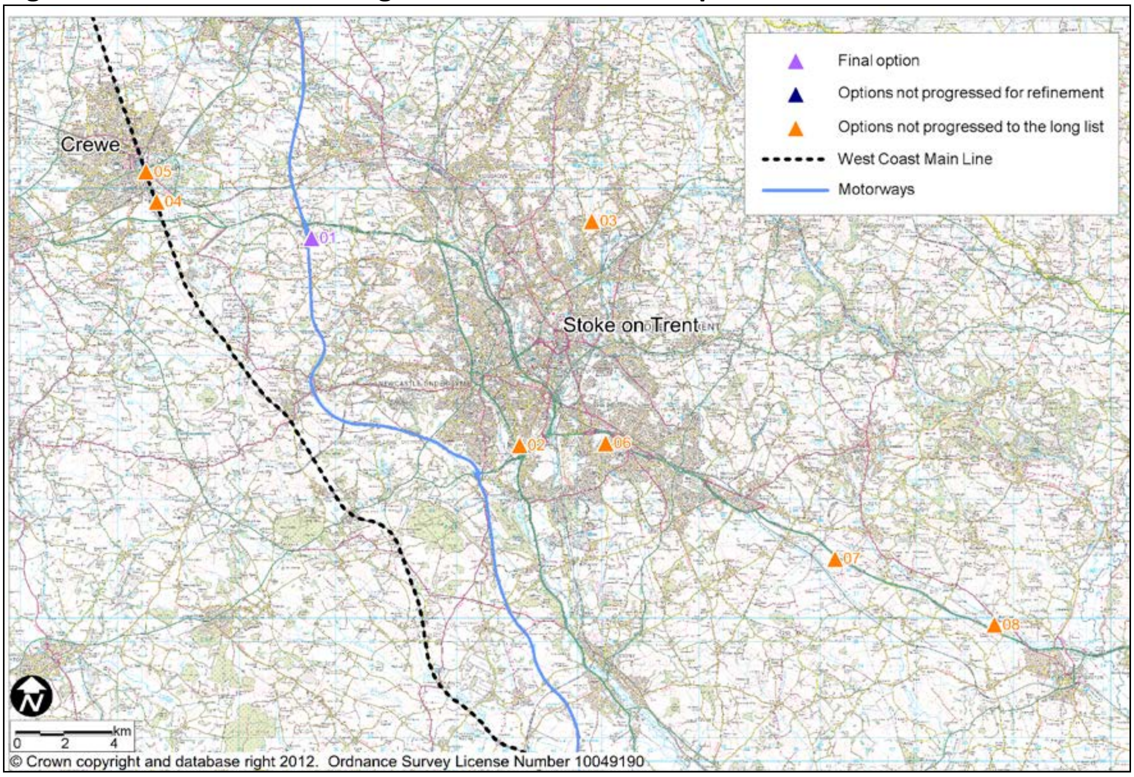
Summary of sifting process results

4.4.5 Top tier local authorities in the area were consulted in confidence on ideas for station location options; namely Cheshire East, Staffordshire and Stoke-on-Trent councils. As this was not a remitted station option and the location options were very dependent on confidential route information, we did not engage at a detailed level with these delivery partners. This is different to the process undertaken for the remitted stations and the Manchester interchange stations, where delivery partners were involved in discussions of the station details at every stage of the sifting process.

The generation of initial ideas and the sifting down to a 'long list'

4.4.6 A total of eight options were initially identified, based on route option locations within the wider area of demand identified. Given that the business case for an intermediate station was known to be marginal, the route options drove the station option locations, not vice versa. Figure 4.15 is a map of the location of the initial options and how long they remained as options (the initial options not progressed to the long list were not named). Following high level development of these options, a sifting process was undertaken. Only option 1 was taken forward – M6 Junction 16 - located between Crewe and Stoke-on-Trent. This was then developed to the same level of detail as the final interchange station options. We briefly describe why we did not progress any of our options below before describing our final option.

Figure 4.15 – Manchester leg intermediate station options



Source: HS2 Ltd

4.4.7 Option 5 would be in Crewe and option 4 nearby, to the south of Crewe. Options in or close to Crewe would provide a clear benefit given the demand for travel from this station as a result of its good connectivity to wider destinations. However, the route in this area would be underground at this point, in order to avoid impacts on Crewe itself. Therefore, any station situated on the high speed line would also need to be underground and extremely expensive. Nevertheless, we recognised the potential importance and value of serving the Crewe and North West market. We described our analysis of serving Crewe, Liverpool and other North West centres in text box 3 on page 55 of section 4.3.

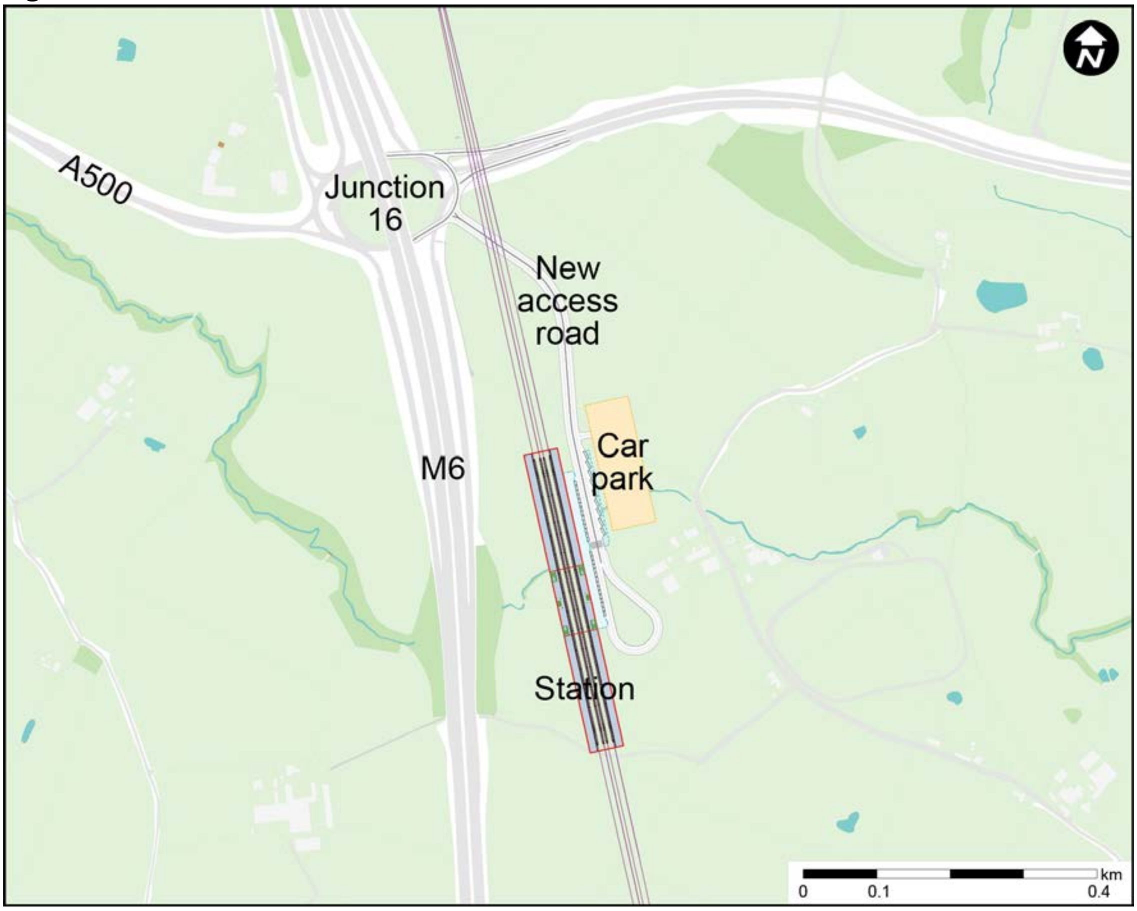
4.4.8 Option 2 was not progressed because option 1 would be on the same route and provide more benefits. Option 6 would also require being deep underground and hence was not progressed. Options 3, 7 and 8 were found to not be viable from a demand perspective – demand for travel would generate fewer benefits than the cost of building the station.

The M6 Junction 16 final option

Location and route

4.4.9 The option that we progressed would lie on the route from Newcastle-under-Lyme to Sandbach. The station would be located on a greenfield site on the south-east corner of Junction 16 of the M6, to the south of the A500. This is 6.8 miles (11km) north-west of Stoke-on-Trent and five miles (8km) south-east of Crewe. The nearest village would be Audley, 1.2 miles (2km) to the south. The route in this area would be significantly elevated on an embankment as it prepared to cross the A500. Therefore the platforms would be elevated. Figure 4.16 is a diagram of the station option.

Figure 4.16 - M6 Junction 16 intermediate station



Source: HS2 Ltd

Engineering

4.4.10 The concourse would be at surface level underneath the platforms and track, which would be elevated at a height of 10m. A car park to the east of the station would provide space for up to 1,500 cars across multiple floors above ground. Highway access to the station and car park would be provided by a new link road, connecting directly to the roundabout for M6 Junction 16, which the A500 also connects onto. These highways experience congestion regularly; so although access is good, further work would need to be undertaken to consider the implications for congestion at busy times if the Government indicates an interest in progressing this option. No buses currently serve the A500 in this location, so a new service would need to be provided in order to allow public transport access. There is no connection to the existing rail network in the vicinity.

Sustainability

4.4.11 The station would be on a greenfield site, within the Green Belt. If a HS2 station were to be built at this location there would be support for Green Belt release for development of employment uses from the local council (Newcastle-under-Lyme Borough Council). Given the rural area that the station would be located in, no demolitions would be required. The nearest settlement to the station would be Audley which would experience minor visual intrusion from the station; however, this would be in the context of the existing motorway. The station site and the four track sections of route required to accommodate it would impact on an area of Flood Zone 3 (land with high probability of flooding).

Intermediate stations on the route to Manchester: demand and section summary

4.4.12 The proposed HS2 station at M6 Junction 16 would capture some of the more distributed market around Stoke-on-Trent and Crewe, owing to its good access to the M6. However, it would not capture a large part of the urban markets, where people would continue to use existing stations to travel to all destinations. The business case for any new intermediate station is therefore likely to be marginal, particularly when the costs of the construction of the station are taken into account. The case for using an existing station, such as Crewe (as we described in text box 3), to serve the south Cheshire and north Staffordshire markets, whilst also providing connections to other destinations, is stronger, with lower costs and higher benefits.

4.5 Routes to Preston and interchange station option

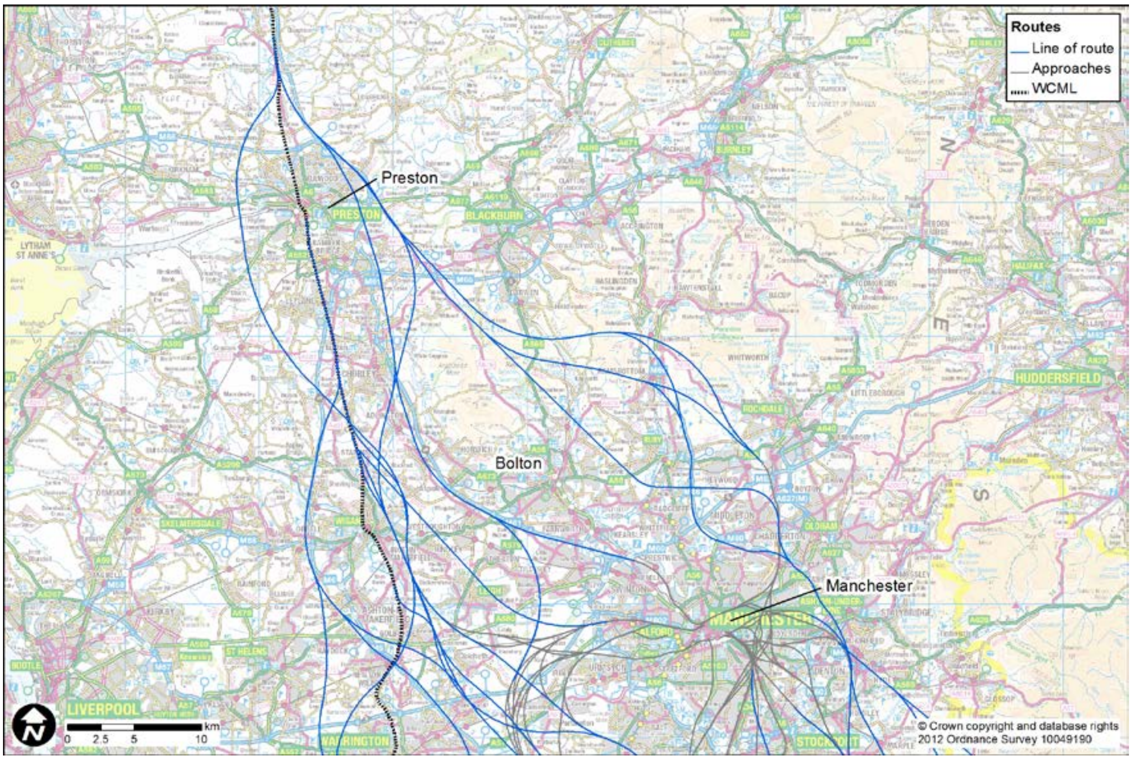
4.5.1 In section 4.3 we described how all of the route options would allow for a connection to the WCML at Bamfurlong near Golborne, to be provided to allow classic compatible trains to serve destinations further north. This section sets out the options considered and our final option for an alternative connection to the WCML further north of Preston, near Brock. Our key consideration here was that a connection further north would mean shorter journey times using HS2 to Scotland; however, it would also mean that such trains would not be able to call at stations on the existing rail network between Bamfurlong and Brock. Extending HS2 further north would also carry a significant additional cost in the region of £2 billion and would have additional sustainability impacts. The additional cost would place pressure on the overall £33 billion cost envelope. It would also mean that the benefits gained from the further journey time savings and markets captured would need to outweigh these significant costs.

4.5.2 We also describe at the end of this section the work we have done considering how best to serve Scotland from the phase two connections. This was a separate piece of work to our consideration of how far north to connect to the WCML and ECML. Text box 6 sets out our analysis of whether it would be better to serve Scotland via the east or west and explains our conclusion that the most efficient way to serve Scotland, in line with Transport Scotland's position, would be via the WCML.

The generation of initial ideas and the sifting down to a 'long list'

4.5.3 A large selection of options for routes and for the point at which the connection is made to the WCML was proposed. Two main groups of route options were put forward (see figure 4.18): those originating from proposed stations in Manchester, passing to the north of Bolton to connect in the Preston area; and those originating from the main route options to the west of Manchester continuing to the west of Bolton before connecting at various points between Golborne and Preston.

Figure 4.17 Routes to Preston long listing stage

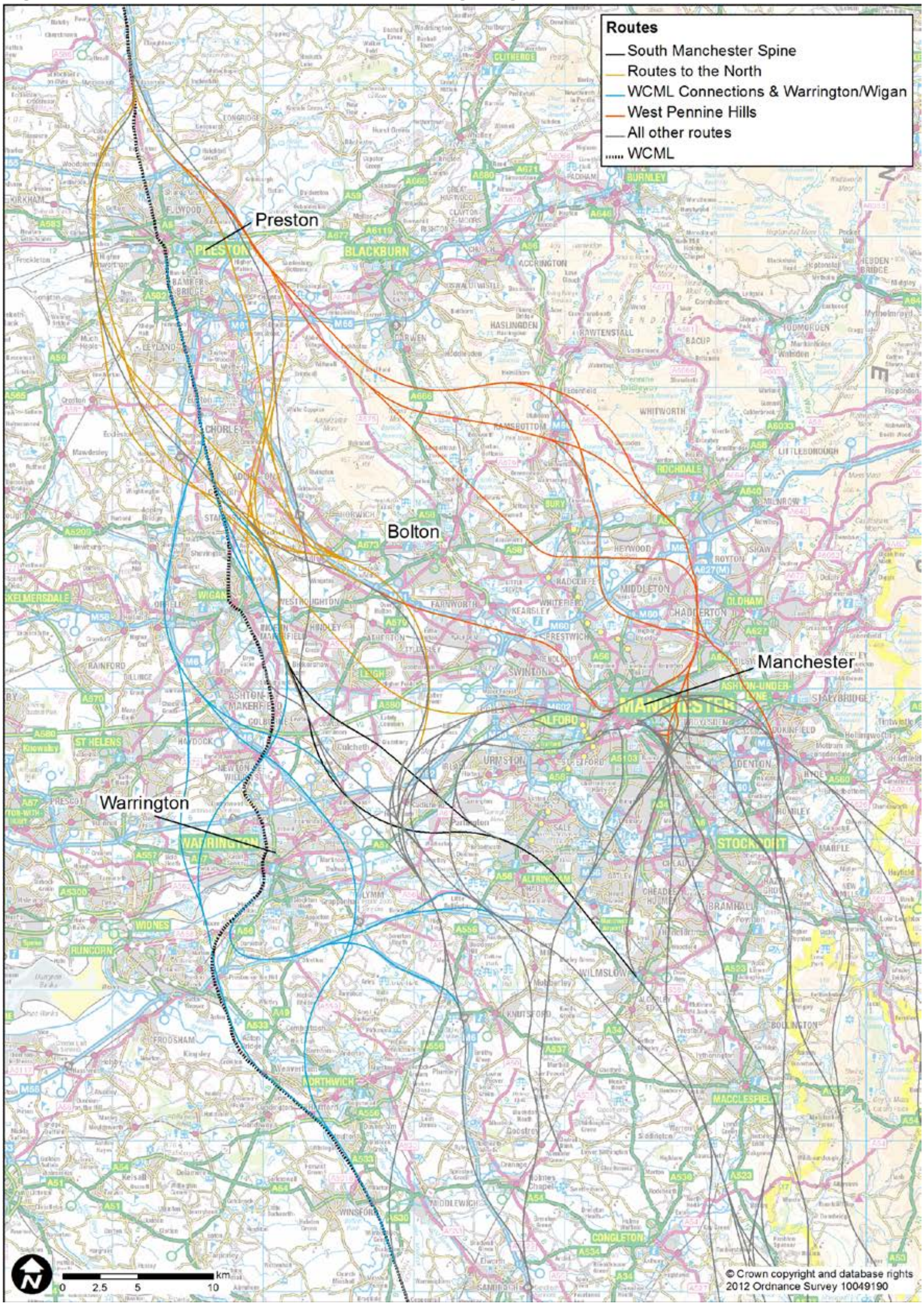


Source: HS2 Ltd

4.5.4 Figure 4.17 shows the initial route options which were all taken forward onto a long list. A sifting meeting was held, but at this early stage, more information was required to choose between the route options and so they were all developed further before sifting to a short list.

The creation of a short list

Figure 4.18 - Routes to Preston short listing stage

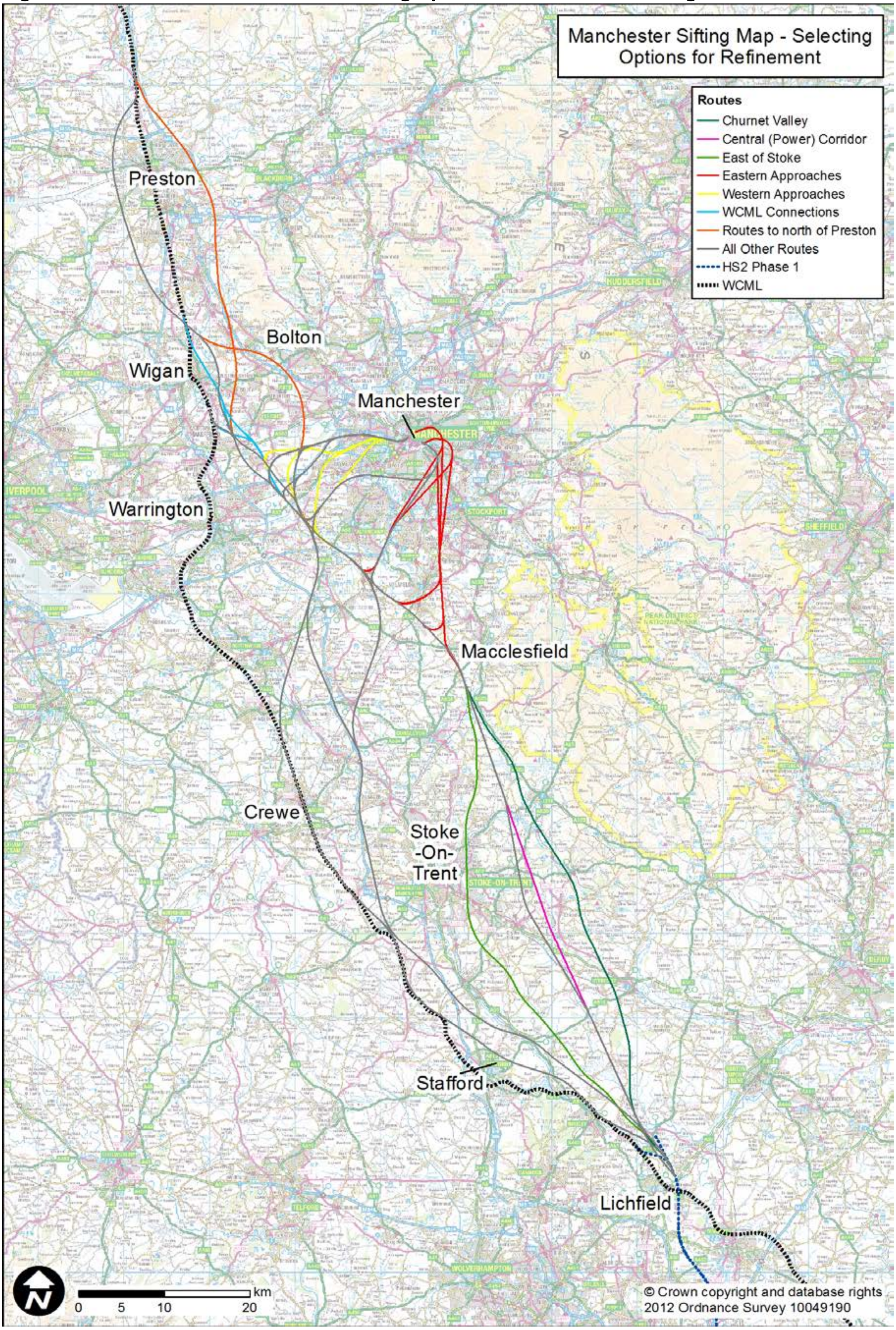


Source: HS2 Ltd

4.5.5 Figure 4.18 shows the long listed options, differentiating those originating from proposed stations in Manchester (West Pennine Hills) and those originating from the main route options to the west of Manchester (Routes to the North). The group passing from the east of Manchester through the west Pennine Hills (north of Bolton) required significant lengths of tunnels and structures and also performed poorly on sustainability, with significant demolition numbers and impacts on an SAC and a SSSI. The routes from the west of Manchester to the east of Preston (west of Bolton) performed in a similar manner, with the alternative route options to the west of Preston performing better on all accounts. The options that would connect to the WCML south of Preston performed less favourably to the north of Preston connection in terms of engineering complexity, sustainability and journey time and so were also not progressed.

Selecting options for refinement

Figure 4.19 - Routes to Preston selecting options for refinement stage



Source: HS2 Ltd

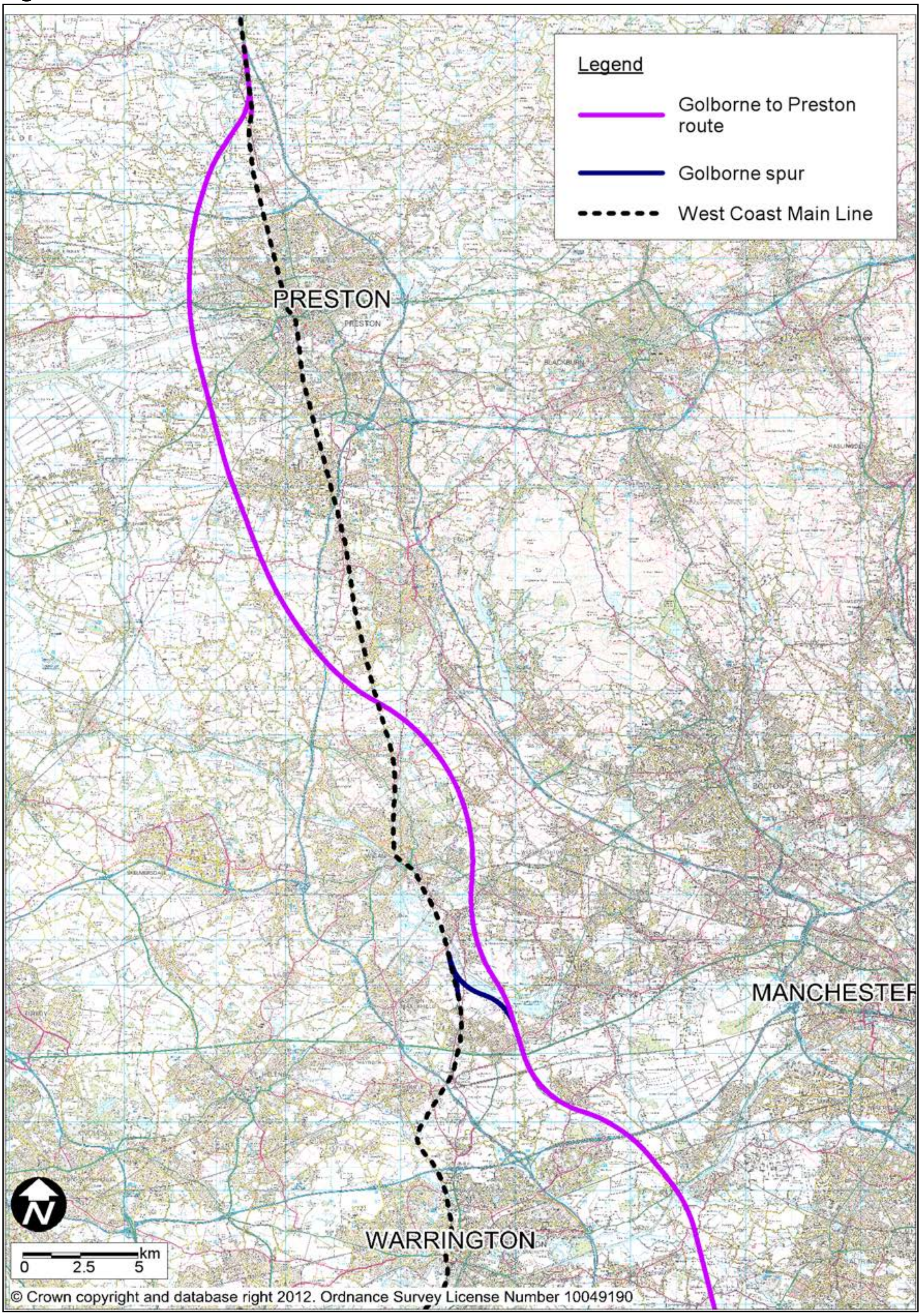
4.5.6 Of the remaining options from the west of Manchester to the north of Preston, only one route, running to the west of Preston, was progressed for further development. The routes to the west of Bolton and the east of Preston were not taken forward due to costly lengths of tunnels and structures and also relatively poor sustainability performance. Figure 4.19 shows these options.

Developing and finalising our options

4.5.7 One option was taken forward to this stage – the route from Lowton to a connection near Brock north of Preston, via the west of Preston. As with the other route options, the emphasis at this stage was on design refinement and mitigation. This improved the performance of the route and reduced impacts. The route is described in more detail below.

A route to the north of Preston

Figure 4.20 – Route from Golborne to Preston



Source: HS2 Ltd

Engineering

4.5.8 The connection to the north of Preston, near Brock, would be provided in addition to the connection near Bamfurlong, described in the above section. This is to allow intermediate destinations on the classic network to be served by classic compatible services and to allow greater operational flexibility. Given that all route options approach to the south of Lowton as one route, this would result in a grade separated junction in the Lowton area, providing a spur to the WCML at Bamfurlong and the main route continuing north to Brock.

4.5.9 Figure 4.20 is a map of the route from south-west Manchester to the north of Preston. We pick up the description of this route from the Lowton area at the spur to the WCML.

4.5.10 The route towards Preston would continue from Lowton in a northwards direction. It would emerge from the cutting and run on embankment for 3.4 miles (5.5km) with a series of short viaducts required to cross several floodplains. The route would pass west of Pennington Flash Country Park, cross over the Leeds and Liverpool Canal and skirt to the east of Abram.

4.5.11 Heading northwards the route would pass over a series of viaducts to cross floodplain, through the Platt Bridge area. Following this the route would run mainly at surface level, with shallow embankments and cuttings. It would cross under the A577 and the existing railway line as it passes between Hindley and Wigan. The route would then continue in cutting through an active landfill site at Top Lock before moving north-west in a cutting for 1.9 miles (3km). In this section the route would pass close to Aspull before crossing under the Leeds and Liverpool Canal, which would be diverted onto an aqueduct.

4.5.12 The route would then rise onto a series of viaducts to cross three brooks and the Worthington Lakes before crossing over the WCML between Standish and Coppull. The route would descend into cutting and, still heading in a north-westerly direction, pass underneath the A49 and the M6 to the west of Coppull. A short section of embankment and surface route would then continue to the east of Heskin Green descending again into cutting past Eccleston. After rising to cross the River Yarrow on a short viaduct, the route would return to cut under the A581 and through the settlement of Ulnes Walton, which is a ribbon development in an east to west direction.

4.5.13 The route would continue to head north-west mainly on embankment. Passing the western edge of Leyland the route would cross over the Wymott Brook floodplain and the Preston to Ormskirk railway line on viaduct. The route would then pass through an area of dispersed settlements including New Longton and Hutton, crossing over the A59, Longton Brook and Liverpool Road at Hutton.

4.5.14 North of Hutton lies the River Ribble, which the route would approach from the south on viaduct. The structure would rise to a height of 28m as it crosses the river estuary, maintaining navigation clearance. Following the viaduct the route would remain elevated to cross the A583, the Millennium Ribble Link and Savick Brook. A section of embankment would then cross the existing railway line and the Lancaster Canal before the route would descend into cutting south of the M55. In this area we have considered providing a HS2 interchange station to serve the Preston area (see the next section).

4.5.15 Crossing the M55 on embankment, the route would continue north-east towards the WCML south of Bilsborrow. It would remain on embankment for around 1.9 miles (3km) passing through a relatively flat area of agricultural land, including two more crossings of the Lancaster Canal on viaduct. Approaching the WCML at Bilsborrow the route would descend into a cutting and pass under the A6. The WCML would need to be re-aligned to the east where the route would join it via a grade separated junction.

Sustainability

4.5.16 This route section would result in the demolition of an estimated 69 dwellings. The Haigh Conservation Area would be crossed for a short distance on its west side, affecting open fields with area of woodland and a Grade II listed windmill. There would be a potential impact on the setting of three Scheduled Monuments. The route would also cross 300m of the Worthington Lakes Country Park and directly impact on two areas of Ancient Woodland which are also BAP habitats. A further 11 BAP habitats would be affected, including three mudflats, seven coastal and floodplain grazing marshes and one reedbed. A limited impact on views from Pennington Flash County Park would be expected, where the route would cross a canal.

Interchange stations in the Preston area

Demand and passenger benefits

4.5.17 Preston is an important market for travel to London and the South East and is potentially an important interchange location due to local services serving the Lake District and Blackpool. If possible, the HS2 network and related classic compatible services should not bypass this. However, the market in Scotland for travelling to London and the South East is significantly larger than the market in Preston. Therefore, shorter journey times to Scotland are also valuable and not stopping at Preston is one way of shortening the journey times to Scotland. The case for a Preston interchange depends on the balance of these two considerations against the cost of providing such an interchange.

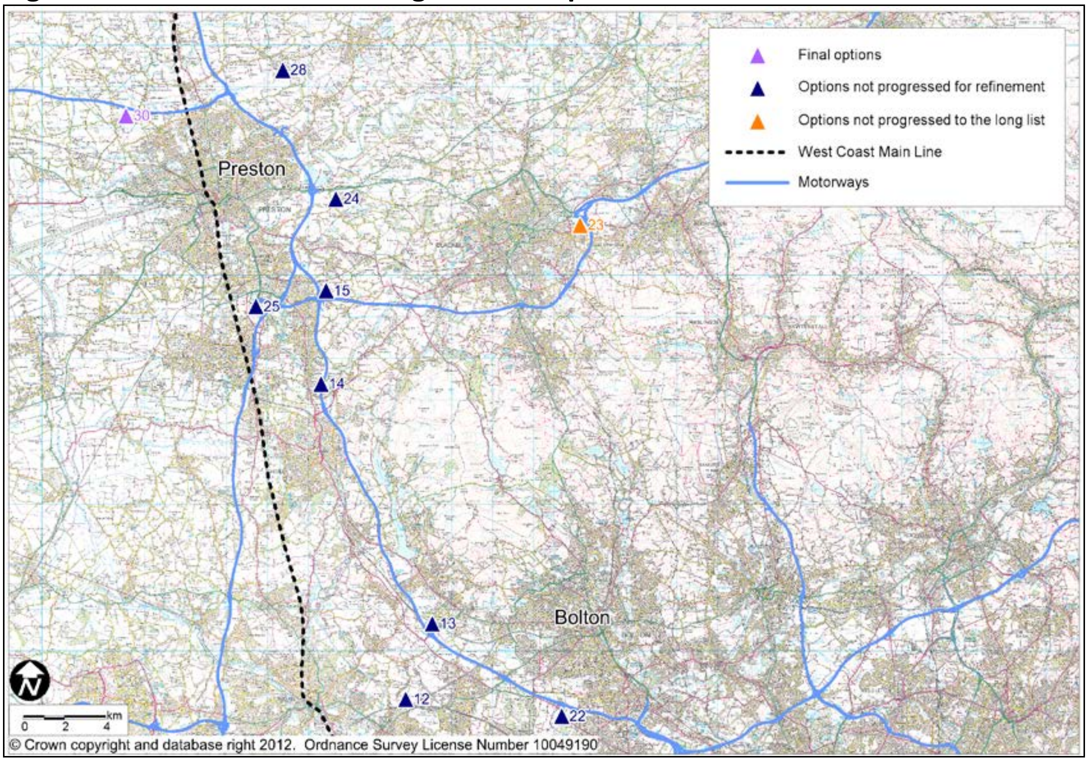
4.5.18 If the interchange station could capture all of the Preston market, the measurable benefits would be roughly equal to the benefits of the journey time savings of bypassing Preston on the additional section of high speed line, to the Scotland market. The best way of achieving the attraction of the Preston market would be for HS2 trains to stop in central Preston, classic compatible trains could do this using the existing station, though we also looked at building the high speed line through Preston which had obvious disadvantages. An interchange station on the outskirts of Preston on an additional section of the high speed line would have the benefits of being on a longer high speed network, but as it would not be in the centre of Preston with its associated connectivity, would not serve the whole of the Preston market.

4.5.19 We have developed an example option to show what such a station might look like and where it might be located. However, should Government wish to progress the option, a more in depth analysis would be needed.

Sifting process

4.5.20 A working group of delivery partners assisted us in option generation, particularly in terms of suggesting development sites. Naturally many of these sites did not correspond to the route options being progressed by us internally in parallel. Figure 4.21 shows the range of options considered as initial ideas. Colours are used to denote which stage the options remained in the process.

Figure 4.21 - Preston interchange station options



Source: HS2 Ltd

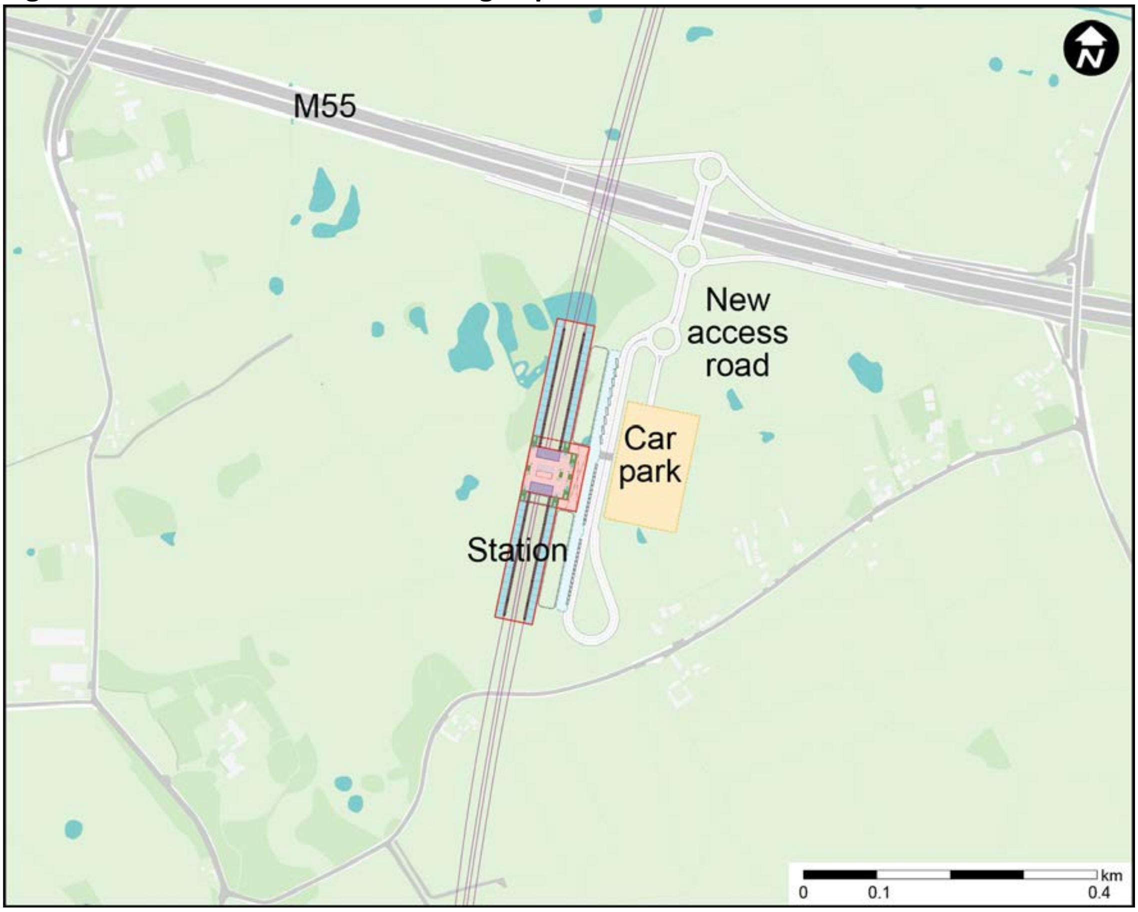
4.5.21 Option 30 - Preston M55, was the only option progressed beyond an initial level of detail. This is because the alternative options were not served by a route option or were no longer served by a route option following sifting. Therefore there was no further sifting of Preston interchange station options. Preston M55 to the north-west of Preston was developed to a 'final' level of detail including a full sustainability appraisal.

Preston M55 interchange

4.5.22 This station option has been developed as the best performing option at this stage of our process to serve a connection to the WCML north of Preston. Both captive HS2 trains and classic compatible trains could call at this station heading north and south. This interchange station would only be an option if the route to the north of Preston was included in the Y network.

4.5.23 The station would be located on the north-western edge of Preston and would be orientated in a north-south direction. A HS2 station here would reduce traffic around the existing station in the city centre. The platforms and tracks would need to be elevated, as the route here would be about to cross over the M55 to the north. The location can be seen in Figure 4.21 above and at a more local level in Figure 4.22 below.

Figure 4.22 - Preston M55 interchange option



Source: HS2 Ltd

4.5.24 The platforms would be elevated to the height of the route which would be on embankment through this area, at four metres. A car park to the east of the station would provide space for up to 3,000 cars across five storeys above ground. To provide highway access a new motorway junction on the M55 would need to be constructed immediately to the north of the station. This would provide good connectivity to the nearby centres of Preston and Blackpool, as well as other locations along the nearby M6 such as Lancaster. A bus service does not run to the site currently, but could be provided. There is no access to the existing rail network at this location. The nearest station would be the main line station in Preston.

Sustainability

4.5.25 Approximately three dwellings would be demolished as a result of building the station and related infrastructure. The station would be on a greenfield agricultural site. Given the proposed height and mass and the relatively flat, open, rural character of the surrounding landscape, the station would be widely visible. The four track section approaching the station would cross land classified as Flood Zone 3 (land at high probability of flooding) for approximately 20m.

6. Serving Scotland in phase two

An important part of the business case for HS2 is the ability to serve markets on the existing railway network with classic compatible trains. This can be achieved in phase one and again in phase two, spreading the benefits of faster journey times to stations off the core HS2 network.

Scotland is an important market with large centres of demand in both Edinburgh and Glasgow. Both cities are a source of demand in their own right and are also well connected to bring in passengers from elsewhere in Scotland. We will serve Scotland in phase one by running classic compatible trains up the WCML from the connection point at Lichfield. In this way we can serve both Glasgow and Edinburgh by splitting 400m trains at Carstairs into two sets of 200m. The reverse would also be possible, with two 200m trains from Edinburgh and Glasgow joining to make a 400m train that would run to London.

A Y shaped network gives the potential to connect the high speed rail network to the WCML or the ECML as there would be connection points from HS2 to both. We carried out a piece of work on whether Scotland would be better served via the WCML or the ECML in phase two. Trains using the WCML could split at Carstairs to serve Edinburgh and Glasgow equally, as in phase one, but with a much faster journey time resulting from the more northerly connection. Trains running on the ECML would have to serve Edinburgh first before going on to Glasgow.

We carried out modelling to understand the size of the markets and compare the two scenarios. We found that demand from Edinburgh was around 1.4 times higher than Glasgow, which is also a significant market. Were we to serve Scotland via the ECML, we would potentially have a quick journey time to Edinburgh, and therefore those passengers would gain benefits; however, we would disadvantage passengers who would use HS2 trains to go to Glasgow by at least 40 minutes. This large amount of additional time to serve Glasgow via the ECML would effectively erode the majority of the time savings gained by the trains using HS2.

Therefore we concluded that the most efficient way to serve Scotland would be using a connection to the WCML as this allows both destinations to be served equally. The use of 400m long train sets from London splitting, so that one 200m train serves Glasgow and the other Edinburgh, would also allow maximum use of the restricted number of train paths on the trunk of the network between London and the West Midlands.

This is in line with Transport Scotland and other Scottish stakeholders' view of how best to serve Scotland in phase two. We will continue to work with Network Rail to ensure that we fully understand what capacity improvements and investment would be necessary to the WCML to run these trains. We have included a high level assumption of the likely costs involved and the proportion attributable to HS2 at this stage of our design process.

Routes to Preston and interchange station option: Section summary

4.5.26 As set out when introducing our work on possible interchange station locations near Preston, above, there would be a benefit to attracting the Preston market onto HS2. There would also be benefits of bypassing Preston to allow journey times to Scotland to be as short as possible. This could be achieved best by providing classic compatible services that serve Preston from the connection near Golborne, and faster classic compatible services that travel straight to Glasgow and Edinburgh from here.

4.5.27 The key trade off with building a high speed line further north is while it would deliver a significant journey time saving for services to Scotland, it would come at a significant additional cost and the significant additional sustainability impacts described above. We estimated that the cost of building the high speed line as far north as Preston, potentially including an additional interchange station in the vicinity, would be around an additional £2 billion over and above the connection at Golborne. Therefore the benefits which would need to be delivered would need to outweigh this significant additional infrastructure cost. In any case, £2 billion will create a significant pressure on the overall cost envelope.

4.5.28 In the event a high speed line was constructed to the north of Preston it is likely that an interchange nearby would not provide sufficient benefit to offset the loss of the classic compatible Preston stop. There would be a cost to build the station and trains stopping at the station would lose nearly half of the time saving gained from the high speed line. We have not engaged in detail with local delivery partners in relation to the possible station option. If such a station option were to be included in the Y network, we would need to engage with delivery partners in the area in relation to the proposed station site, as we have done for all our remitted station options.

4.6 Approaches into Manchester city centre

Introduction

4.6.1 Our remit asks us to develop options to serve a station in Manchester city centre. The centre of the Greater Manchester conurbation is formed of two cities – Manchester and Salford, which are operated as two separate authorities. Where we refer to serving Manchester city centre, this (and indeed our remit), incorporates serving both of these authorities.

4.6.2 We have set out so far in this chapter the options for a route from the end of the phase one route near Lichfield to the outskirts of the Greater Manchester conurbation, and beyond to a connection to the WCML. As alluded to earlier, these routes would allow for more than one route option into Manchester city centre - an 'approach'.

4.6.3 In part, the selection of approach options has been driven by the city centre station option locations, requiring routes approaching from the east and the west of the conurbation. The other driver, as with the main route options, was the balance between sustainability performance, journey time, cost and engineering feasibility. Any city has a number of existing arterial transport, infrastructure or river corridors into it. In the first instance we looked at following these corridors as the land outside these corridors will be very densely populated.

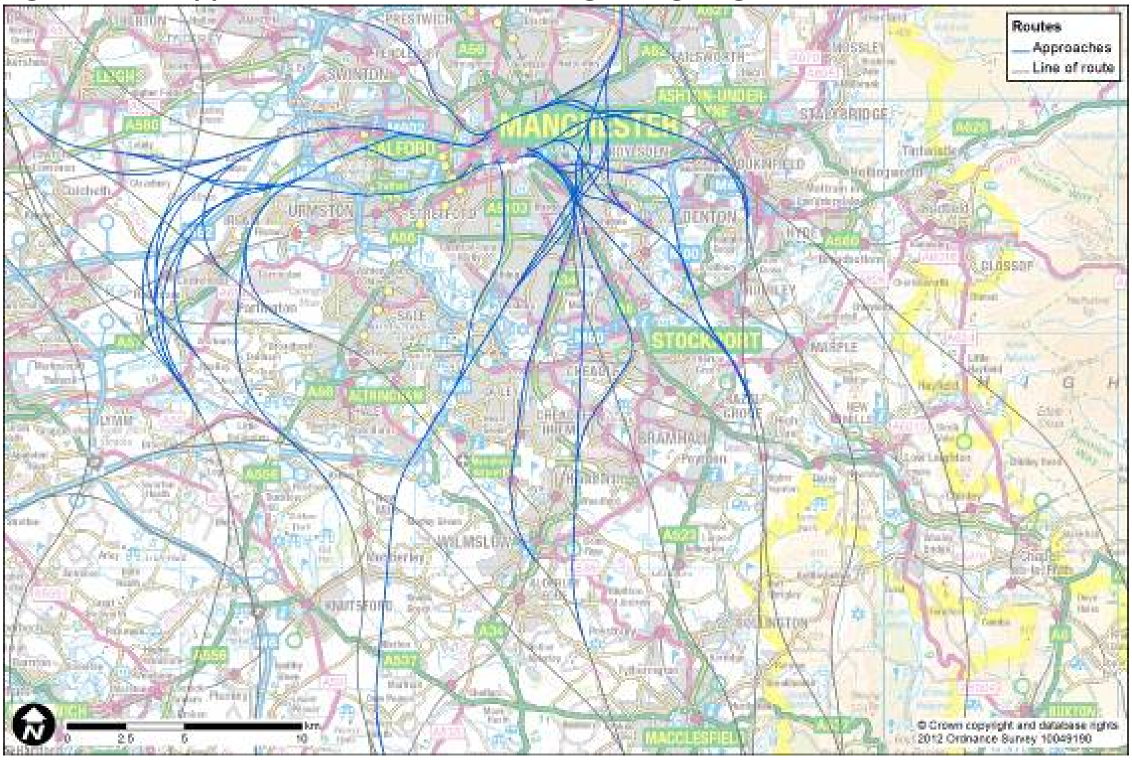
4.6.4 In this section we present the approach options to the city centre station options near to Manchester Piccadilly station, and near to Salford central station (see section 4.7 for details of our final station options). We present the options from the point at which they would diverge from the main route options that have been set out in section 4.3. We first present a summary of the results of this process before the detail of the final options.

Initial generation of options and long listing

4.6.5 The initial options for approaches were formed by looking at the possible ways of linking the main route options and the city centre station options that had already been generated. Often this resulted in approach options connecting to more than one main route and serving more than one city centre station option. Initially approach routes were proposed where there was an existing transport, utilities or natural corridor. In the first instance, options were based on the approach being on the surface; as the design developed, though, it was acknowledged that tunnelled sections may be required to pass through built up areas.

4.6.6 As with the main lines of route all options were progressed to the next stage as long listed options. Figure 4.23 shows the long listed options.

Figure 4.23 - Approaches to Manchester long listing stage

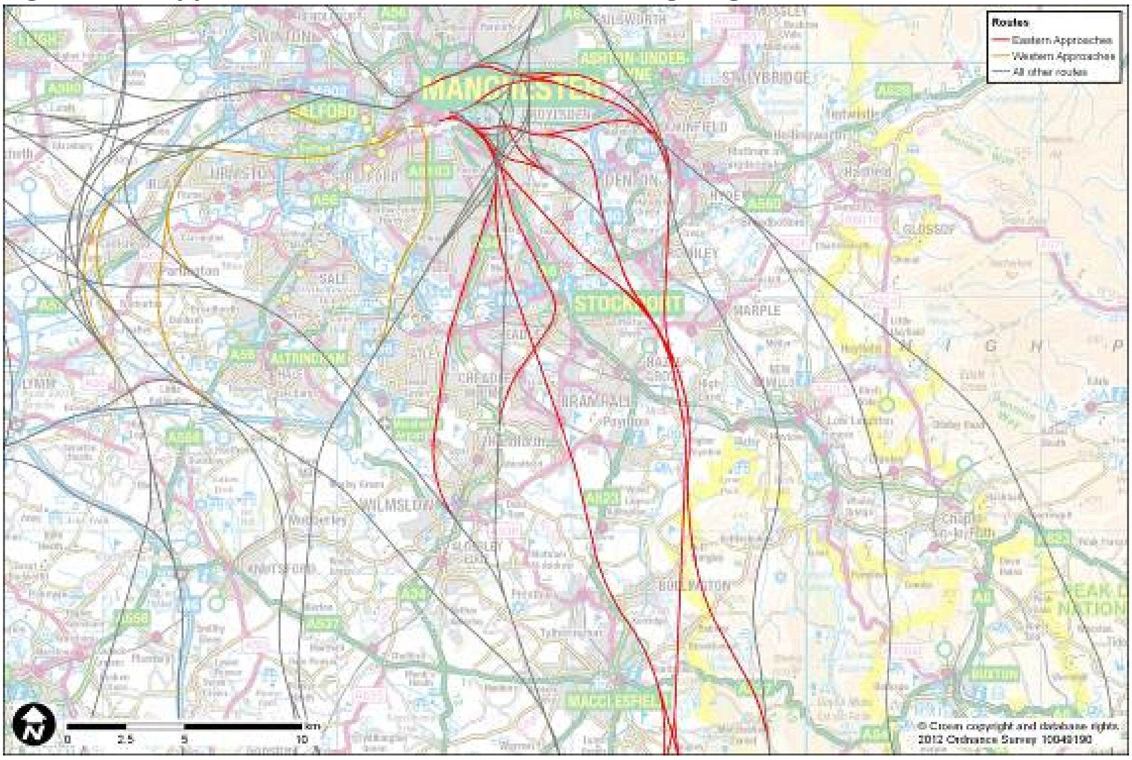


Source: HS2 Ltd

Short listing

4.6.7 The long listed options were developed in more detail from an engineering, sustainability, journey time and cost perspective. The short listing of approach options was driven both by the relative performance of approaches and on the fact that some connecting route and station options had not been progressed. Figure 4.24 shows the options that were not progressed to the short list. Given the iterative nature of the work at this stage, a significant number of new options evolved during this stage, and were subsequently considered in more detail.

Figure 4.24 Approaches to Manchester short listing stage



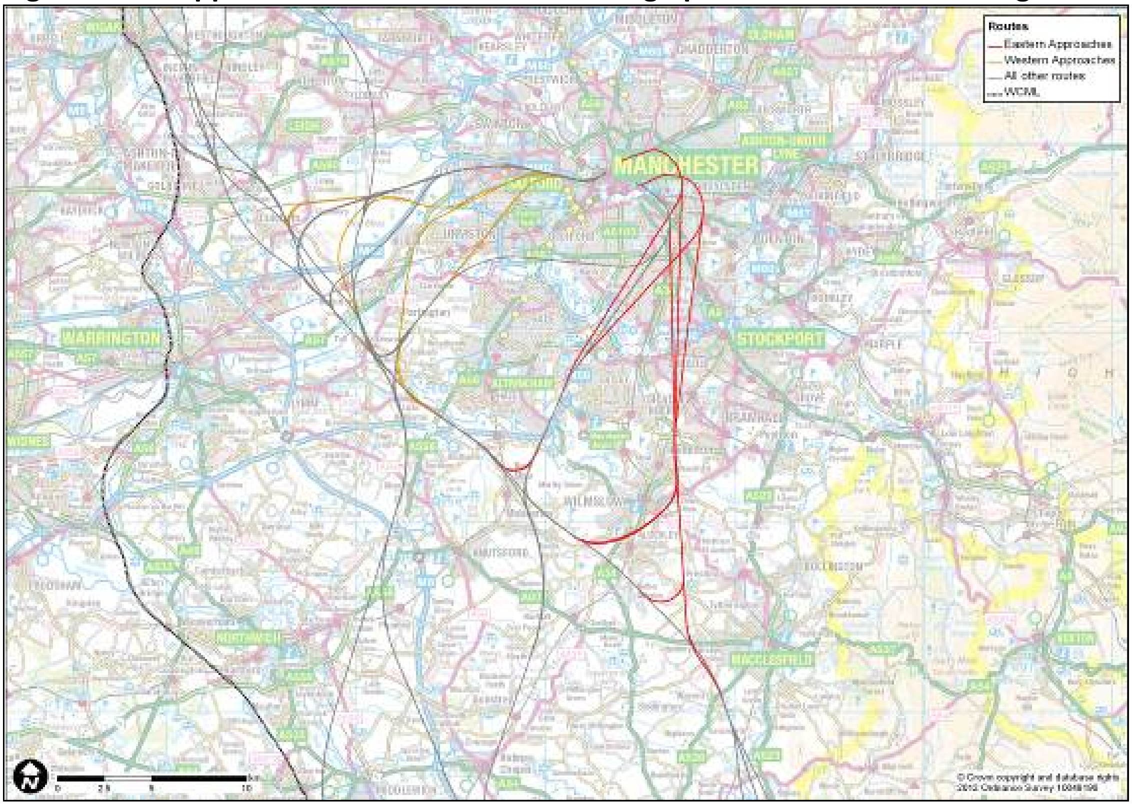
Source: HS2 Ltd

4.6.8 The northern sections of all options form the approaches towards Manchester terminus station options. All approaches were designed to follow existing transport corridors where possible, which nevertheless resulted in high cost engineering solutions to negotiate established infrastructure and dense settlements. The eastern approaches had particularly high demolition numbers, whilst the western approaches negotiated numerous sustainability features of high importance. Three core western approach options were not progressed because alternative routes performed favourably on all accounts. All surface routes options into eastern stations were not shortlisted due to high cost and poor sustainability performance; only tunnel options were taken into the next stage.

Selecting options for refinement

4.6.9 Figure 4.25 shows the options that were not progressed further. This included the approach routes that served the station options at Baird Street and Victoria (in the eastern approaches group). The other eastern approaches were not progressed because of significant sections of tunnel being required while the remaining alternatives, such as the Airport tunnel, would require less.

Figure 4.25 - Approaches to Manchester selecting options for refinement stage



Source: HS2 Ltd

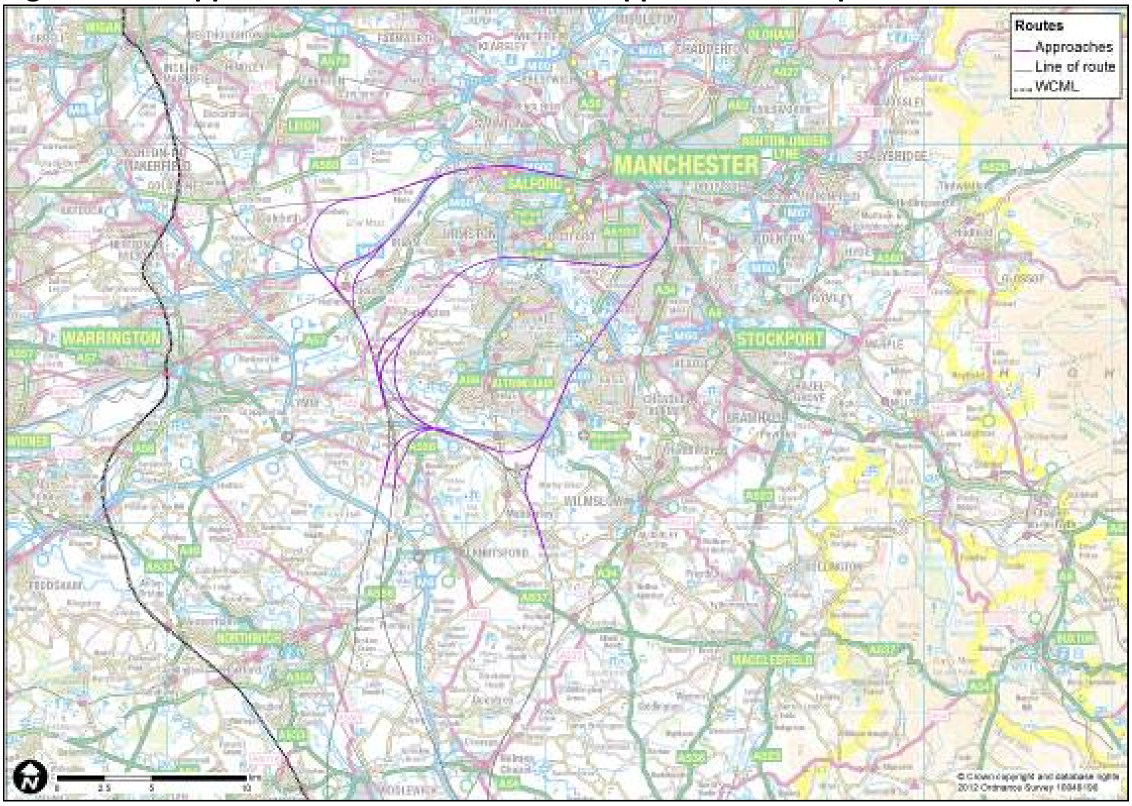
4.6.10 Of the western approaches, the furthest to the west was not progressed due to it performing poorly from a cost and sustainability perspective with no balancing journey time benefits. The western approach option furthest to the east was not progressed as it would include a tunnel underneath Urmston and would have a particularly high cost attached to this when compared to alternative options.

4.6.11 Two new approach routes were proposed and developed to the same level as the others at this stage. One was a route via the River Mersey Valley corridor and then a tunnel to the Piccadilly station options; this was assessed to perform better overall than alternatives to Piccadilly. The other was a route via the M62 corridor that would serve options in Salford, mainly running on the surface and using a comparatively short section of tunnel. In total four approach routes were taken forwards for finalisation, all of them running in tunnel from the city outskirts.

Finalising our options

4.6.12 A more detailed assessment was undertaken of the remaining options, including design optimisation and mitigation. Although it was clear that there are differences between the costs, journey time, complexity and sustainability performance, no options were parked at this stage. There were no clear all round better performers between the two approach options to Salford and the two approach options at Piccadilly. Figure 4.26 presents the final approach route options and the connections to the main routes.

Figure 4.26 - Approaches to Manchester final approach route options



Source: HS2 Ltd

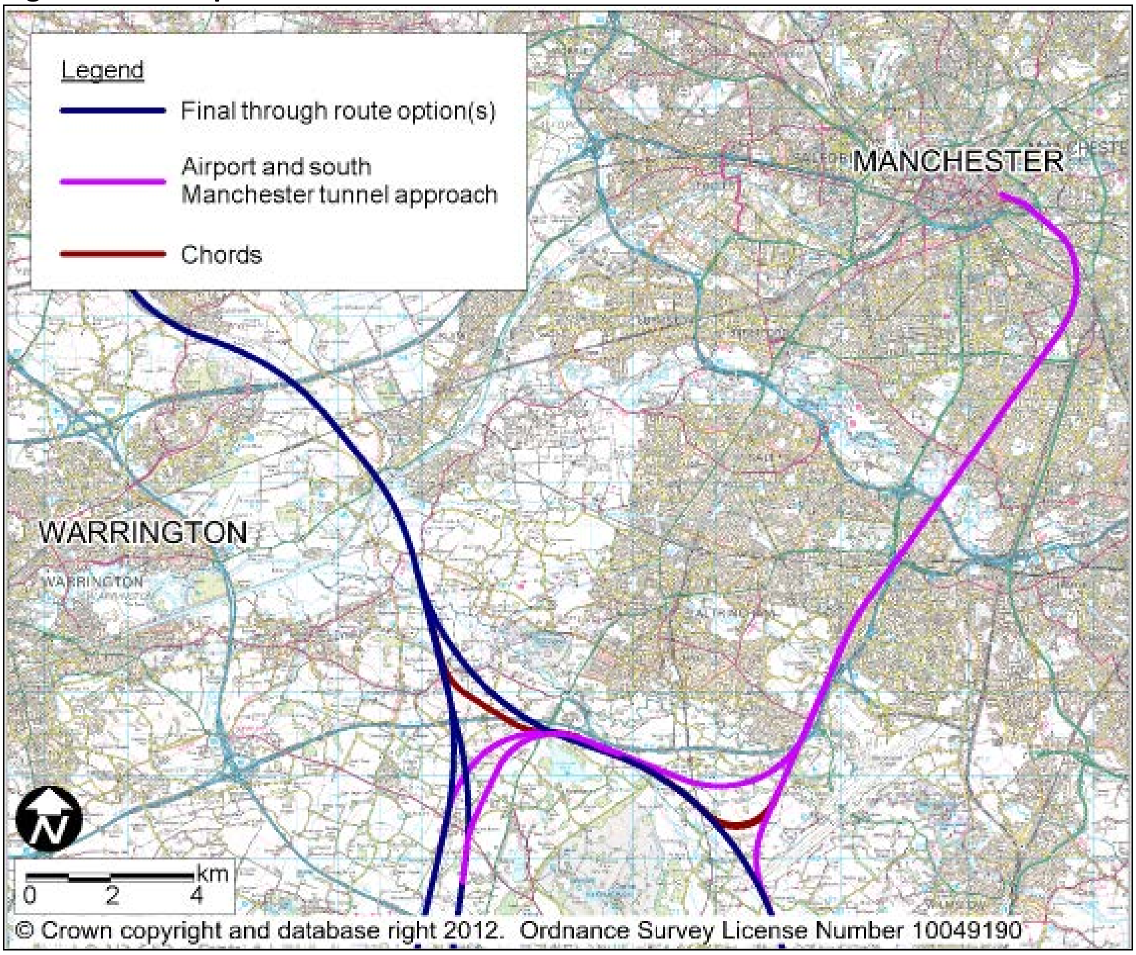
Proposed final options and alternatives

Approaches that would serve a station at Piccadilly and chords to the north

4.6.13 There are two approach options to a station near Manchester Piccadilly, both of which provide connections to all three route options from Lichfield. One option would run to the west side of the Airport and into a long tunnel under the urban area. A second approach option would diverge from the main through route to the east of Partington and pass along the River Mersey Valley before also entering a long tunnel. To enable trains to travel from the WCML connection and rolling stock depot in the north towards any city centre station, northern facing chords would be required. A chord is a short, generally curved, section of route, linking one route to another.

Airport and south Manchester tunnel approach

Figure 4.27 - Airport and south Manchester tunnel route to Manchester



Source: HS2 Ltd

4.6.14 This approach option could connect to all three of the route options via unique sections of route. Figure 4.27 is a map of the approach, showing connections to the main route options. As can be seen, the Crewe to Golborne western route and the Sandbach to Golborne M6 route links to this approach would diverge away from the main route options to the north of Knutsford. They would then move together to follow a common route from the east of Rostherne Mere. The routes would skirt around Altrincham to pass under the M56 and align with the approach from the Sandbach to Golborne Airport route. Finally, the chords shown in maroon would enable trains to pass from the north to the city centre station and vice versa. The route description in the remainder of this section is set out in the above order.

Engineering

Connecting to the Airport and south Manchester tunnel approach from the Crewe to Golborne western route

4.6.15 A spur would diverge from the main route where the route would be running on embankment just north of the M6. A grade separated junction would allow the approach to head eastwards over the main route, with a maximum line speed of 145 mph (230kph). Continuing at surface level the route would be bridged by the A50 before curving to the east in cutting to pass under the A566.

Connecting to the Airport and south Manchester tunnel approach from the Sandbach to Golborne M6 route

4.6.16 A spur would diverge from the M6 route around one kilometre north of the M6 crossing west of Junction 19. The maximum line speed would be 100mph (160kph). The route would use a grade separated junction to pass under the main route in cutting parallel to the A556. The approach route would pass under the A50 to the east of Hoo Green before rising to the surface near Bucklow Hill. Turning eastwards it would descend again into cutting to cross beneath the A556.

Here the two options set out above merge into one common route option

4.6.17 The approach route would continue in cutting, passing to the north of Rostherne Mere, south of the M56 corridor. The route would follow the terrain level passing over Birkin Brook and the existing railway before heading northeast to cross over the River Bollin on viaduct and under the M56 at Warburton Green, to the north of the Manchester Airport runways.

Connecting to the Airport and south Manchester tunnel route from the Sandbach to Golborne Airport route

4.6.18 A spur would diverge from the Sandbach to Golborne route just to the south of Mobberley Brook, where two tracks would widen to four. This would be in the proposed bored tunnel section of the route past Mobberley. The main route would split away and head in a north-westerly direction and this approach route, northwards. After emerging from the tunnel the approach route would remain in cutting as it passes around the western end of the southern runway at Manchester Airport before passing over the Sugar Brook floodplain. At this point we have explored the option of a possible Manchester Airport north-south interchange station (see section 4.8).

4.6.19 The route would continue north-east in cutting to the west of the Airport area, except for a short viaduct across the River Bollin. North of here the route would pass under the M56 and emerge in cutting on the west side of the M56 at Warburton Green.

From this point the approach route would be common for all main line connections to the Airport tunnelled approach route

4.6.20 North of the M56 the route would run in a cutting to the west of the M56. In this location we have developed the Manchester Airport Davenport Green option for a possible interchange station (see section 4.8). Thus, all three main route options could connect to this station. Heading north-east the approach would descend into a tunnel close to Junction 5 of the M56 and remain under the built up area for a distance of 7.6 miles (12.2km). The route would surface just north of Longsight alongside the existing railway into Piccadilly, emerging into a cutting under the A57. The route would continue in cutting through Ardwick alongside the existing railway lines to approach Piccadilly station. At the inner ring road (Mancunian Way) the route would rise onto viaduct and pass over this and the A665 and then approach a station next to the existing Piccadilly station.

Additional chords providing access from Manchester city centre from the north

4.6.21 The chords are described from west to east, as if approaching from the WCML and are coloured maroon in figure 4.27. The first chord serves the Crewe to Golborne western route and the Sandbach to Golborne M6 route from the east of Lymm to the M56 Junction 7. The second chord serves the Sandbach to Golborne Airport route from the M56 Junction 7 area to Thorn Green.

4.6.22 The first chord would begin on the main route from the north to the east of Lymm, where the two track section would diverge to four tracks. All tracks would pass over the River Bollin on a viaduct. The chord route would descend into cutting to pass under the main line and then rise onto embankment to cross over the Bridgewater canal and the Agden Brook. Gradually descending here the chord would pass under the M56 and A56 in cutting approaching the north side of Rostherne Mere. The chord would then re-join the link to the Airport and South Manchester tunnel approach from the Crewe to Golborne western route.

4.6.23 The second chord option would begin on the Sandbach to Golborne Airport route approaching from the north adjacent to Junction 7 of the M56. Initially in cutting, all tracks would rise to cross two brooks on viaduct before the chord route moves onto embankment to cross over the main line and the Chester to Altrincham railway. The chord route would remain on embankment as it turns to the east and would use a second grade separated junction to connect back into the Sandbach to Golborne Airport route.

Sustainability

4.6.24 The Airport and south Manchester tunnel approach, plus the necessary chords would result in the demolition of an estimated 43 to 51 dwellings depending on which main route the approach would stem from. In addition, a Grade II listed former farmhouse near to Hale Barns would need to be demolished.

4.6.25 If this option was linked to the Sandbach to Golborne M6 route, it would pass very close to a moated site called Bucklow Hill – a Scheduled Monument. This would affect its setting. It would also need to run through Hancocks Bank, an Ancient Woodland.

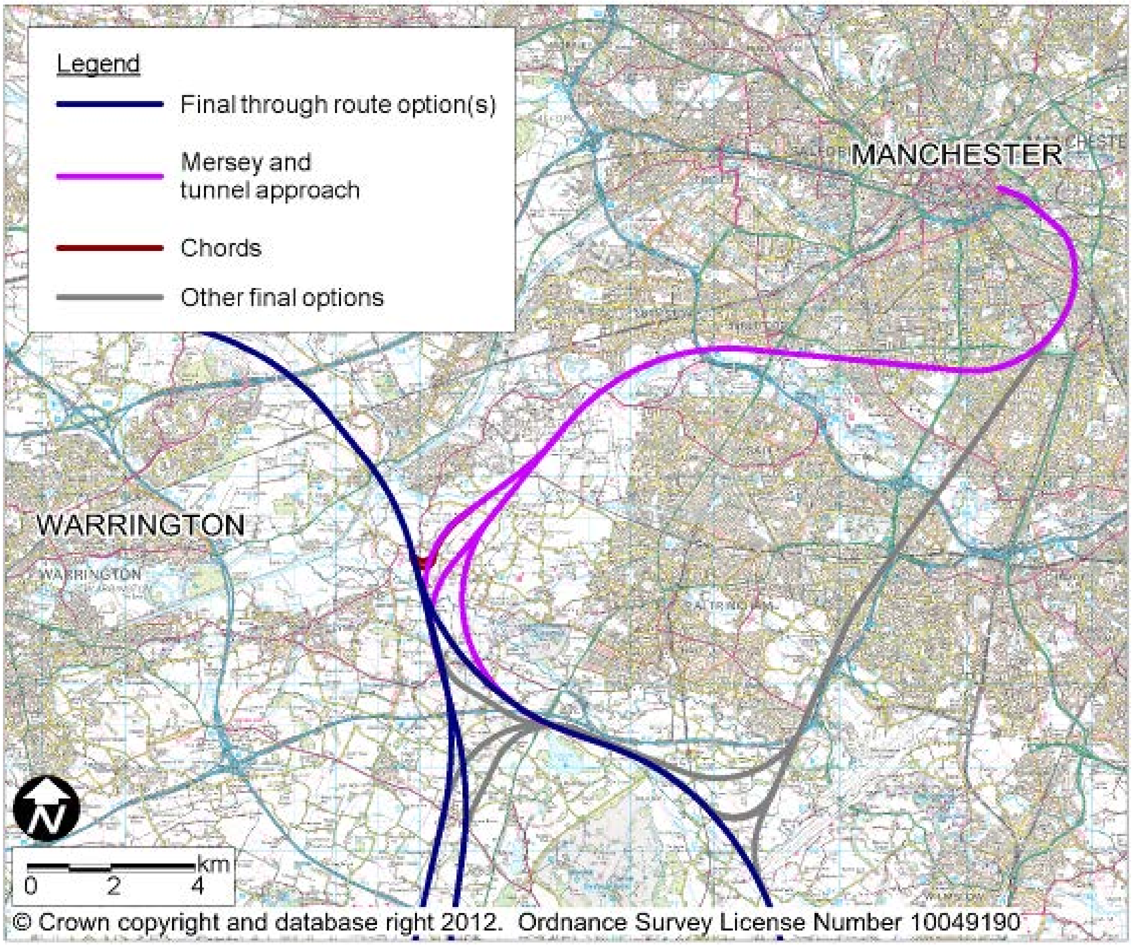
4.6.26 Both the links to the Crewe to Golborne western route and the Sandbach to

Golborne M6 route would pass close to Rostherne Mere Ramsar site (at slightly different points). Appraisal work on this continues although we believe that the associated risks can be mitigated and adverse impacts avoided.

4.6.27 The link from the Crewe to Golborne western route would mean visual impacts on Mere Hall (Grade II listed) and the hamlets of Hoo Green and Hulseheath. The section of the approach common to all routes would cause visual impact on the residential area of Hale Barns. The approach would require an additional crossing of the River Bollin which would be on a high viaduct and would directly impact on the wooded valley sides and give rise to visual impacts.

Mersey and tunnel approach

Figure 4.28 - Mersey and tunnel approach to Manchester



Source: HS2 Ltd

Engineering

4.6.28 This approach option could connect to all three of the route options, again by unique spurs. Figure 4.28 is a map of the approach, showing connections to the main route options. As can be seen, the Crewe to Golborne western route and the Sandbach to Golborne M6 route spurs would diverge away from the main route options to the north of the Bridgewater Canal. The spur from the

Sandbach to Golborne Airport route would diverge away from the main line at the M56 Junction 7, moving toward the other two approaches to follow a common route from Carrington. The route description below is set out in this order. The chord shown in maroon would enable trains to pass from the WCML connection and rolling stock depot in the north to the city centre station and vice versa.

Connecting to the Mersey and tunnel approach from the Crewe to Golborne western route

4.6.29 Shortly after crossing the Bridgewater Canal on embankment, the main route would divide into four tracks. A grade separated junction would allow the spur to Manchester to pass over the main line and diverge in a north-easterly direction forming the approach route. Soon afterwards the route would cross the River Bollin on a viaduct before descending to continue largely at surface level. The route would cross Red Brook on a viaduct and return to surface level to cross Carrington Moss.

Connecting to the Mersey and tunnel approach from the Sandbach to Golborne M6 route

4.6.30 Following the crossing of the M56 on embankment the route would divide into four tracks. After crossing over the A56 and the Bridgewater Canal the spur to Manchester would descend to ground level to pass under the main line. This approach route would head north-east, rising to cross the River Bollin on a viaduct. Continuing mainly at surface level, the route would cross the Caldwell and Sinderland Brook floodplains on a bridge and viaduct respectively before returning to ground level to cross Carrington Moss.

Connecting to the Mersey and tunnel approach from the Sandbach to Golborne Airport route

4.6.31 The route would begin in a deep cutting to the north of Rostherne Mere where two tracks would divide into four. Running alongside the mainline under the A556 and the M56, the route would then use a grade separated junction to pass under the main route and bear northwards to the west of the Dunham Massey estate. The approach route would then cross underneath the A56 and Bridgewater Canal in cutting, before elevating to cross the River Bollin on viaduct. Continuing at surface level the route would curve to the north-east, crossing two dismantled railway lines and Carrington Moss.

From this point all route options would follow a common route to a Manchester Piccadilly station

4.6.32 The approach route would enter the urban area of Carrington, passing through a large industrial area on the surface. The A6144 would pass over the route before the route rises onto a long low viaduct over the Mersey Valley and floodplain. A higher elevated section would follow to cross the M60 at Junction 8, before the route descends into a cutting and then tunnel to the east of Stretford for 6.5 miles (10.5km).

4.6.33 The route would emerge from tunnel into a cutting just north of Longsight and passing underneath the A57. The cutting would run through Ardwick alongside the existing railway lines to the approach to Piccadilly Station. At the inner ring road (Mancunian Way) the route would rise onto viaduct and pass over this and the A665 and then approach a HS2 terminating station next to the existing Piccadilly station.

Additional chord providing access from Manchester city centre to the north

4.6.34 The Mersey and tunnel approach described above would provide access to and from a station near Manchester Piccadilly. To enable trains to travel from a city centre station to a WCML connection in the north, a northern facing chord would be required. The chord proposed for this approach route is shown in Figure 4.28 coloured maroon.

4.6.35 The chord is described broadly from east to west, as if approaching from the Manchester station. The northern chord would begin to the south of Partington where the tracks at surface level would divide into four tracks. All tracks would be on the surface, descending into cutting to the east of Mossbrow to allow the chord to pass under the approach to Manchester. Here, the chord follows a tight curve to face in a north-westerly direction, before using second grade separated junction to pass under and connect into the main through route to the WCML. The main line route options would all have the same alignment at this point.

Sustainability

4.6.36 The Mersey and tunnel approach and associated chord would result in the demolition of an estimated 22 to 28 dwellings depending on which main route the approach would stem from. The Sandbach to Golborne Airport route linking to this approach would impact on the edge of the National Trust owned land that is part of the Dunham Massey estate. The Registered Park and Garden would not be affected. Dunham Woodhouse would experience some visual impact because the route would be above ground near there. The main line of route would pass very close to Rostherne Mere Ramsar site.

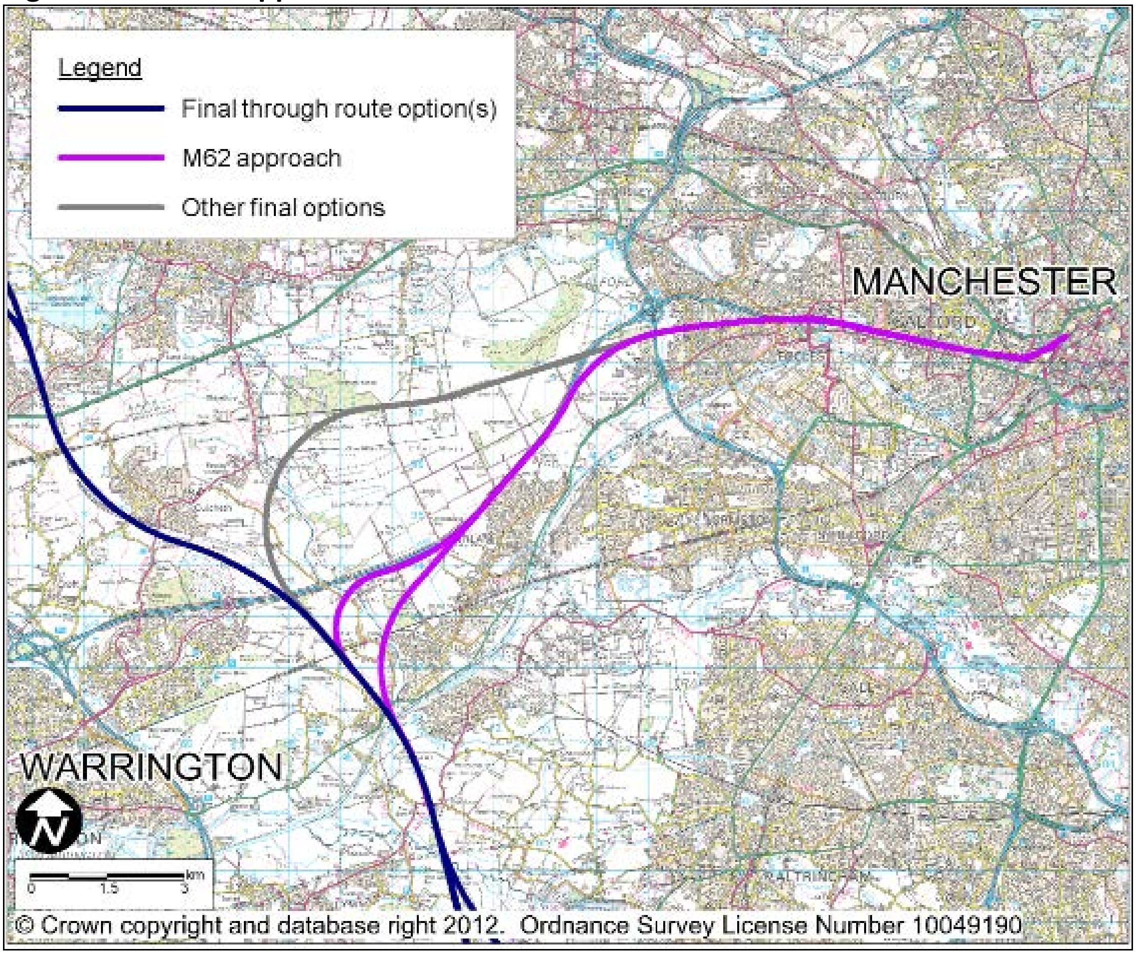
4.6.37 Both the spur to the Crewe to Golborne western route and the Sandbach to Golborne M6 route would require a viaduct over the River Bollin to the east of Lymm which would impact on the character of the Bollin Valley. If the approach linked to the Western route via Crewe, an area of lowland raised bog BAP habitat (in the mosses) would be directly affected. The section of the approach common to all main routes would pass through the mosses adversely affecting this open landscape.

Approaches that would serve a station at Salford

4.6.38 North of the Manchester Ship Canal there are three route options that serve station options in Salford. Two routes follow the M62 corridor to the outskirts of Eccles and the third option follows the existing railway line. From Eccles all three options follow a common route alongside the existing railway before using a section of tunnel to access Salford.

M62 approach route to serve a station at Salford

Figure 4.29 - M62 approach route to serve a station at Salford



Source: HS2 Ltd

Engineering

4.6.39 All route options connect to this approach to the east of Warburton. From this single main line route there are two alternative chords to connect to the approach route: an 'inner' and an 'outer' chord. Figure 4.29 shows the M62 approach route and the two chords diverging from the main through route.

Using the 'inner' chord

4.6.40 This spur would begin in cutting to the east of Warburton where the main route to the WCML would divide into four tracks. The A6144 would pass over all tracks as the spur route passes under the main route going north. Rising steeply onto a viaduct detached from the main line, the route would cross the Manchester Ship Canal. Staying to the west of Cadishead, the viaduct would cross the A57 before descending onto an embankment to pass over the existing railway and the Glaze Brook on a viaduct. Descending to surface level, the curve of the route would bring it to run along the south side of the M62.

Using the 'outer' chord

4.6.41 This spur would begin one kilometre north of the Manchester Ship Canal crossing. It would not require an additional structure and would have less visual impact on the local area, however the maximum design speed would be reduced to 105 mph (170kph). Once on embankment after crossing the canal, the main route would divide into four tracks and the spur route would use a grade separated junction to rise over the main route to the north, before curving sharply to the east to cross the Liverpool to Manchester railway. Continuing on embankment the route would cross the Glaze Brook on a short viaduct and would then bear north-east to run alongside the M62 at surface level.

From this point the two M62 route options would follow a common route to Eccles

4.6.42 The approach route would run along the southern side of the M62 at surface level for 1.6 miles (2.5km). As the M62 diverges to the north the route would cross Barton Moss at surface level before descending into cutting to pass under the existing railway. The route would then rise onto embankment to cross the M60 and the Worsley Brook, just to the south of the M62 and M60 intersection.

4.6.43 The route would continue on embankment eastwards running parallel to and at the same height as the existing railway. The route would cross the Bridgewater Canal before descending into a deep retained cut and then into a tunnel for 2.5 miles (4km). The tunnel would surface west of Junction 3 of the M602 in Salford in a cutting. It would use a viaduct to pass over local highways before continuing east to form the throat of a HS2 station either on the site of the existing Salford Central station, or nearby at a Salford Middlewood site.

Sustainability

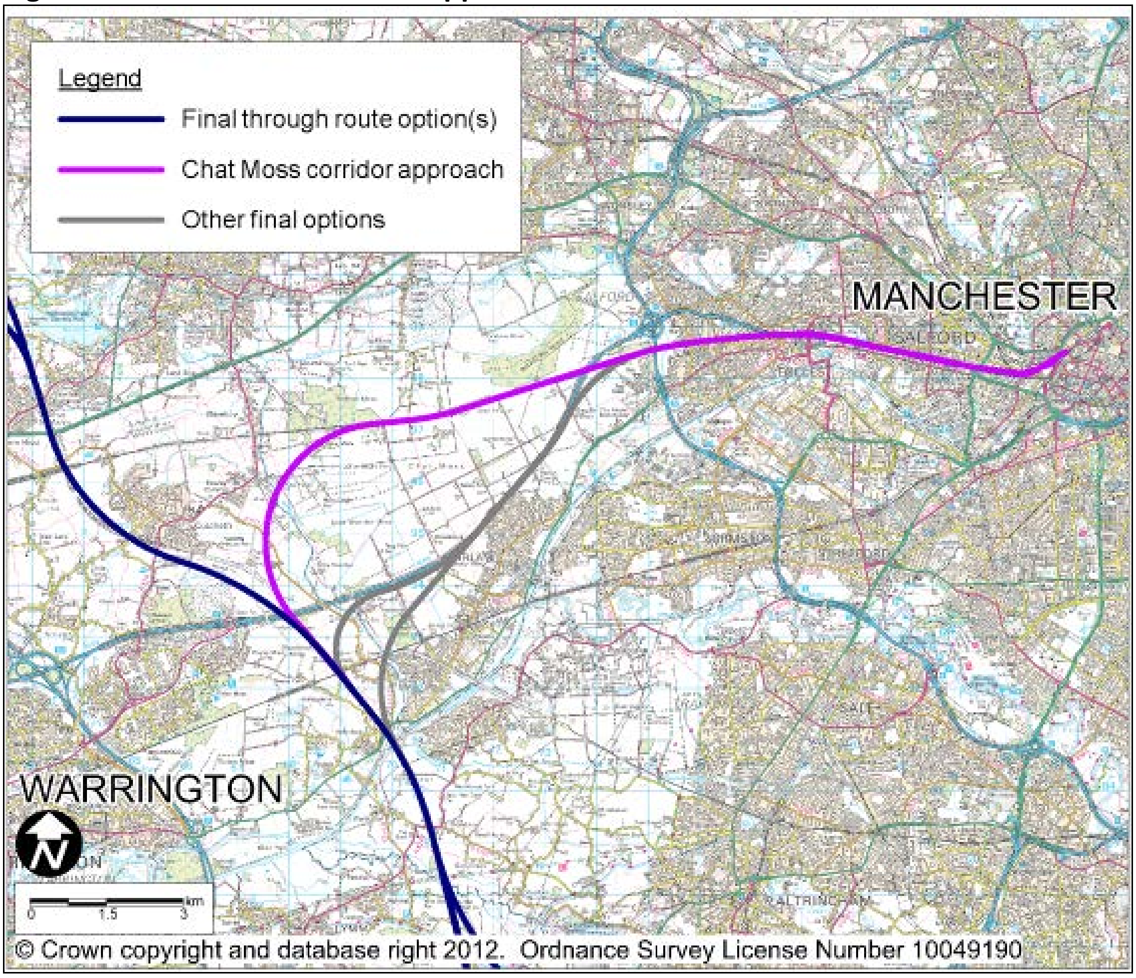
4.6.44 The M62 approach would result in the demolition of between 100 and 117 dwellings depending on which chord would be used to connect to it. A Grade II listed pub in Patricroft and a Grade II listed railway bridge would likely be demolished. An area at risk of potential isolation would be Glazebrook, as this would lie between both of the chords of this approach route and the main through route towards the WCML and the M62. The inner chord would have a much more significant effect than the outer option.

4.6.45 The high viaduct over the Ship Canal and the embankment that would continue to the north-west would give rise to significant landscape impacts and visual intrusion for residents in Partington, Hollins Green and Cadishead. Potential for impacts on three parts of the Manchester Mosses SAC could not be discounted at this stage of design as the route would pass close to these sites.

4.6.46 The approach would cross Coroners Wood, an ancient woodland, on viaduct so careful location of viaduct piers would be required in order to minimise intrusion. The outer chord option would pass close to Glazebrook Iron Age fort. The setting of this would be greatly affected by the proposed viaduct over Glazebrook and careful design of the construction process would be required to avoid impacts. Where the route would diverge from the M62 to join an existing railway alignment, it would potentially cause visual intrusion at Peel Green. The section of route on embankment through Eccles would increase visual impact from transport infrastructure in the area and would also encroach on school playing fields.

Chat Moss railway corridor approach to serve a railway station at Salford

Figure 4.30- Chat Moss corridor approach to Salford



Source: HS2 Ltd

Engineering

4.6.47 Figure 4.30 shows that all main route options could connect to an approach starting at a junction adjacent to Glazebrook, 0.8miles (1.3km) north of the Manchester Ship Canal crossing. Here, the route would divide into four tracks on embankment, with the spur route crossing over the main line to head northeast towards Salford. The route would cross the existing railway and the M62 on bridges before crossing the Glaze Brook on viaduct. The route would then descend to surface level as it passes through Chat Moss and heads east to run on the south side of the existing railway.

4.6.48 The Chat Moss corridor approach would then cross the railway on a bridge to then run along its northern side. It would then rise onto embankment to cross the M60 and the Worsley Brook, just to the south of the M62 and M60 intersection. The remainder of the route would then be identical to the section of route described in paragraph 4.6.42 above.

Sustainability

4.6.49 The Chat Moss corridor approach would result in the demolition of an estimated 101 dwellings. A Grade II listed pub in Patricroft and a Grade II listed railway bridge would likely be demolished.

4.6.50 The high viaduct over the Ship Canal and the embankment that would continue to the north-west would give rise to significant visual intrusion for residents in Partington, Hollins Green and Cadishead. Potential for impacts on three parts of the Manchester Mosses SAC could not be discounted at this stage of design as the route would pass very close to these sites. The section of route through Eccles on embankment would increase the overall visual impact from transport infrastructure in the area.

Approaches into Manchester city centre: Section summary

4.6.51 In this section we described a number of approaches to serve either the station options at Manchester Piccadilly or either of the station options in the Salford area. In addition the choice of whether or not to also serve an interchange station at Manchester Airport dictates which route and approach is taken.

4.6.52 The lowest cost approach route would be the M62 approach which would serve a station in the Salford area. This would also be the best performing approach overall into a Salford station. It would be around £60 million less expensive than the cheapest option into Manchester Piccadilly (Mersey and tunnel). We also set out in our analysis of our final city centre station options that the benefits at Manchester Piccadilly would outweigh the additional costs. The M62 approach would be over two minutes slower than the fastest approach into a Manchester Piccadilly station (Airport and south Manchester tunnel).

4.6.53 Taking account of cost, journey time and sustainability issues, the best performing approach and main route combination to a Manchester Piccadilly station, without serving an interchange station at the Airport, is the Mersey and tunnel approach, accessed from the Crewe to Golborne western route. The approach could also be accessed by the two other main routes. This combination would be around £170 million more expensive than the M62 approach to Salford from the same route. However, the higher cost of stations in Salford compared to at Piccadilly would offset this to some extent. In addition, as we describe in the next section, the benefits captured by the proposed station at Manchester Piccadilly are likely to outweigh these additional costs.

4.6.54 The Mersey and tunnel approach to a Manchester Piccadilly station would be over two minutes slower than the fastest option into Manchester Piccadilly. The fastest option would be the Airport and south Manchester tunnel accessed from the Sandbach to Golborne Airport route (including the tunnel that we recommend). This could also serve an interchange station near Manchester Airport before heading on to a station at Manchester Piccadilly. The cost of this fastest combination of route and approach (excluding an interchange station) would be over £1.2 billion more than the Mersey and tunnel approach described above. A significant proportion of these costs would result from our recommendation to include a tunnel under Mobberley if this route option were progressed.

4.6.55 We go on to examine the case for an interchange station in detail in section 4.8. It is important to understand, though, that the potential benefits of an interchange station would likely be outweighed by such a high cost, particularly if this were accessed via the fastest route and approach option set out above.

4.6.56 The two alternative main routes combined with the Airport and south Manchester tunnel approach would provide a significantly less costly combination for serving the best performing Airport interchange station. The overall best performing main route to combine with this approach and station would be the Crewe to Golborne western route.

4.6.57 An interchange station in the vicinity of the Airport could be accessed from all three route options and then would need to access Manchester using the Airport and south Manchester tunnel. Stopping at an interchange would add approximately five minutes to journey times and would include additional capital costs.

4.6.58 As we underlined, the best performing approach is entirely dependent on which city centre station is selected and whether to include an interchange station. We go on to describe our city centre and interchange station work in the next sections of this chapter.

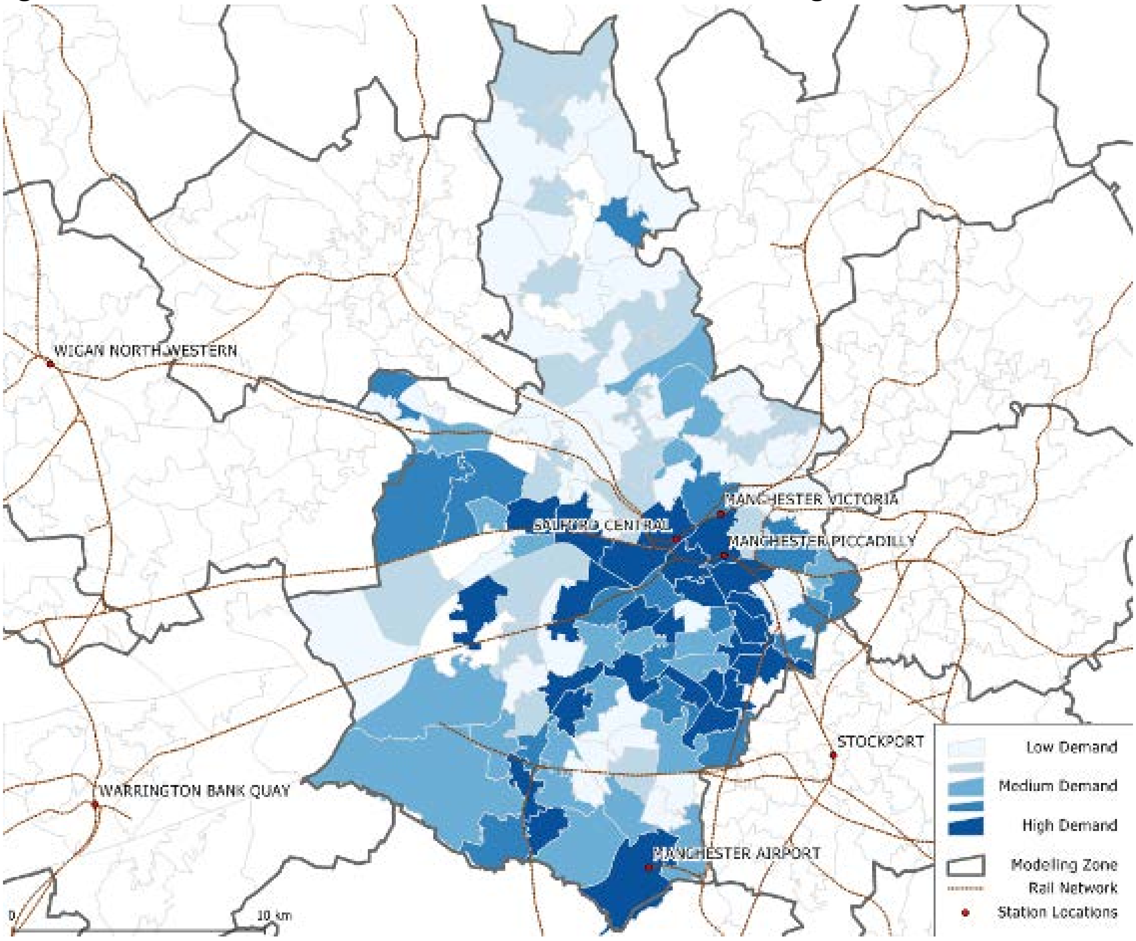
4.7 Manchester city centre stations

Introduction

4.7.1 This section describes our work developing and assessing station options for serving Manchester city centre. It starts by outlining the work undertaken to identify and develop station options. It then goes on to describe the process of assessing and sifting options. Finally it gives a detailed description of the three remaining city centre options. We also considered potential interchange station options located in the wider region around Manchester. That is covered separately in the next section.

4.7.2 The city of Manchester is an important centre of demand in itself, but also represents a significant rail hub, with people travelling into the two main rail stations at Piccadilly and Victoria, capturing markets from London and other major cities. Demand grew with the faster journeys offered by the upgrading of the WCML. A HS2 station would be likely to attract passengers over an even wider area because it could offer more competitive journey times.

Figure 4.31- Manchester and Metrolink area - demand for long distance travel



Source: HS2 Ltd

4.7.3 As already seen by figure 4.31, the locations of demand in Manchester are such that at first sight either of the Salford or Piccadilly locations would seem suitable with both offering high demand. However, overall Manchester Piccadilly offers far more direct heavy rail and Metrolink (Greater Manchester's tram network) connectivity to Greater Manchester and beyond. We describe our comparative analysis of the effect of this on demand later in this section. The principal point being that we expect that both demand figures and benefits would reflect the greater connectivity at Manchester Piccadilly. This holds true even when including the committed Ordsall Chord rail scheme, part of Network Rail's planned Northern Hub improvement to the rail network in the north of England (see text box 7) into the analysis.

4.7.4 This connectivity means that Manchester Piccadilly attracts demand from the whole of the Manchester area including the Stockport market from the south of the city. Conversely, Salford does not provide a good location for the Stockport and other south Manchester markets due to the need to cross Manchester city centre to reach the station. Salford would capture more of the market to the north and north-west of Manchester, but this is a smaller market than the south Manchester market.

4.7.5 Our demand analysis therefore highlighted that Manchester Piccadilly, with its city centre location and its excellent connectivity to the wider region, was likely to be the best location for a city centre station. However, as we explained in the previous section, our analysis of the approaches into Manchester showed that, in order to approach Manchester Piccadilly from the south, there were significant sustainability constraints reflective of the built up and developed city centre. We therefore needed to balance the potential benefits of a Manchester Piccadilly station over its higher costs resulting from its potentially more challenging approach.

7. The Northern Hub

In developing our proposals we were mindful of developments to the existing transport network, particularly the railway. This was from the point of view of getting the best connectivity, but also in terms of potential infrastructure conflicts between HS2 and the existing railway. We worked closely with Network Rail on all of our station options to ensure that they would not conflict with existing or planned infrastructure.

A key consideration was the Northern Hub, Network Rail's plan to stimulate economic growth by improving the rail network of the North.[9] The Hub's reach runs as far as Newcastle and Hull in the East to Chester and Liverpool in the West. It has potential to increase the benefits from HS2 by improving connectivity, allowing more people to access HS2 services. Plans include:

[9] For more information on the Northern Hub including maps, please see Network Rail, *Northern Hub*, http://www.networkrail.co.uk/aspx/6472.aspx

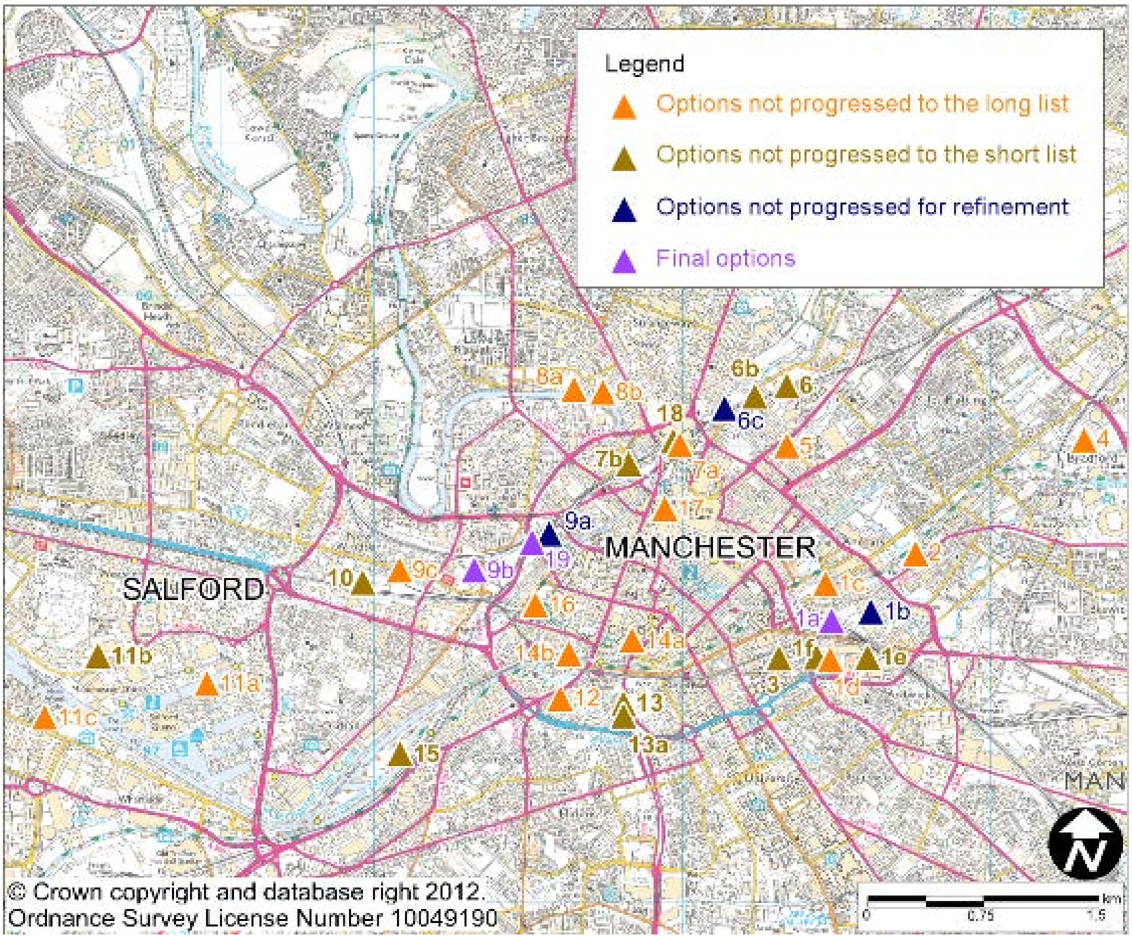
- new lines through the Pennines between Leeds, Huddersfield, Dewsbury and Manchester;
- new track between Liverpool and Manchester (via Newton–le-Willows);
- Manchester Piccadilly and Manchester Victoria directly linked via a new track at Ordsall;
- electrification of the lines between Liverpool and Manchester; and
- new lines between Sheffield and Manchester.

For Manchester city centre options, the Ordsall Chord was a key consideration. The Chord, planned to be built by 2017, includes a new section of track, approximately half a mile (1km) in length, to the north-west of Castlefield Junction, in the vicinity of Ordsall. This will link the Castlefield Junction line with the Deal Street Junction line, connecting Manchester's three main stations for the very first time. We were careful to develop options that would work with this new infrastructure in place. Our modelling work assumed that committed elements of the Northern Hub were in place before HS2.

The generation of initial ideas and the sifting down to a long list

4.7.6 As with other locations we started by identifying options within a wide catchment area independently of our internal work looking at lines of route from Lichfield to Manchester. We developed a long list of options around existing railway stations, key development sites and other locations with good connectivity and/or proximity to the city centre. Figure 4.32 shows the range of options considered. Manchester delivery partners assisted us in option generation, particularly in terms of suggesting development sites.

Figure 4.32 - Manchester city centre station area options



Source: HS2 Ltd

4.7.7 In parallel, the work on line of route refined the long list of approaches into Manchester. When we ceased work on a station option, we would stop work on the associated line unless it appeared particularly promising. When a line was not progressed, we would consider the associated station and potentially take it further rather than immediately stopping work on it. This was to ensure that we did not prematurely park a potentially strong station option simply because we did not have an immediately viable line of route. Options progressed no further are set out in table 4.1.

Table 4.1 - Manchester city centre station - options not progressed to long list

Unique identifier	Name	Main reasons for parking at this stage
1c	Manchester Piccadilly Store St	Potential impact on communities Construction complexity
1d	Manchester Piccadilly Undercroft	Potential impact on communities Construction complexity
2	Ancoats	Poor connectivity Potential engineering footprint impact
4	Sport City	Poor connectivity Lack of proximity to city centre
5	Thomson St Fire Station	Potential impact on communities Poor connectivity
7a	Manchester Victoria Through	Construction complexity Impact on existing rail infrastructure
8a	Cambridge Industrial Estate Irwell Bank	Poor connectivity Lack of proximity to city centre
8b	Cambridge Industrial Estate Wilfred St	Poor connectivity Lack of proximity to city centre
9c	Hope Street	Poor connectivity Lack of proximity to city centre
11a	Salford Quays Erie Basin	Potential impact on communities Construction complexity
11c	Salford Quays Trafford Bank	Poor connectivity Lack of proximity to city centre Construction complexity
12	Knott Mill	Poor connectivity
14a	GMex	Construction complexity Potential impact on communities
14b	GMex South	Construction complexity Potential impact on communities
16	Television Centre	Poor connectivity
17	Underground	Construction complexity Significant cost

Source: HS2 Ltd

The creation of a short list

4.7.8 After the initial sift we were left with a long list with a number of clusters of options around Manchester Piccadilly, Salford Central, Victoria and the First Street area. We also had station options at Salford Quays, Pomona Docks and Liverpool Street.

4.7.9 Through the process of working with delivery partners, some additional options arose. Near Piccadilly we considered a new option called London Road. We also developed a new variant of the First Street option. At Victoria, we carried out work on a new station option at the Manchester Evening News Arena.

4.7.10 The remaining station options were assessed to a greater level of detail against the sifting criteria at this stage. The options that were not taken forward beyond this stage are briefly described below and shown in figure 4.33.

4.7.11 Around Manchester Piccadilly, we narrowed down the options, ceasing work on three. Two options, Manchester Piccadilly Mayfield and Manchester Piccadilly London Road (1e and 1f), would potentially blight the Mayfield development site which was seen as important to the city's development by Manchester City Council. The option at the University (3) lacked integration and connectivity with Piccadilly. The two remaining options at Piccadilly were likely to have more potential so we developed them further.

4.7.12 Neither of the options around First Street (13 and 13a) were progressed. Both would potentially impact upon the existing railway around Deansgate and Oxford Road and the Northern hub plans for services between Piccadilly and Victoria stations.

4.7.13 Manchester Victoria Greengate option (7b) would have complicated connectivity between the HS2 station and the existing rail, bus and Metrolink services at Manchester Victoria station. It would be further complicated by the Manchester Evening News arena which would be located between the two stations and prevent a physical connection between the two concourses.

4.7.14 Manchester Evening News option (18), so called as it would occupy the footprint of the Manchester Evening News Arena, was appraised but taken no further owing to its construction complexity. There was concern over the prospect of losing the Manchester Evening News Arena, an important venue and revenue generator for Manchester, even temporarily.

4.7.15 Liverpool Street option (10) was not progressed owing to its lack of connectivity and its remoteness from the city centre. It would have good motorway access but this was not seen as a good substitute for the lack of public transport options. The Salford Central options were deemed to provide a better alternative in this area, with better connectivity to rail and closer proximity to the city.

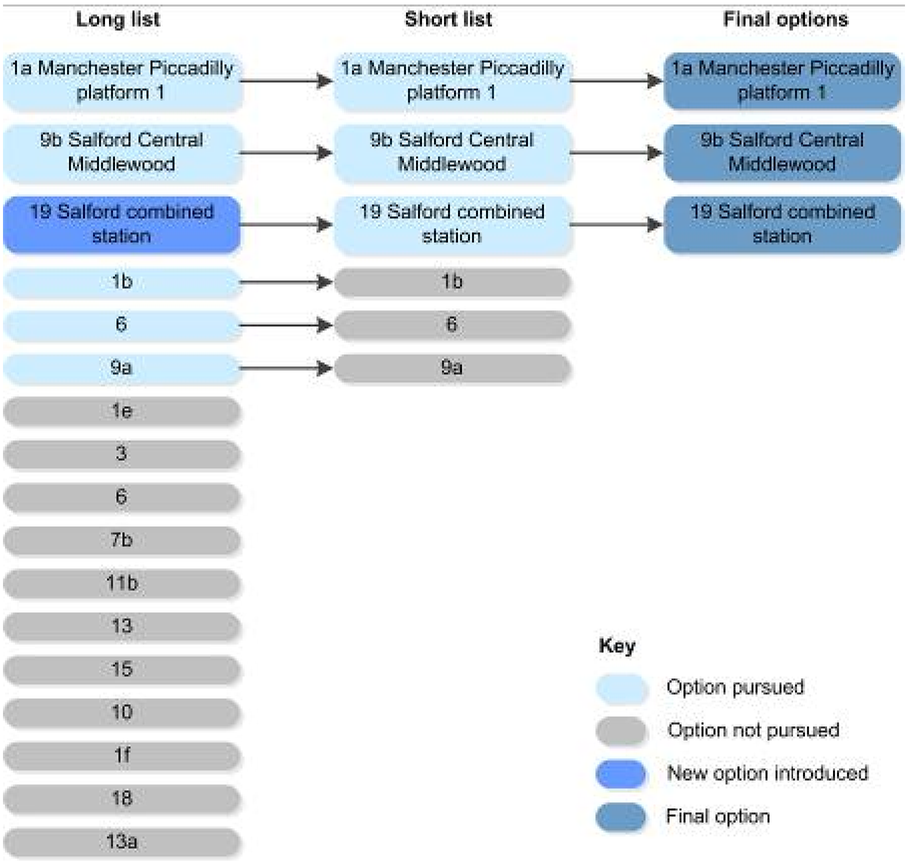
4.7.16 We did not carry out further work on the option at Salford Quays Delta Barge Feeder (DBF) Terminal (11b). The station would have to be elevated for the approach to get over the Manchester Ship Canal and this would mean a complex construction. The lack of proximity to the city centre also led us to stop work on this option.

4.7.17 Option 15 at Pomona Docks would have potential for regeneration on a largely vacant site, but it would suffer from lack of proximity to the city centre and poor connectivity.

Selecting options for refinement

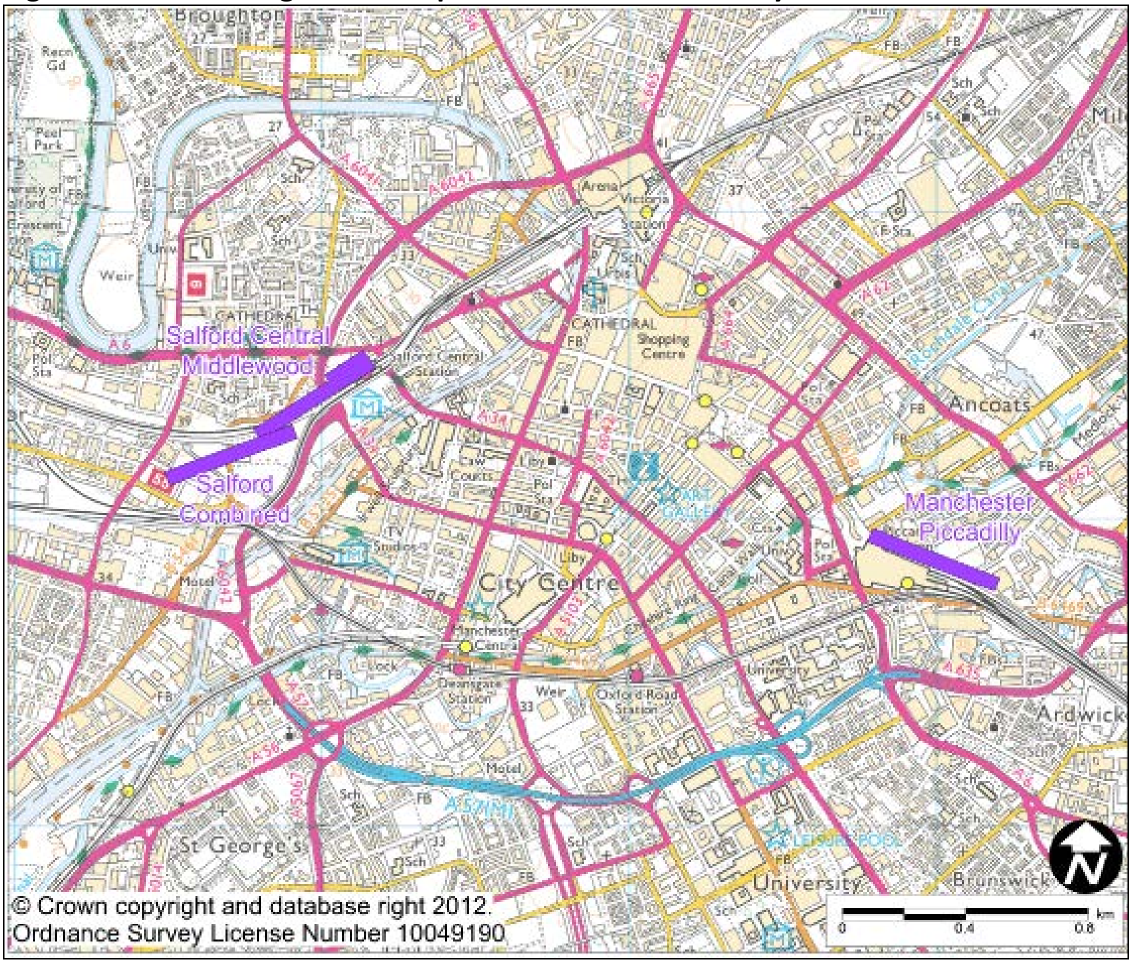
4.7.18 We were left with a shortlist with two station options around each of Piccadilly and Salford Central and one at Victoria. We carried out a more detailed assessment of the remaining station options at this sifting stage. With a smaller number of options to appraise, we also carried out new work. Our socio-economic appraisal determined the potential for options to support growth in the immediate vicinity.

Figure 4.33 – Manchester city centre station long list to final options



Source: HS2 Ltd

Figure 4.34 - Selecting the final options for Manchester city centre station



Source: HS2 Ltd

4.7.19 Where we had a cluster of options around a major station, we compared options and progressed the best performing. The following options were sifted out from the short list and not pursued any further:

- work on Manchester Piccadilly Baird Street (option 1b) ceased in favour of the option by platform one (1a). The Baird Street option had a significant impact on communities; and
- we did not progress work on the variant option at Salford Central (9a) that would be built above the existing railway. It would have considerable impacts upon the existing railway and the construction would be complex and costly.

4.7.20 It was clear that getting close to Victoria would be beneficial due to the station's good connectivity, but the impacts of doing so would be considerable. The original option 6, Green Street Quarter, would have had poor connectivity as it was 10 to 15 minutes walk from Victoria station and the Metrolink. So, we developed a new variant of option 6 by pulling it to the west. Although there were clear benefits in getting closer to Manchester Victoria with the new Green Street Quarter/ Bromley Street option, the development opportunities would not match those possible around Salford Central or Piccadilly, therefore this option was not progressed.

Developing and finalising our options

4.7.21 Following the sifting process described above we came to three final options for a high speed station in central Manchester. They are each described below in terms of their engineering and sustainability. We then summarise the levels of demand they would attract and therefore the overall benefits of each station.

Final options

Manchester Piccadilly

Engineering

4.7.22 The proposed station would consist of four elevated platforms parallel with, and alongside, platform 1 of Manchester Piccadilly station. Escalators and stairs would be located as central as possible to the platforms, within the given site constraints, to aid dispersal of passengers as efficiently as possible.

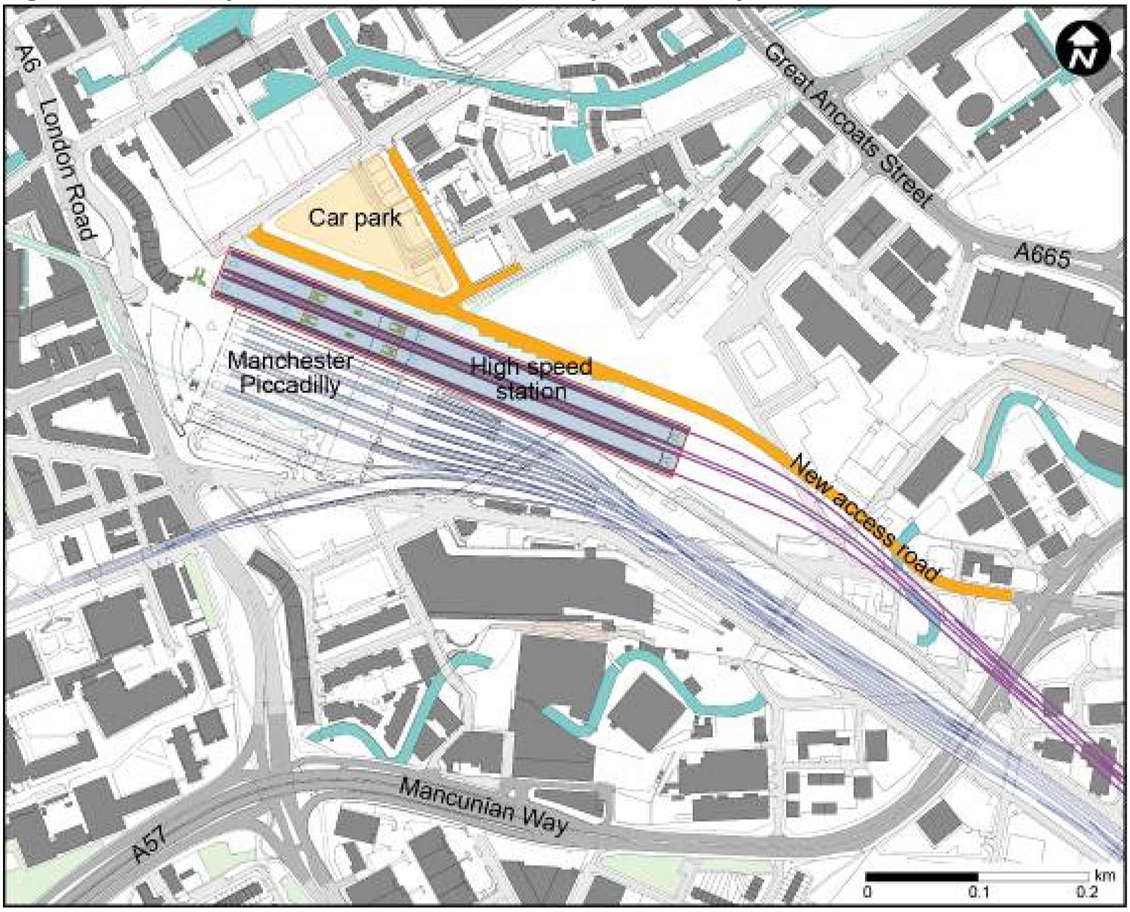
4.7.23 HS2 concourse facilities would be located at grade level, beneath the elevated platforms and to the west side of the Metrolink.

4.7.24 A new combined rail and HS2 forecourt and car park is proposed to the northern edge of the site. A new multi-storey car park with a capacity of up to 2,100 spaces would serve both existing rail and HS2 passengers and accommodate spaces displaced through the removal of existing car parks. The footprint of the station could also accommodate passenger drop off and pick up facilities and taxi ranks.

4.7.25 The existing entrances to Piccadilly station from the station approach road and Fairfield Street would be retained. Our design work also incorporates the ability for passengers to transfer directly between the existing rail and HS2 concourses.

4.7.26 The station would be constructed in phases owing to the constrained nature of the site and to minimise disruption to existing services.

Figure 4.35 – Proposed Manchester Piccadilly station layout



Source: HS2 Ltd

Passenger access and dispersal

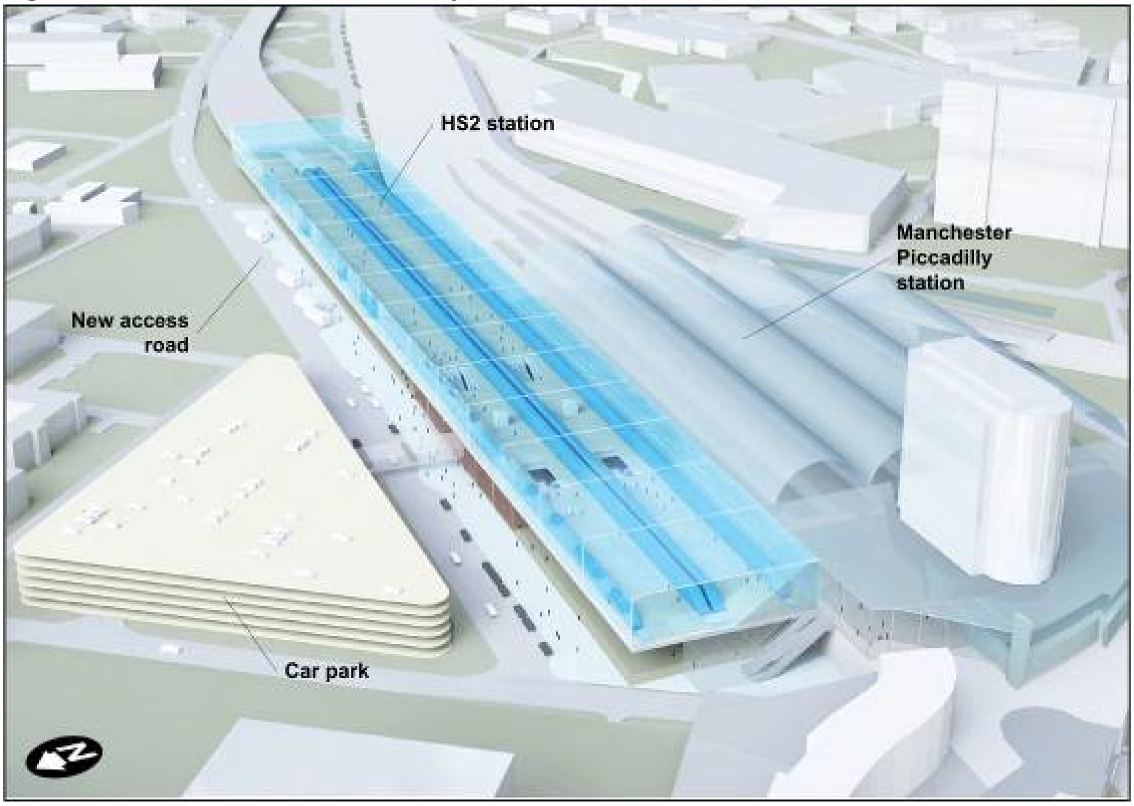
4.7.27 The site benefits from good connections to major highways including the ring road (Mancunian Way), existing Metrolink and bus services which would aid onward dispersal of passengers.

4.7.28 Piccadilly station is served by six train operating companies serving intercity routes to London Euston, Birmingham New Street, South Wales, the south coast of England, Edinburgh and Glasgow Central, as well as routes throughout northern England.

4.7.29 It serves as a terminus for Manchester Metrolink services to Bury, Altrincham, Eccles and MediaCityUK. An East Manchester Metrolink extension is under construction which will create a through station with new services through Piccadilly to Droylsden in Tameside. A further extension to Ashton-under-Lyne is planned to open by winter 2013/14.

4.7.30 Vehicular access from the inner ring road would be via a new spur off the Fairfield Street junction with the Mancunian Way. Traffic accessing the station would travel along a new access road, a realigned Sheffield Street, running in a one way system parallel to the HS2 station. Traffic connecting back onto the inner ring road would be via the top of Sheffield Street.

Figure 4.36 - Manchester Piccadilly indicative station illustration



Source: HS2 Ltd

Sustainability

4.7.31 The station would result in the demolition of an estimated 47 dwellings, all located in one building on Chapel Town Street. The proposed station development and route approach would fit well with the existing townscape in terms of height and scale. Although some views of the northern and southern facades of the existing station would be adversely affected, overall townscape impacts would be low. The setting of the Whitworth Street Conservation Area to the north, and to some extent the Stevenson Square Conservation Area to the west, would be affected. There would be a major adverse impact on the setting of the Grade II listed train shed at Piccadilly Station with an additional minor impact on the setting of the Grade II former goods office.

4.7.32 The new HS2 station would support local policies in the Core Strategy (Public Consultation version, 2011), including the development of the key Mayfield site. It would also encourage the development of an eastern gateway to the city and increase the density and quality of local development, thereby maximising the opportunities of Piccadilly station.[10]

[10] See Manchester City Council, *A strategic plan for Manchester city centre 2009-2012*, www.manchester.gov.uk/download/11683/city_centre_strategic_plan

4.7.33 The works would potentially displace businesses that provide an estimated 1,900 jobs. However, 29,700 jobs would be supported through development around the station generated as a result of HS2. There would be 3,100 housing units supported.

Salford Central Middlewood

Engineering

4.7.34 This station option would be situated directly west of Salford Central station on a brownfield site known as Middlewood Locks. The site is bounded to the north, south and east by the existing rail viaduct approaches to Salford Central station and to the west by Oldfield Road. The areas north of the site contain residential communities with light industrial structures occupying areas to the south and west. The area immediately west of the site is further bounded by the inner ring road and the River Irwell. A recently restored canal and locks, which form part of the Bolton Bury Canal, run in a north-west south-east orientation across the site, linking with the River Irwell via a chamber under the railway viaduct and the Manchester inner ring road.

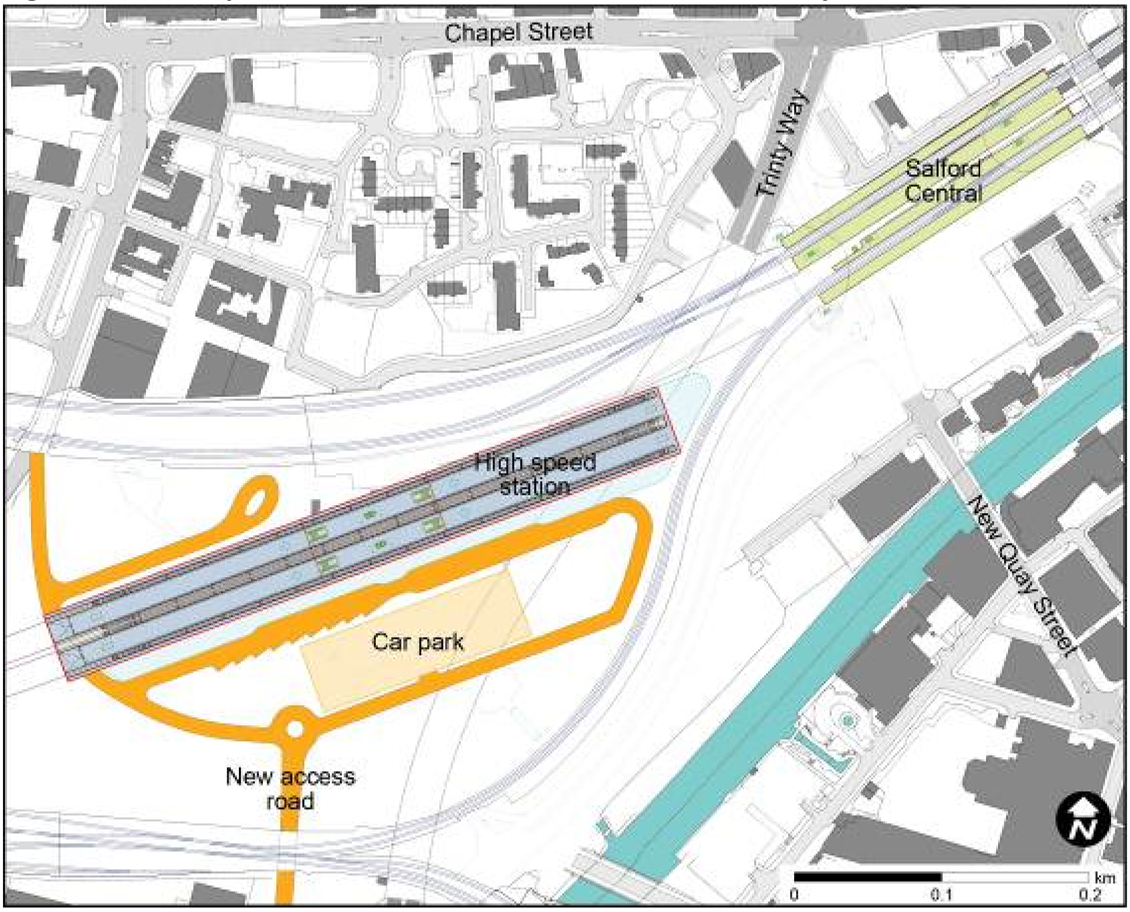
4.7.35 Salford Central station, which lies directly east of the site, consists of two platforms and two through running tracks. The platforms are elevated above the adjacent ground level. The concourse is located at ground level and faces onto New Bailey Street.

4.7.36 The HS2 station (figure 4.37) would require four platforms. In order to improve pedestrian connectivity between the site and the city centre it would be proposed to realign a section of the inner ring road in cut and cover tunnel through the site. Escalators and stairs would be located central to the platforms to aid passenger dispersal and filter passengers through one concourse area. HS2 concourse facilities would be located beneath the elevated platforms. The new multi-storey car park would be located directly opposite the concourse and would accommodate up to 1,500 cars.

4.7.37 Principal access to the station would be via the existing A6 Chapel Street to the north, the A34 Trinity Way, forming part of the Manchester inner ring road, to the east and the M602/A57 Regents Road to the south of the station site. Highway access to the proposed station site and adjacent multi-storey car park will be via a network of new access roads connecting the forecourt and multi-storey car park with the A5066 (Oldfield Road), for access to and from the A6; and Ordsall Lane, for access to the A34 and inner ring road, A57 and M602.

4.7.38 The station would be constructed in stages to minimise disruption to the existing railway.

Figure 4.37 – Proposed Salford Central Middlewood station layout



Source: HS2 Ltd

Passenger access and dispersal

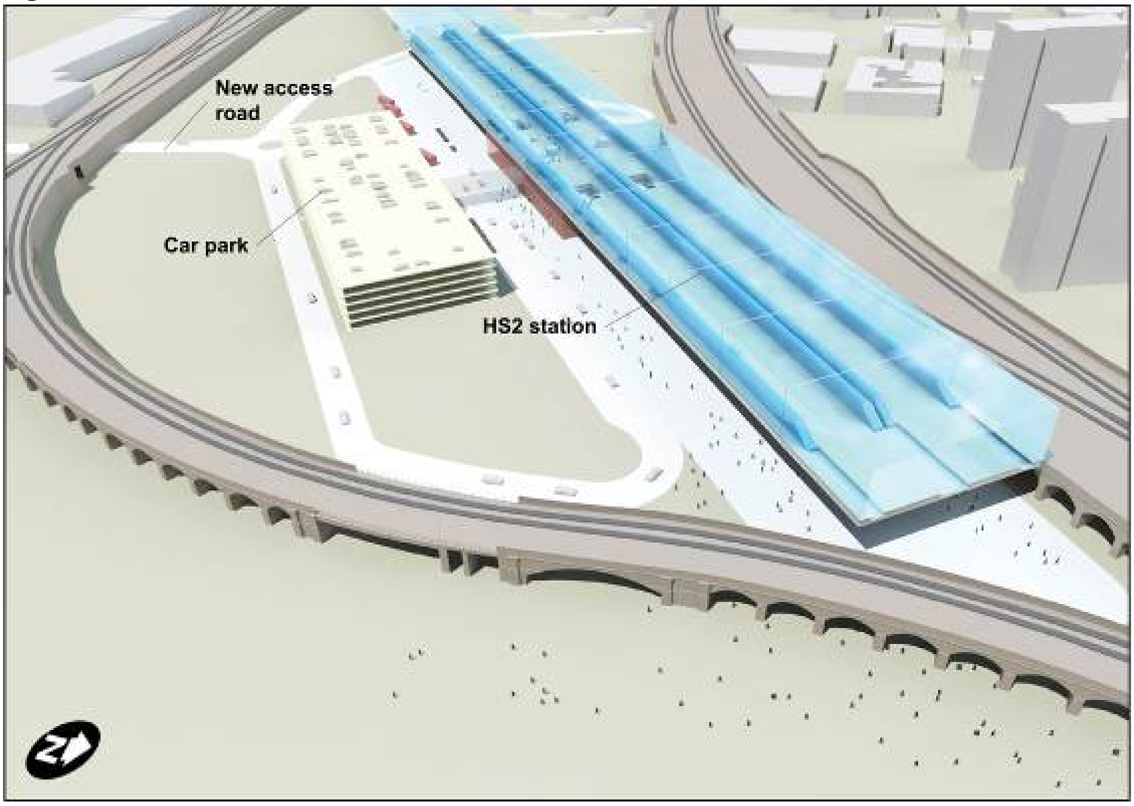
4.7.39 Salford Central station would be retained in its original configuration. Passengers would transfer between the HS2 and rail concourses using the covered area under the existing cast iron viaduct to the south side of the station. This would mean a walk of over 500m.

4.7.40 Consideration has also been given to a more direct transfer at the western end of the platforms which would utilise a new western entrance to the existing rail station as laid out in Salford City Council's masterplan for the station. This would reduce the transfer distance and walk time.

4.7.41 Salford Central provides regional services to the north and west and connects with Manchester Victoria station to the east. Future planned works as part of the proposed Northern Hub development (see text box 7) could include Salford Central station in the Manchester Loop via a new curve at Ordsall which would link Manchester Victoria, Manchester Piccadilly and Manchester Airport.

4.7.42 The site benefits from good connections to major highways but suffers from poor connections to existing Metrolink services and to Manchester city centre. It would also require minor re-routing of existing bus services to serve the HS2 station efficiently. The nearest Metrolink stop would be Deansgate which is approximately 15 minutes walk. There are frequent bus services along Chapel Street and passengers would be required to walk approximately five minutes to the nearest existing bus stops.

Figure 4.38 - Salford Central Middlewood indicative station illustration



Source: HS2 Ltd

Sustainability

4.7.43 The station and throat would result in the demolition of an estimated 225 dwellings of which 211 are within one apartment block on Middlewood Street. The station would have some visual intrusion on Middlewood Locks and may affect views from the high-rise development in Rodney Street. The Grade II former Royal Bank of Scotland building would be demolished and there would be a potential impact on the views and setting of the Grade I listed railway bridge.

4.7.44 The station would support the strategic growth of Greater Manchester due to its location within the core of the region. However, we noted the concerns of our delivery partners as described in text box 8.

4.7.45 It would encourage some growth and development at Salford as promoted by the Unitary Development Plan (June 2006)[11] and Core Strategy (pre-publication version 2011), but such growth may be constrained by the location south of Salford Centre with its limited links to Manchester. It would also remove the

[11] See Salford City Council, *City of Salford Unitary Development Plan 2004 – 2016,* http://www.salford.gov.uk/udp.htm

restored development of Middlewood Locks section of the disused Bolton and Bury canal. However, the station design would support proposals for a riverside park by relocating Trinity Way.

4.7.46 The local authority has secured outline planning consent for a masterplan to redevelop Salford city centre. The station footprint would conflict with some uses identified in this outline planning consent. However, there would be potential to incorporate the station into the masterplan design. The station footprint would also conflict with approval for the redevelopment and change of use of the former Brown Brothers building into a hotel.

4.7.47 The works would potentially displace businesses which provide an estimated 100 jobs. However, 13,600 jobs would be supported through development around the station. There would be 2,100 housing units supported.

8. Salford Central options – delivery partner views on impacts on development

Both Manchester and Salford City Councils supported us in our development of city centre station options. Whilst they support HS2 generally and the inclusion of a station in the heart of Manchester, they expressed significant concerns around the Salford Central options.

Although the blight effects of the Salford Middlewood option would be less, both Manchester City Council and Salford City Council felt that either station site running in a west-east direction might sever those parts of central Salford north of the station from the main areas of economic activity in central Manchester/Salford. This would act against the drive to develop the area joining the two cities.

Both councils recognised the fact that the option at Piccadilly would support development in the heart of Manchester as our analysis shows.

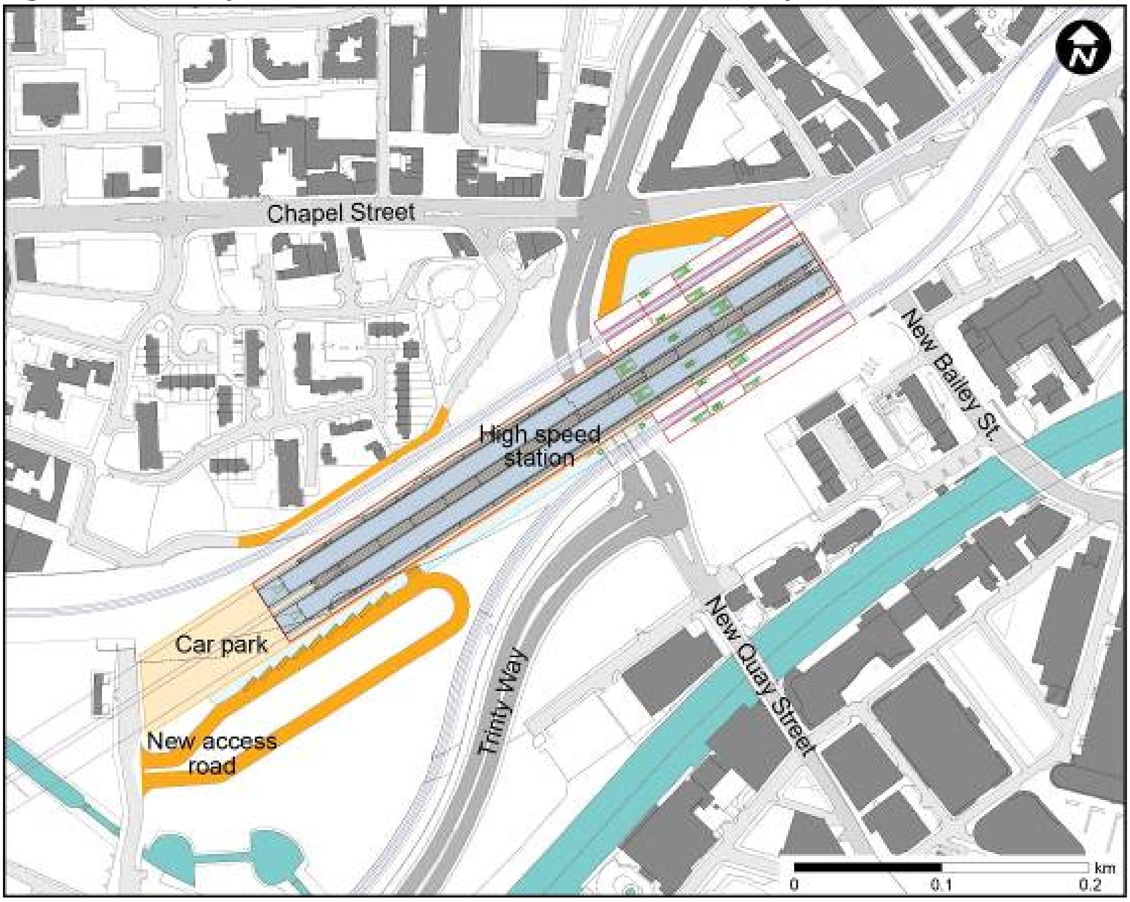
Salford central combined

Engineering

4.7.48 This station would be situated on the footprint of the existing Salford Central station which would create a combined HS2 and rail interchange station.

4.7.49 Salford Central station consists of two platforms and two through running tracks. The platforms are elevated above the adjacent ground level. The concourse is located at ground level and faces onto New Bailey Street.

Figure 4.39 – Proposed Salford Central combined station layout



Source: HS2 Ltd

4.7.50 The proposed station arrangement would deliver four HS2 platforms and either two or four rail platforms (dependent on Northern Hub plans). The existing rail platforms would be split into two to the north and two to the south with the HS2 platforms in between. Accommodating these four HS2 platforms would require the relocation of the eastbound and westbound Salford lines onto a new viaduct to the north of their current location. This in turn would necessitate a number of demolitions, including a section of the existing brick arched viaduct.

4.7.51 A new combined HS2 and rail concourse facility would be located at grade beneath the elevated platforms and to the east side of Trinity Way. The route between concourse and platforms would be via stairs, escalators and lifts through the platforms. Temporary concourse facilities would be required for Salford Central station in the intervening time between demolition of the existing concourse and completion of the new concourse.

4.7.52 A new multi-storey car park would be located underneath the platforms to the east side of Trinity Way and would accommodate up to 1,500 cars. The route between the concourse and the car park across Trinity Way would be facilitated by means of a new pedestrian footbridge and associated passenger lifts.

4.7.53 The station and its associated car park would be located on either side of the Manchester inner ring road. Highway access would be principally from the A6

Chapel Street at the existing junction with New Bailey Street and to the proposed car park via a network of new access roads.

4.7.54 Onward pedestrian travel from the concourse to the city centre would be along New Bailey Street which offers a direct route into the city centre. The existing Salford Central station access would be modified to provide the station forecourt, drop off parking and taxi ranks.

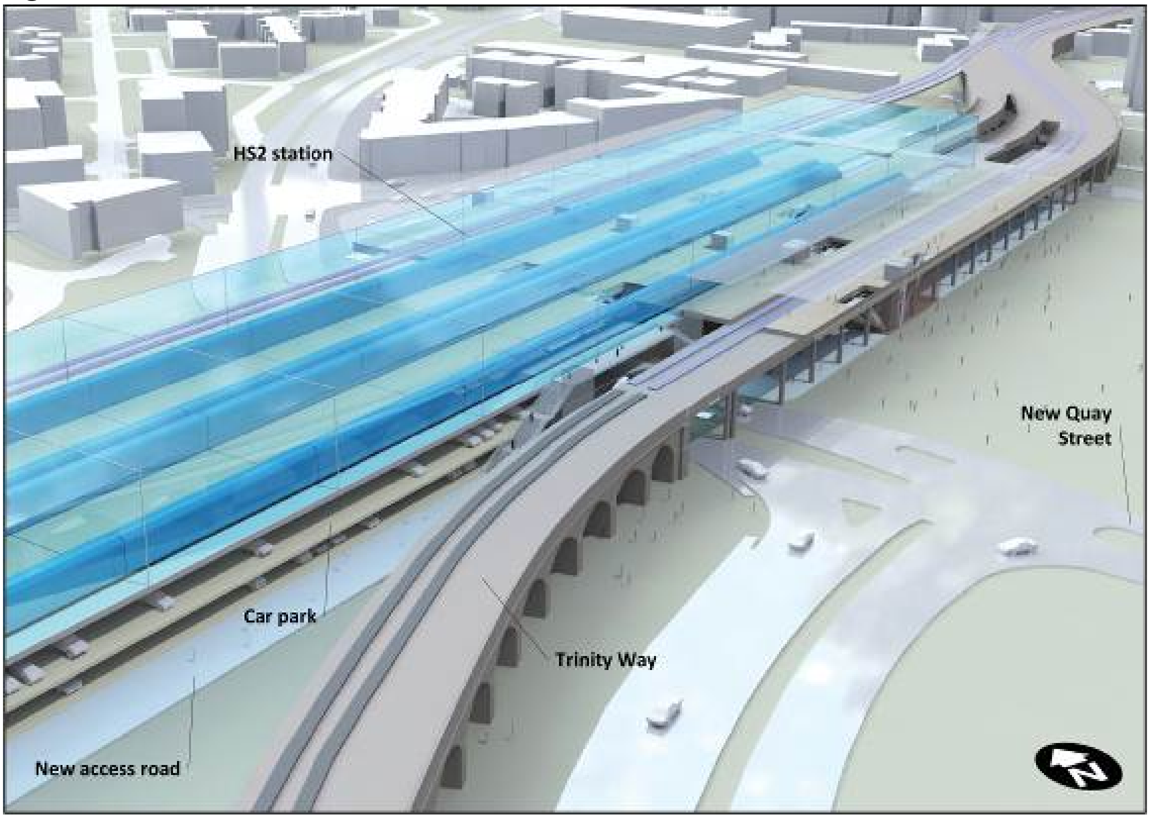
4.7.55 The station would be constructed in phases to minimise disruption to the existing railway and surrounding communities.

Passenger access and dispersal

4.7.56 This option would offer better interchange with Salford Central Station than the Middlewood option. The same benefits of connecting to regional services as outlined above for the Middlewood option could be gained from this option, but the walk time between platforms would be shorter.

4.7.57 The site benefits from good connections to major highways and local bus services. Metrolink services do not currently extend as far as Salford. The nearest Metrolink stop is Deansgate which is approximately 15 minutes walk. There are frequent bus services along Chapel Street directly north of the station.

Figure 4.40 – Salford Central combined indicative station illustration



Source: HS2 Ltd

Sustainability

4.7.58 This station and throat would result in the demolition of an estimated 363 residential dwellings located on Rodney Street, Chapel Street and Middlewood Street. The station would adversely affect views from high rise flats in Rodney Street and the adjacent conservation areas and impact the historic townscape character. As with Salford Middlewood, our delivery partners expressed concern about the impact of this option on development which is described in text box 8.

4.7.59 Chapel Street Hope and United Reform Church and the Chester's Salford Brewery, both Grade II listed buildings, would be demolished.

4.7.60 The station would support the strategic growth of Greater Manchester due to its location within the core of the region. The UDP (June 2006) and Core Strategy (pre-publication version 2011) set out a framework for high residential growth and large scale office development around the station. Salford City Council has outlined approval for a Salford Central masterplan, which aims to stimulate growth and regeneration of the area.

4.7.61 Although the station location would conflict with some uses identified in the outline approval for the masterplan, HS2 would support these policies and aspirations, provided care is taken to integrate the new station development with this masterplan led approach. It would also conflict with approval for the redevelopment and change of use of the former Brown Brothers building into a hotel.

4.7.62 The works would potentially displace businesses which provide an estimated 500 jobs. However, 20,000 jobs would be supported through development around the station. There would be 2,900 housing units supported.

4.7.63 Salford City Council's concern for the Salford Central Combined option was around the impact on existing communities surrounding the station, and also on the impact on adjoining development areas. Their view was that a station there would blight development sites in the Salford Central regeneration area which are earmarked for development within the next decade, and which are critical to the success of the overall development of the central Salford area.

Demand

4.7.64 In the introduction to this section we described the potential additional benefit that a proposed HS2 station at Manchester Piccadilly would have. This translates into a benefit of around £900 million (in present value terms - PV) resulting from its connectivity to the wider region and additional revenue of around £750 million (PV) compared to the HS2 station option at Salford Central. This reflects the poorer connectivity of the station at Salford and the loss of some of the south Manchester markets due to the additional time to cross Manchester city centre.

4.7.65 The scale of benefits that the HS2 station at Manchester Piccadilly would provide would therefore outweigh the marginally higher cost of the approach, assuming the lowest cost option of the Mersey and tunnel described in the previous section.

4.7.66 The alternative site at Salford Middlewood would result in a further loss of benefits resulting from the additional walk time to the existing rail station at Salford Central.

4.7.67 Our demand analysis was supported and enhanced by the separate analysis carried out by Transport for Greater Manchester (TfGM) and which is described in text box 9.

9. Transport for Greater Manchester's work on city centre options

TfGM worked with us throughout the option development and sifting process for city centre and interchange stations. Like delivery partners in other locations, it provided a useful challenge to our work and offered expertise and detailed knowledge of the area.

TfGM carried out extensive work on the access to the station sites in Manchester and Salford using its own urban transport modelling. This modelling provided us with a more detailed picture of projected trips between the proposed station sites and people's end destinations in the city centre and conurbation. This work led to a better understanding of the proposed station sites and we integrated it into our work on station benefits, described in the demand section.

TfGM also did their own work on the regional economic benefits of the three city centre station options. It differed in methodology from ours but the results were very much in line with our own work, with the greatest economic benefits coming from a station site at Manchester Piccadilly.

The headline results of their work are below:

- Providing HS2 services at Manchester Piccadilly could generate almost 13,000 jobs for Greater Manchester and 8,000 for the north of England as a whole.

- Providing HS2 services at either of the Salford Central station options would dampen the long term economic potential of HS2 for Greater Manchester and the north of England – generating between 2,700 – 5,500 fewer jobs for Greater Manchester.

- This would result in a failure to secure up to £300 million of GVA for Greater Manchester and up to £80 million of GVA across the north of England as a whole.

We have submitted their full report to Government alongside this report.

Manchester city centre stations: Section summary

4.7.68 In this section we described our three final options for a Manchester city centre station. Considering our key criteria, a HS2 station at Manchester Piccadilly would offer very good connectivity owing to its excellent public transport links. The direct interchange with the existing railway allows the wider region to be captured. This includes some of the market that would be attracted to an additional interchange station at Manchester Airport which is an important part of our evaluation of interchange options described in the following section. Whilst we have explored ways in which connectivity would work for the two Salford options, public transport access would be poorer and require additional works.

4.7.69 Throughout our work we have noted the contribution that a HS2 station can make to regeneration of cities and regions. We therefore saw the potential benefit that a HS2 station could bring to Salford. However, we also noted and described above the concerns expressed by our delivery partners about the potential negative impact that the long term development of a HS2 station might have on their existing development plans.

4.7.70 The numbers of potential demolitions are also a significant issue. Whilst future design work may reduce the impact of the proposed HS2 station, the numbers would be significantly higher for the two Salford options than for the Manchester Piccadilly option.

4.7.71 As a result of its connectivity and transport links, a HS2 station at Manchester Piccadilly offers the best potential benefits and revenue. Whilst the station and approach combined would be marginally more expensive to construct than the two Salford options, the additional expense would be significantly outweighed by the benefits it would deliver. The assessment of the benefits and revenue of the station option at Manchester Piccadilly were further evidenced in the work that TfGM did and which we described above.

4.8 Interchange station options in the Manchester area

Introduction

4.8.1 Our remit includes the consideration of providing access to major airports in the regions served by the Y network. Manchester Airport is a major airport and our consideration of how access might be provided to it has focussed on options for an interchange station in the vicinity. Given that a station works best when it links well with the road network, public transport and the airport facilities, we investigated options which would provide maximum connectivity.

4.8.2 Interchange stations on the outskirts of major conurbations can offer additional benefits to those of a central terminal. Phase one of HS2 will include a station in central Birmingham and a station on the outskirts that provides an interchange with Birmingham Airport and Birmingham International station via a personal rapid transit system. In this case, the interchange station serves an additional market.

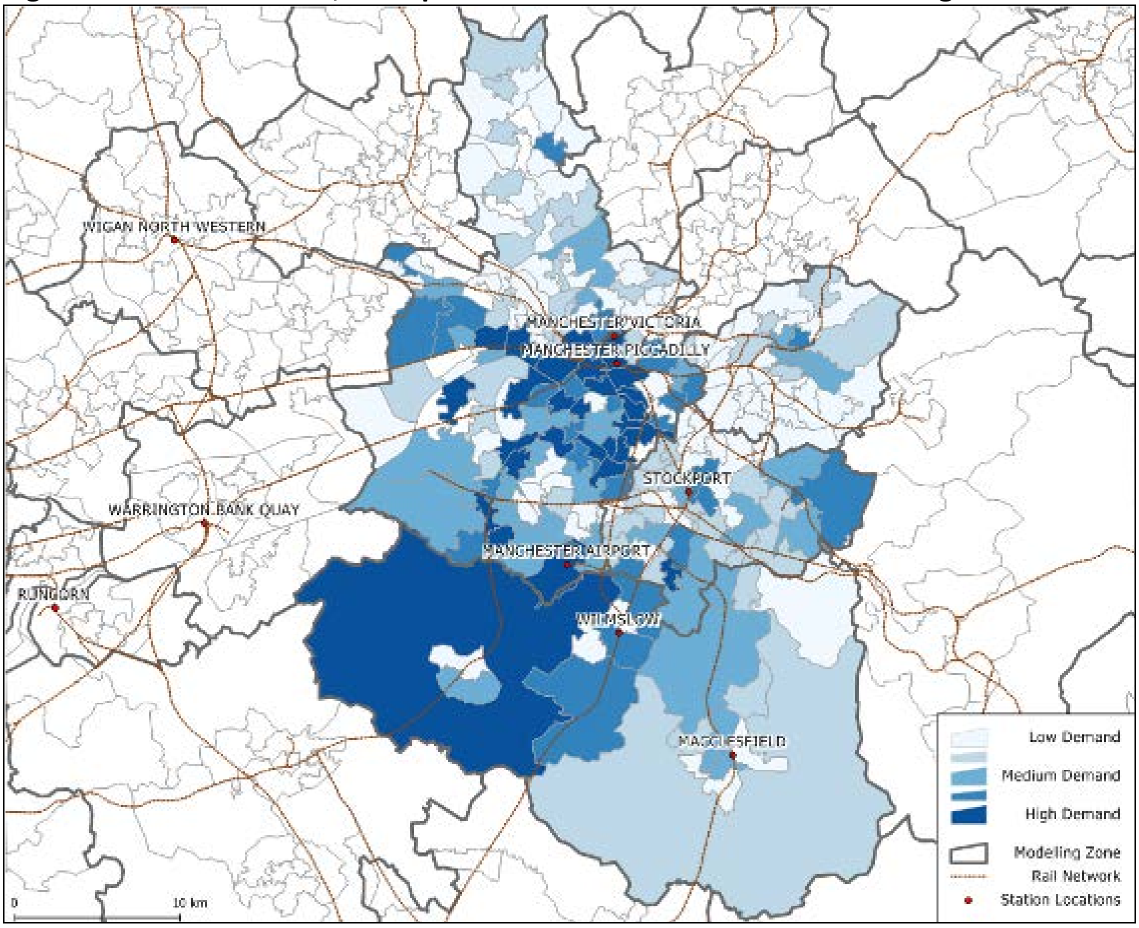
4.8.3 On the Manchester leg we have developed options that would serve Manchester Airport and a wider set of options for an interchange type station in the area in and around Greater Manchester. We present the options with their costs and benefits and assume that an interchange station would only be included in a Y network proposition if it provides a net benefit to the scheme when the additional cost is also taken into account. In any case, this would be an additional cost over the £33 billion cost envelope for the Y network. Accordingly the process for determining the interchange station options presented has been driven by demand for such a station. We describe how demand drives our station options below.

Demand and benefits to passengers

4.8.4 An interchange station on the outskirts of Manchester would give the benefit of time savings for passengers from the Manchester area. It would provide an alternative location to the city centre which would be either more accessible or would provide a better overall journey time than the city centre for a proportion of the total Manchester market. An interchange station would mean that services which stopped there would take longer to reach the city centre station.

4.8.5 The location of the Manchester city centre station has an impact on whether an interchange station would increase overall demand for HS2. An interchange station in addition to a station near Salford Central would increase demand from the lower level of the city centre alone. However, an interchange station in addition to a station near Piccadilly would not increase overall demand for HS2; instead it would re-distribute it.

Figure 4.41 - Manchester, Stockport and Macclesfield - demand for long distance travel



Source: HS2 Ltd

4.8.6 Figure 4.41 depicts the primary catchment area for demand for services to London and the South East. A key consideration in determining the optimum location for a Manchester interchange station is the relative access times from the key target markets of south Manchester, Trafford, Stockport and north Cheshire. A station located towards the northern extent of this catchment offers much better access to the core market than one further south at a location such as Knutsford. Indeed, a location as far south as Knutsford would significantly reduce the size of the market that benefits from an interchange station. However, we explored options in this area as there would be benefits from connectivity to the M6 and access from different route combinations.

4.8.7 Modelling has shown that there is a trade-off between access times and reduced on-train times. This would result in more of the south Manchester market choosing to access high speed services at a Manchester city centre station, particularly if located at Piccadilly, rather than using the existing classic services to London from a location such as Stockport. As such, locations for an interchange station closer to Manchester Airport would be expected to perform better than one further removed to the south-west, such as the Knutsford options, where the access time would be great enough to make the central Manchester station preferable. This combined with the 'time penalty' derived from introducing an additional stop on the way to Manchester city centre, would mean that the two Knutsford options give a reduction in benefits to the economic case.

4.8.8 We now describe our analysis of interchange options describing the sifting process that we went through culminating in a number of final options which we describe in detail. In text box 10 we set out some of the route constraints and opportunities that were considered in appraising the location of a station in the Manchester Airport area.

10. Route and station options in the Manchester Airport area

Here we explain why our route and station options pass by Manchester Airport in the way that they do. The passenger terminal area would be the ideal location for an interchange station because it would be directly connected with the existing railway serving the Airport and would provide a direct interchange for Airport passengers.

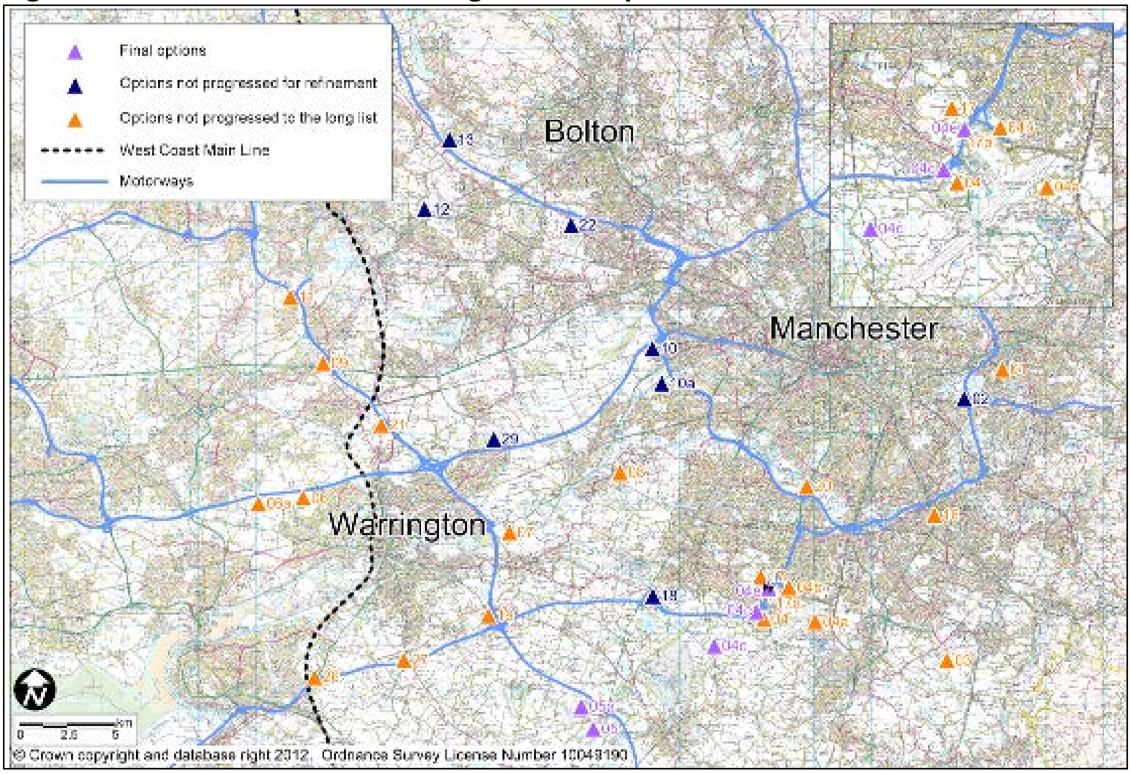
Manchester Airport terminal, however, is located to the east of the wider Airport area, which is the other side from where any of our final route options would run. However, it is not possible to run a route through or immediately adjacent to the terminal area of Manchester Airport. This is because it would not be feasible to tunnel under the whole Airport area and build an underground station, nor would it be feasible to demolish parts of the Airport infrastructure. In addition, we have also attempted to:

- avoid demolition of properties in the Mobberley Conservation Area just south of the runway;
- avoid the Airport runway and the surrounding public safety area;
- avoid the Airport strategic site extension areas as part of Manchester City Council's core strategy; and
- achieve a level and flat location for locating any station box and the associated track work in order to follow the tunnelled approach to Manchester Piccadilly.

The generation of initial ideas and the sifting down to a long list

4.8.9 We started by identifying options within a very wide catchment area independently of the route options work. A working group of Manchester interchange delivery partners assisted us in option generation, particularly in terms of suggesting sites. These were sites identified locally as strategic development areas i.e. those that would benefit from investments that might catalyse associated development. Naturally, many of these sites did not correspond to the route options being progressed by us internally in parallel. Figure 4.42 shows the range of options considered as initial ideas and the stage at which options were no longer progressed. Table 4.2 below explains the reasons why options were not progressed to the long list.

Figure 4.42 - Manchester interchange station options



Source: HS2 Ltd

Table 4.2 - Manchester interchange station option not progressed to the long list

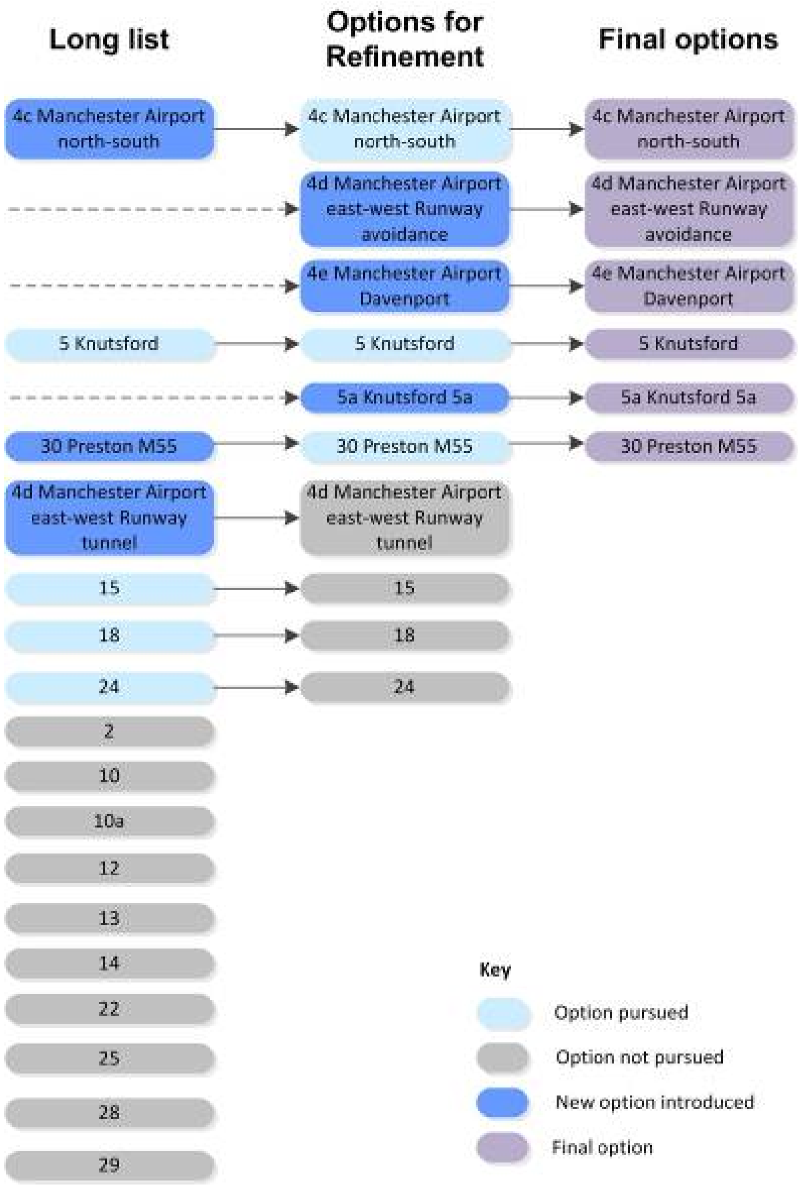
Unique identifier	Name	Main reasons for parking at this stage
1	Guide Bridge	Construction complexity Significant cost
3	Woodford	Not nearby/no longer nearby route option
4	Manchester Airport west	More favourable nearby option was created/optimised
4A	Manchester Airport south-east	
4B	Manchester Airport north-east	
6	Omega	Not nearby/no longer nearby route option
6A	M62 Junction 7	
7	Thelwall	
8	Carrington	Poor connectivity
9	Ashton-in-Makerfield	Not nearby/no longer nearby route option
11	Wigan Junction 25	
16	M60 Gateway	
17	Davenport Green	More favourable nearby option was created/optimised
17A	Davenport Green south	
19	Lymm	Not nearby/no longer nearby route option
20	Sale	Construction complexity Significant cost
21	Parkside	Not nearby/no longer nearby route option
23	Whitebirk	
26	Daresbury	
27	Stretton	

Source: HS2 Ltd

The creation of a short list

4.8.10 Further work was undertaken on the long listed options, including a fuller appraisal of sustainability considerations. However, given that the sifting of route options continued in parallel, the development of an appropriate line of route continued to be a key driver for sifting out options at this stage. In addition, options that clearly performed less favourably than other options on the same routes were not progressed. Figure 4.43 sets out the options presented at each stage of the refinement process, detailing how these progressed to the final set of options.

Figure 4.43 – Manchester interchange station long list to final options



Source: HS2 Ltd

4.8.11 In the sifting process, options Options 2 (Denton),10 (Barton), 13 (Horwich), 14 (Euxton), 22 (Cutacre), 25 (Cuerton) and 28 (Whittingham) were not progressed as the route options that they would be served by were not taken forward. Option 10a (Port Salford) was not progressed because it would not be feasible to construct a station at a height of 28m, which the route option would be at this location. Option 12 (Wigan East) was not progressed because the nearest route option associated to the station would be in tunnel thereby substantially increasing construction costs. Option 29 (Risley) was not progressed because it was found to be on the site of a landfill and would have very high associated costs and risk.

4.8.12 An additional variant to option 4d (Airport east-west) was introduced which would be situated to the south of the runway at Manchester Airport and be on a route option that was being developed through this area.

Selecting options for refinement

4.8.13 Seven options remained in the process, resulting from the long list sifting stage. These options were developed to a further level of detail. The sifting at this stage focussed more on the individual merits of each option. Option 18 (Altrincham south) was not progressed as it would increase the expected impacts around Rostherne Mere (an international ecology designation) and on a planned highway scheme. The route that original options 15 (Preston M61) and 24 (Samlesbuty) would have been on was not progressed at this point and hence these options were also not progressed. Option 4d (Manchester airport east-west Runway tunnel) was discounted due to the station alignment being in tunnel to avoid Manchester airport runway. Three options therefore progressed from this stage: 4c (Manchester Airport north-south), 5 (Knutsford) and 30 (Preston M55).

4.8.14 In addition, at this stage option 4e (Manchester Airport Davenport) was created to serve a new route to Manchester via a tunnel. Option 5a (near Knutsford) was created to serve the second route that would pass through this area on a slightly different path to the route that option 5 (near Knutsford) would serve. Finally, a variant of option 4d (Manchester airport east-west Runway tunnel) was generated. These six options were developed to a final level of detail and are set out in turn below.

Developing and finalising our options

4.8.15 In understanding more about the sustainability and engineering challenges in the Manchester area, the route options were refined at this point. This opened up opportunity for further interchange station options that would then be served by these altered routes.

Final interchange station options

Manchester Airport Davenport Green (option 4e)

Location and route option

4.8.16 This interchange option would provide a connection to Manchester Airport and would lie on the Airport and south Manchester tunnelled approach option accessible to all three main proposed route options from Crewe/Sandbach, but only if the terminating station in Manchester was at Piccadilly. Given that it would be on the Airport and south Manchester tunnelled approach, the cost of serving the station (not including the station cost itself) would add around £180 million compared to the alternative, lower cost approach (Mersey and tunnel), to a Piccadilly Station. Trains would not be able to call at this station before heading north on the through route to the WCML connection, as is possible with the Knutsford options for example.

4.8.17 The location, shown in figure 4.42 above and in more detail in figure 4.44, is to the west of, and parallel to the M56, approximately half way between Junctions 5 and 6. Manchester Airport is situated approximately half a mile (1km) away to the south-east of the site, immediately on the opposite side of the M56. The residential area of Hale Barns lies to the south-west of this site, mainly to the opposite side of the A538. This option is the closest to the Airport out of a number of locations in the area that we explored.

Figure 4.44 – Proposed Manchester Airport Davenport Green interchange station option

Source: HS2 Ltd

Engineering

4.8.18 The Airport and south Manchester tunnel approach would be aligned north-south mostly parallel to the M56 at this point after crossing underneath it approximately half a mile (1km) to the south in a cutting. The route would remain in cutting as it approached the site of the station and remain below surface underneath a ground level station before diving down into tunnel approximately half a mile (1km) north of the station.

4.8.19 The station would have one central platform to serve the two lines to stop at the station (to and from Manchester city centre); the two 'through' lines would be located on either side of the station stopping lines. All lines and platforms would be below surface level. The concourse facilities for the HS2 station would be at surface, above the platform.

4.8.20 A four storey car park for up to 3,000 cars would be constructed adjacent to the southern half of the platforms to the west. The station would be accessed from all highway routes via a new stretch of road extending from a new roundabout on the opposite side of the M56 built into an existing road. This would connect to an improved Junction 6 in one direction and the Airport in the other. The access road would cross over the M56 on a bridge and link to the station car park via a bridge over the high speed route in cutting and also continue in front of the station concourse entrance. It would loop around past this point to provide drop-off/pick-up functionality.

4.8.21 The option would include the possibility of providing a people mover system between the station concourse and the Manchester Airport main terminal area, including the classic rail station. If a people mover system was not constructed, connection to the Airport terminals and the classic rail station could be provided by a lower cost dedicated and frequent bus service. If the Government wishes to consider the potential merits of Manchester Airport Davenport Green further, we would engage with delivery partners about how best to connect this option with the Airport.

4.8.22 The Manchester Airport Davenport Green option and all necessary supporting infrastructure would be the lowest cost of the five options that we have developed to this final stage, at approximately £200 million subject to a full appraisal of costs which would be undertaken if the Government decides to progress this option.

Sustainability

4.8.23 As with the development of all station options, we have involved delivery partners at every stage. If this option were to be developed further we would need to continue working with organisations such as the Highways Agency and local authorities in the area to minimise any disruption to roads during construction and any additional congestion (including on motorways) that might be caused once the station was operational.

4.8.24 Development proposals on and surrounding the Airport site are in progress (including "Airport City") and this option would be complementary to such proposals. We estimate that 300 jobs could be supported by a station in this location.

4.8.25 In addition to the sustainability implications of the Airport and south Manchester tunnel approach which are set out in section 4.6, the station option would involve the loss of some Green Belt land. At this stage of development (with more detailed design expected to reduce impacts) the direct impacts expected would include a moderate visual impact to residential areas nearby. Three demolitions of dwellings would potentially be required for the station and its related infrastructure.

11. Transport for Greater Manchester's work on interchange options

In addition to its work on city centre stations, described above, TfGM also carried out work on the regional economic benefits of interchange options. Again, their work differed in methodology to ours. This box outlines the findings of its work.

The work suggests that all the interchange options would be expected to deliver substantial economic benefits to Greater Manchester and the north of England, building upon a HS2 baseline net impact of 13,000 jobs for Greater Manchester and 8,000 for the north of England as set out in text box 9 on city centre analysis.

The work suggests that the substantial inter-urban connectivity benefits for south Manchester and Manchester Airport significantly outweigh the disadvantages of slightly slower journey times to central Manchester.

The underlying assumptions about the scale of development of the Airport City development matter hugely in TfGM's analysis, with the full allowance for the forecast potential of Airport City substantially improving the case for stopping near the Airport.

When TfGM included the additional benefits of connectivity to an international gateway, the overall incremental impact on Greater Manchester's long term economic potential exceeds 10,000 jobs. This is equivalent to broadly 50% of the total forecast impact of the £1.5 billion Transport Fund programme.

We have submitted their full report to Government.

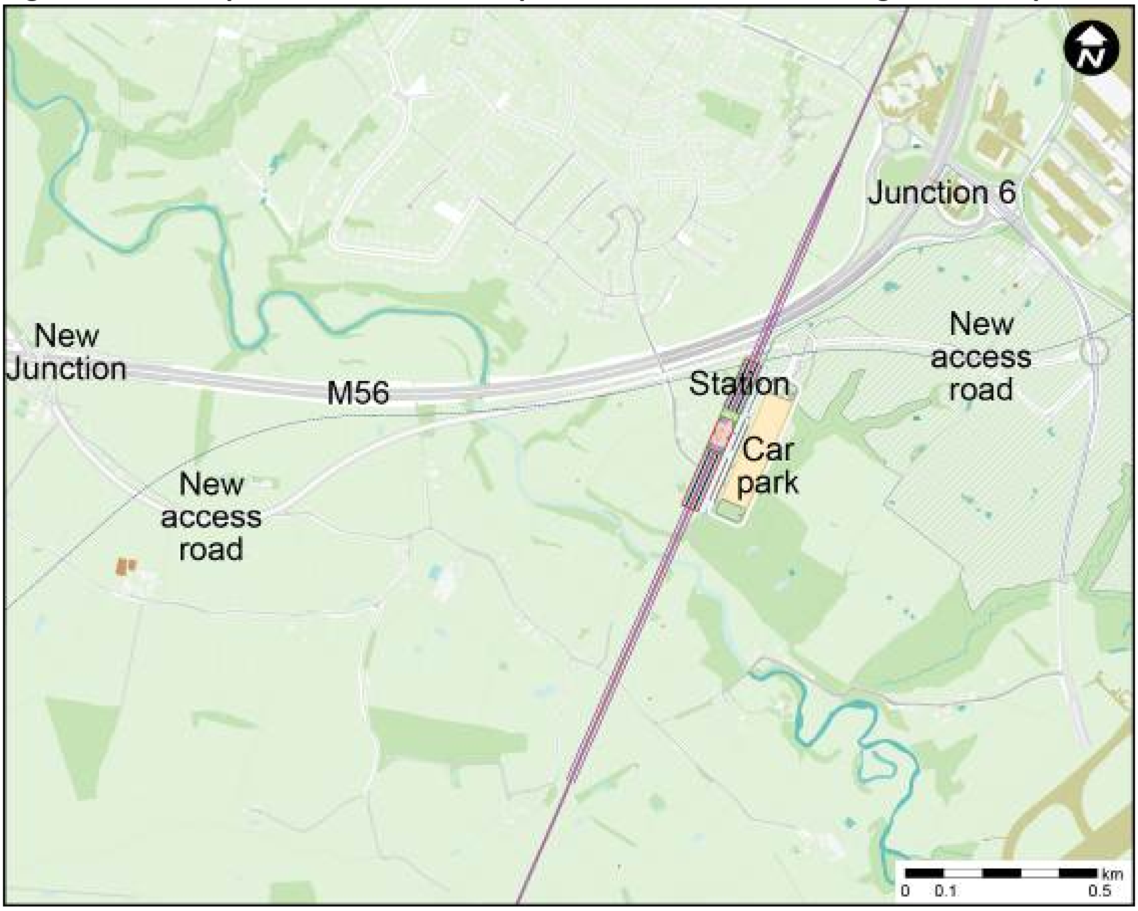
Manchester Airport north-south (option 4c)

Location and route option

4.8.26 This interchange station option would provide a link to Manchester Airport. It would lie on the Airport and south Manchester tunnel approach and would therefore only connect to the city centre station option at Piccadilly. It should be noted that this is not the lowest cost option for the approach to Manchester Piccadilly. All three main routes from Crewe/Sandbach could serve this station as they all connect to the approach route, however, trains would not be able to call at this station before heading north on the through route to the WCML connection.

4.8.27 This option would be located 1.2 miles (2km) to the south-west of the Manchester Airport terminal area, just to the south-west of Junction 6 of the M56. The option would be aligned in a north-easterly direction. The settlement of Hale Barns would be to the north of the site, on the other side of the M56. The location can be seen in figure 4.42 and at a more local level in figure 4.45.

Figure 4.45 – Proposed Manchester Airport north-south interchange station option



Source: HS2 Ltd

Engineering

4.8.28 As the Airport and south Manchester tunnel approach would be at this point, the station would be constructed in a cutting, with the platforms approximately 10m below ground. The station would have two side platforms for the "stopping" lines with the "through" lines running through the centre; the footprint of the building would be approximately 415m by 45m. The concourse would be at ground level and a four storey car park would be located to the east of the station, providing up to 3,000 spaces, all of which would be above ground.

4.8.29 The site and car park would have good access to the road network. A new junction would need to be constructed to the west of Junction 6 of the M56 in order to accommodate the increased traffic. A new road would then be constructed to link between the station and the new junction. This link could be used by existing bus services. The station would increase traffic on the M56 to the extent that the capacity of the M56 would need to be increased. A connection to the existing rail network does not exist at the site. The nearest existing station would be Ashley at 1.6 miles (2.6km) away followed by the existing Airport station at a greater distance.

4.8.30 A connection to Manchester Airport is proposed via a people mover system, as with the Davenport Green option described above. Alternatively, a classic rail connection from the nearby Chester to Altrincham railway line to the existing Airport station could stop at the site of the interchange station, if such a connection were to be built. We have not proposed a design for this or included it within our costs, but if this link were to be built it would provide an efficient mode of transit to classic rail and to the Airport. The Manchester Airport north-south option would cost approximately £100 million more to build than the Manchester Airport Davenport Green option.

Sustainability

4.8.31 The proposed location is in Green Belt; however it is immediately to the west of the proposed extension areas of the Airport Development Area shown in Manchester City Council's draft core strategy (also known as Airport City in other plans), which is identified for release from Green Belt. The station would also support the Enterprise Zone status of the Airport. We estimate that 600 jobs would be supported by a station at this location.

4.8.32 Approximately nine demolitions of dwellings would be required for the construction of the station and its related infrastructure, plus a Grade II listed building (Yew Tree House). Due to the relatively flat nature of the surrounding area, the station at ground level and the four storey car park would mean visual impact for those living in the Halebank area, but this is in context of the station being the other side of the motorway from the settlement. The station and its associated infrastructure would impact on Sunbank Wood, which is an ancient woodland and BAP habitat. The four tracks required to accommodate the station would impact on a small area of Flood Zone 3 (land with a high probability of flooding).

Manchester Airport east-west (option 4d)

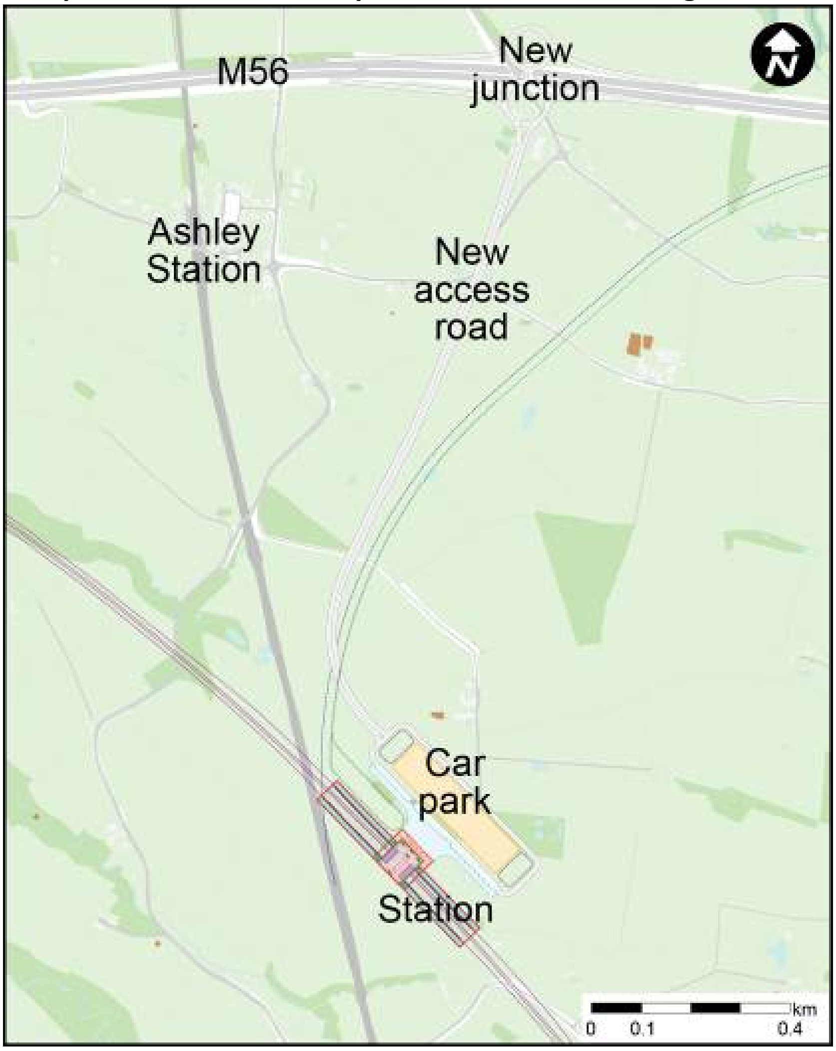
Location and route option

4.8.33 This interchange station option would provide a link to Manchester Airport. It would lie on the Sandbach to Golborne Airport route. Trains could call here before serving Manchester city centre or before heading northwards to connect with the WCML. The other two main route options north of Crewe/Sandbach could not serve this station option. The Mersey and tunnel approach would be used after calling at this option to access a station near Manchester Piccadilly. Either of the approaches to a Salford station could also be used.

4.8.34 The station would be located adjacent to the existing Chester to Altrincham railway line, approximately one mile (1.5km) south of the M56 and 2.5 miles

(4km) to the south-west of the Manchester Airport terminal area. The village of Ashley would lie approximately half a mile (1km) to the north, on the same side of the M56 and New Mills approximately half a mile (1km) to the south. The station would be aligned in a north-westerly direction and would need to be elevated approximately 3m above ground level. The location can be seen in Figure 4.42 above and at a more local level in Figure 4.46 below.

Figure 4.46 – Proposed Manchester Airport east-west interchange station option



Source: HS2 Ltd

Engineering

4.8.35 The station concourse would be at surface level underneath the platforms and tracks, however a crossover between platforms would be required above the platform level as well. The distance between the concourse and terminal one at the Airport would be approximately 4.4 miles (7km). A car park to the east of the station would provide space for up to 3,000 cars across four floors, all of which would be above ground.

4.8.36 To provide access to the road network a new motorway junction would need to be constructed to the west of Junction 6 of the M56 in order to accommodate the increased traffic. A new road would then be constructed approximately one mile (1.4km) to link between the station and the new junction. Bus services currently do not run on the M56, therefore a new service would need to be introduced to serve the station. Peak flows to the station would increase traffic on the M56 to the extent that the capacity of the M56 would need to be increased.

4.8.37 A connection to Manchester Airport is proposed via a people mover system, as with the two above options. Alternatively, a classic rail spur from the Chester to Altrincham railway line just south of this site, connecting to the existing Airport station could serve this interchange station, if such a connection were to be built. We have not proposed a design for this or included it within our costs, but if this link were to be built it would provide an efficient mode of transit to classic rail and to the Airport, being a shorter distance than a people mover. The Manchester Airport east-west option would be the most expensive of the five interchange options to the south of Manchester, significantly more expensive than the Manchester Airport Davenport Green option.

Sustainability

4.8.38 The site is a greenfield site within the Green Belt. Eleven dwellings would likely be demolished as a result of the station and surrounding infrastructure. A Grade II listed structure would need to be demolished. Given the Green Belt location and distance from the Enterprise Zone around the Airport, this option is unlikely to support associated developments and job creation.

4.8.39 Given the elevated nature of the station, it would impact on views from the surrounding hamlets and countryside which is relatively flat. In addition, the beginning of the section of four tracked route approaching the station from the south would be within the Mobberley Conservation Area. The option would directly affect two ancient woodlands, which are also wet woodland BAP habitats – Arden House Wood and Hancocks Bank.

Knutsford - Sandbach to Golborne M6 route (option 5) and Knutsford - Crewe to Golborne western route (option 5a)

4.8.40 To the west of Knutsford, which is south-west of Manchester, we have developed two options for a station in close proximity to one another and to Junction 19 of the M6. The two options have been developed in one area because of the two different main route options that would pass through this area heading in slightly different directions and passing over a slightly different piece of land. In this section we set out the two separate locations and routes that these would serve. The design and engineering of both options would be very similar, so we deal with both options at the same time when describing these aspects of the station options.

Locations and route options

4.8.41 Option 5 would lie on the Sandbach to Golborne M6 route. Option 5a would lie on the Crewe to Golborne western route. Services heading into any station option in Manchester, via any of the approaches or heading northwards to the WCML would be able to call at both options. This would include any classic compatible services continuing northwards after connecting to the WCML.

4.8.42 Both options would lie to the west of the town of Knutsford, the M6 and the A556. Immediately to the north of this point, the M6 curves to the west and hence lies to the north of the station options also. Junction 19 of the M6 lies on this section of motorway to the north of the sites as it curves to the west.

4.8.43 Option 5 would be approximately half a mile (1km) to the south of Junction 19. It would be on a greenfield site in a north-south orientation, parallel to the A556. The route here would be elevated and hence the platforms would also be elevated by approximately 4m. The location can be seen in figure 4.42 and at a more local level in figure 4.47.

Figure 4.47 – Proposed Knutsford - Sandbach to Golborne M6 route interchange station option 5

Source: HS2 Ltd

4.8.44 Option 5a would be slightly to the north-west of option 5, on a greenfield site approximately one mile (1.4km) to the west of Junction 19 of the M6. The platforms would need to be elevated above ground level by approximately 4m as the route would be elevated. The location can be seen in figure 4.42 above and at a more local level in figure 4.48 below.

Figure 4.48 – Proposed Knutsford - Crewe to Golborne western route interchange station option 5a

Source: HS2 Ltd

Engineering

4.8.45 Both options would be elevated with ground level access leading to an elevated concourse area above the tracks. A car park to the east of both of the options would provide space for up to 3,000 cars across four floors, all of which would be above ground.

4.8.46 Highway access to both of the options would be via a new road constructed to connect with the A556, heading off to the west. This would be at the point where Tabley Lane also meets the A556. This road links to Junction 19 of the M6 and further north to the M56. Both motorways can be congested at peak times and traffic to the station options would potentially add to the stress. Currently bus services run along the A556 so could be easily diverted to serve either station option. There would not be access to the existing rail network at either location, as the nearest station would be Plumley, approximately 2.5 miles (4km) away on the Chester to Altrincham line. The cost of both Knutsford options would be approximately £50 million higher than the Manchester Airport Davenport Green option.

Sustainability

4.8.47 Both options would lie within the Green Belt and would conflict with the local planning strategy as there are no plans to release the land for development. Option 5 would require the demolition of approximately three residential dwellings. Care was taken during the design of this option to date to minimise the visual or other impact on the Grade II Registered Park and Garden of Tabley House which is situated to the south-east of the station on the other side of the A556. However, given the relatively flat nature of the surrounding landscape and that the station and approaching sections of four tracks would be elevated, there would be some visual intrusion on the Tabley House parkland as well as views from Knutsford and surrounding hamlets. The edge of Tabley House Registered Park and Garden would be within 150m from the station site at its nearest point. The four tracked section to the south of the station would cut through Round and Rinks Wood, an Ancient Woodland.

4.8.48 Option 5A would require the demolition of approximately four residential dwellings. This option is a little further away from Tabley House Registered Park and Garden and the outskirts of Knutsford than option 5 and care was taken to minimise visual or other impacts on the house and the surrounding areas. There would be visual intrusion of views from surrounding hamlets. The station and the four tracks required to accommodate it would impact on a small area of Flood Zone 3 (land with a high probability of flooding).

Demand

4.8.49 We provided a general demand picture in the introduction to this section. In terms of the performance of the interchange options, we estimate that an interchange station option close to the Airport would pick up around 5,000 daily boarders onto HS2. The Airport tunnelled approach to Manchester from the high speed main line, which two of our three airport station options are on would provide a journey time approximately two minutes faster than the other route option combinations to a Manchester city centre station at Piccadilly.

4.8.50 Overall, we would expect the Manchester interchange option location near to the airport to provide a total net benefit of around £700 million (PV) and revenue of around £500 million (PV); including the additional two minutes time saving to Manchester from the quicker route option. The Knutsford option would, as already mentioned, provide disbenefits when stopping all Manchester services there.

4.8.51 As we have described though the additional benefit has to be traded off against the additional cost of the station and approach to it making the case for an interchange station more marginal.

Interchange station options in the Manchester area: Section summary

4.8.52 Each of the options described in this section would serve a different combination of main route options, approach options into, and stations in Manchester, hence the choice of an interchange station cannot be made in isolation from the choice of route and city centre station options.

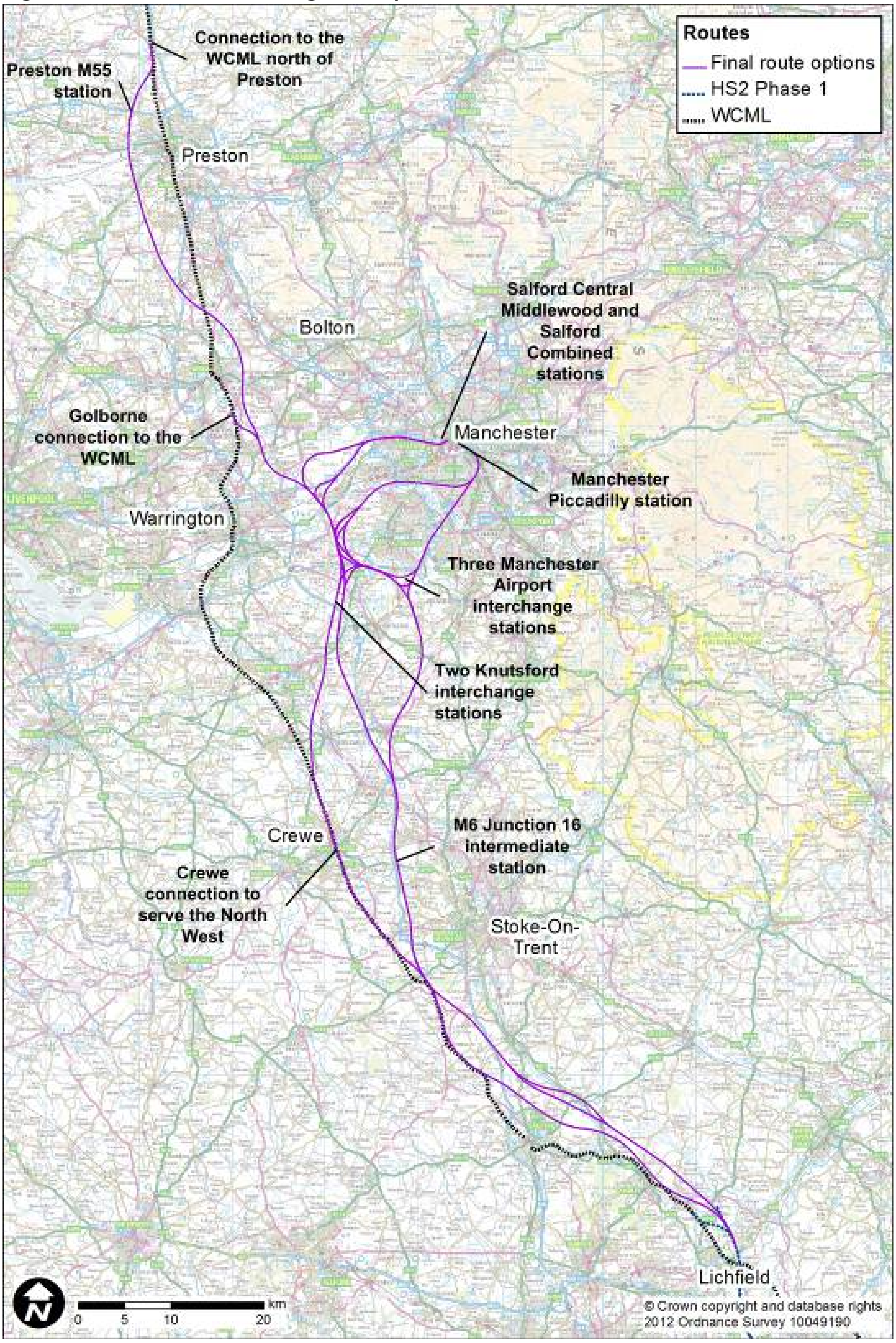
4.8.53 In terms of the station options, Manchester Airport Davenport Green offers the best connectivity and proximity to the Airport and can be delivered at the lowest cost. This station could be accessed from all three main route options, but only from one approach, the Airport and south Manchester tunnel. If the Government indicated an interest in examining the case for this option further, we would propose that we undertake further analysis to understand the station's effect on the business case and engage further with delivery partners to understand how this option would best connect with the Airport and wider region.

4.8.54 The combination of a station at Manchester Piccadilly and an interchange station to the south of Manchester in the vicinity of the Airport would attract the largest number of passengers compared to other combinations of station options. This would not add significant amount of additional boarders though as the interchange would, to some extent, simply pick up passengers who would be well located to the HS2 station at Manchester Piccadilly. This is reflected in our demand analysis, which shows that the benefits are marginal when the additional costs of both the station and the approach are included. Any interchange station would add to the £33 billion cost envelope.

4.9 Routes and stations: Key decisions for Government

4.9.1 Figure 4.49 below reflects the final route options we described in this chapter:

Figure 4.49 – Manchester leg final options



Source: HS2 Ltd

4.9.2 Having described our final route and station options for the western leg of the Y network, we set out below the decisions that Government will need to take to select a preferred scheme. This is based on the options we have presented in this chapter and does not preclude the Government asking HS2 Ltd to undertake further work and analysis or potentially develop new proposals in support of that decision making.

i) HS2 Ltd will need to advise Government, following further analysis, the most appropriate route to avoid or minimise any impact on Pasturefields Salt Marsh SAC. Following this the Government will need to consider and confirm its route choice at the southern end.

ii) Government to consider the merits of providing a connection at Crewe for services to Liverpool and the North West. An alternative option will be to consider the merits of an intermediate station. This will influence route choice.

iii) Government to consider the merits of an interchange station which, if a Manchester Airport interchange is selected, will influence route and approach choice.

iv) Government to select a preferred city centre station option which, in addition to the interchange station decision at (iii), will influence the selection of the approach.

v) Government to select a preferred connection to the WCML and consider how Scotland would best be served from phase two.

Chapter 5 – West Midlands to Leeds

5.1 Introduction

5.1.1 Our remit set out in chapter 1 asks us to develop route proposals and options for a high speed line between the West Midlands and Leeds with a link onto the ECML. The remit asks us to provide options for stations in Leeds and for stations to serve South Yorkshire and the East Midlands. The line of route options are therefore influenced by the need to connect with the potential station options that have been simultaneously developed to serve each of those locations.

5.1.2 When developing station options in the East Midlands and South Yorkshire we have considered serving the principal cities directly and also alternative interchange options located to capture the wider regional market. We have therefore developed line of route proposals which would serve both.

5.1.3 There are trade-offs between serving city centres directly by high speed rail or alternatively serving wider regions through interchange stations connected by good transport access, roads, rail, tram and bus. City centre stations provide a focussed market with passengers located in and around a single location. However, intermediate stations, in the right location, offer the possibility of serving a wider region.

5.1.4 Alternative options include serving both city centres and the wider region, effectively by having two or more high speed stations and associated additional high speed lines. This has a significant cost and requires a substantial market to be captured for it to be viable.

5.1.5 For that reason one alternative is to investigate the option of using the existing railway for 'classic compatible' HS2 trains, which are trains that are capable of leaving the main high speed route and heading into city centres on existing rail lines. This allows high speed rail to capture an additional market at a lower cost by using existing rail infrastructure, but it also allows us to serve only limited destinations.

5.1.6 However, due to capacity constraints on the HS2 network south of Birmingham, we only have a limited number of train paths, up to 18tph, so there are restrictions on the number of trains we can move across the high speed network. We also have to bear in mind the additional capital and operational cost of classic compatible train units. So, even if the additional infrastructure cost is comparably small overall, classic compatible trains still have to capture a significant enough market to pay their way.

5.1.7 As the next sections set out, we kept all these options in play when developing our line of route and station options for the East Midlands and South Yorkshire. We know the potential benefits offered by city centre station options, our phase one process reflected that, but also that our remit asked us to develop station options for serving the East Midlands and South Yorkshire and bring about wider regional benefits.

5.1.8 In this chapter we cover the line of route and station options starting from the West Midlands and running northwards via the East Midlands and South Yorkshire. We then describe the route northwards with spurs to serve our proposed Leeds city centre station options. When describing the different Leeds city centre station options we highlight the finely balanced engineering, sustainability and local development plan issues. We then set out options for connecting with the ECML for onward journeys to York and the North East.

5.1.9 The chapter is broken down into sections dealing with the development of our line of route proposals and then station options in turn:

- section 5.2 provides a geographic overview;
- section 5.3 sets out the line of route options from the West Midlands to station options in the East Midlands;
- section 5.4 describes the station options in the East Midlands;
- section 5.5 sets out the line of route options from the East Midlands to South Yorkshire;
- section 5.6 describes the station options in South Yorkshire;
- section 5.7 sets out the line of route options onwards to Leeds and the spur approaches to the city centre;
- section 5.8 describes the Leeds city centre station options; and
- section 5.9 sets out the options for connecting to the ECML and, briefly, our work considering an additional interchange station.

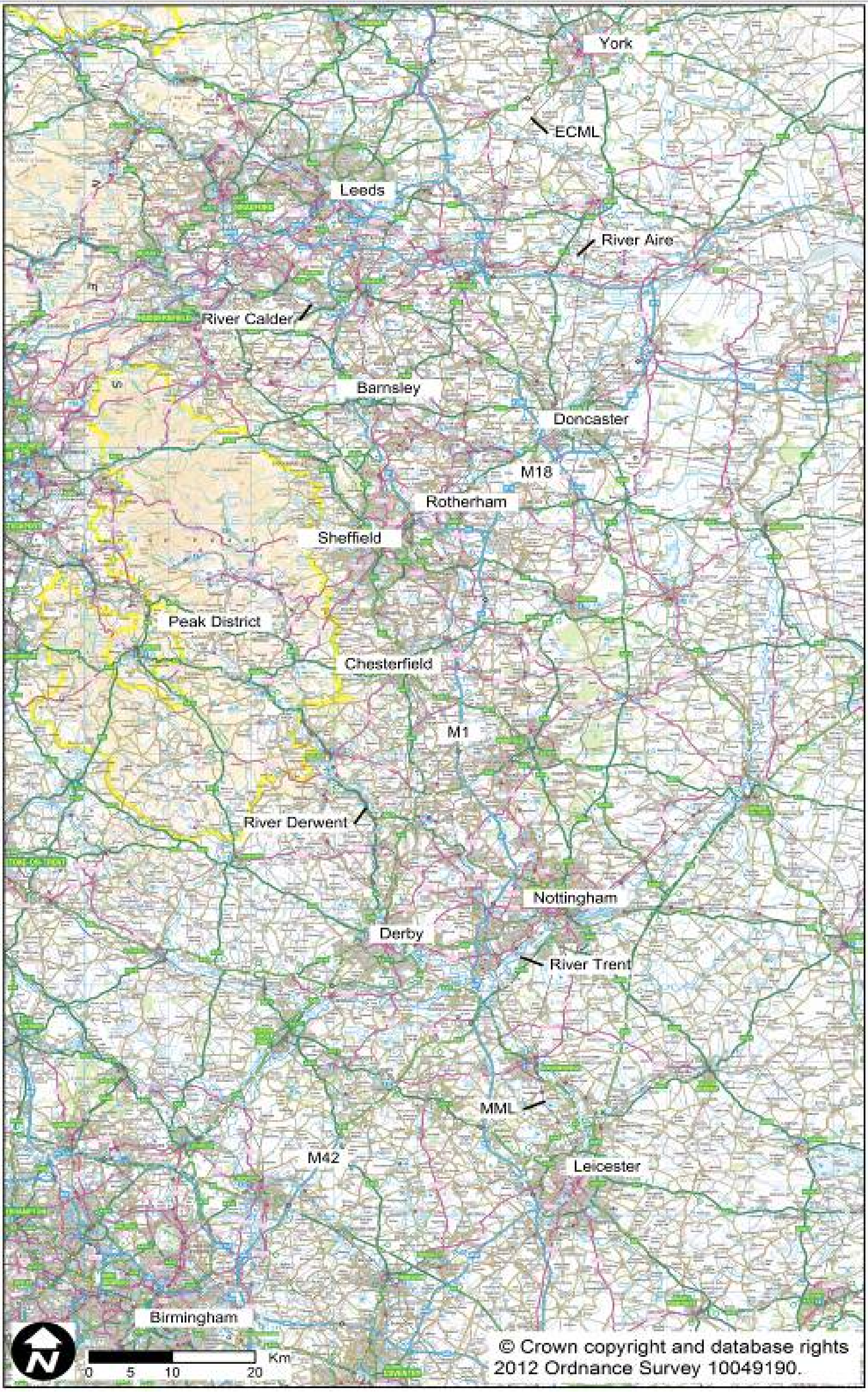
5.1.10 In each section we describe:

- the process that we went through to narrow down and develop options that would meet the remit; and
- an overview of the route or station proposals that we developed as final options.

5.1.11 In section 5.10 we provide an overall summary of our final route and station options and the key decisions that Government will need to take to select a preferred scheme.

5.2 Geographic overview

Figure 5.1 – Geographical overview of West Midlands to Leeds



Source: HS2 Ltd

5.2.1 A short geographic overview of the broad corridor in which we developed our route and station options is set out below. This is to provide some context to the areas in which we developed our route options and proposed station locations. We then go on to introduce some further background on the East Midlands region and the attributes of this market in terms of demand for rail travel, which our remit asks us to serve.

5.2.2 The study area can be divided into four broad sections of terrain and geography. Between the West Midlands and the Derby/Nottingham area the route options pass through undulating and largely rural landscapes, with settlements of former coal mining towns.

5.2.3 Beyond the broad valley created by the confluence of the Trent and Derwent rivers, the route options pass through an area defined by the Peak District to the west, and the Nottinghamshire Coalfield to the east. The topography to the west and the scattered towns and mining villages of the Nottinghamshire Coalfield imposes constraints upon route identification and selection.

5.2.4 Northwards from South Yorkshire into West Yorkshire, the terrain is a mixture of interwoven hills and valleys running perpendicular to the broad route corridor. The area is densely populated with scattered towns and villages of varying size reflecting the former industrial heritage.

5.2.5 After crossing the valleys created by the Aire and Calder rivers the terrain becomes less challenging for the approach into Leeds and the connection to the ECML south of York, with open agricultural land, modest rolling terrain, and far fewer settlements.

5.2.6 The East Midlands has three main cities; Derby, Nottingham and Leicester. The city of Sheffield dominates South Yorkshire. The wider region includes the metropolitan boroughs of Doncaster, Rotherham and Barnsley with the latter two merging with Sheffield to create the Sheffield and Dearne Valley conurbation. The city of Leeds is the largest city in West Yorkshire with the Leeds urban area prevented from expanding further west by the confluence of the Aire and Calder, to the east of which lie Castleford and Pontefract.

5.2.7 The main railway corridors are the MML from London and Leicester and onwards via Derby to Sheffield and the ECML which runs the length of the east coast of the country from London north via Doncaster, Leeds and York, in particular, and then onwards to Scotland.

5.2.8 The main highway corridors are the M42/A42 between the West Midlands and Nottinghamshire and the M1 which runs between London and Leeds via Leicester and Sheffield (where it intersects with the M18 to Doncaster). The A38/A61 corridor connects Derby and Sheffield. Several other main highway corridors cut across this geographical area such as the A52 and A610 in the East Midlands and the M62 and A1(M) in West Yorkshire.

5.2.9 In addition to the rivers mentioned above, other major rivers are the Erewash running from Nottingham to North Derbyshire, and the Rivers Don, Dearne and Rother in South Yorkshire. The River Mease, which runs across the East Midlands region, though not a major river, is designated as a Special Area of Conservation (SAC) which we describe in text box 12.

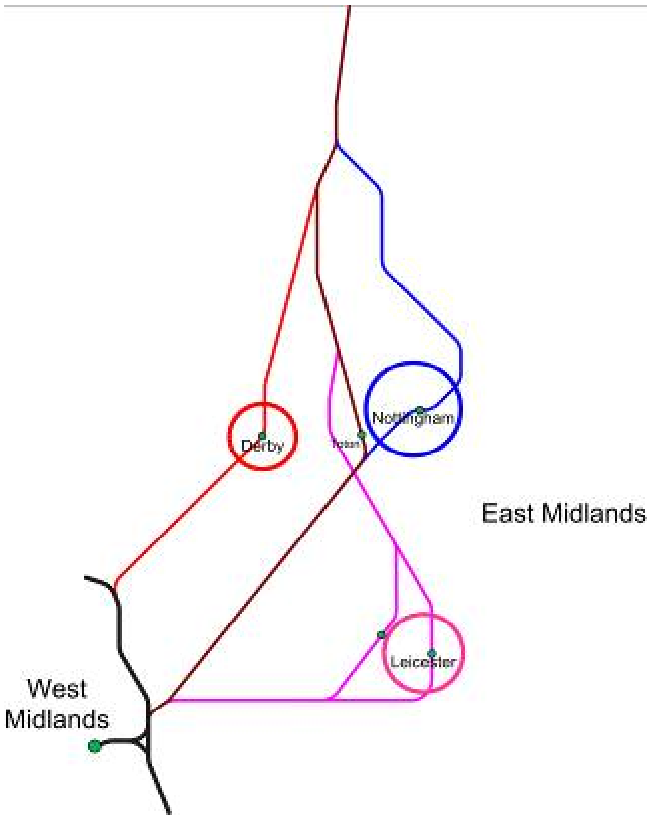
Serving the East Midlands

5.2.10 The three key cities in the East Midlands region are Nottingham, Leicester and Derby. Nottingham offers the largest market, followed by Leicester and Derby, and the size of their respective urban populations correlates well with the rail trips generated between the East Midlands and London.

5.2.11 The markets for serving Leeds and Newcastle (via classic compatible running) significantly outweigh both the East Midlands and South Yorkshire markets. As such, any stop in the East Midlands and its associated journey time impact is likely to reduce benefits to longer distance journeys. This indicates the importance of achieving a fast route through the East Midlands to maximise benefits for the larger markets.

5.2.12 The schematic below shows the broad line of route corridor options for serving the East Midlands. As highlighted, serving Leicester requires a more significant arc from the West Midlands than the other East Midlands cities. Of the three locations, a station in the Derby or Nottingham area would serve a greater proportion of the wider East Midlands region. Given the location of Leicester, some way to the south-east of the region, an interchange station option would only serve Leicester and possibly Loughborough.

Figure 5.2- Broad line of route options for serving the East Midlands



Source: HS2 Ltd

5.2.13 Taking London to Leeds as an example, key journey time impacts are:

- a station serving central Leicester would result in a journey time nine minutes slower compared to a station serving central Derby and five minutes slower than central Nottingham; and
- an interchange station serving the outskirts of Leicester would be five minutes slower than an interchange station between Derby and Nottingham.

5.2.14 Despite capturing the middle-sized market, the journey time penalty of serving Leicester city centre is significant with our analysis suggesting that a five minute penalty would reduce travel benefits by an estimated £1 billion (PV) and reduce revenue by £500 million (PV).

5.2.15 An additional factor is the good service Leicester already has to London and with the possibility that this will improve further in the future. Given the benefits that Leicester already gains from a fast service to London compared to Nottingham, siting the station at Leicester would lead to an overall loss in benefits of approximately £1.6 billion (PV) and a reduction in revenue of approximately £700 million (PV). This would be a result of passengers from Leicester splitting between the high speed and existing rail services and the more limited market for new passengers offered by Leicester compared to Nottingham.

5.2.16 Our estimated construction costs also suggests that a route option via central Leicester would be significantly more expensive than route options via Derby and central Nottingham and the M42 / M1 corridor. The interchange option via Leicester would also be more expensive than the equivalent we compared it against in the Derby-Nottingham ‘gap’.

5.2.17 As a result of this analysis we decided not to progress line of route and station options via Leicester. Throughout our option development process we have continued to explore ways in which Leicester may potentially receive some benefits from high speed rail and continued to involve and discuss options with our delivery partners in the region.

5.2.18 For example, it would be possible to operate a classic compatible service from Leicester connecting with the high speed network further north. The demand for such a service would need to be weighed against the additional costs (infrastructure and operational) and the benefits of using a train path in this way.

5.3 Routes between Water Orton and East Midlands

5.3.1 In this section we describe the detail of our route options from Water Orton to the East Midlands. We start by describing all the route options that were considered and explain those that were sifted out at an earlier stage in the process. The section then describes, in detail, the route options that would serve the proposed high speed station options at Toton or Derby Midland which we describe in the next section.

5.3.2 As we set out in the opening section to this chapter, the final route choices are very much influenced by the choice of station location. Serving a station in Derby requires developing routes that would run to the west of the region whereas serving a proposed station at Toton means developing routes that would run through the centre of the region.

5.3.3 In developing route options a principal consideration was how to minimise or avoid any impact on the River Mease SAC which runs across some of the East Midlands area. This is a similar issue to the salt marsh at Pasturefields SAC on the Manchester leg. As with Pasturefields, we have engaged with Natural England and the Environment Agency. We understand more about the river and have been able to do more at this stage to develop route options that either seek to avoid or minimise any impact. Nevertheless, as we describe in text box 12 , further studies and consultation with Natural England and the Environment Agency about route options that cross the river will be needed if these are taken forwards.

5.3.4 We therefore describe three route options towards Toton, two that cross the River Mease SAC on viaducts either north or south of Measham and one that avoids the river by taking a longer route around the edge of the river catchment.

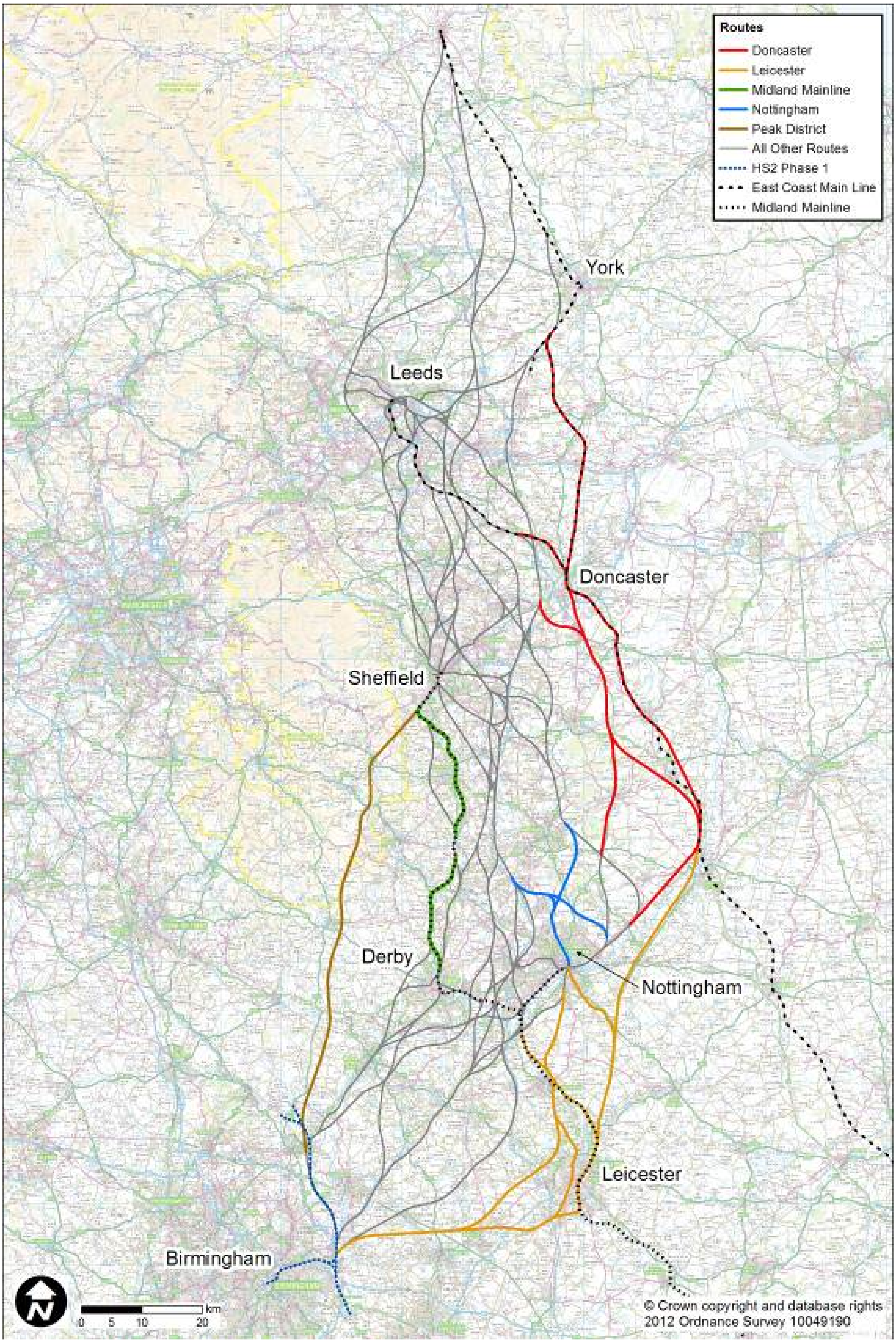
5.3.5 Our route option to the station at Derby Midland would also cross the river, roughly at the mid point of the SAC designation, so any route avoiding the Mease would be significantly longer.

5.3.6 The additional engineering and sustainability issues we faced when developing our route proposals are described in detail as we set out our final route options. We start though by explaining the process we went through to arrive at these final options.

The generation of initial ideas and the sifting down to a long list

5.3.7 The generation of ideas for routes led to a large number of route options being initially developed. Figure 5.3 shows all the route options we developed with the options that we did not take forward beyond this stage highlighted and briefly described.

Figure 5.3 - Generation of initial ideas and sifting down to a long list for route options to the East Midlands



Source: HS2 Ltd

Through the Peak District
('Peak District' on figure 5.3)

5.3.8 We decided not to take one option forward beyond this stage as a result of it being a direct route to South Yorkshire and therefore not serving the East Midlands and a core part of our remit. The option would also have greater sustainability and engineering challenges than comparable routes and would offer only limited journey time benefits.

Route options via Leicester
('Leicester' on figure 5.3)

5.3.9 We developed a set of route options eastwards towards Leicester with options passing to the west on a bypass or through the city centre alongside the Midland Main Line (MML) or along the disused Great Central formation. The routes would then generally run towards Nottingham, approaching it from the south. The issues around serving Leicester were described in more detail in section 5.2. As a result of our analysis described there, work developing line of route options via Leicester was not progressed.

Route options via Nottingham
('Nottingham on figure 5.3)

5.3.10 We developed a set of route options through Nottingham that would use the abandoned Great Central railway through the former Nottingham Central station. Most of this corridor has been lost to development, and it would be a major and expensive engineering challenge to restore such a corridor for high speed services. As a result, this set of line of route options through Nottingham were not progressed.

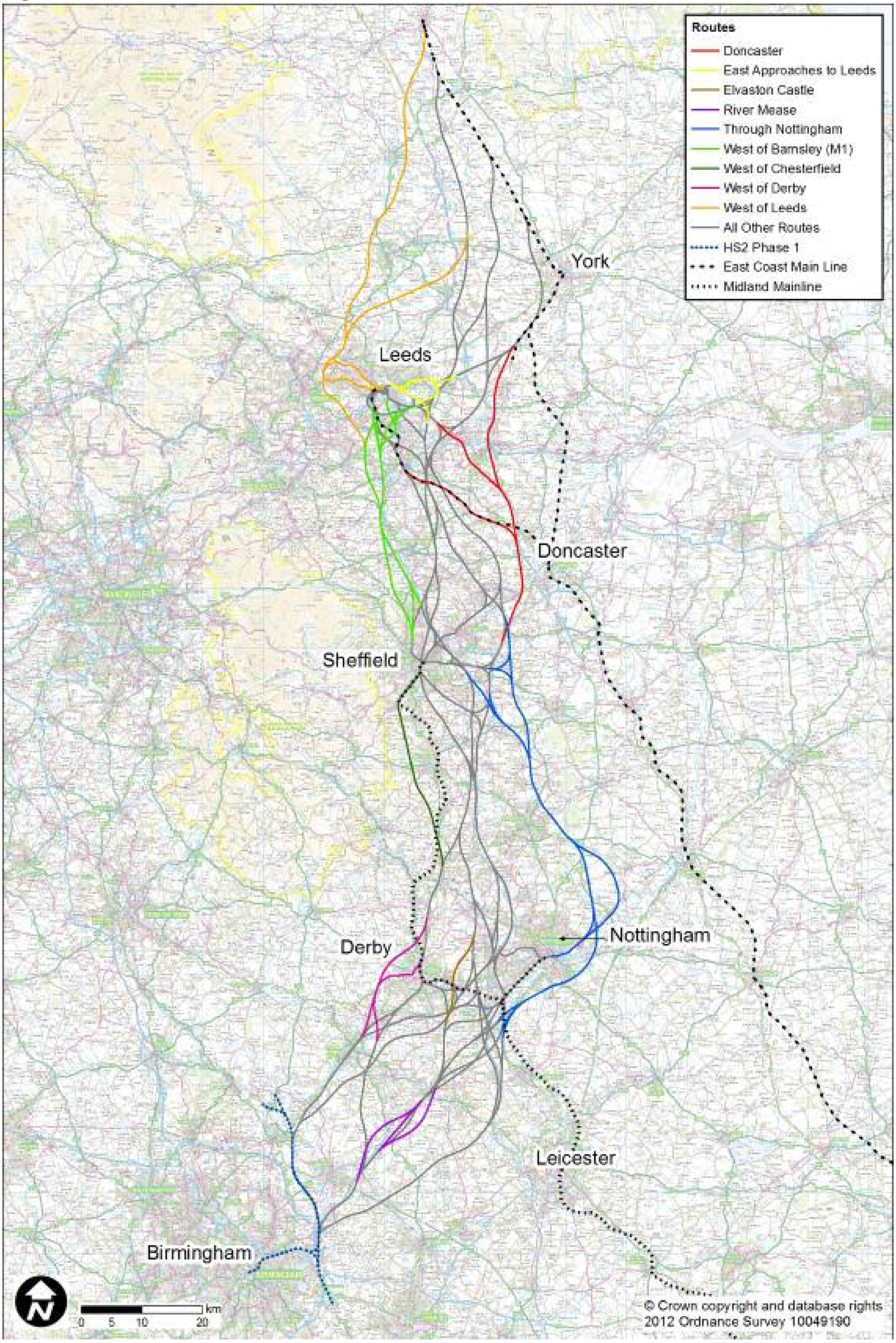
The creation of a short list

5.3.11 The routes taken forward as a long list of options were developed to the next level of detail. As station options were progressed and developed new line of route options were also developed to serve these options. Conversely, as station options were sifted out of the process the associated line of route options were also sifted out.

5.3.12 At this stage, we also began to use the pair-wise comparison process. This allowed us to compare the benefits and impacts of similar route options and in some cases allowed us to take forward the better performing option. As we developed and refined our route options we were also mindful of the potential impact on the River Mease SAC. We describe in text box 12 our work with Natural England and the Environment Agency.

5.3.13 The routes not progressed beyond this stage are highlighted on Figure 5.4 below and then briefly described.

Figure 5.4 - Creation of a short list of routes to the East Midlands



Source: HS2 Ltd

12. River Mease SAC

The River Mease Special Area for Conservation (SAC) is a protected European site of importance because of its valued species which are mainly aquatic.

A number of route options which we developed from the initial stage would cross the river in different places and introduce potential risks to these species, largely through construction disturbance, changes to the hydrology and the operational release of pollution. Of particular concern is the effect of bridge shading on a light-sensitive plant which is a qualifying feature of the SAC.

Routes were considered that tunnelled under the river, crossed parallel to the A42 crossing or crossed numerous tributaries of the river but avoided crossing the SAC designation. These were ruled out because of costs and concerns over pumping, the effect of bridge shading and the cumulative construction impact on the SAC. These are shown as 'River Mease' on figure 5.4.

The potential impacts of crossing the river have triggered a Habitats Regulations Assessment (HRA) screening, and with the information available it has not been possible to determine whether the route options would have a significant effect on the SAC.

The findings of the HRA screening have been discussed with Natural England and the Environment Agency, and more detailed investigations in the form of an Appropriate Assessment are required to determine whether the route options would have an adverse impact on the integrity of the SAC.

We present in this report three route options that cross the River Mease SAC and one option, serving the proposed station at Toton that would avoid it. The options that cross the river have been designed to avoid or mitigate any impact on the river as far as possible at this stage. Due to the width of the river, it is envisaged that it could be protected from any adverse impact through best practice construction and operation, but this has yet to be demonstrated.

The option avoiding the SAC would skirt the eastern edge of the Mease catchment - broadly along the watershed and in cutting. Design measures would potentially avoid any significant hydrology impacts on the River Mease SAC.

If route options crossing the River Mease SAC are progressed we would carry out further light shading, bridge design, hydrology and ecology studies in consultation with Natural England and the Environment Agency. This would include the development of any necessary impact avoidance and mitigation measures.

Routes west and through of Derby
('West of Derby' on figure 5.4)

5.3.14 We considered a number of route options that would run to the west of Derby, run through Derby or, through a combination of the two, form a bypass line and a city loop. Routes around the western edge of Derby would not serve the centre of Derby or provide an interchange with existing rail services or serve the Nottingham area. Moreover they would not readily serve the East Midlands market being situated too far west. These route options would also potentially affect the Derwent Valley Mills World Heritage site.

5.3.15 Route options passing via the former Friargate station would have a low design speed whilst a combination of the western Derby bypass and Derby Friargate loop would require significantly more additional railway construction. We therefore chose not to take forward a number of route options beyond this stage.

Routes around Nottingham

(Grouped with 'Through Nottingham' on figure 5.4)

5.3.16 We chose not to develop a route option around Nottingham at this stage as it would be significantly more expensive and slower than the alternative options as well as being on a greenfield site. This decision also confirmed the decision not to develop the proposed station option at Clifton.

Through Nottingham

('Through Nottingham' on figure 5.4)

5.3.17 Our analysis showed that, in benefit terms, Nottingham and Derby as through stations would both offer worse journey times than the station option at Toton. A Nottingham through station would be significantly worse than other options in terms of cost, and poorer still in revenue and benefit terms. Derby as a through station had better value for money compared to Nottingham on a through route or a spur. We took the development of Nottingham through route options no further.

Routes through the Derby – Nottingham 'Gap'

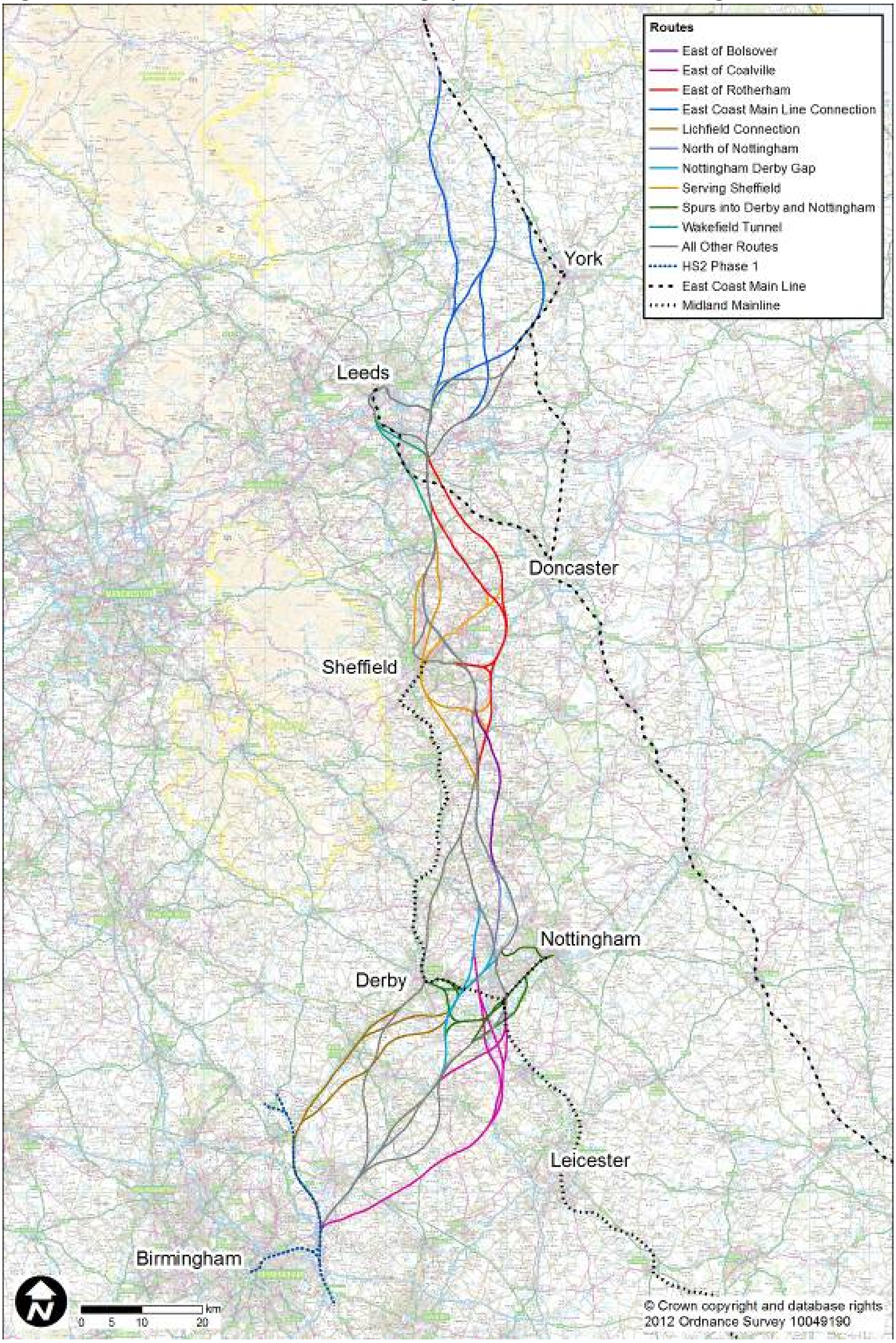
('Elvaston Castle' on figure 5.4)

5.3.18 We chose not to develop one of the through routes through the Derby-Nottingham Gap primarily because of the impact it would have on the Elvaston Castle Grade I Registered Park and Garden as the route would intersect the start of a tree-lined avenue forming the major sightline from the house.

Selecting options for refinement

5.3.19 We then developed the remaining route options in further detail ahead of a final sift to reduce the number of options. This process led to the further refinement of options using the pair-wise comparison process again. The outcomes of this process are highlighted on Figure 5.5 and described below.

Figure 5.5 East Midlands routes selecting options for refinement stage



Source: HS2 Ltd

East of Coalville

('East of Coalville' on figure 5.5)

5.3.20 We considered a collection of routes which would start at Water Orton, heading east to pass Coalville before heading north following the M1 motorway towards Nottingham as an alternative to following the M42/A42 corridor. The routes would pass through hilly terrain in this area requiring a large number of tunnels, embankments and cuttings as well as steep gradients and complicated crossings of the motorway. In addition, passing to the east of Coalville would add to the overall length of the route and have a journey time impact. We chose not to take forward these route options beyond this stage.

Spurs into Derby and Nottingham

('Spurs into Derby and Nottingham' on figure 5.5)

5.3.21 We considered route options that would spur into Derby or Nottingham or both as alternatives to through route options. The spur options would be costly to construct due to the additional length of route being constructed and would result in significant disruption to the existing railways. They would also provide little journey time benefit compared to through route options. The time penalty for passengers heading northwards would also be significant.

5.3.22 In addition, both the spur to Derby and the spur to Nottingham would have a high number of potential demolitions with the spur options to Nottingham incurring significant additional cost. We therefore chose not to develop these options beyond this stage.

Routes from Water Orton through the Derby-Nottingham 'gap'

('Nottingham – Derby Gap' on figure 5.5)

5.3.23 We considered a number of routes that would effectively serve stations in the 'gap' between Derby and Nottingham. These routes offered the fastest journey times. However, the decision not to take forward the associated stations at Breaston, Lockington and Draycott, with the concern about developing through this sensitive area, meant that we did not take these lines of route forward.

Routes through the East Midlands

('Lichfield Connection' on figure 5.5)

5.3.24 Considering the route options for serving Derby, we chose not to take forward the option that followed the A38 from Lichfield before running along the existing railway corridor through Burton-upon-Trent. This would have served as an alternative to following the M42/A42 corridor. This option would result in difficult constructability issues along the railway corridor through Burton and have a potentially significant impact on Hints. This option would have a potential noise impact on the National Memorial Arboretum. Our decision not to take forward this option meant that we had no option for serving central Derby which would avoid the River Mease SAC. We noted that this would need to be discussed and reviewed further with Natural England should the decision be made to serve the East Midlands by the proposed station option at Derby.

Developing and finalising our options

Route options between Water Orton and East Midlands

5.3.25 Following the sifting process outlined above, two broad route options from Water Orton to the proposed East Midlands stations remained. One of these options would be a route from Water Orton to the proposed HS2 station option at Derby Midland. This option would leave the M42 route corridor after Tamworth, heading north cross country to cross the River Mease SAC at Clifton Campville and passing between Burton-upon-Trent and Swadlincote before reaching the outskirts of Derby.

5.3.26 The other route option would be from Water Orton to the proposed station option at Toton, following the M42/A42 corridor past Ashby-de-la-Zouch. This route would cross the River Mease SAC to the north of Measham. Variants to this route provide an alternative crossing of the Mease to the south of Measham or avoid the Mease altogether by heading further east towards Coalville.

5.3.27 We describe the key engineering and sustainability features of each of these routes below.

Route options to Toton

5.3.28 We first describe the three route options from Water Orton to the proposed station at Toton. These route options would run as follows:

- Water Orton to Birchmoor - common route for all three options
- Birchmoor to Tonge - includes options that would:
    - ii) cross the River Mease SAC to the north of Measham
    - iii) cross the River Mease SAC to the south of Measham
    - iv) avoid the River and Measham by running further to the east.
- Tonge to Long Eaton – common route for all three options
- Long Eaton to Sandiacre – common route for all three options with an HS2 station at Toton.

5.3.29 Following this we describe the alternative route option to the proposed station at Derby which would cross the River Mease SAC.

5.3.30 Figures 5.6 to 5.8 show the whole routes from Water Orton to either the proposed stations at Toton or Derby Midland.

Water Orton to Birchmoor

Engineering

5.3.31 All route options would start at the end of the northern chord of the Water Orton delta junction. The spurs to Leeds would diverge from the route to Manchester at a speed of 145 mph (230kph) just south of the M42. The route would then run north-east running parallel to the M42 on the eastern side, cross the River Tame and associated floodplain, before crossing over the M42 to lie on the west of the motorway past Tamworth.

5.3.32 With the route now on the eastern side of Tamworth, to the west of the M42, it would continue north-east with new bridges required over local roads. Junction 10 of the M42 would need to be re-built on its western side to accommodate new bridges. North of Junction 10 the route would enter deep cutting.

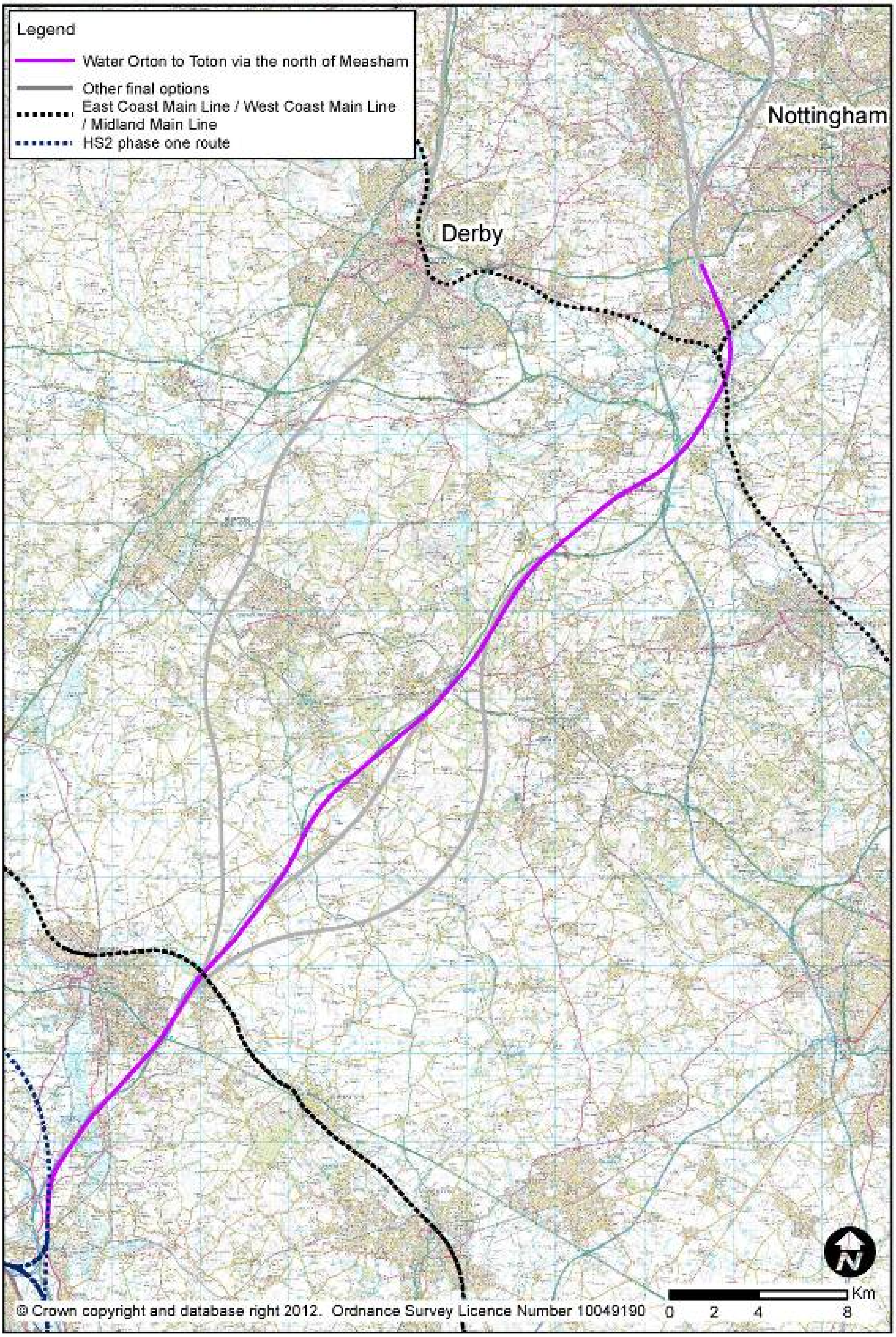
Sustainability

5.3.33 This route section would result in the potential demolition of six dwellings. The generally close alignment to the M42 through this area would limit the visual impact though with some potential impact on Kingsbury Water Park (Country Park) and BAP habitat.

Birchmoor to Tonge – north of Measham

5.3.34 The route from Birchmoor on towards Tonge would follow the M42/A42 corridor, crossing the River Mease SAC to the north of Measham. There are two other variants that either provide an alternative crossing of the River Mease SAC to the south of Measham or avoid crossing the river by leaving the highway corridor to head east towards Coalville. We describe all three options below, beginning with the route via the north of Measham.

Figure 5.6 - Water Orton to Toton via north of Measham



Source: HS2 Ltd

Engineering

5.3.35 From Birchmoor the route would pass under the M42 and the B5000 whilst still broadly following the motorway though not its more winding course. The route would then cross over the Coventry Canal, the existing West Coast Main Line railway through Polesworth and then the River Anker.

5.3.36 The route would pass to the west of Austrey at ground level before continuing on a mix of embankment and then deep cutting reflecting the terrain through this area and the hill which the M42 cuts into.

5.3.37 The route would then cross the River Mease SAC and its floodplain on a 110m long viaduct, passing between Measham and the A42. The route would then adopt the alignment and positioning of the A42 which would be diverted for 1.4 miles (2.3km).

5.3.38 Continuing to follow the A42 past Ashby-de-la-Zouch the route would pass under Ashby Road, Leicester Road and the existing Leicester to Burton railway. The route would continue to run parallel to the A42 in a north-easterly direction before crossing it at Breedon on the Hill where the road veers towards the east and Junction 23A of the M1.

Sustainability

5.3.39 The route section would result in the potential demolition of three dwellings. In general the route would be close to the M42 corridor minimising its impact. The route section would have a potential landscape impact on the character of Pooley Country Park which it would pass on viaduct with additional visual impacts on Polesworth.

5.3.40 The route would be on embankment or short viaduct close to Austrey, Measham and Packington causing a potential visual impact to residents at the edges of these villages. There would also be a potential visual impact on the residents of Worthington village and further on, on the residents of Breedon on Hill and Tonge which the route would pass on high viaduct close to the A42.

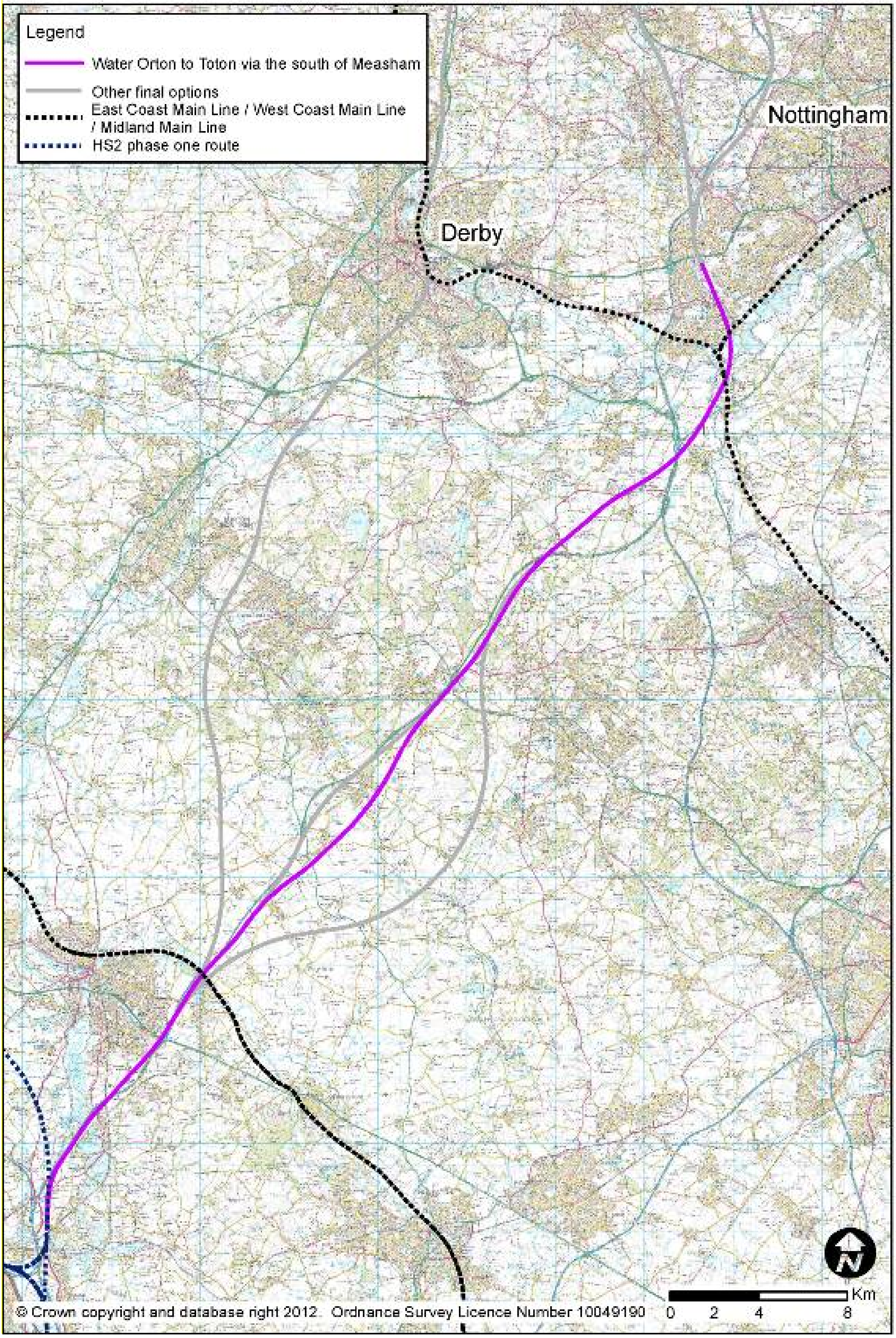
5.3.41 The setting of two scheduled coal mining remains, both near Smoile Farm, would potentially be affected. The setting of the birch coppice designated area may be impacted but potentially reduced by the screening from the woodland.

5.3.42 The route section would cross the River Mease SAC. See text box 12 for a description of our analysis and further work.

5.3.43 There would be some risks at Alvecote Pools SSSI and Lount Meadows SSSI. Best practice in design construction would seek to lessen the risk. Three areas of coastal and floodplain grazing marsh BAP habitat would be directly affected.

Birchmoor to Tonge – south of Measham

Figure 5.7 - Water Orton to Toton via south of Measham



Source: HS2 Ltd

Engineering

5.3.44 The alternative route option for crossing the River Mease SAC, and also serving the proposed HS2 station at Toton, would follow the same alignment described above for the most part. This alternative diverts from the M42 corridor at Austrey, passing to the south-east edge of Appleby Parva and Appleby Magna. The route would cross the River Mease SAC on a significant viaduct for approximately half a mile (1.1km).

5.3.45 The route would then continue to the south-east of Measham on embankment to pass over the local roads, re-joining the M42 corridor at Packington.

Sustainability

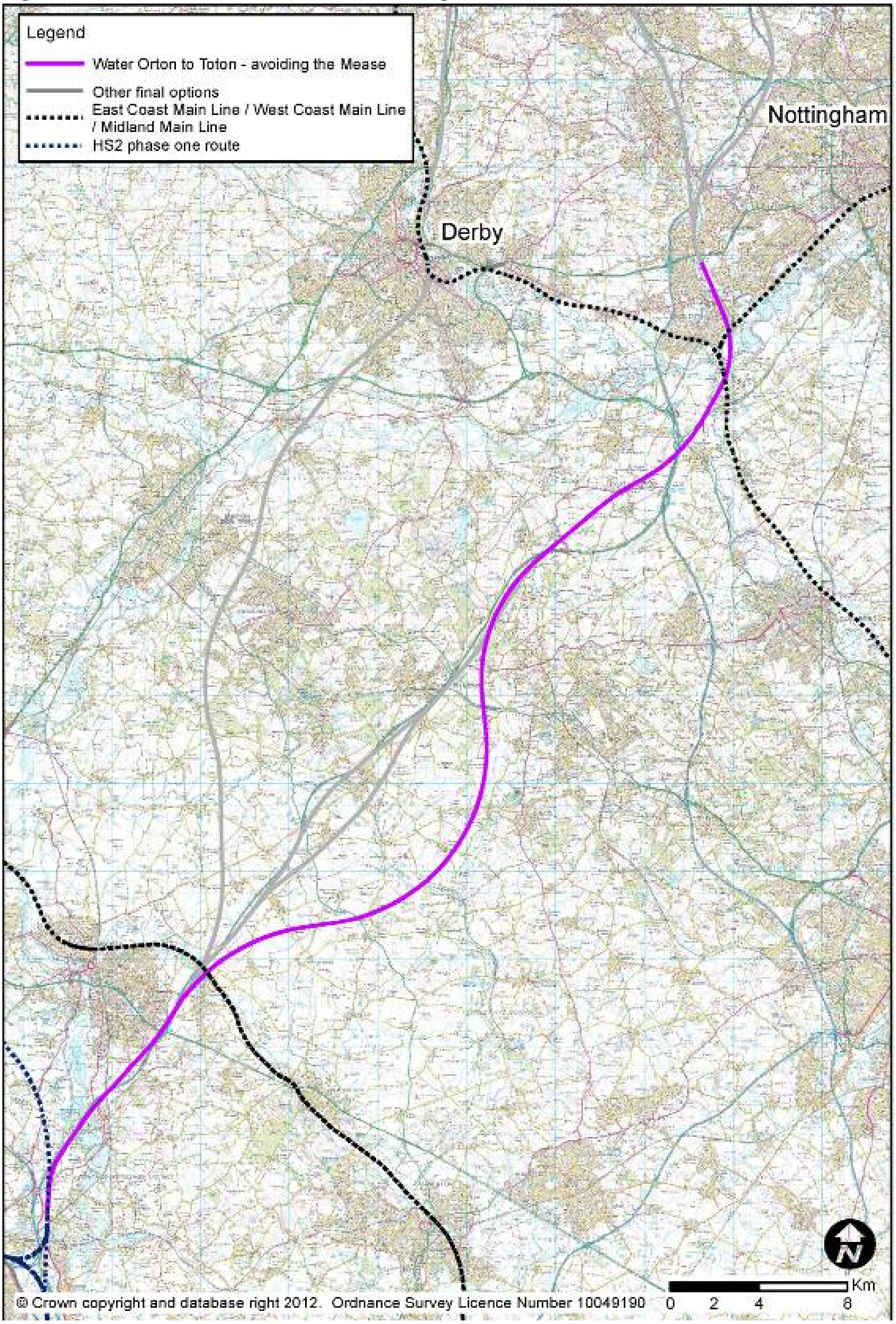
5.3.46 The route section would result in the demolition of three dwellings. As with the route to the north of Measham there would be potential visual intrusion to Pooley Country Park and Village. Further on there would be a visual impact to the residents at Austrey, Appleby Parva, Measham and Packington.

5.3.47 The route would have potential impacts on Worthington, Breedon on the Hill and Tonge and Birch Coppice. The route would have a minor impact on the setting of the Grade II* Listed Church of the Holyrood. There would also be a minor impact on the Grade I Listed Sir John Moore Church of England School near Appleby Magna.

5.3.48 The potential impact on the River Mease SAC, and the need for more detailed analysis has been described in text box 12. As with the alternative route crossing the River Mease SAC, the potential impacts on Alvecote Pools SSSI and Lount Meadows SSSI would also be the same and would require best practice in design to lessen the risk. Three areas of coastal and floodplain grazing marsh BAP habitat would also be directly affected.

Birchmoor to Tonge – alternative alignment avoiding the River Mease SAC

Figure 5.8 - Water Orton to Toton avoiding River Mease SAC



Source: HS2 Ltd

Engineering

5.3.49 The alternative route option to Toton, avoiding crossing the River Mease SAC, would follow a common alignment as far as Polesworth before heading east through undulating countryside towards Coalville passing Twycross Zoo and crossing the Ashby Canal at Shackerston before arcing north to pass the villages of Newton Burgoland and Normanton le Heath. This route would avoid the River Mease SAC and its tributaries, resulting in a route which would be 1.8 miles (2.9km) longer than the alternatives via Measham described. The route would cross the A444 and the A511 and the Leicester to Burton railway. It would re-join the A42 corridor between Coleorton and Ashby-de-la-Zouch.

Sustainability

5.3.50 This route section would result in the potential demolition of an estimated eight dwellings. The route would be mainly in cutting following the M42 but would affect the character of Pooley Country Park and would have visual impacts at Polesworth where the high viaduct would be close to part of the village. There would be a further landscape impact on the undulating land between Polesworth and Orton on the Hill. The Ashby Canal Conservation Area would be crossed on viaduct and low embankment with its setting moderately impacted.

5.3.51 There would be moderate visual impacts on Breedon on the Hill and Tonge and an impact on the settings of the sites of Rough Park and Birch Coppice. The route would pass in close proximity to Coleorton Hall Grade II* Registered Park and Garden though it would be in cutting, limiting the impact on its setting.

5.3.52 The Ashby Canal SSSI would be crossed by the route section for a short distance. There would be a risk of impact from shading to the aquatic plant communities and invertebrates for which the Canal is designated. There would be some risks at Alvecote Pools and Lount Meadows SSSI. Best practice in design would seek to lessen the risk. Three BAP habitats would also be affected including one area of coastal and floodplain grazing marsh and two areas of wet woodland that include pockets of ancient woodland.

Tonge to Long Eaton

Engineering

5.3.53 From this point northwards the three route options described above would follow the same alignment towards Long Eaton and the station options at Toton. At this point and heading north, the route would leave the A42 corridor passing under the East Midlands Airport in tunnel.

5.3.54 North of the tunnel portal the route would be on viaduct to cross over the M1 at Junction 24. The route would then be on a short section of embankment past Kegworth. The route would adopt a long viaduct to cross over the A453, the River Soar and its floodplain, the Midland Main Line and the rail access to Ratcliffe on Soar Power station.

5.3.55 A short cut and cover tunnel would be used to preserve the ridge of Red Hill before another viaduct would be used to pass over the River Trent and its floodplain. The north end of this viaduct would cross the Trent Junction complex, a railway junction that connects the routes form Derby, Leicester and Nottingham.

5.3.56 North of the end of the viaduct the route would run through Long Eaton at the level of the existing railway. This existing railway is one of two existing railway corridors that currently run north-south through Long Eaton.

Sustainability

5.3.57 This route section would result in the potential demolition of an estimated 18 dwellings. There would be some visual intrusion from the long and high viaduct across the River Soar floodplain to the north of Kegworth affecting the residents of Kegworth and Ratcliffe on Soar and users of the recreational waterway. This is set within the context of East Midlands Parkway station and the power station. There would also be potential visual and landscape impacts in the Trent Valley where the route would again be on viaduct. There would also be some impact to the townscape character in the centre of Long Eaton Conservation Area.

5.3.58 One scheduled monument, a Roman site on Red Hill at Ratcliffe on Soar, where the route would be on viaduct, would be affected by this route section. One ancient woodland and two areas of coastal and floodplain grazing marsh BAP habitat may be impacted though the impact to the woodland is potentially avoidable through further design work.

Long Eaton to Sandiacre

Engineering

5.3.59 Between Long Eaton and Toton, the high speed route would take over the position of the low level lines which would be closed to existing railway traffic. The route would widen as a result of the increase in the number of tracks to accommodate the proposed station at Toton and the effect of this is set out in our supporting documents. Beyond the location of the station and from Toton to Sandiacre the number of tracks would revert to a two track railway at Stanton Gate. The route onwards from Sandiacre is picked up in section 5.5 covering route options from the East Midlands towards South Yorkshire.

Sustainability

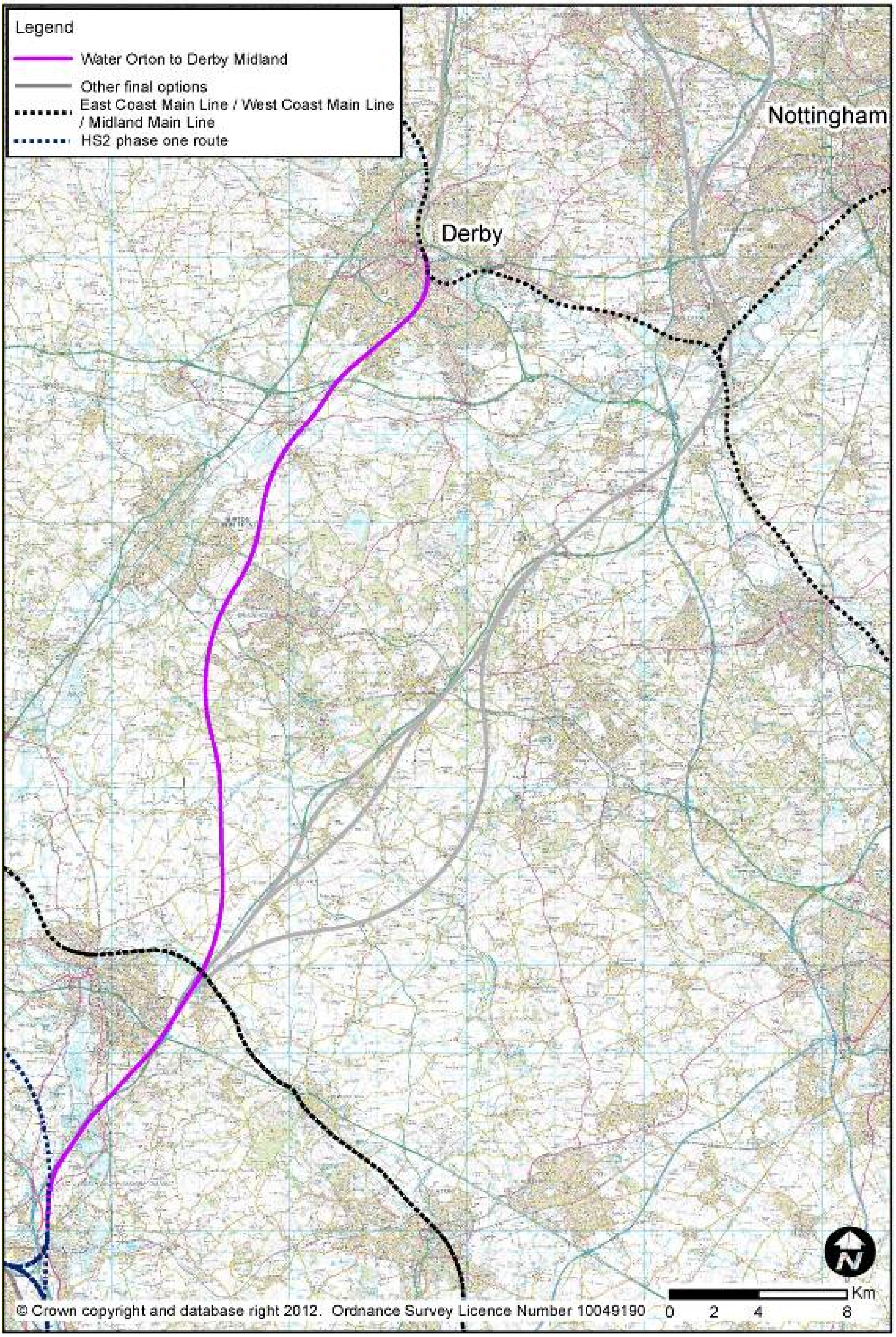
5.3.60 The impacts associated with this route section are a combination of impacts from the HS2 route through this area, realignment of the existing railway, and a result of the station footprint. These are described in detail in the next section. This also describes the numbers of jobs displaced and supported by the development of the station and the number of housing units supported. See the description of the proposed HS2 station at Toton in section 5.4 in particular.

Alternative route – Water Orton to Derby Midland

5.3.61 We now describe the alternative route option from Water Orton to Derby Midland. This route option would run as follows:

- Birchmoor to Sunny Hill
- Sunny Hill to Breadsall

Figure 5.9 - Water Orton to Derby Midland



Source: HS2 Ltd

Birchmoor to Sunny Hill

Engineering

5.3.62 This route option would follow the same alignment, between Water Orton and Birchmoor, as the routes already described, but would head towards the southern outskirts of Derby in order to serve the alternative HS2 station option at Derby Midland.

5.3.63 The route would initially follow the same alignment adjacent to the M42 as far as Birchmoor as already described. It would then cross the WCML and M42 on viaduct before heading almost due north at ground level.

5.3.64 East of Clifton Campville the route would pass over the River Mease SAC and its floodplain on a 180m long viaduct. It would then climb with the terrain in cutting and on embankment before descending in cutting passing over the existing Leicester to Burton railway and skirting the westerly edge of the sewage works.

5.3.65 The route would then pass under the A444 in a gradually deepening cutting past the eastern edge of Burton-on-Trent before passing under the A511 and entering a cut and cover tunnel for 400m through a localised high point.

5.3.66 East of Newton Solney the route would descend into the Trent floodplain, as the landform drops into the valley, crossing the western edge of Repton on viaduct. The route would run through the edge of the proposed Willington Power station major development site.

5.3.67 Further on the route would be on a viaduct to cross the existing railway, Trent and Mersey Canal and the River Trent and its floodplain before returning to ground level at Stenson Fields lying to the west of the Birmingham to Derby railway on the outskirts of Derby adjacent to Sunny Hill.

Sustainability

5.3.68 This section of route would result in the potential demolition of an estimated 35 dwellings.

5.3.69 The proposed M42 viaduct crossings would create a visual impact for the residents on the outskirts of Tamworth and Polesworth as well as for users of Pooley Country Park. The principal impacts would be disruption to landscape character due to the viaduct with visual impacts at Repton and its conservation area, Willington, Stenson Fields and the Derby suburb of Sinfin. The route section would pass through the edge of the proposed Willington Power station major development site.

5.3.70 There would be an impact on the character of the Trent Valley and the Trent and Mersey Canal as a result of the route passing over this area on viaduct. The route could have minor impacts on the setting of the Grade II* listed Pooley Hall.

5.3.71 An HRA screening concluded that it has not been possible to determine whether the route options would have a significant effect on the River Mease SAC Text box 12 describes this in more detail. One SSSI, Alvecote Pools, would be potentially affected by the route crossing which includes four areas of BAP habitat. There would be a high risk of impact to this site. Six further areas of BAP habitat would be affected where the route would cross the River Trent floodplain on viaduct.

Sunny Hill to Breadsall

Engineering

5.3.72 From Stenson Fields to the centre of Derby the route would run alongside, and to the west of, the existing Birmingham to Derby railway. This would require the widening of the existing corridor to accommodate HS2 and its tracks on the approach to Derby station as well as virtually the complete re-build of the existing railway alignments and all the associated infrastructure. The HS2 station option is described in detail in the next section of this report.

Sustainability

5.3.73 The numbers of jobs displaced and supported and houses supported, associated with this section of route would be a result of the proposed HS2 station. These impacts are described in detail in section 5.4. Additional impacts resulting from the station are also set out in that section.

5.3.74 The route section would result in the demolition of 28 dwellings.

5.3.75 To the north of Derby, this route section would cross the buffer of the Derwent Valley Mills World Heritage Site, for just over half a mile (1km). The landscape and visual impacts would be expected to be minor or moderate at worst as a result of the route being screened by existing buildings and trees and as the existing setting is of a largely modern industrial character.

5.3.76 Impacts to the settings of the Grade II* listed Derby Arboretum Registered Park and Garden through this area would be expected to be negligible. There may be a minor visual and noise impact on the Little Chester Conservation Area.

5.3.77 The route would cross the River Derwent where the line would potentially be at risk of flooding and would obstruct flood flows. Continuing scheme design would seek to avoid these impacts or at least minimise their extent.

Routes between Water Orton and East Midlands: Section summary

5.3.78 We described four route options in this section. Three routes would serve the proposed high speed station at Toton. Of these, two cross the River Mease SAC on viaduct at different crossing points to the north or south of Measham. The alternative option would avoid crossing the river by running some distance to the east. The fourth option we described is our single route option to serve the proposed high speed station at Derby Midland that would cross the River Mease to the west.

5.3.79 Route selection will depend first on which station is selected. We explain the costs and benefits of both Toton and Derby Midland in the next section. Once a station choice is made a key issue is how to avoid or minimise any impact on the River Mease SAC. We have described the design work we have already done on this and the productive discussions we have had with Natural England and the Environment Agency. These would continue as design work develops and once a station choice is made.

5.3.80 Whilst we have included a route option to Toton that avoids the River Mease SAC, our assessment is that this has the most significant sustainability impacts. We have retained it though for further discussion with Natural England and the Environment Agency.

5.3.81 Of the two options via Measham, the performance of the options would be generally similar with the route via the north of Measham having a slightly higher cost. Our assessment of noise annoyance, set out in the Appraisal of Sustainability options report, highlights that a larger number of people would be potentially affected by noise from the route via the south of Measham. We retain both route options for future discussion with Natural England and the Environment Agency.

5.3.82 We have a single route option to the proposed HS2 station at Derby Midland. Should this be the preferred station then we would again need to consider the crossing of the River Mease SAC with Natural England and the Environment Agency.

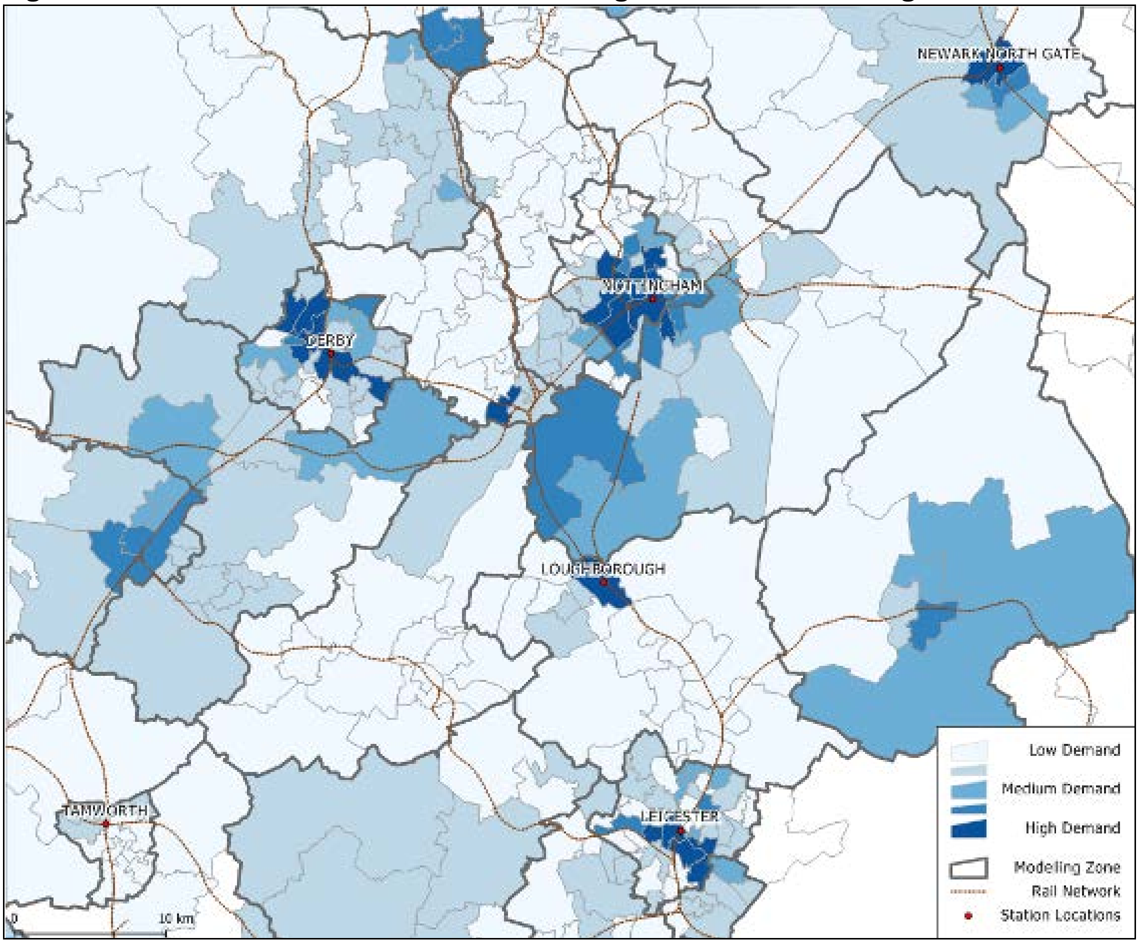
5.4 East Midlands stations

Introduction

5.4.1 This section describes our work developing and assessing station options for the East Midlands. It starts by outlining the work we have undertaken to identify and develop options and the process for sifting them down. It then describes our two final station options for serving the East Midlands in detail.

5.4.2 The East Midlands presented a unique challenge in terms of the development of our station options. It has three main cities, which could all benefit from a high speed rail service and which all have significant demand for long distance journeys. This differed from other station locations where there tended to be one major focus of demand. Our base methodology for finding a station location was the same as that used in the other areas, but the question of how best to serve the region was more difficult.

Figure 5.10 – East Midlands three cities sub-region - demand for long distance travel



Source: HS2 Ltd

5.4.3 Nottingham offers the largest market, followed by Leicester and Derby, and the size of their respective urban populations correlates well with the rail trips generated between the East Midlands and London (see table 5.1). The table also shows trips to the West Midlands. As can be seen from figure 5.1, the demand is focused around the urban areas of the East Midlands.

Table 5.1 East Midlands three cities: population and rail trips

	Nottingham	Leicester	Derby
Population*	668,000	572,500	399,500
Daily trips to/from London & South-East**	3,092	2,568	1,680
Daily trips to/from West Midlands**	1,549	2,031	1,691

**Population counted within a radius of 6.2 miles (10km) from the main railway station in each city*
***Trip numbers based upon National Rail Travel Survey figures, counted within a radius of 6.2 miles (10km) from the main railway station in each city*

Source: HS2 Ltd

5.4.4 As our remit asked us to look at options for serving the East Midlands region, we looked both at interchange station options that if located in the right area would potentially serve the region and options serving cities directly (see text box 13 below on the choice between city centre and interchange station options). For city centre stations we considered options to spur off the main high speed route into the centre as well as running through the cities, either on the main high speed line or on a loop. We also looked at the potential to serve cities in the East Midlands with classic compatibles and that is described later in this section.

13. City centre or interchange

When considering station options for serving the East Midlands and South Yorkshire both city centre and interchange station types were considered.

City centres offer densely populated markets to which high capacity, high speed lines are well suited, with ready access to business destinations. They also provide the hubs for local transport networks. High speed rail works best when it focuses on serving those markets directly. As the established centres of business and commerce, city centre locations are also likely to offer the highest value development opportunities. By running city to city, the maximum benefit can be offered to the most people. City centre stations are more likely to have a comparatively low-speed approach, causing extended journey times for all users and have a higher sustainability impact from building the railway infrastructure into the city centre.

Interchange options are generally out-of-town stations, typically near to a motorway or other major road. Station options tend to be less well located for city centre passengers but better for those who drive to the station from the outskirts. They can potentially be accessed by public transport either by optimising existing links or through investment in new links. As they are less likely to be in well developed locations it is likely, at least initially, that there will be less development and established commerce and businesses. Interchange station options are likely to have a high-speed approach, minimising journey time loss. By potentially being accessible to a wider region such as a specific city centre, they can spread the benefits to a wider market.

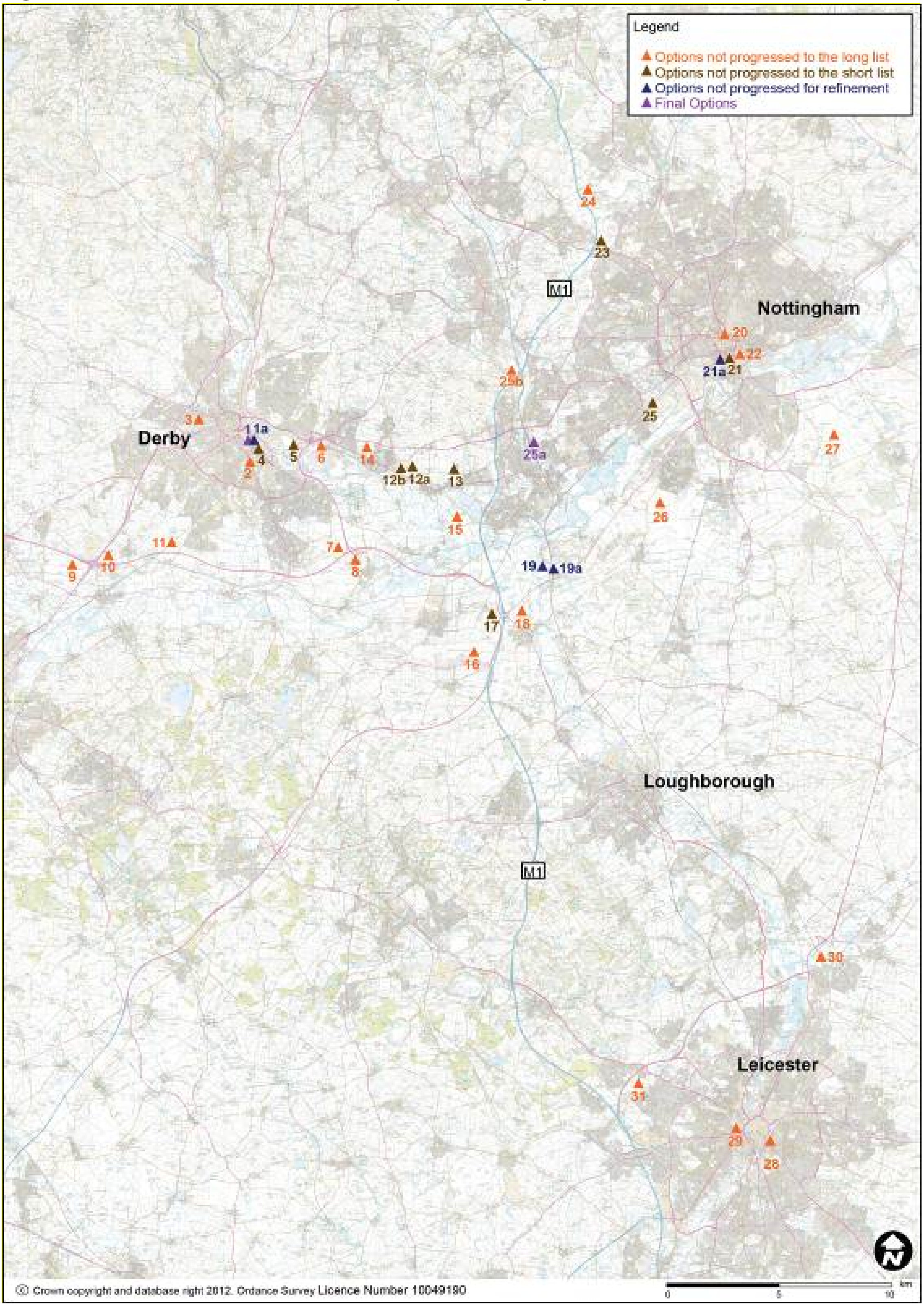
The generation of initial options and sifting down to a long list

5.4.5 As with other locations we started by identifying options within a very wide catchment area independently of the work looking at lines of route through the East Midlands. East Midlands' delivery partners assisted us in confidential option generation, particularly in terms of suggesting development sites. We developed a list of sites clustered around the three cities and also in between where there were likely to be potential lines of route. Figure 5.11 shows all the station options identified and considered and provides an overview of the stage that they were sifted out.

5.4.6 In parallel to our work developing station options, our work on line of route refined the long list of lines through the East Midlands. When we ceased work on a station option, we stopped work on the associated line of route unless it performed particularly well, in which case we continued with our analysis. When a route was not progressed, we would consider developing the associated station further, rather than immediately stopping work on it. This was to ensure that we did not prematurely stop work on a station option simply because we did not have an immediately viable associated line of route.

5.4.7 Options progressed no further are outlined in the table 5.2 with the main reasons for parking the option at this stage.

Figure 5.11 - East Midlands station options sifting process



Source: HS2 Ltd

Table 5.2 – East Midlands station options not progressed to long list

Unique Identifier	Name	Main Reasons for Parking at this stage
2	Pear Tree	Poor proximity to major centres
3	Derby Friargate	Poor Proximity Complexity of route approach
6	Spondon	Poor proximity to major centres
7	Chellaston	No line of route Sustainability impacts
8	Aston on Trent	Sustainability impacts
9	Etwall Common	Would not serve the East Midlands region effectively
10	Toyota	Would not serve the East Midlands region effectively
11	Stenson Fields	Would not serve the East Midlands region effectively
14	Borrowash	Impact on Community
15	St Chad's Water	Poor connectivity
16	East Midlands Airport	Construction impacts and cost
18	Kegworth	Poor proximity to major centres Average connectivity
20	Victoria Centre	Construction costs and impacts
22	Nottingham Midland station East	Inferior to alternative option
24	Rolls Royce	Poor proximity to major centres Poor connectivity
25b	Stanton	Poor proximity to major centres Poor connectivity
26	Clifton	Poor proximity to major centres Poor connectivity
27	Nottingham Airport	Poor proximity to major centres Poor connectivity
28	Leicester Station	Parked as a result of the analysis described in section 5.2
29	Blackfriars	Parked as a result of the analysis described in section 5.2
30	Syston	Parked as a result of the analysis described in section 5.2
31	Glenfield	Parked as a result of the analysis described in section 5.2

The creation of a short list

5.4.8 The process described above resulted in a long list of options around Derby; options closer to central Nottingham and at Nottingham Midland station itself;

and options in the 'gap' between Derby and Nottingham. In the last category we looked at whether a station could serve East Midlands Airport or be located at the existing East Midlands Parkway Station. We carried out more detailed work on these options and on the lines of route that would serve them.

5.4.9 The remaining station options were then assessed to a greater level of detail against the sifting criteria. The following options were not progressed to the shortlist.

5.4.10 Although we have a remit to consider serving major regional airports, the East Midlands Airport market is not significant enough on its own to warrant a station. The Airport ranked twelfth out of UK airports in terms of passenger arrivals and departures in 2010, though it is a significant air freight hub. We did not progress option 17 (Lockington) as it would not perform as well as other interchange stations in terms of connectivity and proximity to demand markets.

5.4.11 We did not progress options 4 (Etches Park) and 5 (Derby Pride Park) as they would not offer any advantages over the other options serving Derby Midland directly, which would allow better access to the city centre and better connectivity.

5.4.12 We refined the options along the A52 between Derby and Nottingham. Options 12a (Draycott, north-east facing), 12b (Draycott, north facing) and 13 (Breaston) would give the potential for the fastest onward journey to Yorkshire and the North East. However, development would be limited as these options would be in the Green Belt. We agreed with delivery partners that the benefits of the faster onward journey did not outweigh the sustainability impacts and the lack of potential for economic development. The three options did not progress any further.

5.4.13 Further north and towards Nottingham was option 23 (Nuthall). The option would be in close proximity to the M1 offering north-south connectivity by road, although it would be towards the north side of the region. However, it was not as good as the proposed option 25a at Toton because of its relatively poor availability of public transport links and the difficulty of improving these. Therefore this option was not progressed further.

5.4.14 Option 25 at Nottingham University Park was considered owing in part to its proximity to Nottingham city centre and potential development areas. It could have the Nottingham tram extended to serve it. It was, however, not felt to offer the demand and connectivity that a station at Nottingham Midland could, so it was not progressed.

5.4.15 We considered whether a station at Nottingham Midland could be feasible (option 21). This would enable direct access to the biggest single market in the East Midlands. As Nottingham Midland is orientated east-west, the line would not naturally fit a route from West Midlands to the north, and there would also be a significant journey time penalty to services northwards. The route would also be significantly more expensive because of the extra track length. Incorporating a HS2 station into the existing station would also be extremely costly and disruptive and would have significant sustainability impacts including on the Grade II* listed station frontage.

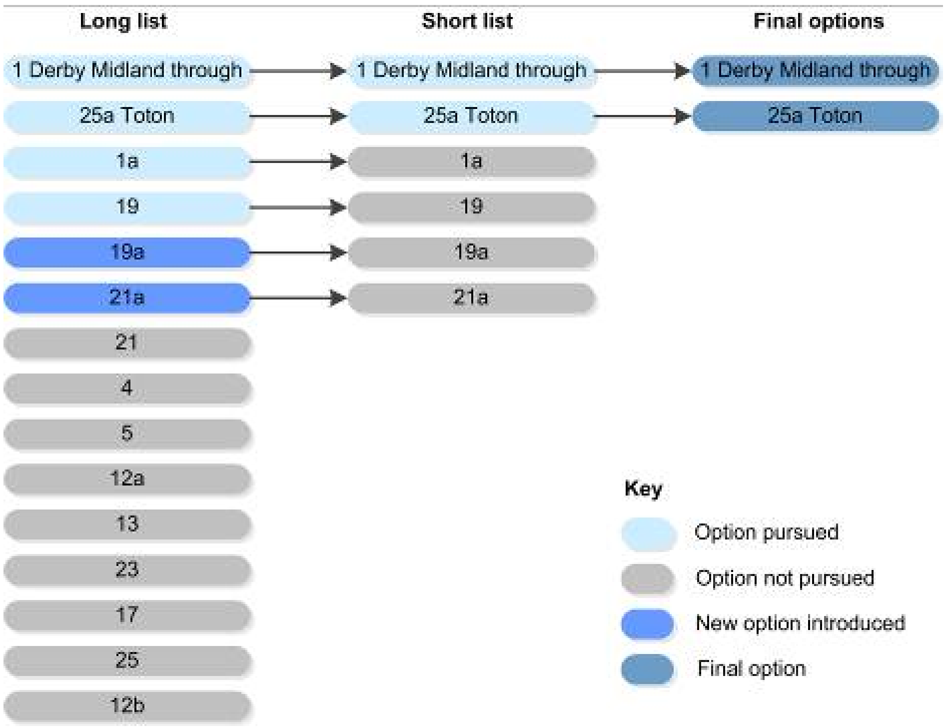
5.4.16 We also ruled out serving Nottingham on a loop off the main high speed line because of the engineering complexity as a significant loop would be required. This would be very costly and would have sustainability impacts. It would also have a journey time impact on services north from this station.

5.4.17 As a consequence it was decided to take an option of serving Nottingham from a spur (option 21a) forward to the next stage. We felt that this offered the most potential to mitigate some of the impacts of option 21.

Selecting options for refinement

5.4.18 As shown in figure 5.12, we were left with a shortlist of options at Derby Midland, Nottingham Midland, East Midlands Parkway and Toton.

Figure 5.12 - East Midlands station long list to final options



Source: HS2 Ltd

5.4.19 We carried out a more detailed assessment of the remaining station options at this sifting stage. With a smaller number of options to appraise, we also carried out new work, which included a socio-economic assessment to determine the potential for options to support growth in the immediate vicinity. Through this work we concluded that a through station at Derby and an interchange station at Toton where worthy of further detailed work.

5.4.20 The following options were sifted out from the short list and not pursued any further.

5.4.21 Option 1a, terminating at Derby Midland Station, was not progressed on demand grounds. It would not support more than one train per hour on its own and as such would be better suited as an intermediate stop, rather than a terminus. It was thought infeasible for a London service, say, to call at Derby and then progress to South Yorkshire and Leeds with a significant journey time penalty from the need to stop and reverse back out.

5.4.22 Therefore it was concluded that if a station were located at Derby, it should be a through station. This would allow the picking up of other markets without significant delay to onward passengers. The sustainability appraisal was broadly the same for both station types and is detailed in the next section for the through station.

5.4.23 A Nottingham Midland spur station (option 21a) would have generated a larger market on its own than Derby, but it would still not justify more than one service per hour to London. The option was not progressed for the same reason as for the Derby spur. Serving Nottingham Midland by classic compatible trains coming off the high speed line onto the existing network would be a cheaper way of achieving the same city centre service and is described in more detail below.

5.4.24 In many ways the intuitive option would be to incorporate an HS2 station with the existing East Midlands Parkway station: already served by classic network trains from right across the East Midlands and beyond and positioned relatively centrally for the three cities. East Midlands Parkway was close to two of the remaining lines of route through the East Midlands. A station at Parkway could offer a similar interchange proposition as Toton. We looked at two variant options (19 and 19a) at East Midlands Parkway on slightly different lines of route.

5.4.25 Option 19 (East Midlands Parkway – south-west approach) would be raised on a high viaduct and as the line of route curves in that area, the footprint would be longer and wider than at other locations. We would propose a link to the existing rail platforms which would allow interchange with a walk time of around five minutes.

5.4.26 Option 19a (East Midlands Parkway – south approach) would follow the existing MML from the south and would require it to be realigned eastwards. As it would be immediately adjacent to the MML it would have the advantage of providing direct interchange. The approach from the south, however, would have significant sustainability impacts.

5.4.27 East Midlands Parkway also sits within the Green Belt. Rushcliffe Borough

Council indicated that this designation was not likely to be reviewed. This would mean that development around East Midlands Parkway would not be supported. This restrictive planning framework was felt to be a significant differentiating factor compared to the potential for development around a station at Toton.

5.4.28 We carried out a rigorous comparison of Toton versus East Midlands Parkway as they both potentially offered a similar interchange proposition for the East Midlands. It was concluded that Toton could be made to work if comparable classic connectivity was provided. Even including costs for this, the East Midlands Parkway options would be more expensive than Toton. Text box 14 below outlines further work carried out on Toton to ensure that it could operate with the existing railway.

14. East Midlands Parkway and Toton – connecting to classic rail

Our demand analysis showed that an interchange station should be connected to public transport to gain the most benefits. We carried out a piece of work comparing Toton to East Midlands Parkway in terms of how each could be served by rail. Parkway is already served by a number of passenger services, but we wanted to understand how it would compare with Toton on a like for like basis, i.e. with the same level of passenger services.

To do this we considered a range of options, from redirecting a number of regional services, to providing new shuttle trains from the three cities to Toton and combinations of the two.

Network Rail carried out a high level assessment of our assumptions to validate them. It concluded that we had allowed for adequate infrastructure to enable the classic network to serve Toton by a combination of redirecting services or providing new shuttles.

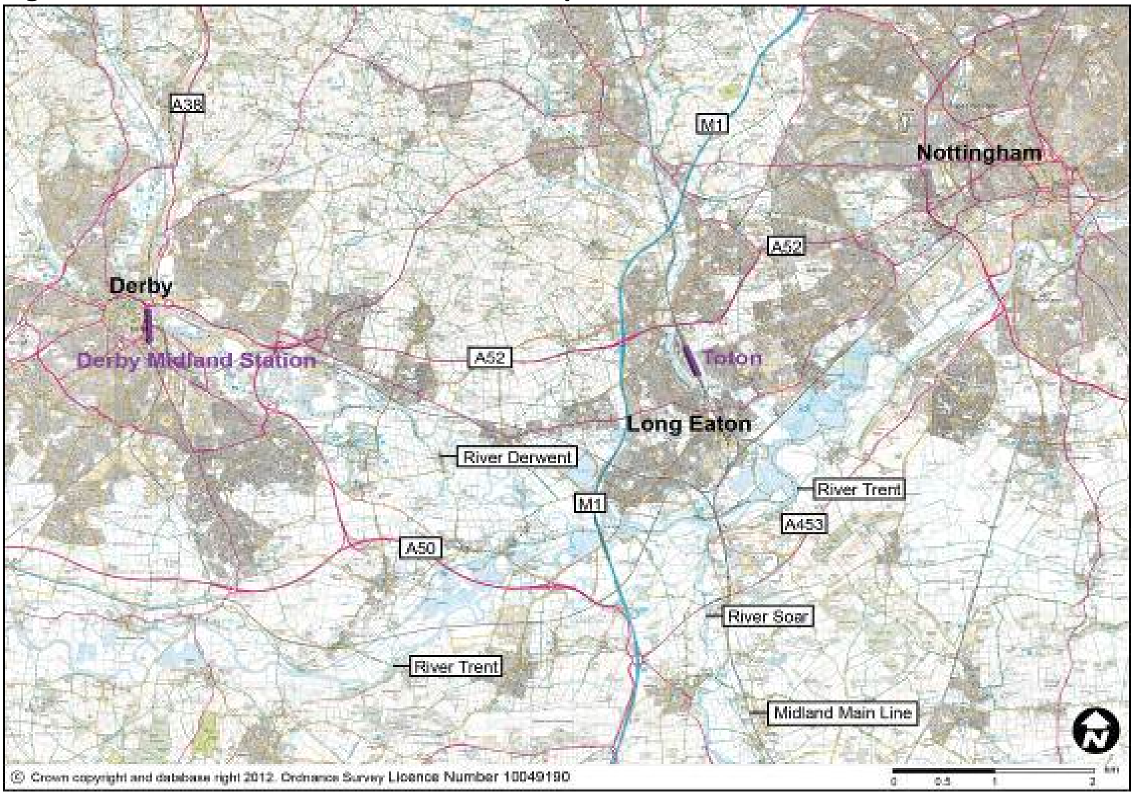
Their report indicated that a station at East Midlands Parkway would have less impact upon existing services than Toton. They were clear that further work would be essential if Toton were progressed, to understand how best to link Toton to the existing rail network whilst minimising any negative impacts on passengers from redirecting services.

If the Government is minded to select this option in the future, we would work closely with Network Rail on this and the detail of what trains would stop at Toton as this represents a significant reordering of the existing railway services.

Developing and finalising our options

5.4.29 Following the rigorous sifting process described above we came to two final options for a high speed station in the East Midlands. These two options, Derby Midland and Toton, are highlighted in figure 5.13. The options are each described below in terms of their engineering and sustainability. We then describe the comparable demand for these station options.

Figure 5.13 - East Midlands stations final options



Source: HS2 Ltd

Final options

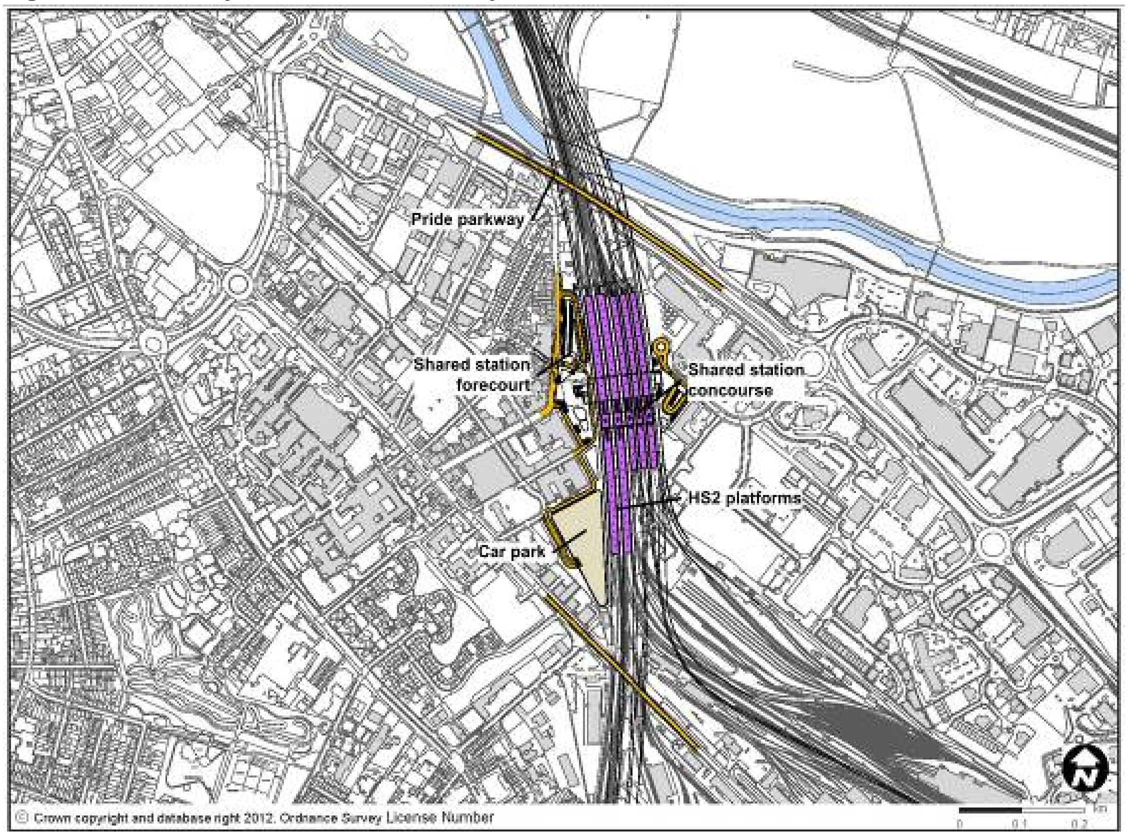
Derby Midland (through station)

Engineering

5.4.30 This option would be an HS2 station on the main line of route going through Derby. The station option would be sited on the existing Derby Midland site to the south-east of Derby city centre.

5.4.31 The station would have four high speed platforms at the same level as the existing platforms and would be integrated into a reconstructed Derby station, providing direct interchange to existing rail services. We would reconfigure the concourse and forecourt to provide additional capacity. An entrance foyer at street level would lead to a new central concourse bridge, providing a pedestrian link between the two sides of the station. The concourse and all station facilities would be located above the platforms, freeing up space on the platforms for passenger movement.

Figure 5.14 Derby Midland station layout

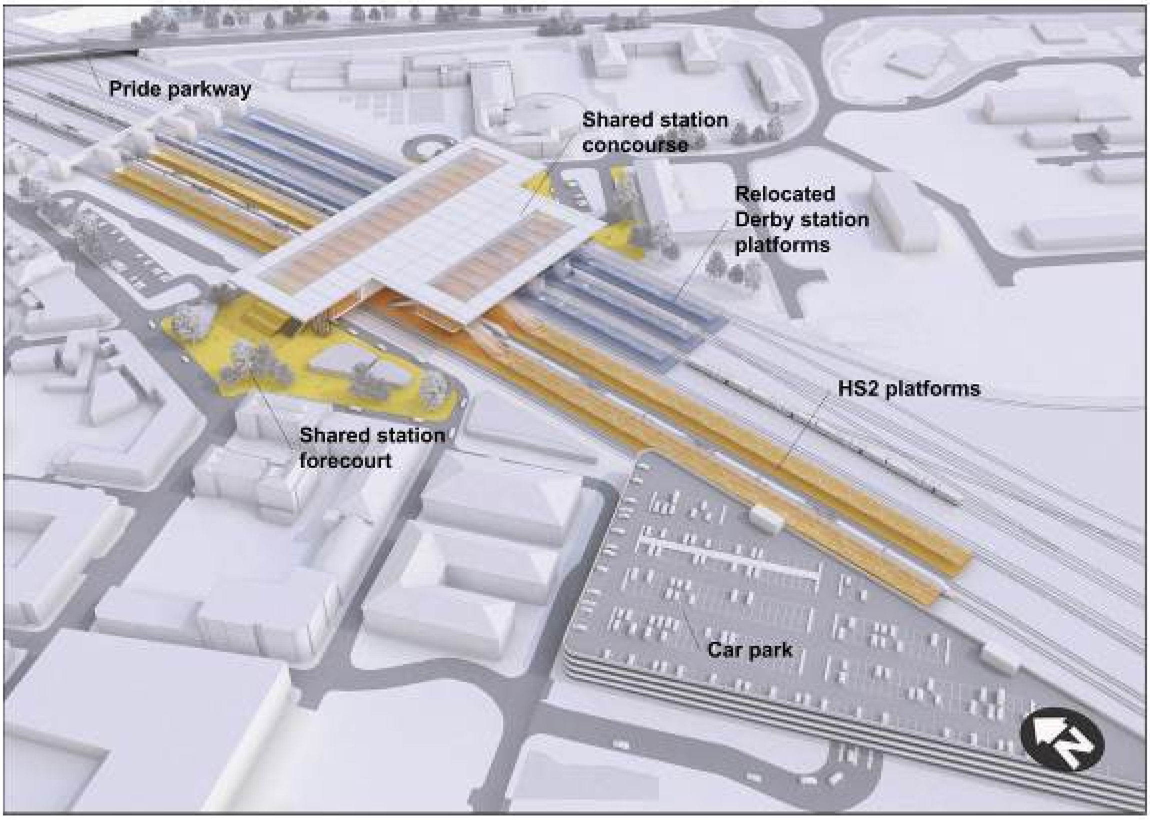


Source: HS2 Ltd

5.4.32 Construction would be phased to minimise disruption, with new Network Rail platforms constructed first so that existing services would remain operational and then switch over. Then the high speed platforms would be constructed on the space.

5.4.33 We would provide taxi and car drop off spaces in the forecourt. Short stay car parking would be located next to the station and a long stay multi-storey car park would be constructed on the site of the existing Derby south station car park.

Figure 5.15- Derby Midland indicative station illustration



Source: HS2 Ltd

Passenger access and dispersal

5.4.34 Derby Midland is a major node on the railway network and is served by a range of east-west and north-south local and inter-city services, with destinations including Sheffield, Birmingham, Leicester, Nottingham and London. Passengers could interchange easily with high speed services in the new station arrangement.

5.4.35 Road access to the station would be from Railway Terrace on the west and Roundhouse Road on the east. Railway Terrace and the western concourse would connect to the city centre and Derby's northern, western and southern suburbs via London Road and Station Approach/Pride Parkway. The eastern concourse would serve Pride Park, Derby's eastern suburbs and traffic from the A52. Good bus connectivity to central Derby and its south-eastern suburbs would be available directly outside the station with new bus stops added to those already there.

Sustainability

5.4.36 The station would require the demolition of 11 dwellings. To the south and north of Derby any visual impact created by the station would be very limited given its existing industrial setting and the route following the existing railway. Therefore, any landscape or visual impacts are expected to be minor or moderate at worst, especially as existing buildings and trees would block views of the viaduct structure.

5.4.37 Our socio-economic analysis suggests the station would potentially displace businesses providing an estimated 1,500 jobs. However, 3,600 jobs would be supported through development around the station generated as a result of HS2. There would be 500 new housing units supported.

Toton

Engineering

5.4.38 The proposed station at Toton would be a new development located between the Nottingham suburbs of Toton and Sandiacre in the Erewash Valley. It would be situated alongside the rail yard north of Long Eaton. The site is bounded to the north by Brian Clough Way (A52), by Toton Yard and the Erewash River to the west and south, and by fields and residential development to the east. The station and its approaches would require alterations to the existing rail lines in the area, though the freight and maintenance facilities to the west of the yard could remain largely as they are apart from changes to access from the through lines.

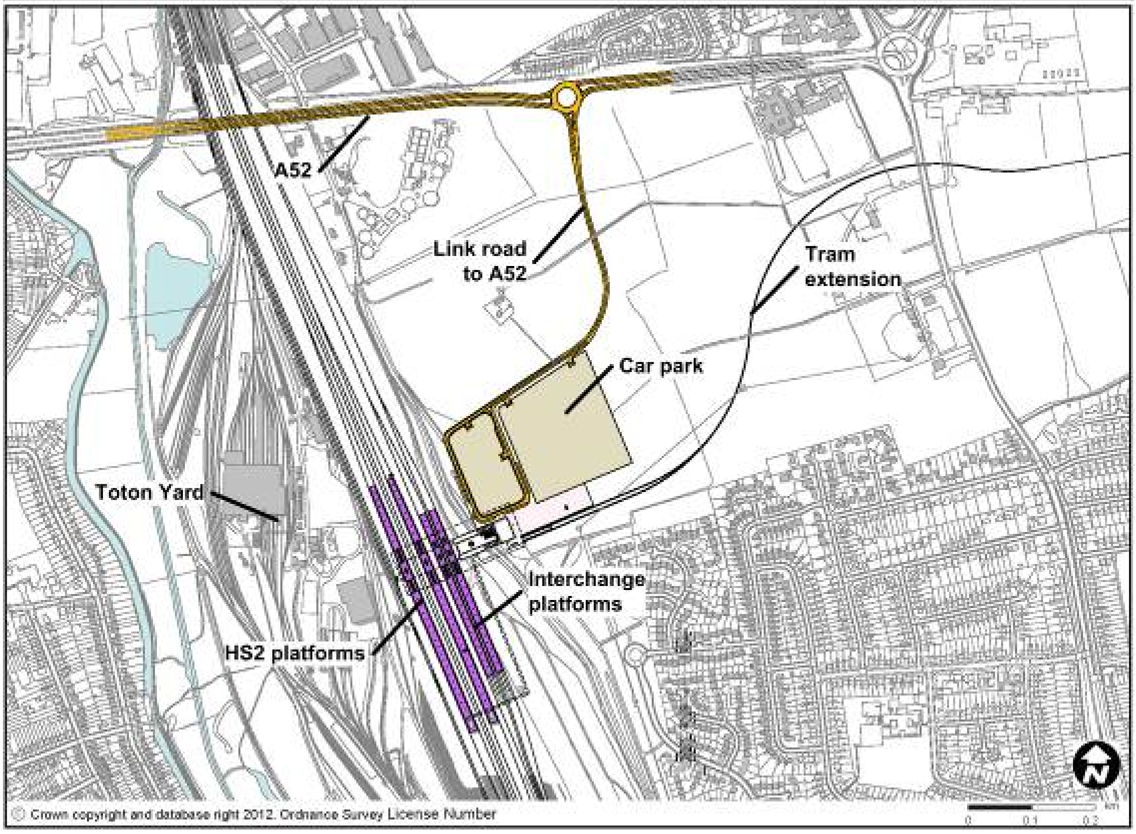
5.4.39 The station would consist of four high speed platforms and four platforms for Network Rail use. There would also be two fast lines through the middle of the station for non-stopping services. The platforms would be at ground level in the valley bottom, with the station entrance and forecourt located above and to the east, with a concourse at an intermediate level connecting the two. The topography of the area would mean that passengers would enter the station at the higher level and would descend to the platforms via stairs, escalators or lifts.

5.4.40 Passenger access would be from a forecourt on the higher ground to the east of the station. Vehicular access would be provided there for taxis and buses. Highway access would be provided from a new junction on the A52.

5.4.41 Over 1300 car parking spaces would be provided in a new car park. The site could also be served by the Nottingham Express Transit (NET) tram. This could be achieved by extending the proposed Tram Line 3, Phase II scheme by approximately half a mile (1km) across Toton Lane to the station which we have included in our cost assumptions.

5.4.42 In terms of constructability, the most significant challenge would likely be modifications to the existing railway infrastructure while maintaining services and highway works on the A52.

Figure 5.16- Toton station layout



Source: HS2 Ltd

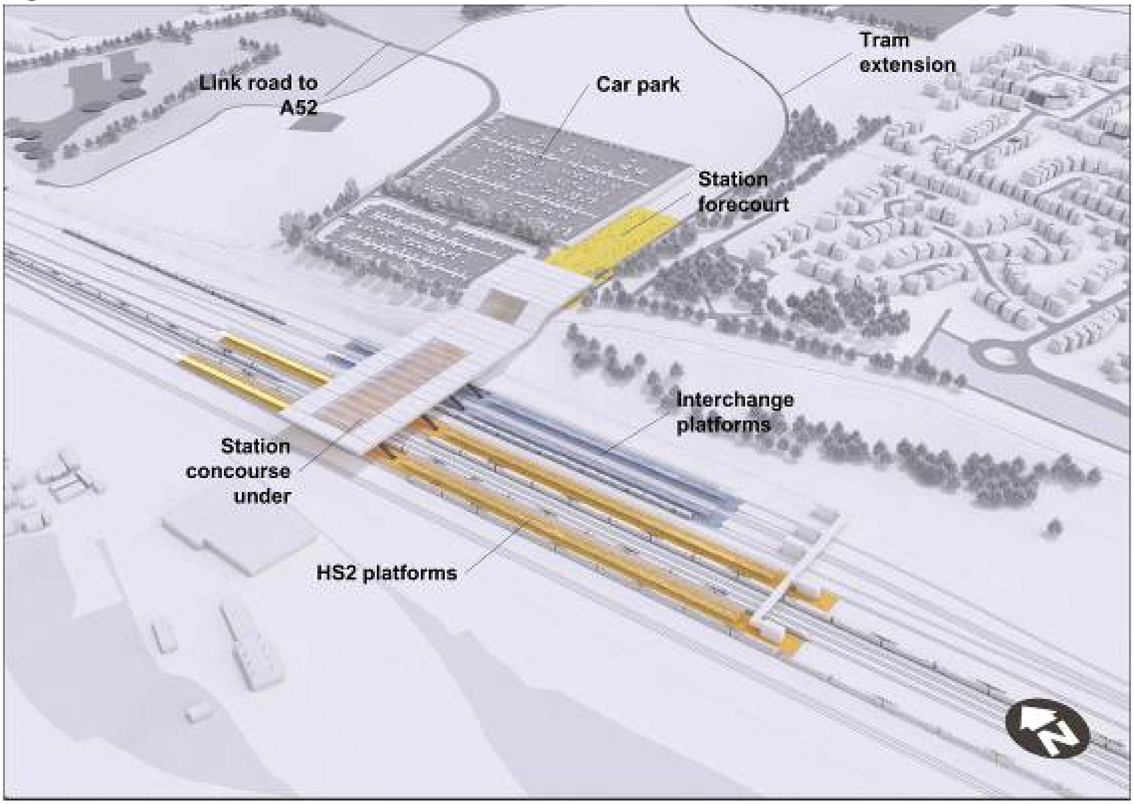
Passenger access and dispersal

5.4.43 Road access would be by a new link road off the Brian Clough Way, the A52. This would offer good road access to and from both Derby and Nottingham. The M1 Junction 25 would be approximately 1.2 miles (1.9km) to the west providing good highway access to the wider region.

5.4.44 Extending the tram to serve the station would allow interchange between the station and central Nottingham, the residential areas of Beeston and Chilwell and the University of Nottingham and Queens Medical Centre. Local bus services would also be enhanced to serve the station.

5.4.45 The station would provide interchange between HS2 and the existing rail services from Nottingham, Derby and Leicester as well as other locations in the East Midlands and beyond.

Figure 5.17- Toton station indicative station illustration



Source: HS2 Ltd

Sustainability

5.4.46 The station would result in the potential demolition of 23 dwellings. The track works south of the station associated with provision of the shuttle service would require the demolition of an additional 13 dwellings.

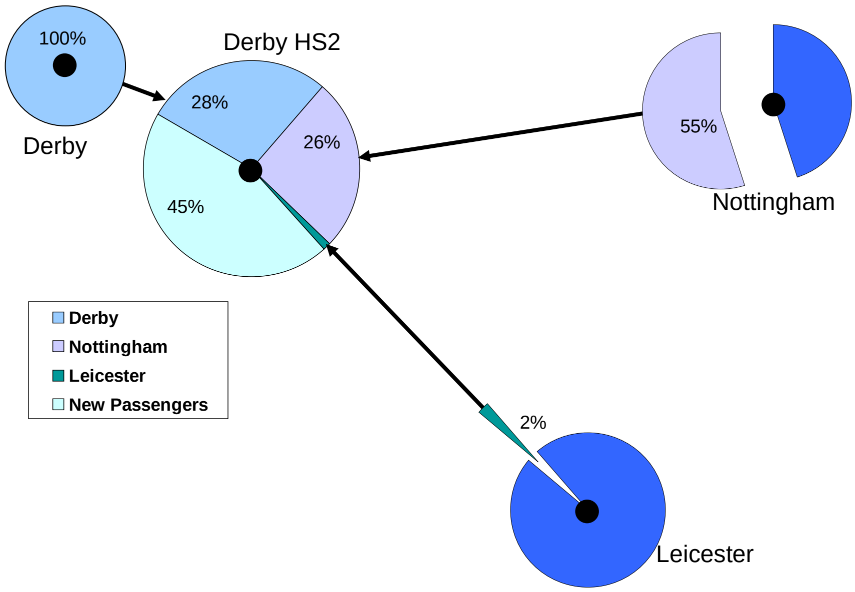
5.4.47 The station would involve the development of greenfield land to provide the new access road to the A52 across open, farmed hillside. The new station would be sited on the east side of Toton Yard and would step up the hillside from the valley floor. There would be one Grade I listed church (St Giles) adjacent to the north approach to the station, but impacts on its setting would be minor.

5.4.48 The station would potentially displace businesses providing an estimated 600 jobs. However, 1,500 jobs and 150 houses would be supported through development around the station generated as a result of HS2.

5.4.49 The station would lie within the Borough of Broxtowe, with part of the construction boundary in the Borough of Erewash. It is currently designated as Green Belt. Planning officers at Broxtowe Borough Council have stated that a HS2 station at this location would be likely to be supported with the potential release of adjoining Green Belt land for appropriate development.

Demand: Derby Midland and Toton

Figure 5.18– Demand changes in East Midlands – Derby station

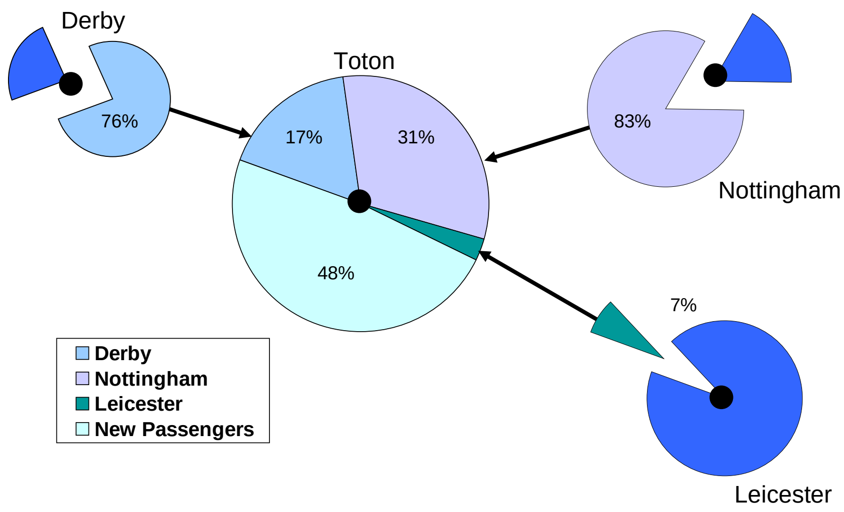


Source: HS2 Ltd

5.4.50 Figure 5.18 above indicates how the demand for travel to London changes when we introduce a new high speed station at Derby Midland. It shows the proportion of passengers moving from the existing stations to the HS2 Derby Midland and what proportion of total demand those passengers would represent at the new HS2 station.

5.4.51 The figure shows that a high speed station at Derby would be used by the majority of people already using Derby Midland to go to London because of the faster journey time. It would also attract just over half the passengers who would have used the existing Nottingham Midland service though around 45% would continue to use the existing service as a result of the additional time to travel to Derby. As already explained, we would not expect many passengers to travel north from Leicester to go to London because of the distance they would have to travel and the already very good existing rail service. A high speed station at Derby Midland would therefore be expected to generate around 45% of its total passenger trips to London from new passengers. Overall, our demand modelling suggests that around 7,000 passengers daily would use the HS2 station at Derby to travel to London.

Figure 5.19– Demand changes in East Midlands – Toton station



Source: HS2 Ltd

5.4.52 Figure 5.19 above indicates how the demand for travel to London changes when we introduce a new high speed station at Toton. It shows the proportion of passengers moving from the existing stations to the new Toton station and what proportion of total demand those passengers would represent at the new HS2 station.

5.4.53 The figure shows that over three quarters of passengers currently using Derby and Nottingham would use Toton for journeys to London. A small number of passengers from Leicester would use the Toton service though, as with Derby Midland, most would continue to use the existing good service. Those who would transfer would predominantly come from the area between Leicester and Toton who would find the HS2 station at Toton preferable to travelling to Leicester. A high speed station at Toton would therefore be expected to generate around 48% of its total passenger trips to London from new passengers. Overall, our demand modelling suggests that we would expect around 8,500 passengers daily would use the HS2 station at Toton to travel to London, noticeably more than the Derby option.

Comparative demand analysis

5.4.54 Figures 5.18 and 5.19 highlight how demand changes with an HS2 station located at either Derby or Toton. Figure 5.19 shows that the option at Toton would serve a wider area of the East Midlands, due to its ability to pull in larger numbers of passengers from a wider area of the East Midlands. As well as capturing a sizeable proportion of the Derby market, the station at Toton would be better at serving Nottingham and Mansfield than the option at Derby Midland. The option at Derby Midland would better serve Derby and the wider Derbyshire region and would also attract passengers from Nottingham, but less than the option at Toton.

5.4.55 As a result, a station at Toton would generate benefits of £550 million (PV) and revenue of £190 million (PV) compared to the equivalent service through Derby Midland, due to the wider area of impact and the greater number of passengers attracted to the station.

Classic compatibles

5.4.56 The station option at Toton and its surrounding infrastructure would support classic compatible running into Derby, Nottingham or Leicester, subject to demand and competing services. These are our high speed trains that are also able to run on the existing railway network as well as the high speed network.

5.4.57 We carried out high level work to assess the option of running classic compatibles. As Nottingham, of the three cities, is currently least well served by rail today and has the highest demand, we looked particularly at classic compatible services from there. Our initial analysis suggested that Derby may offer a similar proposition but we would need to appraise this further.

5.4.58 There would not be a case for classic compatible trains from Leicester going to Toton and then south but delivery partners expressed interest in services going north from Leicester. This would be possible with the infrastructure if demand dictated that the additional costs were worth it.

5.4.59 In the Nottingham scenario, a 200m train from London to Nottingham would arrive at Toton station, but would then reverse to travel south, before crossing over onto Network Rail infrastructure on the high-level lines through the Long Eaton area. It would then run towards Nottingham via Meadow Lane Junction, before joining the Trent to Nottingham route at the Attenborough Junction. In the reverse direction, trains would leave Nottingham before entering Toton station on its easterly side, where they could be joined by another 200m set from elsewhere.

5.4.60 The following infrastructure works would be required:

- crossovers on the widened length of railway on the high-level lines at Long Eaton;
- at Attenborough Junction, grade separation may be required across the junction in the east to north-west direction to prevent conflict between increased service in this direction and the existing Nottingham-bound trains from the south;

- resignalling could be required between the new intersection and Trent Junction as the existing headway may not support the increase in trains; and
- all affected lines would need to be electrified, unless the potential MML electrification had already undertaken such works.

5.4.61 We have done some limited early investigation into some aspects of the potential for classic compatible services in the East Midlands. This was not to the exact infrastructure specification described above but does give an idea of some of the potential for classic compatible services. As we described at the start of this section, classic compatible services serve limited destinations and also use one of the available train paths. There therefore has to be high demand for the service.

5.4.62 We tested what would happen if we added one train per hour from London to Nottingham direct. This service generated additional benefits of around £200 million (PV) and revenue of around £100 million (PV). We also looked at the potential for one train per hour from Birmingham to Nottingham. This service generated additional benefits of around £180 million (PV) and revenue of around £50 million (PV). We would expect much smaller benefits for a service from Derby as the existing service is significantly better than the equivalent from Nottingham.

5.4.63 If the option at Toton were to progress, there may be a case for further work on the opportunity of running classic compatible services into East Midlands cities. We would also need to assess the benefit from using a train path in this way. We would undertake more detailed analysis should it be requested.

East Midlands Stations: Section summary

5.4.64 In this section we described our station sifting process for the East Midlands culminating in two final options being presented, a city centre station at Derby Midland and an interchange station at Toton. We have reflected on the trade-offs between city centre and interchange stations.

5.4.65 Our remit asks us to consider station options that serve the East Midlands region. As our demand analysis reflects, the proposed station at Toton would be better placed to do this, with a wider catchment area across the East Midlands. An HS2 station at Derby Midland would inevitably serve Derby and the Derbyshire region well but would not serve the wider region as effectively. The proposed station at Toton therefore delivers higher benefits.

5.4.66 We note that, as an established city centre, Derby has the potential to attract more employment and housing growth, which an HS2 station has the potential to support. An HS2 station at Toton would have the potential to support development too, and in this regard it is important that local Council officers have indicated that appropriate development would be considered if an HS2 station is proposed at this location.

5.4.67 A station at Derby would be well placed to access existing transport infrastructure but, as we have described here, we are also confident that the station at Toton could be an HS2 interchange station that is fully connected with good roads and passenger transport access.

5.5 Routes between East Midlands and South Yorkshire

5.5.1 In this section we cover the line of route options between the East Midlands and South Yorkshire. We developed line of route options within the broad corridor described in section 5.2. This section describes how we arrived at the three main route options from the East Midlands to South Yorkshire.

5.5.2 We described in the last section our remaining HS2 station options at Derby Midland and Toton. These are effectively on different sides of the East Midlands region. As a result we present in this section route options from both Derby Midland northwards and route options from Toton northwards. The decision on which East Midlands station is preferred will therefore influence route choice. If the HS2 station at Derby Midland is taken forward then we have a single route option broadly following the A38. If the station at Toton is selected then we have two final route options either broadly following the M1 or the Erewash Valley. All three routes converge at a common point in north Derbyshire becoming a single route option heading on through South Yorkshire.

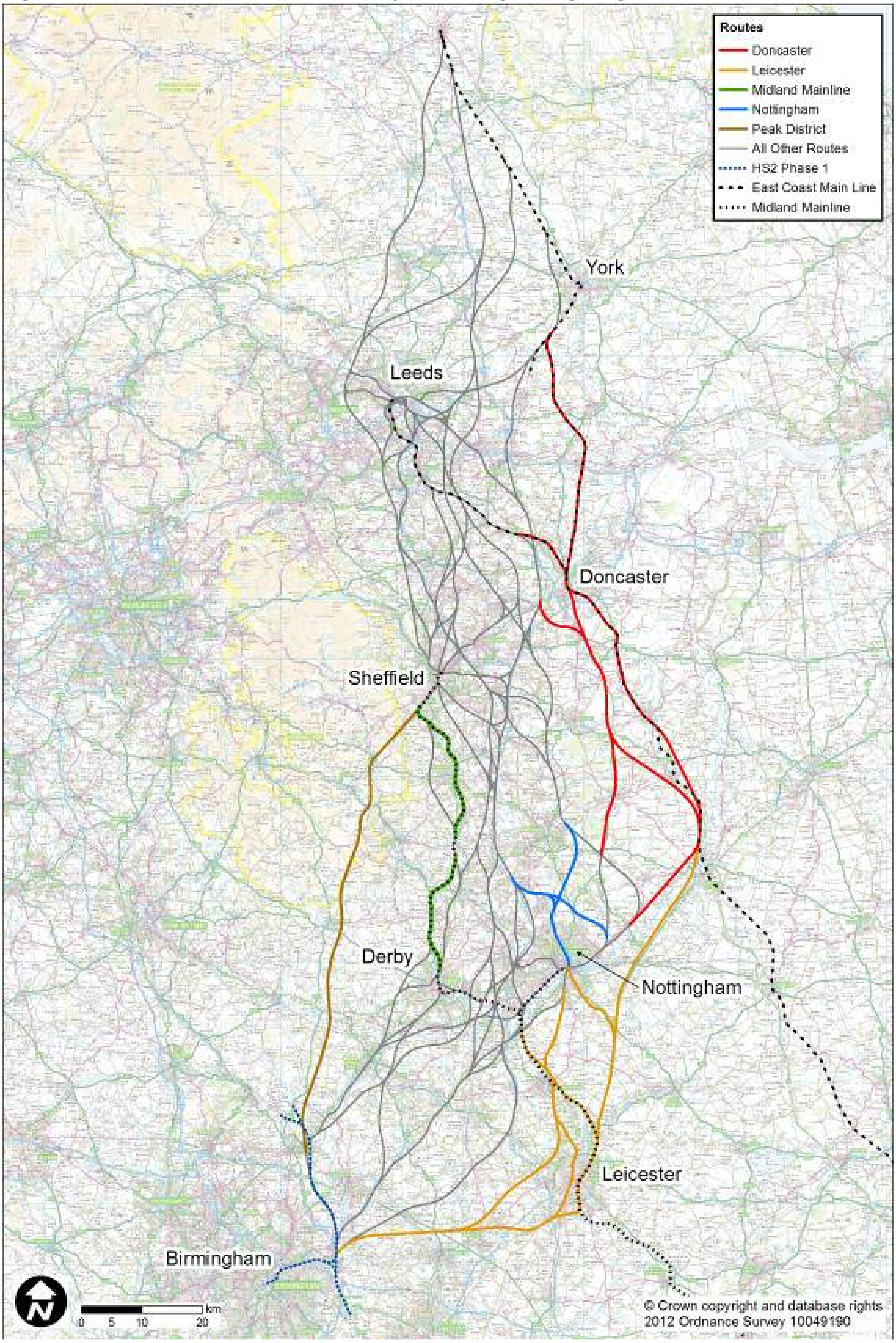
5.5.3 In presenting the final route options we also describe in more detail how our routes have been developed to avoid or minimise any impact on three important sustainability features in particular, Hardwick Hall, Sutton Scarsdale and Bolsover Castle. Their collective location and the constraints of the wider area, has influenced the development of our route options.

5.5.4 Before describing these route options in detail we describe the sifting stages we went through covering all the options that were initially considered through to the routes that remain.

The generation of initial ideas and the sifting down to a long list

5.5.5 The generation of ideas for routes led to a large number of route options being initially developed. The route sections parked at this stage are set out on figure 5.20 and briefly described below.

Figure 5.20 – South Yorkshire route options long listing stage



Source: HS2 Ltd

Doncaster
('Doncaster' on figure 5.20 above)

5.5.6 The group of routes which would pass through or to the east of Doncaster, from the Nottingham area towards the York area were not taken forwards beyond this stage. These route options would not serve the densely populated parts of South Yorkshire. In addition, routeing HS2 via Doncaster would provide no connection to a South Yorkshire station because of the sifting decisions described in section 5.6. Construction through Doncaster would also have been complex and disruptive.

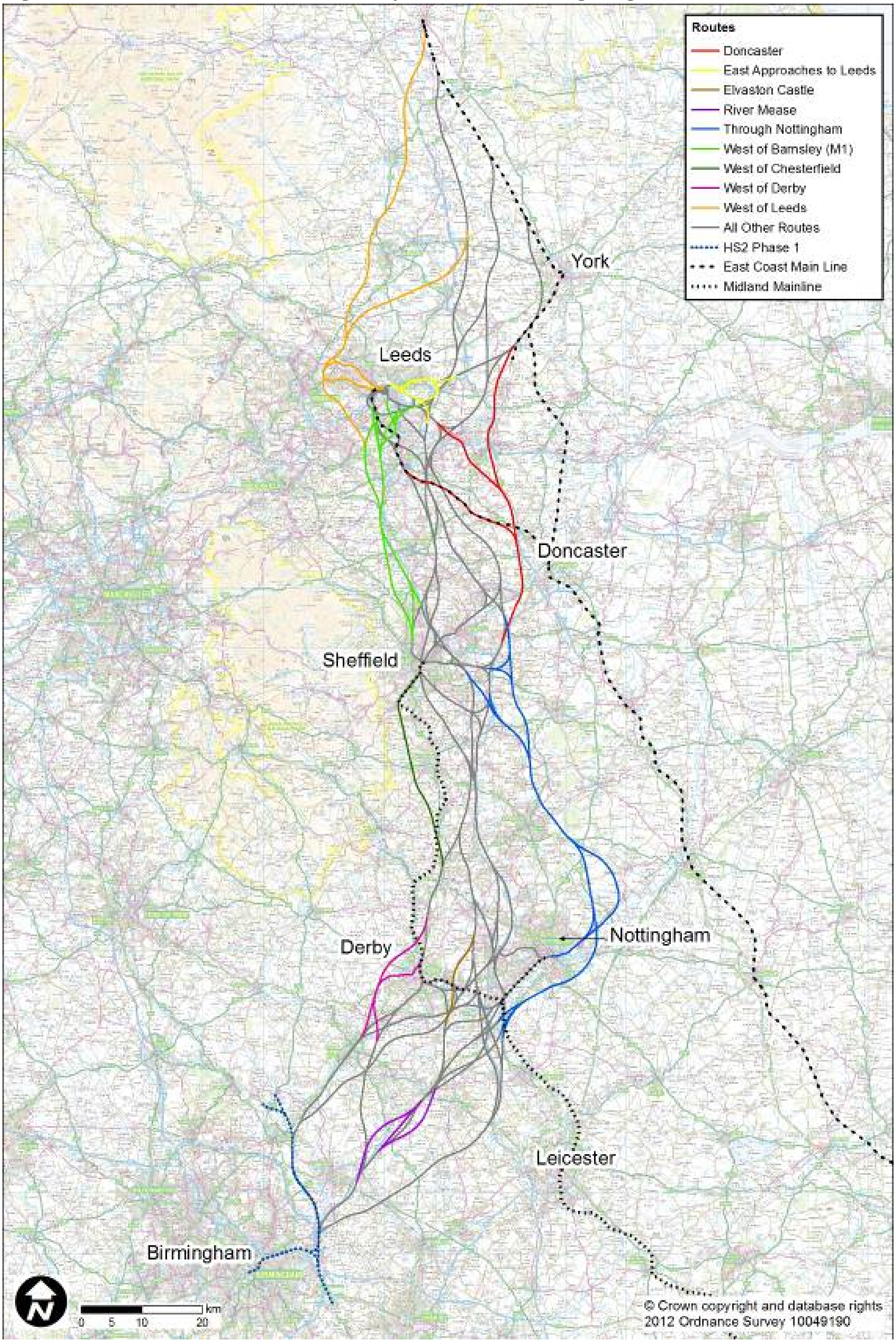
Midland Main Line from Derby to Sheffield
('Midland Main Line' on figure 5.20 above)

5.5.7 The route option from Derby to Sheffield following the Midland Main Line (MML) corridor was also not developed beyond this stage. This route would involve adding two additional tracks alongside the MML from the Derby area to Sheffield via Dore. This route option would not meet the speed and journey time aspirations of other competing routes. The route would require heavy engineering works through challenging terrain and through heavily populated areas along the MML. At its southern end the route would also pass through the Derwent Valley Mills World Heritage Site.

The creation of a short list

5.5.8 The routes taken forward as a long list of options were developed to the next level of detail as described in chapter 3. As station options were progressed and developed new line of route options were also developed to serve these options. Conversely, as station options were sifted out of the process the associated line of route options were also sifted out. The outcomes of this process are set out on figure 5.21 and described below.

Figure 5.21 – South Yorkshire route options short listing stage



Source: HS2 Ltd

East of Rotherham

(included as part of 'Doncaster' on figure 5.21 above)

5.5.9 A route option was considered that would broadly follow the A1(M) north of the Doncaster area with the aim of following an existing transport corridor. The A1(M) corridor passes around 6.2 miles (10km) to the east of Leeds and as a result a greater length of new track would be required in order to provide the connection into Leeds compared to other comparable routes. The route would be challenging to construct, would impact on a number of SSSIs and would require more demolitions than comparable routes.

West of Chesterfield

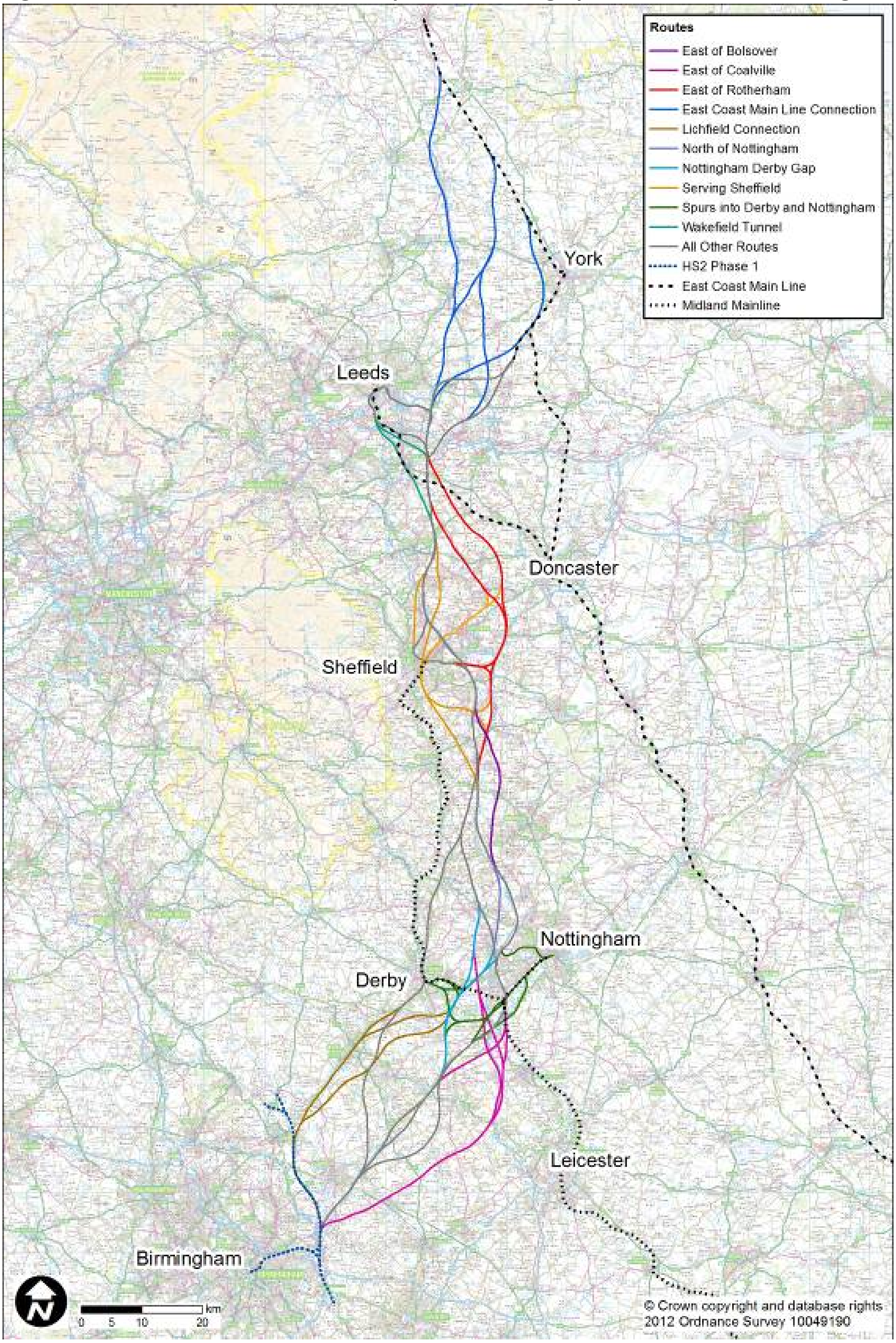
('West of Chesterfield' on figure 5.21 above)

5.5.10 A route option was considered that would pass around the western side of Chesterfield before joining the existing railway corridor to reach Sheffield Midland station. This route would pass through challenging topography at the foothills of the Derbyshire Peak district with approximately 6.2 miles (10km) of new tunnel making this route comparatively more expensive than other alternatives.

Selecting options for refinement

5.5.11 The remaining route options after short listing were then developed in further detail ahead of a final sift to reduce the number of options. This process led to the further refinement of options using the pair-wise comparison process again. The outcomes of this further process are indicated on figure 5.22 and described below.

Figure 5.22 – South Yorkshire route options selecting options for refinement stage



Source: HS2 Ltd

Toton to Sheffield

(Grouped with 'Serving Sheffield' on figure 5.22 above)

5.5.12 At this stage three broad route options from Toton towards Sheffield had been short listed. We chose not to take forward the route option via Cossall as it was inferior to the other two options via the M1 and Erewash Valley, particularly from a sustainability perspective where this option would potentially impact on a Grade I listed church which would be difficult to avoid. We therefore chose not to develop this route option further.

Serving Sheffield

('Serving Sheffield' on figure 5.22 above)

5.5.13 As our work progressing station options developed, we explored route options through Sheffield and options to loop round to Sheffield before connecting back with the high speed route further north.

5.5.14 The group of options from the south would all require tunnels under hilly terrain and would pass under urban areas. The more direct options would also require significant tunnels under the Grade I listed Sutton Scarsdale (see text box 15 for a description about this designation), Staveley and the Gleadless Valley, to emerge in the centre of Sheffield. Lowering speed through these areas would reduce the tunnel requirements but would still have a significant capital cost compared to the benefits.

5.5.15 Options north from Sheffield would either involve following the existing railway at a low speed or entering tunnel to pass under the northern suburbs of Sheffield. The former would require the elevation of the high speed route over floodplain and to avoid existing infrastructure whilst the latter would involve extensive tunnelling.

5.5.16 As a result through or loop route options were not taken forwards because of the length of tunnel they required, the negative journey time impacts of the lower speed options and the capital cost outweighing any potential benefits.

Sheffield spurs

('Serving Sheffield' on figure 5.22 above)

5.5.17 Two spur route options into Sheffield were evaluated at this stage. The first spur option would diverge from the through route following the M1 with a spur into Sheffield Midland via the Sheffield to Worksop line. The alternative spur option would diverge from the through route following the M18, east of Rotherham, with a longer spur into Sheffield Midland again via the Sheffield to Worksop line.

5.5.18 The spur from a through route which would run parallel to the M1 would pass through a more built up environment and would therefore potentially have a comparably larger noise and demolition impact. This spur would also require complex engineering around Orgreave, with a major development site in the area, and would have a more significant impact in comparison to the spur from a through route which would run parallel to the M18, east of Rotherham, which could be more easily mitigated.

5.5.19 The spur from the through route running parallel to the M18, east of Rotherham, was also considered lower risk in terms of geotechnical issues, avoiding more of the shallow mining and opencast workings though still affected by a number of recent and historical opencast workings. In addition to the engineering issues, key to our decision not to take the spur options forward was our understanding of the impact on demand. This is described in more detail in the next section of South Yorkshire station options.

East of Bolsover

('East of Bolsover' on figure 5.22 above)

5.5.20 A route option was considered that would pass around the eastern side of Bolsover but not following the M1 corridor. The terrain along this route is challenging with a tunnel required under Sutton-in-Ashfield. In addition large cuttings and embankments as well as steep gradients are required to reach the higher plateau to the East of Bolsover. At this stage the decision was taken not to progress this route further.

Developing and finalising our options

Route options between East Midlands and South Yorkshire

5.5.21 The emphasis at this stage was on the refinement and mitigation of the route options taken forward from the previous stage rather than a reduction of options. A high level summary of the engineering and sustainability features that would influence the costs and benefits of the routes is described below.

5.5.22 From the proposed station option at Toton there would be two route options, one of which would broadly follow the M1 corridor and one which would broadly follow the Erewash Valley rail corridor. From the alternative proposed HS2 station at Derby Midland, the route option would head north and broadly follow the A38 corridor as far as Alfreton before converging with the Erewash Valley route option at Tibshelf.

5.5.23 The route option from Toton following the M1 converges with the other two routes at a common point in north Derbyshire near Killamarsh. From here all three routes follow the same alignment through South Yorkshire.

5.5.24 The principal station options are at Meadowhall on the main high speed through line described in this section and, as an alternative proposition, a station at Sheffield Victoria in the city centre served by a loop that would leave the HS2 through line at Orgreave and reconnect with it south of Chapeltown. We describe the loop in this section. The stations are described in detail in section 5.6.

Proposed route options and alternatives

Overview

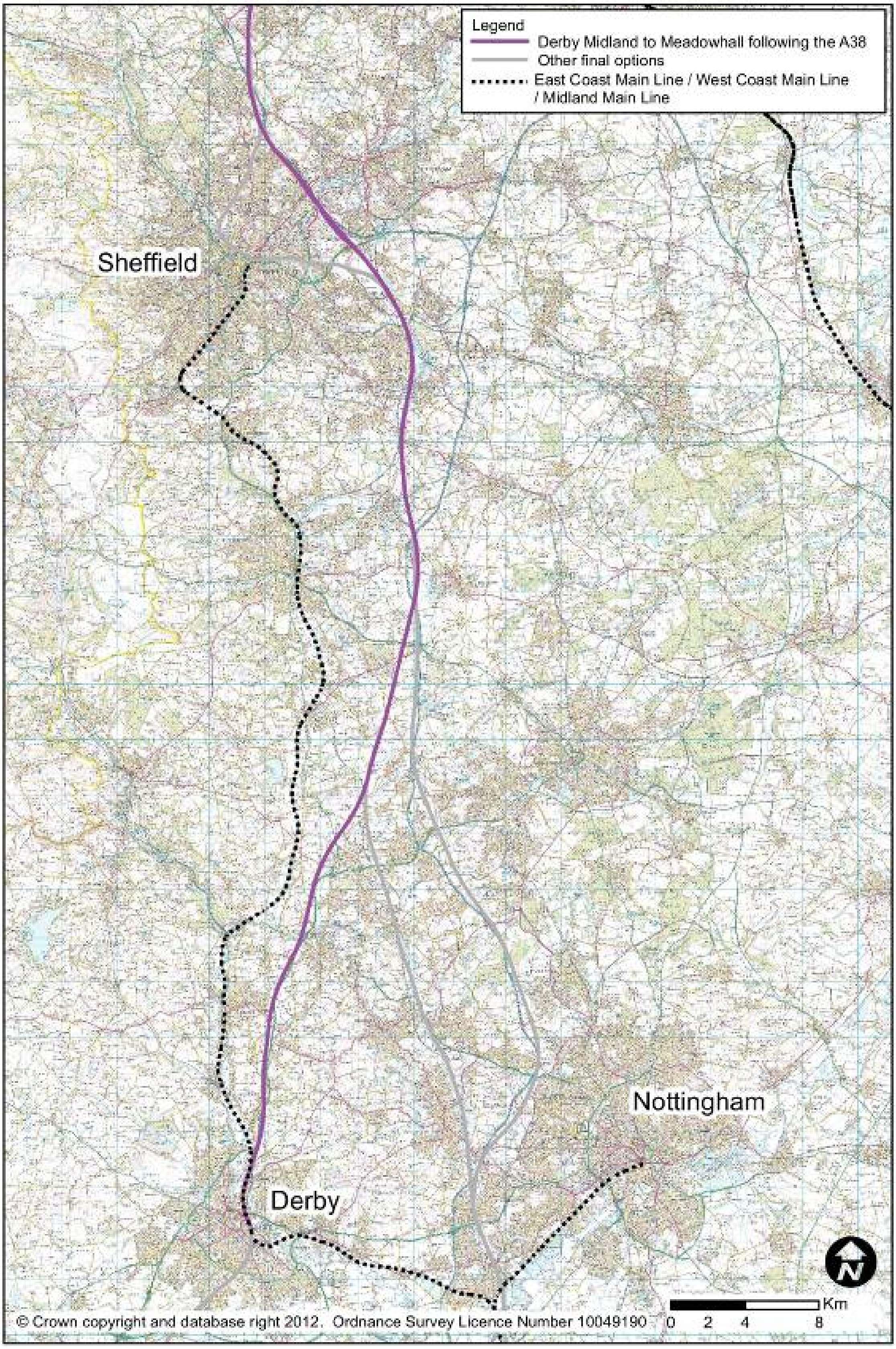
5.5.25 We now describe the first part of the route option from the proposed station at Derby Midland which would run from Breadsall to Tibshelf. We then describe the first part of the route option from Toton following the Erewash Valley which runs from Sandiacre to Tibshelf. At this point these two routes converge and we describe the common alignment that both would follow as far as Killamarsh.

5.5.26 We then describe the third route option from Toton broadly following the M1 which would run from Trowell to Killamarsh.

5.5.27 From Killamarsh onwards all three route options follow the same alignment to Tinsley and then onwards to Blackburn with a potential HS2 station at Meadowhall or at Sheffield Victoria via a loop off the high speed main line.

Derby Midland to South Yorkshire

Figure 5.23 - Derby to South Yorkshire via the A38



Source: HS2 Ltd

Breadsall to Tibshelf

Engineering

5.5.28 This section of route is characterised by undulating and more challenging topography, resulting in substantial cuttings, embankments and tunnel sections. North from Derby station the route would follow the existing railway towards Breadsall requiring alterations to the Network Rail infrastructure and running adjacent to the Derwent Valley Mills World Heritage Site. The route would pass over the existing Derby to Sheffield railway and A61 before entering tunnel at Little Eaton.

5.5.29 On the exit from the tunnel, the route would pass on viaduct parallel to the B6179 and A38 between Holbrook and Horsley. After a short stretch on embankment, the route would rise towards higher land in cutting to pass between Cinderhill and Belper.

5.5.30 Further north the route would adopt the alignment of the A38 with the road realigned to the east over a length of 1.2 miles (2km). There would then follow a series of deep cuttings, high embankments and viaducts prior to leaving the A38 corridor west of Alfreton.

5.5.31 The route would cross over Oakerthorpe Brook, affecting the Alfreton Golf course before crossing the A615 Wingfield Road, the A61, Alfreton Brook and B6025. The route would then pass over the Erewash Valley line on viaduct before lying to the west of Tibshelf.

Sustainability

5.5.32 This route section would result in the potential demolition of an estimated 15 dwellings. This route would intersect the designated buffer of the Derwent Valley Mills World Heritage Site for around 600m. Given the nature of the modern industrial setting and the screening provided by buildings and trees, the viaduct through this area would be partially screened and the visual impact minor or moderate at worst.

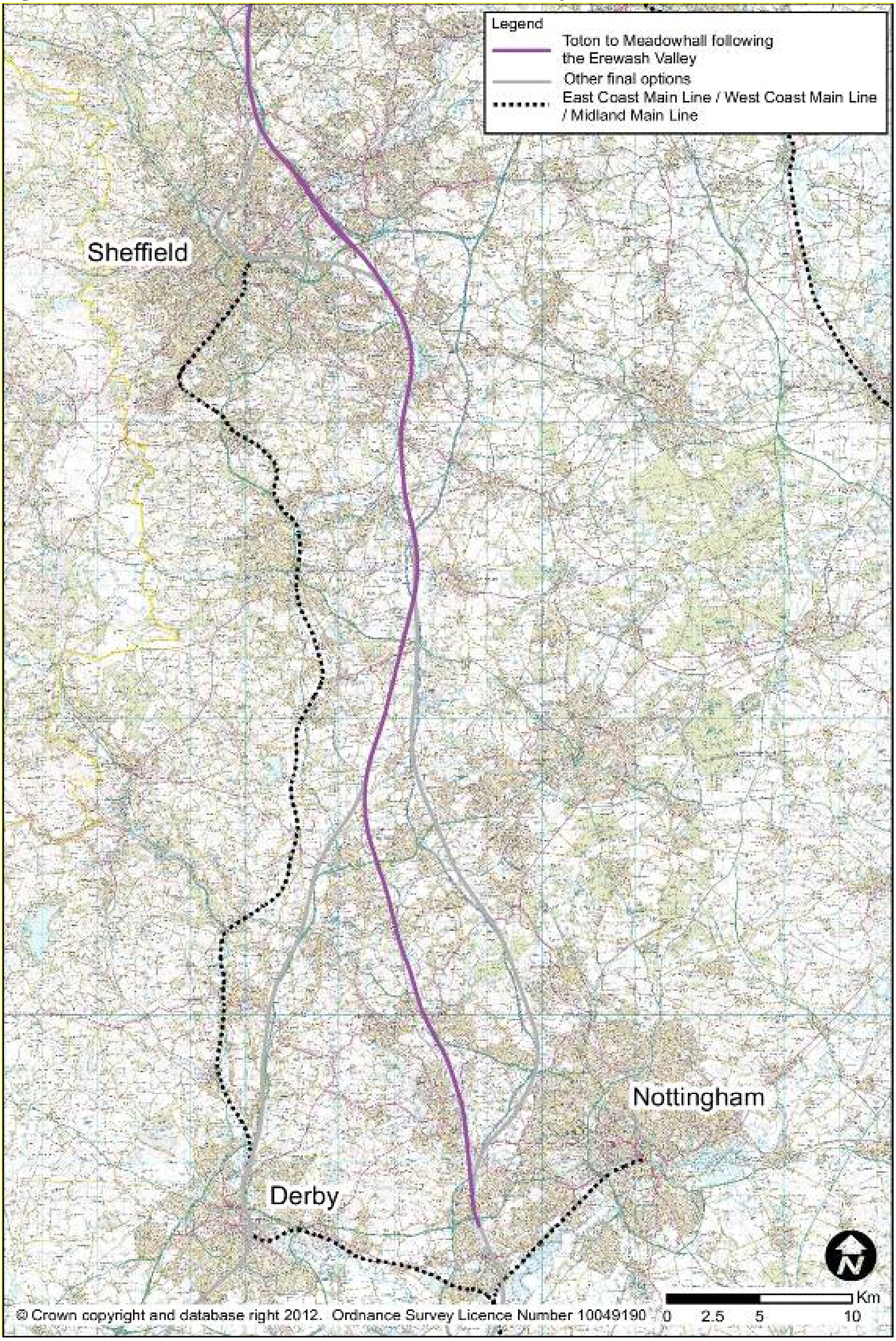
5.5.33 Whilst following the A38 corridor, the route would be on embankment and viaduct in a number of places and would have an impact on the landscape character, particularly near Alfreton Golf Club. It would also have a potential visual impact on the residents at Breadsall, Outwoods and Pentrich and would directly affect Pond Wood and the small scale valley landscape.

5.5.34 The route would have a potential impact on the setting of the Grade I listed Church of St Matthew in Pentrich and on the setting of the Grade II* listed furnaces at Morley Park Ironworks which are also a Scheduled Monument.

Toton to Sheffield via the Erewash Valley

5.5.35 We now describe the first part of the route option from Toton to Sheffield following the Erewash Valley from Sandiacre to Tibshelf. From Tibshelf onwards this route would follow a common alignment with the Derby Midland route option.

Figure 5.24 - Toton to Sheffield via the Erewash Valley



Source: HS2 Ltd

Sandiacre to Tibshelf

Engineering

5.5.36 This route option would run from the proposed station option at Toton broadly following the Erewash Valley. At Tibshelf, the route from Derby Midland following the A38 described above converges with this route from Toton to follow the same single route northwards towards Killamarsh.

5.5.37 The route would pass under the M1 at Stanton Gate before crossing the Erewash Canal and the River Erewash and its floodplain on viaduct. The winding nature of the existing Erewash Valley line presents a challenge to the engineering of the high speed line. Where possible the high speed route would sit at the level of the existing railway; but the high speed route would cross the Erewash Valley railway several times between Stanton Gate and Afreton with major interfaces at Trowell Junction, Ilkeston, Ironville and Alfreton.

5.5.38 To the east of Ilkeston the route would pass between the piers of the Grade II* listed Bennerley viaduct, before passing onto a viaduct over the River Erewash and the floodplain.

5.5.39 Returning to ground level, the route would deviate from the existing railway corridor to run alongside the A610. North of the A608 junction the route would rise on viaduct to cross the River Erewash again, its floodplain and the disused Cromford Canal.

5.5.40 The route would cross over the Erewash Valley railway to its eastern side where the existing railway is in cutting on the approach to the existing Alfreton Tunnel before passing under the A38.

5.5.41 Continuing north the route would then briefly follow the Erewash Valley railway on its eastern side, rising to cross over the Normanton Brook and out of the Erewash Valley east of Pilsley. At Tibshelf the route north towards Killamarsh would be common for both the Derby Midland to Sheffield and Toton to Sheffield via the Erewash Valley route options. This common route north via Killamarsh is described below.

Sustainability

5.5.42 This route section would result in the demolition of an estimated six dwellings.

5.5.43 The route would pass Stanton Ironworks regeneration site which has been identified as a major area for employment development by the Erewash Borough Council Local Plan. The site is also identified as a Sustainable Urban Extension to Ilkeston for housing development with a planning application expected in the summer 2012.

5.5.44 The route would potentially cause significant landscape impacts on parts of the Erewash Valley which is an attractive landscape with many small scale historic features and well used for recreation. The route would repeatedly cross the

River Erewash and canal on viaduct with cumulative impacts on landscape character. The route would also potentially cause visual impacts to residents along the route in those locations where the route is higher than the existing railway.

5.5.45 The route is likely to be quite disruptive to the underlying landform and townscape at Ironville and Somercotes where the route would not follow the existing railway. There would also be a direct impact on the ancient woodland at Carnfield Hall. Three conservation areas would also be directly affected which would result in moderate impacts. The route would pass the edge of the Amber Valley though this could be avoided through further refinement.

5.5.46 The route would have a direct impact on the two Grade II* listed elements that form the Bennerley viaduct which is no longer in use, albeit that the route is designed to pass between the viaduct piers. An impact on the setting would remain.

5.5.47 Three Grade II listed structures would be directly affected though they have already been by the existing railway and industrial premises which would reduce the significance of the impact. Moderate impacts would affect the setting of the Grade II* Carnfield Hall.

5.5.48 A significant area of lowland meadow BAP habitat and a large area of fen and undetermined grassland at Aldecar Western Meadows nature reserve would be affected. Carnfield Wood, an ancient woodland and wet woodland BAP habitat would be directly affected. The River Erewash may require up to three diversions.

Tibshelf to Killamarsh

5.5.49 From Tibshelf onwards the routes from Derby Midland and Toton (via the Erewash Valley) converge and follow a common alignment which we describe below.

Engineering

5.5.50 This section of route would be common for both the route option from Derby Midland and for the route option from Toton following the Erewash Valley. The route description is therefore common for both these options from this point.

5.5.51 Heading northwards the route would encounter relatively steep hills and deep valleys running laterally across the route necessitating a series of cuttings, embankments and viaducts.

5.5.52 The route would pass to the west of Astwith, emerging from cutting at the northern fringe of the village. A series of embankments and viaducts would follow before the route would pass under the A6175, through a cut and cover tunnel, emerging north of the A617 and north-west of the village of Heath.

5.5.53 The route would continue to the east of Sutton Scarsdale before crossing over to the east of the M1. The route would then run broadly at ground level past the Markham Vale Environment Centre.

5.5.54 The route would again bridge over the M1 to re-cross to its western side. Further north the route would be on a viaduct to cross over the River Doe Lea and its floodplain and the A619 before passing to the west of Renishaw. The route would rise and once again use a viaduct to cross over the River Rother and floodplain. Much of this route section would be affected by underground and opencast coal mine works.

Sustainability

5.5.55 The route section would result in the potential demolition of an estimated nine dwellings. The southern part of the route section would be mainly in cutting there would be a limited visual impact on the nearby villages of Pilsley, Hardstoft and Astwith.

5.5.56 Whilst the route section would largely avoid direct impacts on the Sutton Scarsdale Conservation Area, there could be some impact on the landscape character. The route would be visible from Sutton Scarsdale Hall but would be seen in the context of the motorway. The route would be visible from Hardwick Hall but at a distance of over 2km the impact would be minor.

5.5.57 We have been conscious of the importance of Hardwick Hall, Sutton Scarsdale and Bolsover Castle throughout our design process, and would continue to be as our design develops. Text box 15 describes in more detail our design work to date and future plans. There would also be views of the embankment from Bolsover Castle and Bolsover Conservation Area but at some distance. There would also be a localised visual impact on the residents between Netherthorpe and Mastin Moor.

5.5.58 Where the route crosses the River Rother and floodplain on embankment and viaduct there would be some localised visual impact. The route would also pass through the Eckington and Renishaw Park Conservation Area. The Grade II* listed Renishaw Hall Registered Park and Garden lies on rising ground to the west although separated from the route by woodland and existing railway embankment. Owlcotes Wood, an ancient woodland and wet woodland BAP habitat, and Heath Wood would be directly affected.

5.5.59 Two major river diversions may be required - the River Doe Lea and the River Rother. Continuing scheme design would seek to minimise or avoid these impacts.

15. Hardwick Hall, Sutton Scarsdale and Bolsover Castle

Route options to Leeds are constrained by topography and settlement patterns resulting in them needing to follow the transport corridor established by the M1. The corridor is overlooked by important heritage properties which occupy prominent positions on higher ground.

Hardwick Hall and Hardwick Old Hall are Grade I Listed Structures within a Registered Park and Garden, and within National Trust land. The inalienable land extends westwards of Hardwick Hall on rising ground in agricultural use, with the M1 following the bottom of the valley. A route option runs close to and broadly parallel with the M1 past Hardwick Hall which occupies a prominent position on an escarpment immediately to the east. A strip of National Trust inalienable land would be lost just to the west of the M1. The terrain and the existing mature woodland along the M1 would have the effect of screening most (but not all) of this route option from Hardwick Hall. The route option (after the routes following the A38 and Erewash Valley converge) would be on the rising ground to the west and would involve the loss of inalienable land and have an impact on views from Hardwick Hall.

Sutton Scarsdale is a Grade I Listed Structure and associated Scheduled Monument within a Conservation Area. The route options would pass through the edge of the Conservation Area to the east of the Listed Structure and Scheduled Monument where they cross eastwards over the M1. Impacts on the views and setting of Sutton Scarsdale are limited by the landform and landscape features to the west and by running the route options to the east of the motorway between Sutton Scarsdale and Bolsover castle.

Bolsover Castle is a Grade I Listed Structure and associated Scheduled Monument within a Conservation Area occupying a prominent position on a similar escarpment to Hardwick Hall, but further to the north. The M1 is visible from Bolsover Castle and running the route options to the east of the motorway would widen the existing (M1) transport corridor bringing it closer to the castle.

Throughout our option development process we have been mindful of the potential impact in this section of the M1 corridor. Alternative route options would require significant re-alignment to the east across open countryside and between numerous settlements, resulting in worse sustainability impacts.

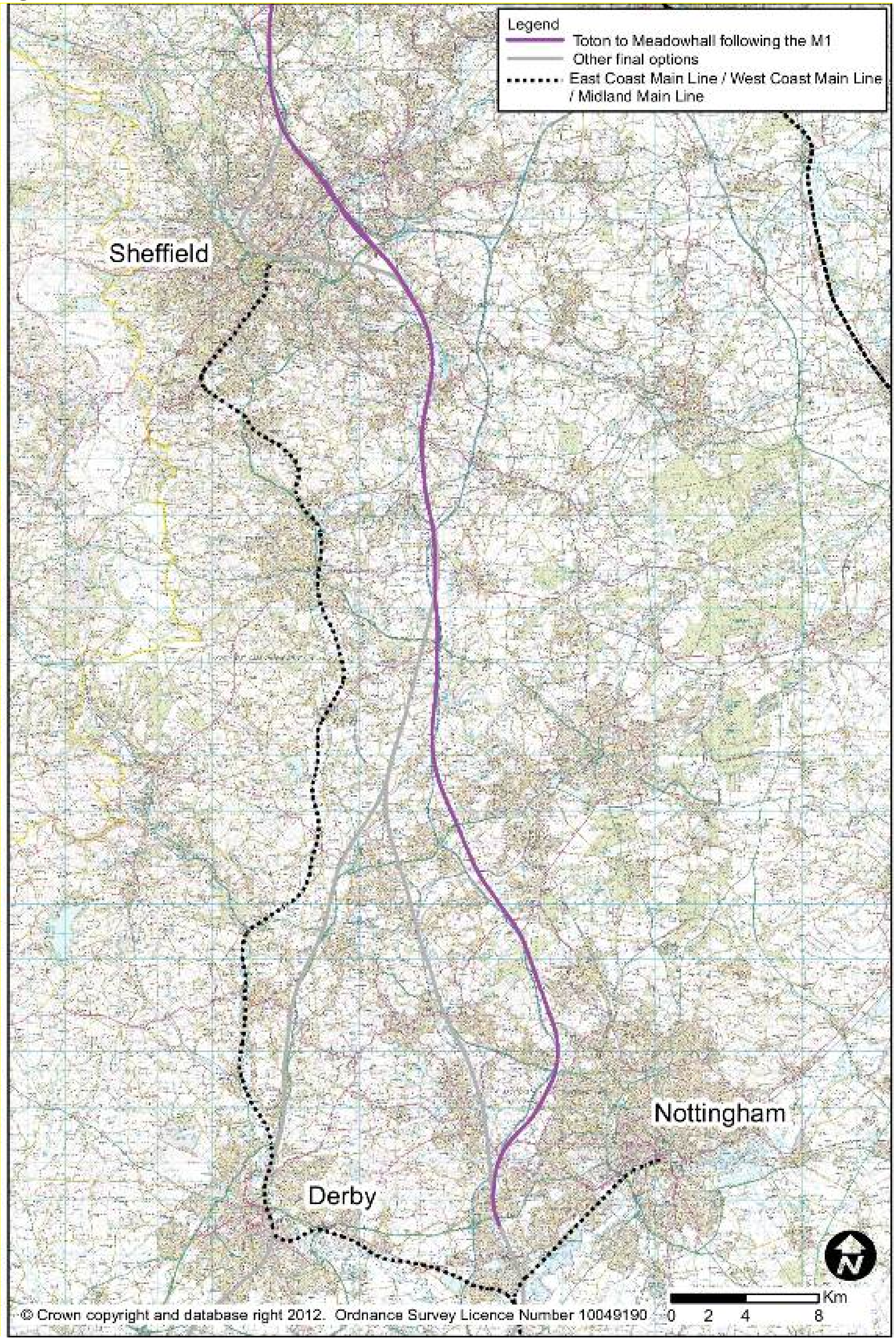
Minimising the visual impacts on Hardwick Hall, Sutton Scarsdale and Bolsover Castle, and the loss of National Trust land would be a key consideration during future detailed design work. This would involve further discussions with the National Trust and English Heritage.

Toton to Sheffield via the M1

5.5.60 We now describe the route option from Toton to Sheffield broadly following the M1. This route follows a different alignment to the two options described as far as Killamarsh. From Killamarsh onwards all three routes follow a common alignment towards Sheffield which is picked up in the section Killamarsh to Tinsley. This route option would run as follows:

- Trowell to Killamarsh;
- Killamarsh to Tinsley – common for all three route options;
- Tinsley to Blackburn with a potential HS2 station at Meadowhall; and
- Sheffield Victoria Loop – loop off the high speed line to serve a proposed station option at Sheffield Victoria.

Figure 5.25 - Toton to Sheffield via the M1



Source: HS2 Ltd

Trowell to Killamarsh

Engineering

5.5.61 The alternative route option from Toton to Sheffield would broadly follow the M1 between Trowell and Killamarsh. Just north of Toton, and in the vicinity of Trowell, the route would require the realignment of the M1 over a length of just over 1.2 miles (2km) moving the motorway west of its current position.

5.5.62 Until Junction 26 of the M1, the route would broadly follow the south-eastern side of the motorway before entering first into cutting and then a cut and cover tunnel. The route would continue northwards alongside the M1 passing over the A610 at the M1 Junction 26.

5.5.63 With the maximum line speed now increasing to 250mph (400kph), the route would broadly follow the motorway on its eastern side with up to 500 metres between the high speed line and the M1 due to the curvature of the motorway. A series of cuttings would be required due to the hilly terrain before the route would pass under the A608 Mansfield Road.

5.5.64 The route would gradually peel away from the M1 as it approaches Junction 28 before crossing the bottom of the steep valley containing the River Erewash and its associated floodplain on a high viaduct. The route would then continue on a mix of embankment and shallow cutting before passing below the A38.

5.5.65 The route would pass between the industrial and warehousing areas north of the A38, crossing a floodplain to the east of Hilcote. As the route rejoins the M1 corridor it would then rise with the landscape passing to the immediate east of Tibshelf Motorway Services before crossing to the western side of the M1 passing below the motorway.

5.5.66 The route would continue in close proximity to the M1 for some distance in this area in continuous deep cutting. The route would be to the west of the M1 which itself runs to the west of Hardwick Hall.

5.5.67 North of Hardwick Hall the route would pass to the east of Stainsby before passing under the M1 Junction 29 which would need some remodelling.

5.5.68 The route would again re-cross to the eastern side of the M1 on viaduct where Palterton Lane presently crosses the motorway. At this point the route would follow the same alignment to Sheffield as the Erewash Valley route option described above.

Sustainability

5.5.69 This route section would result in the potential demolition of an estimated 29 dwellings.

5.5.70 At Stapleford the route would be on high embankment or viaduct which could have a potential impact on the setting of the conservation area at Sandiacre and on the residents of Stanton Gate and north Stapleford as well as on the character of the River Erewash and Nottingham Canal.

5.5.71 There may be some impacts to properties on the edge of Hucknall and a landscape impact on the plantation woodland north of Hucknall. There would also be a visual impact from the very high crossing of the River Erewash at Pinxton and to the sensitive landscape around Hardwick Hall where the route would be outside the boundary of the park on high embankment or in cutting. Proximity to the M1 corridor would reduce impacts in this route section but they would still be potentially major given the sensitive nature of the area.

5.5.72 There would be some impact on views from Sutton Scarsdale although the route through this area would be in conjunction with the motorway. There would also be impacts on views from Bolsover Castle and its conservation area though at some distance.

5.5.73 There would be localised visual impacts where the route would pass close to Staveley and Mastin Moor. The route would be on high embankment or viaduct through Eckington and Renishaw Park Conservation Area. Renishaw Hall Grade II* Registered Park and Garden would be in close proximity to the route but separated by woodland and existing railway embankment so with a negligible impact on its setting but with a potentially greater impact on the landscape and visual setting.

5.5.74 The setting of the Grade I listed Church of All Saints at Strelley would be affected. There would be moderate impacts on the scheduled Stainsby manorial complex which would be close to the route section and passed on embankment.

5.5.75 The route would have a direct impact on Bulwell Wood SSSI, which would be intersected for a short distance, and Bogs Farm Quarry SSSI. The risks of impact to Annesley Woodhouse Quarries SSSI, which would be in close proximity at its nearest point, would be moderate. The route would directly affect three Ancient Woodlands namely New Farm Wood, Watnall Coppice and Bulwell Wood with the latter two also BAP habitats. Two areas of wet woodland and one lowland calcareous grassland BAP habitat would also be crossed.

5.5.76 There would be two potential major watercourse diversions of the River Doe Lea and the River Rother. Continuing scheme design would seek to avoid or minimise these impacts.

Killamarsh to Tinsley

Engineering

5.5.77 At this point all three route options from the East Midlands area towards South Yorkshire would follow a common alignment. This section would cross areas affected by shallow coal mining and backfilled opencast sites but would avoid most opencast areas.

5.5.78 West of Killamarsh the route would follow the line of the disused Chesterfield Canal before using a viaduct to cross over the Sheffield Road and River Rother floodplain.

5.5.79 The route would then adopt the alignment of the existing Chesterfield to Rotherham railway past the Rother Valley Country Park. North of the crossing under the Sheffield to Worksop railway line the high speed route would again adopt an independent alignment.

5.5.80 The route would be alongside the B6200 and in close proximity to housing at Haigh Moor Way where there would also need to be some significant remodelling of local roads.

5.5.81 North of Retford Road a series of viaducts would take the route over the River Rother floodplain and the existing Chesterfield to Rotherham railway and local roads. The route would pass through the Waverley major development site on the former Orgreave Colliery site.

5.5.82 The route would then enter cutting to pass beneath the A630 Sheffield Parkway and twice under Europa Link before emerging from cutting to pass on embankment along the site of the former Tinsley Marshalling Yard.

5.5.83 As well as areas of shallow coal mining and backfilled opencast sites, there are also likely to be areas affected by ground contamination such as the Outokumpu Steelworks at the northern end of this section.

Sustainability

5.5.84 This route would result in the potential demolition of an estimated eight dwellings.

5.5.85 The route section would pass through a number of planned growth sites at Orgreave, east of Sheffield. The site forms part of the Sheffield Enterprise Zone and has planning permission for the development of Waverley New Community.

5.5.86 Waverley New Community includes 3,890 residential units, commercial development, finance and professional services, leisure and community uses. The scheme was granted outline permission in March 2011, with a 30 year time limit on the consent. The masterplan for the site also includes the Waverley Advanced Manufacturing site.

5.5.87 There would be some limited visual impact on the Rother Valley Country Park to the east where the route crosses the River Rother on high viaduct and minor landtake of the park itself. There may also be some visual impact on the recreational users of Treeton Dyke and further to the north-west on users of Catcliffe Flash and the residents of Catcliffe. Renishaw Hall Grade II* listed Registered Park and Garden would be some distance away so impacts would be negligable.

5.5.88 There would be a direct impact on three BAP habitats (one of which is an Ancient Woodland).

Serving the final station options

5.5.89 We now describe the two alternative ways in which the final South Yorkshire station options could be served. The proposed station at Meadowhall would be a through station on the main high speed line.

5.5.90 The alternative option is for a station at Sheffield Victoria. The inclusion of a city centre station option reflects our analysis of the potential benefits. The analysis that Sheffield City Council and South Yorkshire Passenger Transport Executive (SYPTE) have carried out about the benefits of a city centre station are set out in text box 18.

5.5.91 However, as we describe in detail in section 5.6, there is a potentially significant reduction in benefits too, particularly to the larger market of Leeds. As a result, it is necessary to find the optimal option for serving the city centre that does not have a journey time impact on services heading northwards. The loop option we describe from paragraph 5.5.96 onwards seeks to achieve that. However, as we also explain, this also carries a significant additional cost of around £1 billion.

5.5.92 We describe first the short continuation of the main high speed line that would serve a HS2 station at Meadowhall.

Route from Tinsley to Blackburn – station option at Meadowhall

Engineering

5.5.93 North of Tinsley the route would be on viaduct to cross the Don Valley at a level comparable to the M1 as it crosses the Tinsley viaduct. The high speed viaduct would be south-west of the M1 viaduct and east of the Meadowhall Shopping Centre crossing a series of obstacles before continuing northwards between the M1 and Ecclesfield Road.

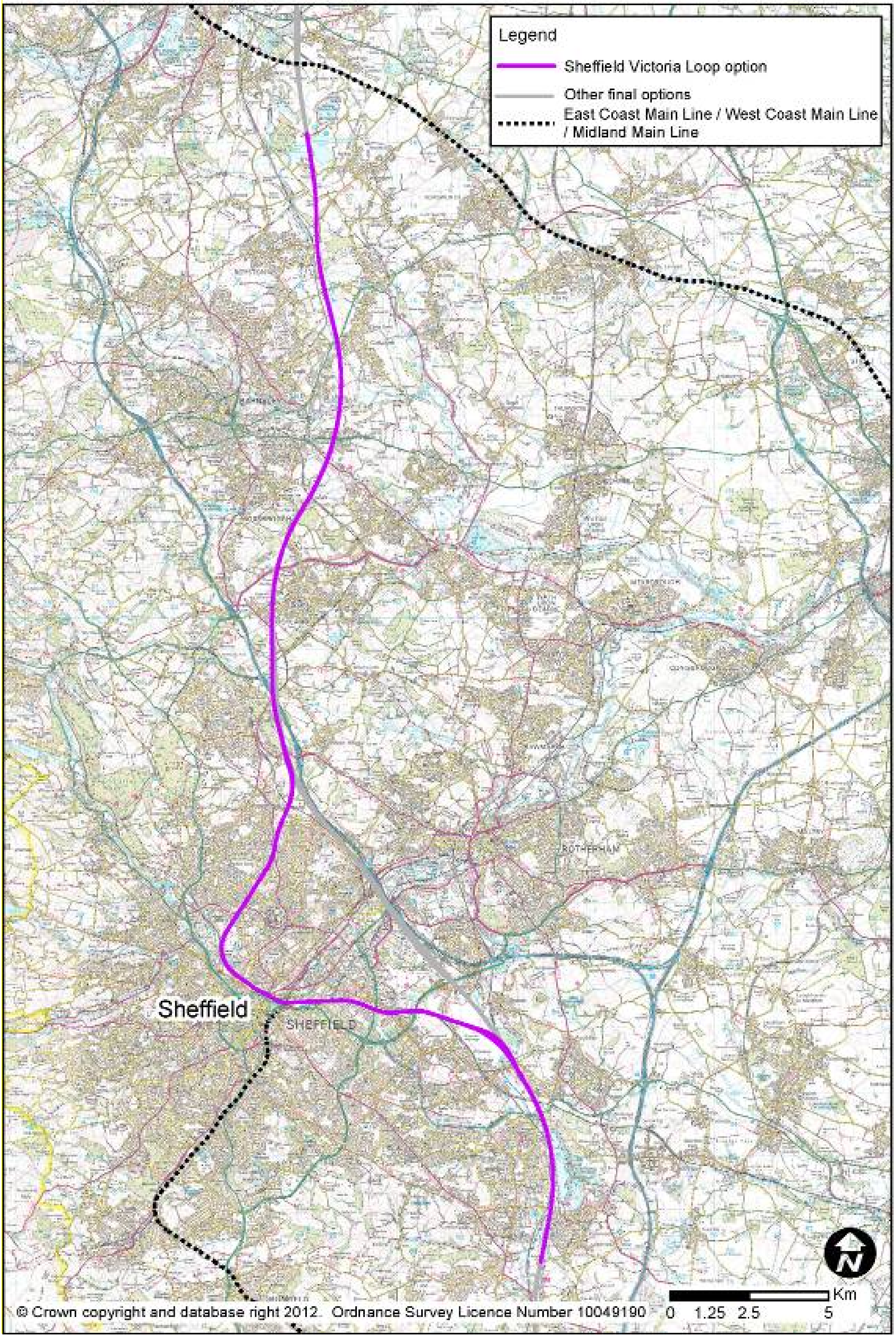
Sustainability

5.5.94 The station and four-track sections would result in the demolition of an estimated 52 dwellings including a cluster at Greasbro Road. Other impacts would be a result of the station infrastructure and these are described in section 5.6.

5.5.95 The River Don may require in channel works or a possible diversion though through more detailed analysis this would be potentially avoidable.

Sheffield Victoria loop

Figure 5.26 - Sheffield Victoria loop



Source: HS2 Ltd

5.5.96 The loop via Sheffield Victoria would leave the north-south main line through Meadowhall in the vicinity of the Waverley major development site.

5.5.97 The northbound and southbound spurs would be elevated on viaduct to cross the existing Chesterfield to Rotherham railway, the River Rother and its floodplain. The southbound spur would also cross the high speed main line. The spurs would converge as this section of route would pass through the planned Waverley major development site.

5.5.98 The route would pass under the B6066 Highfield Spring entering a shallow cutting as it converges with the existing Sheffield to Worksop railway. It would then enter a deeper cutting to pass under the A630.

5.5.99 West of the A630 the route would run parallel to and north of the existing Sheffield to Worksop line. There would need to be significant works to the existing bridges over the railway and to the corridor itself with Darnall station being demolished and rebuilt and Woodburn Junction altered to suit a more southerly alignment of the existing railway.

5.5.100 As the route passes through Sheffield Victoria station the high speed route and existing Sheffield to Stocksbridge railway (freight) would be carried over the Wicker Arch which would remain but with a new viaduct over it to carry the high speed lines. The route would then enter a 2.4 mile (3.9km) long tunnel.

5.5.101 The north portal would be on the A6135 Highgreave Road adjacent to the floodplain of the Sheffield Lane Dyke. The route would then be in cutting with some potential impact on properties between Shiregreen and Ecclesfield before a long viaduct carries the route over local roads and the Sheffield to Barnsley railway.

5.5.102 The route would enter cutting towards Chapeltown before merging into the main high speed through alignment from Meadowhall immediately south of the A629 Cowley Hill under which the route would pass.

Sustainability

5.5.103 The route section would result in the demolition of an estimated 41 dwellings including a cluster at Handsworth. The sustainability appraisal of the proposed HS2 station, including how it could potentially support Sheffield City Council's Core Strategy, is described in section 5.6.

5.5.104 The route would pass through a number of planned growth sites at Orgreave, east of Sheffield. Text box 16 reflects the concerns expressed to us by some of our South Yorkshire delivery partners about the potential impact in this area.

5.5.105 The site forms part of the Sheffield Enterprise Zone and has planning permission for the development of Waverley New Community, which includes 3,890 residential units, commercial development, finance and professional services, leisure and community uses. The scheme was granted outline permission in March 2011, with a 30 year time limit on the consent. The masterplan for the site also includes the Waverley advanced manufacturing site.

5.5.106 The twin-track route section would rise on viaduct across the reclaimed Orgreave opencast works. There would be a small direct impact on the informal open space at Treeton Dyke as well as some visual impacts on recreational receptors on the Trans Pennine Trail and on residents at Woodhouse who would have views of the viaducts over the railway. Given the setting, with existing railways and industrial areas close by, the visual impact has been assessed as moderate.

5.5.107 As the route follows an existing railway between Orgreave and Sheffield Victoria across former opencast workings and landscape the visual impacts here would be minor. There would be a more significant impact on the character of the valley at Ecclesfield where the route emerges from tunnel in deep cutting. There would also be a loss of woodland much of which would be ancient and which would have a major visual and landscape impact as a result.

16. Sheffield Victoria Loop – Rotherham Metropolitan Borough Council views

Rotherham Metropolitan Borough Council were one of our delivery partners involved in the station optioneering process described in the following section. Through this process we described the proposed station option at Sheffield Victoria and the loop line of route that would serve it from the HS2 main line. Whilst Rotherham Metropolitan Borough Council were fully supportive of HS2 and appreciated the wider benefits of a station in central Sheffield, they also set out their concerns with the potential impact the loop route would have on committed and future development.

As we reflected in our own analysis above, Rotherham Council expressed concern that the potential line of route would cut across and through the proposed Waverley New Community housing development (circa 4000 homes and ancillary development) and the Helical Governetz Office campus and the Advanced Manufacturing Park. All of these developments have been granted planning permission and are essential to the growth of the local and regional economy. The Council described the importance of the Advanced Manufacturing Park which lies at the heart of the Sheffield City Region Local Enterprise Zone and is one of the first Technology Innovation Centres.

They also drew our attention to the recent announcement on the Anglo-French Civil Nuclear Agreement, elevating the national and international importance of the developments at Waverley. The Advanced Manufacturing Park is the proposed location of the three Rolls Royce factories totaling 475,000 square feet which will manufacture, assemble and test components for the proposed civil nuclear power stations.

Rotherham Metropolitan Borough Council therefore would like to continue to work with us if this route and station option is taken forward by Government to minimise the impact that any line of route will have on these key development sites. We fully appreciate and understand their position and would continue to work with them should this option be taken forward to the next stage of design.

Route options between East Midlands and South Yorkshire: Section summary

5.5.108 In this section we set out our final route options from the East Midlands to South Yorkshire. We described a single route option from Derby Midland heading northwards, broadly following the A38. We also described two options from Toton heading northwards. We described where the first of the route options, via the Erewash Valley, would converge with the route option from Derby Midland, and follow a common alignment. We also described an alternative route from Toton broadly following the M1.

5.5.109 We explained that all three route options converge in north Derbyshire to head northwards and serve a HS2 station on the main high speed through line at Meadowhall. We also described the alternative proposition of a loop from the main high speed line to serve a potential HS2 station at Sheffield Victoria. The next section picks up the costs and benefits of the station options.

5.5.110 Once again the first choice to be made is on which East Midlands station is selected. If it is the station at Derby Midland then we have presented a single route option. If it is Toton then there are two options, via the Erewash Valley or the M1.

5.5.111 At this stage of our design work the principal differentiating factor between the two route options is their cost. Our current estimate is that the route option following the Erewash Valley would be around £280 million cheaper to construct. However, we note that there are significant sustainability issues with the route, particularly the terrain it would run through and the potential mitigation that could be required. As part of the ongoing design process we will continue to assess the risks around route development. It is likely that this would lead to both the Erewash Valley and M1 routes being of a similar cost.

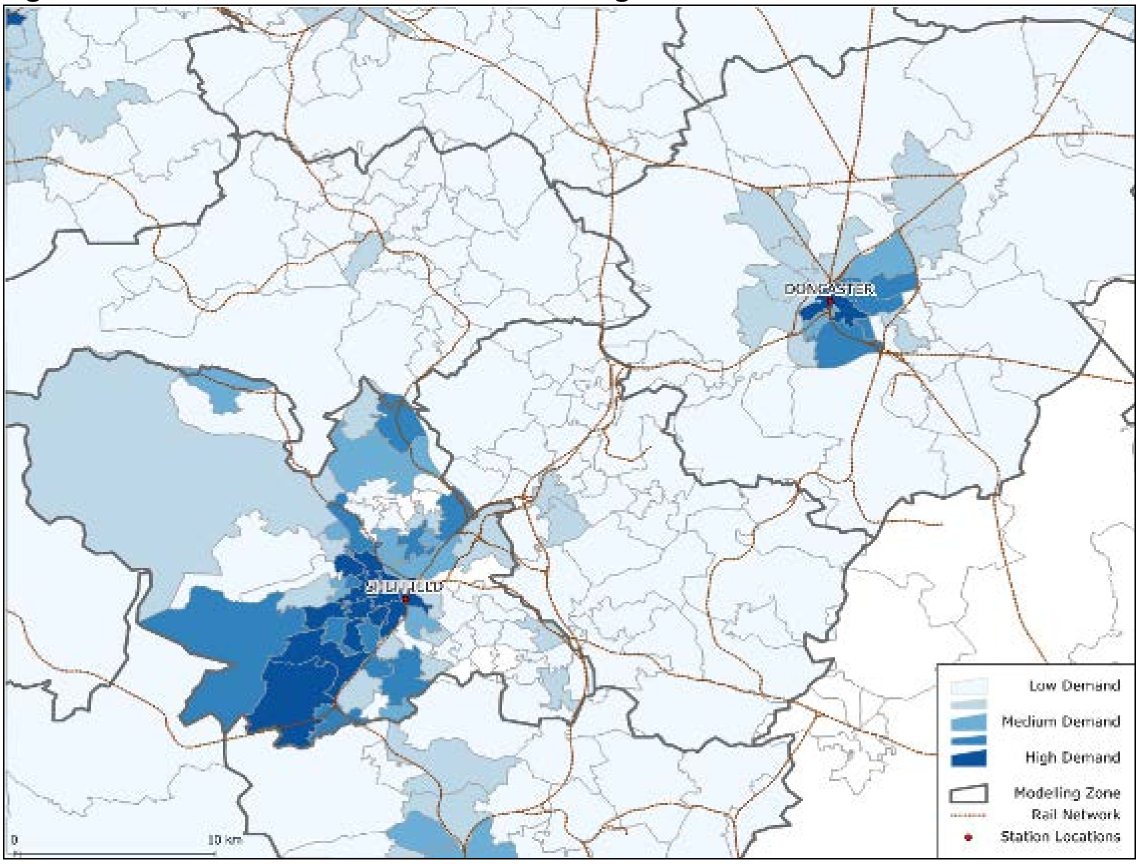
5.5.112 Should Toton be selected as the East Midlands station, we would expect to provide Government with further analysis of which of these two routes to Sheffield would be the best performing based on a more detailed development of both route options and a fuller understanding of the risks associated with the route via the Erewash Valley.

5.6 South Yorkshire stations

Introduction

5.6.1 This section describes our work developing and assessing station options for South Yorkshire. Firstly it outlines the work undertaken to identify and develop options. It then goes on to describe the process for sifting options down. It gives a detailed description of the two remaining options. Finally, it outlines the work that we did looking at running classic compatible trains into Sheffield.

Figure 5.27 - South Yorkshire - demand for long distance travel



Source: HS2 Ltd

5.6.2 Figure 5.27 above shows the distribution of demand for long distance trips from South Yorkshire. It shows that demand is concentrated in the urban areas of Sheffield and Doncaster with the majority in Sheffield. In Sheffield there are two big areas of demand – the city centre and the area to the south-west of the city.

5.6.3 South Yorkshire stands to be one of the biggest beneficiaries of HS2. Existing journey times are slow with Sheffield Midland about two and quarter hours from London. High speed rail could reduce this journey time by around an hour so serving the market is important to the business case. Journey times to Leeds, the second biggest market for services from Sheffield, will also significantly improve from 40 minutes down to around 17 minutes.

5.6.4 At the same time, it would be one of the smaller markets on the network. In terms of passenger numbers, we estimate that the South Yorkshire station on its own would support only one train per hour to London. It is important therefore, that trains call at multiple destinations so that South Yorkshire justifies the frequent service and benefits from the significant time savings.

5.6.5 The relative size of the market is also important when considering journey times to locations further north. We estimate that around four and a half times more passengers would travel on to places such as Leeds, York and Newcastle than would use the South Yorkshire station. This is important as many options offer a trade-off between accessibility for South Yorkshire and journey times further north.

5.6.6 We found that running all services through central Sheffield would give a journey time penalty of around six minutes to those going to Leeds or further north compared with a route through Meadowhall. This journey time penalty would apply to around 31,000 single daily trips and would mean a reduction in benefits of around £500 million.

5.6.7 The trade-off here is that we understand that Sheffield city centre offers the most concentrated demand in the South Yorkshire region but that the market is relatively small particularly compared to the total of the larger markets further north.

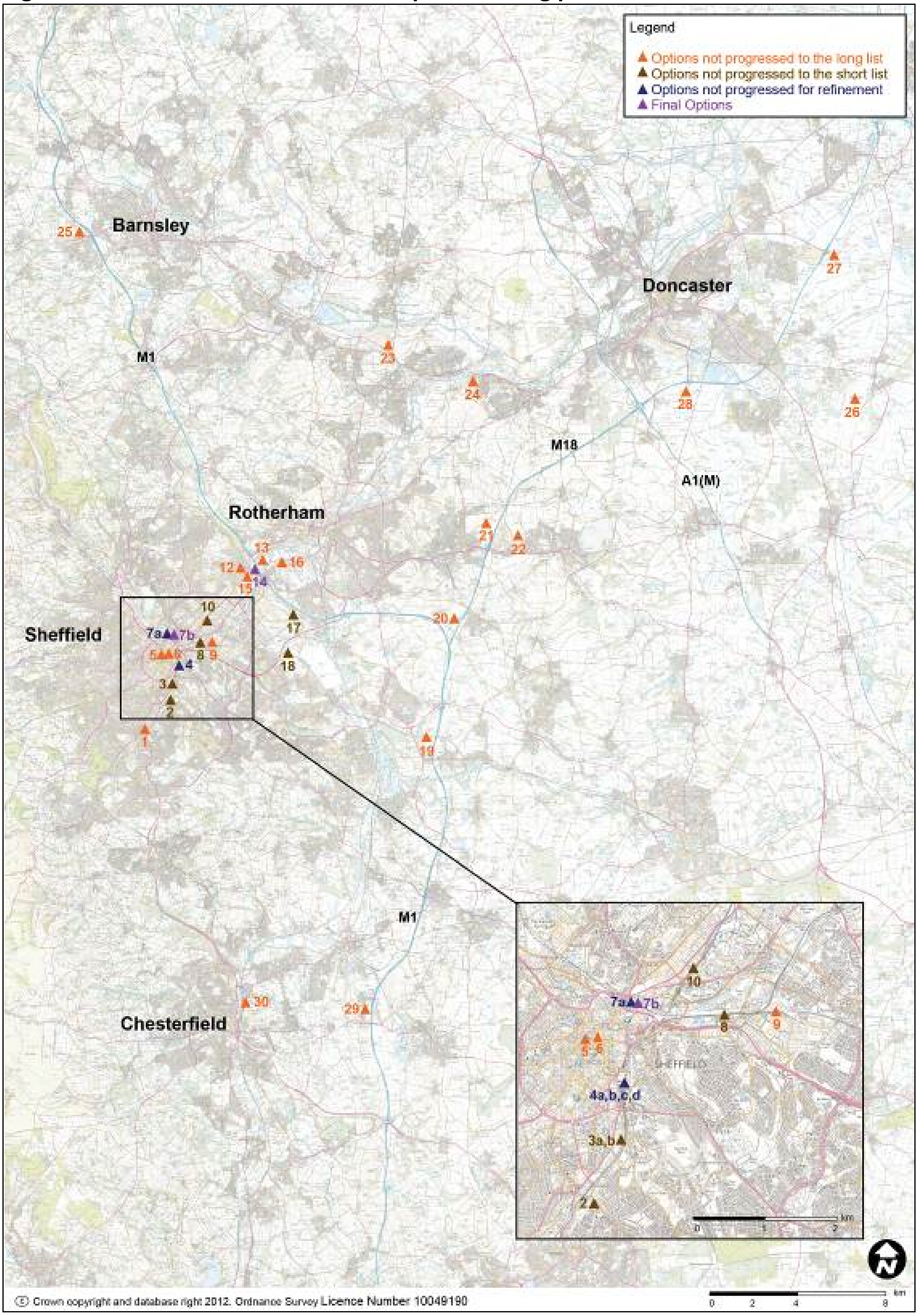
5.6.8 Nevertheless, given the concentration of demand around Sheffield city centre, we considered all the possible ways to serve central Sheffield by high speed rail. These included running the main high speed line through central Sheffield, running a spur into Sheffield from the mainline or creating a loop off the mainline. As we described in the previous section, the difficult topography and built up areas around Sheffield, means there is not a straightforward route through for a high speed line compared to what could be achieved on the outskirts near the M1. As a result, we described our final loop option in the last section and here we describe the HS2 station at Sheffield Victoria that it would serve. As we have noted, this would add around £1 billion to overall costs creating significant pressure on the overall cost envelope.

5.6.9 We begin by describing the process we went through to arrive at our two final station choices.

The generation of initial ideas and the sifting down to a long list

5.6.10 As with other locations we started identifying options within a very wide catchment area independently of our work looking at lines of route. Figure 5.28 shows the range of options considered. South Yorkshire delivery partners assisted us in option generation, particularly in terms of suggesting development sites.

Figure 5.28 - South Yorkshire station options sifting process



Source: HS2 Ltd

5.6.11 In parallel, the work on line of route refined the long list of lines through South Yorkshire. When we ceased work on a station option, we would stop work on the associated line unless it looked promising. When a line was not progressed, we would consider the associated station and potentially take it on further rather than immediately stopping work on it. This was to ensure that we did not prematurely park a potentially strong station option simply because we did not have an immediately viable associated line of route.

5.6.12 Options progressed no further are outlined in the table 5.3.

Table 5.3 – South Yorkshire station options not progressed to the short list

Unique Identifier	Name	Main Reason for parking at this stage
1	London Road	Potential impact on communities Poor connectivity Option 2 (Olive Grove) seen as a more viable option
5	Cathedral (North-South)	Construction complexity and underground station cost
6	Cathedral (East-West)	
9	Nunnery East	Average connectivity Alternative options on better sites
12	Meadowhall Interchange	Construction complexity Potential impact on communities Other more viable options
13	Tinsley Viaduct East	
15	Meadowhall Shopping Centre	
16	Templeborough	
19	Wales	Poor proximity to major centres Average connectivity Lack of development potential
20	Thurcroft	
21	Bramley	
22	Hellaby	
23	Wath upon Dearne	Poor proximity to major centres given line of route choices Poor/Average connectivity.
24	Conisbrough	
25	Dodworth	
26	Robin Hood Airport	
27	Armthorpe	
28	South Doncaster	
29	Bolsover	Poor proximity to major centres Poor connectivity
30	Chesterfield	

Source: HS2 Ltd

The creation of a short list

5.6.13 Following the process described above, we were left with a long list of options with one cluster as close as possible to central Sheffield and another of options further out towards Meadowhall and the M1 to the northwest. We had initially generated five station options in that area as this was emerging as a likely line of route through the region. No individual option was felt to be the optimum solution, but both we and our delivery partners felt that there should be an option in that broad area.

5.6.14 We carried out more detailed work on the station options and on the lines of route that would serve them. The remaining station options were assessed to a greater level of detail against the sifting criteria at this stage. The following options were not progressed to the short list.

5.6.15 We felt that option 2, at Olive Grove, would be too far from the city centre and interchange. It would be distant from the Supertram and rail connectivity. We compared it directly with Sheffield Midland which performed better on both aspects. This outweighed the fact that Olive Grove would incur fewer demolitions. In addition the line of route coming out of the station to the north would either require a costly tunnel or would have to go through Midland which would need to be remodelled as a result at a significant additional cost.

5.6.16 The options by Sheffield Ice Rink (3a and 3b) were not progressed further. We had considered two variants for a terminating station and a through station. We considered the ice rink site to be inferior to Sheffield Midland in terms of connectivity and how close it was to the city. That was despite the impacts on communities being broadly similar in magnitude.

5.6.17 We also looked at the option 8, at Nunnery West, in comparison with the other central Sheffield sites. It would not achieve the same connectivity and it is further away from the city centre. It could offer an opportunity to reinstate Attercliffe station but this would involve significant work. On the whole we decided that the Victoria and Midland options were more promising locations.

5.6.18 Option 10, at Attercliffe, would offer good access to other parts of the region, such as Rotherham and Barnsley. It would still be distant from Sheffield city centre and interchange with tram would be poor. It was not progressed in favour of the options at Meadowhall, Midland and Victoria.

5.6.19 Tinsley Yard (option 17) was not progressed as it would not offer the connectivity available at other options around Meadowhall. It could be served by the bus rapid transit system (we describe the bus rapid transit system in the Meadowhall option) but it would not offer rail connectivity.

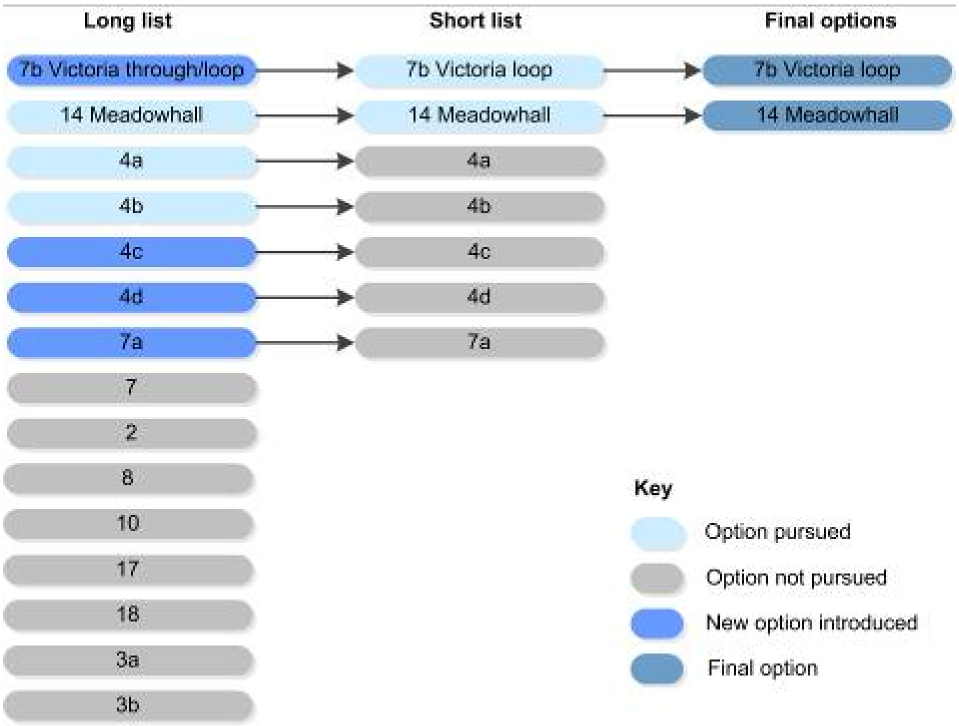
5.6.20 The option at Catcliffe (18) would not work as a station on the main high speed line through South Yorkshire, so it was considered as a loop station. It was not progressed because we felt that in order to justify the additional cost and impacts a loop station should be in Sheffield city centre to maximise access to demand and connectivity. A station in that location would also impact upon development plans in the Orgreave area.

Selecting options for refinement

5.6.21 We were left with a shortlist of station options at Sheffield Midland, Sheffield Victoria and Meadowhall. We had optimised the Meadowhall option from the cluster in that area and felt the option we had developed provided the best connectivity and fit with line of route.

5.6.22 We carried out a more detailed assessment of the remaining station options at this sifting stage. With a smaller number of options to appraise, we also carried out new work. Our socio-economic appraisal determined the potential for options to support growth in the immediate vicinity.

Figure 5.29 – South Yorkshire station long list to final options



Source: HS2 Ltd

5.6.23 At this level of detail we considered variants at Victoria and Midland for stations on a through route, a loop or a spur. They were assessed separately as they would serve a different purpose and would in some cases have different footprint and associated impacts. The Meadowhall option was only considered as a station on the main line of route. We concluded that if HS2 trains were to loop or spur off the main route then it should be to access a city centre location in Sheffield.

17. Through, loop or spur

Throughout our work, we considered a variety of different ways to serve cities and regions. These can be described in three broad categories: stations on the main line of route; stations on a loop off the main line, and stations on a spur off the main line. We describe the options that were considered in our remitted station locations in chapters 4 and 5, but the general pros and cons of each are described below.

Through

It can be possible to have a through station on the main line, minimising the overall track required. This does typically mean that the station requires additional infrastructure to accommodate both stopping and fast through running, increasing its footprint. In terms of operations, this option means that trains can be stopped or not depending on levels of demand, as all trains head further on. Some locations do not have the demand to justify many trains on their own, but can work well as intermediate stops. In this case a through station can work well. A through station does not always work well for city centres as threading the route through a built up area can have a high impact. For example, running a high speed line through central Birmingham was not feasible as the city is so built up. Running through a city also usually means compromising on line speed to minimise those impacts. This leads to onward passengers being slowed down to go through, even if the train is not stopping, and this can be unacceptable if the larger proportion of passengers are travelling further.

Loop

A loop from the main line necessarily requires more track, which typically increases the impacts and the costs. However, a slower speed than the above though route can be adopted to reduce impacts. The loop does not need to be as fast as the though route because not all trains will have to use it, and trains would be slowing down on approach to the station. Trains can either serve the station via the loop, or bypass it on the main line giving onward passengers the benefit of the fastest possible journey. This gives the maximum possible operational flexibility. Again, the impacts of running a route (even a slightly slower loop) through a city can be high and potentially unacceptable and cost is a significant consideration.

Spur

To get into a city, a spur is often the best option as it does not have the impacts of an exit route. Operationally, it can be limiting because it means the station cannot serve as an intermediate location (to go in, stop, turn around and carry on typically incurs an unacceptable time penalty). If a city has high demand then a spur can be suitable, as in the case of Birmingham Curzon Street. Cities like this can justify more than one train per hour on their own so a spur does not restrict operations. This is also the case if the city is further north on the network, allowing several intermediate locations to be served on the way there. If a city has relatively low demand then a spur can be restrictive. With several locations feeding London Euston, it is important that we use the capacity on the trunk between there and the West Midlands in the most efficient way. That means that a spur to a city with low demand may not be justified on the basis that it would not be the most effective use of a train path on the trunk.

A cheaper and less impactful way of serving city centres can be to have a junction off HS2 onto the existing railway and use classic compatible trains. The trains come with a higher cost.

5.6.24 The options below were sifted out from the short list and not pursued any further.

5.6.25 The option to serve Victoria on a through route was not progressed. The footprint would be the same for a Victoria station whether it were on the main high line or on a loop. This is because the through line would be relatively slow meaning that fast through lines would not be necessary. Whilst we thought the station could work well with some improvements to connectivity, the route through Sheffield would be significantly slower than the M1 route.

5.6.26 The option (7a) of a spur into Sheffield was also considered with a Victoria terminating station. The footprint for this would have no impacts on the west side compared to the through or loop variant. However, Sheffield Victoria on a spur was considered inferior to a spur into Sheffield Midland because of the latter's better connectivity. We concluded therefore that, whilst potentially having a greater impact, the best way to serve Victoria would be on a loop.

5.6.27 We assessed four variant options at Sheffield Midland (4a, b, c and d). We acknowledged delivery partners' views that Midland would be the best location for a station in central Sheffield owing to its good connectivity to the Supertram and existing rail services and it being close to the city. However, the sustainability impacts and engineering challenges would be considerable.

5.6.28 We assessed the option for the main line to go through Sheffield Midland (4d). This option would involve complex construction and phasing works as it would require the entire existing station and its approaches to be rebuilt. There would be major disruption at the station with an expected significant reduction of train services over several years. The high speed line would need to enter tunnel just south of the station where the portal would be in the flood plain of the River Sheaf and Porter Brook. This would create a serious risk of flooding. It would also require significant realignment of local roads and it would also be necessary to extend the station footprint eastwards by excavating into the adjacent Park Hill. In view of the complexity and risks involved at the Midland site, we decided that the best way to serve central Sheffield would be with a station at Victoria. Although the location is not as well connected, it would not have the disruptive effects of a station at Sheffield Midland.

5.6.29 Two variants of Midland loop stations were assessed: one with the loop to the east (4c) and one to the west (4b) of the station. Option 4c would require the remodelling of the existing station platforms 7 and 8 necessitating alteration of the Grade II elements of the concourse and associated platform facilities as well as significant engineering works to widen the station footprint into Park Hill. The adjacent tram would also have to be diverted and realigned around 15m up the hill to enable extension of the station to the east. Option 4b would require total remodelling of the station, including its listed concourse and approach tracks. This option would have similar major and prolonged disruption to train services and passengers, impact on highways and potential flooding risks as described for the Sheffield through (4d) option.

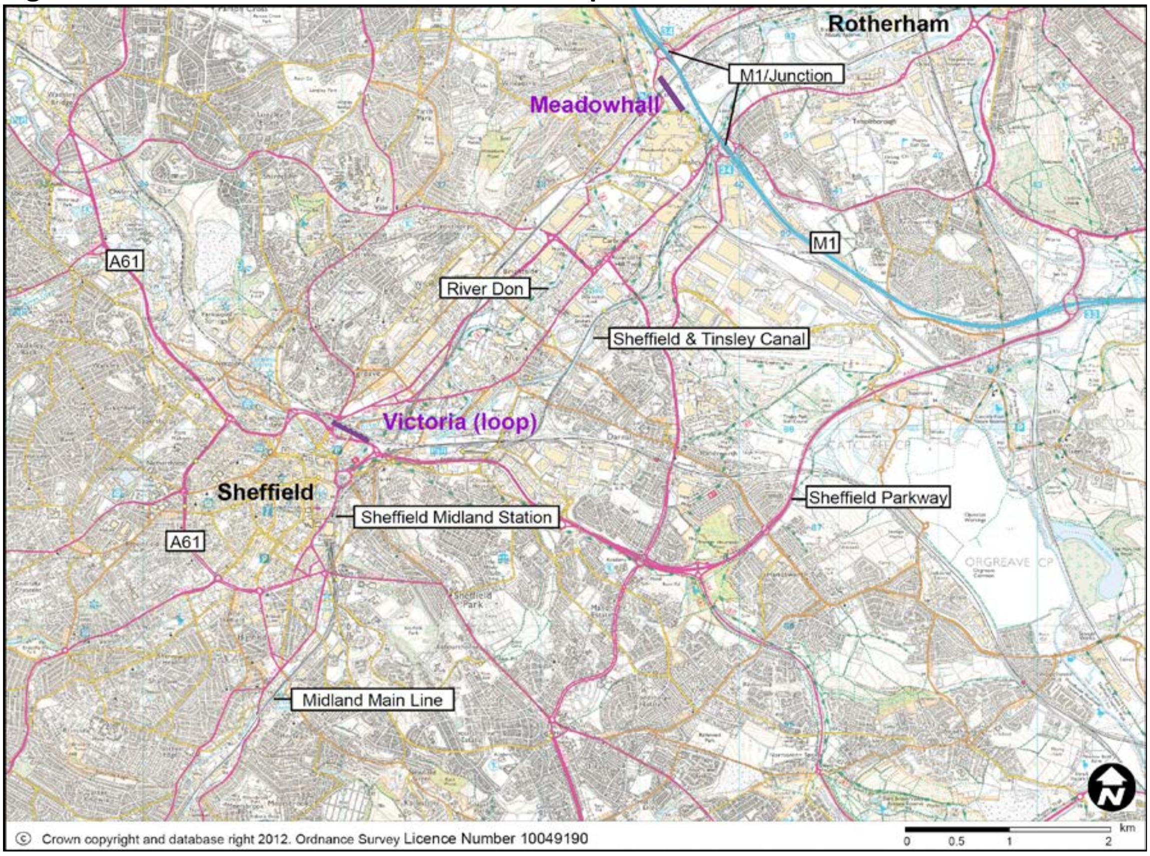
5.6.30 A Midland terminal station (4a) was also considered. This would be served by a spur from the main line through South Yorkshire. It could be constructed to the east of the current station and so would cause significantly less disruption to the station than the through option. Construction works would only disturb platform 8, concourse areas and forecourt to the west. It would affect both the north and south throats, but would have less disruption to the existing station and adjacent roads than the other options, but it would require excavation into Park Hill and realignment of the tram. This option would have much less impact on the floodplain and protection of the station would be more feasible. It would however require more demolitions of dwellings than the through option. We decided that the case for a full high speed spur was not likely to be stronger than that for running classic compatible trains into Midland, which could be achieved at much lower cost. We describe our analysis of the classic compatible services later in this section.

5.6.31 At this stage, we therefore concluded from our analysis that the best way to serve central Sheffield by high speed would be on a loop from the main route to the proposed station at Sheffield Victoria whilst also exploring the option of classic compatible services into Sheffield Midland.

Developing and finalising our options

5.6.32 Following the sifting process described above, we came to two final options for a high speed station in South Yorkshire. Figure 5.30 shows the two final options. Their key engineering and sustainability features are then described. We then set out the comparable demand for these station options.

Figure 5.30 - South Yorkshire stations final options



Source: HS2 Ltd

Final options

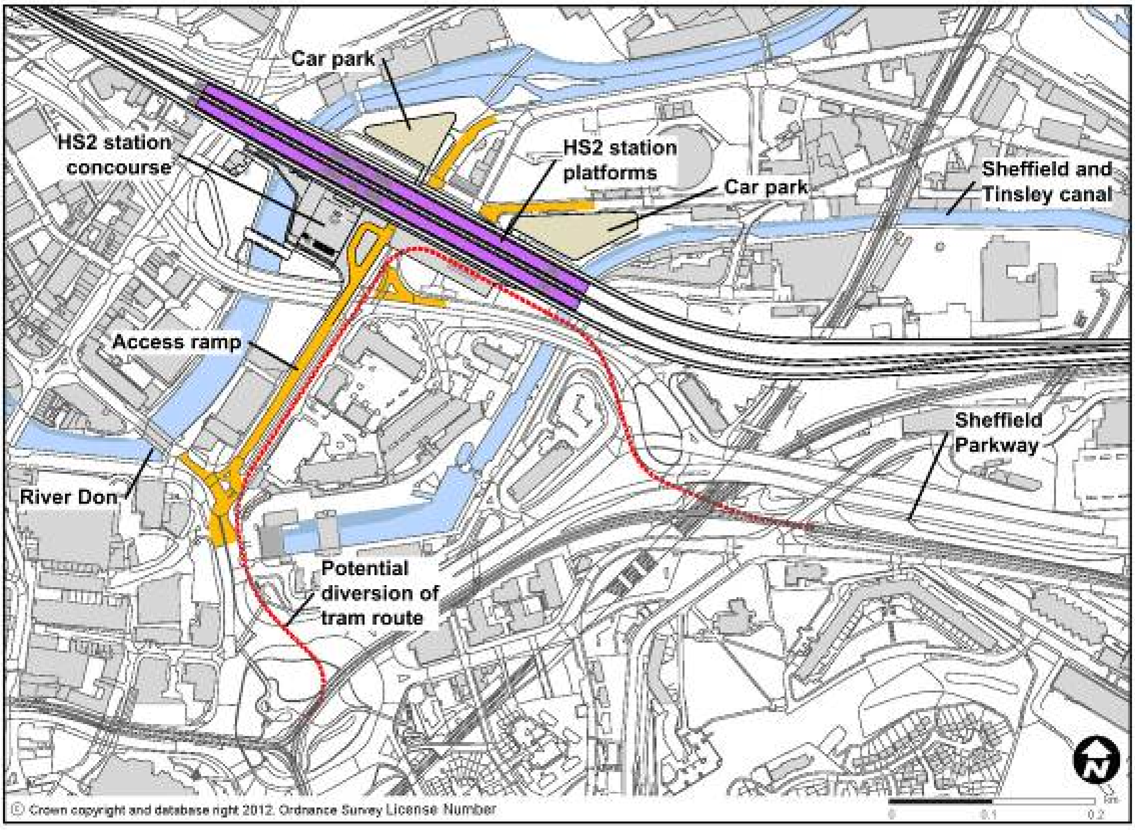
Sheffield Victoria (through station on a loop from the main high speed line)

Engineering

5.6.33 The station option would be located on the site of the former Sheffield Victoria station. It would be served by a loop off the main high speed line, which would continue to follow the M1. The station site would lie to the north-east of the city centre, on the north side of the dual-carriageway A61 inner ring road (Derek Dooley Way) and over the River Don and Sheffield and Tinsley Canal. Victoria station was situated on an elevated structure which is Grade II* listed (apart from the Grade II Royal Victoria Hotel). Victoria station was closed to passengers in 1970, but a single track remains for freight services to the Stocksbridge Steel Works, north-west of Sheffield.

5.6.34 The new high speed station concourse, forecourt and short-term parking would be at the level of the former station and platforms. Due to limited space at this level, the high speed platforms and tracks would be on a new viaduct above the existing viaduct. This would enable the new structure to be built clear over the Grade II* Wicker Arch.

Figure 5.31- Proposed Sheffield Victoria station layout



Source: HS2 Ltd

5.6.35 The station would have four platforms. Platforms would be accessed from the level below where the station concourse and forecourt would be located. These would be constructed on the site of the existing Grade II listed Royal Victoria Hotel, which would have to be demolished.

5.6.36 The main station entrance and the forecourt for private car and taxi traffic, would be accessed by Victoria Station Road to the east of the concourse. A tram stop could also be located at this level. Bus interchange would be provided on Wicker, to the south of the Wicker Arch, accessed by a new pedestrian bridge leading to the southern station entrance, with immediate vertical access to the station concourse.

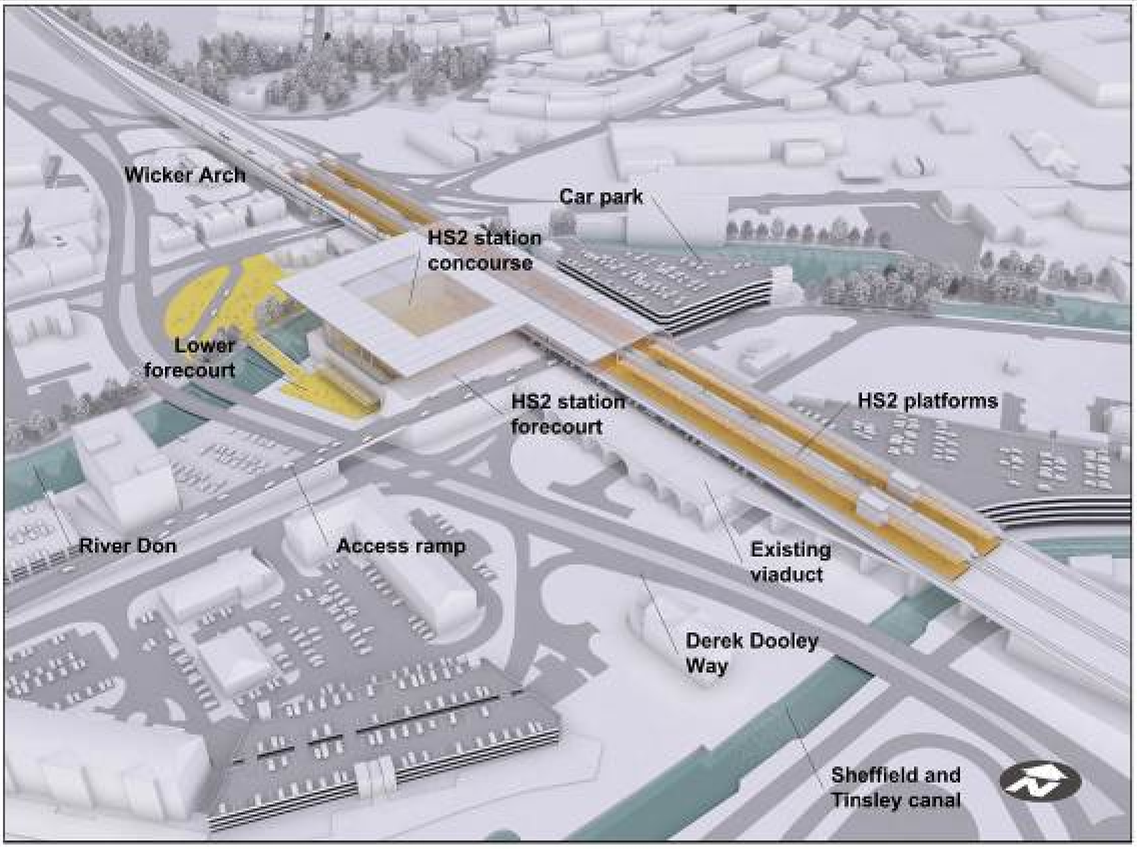
5.6.37 Short-term parking would be provided underneath the station platforms, with sufficient space for drivers waiting to pick up arriving passengers. Multi-storey car parks for long-term parking would be located to the north of the station.

5.6.38 As we noted in the last section, the cost of the loop from the main line to a station at Sheffield Victoria would add around £1 billion to the overall costs.

Passenger access and dispersal

5.6.39 Victoria is not served by the Supertram and there would be a long walk to get to Sheffield Midland station. We carried out some high level work to consider how to connect the two stations. We looked at diverting the Supertram (via a spur or a loop) or introducing a people mover between the two stations. Delivery partners favoured introducing a new loop to the tram network to integrate the new station into Sheffield and the surrounds. We have included this cost in our assumptions for the station. If this option were chosen by Government to progress, we would carry out further work with delivery partners to find the best solution to public transport connectivity.

Figure 5.32 - Sheffield Victoria station indicative illustration



Source: HS2 Ltd

Sustainability

5.6.40 The line of route for the loop through Sheffield Victoria would have its own sustainability impacts. These were outlined in the previous section. This section covers impacts caused by the station and its throats.

5.6.41 The station would not result in the demolition of any residential dwellings. The station would have a potentially major impact on the townscape due to the demolition of the Grade II listed Royal Victoria Hotel, which forms a key component of the historic station complex. There would be a loss of attractive unlisted buildings that frame the Grade II* listed Wicker Arch and associated viaduct on its south side, although there may be potential to integrate these structures into the new station.

5.6.42 There would be further implications on the setting of the Grade II listed National Westminster Bank and 85-93 Wicker Street, and the unlisted buildings associated with the Crucible Steel Works and Attercliffe Sipelia Works. In addition, the townscape character would be adversely affected by the introduction of sizable structures which would enforce the visual separation between areas north and south of the viaduct. This may affect views from the Park Hill Estate and the wider area.

5.6.43 The station would have an intersection with Flood Zone 3, but impact would be limited as the railway is on viaduct. There would be an impact on people accessing the station and on any associated station development such as car parking. Constructing in Flood Zone 3 would have to be considered carefully.

5.6.44 The works would potentially displace businesses providing an estimated 1,300 jobs. However, an estimated 9,000 jobs would be supported through development around the station generated as a result of HS2. There would be an estimated 900 housing units supported.

5.6.45 The Sheffield City Council Core Strategy 2009 acknowledges that the city centre will be the driver of the city and the region's economy, providing sustainable employment opportunities, which will be supported by sustainable transport and a high quality environment. The station would conflict with three proposed site allocations (for retail, business and industrial uses), although provided the detailed design is taken forward as part of a masterplan led approach, the station would support the key objectives set out in the core strategy.

5.6.46 In general, Sheffield City Council were of the view that the station could be made to work and would be an asset to city development.

Meadowhall

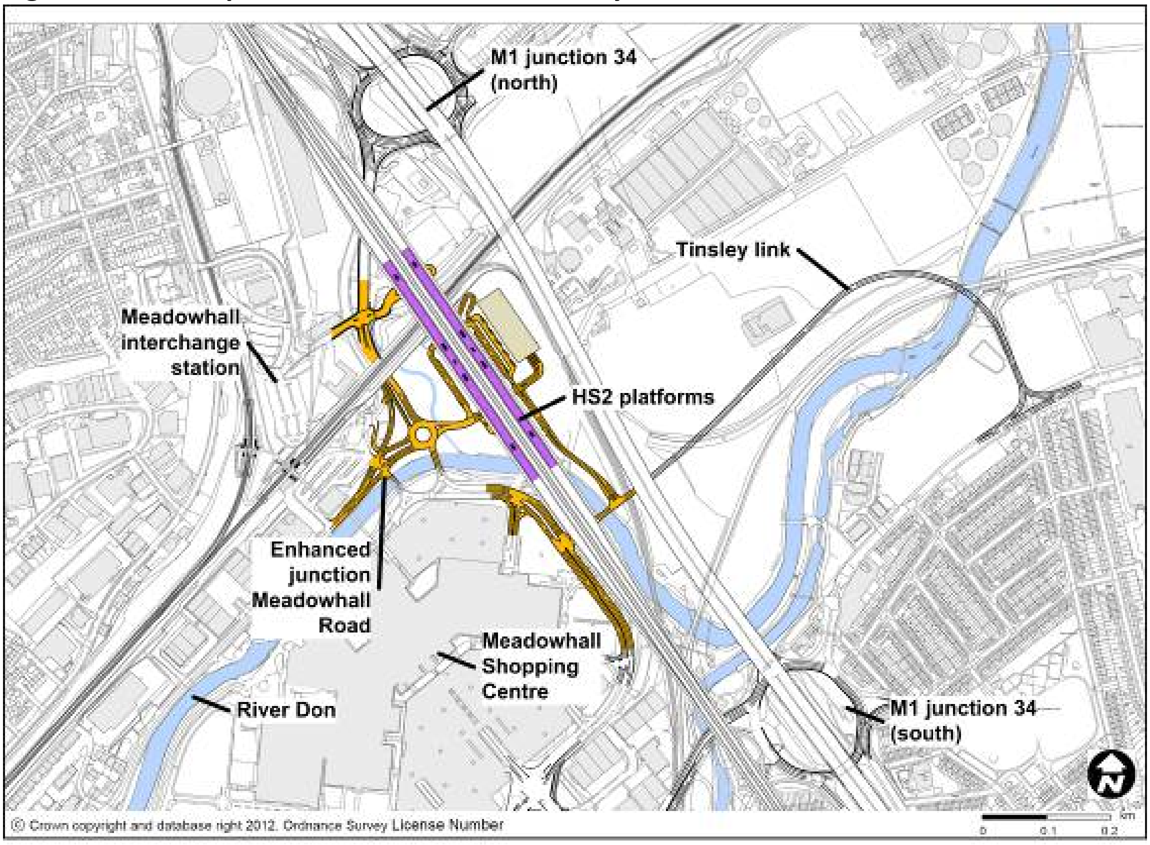
Engineering

5.6.47 Meadowhall high speed station would be a new station located on the high speed main line, located between Meadowhall shopping centre to the west and the M1 on the Tinsley Viaduct to the east. Meadowhall is located in the Lower Don Valley to the north-east of Sheffield and the south-west of Rotherham.

5.6.48 The high speed station would link to other modes of transport for passengers to complete their journeys to Sheffield city centre and the surrounding areas. Meadowhall is well served by buses, trains and the Supertram network at Meadowhall interchange. As a result, access to the station would be designed primarily for public and private transport, as well as improving the pedestrian link between the HS2 station and the Meadowhall Interchange station.

5.6.49 Meadowhall is well served by buses, trains and the Supertram network at Meadowhall Interchange. The main high speed line would run from south-east to north-west and be elevated on a viaduct and the four station platform faces would be provided at the same level (approximately 23m above ground level), arranged as two islands. Two additional central tracks would be dedicated fast lines for trains not stopping at the station and would be capable of a line speed of 250mph (400kph).

Figure 5.33 – Proposed Meadowhall station layout



Source: HS2 Ltd

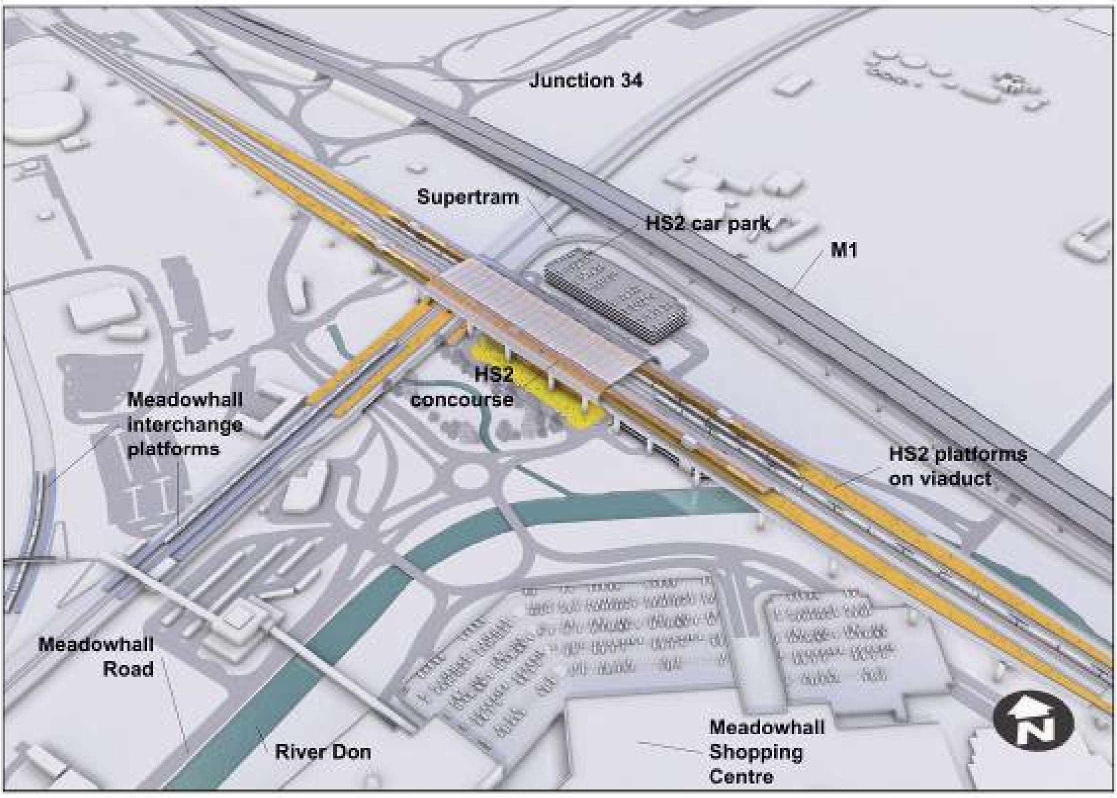
5.6.50 At ground level, the four-platform Network Rail station at Meadowhall Interchange would remain. There is potential for modification to some or all of the existing station in order to improve the interchange with high speed services. We assume the movement of platforms on the Sheffield to Rotherham line to provide better interchange with HS2 platforms and have included this cost. New platforms are proposed on the Supertram line which would pass underneath the station.

5.6.51 The station would have multiple entrances, for access to and from different travel modes. The primary station entrances and main concourse building with ticket hall and other station facilities would be located at ground level, beneath the viaduct. A series of escalators and lifts would provide vertical circulation for access to an upper concourse.

5.6.52 At the upper concourse, a bridge would lead directly to the Supertram and Meadowhall Interchange. A further bridge on this level would give direct access to a multi-storey car parking structure.

5.6.53 The station would be located in between Sheffield and Rotherham and would be easily accessed from both as well as from the M1. The roads in that area are already very heavily loaded so there would need to be capacity improvements to support a station and other developments planned in the area. Road access would be provided by means of a road connection to the existing road network and to address capacity constraints. Further interventions could range from widening and reconfiguration of the roundabouts on M1 Junction 34 to new roads and links onto and from the M1. Were this option to progress, the level of provision of capacity enhancements would need to be determined in conjunction with the Highways Agency and local transport authorities.

Figure 5.34 - Meadowhall station indicative illustration



Source: HS2 Ltd

Passenger access and dispersal

5.6.54 Meadowhall high speed station would have both major road access and car parking provision as well as being well-connected to rail, tram and bus. As mentioned above, we would potentially provide interventions on the road network.

5.6.55 The existing Meadowhall rail interchange has a high frequency peak hour service to Sheffield Midland with nine trains an hour, on average one every seven minutes, providing a good opportunity for rail connectivity. The current minimum travel time between Meadowhall Interchange and Sheffield Midland station is five minutes.

5.6.56 In order to provide good interchange with the South Yorkshire Supertram, a new tram stop integrated into the high speed station would be proposed. Bus provision would include the existing bus station at Meadowhall Interchange and new bus bays on the station forecourt. Future design would investigate the desirability of merging these facilities.

5.6.57 A bus rapid transit proposal made by the South Yorkshire Passenger Transport Executive (SYPTE) for the corridors linking Rotherham and Sheffield would create a fast bus route into Sheffield to augment the existing bus, tram and rail connections.

Sustainability

5.6.58 As we noted when we described the loop, the station and four track sections would require the demolition of 52 dwellings.

5.6.59 The River Don, a major watercourse, may require diversion or significant in-channel works, although more detailed analysis suggests that the need for this could be avoided.

5.6.60 The station would support the designation of the new Enterprise Zone at Meadowhall. The station would also support the development of the Meadowhall area as a location for offices and potentially meet some longer term housing needs.[12] It would also support the growth of the Lower Don Valley and the wider city region.

5.6.61 The works would potentially displace businesses providing an estimated 1,300 jobs. However, an estimated 5,000 jobs would be supported through development around the station generated as a result of HS2. There would be an estimated 400 housing units supported.

Demand - Sheffield Victoria and Meadowhall

5.6.62 As already set out, our analysis indicated early on that a through station at Victoria would have a poor business case due to the impact on journey times for passengers travelling further afield. However, the loop off the main high speed line would allow non-stopping services (and therefore passengers) a faster journey time because they would be able to use the direct through route, whilst providing a city centre location for passengers to Sheffield itself.

5.6.63 Compared to a Meadowhall through service, with the same service frequencies, the loop would provide significant benefits of around £500 million and revenue of around £200 million. These benefits and revenues assume the same car and public access to Victoria as is currently available to Sheffield Midland. For this assessment, we assumed the rail connectivity for Meadowhall described in the description of the option.

5.6.64 Sheffield City Council and SYPTE conducted their own analysis of the relative economic impacts of the two final station options and this is set out in text box 18.

[12] See Sheffield City Council, 2009, *Sheffield Development Framework Core Strategy,* https://www.sheffield.gov.uk/planning-and-city-development/planning-documents/sdf/core-strategy.html

18. Sheffield City Region and SYPTE work on economic impacts

Sheffield City Council and officers at SYPTE supported us in our work to generate, assess and sift station options. Their strong view was that in terms of maximising the economic benefit, the station should be on a main line or a loop in central Sheffield. They carried out their own assessment of the relative economic impacts of the two final options taking the same base data and assumptions, but then using a different methodology to ours.

Their economic impact assessment provided a comparison of the net additional employment and gross value added (GVA) effects projected from the alternative station locations.

They concluded that a key factor at Victoria is the propensity to attract higher value business service activities from outside of the city region seeking city centre proximity, rather than lower value office sector relocations from within the city region to Meadowhall.

Their net additional employment projections over 25 years for each location (allowing for displacement and multiplier effects) suggested that Victoria could generate approximately 9,500 net additional jobs, whilst Meadowhall was projected to generate approximately 3,000 jobs as a result of HS2 station investment. In addition the jobs at Victoria would individually be higher value than those attracted to Meadowhall. Overall, this assessment indicates a potential to generate between £2 billion and £5 billion net additional economic value over 25 years if the Victoria station option was selected.

Their conclusion was that the location of the HS2 station is crucial to the economic future of Sheffield and the wider city region. The Victoria option would reinforce the existing economic strategy focus on the city centre for high end service jobs, stimulating new quality development opportunities and investment in line with the City Region's economic ambitions. Their view is that a city centre location will generate a substantial level of additional economic value which should be taken into account alongside the range of other considerations in reaching a decision on the preferred HS2 station location in South Yorkshire. In particular, the greater economic benefits would outweigh the marginally higher infrastructure costs.

We have submitted Sheffield City Region and SYPTE's report to Government.

They consider that other factors affect the strength of the case, and are undertaking further work to examine the released capacity and local connectivity costs and benefits of the two station location options.

Classic compatibles

5.6.65 The options for providing a full high speed line into Sheffield all come with significant costs as outlined above. We looked at whether it would be feasible to provide a link off the high speed line to the classic network so that classic compatible trains could run into Sheffield Midland. This could be done in addition to having an interchange station allowing two different ways to serve South Yorkshire.

5.6.66 The infrastructure required for this option would have a spur to Sheffield, from a grade separated junction on the HS2 main route near Orgreave. A minor modification of the high speed alignment would be needed to accommodate the junction. West of the junction, there would be a new twin-track railway turning west, to join the existing Sheffield to Worksop railway into Sheffield Midland.

5.6.67 The classic compatible trains would approach Sheffield on the existing route from Worksop to Sheffield, passing Darnall Station which would be unaffected. Trains would continue towards the Nunnery area, and would turn south to follow the existing Nunnery Curve to enter Sheffield Midland from the north. Throughout all of this length, the route would need to be electrified, this would mean that existing bridges over the route would need to be raised to provide the electrification clearances.

Classic compatible demand

5.6.68 We considered two potential methods of providing for a one train per hour service from London to Sheffield Midland using a classic compatible service in addition to high speed services from London to Sheffield Meadowhall as already described.

5.6.69 The first of these methods considered replacing one of the two modelled high speed train services to Meadowhall with a classic compatible service into Sheffield Midland. This replacement would reduce benefits compared to the 2tph service to London from Meadowhall. This is because passengers in general prefer a more frequent service from one location rather than a less frequent service from two separate locations. This particularly applies to people with fixed appointments or appointments of an unknown or unreliable duration.

5.6.70 The second method considered providing a classic compatible train service to Sheffield Midland in addition to the two high speed train services to Meadowhall per hour. The 1tph service would also stop at the East Midlands HS2 station as part of its stopping pattern. This additional service gave benefits of around £500 million and revenue of around £200 million. Much of the benefit was associated with the additional frequency at East Midlands. This additional service would also incur additional operational costs to run that we would expect to cost in excess of the benefits received for the service.

South Yorkshire stations: Section summary

5.6.71 In this section we described the process we went through to arrive at our two final options for stations in South Yorkshire. Our analysis reflected the value in serving Sheffield city centre, the largest market in the South Yorkshire region. As we reflected, Sheffield City Council and SYPTE's own analysis suggests the benefits of serving the city centre are greater than we estimate.

5.6.72 We identified and developed a wide range of options for serving Sheffield city centre. The significant engineering and sustainability constraints make this very difficult. They were particularly relevant in our decision that Sheffield Victoria rather than Midland was the only achievable way of serving the city centre.

5.6.73 In Section 5.5 we described a loop from the main HS2 line to a station at Sheffield Victoria. However, the additional infrastructure required would add around £1 billion to costs. This would create significant additional pressure on the overall cost envelope for HS2. The loop would also have significant additional sustainability impacts including potentially conflicting with the major development site at Waverley. It also means that the benefits of the city centre station have to outweigh these costs. Our analysis suggests that, although significant, they are not of sufficient scale.

5.6.74 The proposed station at Meadowhall would be a well integrated high speed station. It would have good passenger transport access through rail, tram and bus interchange serving Sheffield city centre and the wider region. We recognise that the road network is constrained and we have described our work on this to date with further design work necessary should this station be selected. As a through station en route to the larger markets of Leeds and the North East, this station option would also not penalise onward passengers. It would also be constructed at a significantly lower cost than a city centre station.

5.6.75 We also described the potential option of running a classic compatible service into Sheffield Midland in addition to a high speed station at Meadowhall. This was found to have a reasonable level of additional benefit, but once operational costs were taken into account and the costs of some additional supporting infrastructure, it was found to be a more marginal case.

5.7 Routes between South Yorkshire and Leeds

5.7.1 In this section we cover the line of route options between South Yorkshire and Leeds and the approaches into the city centre station options in Leeds city centre. This section describes the process of option development and refinement we went through covering all the route options initially considered and how these were sifted down to a single broad route option. It then describes that option in detail, and the two approaches from it into Leeds city centre.

5.7.2 Selecting the approach into Leeds city centre is clearly linked to the choice of station. Approaches into city centres are made more challenging by the need to avoid or minimise impacting on existing development. In establishing the best approach we seek to maximise the best journey time and route with avoiding or minimising impacts as far as possible.

5.7.3 As with the development of our other station options, the potential benefits of being close to the existing rail network to maximise connectivity to the wider region were clear. In Leeds the additional benefit is that most of the existing development of the city is to the north of the station. This means that passengers dispersing from an HS2 station in the vicinity of the existing Leeds Central station would be well placed to access the city centre. However, routes to the existing Leeds station are constrained both by the sprawl of development and by the river. Accessing Leeds city centre station also means heading further into central Leeds with an associated journey time impact on services from the south.

5.7.4 We therefore also developed and assessed possible station options, and approaches to them, in the south of the city. By being more direct on the high speed route from the south this had the advantage of a faster journey time. It also meant a potentially lesser impact overall. Moreover, whilst this area of the city is currently less well developed, the City Council has significant development plans for this area. Some of these plans will take shape over a shorter timescale compared to the long term development of phase two of HS2. This became a key issue in the development of our station options to the south of the city and the approaches to them – identifying a high speed station location that would support and enhance this development rather than conflict with it.

5.7.5 We begin by describing the development of all our route options down to the single common route. We then describe the different approaches into the final Leeds station options set out in the next section.

The generation of initial ideas and the sifting down to a long list

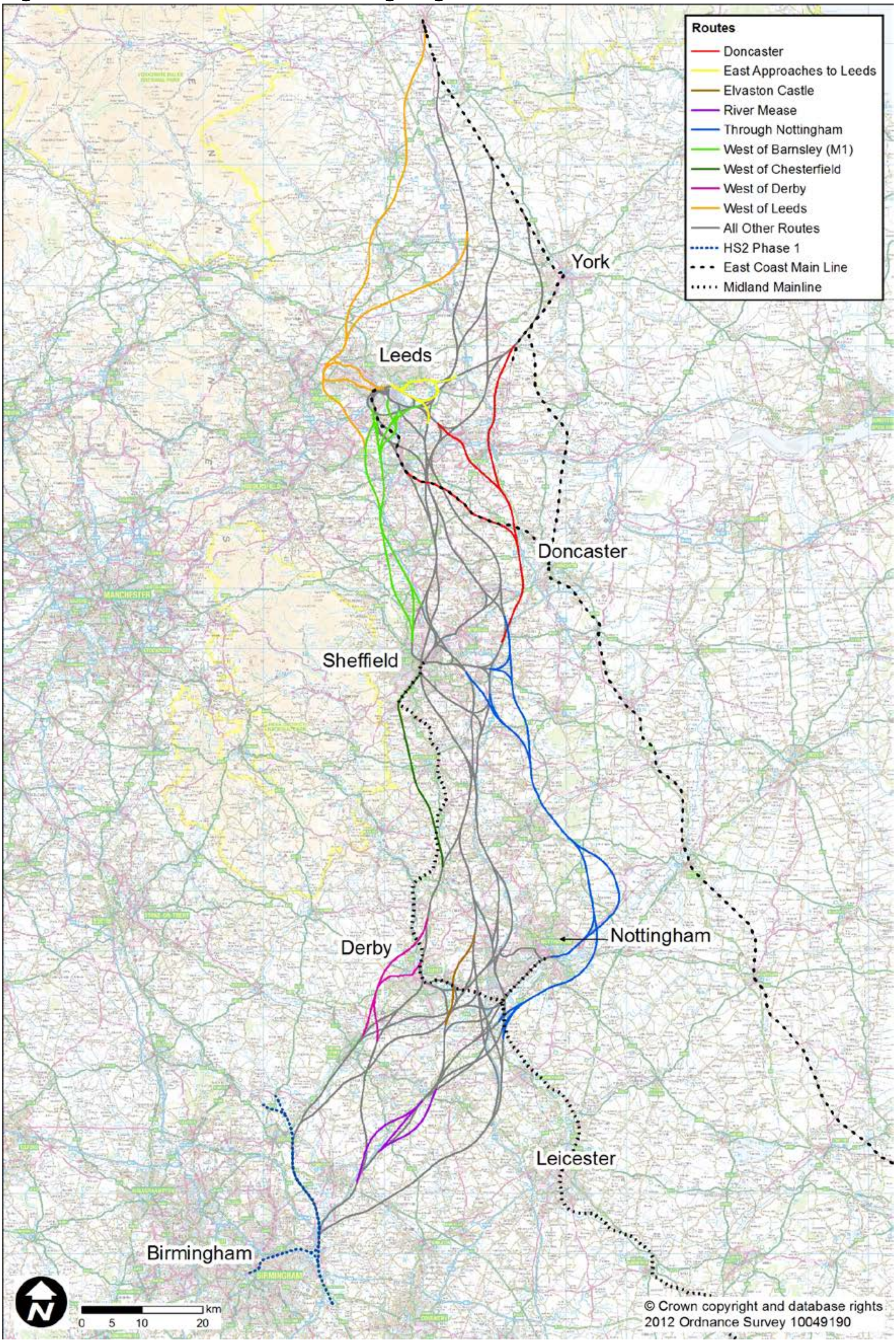
5.7.6 The generation of ideas for routes led to a large number of route options being initially developed. All the route options northwards from South Yorkshire to

Leeds were progressed beyond this first identification stage.

The creation of a short list

5.7.7 The routes taken forward as a long list of options were developed to the next level of detail. As station options were progressed and developed new line of route options were also developed to serve these options. Conversely, as station options were sifted out of the process the associated line of route options were also sifted out. The outcomes of this process are indicated on figure 5.35 and described below.

Figure 5.35 – Leeds route short listing stage



Source: HS2 Ltd

Eastern routes into Leeds

('Eastern approaches to Leeds' on figure 5.35 above)

5.7.8 As a result of our decision taken not to develop the Leeds city centre station option to the east, we stopped the development of eastern route options into Leeds at this stage. See section 5.8 for further details.

Approaching Leeds from the west

('west of Leeds' on figure 5.35 above)

5.7.9 At this stage we considered why approaching Leeds from the west was a less optimal solution. We noted that the western routes would have more challenging topography with significantly greater changes in elevation meaning that the length of tunnel and viaduct may increase as the alignment is refined. These route options would enter Leeds via either the Wharfedale or Pudsey corridors but would also only serve the west facing stations whereas routes from the south and south-east would serve all Leeds city centre station options.

5.7.10 The routes into Leeds from the west were also significantly longer and four to five minutes slower. In addition to this routes to the west of Leeds would also not serve York or have the opportunity to connect with the ECML further south.

5.7.11 Routes to the west of Leeds would have a direct impact on more priority sustainability features, require notably more dwellings to be demolished and have potential noise impacts on more dwellings due to the greater lengths of viaduct in built up areas. In addition to this they would also have a potentially significant sustainability impact on a number of listed buildings in the centre of Leeds in particular. We therefore decided not to develop the route options to the west of Leeds beyond this stage.

Routes to the west of Barnsley

('west of Barnsley (M1)' on figure 5.35 above)

5.7.12 Routes were considered which would pass to the west of Barnsley and broadly follow the M1 corridor. North of Sheffield the M1 runs through hilly terrain. Several towns and villages have also developed towards the motorway. As a result any high speed rail alignment through this area would require the extensive use of steep gradients, tunnels and significant earthworks. In addition to this the route north of the M1 corridor would have to be at a reduced speed or in a greater length of tunnel because of the urban nature of the area near the Junction of the M1 and M62 to the south of Leeds.

5.7.13 The route options would, as with the previous scenario, have a notable sustainability impact. The potential impact on the Bretton Hall Grade II listed Registered Park and Garden would be difficult to avoid due to its proximity to the motorway. The route option following the M1 south of West Bretton and to the east of Dewsbury would also have the highest number of potential demolitions and would not have the possibility of serving York. We therefore decided not to develop this group of options further beyond this stage.

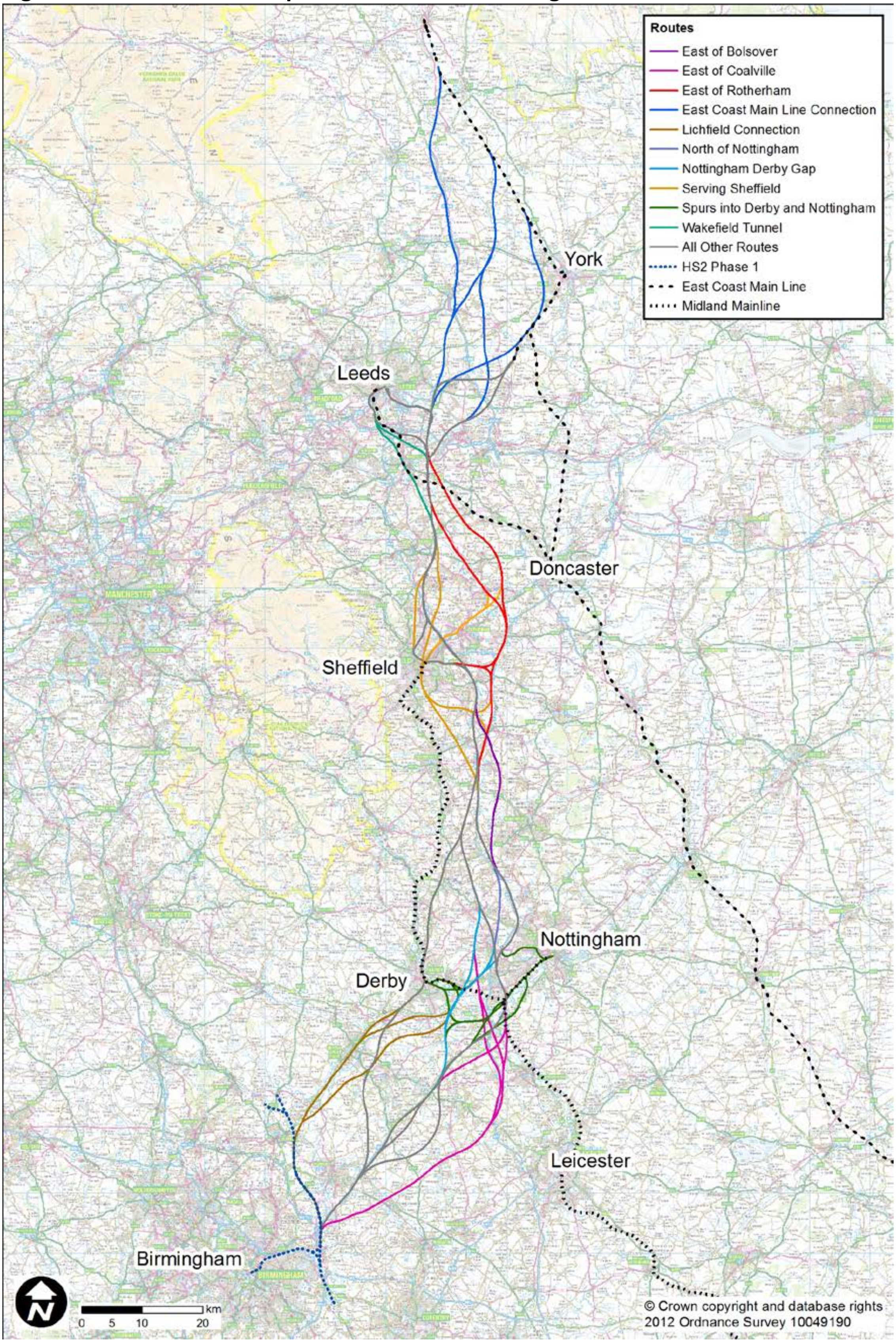
5.7.14 As part of the assessment into the viability of a route following the M1 to the west of Barnsley the best approach into a west-facing Leeds station considering two, almost parallel, routes from the south was also considered. The option following the Doncaster to Leeds railway line was considered to be more complicated to construct as a result of the topography and properties in close proximity to the existing railway. This option would also have a potentially islanding effect cutting off the commercial properties in the area. This option following the Doncaster to Leeds line was therefore not taken forward in favour of the option following the Dewsbury to Leeds (Transpennine) line.

5.7.15 We noted that the delta junction would cause a significant proportion of the potential impacts and that they would be difficult to mitigate. We decided to remove it from further consideration and assessment at this stage.

Selecting options for refinement

5.7.16 The remaining route options after short listing were then developed in further detail ahead of a final sift to reduce the number of options. This process led to the further refinement of options using the pair-wise comparison process again. The outcomes of this further process are reflected on figure 5.36 and described below.

Figure 5.36 – Leeds route options for refinement stage



Source: HS2 Ltd

Routes into the west of Leeds from the east of Barnsley

('Wakefield Tunnel' on figure 5.36 above)

5.7.17 The purpose of this assessment was to establish the best route into the Transpennine corridor and west facing station from routes to the east of Barnsley.

5.7.18 A large number of different route options were considered. We noted that in comparing these options the northern spur of the junction added up to £1 billion to the cost. This was a consequence of the large size of the delta junction to the south of Leeds with much of the junction in tunnel due to the complex urban environment with multiple transport corridors between Leeds and Wakefield. We agreed that given the choices made on serving Scotland, see text box 6, and our remit, the northern spur of the junction would be omitted to allow for a more feasible junction arrangement.

5.7.19 We compared three route options through this area, one on surface and two in tunnel. The first options on the surface passed round the northern edge of Wakefield broadly following the M62. The two tunnelled options involved tunnels of lengths 3.1 miles (5km) and 6.8 miles (11km), the former would pass under the northern extremities of Wakefield and the latter would pass under the centre of Wakefield.

5.7.20 The surface route option would be significantly less expensive but with no major difference in journey time compared to the tunnelled options. We noted that there were sustainability issues with the surface option, particularly its potential demolition impact, and that these would need to be further mitigated as the route option was developed. We decided at this stage that the prospects of developing and mitigating the surface route option were better than the alternative tunnel options which we decided not to take forward.

Developing and finalising our options

Route options between South Yorkshire and Leeds

5.7.21 The emphasis at this stage was on the refinement and mitigation of the route options taken forward from the previous stage rather than a reduction of options. A high level summary of the engineering and sustainability features that would influence the costs and benefits of the routes is described below.

5.7.22 As a result of the sifting process described above, a single route option remained. We describe this route from Blackburn to Cold Hiendley. We then describe the two alternative approaches into Leeds with the second including a minor variant to serve an alternative station. The options are:

5.7.23 From Cold Hiendley via Lofthouse (Transpennine corridor) to serve a west facing station option at Leeds city centre North; and

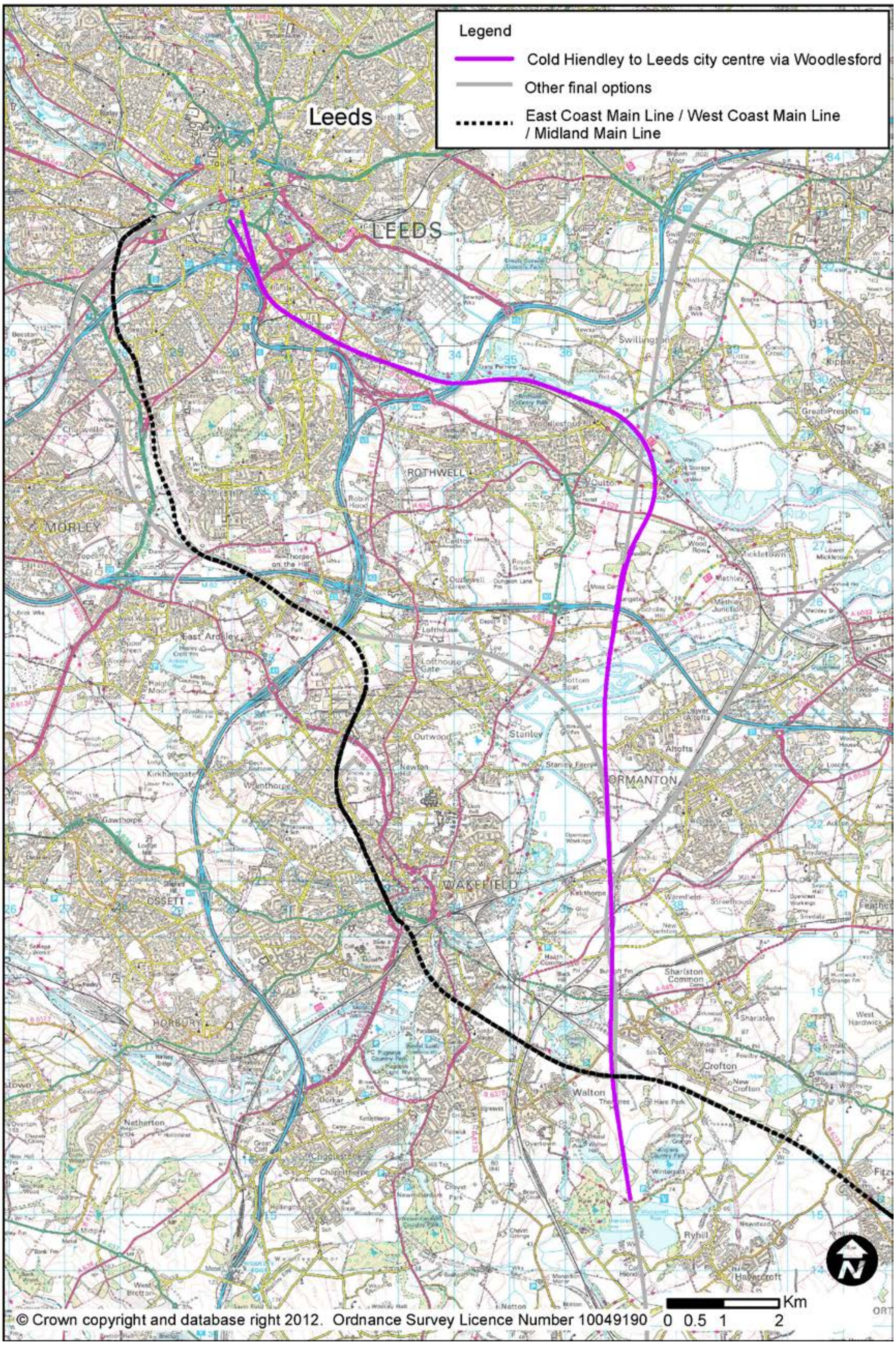
5.7.24 From Cold Hiendley via Woodlesford to serve a south facing station option at

Leeds New Lane. The minor variation to this approach is also briefly described which would also serve a south facing station option at Leeds Sovereign Street South.

Final options

Blackburn to Cold Hiendley

Figure 5.37 – Cold Hiendley to south facing Leeds station via Woodlesford



Source: HS2 Ltd

Engineering

5.7.25 North from Meadowhall the route would continue on viaduct. It would run parallel to the M1 and to the existing Sheffield to Barnsley railway. Heading north the route would head out of the Don Valley, gradually moving away from the alignment of the M1 through difficult terrain requiring potentially complex earthworks.

5.7.26 The route would then pass under the M1 just south of the A6135. The route would then descend predominantly in cutting with a short viaduct over the existing Sheffield to Barnsley railway.

5.7.27 As the route continues, it would head for the lower-lying land of the Dearne Valley, passing under the A6135 initially in a cut and cover tunnel at Hoyland Common. The route would then enter a tunnel at Hoyland for just under 1.2 miles (2km). The northern tunnel exit portal would lie just north of the A6195 Dearne Valley Parkway.

5.7.28 North of the Hoyland tunnel, the route would briefly be on embankment. The route would then cross the River Dove and its floodplain on viaduct and, following a short section of embankment, would once again cross over the existing Sheffield to Barnsley railway.

5.7.29 The route would then pass under the A633 before entering another short tunnel passing beneath Ardsley and under Northumberland Way. On exit from the tunnel the route would then cross the River Dearne and its floodplain on viaduct, to the east of Barnsley and the sewage works.

5.7.30 The route would then continue elevated on a series of viaducts and embankments to cross over local roads and Cudworth Dike and its associated floodplain. Continuing on embankment the route would pass to the west of, and avoid, Carlton Marsh Nature Reserve, albeit with potential impacts on industrial property in this area. The ground conditions are also likely to be contaminated through this area. The route would then run in a series of shallow cuttings as it approaches the Cold Hiendley and Wintersett Reservoirs.

5.7.31 The route would use a multi-span viaduct to cross Cold Hiendley Reservoir just west of the dam wall between it and the Wintersett Reservoir.

Sustainability

5.7.32 The route section would result in the potential demolition of an estimated seven dwellings.

5.7.33 The route would have some localised visual impacts around Worsbrough. East of Barnsley, the route would be mainly in cutting or tunnel but the viaducts and embankments in the vicinity of the River Dearne would cause some localised visual impacts for the residents of Lundwood and Cudworth. There would also be a minor impact on the recreational users of Cold Hiendley Reservoir and

Wintersett Country Park which the route would pass over on viaduct.

5.7.34 The Scheduled Monument of Wombwell Wood Romano-British settlement would be near the route though impacts on setting would be minimised by the location of the monument in woodland. The Monk Bretton Priory scheduled monument has a Grade I listed building in the complex and its setting may be affected though potentially not significantly (it is further from the route than Wombwell Wood). The proposed viaduct over the River Dearne is likely to have some impact on setting though this may not be significant.

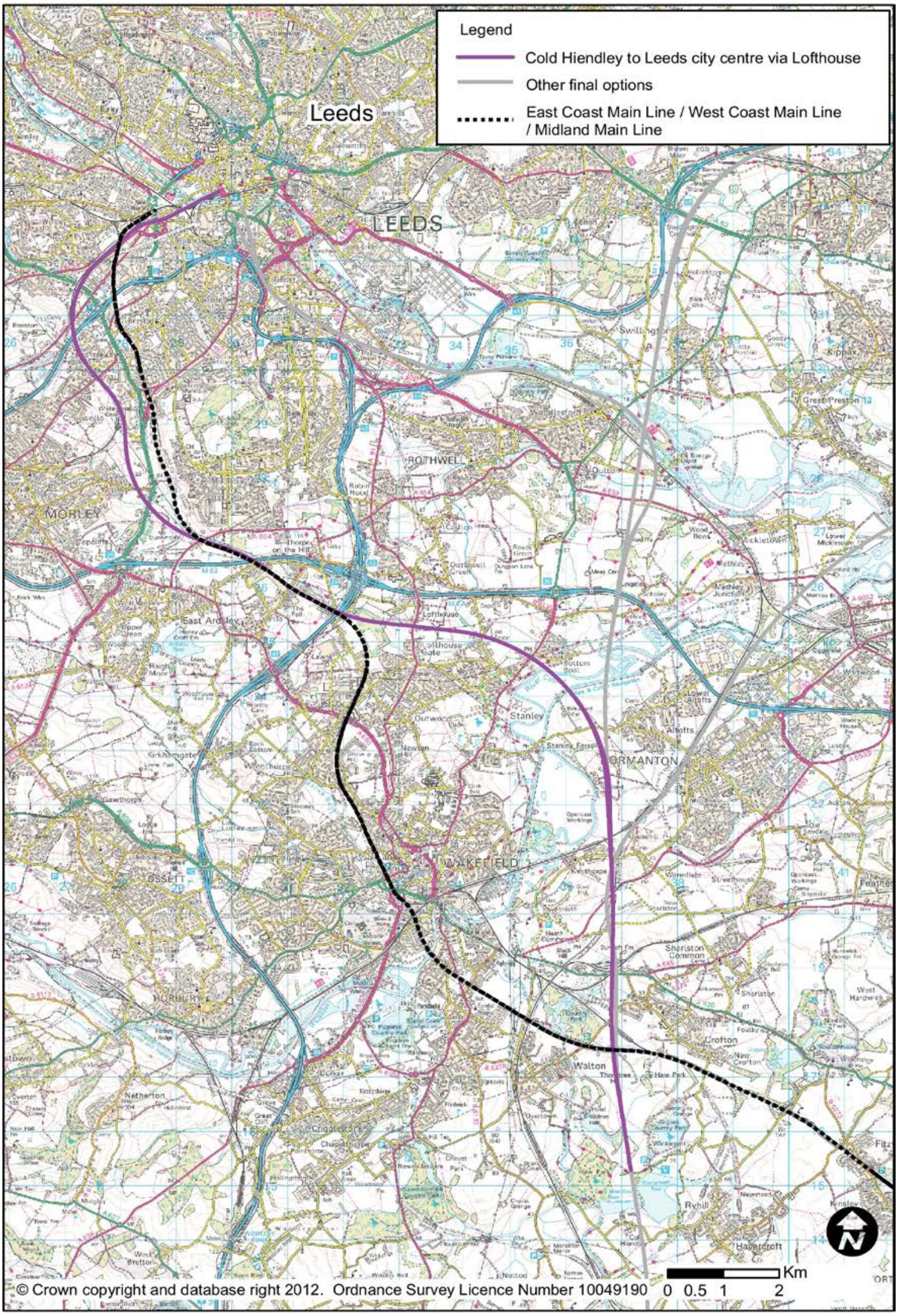
5.7.35 Seven areas of ancient woodland would be potentially impacted. These are either wet woodland or lowland mixed deciduous woodland BAP habitats.

Leeds approaches

5.7.36 Having described the single route north from Blackburn towards Cold Hiendley, we now describe the two alternative route approaches into Leeds (and the minor variant). The first of these approaches via Lofthouse (Transpennine corridor) would serve an HS2 station alongside the existing Leeds city centre station ('Leeds Station North'). We then describe the alternative approach via Woodlesford to serve an HS2 station south of the existing Leeds city centre station ('Leeds New Lane'). We also describe a slight variation to this approach to serve a proposed station at 'Leeds Sovereign Street South'. We describe all the station options in detail in the next section.

Cold Hiendley to a west facing Leeds station at Leeds City Centre North following the Lofthouse (Transpennine) corridor

Figure 5.38 – Cold Hiendley to Lofthouse (Transpennine) route



Source: HS2 Ltd

Engineering

5.7.37 North of the Wintersett Reservoir the route would descend into a shallow cutting and then onto embankment to run east of Walton Hall and west of Anglers Country Park. The route would then be on embankment to cross the roads and existing railways, including the Doncaster to Leeds line through this area as well as the Bombardier Train Maintenance Facility.

5.7.38 The route would then enter cutting west of Burcroft Farm where there would be a number of junction options for spurs off towards York and the ECML including leaving the opportunity for the future expansion of the high speed network further north in the future.

5.7.39 The spur towards Leeds would be in a mix of cutting and embankment to pass under roads through this area and over the existing Wakefield to Normanton railway. Viaducts would be required over disused brickworks and over the main rail lines.

5.7.40 After a stretch in cutting the route would use a viaduct to carry the route over the Aire and Calder Navigation and the River Calder and its floodplain before curving sharply west to aim for a narrow gap in the built up areas between Stanley and Bottom Boat. The route would then climb entering an increasingly deep cutting north of Lofthouse to pass under a number of roads through this area.

5.7.41 The route would pass under both the M1 and M62. A diversion of the existing Doncaster to Leeds railway would be required between the M1 and M62 prior to the construction of the high speed line. The route would climb to pass over the existing railway tunnel at Ardsley before climbing on embankment and viaduct over the valley in which the A653 runs.

5.7.42 After the viaduct, the route would be first on embankment and then in cutting before joining the existing Dewsbury to Leeds railway alignment. A viaduct over part of the surface car parking at the White Rose shopping centre would be required before the route then crosses the valley containing the A643 on a parallel viaduct to the one carrying the existing Dewsbury to Leeds line. The route would then continue adjacent to the existing railway descending into cutting past Cottingley station.

5.7.43 The route would then pass under the M621 making use of former railway land on approach into the proposed Leeds City Centre North HS2 station. Just short of the existing Leeds station the route would diverge on a long viaduct over a number of arterial roads and industrial premises to cross over the western approach tracks to Leeds station before descending around three metres into the proposed HS2 station described in the next section.

Sustainability

5.7.44 The route section between Cold Hiendley and Lofthouse would result in the demolition of two dwellings. From Lofthouse to Holbeck, the final approach to the proposed Leeds Station North, would result in the potential demolition of a further 41 dwellings.

5.7.45 There would be a potential impact on the development of the new commercial and industrial waste recycling facility at Welbeck.

5.7.46 North of the Wintersett Reservoir there would be a limited impact on the landscape character, though with views of the embankment from two country parks and the western edge of Crofton would result in some intrusion. There would also be a potential visual impact at Kirkthorpe especially where the route would pass the River Calder and Newland Preceptory Scheduled Monument. There would not be a significant impact on the setting of the Scheduled Henge at Birkwood Common which is believed to survive as a low earthwork.

5.7.47 There would be a potential moderate impact on the setting of two Grade II buildings on the site of the former Newland Hall. The viaduct over the River Aire and Calder Navigation and River Calder would potentially impact the setting of the Grade II Birkwood Lock. There would also be a landscape and visual impact on the residents of Bottom Boat and Lee Moor. The River Calder, a major river, may require diversion though through continuing design work we would look to avoid or minimise this.

5.7.48 The embankments and viaduct over the A653 would cause some visual intrusion in the relatively undeveloped landscape east of Morley. There would also be some visual intrusion, mainly through the light industry, warehousing and retail, on the approach to Leeds city centre. There could also be some, likely to be insignificant, impacts on the Holbeck Conservation Area. One ancient woodland, Thorpe Wood, would be affected by this route section.

5.7.49 The route would have a direct impact on the Grade II listed walls, gates and gate piers at Jacob Kramer College and to its setting. Impact on the setting of the College Caretaker’s House at Kildare Terrace would also be moderate.

5.7.50 Thorpe Wood would also be directly affected which is both ancient woodland and a wet woodland BAP habitat.

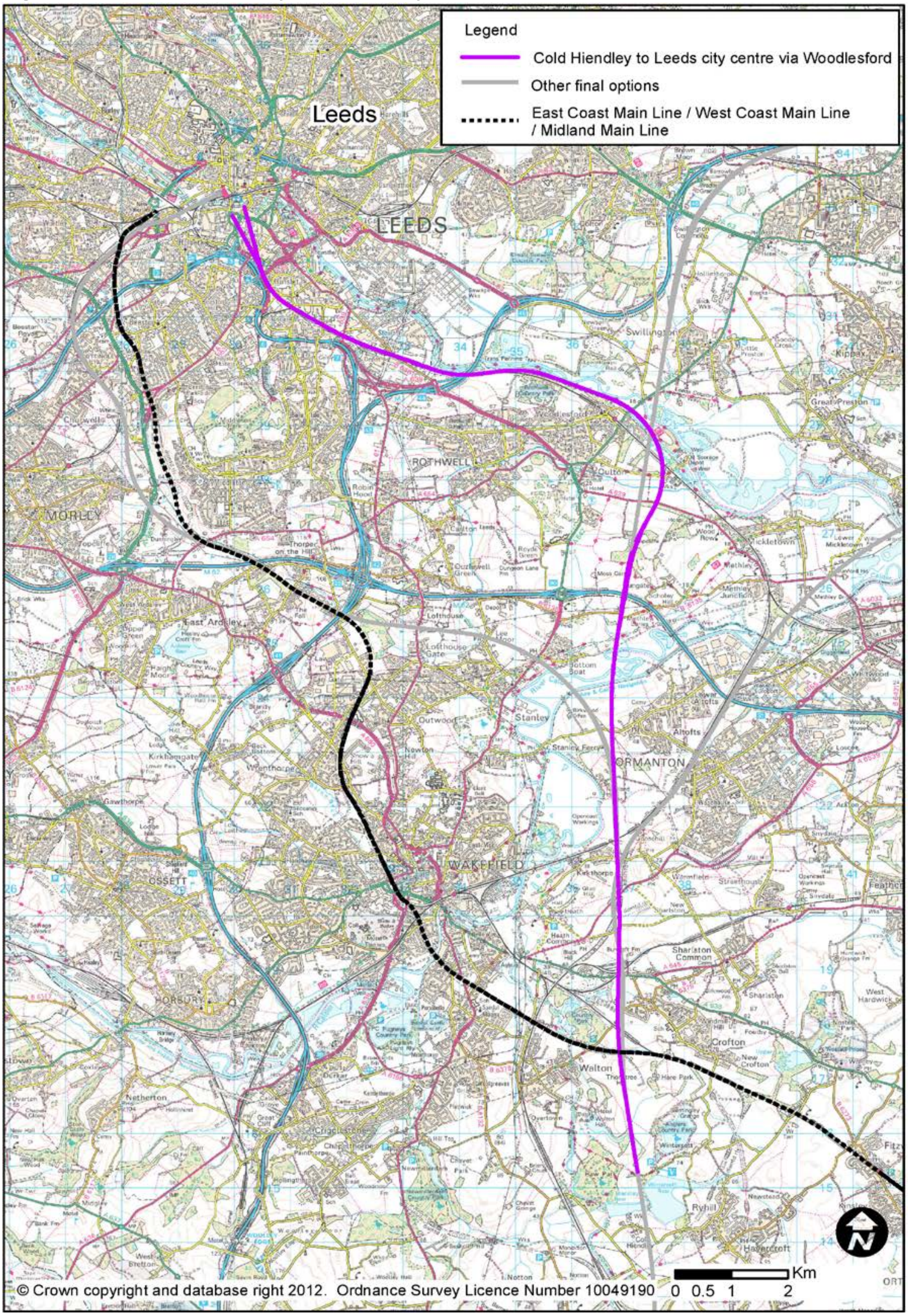
Approach to Leeds New Lane

Cold Hiendley to Woodlesford

5.7.51 We now describe the alternative approach to the proposed station at Leeds New Lane. We describe this approach from the same starting point at Cold Hiendley but this would follow the Woodlesford corridor.

Cold Hiendley to a south facing Leeds station ('New Lane') via the Woodlesford corridor

Figure 5.39 – Cold Hiendley to Leeds city centre via Woodlesford



Source: HS2 Ltd

Engineering

5.7.52 North from the Wintersett Reservoir this route would follow the same path as the approach described above as far as Kirkthorpe. To the north-east of Kirkthorpe the route would be at first on embankment over the existing Wakefield to Normanton railway before falling into the valley of the River Calder.

5.7.53 The route would be on viaduct over the Aire and Calder Navigation and would require multiple crossings of the River Calder and its floodplain. After rising to cross over the M62, the route would descend into the valley of the River Aire on embankment, before passing on viaduct over the existing Normanton to Leeds railway, the Aire and Calder Navigation, River Aire floodplain and the A642 Aberford Road. The route would then run in a narrow area of land between the Aire and Calder Navigation and the River Aire which would potentially create some construction access difficulties.

5.7.54 From Woodlesford towards Hunslet, the route would cross under the M1 on the formation of the existing railway with the existing Normanton to Leeds railway being diverted for a stretch. For the remainder of the route into Leeds, the high speed route would run parallel to the existing Normanton to Leeds railway on its northern side. The high speed route would be at approximately the same elevation as the existing railway, but slightly lower due to the additional headroom required. Some roads in this area would need to be temporarily closed during construction and rebuilt with new bridges to span both HS2 and the existing railway.

Sustainability

5.7.55 Between Cold Hiendley and Woodlesford the proposed route section would result in the demolition of no dwellings. The final approach towards Hunslet would result in four dwellings being demolished.

5.7.56 The proposed development of a new commercial and industrial waste recycling facility at Welbeck would be potentially affected by this route section.

5.7.57 North of the Wintersett Reservoir impact would be generally limited though there would be some visual intrusion from two country parks to the western edge of Crofton. Embankment and cutting west of Normanton would cause visual impact at Kirkthorpe and would affect the landscape character. There would be a moderate impact on the setting of two Grade II listed buildings at the site of the former Newland Hall. Immediately north of Newland there would be a direct impact on the Scheduled Henge on Birkwood Common although this may be avoidable through further scheme design.

5.7.58 The high viaduct on the edge of Woodlesford would be potentially intrusive and result in visual impacts on both the users of the Aire and Calder Navigation and residents. The Grade II listed Swillington Bridge over the Aire and Calder

Navigation would also be directly affected. The setting of the Grade II*Listed gazebo near Clumpcliffe Farm would be subject to minor impacts

5.7.59 Moss Carr Wood ancient woodland and lowland mixed deciduous woodland BAP habitat would be peripherally affected by the route section. The Aire and Calder navigation may need to be diverted, though through more detailed design this could potentially be avoided.

Approach to Leeds Sovereign Street South

Engineering

5.7.60 The approach to the proposed station at Leeds Sovereign Street South would follow the same alignment as the approach to New Lane described above apart from the final 600m to the start of the platforms.

Sustainability

5.7.61 The potential sustainability impacts of this approach would be as described for New Lane except there would be direct impacts on the Victorian Boyne Engineering Works office as well as on the gate piers for the works both of which are Grade II listed.

Routes between South Yorkshire and Leeds and approaches: Section summary

5.7.62 In this section we described the process we went through to arrive at a single route option from South Yorkshire to Leeds. We then described the two different approaches into the final Leeds city centre station options and the minor variant to one of these.

5.7.63 Overall our assessment would have a sustainability preference for the approach following the Lofthouse (Transpennine) corridor into the proposed HS2 station at Leeds Station North. This reflects the route affecting fewer designations and with a potential reduction in noise impacts.

5.7.64 However, this approach would be over £200 million more expensive than the alternative approach via Woodlesford and its variant. It would also be around two minutes slower getting to Leeds city centre though it would then be alongside the existing Leeds rail station and well placed also for access into the existing developed Leeds city centre.

5.7.65 The faster approaches into the south facing Leeds stations would be well placed for the potential future expansion of the city south of the river though, as the next section expands on, raises issues of potential conflict with the short term development of Leeds.

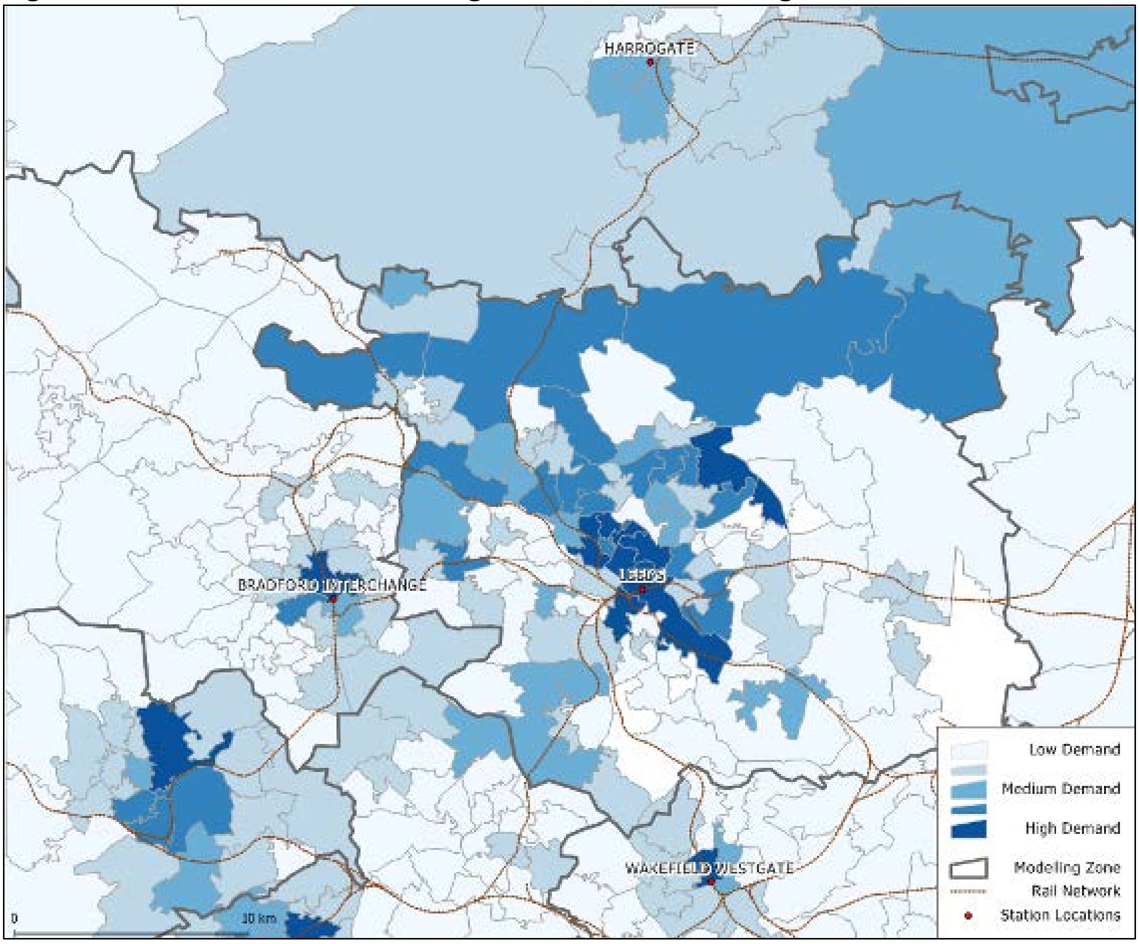
5.7.66 The choice of approach is therefore dependent on which station is chosen.

5.8 Leeds city centre stations

Introduction

5.8.1 This section describes our work developing and assessing station options for Leeds. It outlines the work undertaken to identify and develop Leeds station options and the process for sifting options down. It then describes in detail the three different station options that we considered to be the best alternatives for a station in Leeds. We begin this section by highlighting how demand informs the potential location of a high speed station to serve Leeds.

Figure 5.40 – Leeds and surrounding area - demand for long distance travel



Source: HS2 Ltd

5.8.2 The demand for long distance travel around Leeds is primarily located in the city centre with relatively high levels of demand towards the north of the city as can be seen in figure 5.40. Survey data from the National Rail Travel Survey (NRTS) suggests that around a fifth of passengers from Leeds to London and South East England interchange at the station with other rail services. This demand is coming from the wider region surrounding Leeds, including towns like Harrogate.

5.8.3 As with the development of our other station options, connectivity to the existing Leeds station is important. In addition, Leeds station is well placed for access to the existing Leeds city centre developments and the commercial and business districts. However, as we explained in the previous section, developing approaches into the north of the city is complicated by the river and by the sprawl of development. Avoiding or minimising impacts tends to add to the costs. And in order to access the north of the city successfully, the approach would be longer and slower with an overall journey time impact.

5.8.4 Therefore our final options include station options to the south of the city. These would be less restricted by existing development and by the river. By being to the south, they provided a faster journey time to the high speed station. They would also have the potential to tap into the future plans for developing Leeds to the south. This became a significant issue in our discussions with delivery partners as they also had the potential to conflict and even blight that development. Leeds City Council was therefore concerned that one of these options in particular would conflict with development plans, blighting the area in the short to medium term.

5.8.5 The second option would be more peripheral to development sites. We describe the development plans in text box 19. Options to the south would also not be as well placed to access the existing Leeds rail station and the benefits of connectivity we have described above. We set out the design work we have done to consider opportunities for linking a south facing Leeds station to the existing rail station.

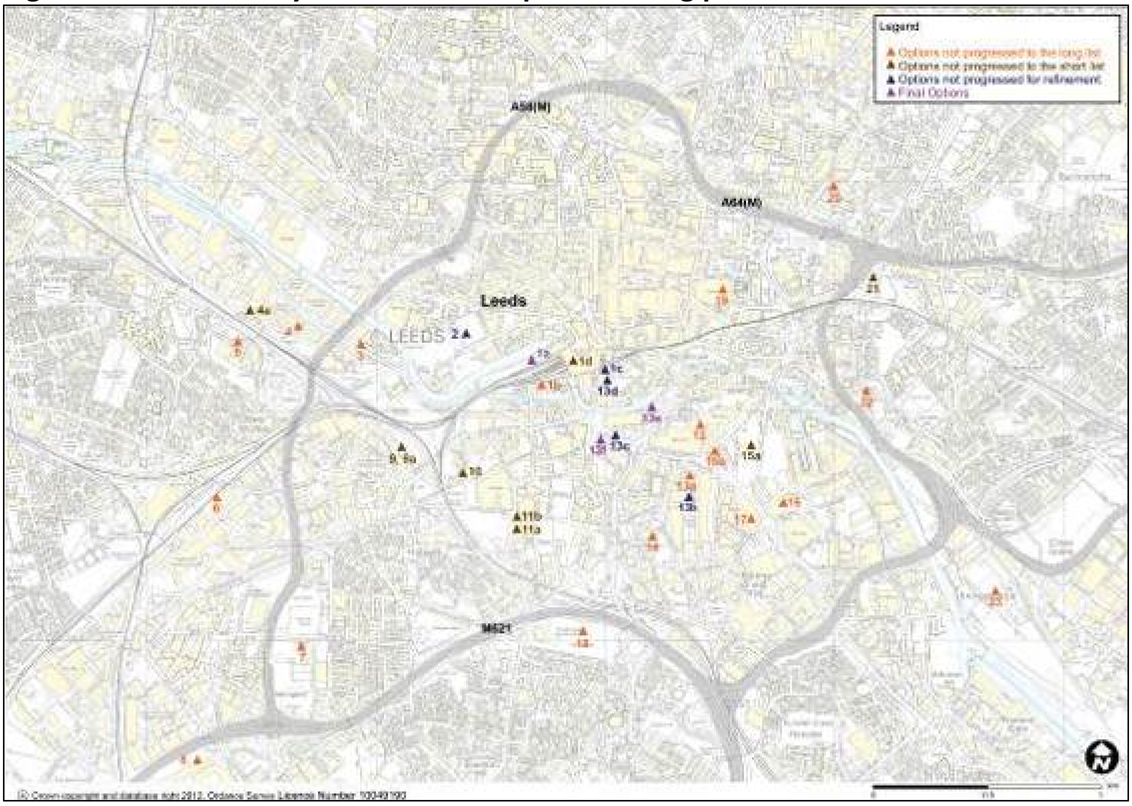
5.8.6 Before describing our proposed final stations we set out the sifting process we went through to reduce and refine options.

The generation of initial ideas and the sifting down to a long list

5.8.7 As with other locations we started by identifying options within a very wide catchment area independently of the work looking at lines of route to Leeds. Figure 5.41 shows the range of options considered. Leeds delivery partners assisted us in option generation, particularly in terms of suggesting potential available development sites.

5.8.8 The centre of Leeds is bounded by the ring road. Most of the development to date has been in the area north of the River Aire with major retail, commercial and civic centres located there. We found it difficult to find any sites with sufficient space for a high speed railway station north of the river. As it moves forward though, it is clear that Leeds is developing to the south of the river, taking advantage of some significant sites becoming available. One example is where the Carlsberg Tetley brewery has recently closed down. We worked closely with Leeds City Council to understand the development aspirations and opportunities and how a high speed station might complement them.

Figure 5.41 - Leeds city centre station options sifting process



Source: HS2 Ltd

5.8.9 In parallel, the work on line of route refined the long list of routes to Leeds. When we ceased work on a station option, we would stop work on the associated route option unless it looked promising. When a route option was not progressed, we would consider the associated station and potentially take it on further rather than immediately stopping work on it. This was to ensure that we did not prematurely park a potentially strong station option simply because we did not have an immediately viable associated line of route.

5.8.10 Options progressed no further are outlined in table 5.4.

Table 5.4 – Leeds city centre stations not progressed to the long list

Unique identifier	Name	Main reasons for parking at this stage
1b	Leeds Station South	Potential impact on communities Potential conflict with planning policy.
3	The Roundhouse	Optimised into a single option (Armley Road 4a)
4	Armley Road	
5	Canal Street	
6	Copley Hill	Lack of proximity to city centre Poor connectivity
7	Islington	Lack of proximity to city centre Average connectivity
8	Eland Road	Lack of proximity to city centre Average connectivity
12	Brewery	Complexity of route approach Potential conflict with planning policy
13a	Pottery Fields, Manor Road	Complexity of route approach Potential impact on communities
14	Pottery Fields, Sweet Street	Complexity of route approach Potential impact on communities
15b	Brewery, Hunslet Road	Complexity of route approach
16	Carlisle Road	
17	Pottery Fields, Hunslet Road	Lack of proximity to city centre Poor Connectivity Complexity of route approach
18	Northcote Drive	Lack of proximity to city centre Average connectivity
19	Market	Potential impact on communities
20	Macaulay Street	Lack of proximity to city centre Poor connectivity Potential impact on communities
22	Ellerby Road	Lack of proximity to city centre Poor connectivity
23	Knowsthorpe	Lack of proximity to city centre Poor connectivity
24	Underground	Construction complexity and potential cost

Source: HS2 Ltd

The creation of a short list

5.8.11 Following the process described above, we were left with a long list of options with clusters around Leeds station and to the south, east and west.

5.8.12 We carried out more detailed work on these options and on the lines of route that would serve them. The remaining station options were assessed to a greater level of detail against the sifting criteria at this stage.

5.8.13 The options below were not progressed to the short list.

5.8.14 Option 11a (Sweet Street), was refined from its long list position. We felt it was too far from the city centre with a walk of around 20 minutes to the office and retail quarters. There was also a risk of impacting upon the Grade I listed Temple Mill, although it was acknowledged that it should be feasible to incorporate it into an appropriate design. Option 11b at Temple Mill would also impact the Holbeck residential area and would be closer to the listed building and so potentially impact it more. It suffered from the same lack of proximity to Leeds city centre as Sweet Street. We progressed neither option.

5.8.15 Option 15a (Black Bull Street) was also too remote from the city centre and station. We progressed other options with an approach from the south which would get closer in.

5.8.16 Option 4a (Armley Road) was developed from the previous options 3, 4 and 5 (see table 5.4 for details). It was not taken further, though, because it would have a difficult approach with impacts on the development area to the south of the river and was still too remote from Leeds station and city centre.

5.8.17 Options 9 and 9a (Springwell Road) were assessed. One option was at ground level and the other was in a cutting sub-surface, reflecting approaches to the station from different sides of the Woodlesford corridor. We did not feel that either option would work as they would be on the wrong side of the railway junction and separated from the city centre. We noted the development potential to the south of the river but felt that the options further east had more potential.

5.8.18 Option 10 (Bath Road) would have to be below ground level and this would be extremely costly. It was considered as a station on the line of route through Leeds but the impacts of the approaches would be major. We felt that the station would be too far from Leeds station even with some form of transit system.

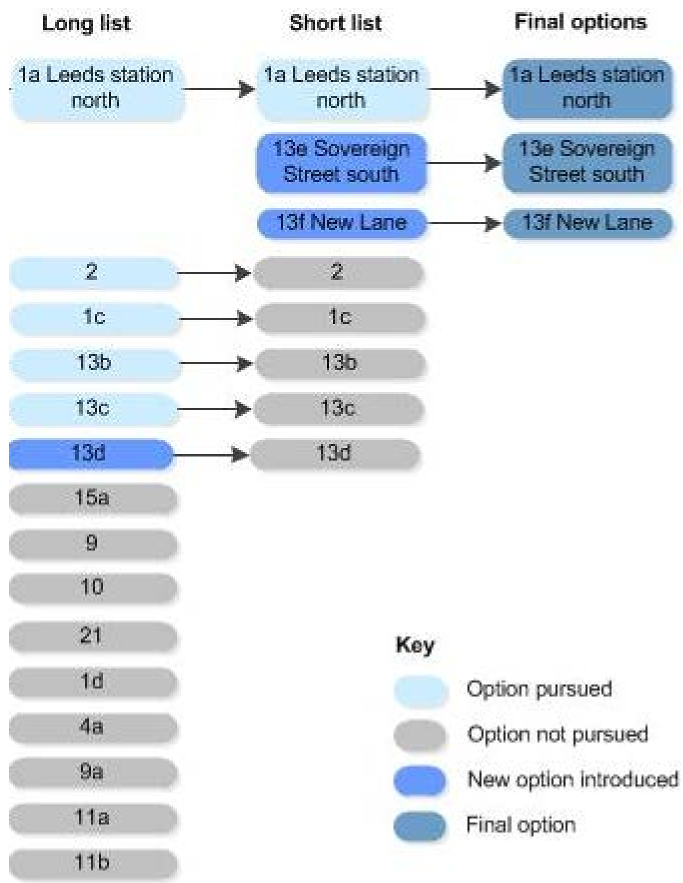
5.8.19 Option 21 (Marsh Lane) was just too far away from the centre of the city and any rail connectivity. It would also involve significant demolitions. The approach route to the station would also involve complex engineering works on the existing railway.

5.8.20 We looked in some detail at whether you could remodel the existing Leeds station to accommodate high speed services alongside the existing services. This option would require the complete remodelling of the existing station to provide space for the new high speed services whilst maintaining existing capacity. The option would have major impact and disruption to rail operations for several years while the works are being carried out. We chose not to progress this option as a result and also because we had viable alternative options.

Selecting options for refinement

5.8.21 We were left with a short list of options centred around the existing Leeds station with approaches from the west, east and south.

Figure 5.42 – Leeds station long list to final options



Source: HS2 Ltd

5.8.22 We carried out a more detailed assessment of the remaining station options at this sifting stage. With a smaller number of options to appraise, we also carried out new work. Our socio-economic assessment determined the potential for options to support growth in the immediate vicinity.

5.8.23 The options below were sifted out from the short list and not pursued any further.

5.8.24 We did not progress work on option 2 on the site of the old Leeds Central Station. Although it did seem promising with a viable approach, and a relatively open site, the area is earmarked for office development and this is likely to come forward in advance of HS2 with some of the Wellington Place developments having been granted planning consent already. The station would also need to be linked with the existing one and it would still involve a reasonably long interchange time as it would be about 400m away. We decided that the option Leeds station north would be better so we did not progress the Leeds Central station option.

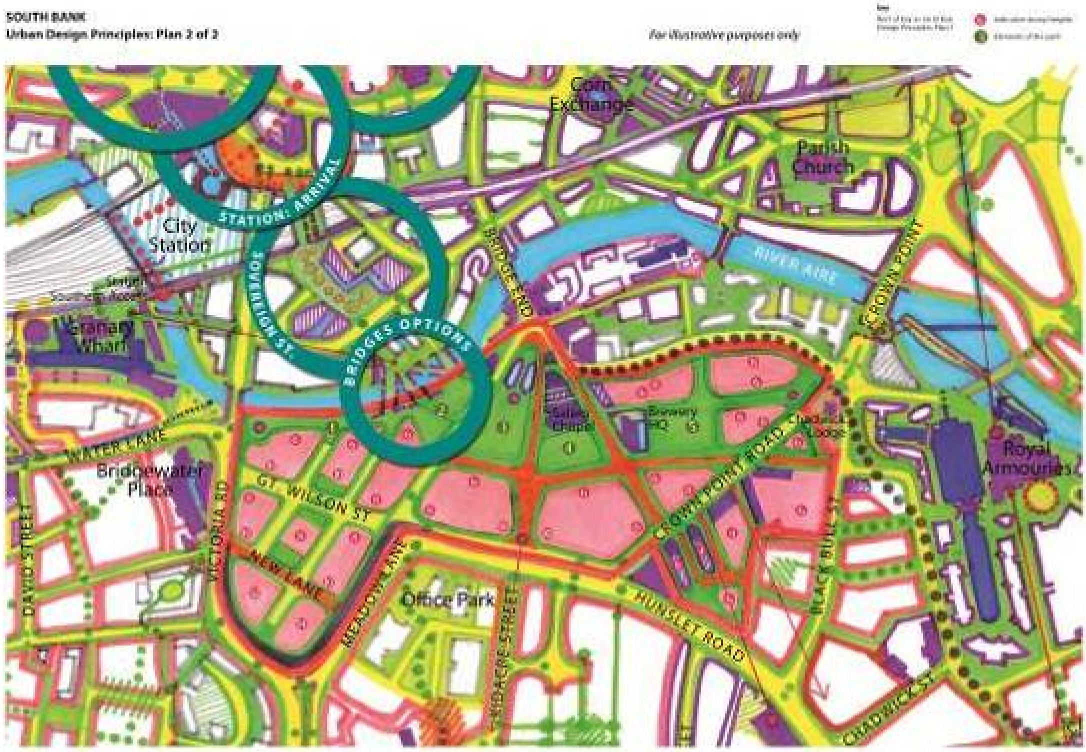
5.8.25 Option 1c (Leeds Station East), to the east of the existing station, would offer good proximity to the city and the existing station, which it would adjoin. It would however, exacerbate the severance of the north of Leeds from the south where significant city development is planned. This option would require a very substantial number of dwellings being demolished and would also impact on the setting of several listed buildings including a Grade I listed church. It would also conflict with the Sovereign Street development site. In summary the sustainability impacts of this option were not thought to be acceptable so it was not progressed.

5.8.26 We looked at a range of station options to the south of the River Aire. Option 13b (Hunslet Yard) would sit where the Crown Point shopping centre is. It would be around 800m from the existing station. The option would potentially conflict with the South Bank development framework. We still had other options for a station approached from the south which could get closer to the city centre and existing station. Therefore, we stopped work on option 13b.

5.8.27 Option 13d (Sovereign Street) offered the potential to interchange directly with the existing station from a southerly approach. It would however conflict directly with the Sovereign Street development site, which Leeds City Council are keen to implement in the short term and as a result, were concerned that proposing a station option there would blight the development opportunities (see text box 19).

5.8.28 Option 13c (Gasworks) was not progressed as it would conflict with Leeds City Council's South Bank planning framework. It would not get as close to Leeds Station as the other Leeds Station North option and did not offer any other particular advantages over it.

19. Development in Leeds - Leeds South Bank



Source: Leeds City Council

Immediately to the south of River Aire is an area known as 'Leeds South Bank', which sits between the traditional City Centre core and the riverside to the north, Holbeck Urban Village to the west, the Aire Valley to the east, and Beeston Hill and Holbeck to the south. Leeds South Bank is likely to change significantly in the coming years, particularly as a result of the closure of the Carlsberg Tetley Brewery in 2011. Leeds City Council's South Bank Planning Statement[13] aims to provide clarity for developers in terms of development expectations, aspirations and scale of planning obligations, and for Leeds City Council in achieving its aspirations for promoting a new City Centre Park, both as a destination in its own right, and as a catalyst for the reconnection of the South Bank to the city centre and surrounding neighbourhoods.

We considered a range of station options approaching Leeds from the south. This would give a faster and lower cost approach than alternatives as described in the line of route section whilst delivering a station in the area Leeds City Council is focussed on developing in the short to medium term. The Council expressed concern though that a proposal for such a station could blight the development area. In terms of the final options, this was particularly the case for Sovereign Street South which would run through the middle of the development area. New Lane would sit more towards the edge of the development area.

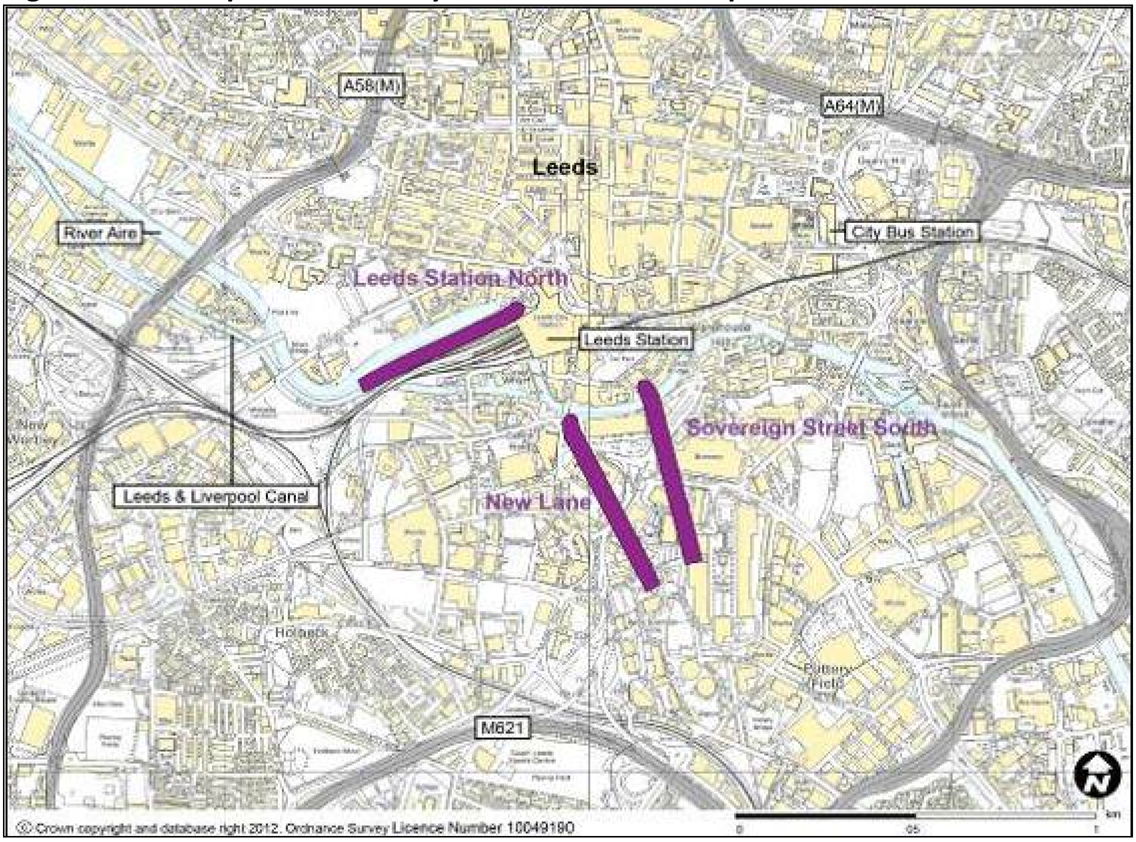
[13] See Leeds City Council, 2011, *South Bank Planning Statement,* http://www.leeds.gov.uk/files/Internet2007/2011/45/south%20bank%20planning%20statement%20adopted%20web.pdf

Some initial work was done with Leeds City Council to study how a high speed station could fit development aspirations for the area, and if a station to the south of Leeds were to progress, there would need to be more detailed work with the Council on how it would interact with development plans.

Developing and finalising our options

5.8.29 Following the sifting process described above, we were left with three options for a high speed station in Leeds city centre. Figure 5.43 shows the three final options, which were refined and assessed. Our engineering and sustainability appraisal is described below. We then describe the comparable demand of the options.

Figure 5.43 – Proposed Leeds city centre station final options



Source: HS2 Ltd

Final options

Leeds Station North

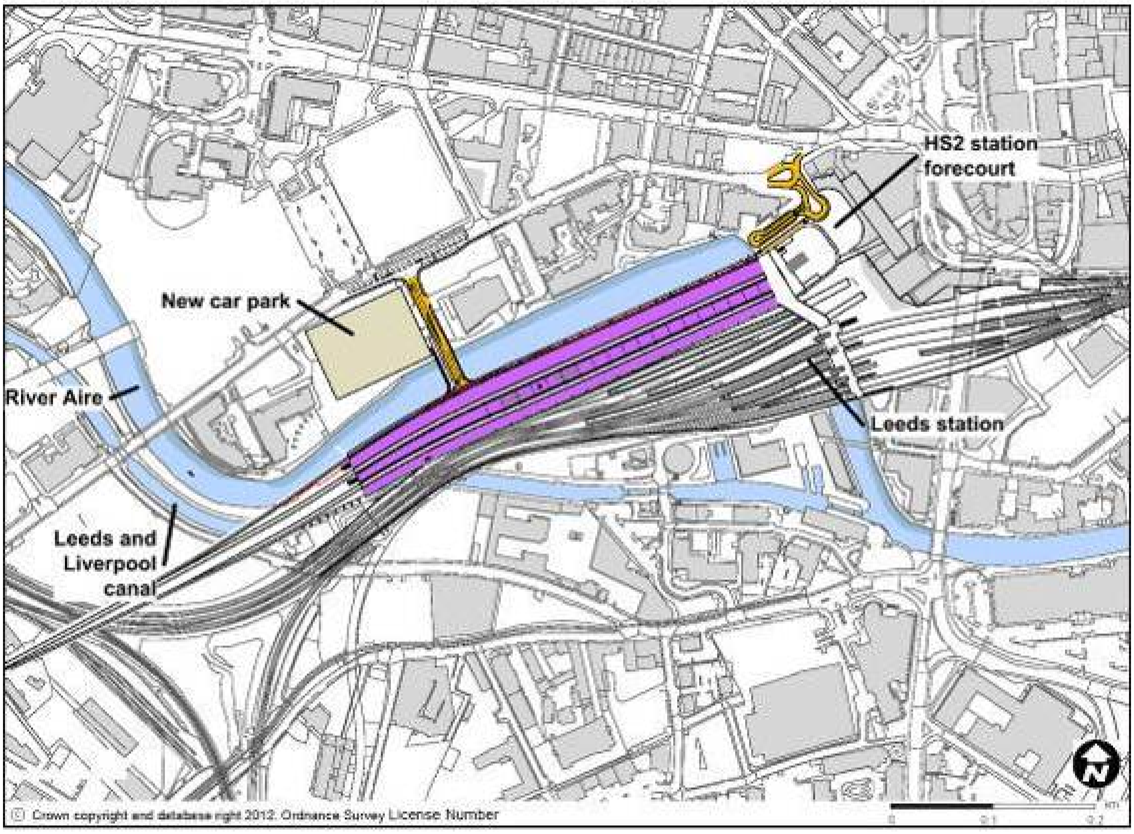
Engineering

5.8.30 The station would be located adjacent to and directly north of the existing Leeds Station. It would be orientated east-west, on the site of the current station car park bounded on one side by the station and the other by the River Aire. This station would be served by an approach via Lofthouse (Transpennine) described in section 5.7.

5.8.31 The existing Leeds station has 16 platforms and handles a large number of passengers making it the third busiest station in the UK outside London. Station layout comprises main entrances on Princes Square and New Station Street leading to a single concourse. A forecourt for pick-up and drop-off is located at the north side of the existing station, on Princes Square, with parking along the north side of the station. Bus interchange and taxi pick-up is provided on New Station Street, on the north-east side of the station. Network Rail are currently planning to construct a further station entrance, located on the southern side of the station above the River Aire at Granary Wharf.

5.8.32 The new high speed station would comprise five platforms, elevated at a similar level to the existing station footbridge. They would be higher than existing platform level due to the approach to the new station having to cross over the existing railway junction to the west. The platform edges would be curved and tapered towards the west end to minimise the overhang of the station structure over the river. This is a tight fit site and a high speed station on the site would make any future Network Rail expansion of the existing Leeds station very difficult and costly to achieve.

Figure 5.44 - Leeds station North layout



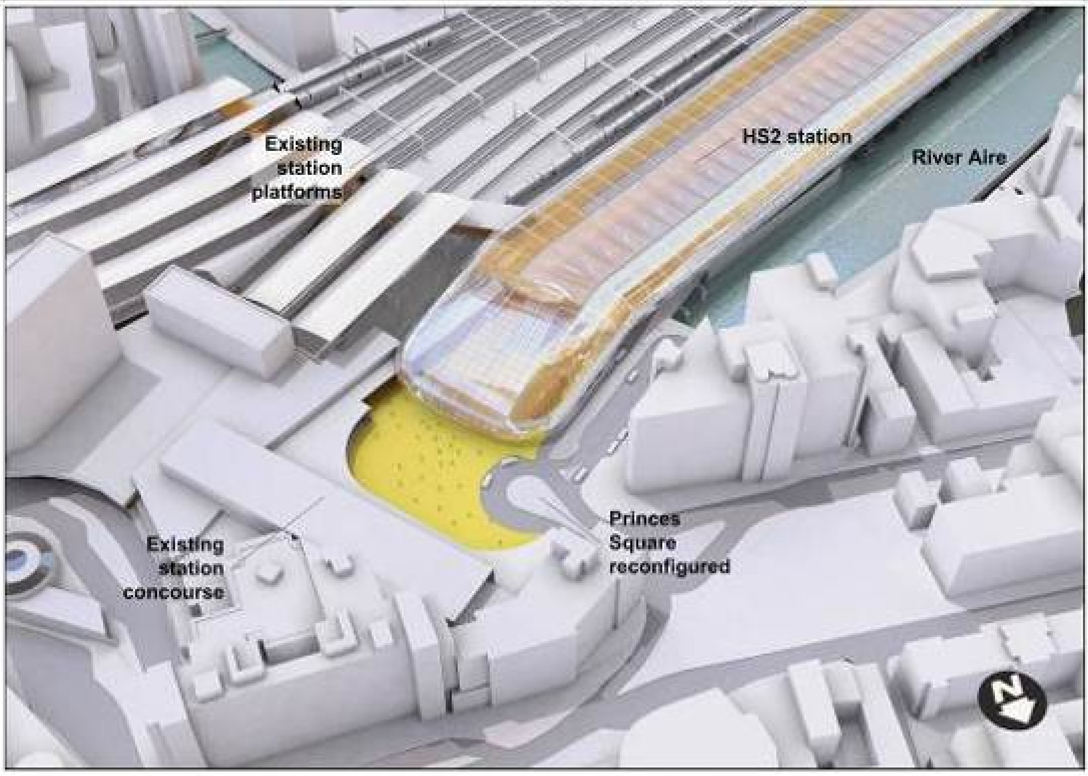
Source: HS2 Ltd

5.8.33 The HS2 station would have two primary entrances, one at the east end facing onto Princes Square, and another towards the west end facing the river and the car park on the opposite bank. At Princes Square there would be a large forecourt area shared with the existing station. Taxi and car drop off/pickup areas would be provided here. All taxis would be relocated to here from the New Station Street side and so free up more space for bus interchange and an improved pedestrian environment. There would also be access to the existing station concourse here.

5.8.34 A multi-storey car park would be located on the north side of the River Aire, just south of Whitehall Road. Short term car parking would be located at the ground floor under the station. Locating the car park under the station has been considered and would be feasible, but this would involve considerable excavation and have significant cost implications.

5.8.35 A new road off Whitehall Road would provide access to the new car park. The road would continue on a new bridge over the river and along the north side of the station to the main forecourt and pick-up/drop-off area at Princes Square.

Figure 5.45 - Leeds Station North indicative illustration



Source: HS2 Ltd

5.8.36 The station platforms would be constructed on structures partly over the River Aire. The highly constrained nature of the site would likely mean multiple phases during the construction.

Passenger access and dispersal

5.8.37 The station would be well located in terms of accessing the city centre and, because of its access to rail and other connectivity, the wider region. It would provide direct and short walking routes to the city centre. The station car park and forecourt would lead to Wellington Street connecting to the Inner Ring Road and onto the M621 and the M1, giving good connection to Leeds suburbs and the wider region.

5.8.38 Bus provision would remain as it is on New Station Street. The loop road running alongside the station on its north edge, in between the station and the river, would provide taxi queuing, leading to the taxi pick-up points on the station forecourt.

5.8.39 This option would give excellent interchange with classic rail services with passengers only having to walk for a few minutes to change platforms. This would be provided by the high-level walkway connection into the existing station footbridge or via the existing station concourse.

5.8.40 The trade-off between interchange and walk times and overall journey times is described in more detail in the section on demand below. Whilst this option would benefit from excellent connectivity and good walk time to the existing city centre, this is contrasted with a journey time penalty resulting from the slower approach compared to Leeds New Lane and Sovereign Street South.

Sustainability

5.8.41 This station option would result in no dwellings being demolished.

5.8.42 The station would have some limited impacts on the existing townscape fabric with slight impacts on the waterfront areas and views. In particular, the southerly aspect of the buildings on the north side of the River Aire would be adversely affected by the new station structure and proposed elevated road bridge and throat to the west. This would reinforce the existing visual severance.

5.8.43 Leeds City Council have progressed their core strategy to the preferred approach stage. The city centre is promoted as a primary focus for shopping, economic development and urban renewal. The station option would support these policies.

5.8.44 The works would potentially displace businesses providing an estimated 500 jobs. However, an estimated 14,500 jobs would be supported through development around the station generated as a result of HS2. There would be an estimated 1,900 housing units supported.

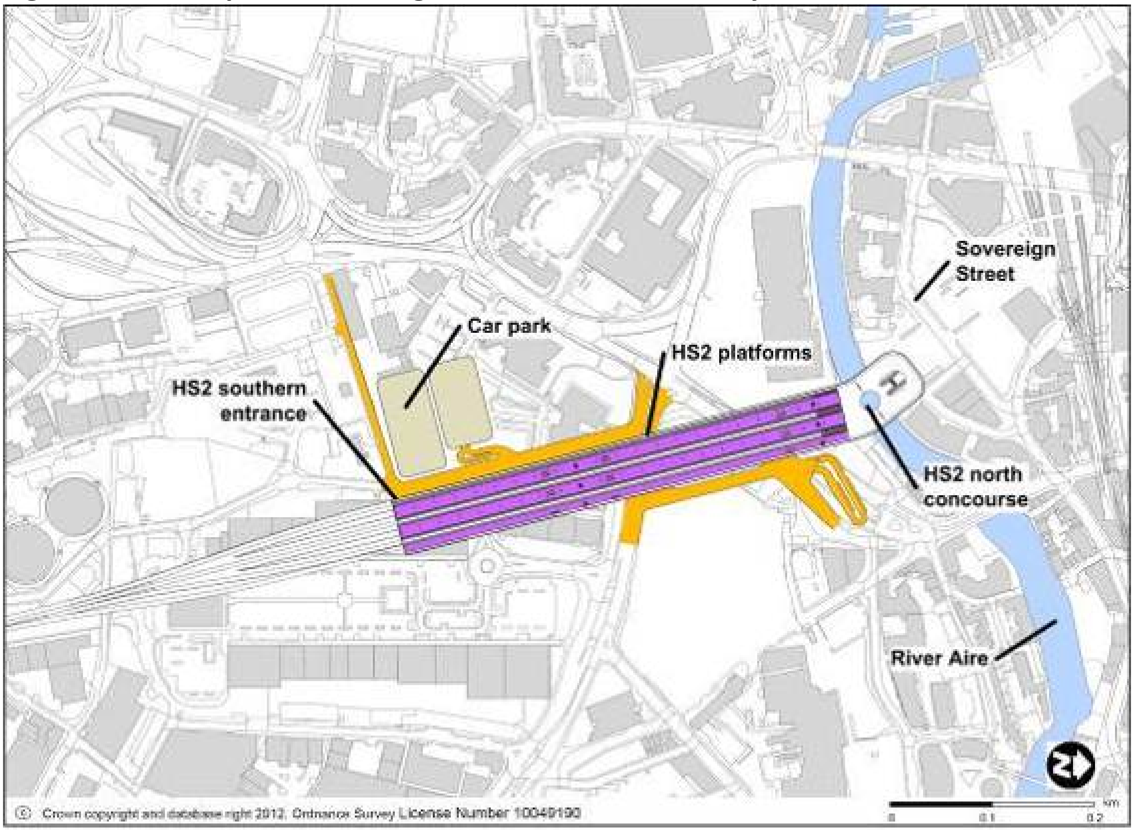
Sovereign Street South

Engineering

5.8.45 Leeds Sovereign Street south would be a new station, located approximately 200m south of the existing Leeds station, and would be aligned north-south. While the elevated tracks would terminate on the southern side of the River Aire, the concourse would cross the river to the east of Asda House and would front onto the new public plaza associated with the currently proposed Sovereign Street development.

5.8.46 The station would comprise five platforms, elevated over the adjacent streets with access from a concourse at grade. Elevating the main structure over Meadow Lane and Great Wilson Street would help minimise potential east-west severance that the station would cause. The station would be served by the Woodlesford (variant) approach described in section 5.7.

Figure 5.46 – Proposed Sovereign Street South station layout



Source: HS2 Ltd

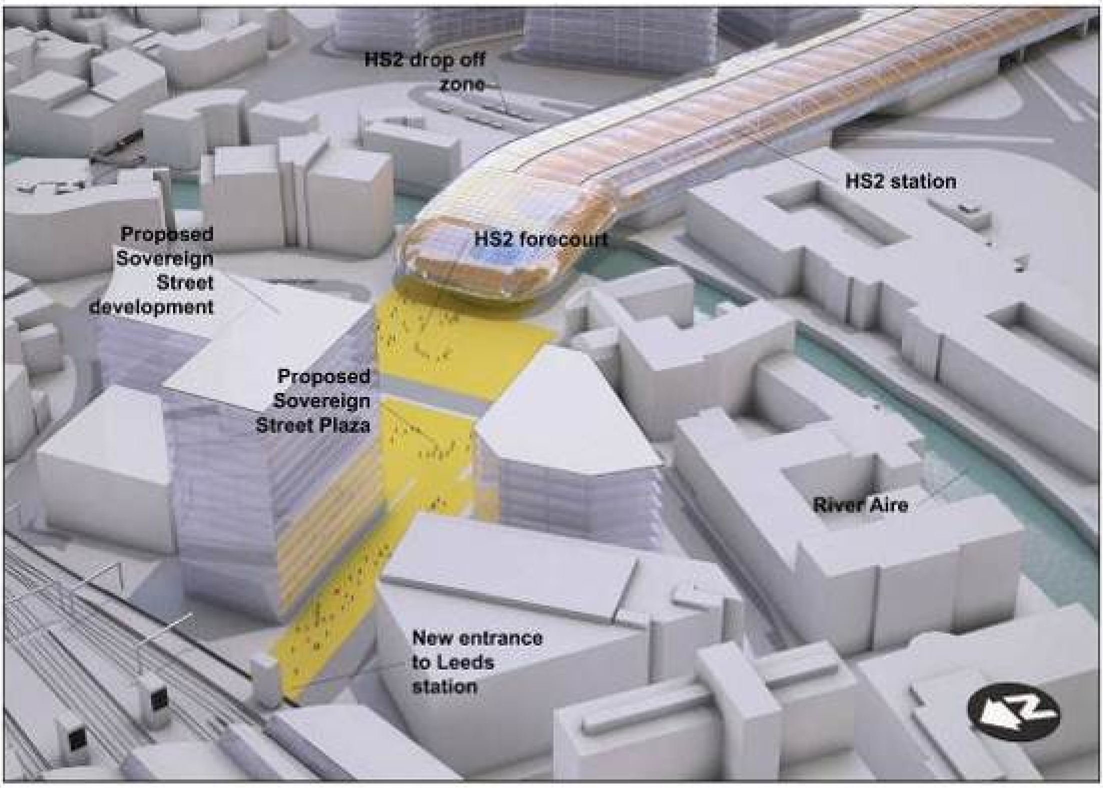
5.8.47 The station would have three entrances: one on a bridge leading from the north side of the river that would provide pedestrian access to Leeds station and the city centre; an entrance just south of the river with a forecourt for car and taxi drop off/pick up and local buses; and a southern entrance that would provide access for passengers arriving by car using longer term parking. Short stay car parking would be adjacent to both ends of the station.

5.8.48 Passengers connecting to the existing Leeds station would gain access through the new public plaza at Sovereign Street, leading to a new southern entrance to Leeds station, with escalators leading from the arches in the station viaduct up to platform level.

5.8.49 Pedestrians would be able to access the station from the city centre by enhanced walking routes through the Leeds Station viaduct arches.

5.8.50 Highway access would be provided for the car parking on the south of the site off the A653 gyratory, which would need to be remodelled to accommodate it.

Figure 5.47 - Sovereign Street South indicative station illustration



Source: HS2 Ltd

Passenger access and dispersal

5.8.51 The station would be over five minutes walk to the existing Leeds station. This would impact overall benefits as Leeds station offers good connectivity to the wider region as already described.

5.8.52 As the proposed station is south of the existing city centre there would be a reasonably lengthy walk time. However, as Leeds is developing to the south, the negative impact this would have on overall benefits may not be significant.

5.8.53 The trade-off between interchange with the existing station, walk times to the city centre and journey times is covered in the demand section below. Whilst there is a reduction in benefits for this option and for Leeds New Lane from the longer interchange with the existing station and from the additional walk time, both have additional benefits resulting from the quicker approach to them and therefore better overall journey times.

5.8.54 The southern entrance to the station would have good proximity to the Inner Ring Road, M621 and motorway network, and so provide good highway access to the West Yorkshire region.

Sustainability

5.8.55 This station option would result in no dwellings being demolished.

5.8.56 The station would be elevated and span the width of the River Aire. The roof line would be approximately 20m above the River Aire and would obstruct key views along the river from the open space along the river and adjoining bridges, and would affect the distinctive historic riverside setting.

5.8.57 Overall, a major adverse impact would be expected on the townscape, although there may be some opportunities for townscape enhancement as part of the future redevelopment south of the river in the longer term.

5.8.58 The station would conflict with the Sovereign Street and South Bank Planning Statements. Leeds City Council had concerns around the impacts of this option on development, particularly in light of the likely timescales. As such it would be the worst of the three options from their perspective. However, if taken forward there is the potential to work with Leeds City Council to ensure that the station is integrated into this masterplan led approach for the areas both north and south of the River Aire.

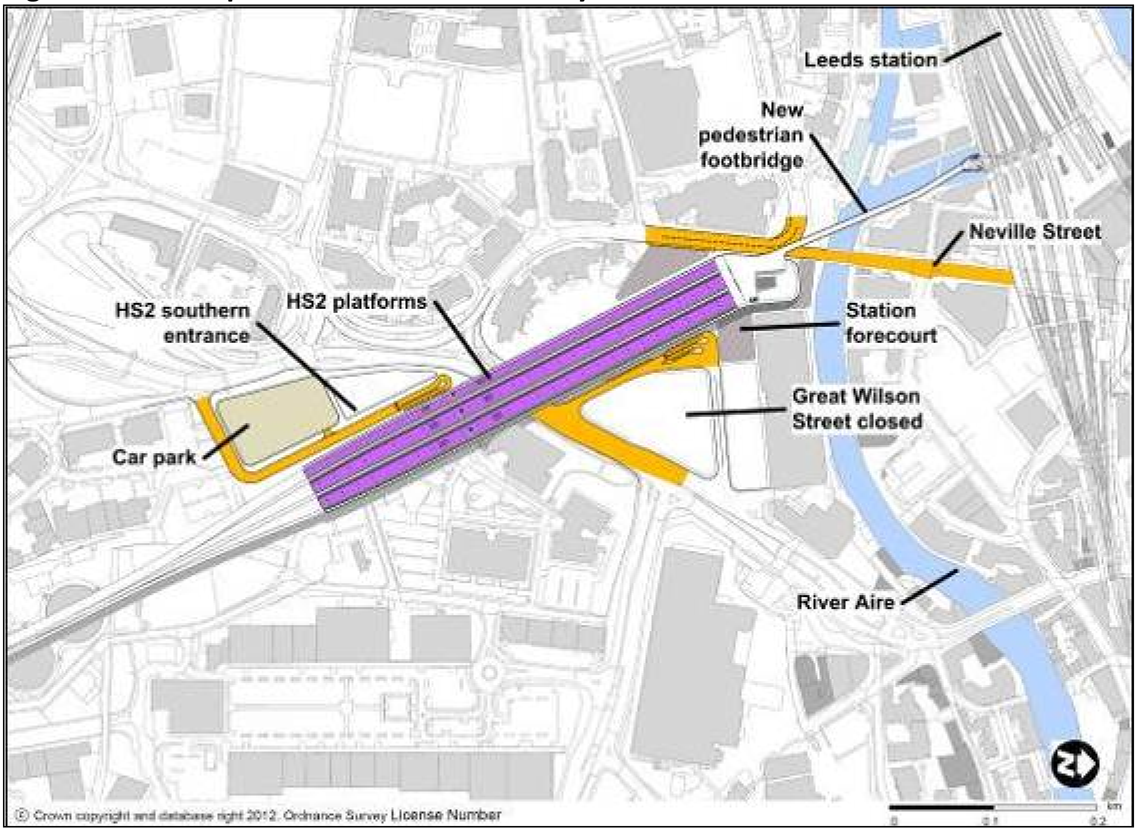
5.8.59 The works would potentially displace businesses providing an estimated 5,500 jobs. However, an estimated 12,100 jobs would be supported through development around the station generated as a result of HS2. There would be an estimated 1,100 housing units supported.

New Lane

Engineering

5.8.60 Leeds New Lane would be located approximately 200m south of the existing Leeds Station, just south of Victoria Bridge. It would be bounded by Asda House and Leeds Business Park to the east and Bridgewater Place to the west. The station would be orientated approximately north-south and positioned so as to end directly on the south side of the River Aire. This option would be served by the Woodlesford approach described in section 5.7.

Figure 5.48 – Proposed New Lane station layout



Source: HS2 Ltd

5.8.61 The station would comprise five platform faces. The platforms would be elevated over the adjacent Meadow Lane to avoid east west severance. It would be necessary to close the west end of Great Wilson Street to through traffic in order to accommodate the station.

5.8.62 The station would have two entrances. The main entrance at the forecourt on the south side of the river would provide access for passengers going to and from the city centre as well as arriving or departing by bus, car and taxi. The southern entrance would provide access for passengers from suburban locations, arriving or departing by car and using the long stay car park. There would be a concourse at both entrances, and there would be an internal pedestrian link between the two entrances.

5.8.63 A pedestrian bridge crossing the River Aire would be provided to optimise interchange times with the existing Leeds station. This would lead from the high speed station platform level to the existing platform footbridge, possibly via the currently proposed new southern entrance at Leeds station. If this option were to progress, we would carry out further work with delivery partners to identify the optimal interchange arrangement.

5.8.64 Access to the city centre would be enhanced if Neville Street were to be closed to through traffic and become a shared pedestrian and public transport route.

5.8.65 Highway access would be similar to that for Leeds Sovereign Street South. Access would be provided for car parking to the south of the site off the A653 gyratory and from the M621.

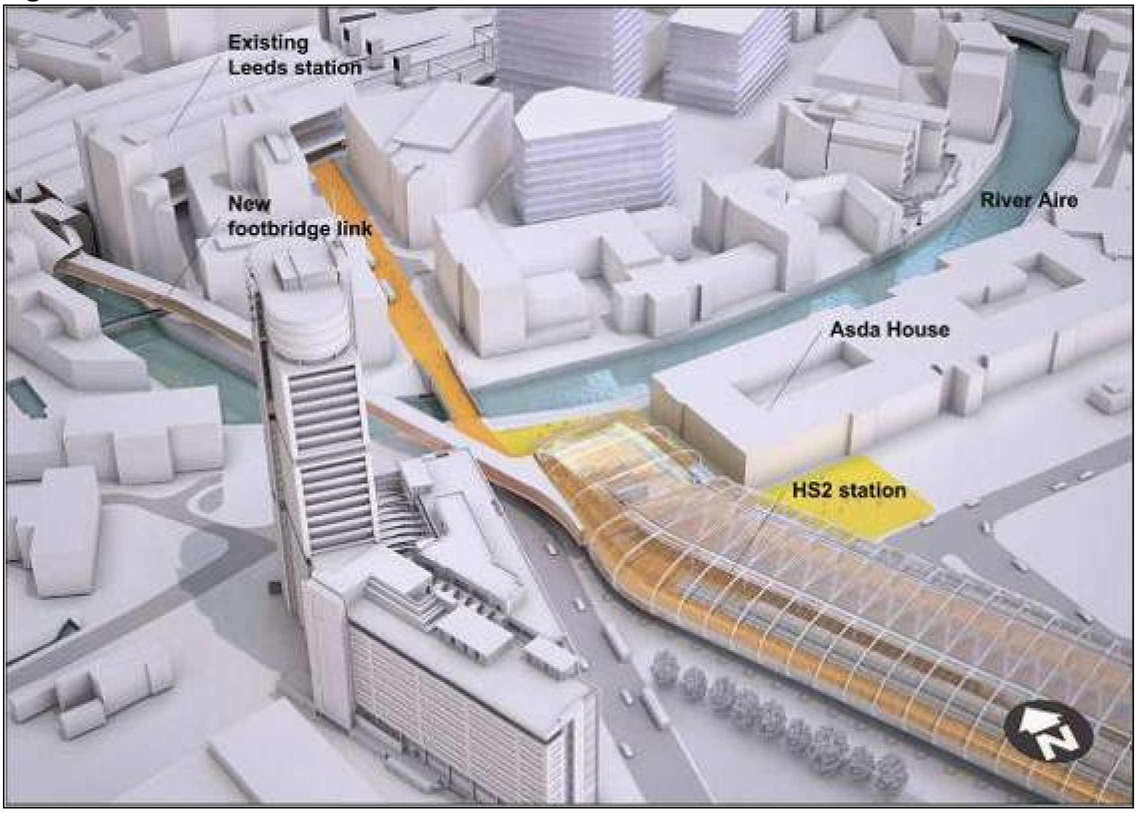
Passenger access and dispersal

5.8.66 The station would be over five minutes walk to the existing Leeds station and its good connectivity to the wider region. As the proposed station is south of the existing city centre there would also be a reasonably lengthy walk time. However, as Leeds is developing to the south, the negative impact this would have on overall benefits may not be significant.

5.8.67 Similar to Leeds Sovereign Street, New Lane would be easily accessed by passengers using cars from the Leeds suburbs, due to its proximity to the ring road and highway network. The southern entrance to the station would have good proximity to the Inner Ring Road, M621 and motorway network, which would provide good highway access to the West Yorkshire region.

5.8.68 The trade-off between interchange with the existing station, walk times to the city centre and journey times is covered in the demand section below. Whilst there is a reduction in benefits for this option and for Sovereign Street South from the longer interchange with the existing station and from the additional walk time, both have additional benefits resulting from the quicker approach to them and therefore better overall journey times.

Figure 5.49 - New Lane indicative station illustration



Source: HS2 Ltd

Sustainability

5.8.69 The station would result in no dwellings being demolished.

5.8.70 The station roof would be approximately 20m above ground level, broadly in keeping with the taller existing buildings in the area. However, the station and high level passenger link may cause an adverse impact on the local townscape.

5.8.71 There would be substantial impacts on the Canal Wharf Conservation Area. The high level passenger link would restrict views from across the river and affect river users, it would also change the character of the conservation area. There would also be a moderate impact on the setting of the Grade II listed Victoria Bridge.

5.8.72 The station would conflict with the South Bank Planning Statement. However, there is potential for the station to be integrated into this master plan led approach for the area south of the River Aire. Leeds City Council indicated that New Lane would have less of an impact on their development plans than Sovereign Street South would. The station would support the growth of the southern side of the city and the wider city region, as identified in the Council's draft core strategy.

5.8.73 The works would potentially displace businesses providing an estimated 1,500 jobs. However, an estimated 13,200 jobs would be supported by development around the station generated as a result of HS2. There would be an estimated

1,700 housing units supported.

Demand - Leeds station options

5.8.74 Leeds Station North is the closest to the existing station, thus providing the best connectivity for interchanging passengers. We estimate that this could provide a benefit of around £100 million. The downside is that the line of route approach to the station would take two minutes longer to get to than the south facing station options. This increase in journey time would decrease the benefits to all passengers using the station, not just the people who would interchange there. We estimate this would more than offset the benefits from the interchange passengers.

5.8.75 The Sovereign Street and New Lane options would both be further away from the existing station location, and would therefore provide lower benefits to those passengers who would interchange between the station locations. They would also have an impact on those directly accessing the station from the Leeds city area, however primarily for those walking from the city centre. For our modelling analysis, we assumed car access was comparable with the Leeds Station North option, which may have underestimated the advantage of a southern station having better highway access.

5.8.76 As these options both have quicker journey times and lower overall costs, this means that we would expect either of these options to provide a higher PV than the Leeds Station North option. We estimate at the present time this would be in the region of £100 million (PV) to £200 million (PV).

Leeds city centre stations: Section summary

5.8.77 In this section we described the process we went through to arrive at the three final station options. We have then described our engineering and sustainability analysis of each of these options.

5.8.78 The decision over which station to choose will be finely balanced. Leeds Station North provides excellent connectivity with the existing Leeds station and therefore potentially serves the wider Leeds region well. We have described the ways in which the two options to the south of the city, New Lane and Sovereign Street South, can link to the existing station, but neither will perform better than Leeds Station North in this regard.

5.8.79 The options to the south of the city benefit from faster overall journey times and, as a result of the lower cost approaches to them, both would be less expensive options overall. They would be less well placed for the established city centre and require a longer transfer. Conversely, they would both be potentially well placed to both support and enhance the future development of the city to the south. However, Leeds City Council expressed serious reservations about the potential impact of either southern option on its short term development plans. Leeds City Council's clear preference of the two southern options would be for New Lane, which would be more peripheral to development sites. We understand their concern and would continue to seek to develop a station option that supports rather than conflicts development.

5.8.80 Leeds Station North would benefit from being well located for the established centres of commerce and business to the north of the existing rail station. The proposed Leeds Station North would make Network Rail's planned expansion of the existing station very difficult and costly. If this site were taken forward, it would be important to work with Network Rail on this issue. Nevertheless, as this station option would not conflict with development plans, it would benefit from being alongside the existing Leeds station and be well placed for the established city centre. It was favoured overall by Leeds City Council.

5.9 Connecting to the East Coast Main Line and interchange station options

5.9.1 The last two sections of this report dealt with the spurs and station options into Leeds city centre. This section describes the routes from Leeds northwards to a connection to the ECML with classic compatible HS2 services running onwards to the North East on the existing railway network.

5.9.2 This section begins with a description of our initial creation and sifting of options before describing in detail the final two options. We also set out what this means for the future provision of HS2 services further north. Our high level work considering the merits of a possible interchange station option north of Leeds is also set out in this section. This includes consideration of serving the North East with classic compatible services.

5.9.3 We described in text box 6 our conclusion that the connection from the high speed line to the WCML and on to Scotland was the best way to capture both the Glasgow and Edinburgh markets equally. Serving Scotland via the ECML would have enabled Edinburgh to be served directly but would have led to the sizeable Glasgow market being served via Edinburgh impacting on overall benefits.

5.9.4 As a result of this decision, our work on connecting to the ECML focussed on where to connect and what markets might be served en route to the North East.

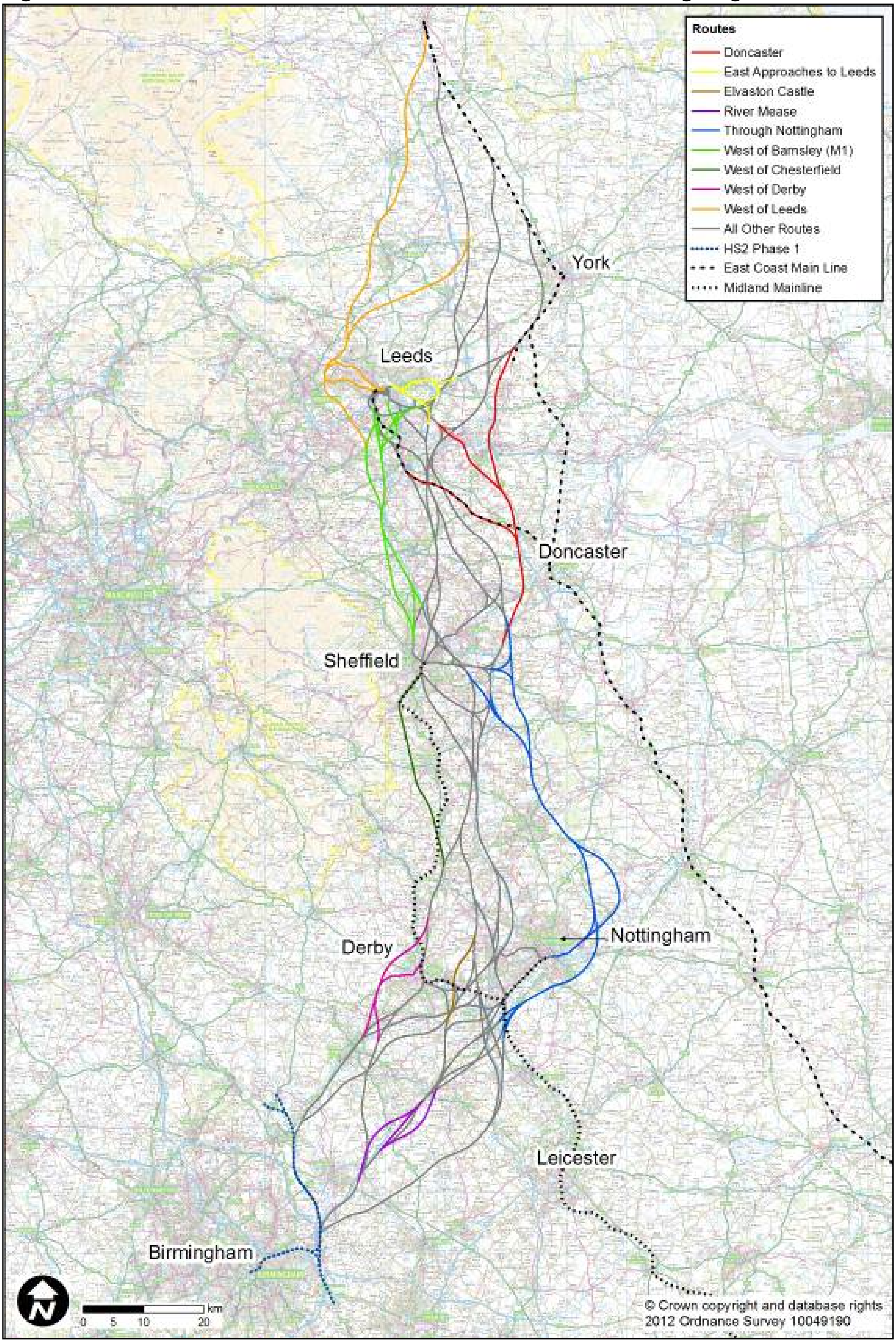
The generation of initial ideas and the sifting down to a long list

5.9.5 The generation of ideas led to a large number of route options being initially developed. All of the route options were progressed beyond this first stage.

The creation of a short list

5.9.6 The routes taken forward as a long list of options were developed to the next level of detail. We considered a number of options for connecting to the ECML. At this stage in the process we also made use of the pair-wise comparison process. This allowed us to compare the benefits and impacts of similar route options and in some cases to park one or more to allow us to take forward the better performing option. The results of this process are highlighted on figure 5.50 and described below.

Figure 5.50 – Connections to the East Coast Main Line short listing stage



Source: HS2 Ltd

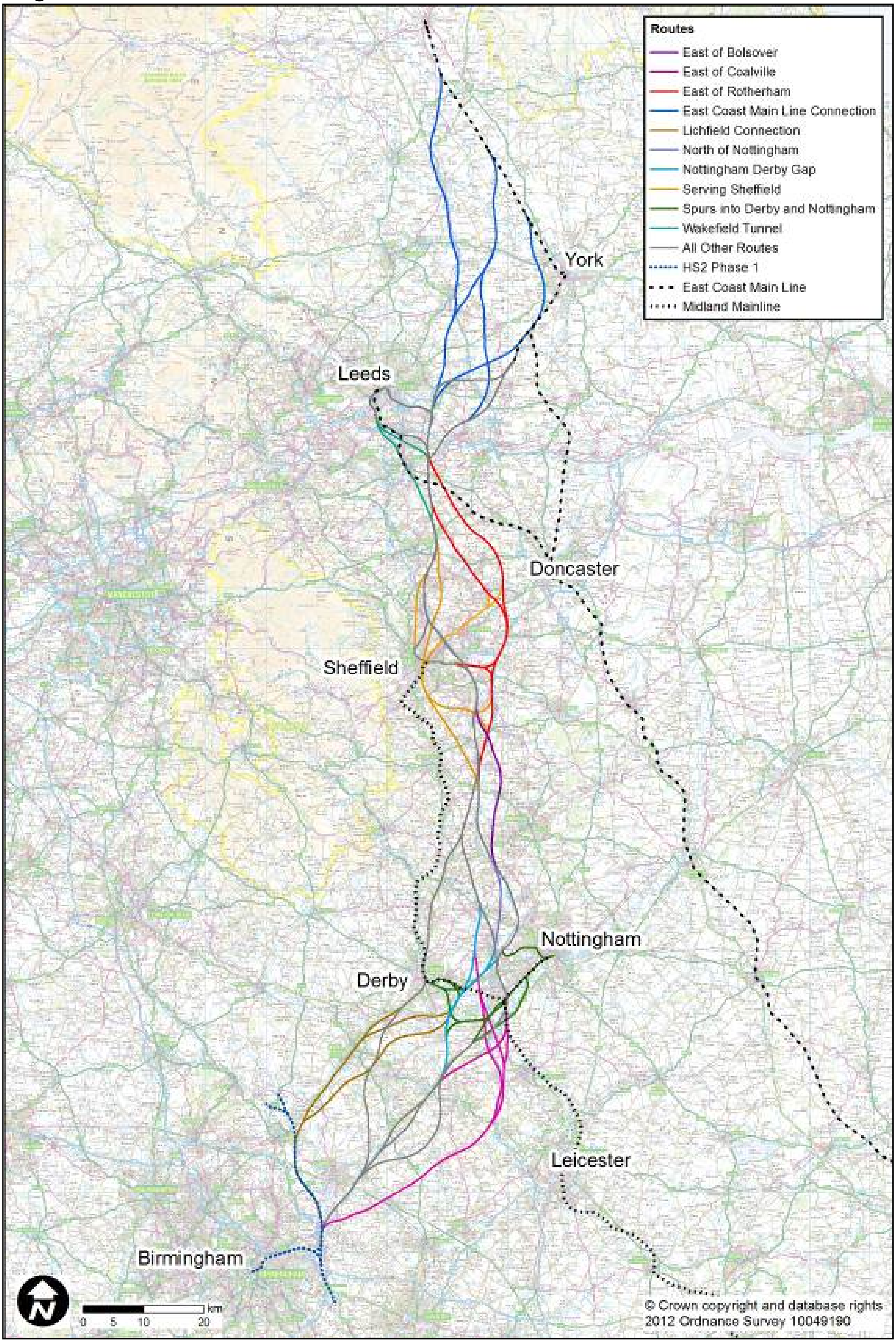
Routes around the western side of Leeds
('west of Leeds' on figure 5.50 above)

5.9.7 A group of route options were considered that would pass around the western side of Leeds in order to reach the ECML. Routes would need to pass to the west of Barnsley and would not be able to connect to the ECML further south than Northallerton as a result of the topographical and urban constraints. This would mean that HS2 trains would not be able to serve York. The benefits of capturing the sizeable York market are described further in the text box 20. Construction through this terrain would also be complex and challenging. Western route options would also have a direct impact on a number of priority sustainability features. We chose not to develop these route options further.

Selecting options for refinement

5.9.8 The remaining route options after short listing were then developed in further detail ahead of a final sift to reduce the number of options. This process led to the further refinement of options using the pair-wise comparison process. The outcomes of this further process are highlighted on figure 5.50 and described below.

Figure 5.51 – Connections to the East Coast Main Line selecting options for refinement stage



Source: HS2 Ltd

East Coast Main Line connection

(‘East Coast Main Line connection on figure 5.51 above)

5.9.9 We considered a number of connection points between Colton Junction and Northallerton. Four routes were initially considered with the most northerly joining the ECML immediately south of Northallerton, one between York and Northallerton at Raskelf, an option which would bypass York and an option for connecting south of York at Colton Junction.

5.9.10 All these route options would have sustainability impacts including direct impacts on a Grade I Registered Park and Garden (Bramham Park) and surrounding ancient woodland and on the settings of a number of Historic Battlefields (including Boroughbridge, Marston Moor and Towton). The routes via Raskelf and a York bypass had additional impacts whilst not providing either the best journey time or the lowest cost solution.

5.9.11 Having considered these options, we identified five further potential connections all at more southerly points. The most southerly connection was at Normanton, the next at Castleford, followed by Church Fenton, an option which bypassed Church Fenton and Colton Junction.

5.9.12 Connecting too far south would have a significant journey time penalty to services to York and beyond of between nine and 15 minutes. These options would also require significant works to the existing rail network as this is a heavily used freight line with some passenger services.

5.9.13 We settled on a connection point at Church Fenton on the basis of it offering a reasonable journey time saving for services northwards at a proportionate cost.

5.9.14 We also considered further the design options for the Leeds Junction at this point and the potential benefits of both the route into Leeds and the routes towards the ECML connection. By developing these options as spurs we would be able to weave the route options better through the scattered urban areas and infrastructure to the west of Leeds, particularly in the gap between Wakefield and Normanton. For the connection to the ECML this would also significantly reduce the impact to the St Mary Church and Towton Battlefield. Additionally it would have the advantage that any future provision of HS2 further north than York would be served by the route following the A1(M) past Wetherby to Northallerton. Effectively therefore we would be able to make passive provision for the potential future development of HS2 northwards should the Government wish to explore this further in the future.

20. Leeds interchange and serving York and the North East

We were not formally remitted to consider additional interchange options on the Leeds leg. However, we explored at a high level potential interchange options.

Our early demand work highlighted that the more southerly interchange options, closer to Leeds, would simply abstract passengers from Leeds city centre rather than add to the market, and would incur additional time penalties to the main Leeds market.

As a result, our work focussed on two potential interchange options between Leeds and the connection to the ECML at Garforth and Knaresborough. Looking at the wider West and North Yorkshire area, the most significant market outside Leeds is York. This is a potentially significant and valuable market with over six million passengers using York station in 2010/11.

Garforth was considered both with an additional stop at York and without a stop (thus bypassing York). We considered Knaresborough only in the context of the option of a York bypass. Both stations would principally abstract some demand from the Leeds HS2 station and from the York area. They would provide only little additional demand on HS2. In addition, both stations would add a time penalty to the larger markets in the North East. Knaresborough would also erode much of the benefits of the improved journey times offered by the York bypass option were all trains to stop there. We therefore concluded that both options would have poor business cases in comparison to the impact on the North East markets.

The further option of bypassing York without attempting to capture the market through an interchange station would lead to reductions in benefits and revenue in the order of £1 billion (PV). However, the counterpoint to this is that our analysis also indicated that there could be benefit to serving the North East market with fast services. We therefore have made passive provision for this expansion in the future.

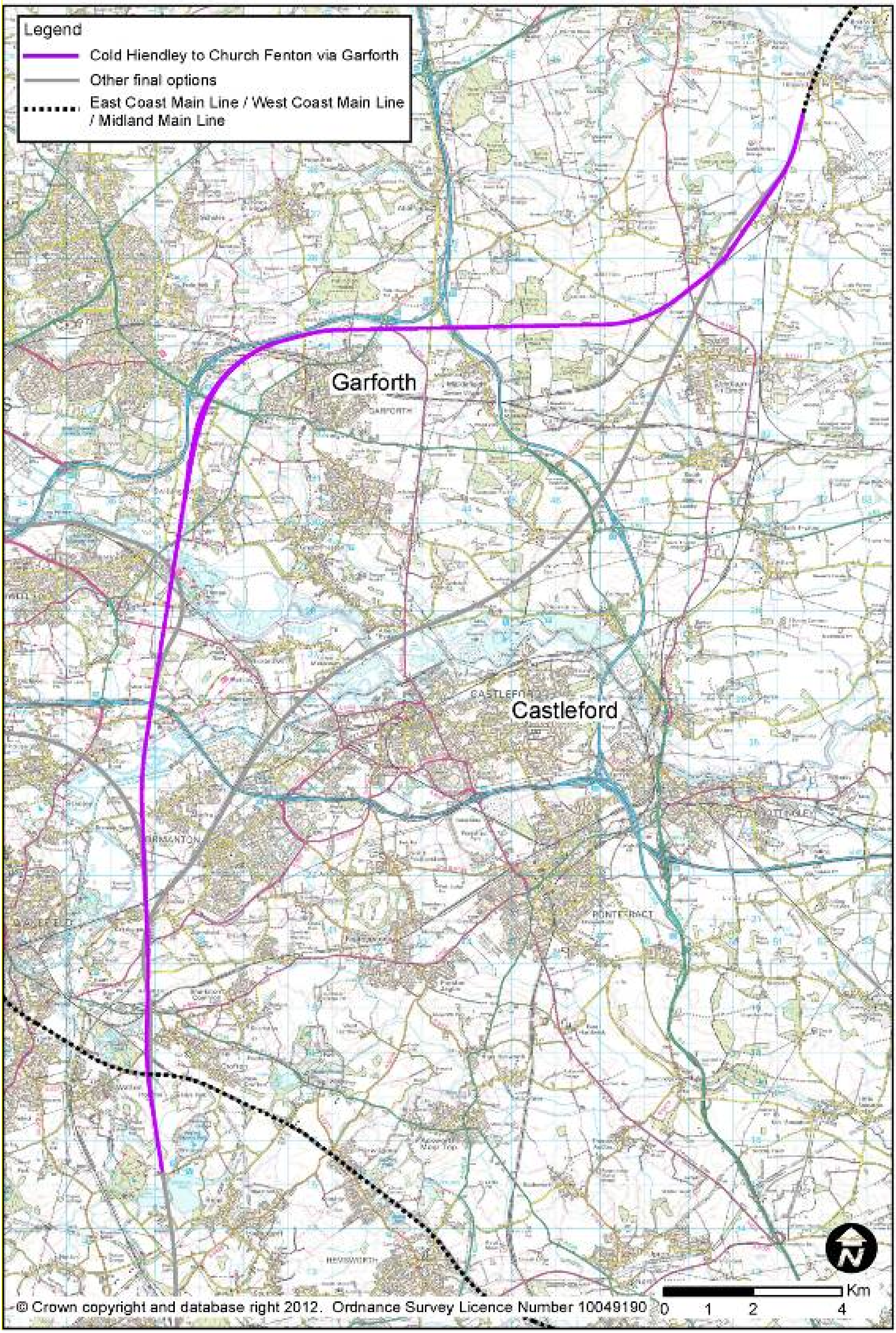
Considering the North East market further, it is focussed on a group of cities and towns situated along the river valleys of the Tyne, Wear and Tees. The main existing ECML stations are at Newcastle, which covers the Tyne and Wear areas, and Darlington which provides its own market and serves as a connection point to Teeside. Our modelling shows that serving these markets with classic compatible services provide important benefits to the overall scheme.

Developing and finalising our options

5.9.15 We now describe the two route options to the ECML connections at Church Fenton. The description begins at Cold Hiendley before heading via Garforth or Castleford to a connection with the ECML at Church Fenton.

Cold Hiendley to Church Fenton via Garforth

Figure 5.52 - Cold Hiendly to Church Fenton via Garforth



Source: HS2 Ltd

Engineering

5.9.16 As the route heads north from the Wintersett Reservoir it would be in a mix of shallow cutting and embankment to run east of Walton Hall and west of Anglers Country Park. The route would then pass onto a series of embankments and viaducts to cross a series of obstacles including the existing Doncaster to Leeds line.

5.9.17 After a brief cutting, the route would gradually descend into the valley of the River Calder. The route would lie to the south-western edge of Altofts. After rising to cross over the M62 the route would descend into the valley of the River Aire on embankment and viaduct over the existing Normanton to Leeds railway, the Aire and Calder Navigation, River Aire floodplain and the A642 Aberford Road.

5.9.18 The route would then rise out of the Aire Valley, on a shallow embankment, passing to the west of Swillington before entering a shallow cutting. North-west of Swillington the route would run in close proximity to the M1 on its eastern side.

5.9.19 The route would pass below the A63 east of Junction 46 of the M1. It would then swing eastwards to follow the curve of the M1 in cutting, passing below the existing Leeds to York railway line. It would run immediately adjacent to the M1’s southern boundary for a distance of 2.5 miles (4km), broadly at the motorway’s level.

5.9.20 Further east the route would pass below the Roman Road and the A1(M) north of Old Micklefield The route would then emerge at ground level east of the motorway near Weet Wood.

5.9.21 The route would still be heading due east, at ground level and then on embankment before turning north-east to run parallel to the existing Leeds to York railway between Micklefield and Church Fenton on its northerly side and at its level.

5.9.22 The route would cross the A162 passing south of Barkston Ash before a series of short viaducts allowed the route to connect into the existing Leeds to York railway. As described in the earlier development of this route option, the alignment of the existing railway would be moved to accommodate the high speed alignment arriving from the west. HS2 trains would then briefly run on the existing Leeds to York line before connecting into the ECML at Colton Junction some 3.7 miles (6km) north-east towards York.

5.9.23 Of all the spur options we describe, including the spurs into Leeds city centre stations, this connection would require the high speed main line to go furthest north before spurring off to the ECML connection. This simply means that more of the high speed route north would be built as part of this phase of work. So if the Government should decide at some point in the future to extend the high speed line on this side of the country further north, it would be from a more northerly point with this connection option.

Sustainability

5.9.24 The route would result in the potential demolition of 11 dwellings.

5.9.25 The development of a new commercial and industrial waste recycling facility at Welbeck would be potentially affected by this route section.

5.9.26 North of the Wintersett Reservoir the route would be mostly on embankments and would generally have a limited visual intrusion except from the two country parks and the western edge of Crofton. There would be a visual impact at Kirkthorpe too where the route would pass the River Calder near the Newland Preceptory Scheduled Monument. There would be a moderate impact on the setting of two Grade II listed buildings at the site of the former Newland Hall. Where the route crosses the river there would be a visual intrusion on the users, and residents of, Bottom Boat and Normanton. Towards Oulton there would also be an impact on the character of the floodplain.

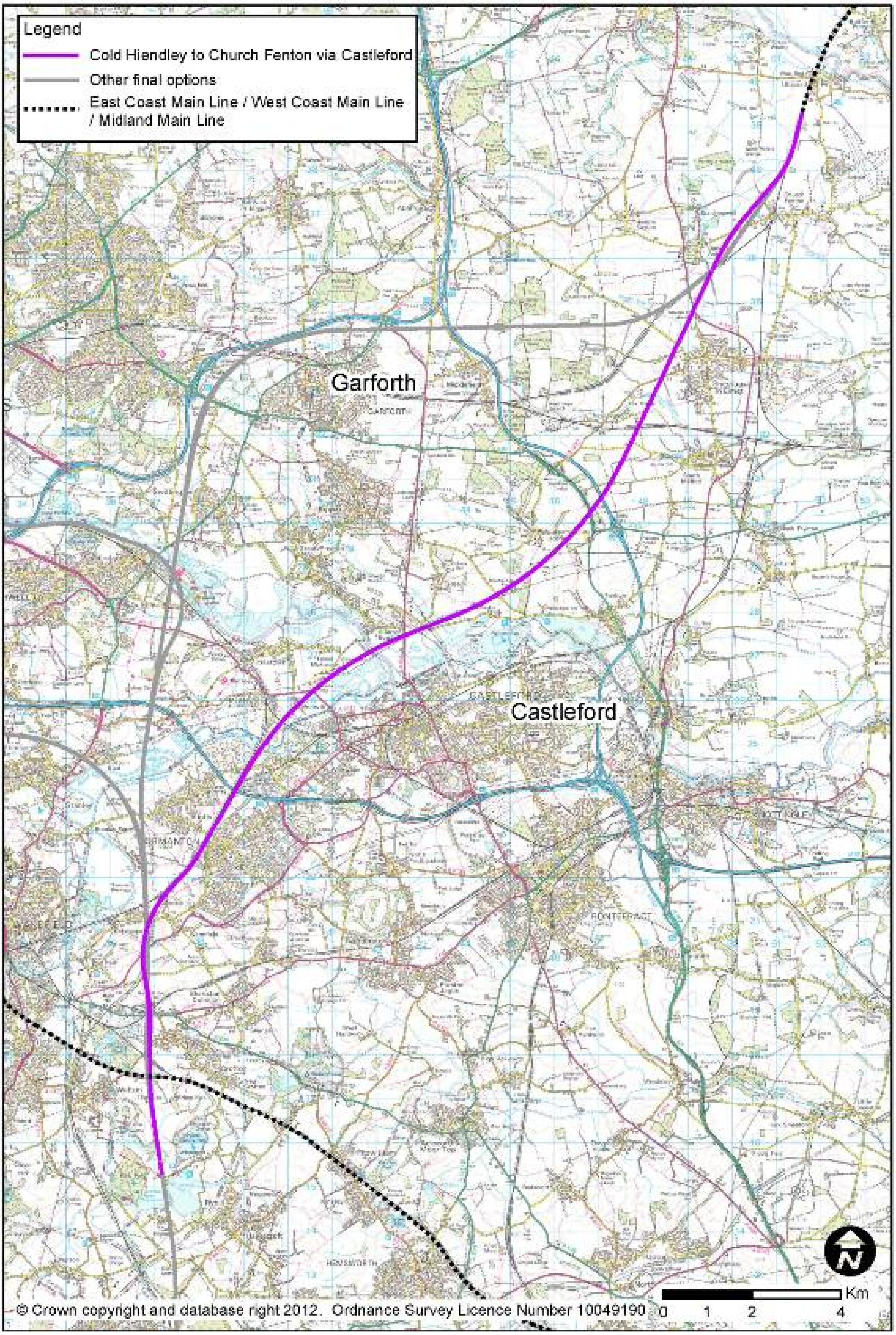
5.9.27 There would be a major visual impact on the users of the River Aire and Calder Navigation and the Trans Pennine Trail and on the residents of part of Woodlesford and further north Swillington. There would be some visual or landscape impacts to the west of Garforth and some localised woodland loss. Further on there would be some landscape and visual impacts south of Barkston Ash and west of Church Fenton.

5.9.28 Three sections of Grim's Ditch Scheduled Monument would be near to the route and could potentially have their settings affected, though the close proximity of the M1 means that these sections are relatively poorly preserved and the impact would not be expected to be significant.

5.9.29 Four BAP habitats including two areas of coastal floodplain grazing marsh south of Ulleskelf and an Ancient Woodland at Moss Carr Wood would be directly affected though the latter may be avoided through future scheme design.

Cold Hiendley to Church Fenton via Castleford

Figure 5.53 - Cold Hiendley to Church Fenton via Castleford



Source: HS2 Ltd

Engineering

5.9.30 This route option would head north from the Wintersett Reservoir in the same way as the Garforth option described above and would be on embankment to cross the same obstacles. The route would remain elevated to cross the A655 which would be realigned.

5.9.31 The route would then run parallel to the existing Wakefield to Normanton railway which would be realigned over a distance of 1.2 miles (2km) and which would require the re-building of Normanton station. As the route heads north-east it would be continuously elevated on bridges, viaducts and embankments over a number of features and obstacles including over the River Aire and its floodplain. The route would return to ground level west of Newton and would then proceed in cutting. Further north the route would enter cutting to pass under the A63, the A1(M) and the existing Leeds to Selby railway.

5.9.32 The route would pass over several floodplains and the A162 and on viaduct over Bishop Dyke, the existing Leeds to York railway and Barkston. The existing Leeds to York railway would have to be altered in alignment in a similar manner to that described above to accommodate the high speed alignment arriving from the west.

5.9.33 Of all the spurs options, including those into Leeds city centre, this would be the most southerly spur off the main high speed route. This means that the high speed route would have to be built further north to then enable a spur off into either of the Leeds city centre spurs. It also means that less of the main high speed line north would be constructed as part of phase two compared to the alternative option described above. This would mean that should the Government decide to extend the high speed line northwards on this side of the country, at some point in the future, this option would be the most southerly starting point and would require the greatest additional length of high speed rail.

Sustainability

5.9.34 The route section would result in the demolition of an estimated 23 dwellings.

5.9.35 The development of the new commercial and industrial waste recovery facility at Welbeck would be potentially affected by this route section. The route would also pass through the Wakefield (Whitwood) Europort Distribution Centre which has been identified as an employment site in the Wakefield Metropolitan Borough Council Sites Allocation Development Plan document.

5.9.36 The route would potentially cause some visual intrusion on two country parks and visually to the residents at the western edge of Crofton. Users of the Aire and Calder navigation would be impacted visually though within the context of the existing industrial landscape.

5.9.37 The route would have moderate impact on the setting of Ledston Hall and Park, a Grade II* Registered Park and Garden which would be approximately half a mile (1km) to the east. There would be a potential visual impact, which in some cases could be major, on the residents of Sherburn-in-Elmet and on views from the Grade I Church of All Saints the setting of which would also be affected. The setting of King Athelstan's Palace, a scheduled site immediately to the north of the church, would also be impacted as the route would be visible from the monument. Further north, there would be a potential visual intrusion affecting the villages of Barkston Ash and Church Fenton.

5.9.38 There would be a direct impact on the Grade II listed Newhall Lodge (Goosehill) as well as on its separately listed gate piers and flanking wall. Otherwise there would be a negligible impact on the Grade II structures near the route.

5.9.39 There is a moderate risk of impact on Fairburn and Newton Ings SSSI and Mickletown Ings SSSI due to potential disturbance of birds and fragmentation and loss of supporting habitat. There is also a moderate risk of hydrological impact to Madbanks and Ledsham Banks SSSI. There would also be a direct impact on four areas of BAP habitat one of which could be potentially avoided through further design.

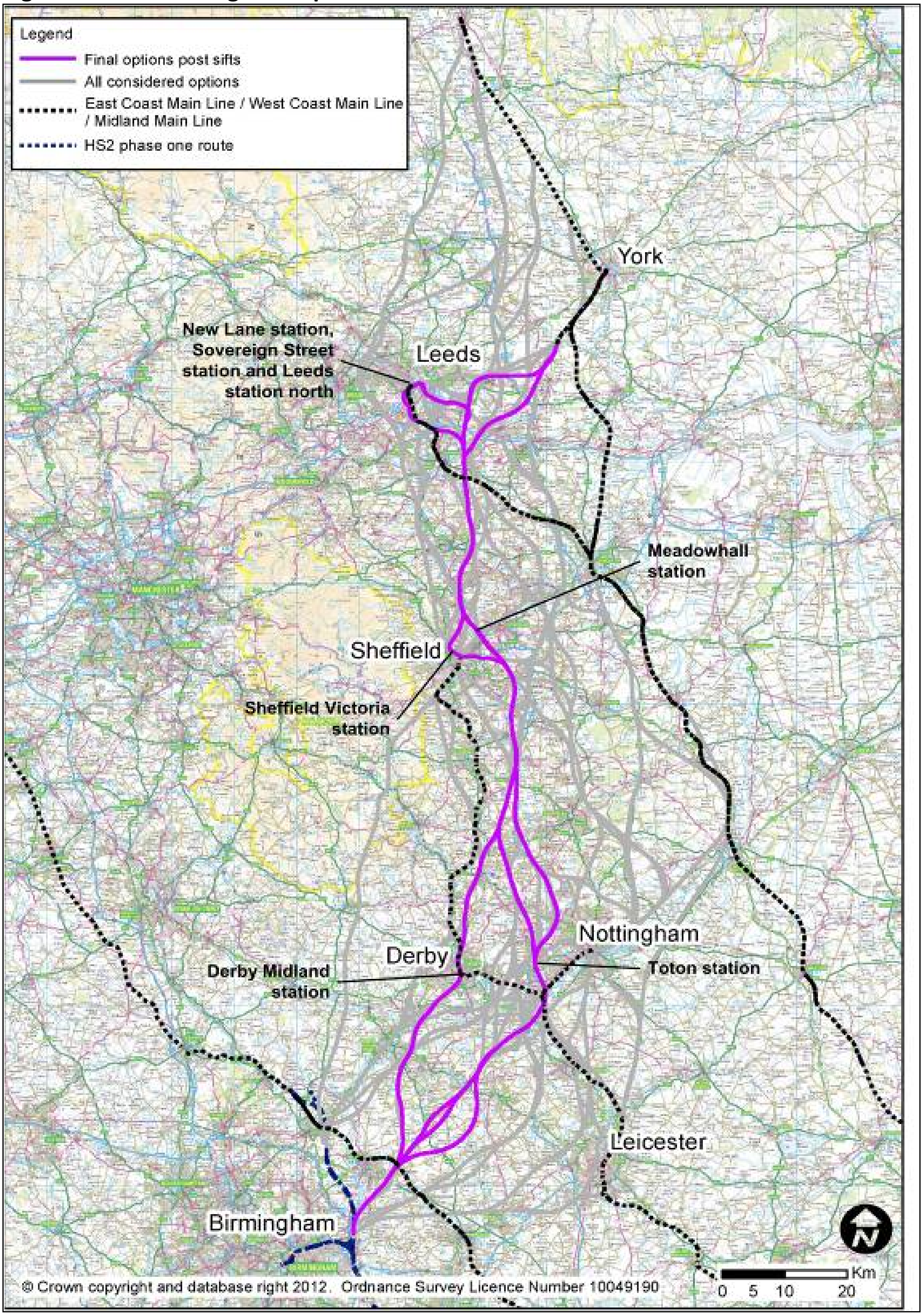
Connecting to the ECML and interchange station options: Section summary

5.9.40 In this section we described the possible connections to the ECML and whether to serve any additional markets en route to the North East. Our analysis suggests that there is little to choose between either route option to the connection at Church Fenton. The route option via Garforth would be slower by around a minute but would be in the region of £100 million to £350 million less expensive depending on which approach into Leeds is selected. We noted as well the benefit in capturing the sizeable York market en route to the North East and the additional benefits from capturing that market too which can be achieved by both connection options.

5.10Routes and stations: Key decisions for Government

5.10.1 Figure 5.54 below reflects the final route options we described in this chapter.

Figure 5.54 - Leeds leg final options



Source: HS2 Ltd

5.10.2 Having described our final route and station options for the eastern leg of the Y network, we set out below the decisions that Government will need to take to select a preferred scheme. This is based on the options we have presented in this chapter and does not preclude the Government asking HS2 Ltd to undertake further work and analysis or potentially develop new proposals in support of that decision making.

i) Government to select a preferred East Midlands station.

- *If* Derby Midland is selected then Government to consider the proposed route option described in this report. HS2 Ltd would need to engage further with Natural England and the Environment Agency about the proposed crossing of the River Mease SAC.
- *If* Toton is selected, subject to HS2 Ltd engaging further with Natural England and the Environment Agency and providing further advice, Government to select a preferred route from the proposed options.

ii) Route selection from the East Midlands to South Yorkshire will also be dependent on the choice of East Midlands station.

- *If* Derby Midland is selected then Government to consider the proposed route option following the A38.
- *If* Toton is selected then Government to consider the route options following the Erewash Valley or M1. HS2 Ltd would intend to undertake further design work on these routes to advise Government further about their relative merits.

iii) Government to select a preferred station option for South Yorkshire. The final options in this report are an HS2 station at Meadowhall or at Sheffield Victoria (served by a loop from the main high speed line).

iv) Government to consider the case for classic compatible services in the East Midlands and/or South Yorkshire.

v) Government to confirm the route from South Yorkshire to Leeds and select a preferred Leeds city centre station. This will confirm the choice of approach.

vi) Government to select a preferred route, and connection, to the ECML.

Chapter 6 – Heathrow

6.1 Introduction

6.1.1 The issues around serving Heathrow Airport from HS2 are complex, involving wider strategic considerations of aviation and transport policy which affect both where an airport station might be located, and the best way of linking it to the high speed line.

6.1.2 The landscape between Heathrow Airport and HS2 (phase one) is largely suburban in nature, but with some substantial areas of open space. It is crossed by the Chiltern Line, the M40-A40 Western Avenue, the M4 and the Great Western Main Line (GWML) all heading broadly east-west, while the M25 runs to the west of the Airport, heading broadly north-south. The Colne Valley Park also covers this whole area. There are also areas of floodplain, historic landfills, important water courses and protected water bodies.

6.1.3 Of particular importance is the South West London Water Bodies (SWLWB) Special Protection Area (SPA) and Ramsar site. There is potential for in-combination effects from the phase one route and proposed phase two Heathrow spur. Any potential in-combination effects would form a necessary part of ongoing HRA screening requirements to determine the likelihood of a significant effect on the SWLWB SPA and Ramsar site. This would need to be considered in order to inform the decision on the choice of link to serve Heathrow.

6.1.4 Finding a suitable surface route between Heathrow and HS2 phase one is therefore challenging, although the M25 does provide an existing transport corridor.

6.1.5 A direct high speed link to Heathrow could reduce the number of domestic air services, releasing runway capacity at Heathrow for more long-haul flights and strengthening the role of Heathrow as a hub airport. However, high speed rail is best suited to serving high volume long distance flows from city centre to city centre, and it is these passengers that drive the business case for HS2. Decisions on how to connect the Airport to the high speed rail network therefore need to balance:

- the needs of passengers to and from Greater London; and
- providing a high quality link to attract transfer passengers from major urban centres to the UK’s only international hub airport.

6.1.6 Our original remit from Government included considering and providing advice on options for an international station at Heathrow on the GWML and an interchange with Crossrail.

6.1.7 The process for identifying our recommended option for serving Heathrow is detailed in our report to Government published in March 2010.[14] We considered that, initially at least, there was a stronger case for a station closer to London at Old Oak Common. This would provide a straightforward interchange for Crossrail and the Heathrow Express for access to Heathrow. Importantly, it would also provide good access to London, helping passenger dispersal across London and reducing pressure on the London Underground at Euston. The station at Old Oak Common was included in the HS2 phase one route.

6.1.8 Following consideration of our advice, and new aviation priorities, we were asked by the Coalition Government to develop route options for a direct high speed link to Heathrow, including options for a loop and a spur from the high speed main line and for a through route via Heathrow.[15] The outcomes of that work were submitted to Government in September 2010 and published in December 2010.

6.1.9 Our December 2010 advice to Government is briefly summarised below. We then describe the work we have carried out looking at route options for a direct connection to an HS2 station at Heathrow Terminal 5 (T5) as part of phase two. We also describe the analysis we have done considering the demand for international high speed rail services from Heathrow.

Summary of our December 2010 advice

Station locations

6.1.10 Heathrow is not a single destination but a large area with terminals quite some distance apart. As such, it is important to understand the optimal location for a new rail station. Within the Airport we considered that the high cost and difficulty of constructing a high speed station underneath the central terminal area would rule it out as a desirable location. The main station options considered for a station at Heathrow were:

- T5;
- a site on the Northern Perimeter Road (which we called Heathrow north); and
- Iver on the GWML.

6.1.11 While a station at Iver would provide an interchange with the GWML, it would be nearly three miles (4.8km) from Heathrow Airport itself and would require the provision of an entirely new passenger transit system to the main terminal

[14] See HS2 Ltd, 2010, *High Speed Rail London to the West Midlands and Beyond – a report to Government by High Speed Two Limited,* http://webarchive.nationalarchives.gov.uk/+/http:/www.dft.gov.uk/pgr/rail/pi/highspeedrail/hs2ltd/hs2report/

[15] See HS2 Ltd's remit of 11 June 2010, http://www.hs2.org.uk/publications/HS2-Ltds-remit-of-11-June-2010-56111

areas, crossing both the M25 and the M4. It would therefore not provide a significantly better passenger experience than the interchange at Old Oak Common, which is part of phase one.

6.1.12 An on-airport location would provide a better interchange, could be well-integrated into airlines' operations and would be more likely to attract aviation passengers. We did not undertake a detailed analysis of the pros and cons in terms of access to these locations. However, while a T5 station would be more expensive to construct than Heathrow north, it would provide better links to the main terminal areas, based on existing infrastructure, offering a more attractive passenger experience. A station at Heathrow north would also require a new and extensive people mover system to the Airport terminals. We therefore considered T5 to be the most appropriate location for a Heathrow interchange.

Through, loop or spur routes to the Airport

6.1.13 The options we considered for connecting the Heathrow station to HS2 were to design HS2 to run through or close by the Airport, or to construct a loop or a spur off the main high speed line.

6.1.14 We did not consider that it would be feasible to construct a viable through route via a station at T5. The only viable options for interchange on a through route would therefore be remote from the main terminal complexes which would not provide a significantly better passenger experience than Old Oak Common. Furthermore, journey times for the majority of passengers travelling to and from Birmingham would be longer.

6.1.15 With passengers for Heathrow forming only a very small proportion of total passengers on HS2, we did not consider it appropriate to impose this additional journey time on the great majority of passengers travelling to and from central London. The Government agreed with our analysis and decided in January 2012 not to pursue a route for HS2 through Heathrow Airport.[16] Other options for serving the Airport would be via a loop or a spur from the main HS2 line.

6.1.16 Although running services to an interchange on a spur would require some capacity into London to be foregone, based on our economic analysis overall it would be better than a through route for the great majority of HS2 passengers travelling to and from Birmingham, because of the faster journey time.

6.1.17 A spur would also be compatible with a station at T5, providing a high quality passenger experience for those travelling to the Airport. We consider that the best option for Heathrow would be to run additional services northwards from Heathrow along a spur to serve a number of destinations. Displacing some services to and from central London would, on balance, be preferable to

[16] See page 74 of Department for Transport, 2012, *High Speed Rail: Investing in Britain's Future – Decisions and Next Steps*

incurring the substantial additional construction cost associated with a loop, which would need to be in tunnel back onto HS2. Depending on the configuration of the station, however, a spur to T5 could be extended into a loop if future demand required.

6.1.18 We developed two broad corridor options for a connection from HS2 to Heathrow:

- a spur along the M25 corridor which could, in part, be at surface level to reduce construction costs; and
- a loop entirely in tunnel from the Northolt area to Heathrow, before following the route of the spur along the M25 corridor.

Phase two spur to a T5 interchange station

6.1.19 Following consideration of our work by Government, we were asked to develop options for a spur from the main trunk of HS2 to a new interchange at T5 to be constructed as part of phase two. The design of phase one allows for the construction of a spur as part of phase two, without having to close the line, and for its extension to a loop should that be required. The remainder of this chapter presents the station and line of route options that we have developed.

Station options

6.1.20 At T5 the station can be orientated in a variety of ways, from east to west, to north to south, with the approach route varying from the west to the north. For the purposes of this activity, we considered three orientations:

- north-west to south-east;
- east to west; and
- north to south.

6.1.21 For each of these, the station could be either elevated, at surface or below ground, giving nine basic variants.

6.1.22 Of these, elevated options were not progressed because the approach tracks would clash with either the M25 or the runway exclusion zone, and access to the Airport would have to be through the car park. Existing infrastructure and safeguarding for possible future rail access schemes from the west would mean that sub surface stations would need to be located very deep underground, adding significantly to the cost and engineering complexity. Therefore, at this stage these were parked while viable surface options remained. This left:

- surface, east to west;
- surface, north-west to south-east; and
- surface, north to south.

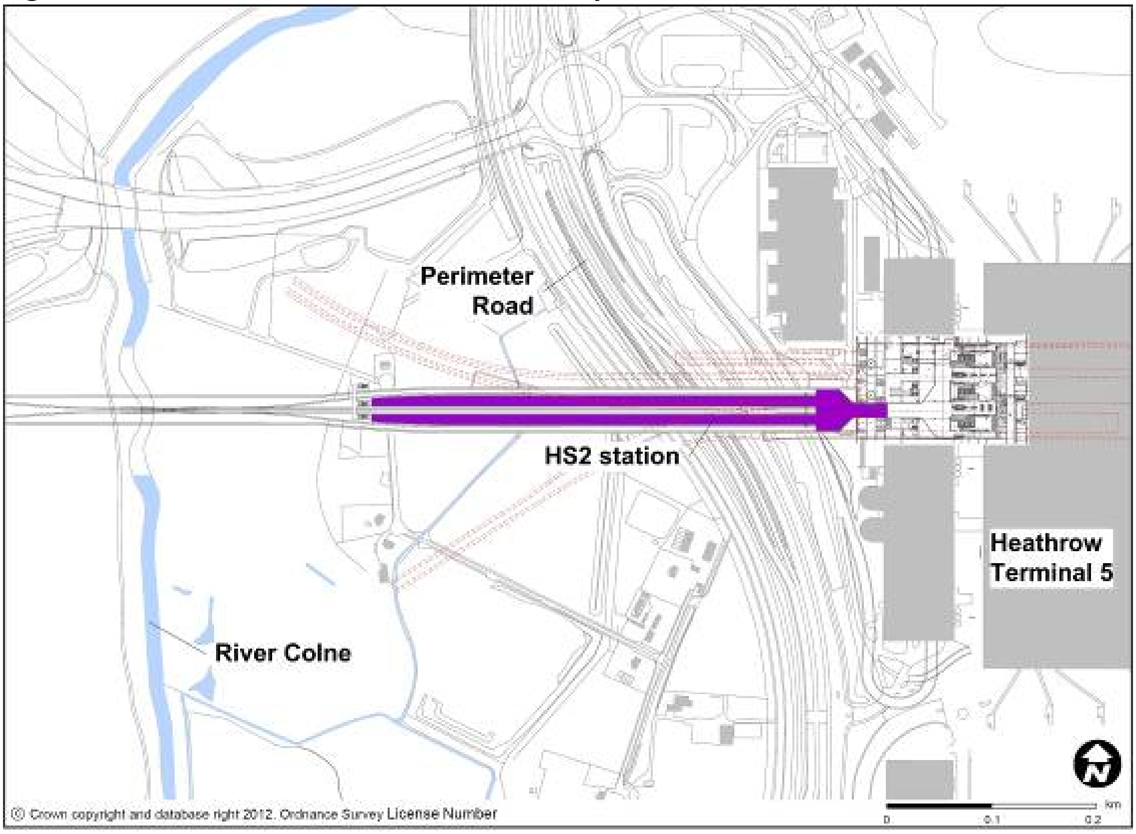
6.1.23 Our original proposal for a north to south surface level station could be closely aligned with T5 but would directly cross the end of the northern runway and therefore was not taken further. A north-west to south-east station would avoid this conflict but would need to be located further from T5 itself, making for a less attractive interchange. We therefore developed a variant of the north-west to south-east option. This curved slightly to the north-west, resulting in a station closely aligned with T5 that would also avoid conflict with the runway. This option was progressed together with the option for an east to west station.

East to west station

Engineering

6.1.24 The station would be aligned east-west between the M25 and T5. It would be set in a shallow open box approximately six metres below existing ground level, providing four platforms, two for domestic and two for international services. Passenger access would be via one end of the platforms into the unused mezzanine level of the existing T5 station. This would give simple connections to London Underground, Heathrow Express and Crossrail services, and any future western access rail scheme as well as T5 itself.

Figure 6.1 - Heathrow east to west station layout



Source: HS2 Ltd

6.1.25 The station would require some permanent and temporary diversions of existing roads and waterways. The River Colne would have to be diverted around the end of the station and the Duke of Northumberland's and Longford rivers (the "twin-channelled rivers") would have to be diverted back into the River Colne system to which they are linked. The existing roads and services would have to be temporarily diverted and new access provided via bridges over the station.

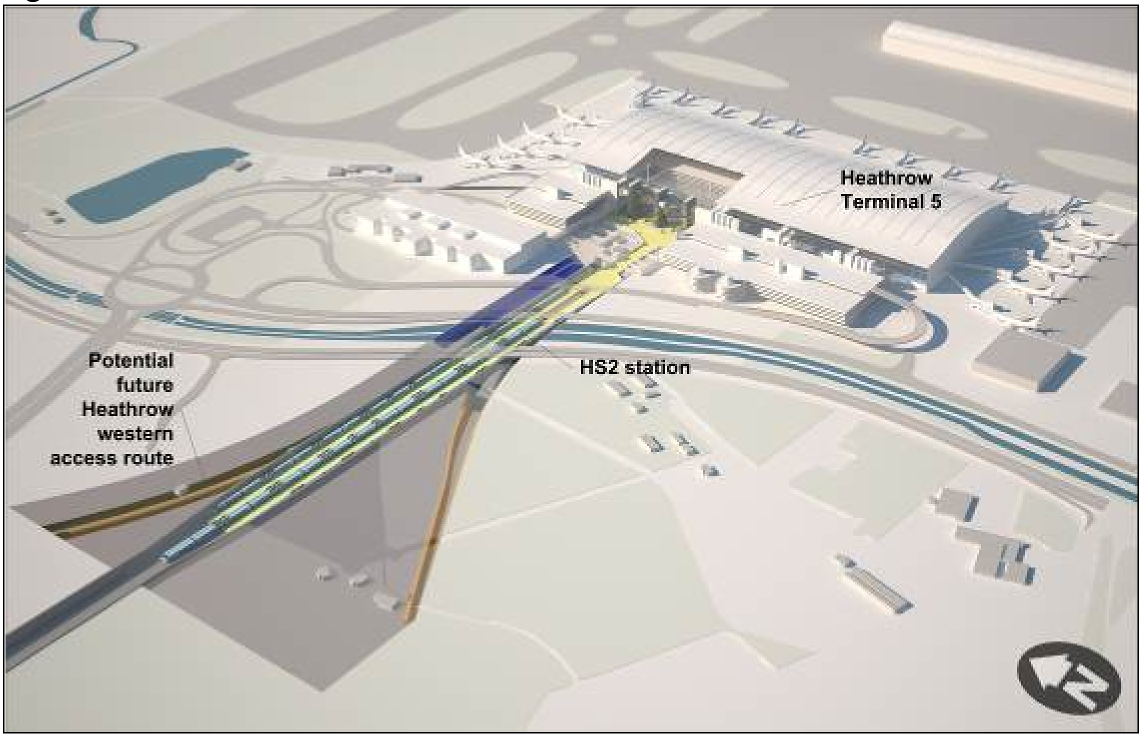
6.1.26 A significant constraint of an east-west station at surface level is that it would not be compatible with future provision of a loop as it would impact directly on the T5 complex and other airport infrastructure. To make it compatible with a future extension, it would need to be located deep underground, making this a significantly more challenging and expensive construction project.

Sustainability

6.1.27 An east-west station footprint would have minimal impact to cultural or heritage designations, however the proximity to Natura 2000 sites (including South West London Water Bodies SPA and Ramsar) could trigger an Appropriate Assessment under HRA. The footprint of the station would result in two demolitions of dwellings. The station is also located in Green Belt.

6.1.28 Overall impacts on water resources could be major given that over 14,000m^2 of the station would be located within the 1 in 100 year flood zone of the River Colne which would require an equivalent area for flood compensation.

Figure 6.2 - Heathrow east to west indicative station illustration

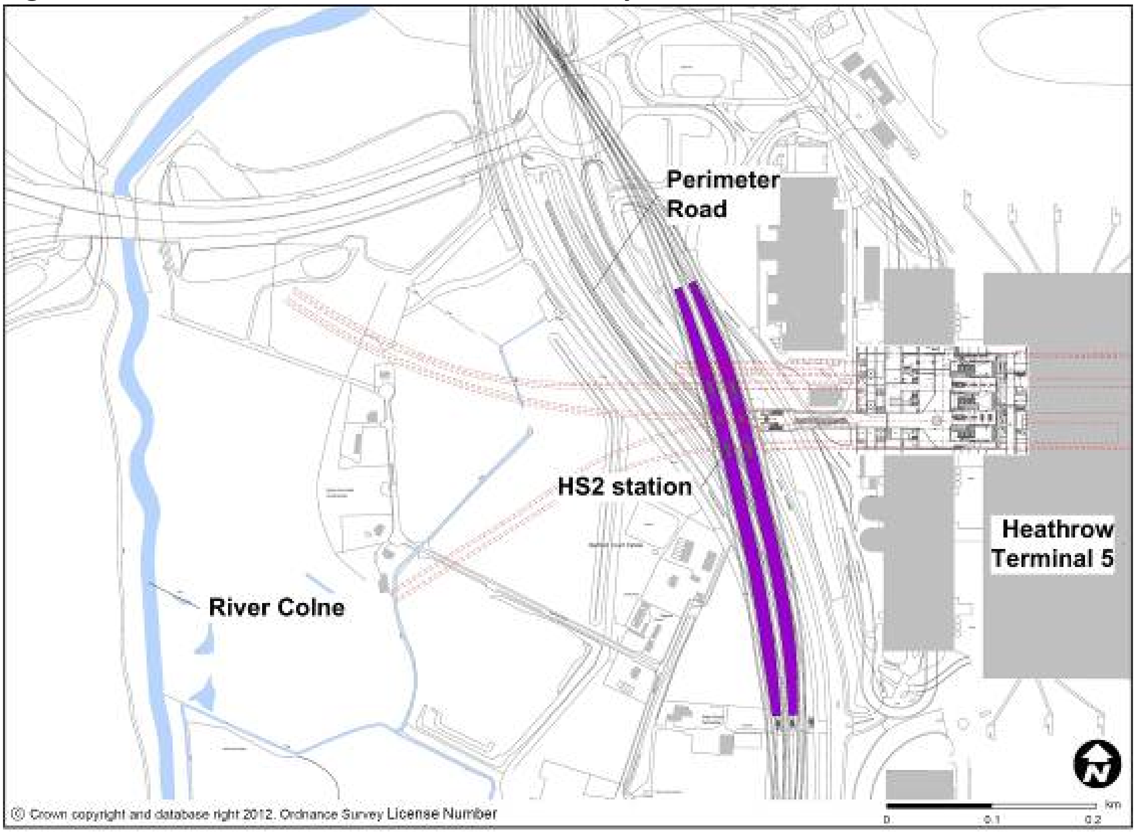


Source: HS2 Ltd

North to south station
Engineering

6.1.29 The station would be aligned roughly north-west to south-east between the M25 and T5. It would be set in a shallow open box approximately six metres below existing ground level, providing four platforms with capacity for both domestic and international services. The platforms would be curved to give a footprint which minimises the impact on existing roads and water bodies and to bring it as close as possible to T5 itself. This option would be compatible with development into a loop at a future date.

Figure 6.3 - Heathrow north to south station layout



Source: HS2 Ltd

6.1.30 Passenger access would be via a central concourse with escalators down to a connecting concourse into the unused mezzanine level of the existing T5 station. This would enable simple connections to London Underground, Heathrow Express and Crossrail services, and any future western access rail scheme as well as T5 itself.

6.1.31 The station would require some extensive and complex, permanent and temporary diversions of existing roads and waterways around the station box, although the River Colne would not have to be permanently diverted. The existing roads and services would have to be temporarily diverted and new access provided via bridges over the station and in particular, the access from the M25 to T5 would have to be adapted.

Sustainability

6.1.32 A north-south station footprint would have minimal impact to cultural or heritage designations; however, the proximity to Natura 2000 sites (including

South West London Water Bodies SPA and Ramsar) could trigger an Appropriate Assessment under HRA. The footprint of the station would result in the demolition of one community building (a water treatment facility) located along the Western Perimeter Road.

6.1.33 Overall impacts on water resources could be major given that approximately 6,000m^2 lies in the one in 100 year flood zone of the River Colne system. The station would also be located in Green Belt.

Figure 6.4 - Heathrow north to south indicative station illustration

Source: HS2 Ltd

Route options

6.1.34 There are a limited number of options available within this corridor for a spur from the main high speed line (HS2 phase one) to a proposed HS2 station at T5. The connection to the main route could only be made over a short length given the position of the Colne Valley Viaduct and Chiltern and Ruislip tunnels of HS2 phase one. As such, the northernmost section is largely fixed. Equally, the end point of the spur is fixed at T5.

6.1.35 We have developed one option that runs to the west of the M25. We have developed two options that run to the east of the M25 although these are in effect two variations of the same option, with one variation passing beneath the M25/M4 junction in tunnel, and the other variation passing over it on viaduct.

6.1.36 All options would join HS2 phase one at the same points, with the northernmost section of the route in tunnel to avoid impacts on communities around Denham. All options include a north facing connection to the main high speed line for services to the North, and a south facing connection enabling services towards Old Oak Common and the HS1 link towards Europe.

6.1.37 We have considered whether it would be possible to reduce the cost of this southern-facing connection either by making it single track or by running on the surface. We concluded that, overall, the disadvantages in terms of operational flexibility or sustainability impacts could not be justified by any cost reductions that could be achieved. This is discussed in more detail in text box 21.

6.1.38 We have considered whether there would be scope to share a corridor with the scheme for linking T5 to the GWML which is currently under development by Network Rail. Network Rail has not at this stage been able to identify a viable surface level route for the GWML link and is considering a tunnelled option. While we have identified a surface level route, Network Rail does not consider this to be suitable for the link as a connection back onto the GWML in this area would cause major disruption and demolitions. While it may be possible to develop a shared corridor in tunnel for a short distance, we do not consider that there would be any real benefits of this, particularly as the construction periods are likely to be some years apart.

6.1.39 However, it is likely that if the GWML link were to be constructed in the early years of the next decade, this would be around the same time as the construction of the HS2 phase one tunnels around Old Oak Common, the Northolt corridor and the Chilterns. Given this, there is a clear opportunity to seek efficiencies in the construction of these tunnels, so HS2 Ltd and Network Rail will continue to work together as proposals develop to ensure that any synergies can be exploited, and that any conflicts between developing proposals are identified and avoided at an early stage.

21. Southern facing connection to HS2 main line

The proposals for the Heathrow spur include a north facing connection to the main high speed line for services to the North. They also include a connection facing east towards London, which would allow services to connect on to HS1. We considered whether construction costs could be reduced by simplifying the infrastructure of the southern facing connection. For this, we considered whether the tunnel could be single track, and whether a surface route, either single or twin track, could be developed.

Single track tunnel

We developed an option for a single track bi-directional tunnel, broadly following the same route as the twin single track tunnels. It would necessitate changes to the route of the main HS2 route in the Colne Valley area. It would require a realignment of the Colne Valley viaduct. A single track tunnel option would retain grade separation with the main line, with the Heathrow route emerging in between the two main lines. The viaduct crossing the Colne Valley as part of phase one would move away from the Hillingdon Outdoor Activity Centre but closer to South Harefield and could have greater impacts on the Colne Valley SSSI. Advanced works would be required during the construction of phase one to build the start of the tunnel.

Cost savings would be in the region of around £50 million to £100 million. However, overall it would be worse in sustainability terms and importantly it would introduce an operational constraint of only having one southern facing track. Therefore it was decided not to pursue this option further.

Surface level connection

To reduce unacceptable impacts on communities in this area, any surface option would require the junction with the main route to be relocated eastwards. This would require the bored-tunnel at Ruislip to be shortened, although a cut and cover section may be possible. However, West Ruislip station would be demolished and rebuilt and would need to be closed for a considerable period during construction. The surface options would cross the Colne Valley and the A40 on viaduct, creating substantial structures in this area.

A single or two-track surface route would have major landscape and visual impacts, and would raise potential flooding issues associated with the River Colne. It would also impact directly on Dedham Lock Wood SSSI and a Scheduled Monument at Brackenbury Farm. Both surface route options would result in more demolitions of dwellings than the tunnelled route option.

Although there would be some potential cost reductions from a surface level route, in the region of £50 million for a two-track option and £120 million for a single-track, we consider that these would come with unacceptable impacts on the environment and local communities and therefore these were not pursued.

Option 1: M25 western route

Engineering

6.1.40 This route would be compatible with both station options. The route would leave the Airport via twin bored tunnels which pass under the M25 and continue below the village of Poyle to surface north of the M4 and west of the M25. From here the route would continue at surface level, curving to pass between Iver and Iver Heath, with viaducts over the GWML and the M25.

6.1.41 There would be a flat junction just to the south of the M40 as the route splits, entering two pairs of bored tunnels to pass under Denham to connect to the main route. One connection between the Colne Valley Viaduct and the Amersham tunnel portal would be for services heading to the North with the tunnels coming to the surface north of Denham and connecting to the main line in retained cutting as the route passes into the Amersham tunnel.

6.1.42 The second connection would be London facing, with the tunnels passing under the water bodies in the Colne Valley and connecting to the main line to the east of the HS2 phase one proposed Colne Valley viaduct. This would enable trains from Heathrow to run onto HS1 for services to the continent.

Sustainability

6.1.43 The route would result in around 20 to 30 demolitions of dwellings, when linking to the east west or north south station respectively.

6.1.44 This option would have an impact on the Mid-Colne Valley SSSI. The route is in close proximity to Natura 2000 sites (including South West London Water Bodies SPA and Ramsar) and could trigger an Appropriate Assessment under HRA. The route would also have direct impacts to flood risk and source protection zones. A major diversion of the Alder Bourne River would be required.

Option 2: M25 eastern route – tunnelled approach

Engineering

6.1.45 This route would be compatible with both station options. The route would leave the Airport via twin bored tunnels which pass under the M25 and M4, GWML and Grand Union Canal. The route would surface just north of the Grand Union Canal on the eastern side of the M25, remaining on the surface alongside the M25 within this existing transport corridor and to allow for flat junctions.

6.1.46 The route would split into two pairs of bored tunnels just to the south of the M40 to connect to the high speed main line. From here it would follow the same route as option 1.

Sustainability

6.1.47 The route would result in approximately six demolitions of dwellings for both station options.

6.1.48 This option would have no direct impact on any international or nationally recognised biodiversity sites, but would be in close proximity to Natura 2000 sites (including South West London Water Bodies SPA and Ramsar) and could trigger an Appropriate Assessment under HRA. The route in addition would have direct impacts to a major source protection zone and a diversion of the Colne Brook River would be required.

Option 3: M25 eastern route – surface approach

Engineering

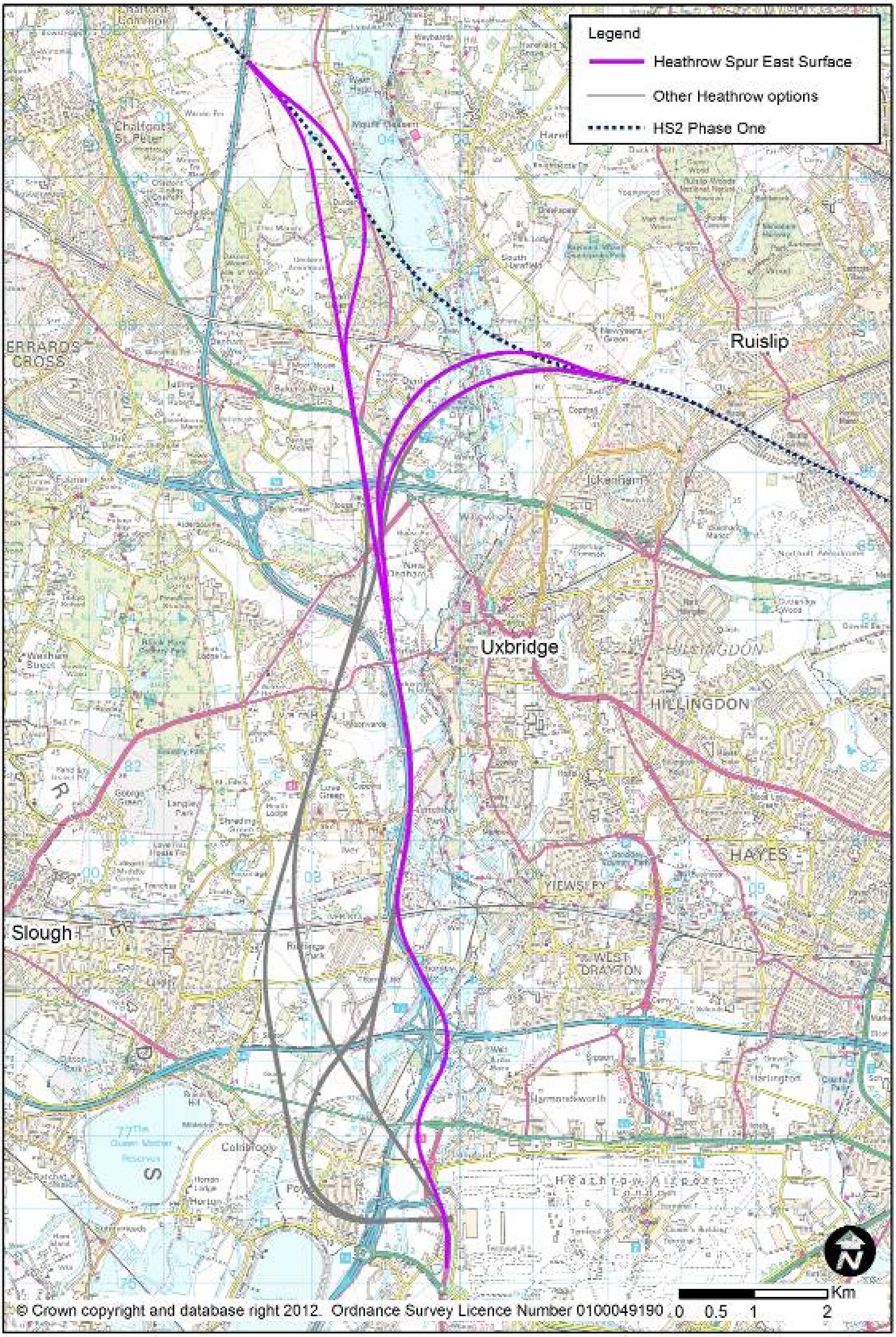
6.1.49 This option is similar to option 2, but would leave the station in a short section of cut-and-cover tunnel to avoid conflict with the runway exclusion zone, before rising up to pass over the eastern side of the M25/M4 junction. This would reduce the extent of tunnelling considerably but would require a large viaduct over the existing M25/M4 junction, which would be complex to construct. It does mean, however, that it would not be compatible with an east-west aligned station.

Sustainability

6.1.50 The route would result in around eight demolitions of dwellings.

6.1.51 The route would have direct impacts on source protection zones and a diversion of the Colne Brook River would be required. It would have an impact on the Mid-Colne Valley SSSI. The route is in close proximity to Natura 2000 sites (including South West London Water Bodies SPA and Ramsar) and could trigger an Appropriate Assessment under HRA.

Figure 6.5 - Option 3 M25 eastern route surface approach



SS

Source: HS2 Ltd

6.2 Demand for international high speed rail services from Heathrow

6.2.1 It is expected that, following the extension of HS2 to Leeds and Manchester the main trunk of HS2 would be an intensively used railway, running at a capacity of 18tph. However, every HS2 service from the North to Heathrow would free up a slot on the section of HS2 south of the spur, which could be taken up by services starting at Heathrow bound for central London or HS1 for services to the continent.

6.2.2 We have carried out a high level analysis of the potential market for international high-speed rail services from Heathrow to the continent, using the HS2 – HS1 link. Most of the market for trips from London to Paris and Brussels has already switched to high speed rail. However, there remain around 30 flights per day to and from Heathrow and Paris Charles de Gaulle and 20 flights to and from Brussels, almost exclusively serving the interlining market. By 2030 daily aviation passenger demand is expected to be around 4,000 to and from Paris and 3,000 to and from Brussels. This represents the likely maximum market for international high speed services from Heathrow to the continent.

6.2.3 Analysis suggests that the introduction of a broadly comparable level of high speed services, broadly an hourly service, could see around 70% to 75% of these transferring to high speed rail,[17] although research suggests that high mode share can only be achieved where airlines completely integrate rail service into operations. That poses an important question as to the viability of maintaining air services from Heathrow to these cities. The introduction of high speed rail services could prompt an active decision to withdraw air services on these routes.

6.2.4 This analysis suggests that the level of demand may be sufficient to provide a viable service, particularly if some or all of these were to operate as splitting services to serve both cities in a single service from Heathrow. Assuming an hourly service, this would result in average passenger loadings of around 400 to 450 per train across the day. This would have a further advantage of reducing around 50 take off and landing slots at Heathrow.

6.2.5 A further consideration is how Old Oak Common would act as an international station for HS2 passengers from the North. Our analysis of demand for direct international HS2 services from the Midlands or the North indicated that it would not be likely to be sufficient to justify a regular service pattern. An alternative would be to use Old Oak Common as a collecting point for HS2 passengers from the Midlands and the North for HS1 services. Such a service could start at Heathrow station's international platforms picking up the aviation market, call at Old Oak Common to pick up passengers from the

[17] See Atkins 2011, *International Connections: A report for HS2 Ltd by Atkins*, http://www.hs2.org.uk/assets/x/77823

Midlands and the North, before heading for the continent. This would increase the viability of international services from Heathrow and Old Oak Common, but may also have benefits for the operation of Old Oak Common, avoiding the need for a train to sit for some time at Old Oak Common awaiting connecting services from HS2.

6.2.6 There are, however, some important caveats to this analysis. It assumes that the aviation industry responds to international high speed services by replacing flights on these routes with rail services. Pressure on capacity at Heathrow may make it attractive to free up as many slots as possible for intercontinental flights, but equally the aviation industry may consider an air service an important element of their offer to passengers.

6.2.7 It is not clear that a high speed rail service with journey times in excess of two and a half hours would offer a genuinely more attractive option than a flight time of around an hour. A further consideration is whether, in the wider aviation market, the removal of flights from Heathrow to Paris and Brussels would see intercontinental passengers travel via an entirely different 'hub' airport rather than using Heathrow and high speed rail.

6.2.8 This is a high level analysis of the potential demand. We do not have the tools or expertise to undertake a detailed analysis of costs and benefits which would be more properly addressed as part of wider aviation and airports policy. We recommend that further work be undertaken with the Airport operator to assess the benefits of international high speed services and how the aviation market between Heathrow and Paris and Brussels would be affected by the introduction of these services.

Section summary: Heathrow station and route package

6.2.9 We have developed five route and station options for a spur from the HS2 main line to T5. We considered these route and station options in packages. Our analysis shows that the east-west station would perform worse in sustainability terms and would be more expensive to construct when combined with the expensive Western route. It would also effectively prevent the spur ever being extended into a loop. On that basis it was decided not to pursue an east-west station further, and to develop options to a north-south station.

6.2.10 The M25 Western route would perform substantially worse in terms sustainability, largely due to impacts on local communities through demolitions and noise, and its impacts on water sources. This option would also be between £800 million to £1 billion more expensive to construct than the Eastern route options. On that basis it was decided not to pursue this option.

6.2.11 The differences between the remaining two M25 Eastern route options are fairly small, the main difference being whether the M4/M25 viaduct is negotiated in tunnel or on viaduct. Although the tunnelled option would have slightly lower impacts on local communities, it would be more expensive to construct than a viaduct, and construction of the tunnel in a floodplain would be challenging. On that basis we have included the viaduct over the junction.

6.2.12 Our analysis therefore shows that the best performing option would be for a spur to Heathrow that would leave the main HS2 route between the Northolt Corridor and Chilterns Tunnels, diving quickly into tunnel to avoid impacts on the village of Denham. It would surface to the south of the A40 and run close to the eastern side of the M25, before crossing the M25 / M4 junction on viaduct. It would then dive sharply down to avoid the runway exclusion zone into a curved station, aligned broadly north-south, located just below surface level. This option would be at the lower end of the cost range for servicing Heathrow and would leave open the option of being developed into a loop at a later date. This would not be the case for an east-west orientated station.

Chapter 7 – Maintenance and stabling infrastructure

7.1 Introduction

7.1.1 In order to operate phase two of HS2 as a functioning railway, the station and route options which we have described would require infrastructure and rolling stock maintenance depots and additional stabling and servicing to support classic compatible destinations. This chapter sets out our work to date on this infrastructure which would support whatever route and station decisions are taken by Government.

7.1.2 It should be noted that in terms of rolling stock depots and train stabling and servicing requirements, the exact requirements for the Y network could be subject to refinement and will take account of developing maintenance and rolling stock procurement strategies.

7.2 Maintenance depots - approach

7.2.1 As well as identifying options ourselves, we approached relevent top tier local authorities to assist us in option generation. Following this we developed proposals for options. A summary of the sifting process is set out below. Our approach for depots was similar to our approach for Manchester interchange station options in that:

- our engineering and sustainability appraisal was carried out on the same basis; and
- any depot site would be driven by the presence of a route option; therefore if a route option with one or more depots serving it alone was not taken forward then the depot options would also not be taken forward.

7.2.2 Our approach differed from what we did in relation to stations in that:

- we set out a relatively detailed set of mainly operational criteria for both types of depot which we assessed options against at each sifting stage;
- we did not undertake a socio-economic or demand appraisal in our development of options as this is not relevant for depot sites;
- we followed a solely internal two stage sifting process to avoid unnecessary blight; and
- the development of depot options came at a later stage in our work and focussed on a relatively small number of viable route options to avoid undertaking significant unnecessary work. Options were finalised in conjunction with the selection of final route options.

Our assumptions

7.2.3 Phase one of HS2 includes the provision of one infrastructure maintenance depot and one rolling stock depot. As part of the process for identifying additional depot options for phase two we began by making assumptions about the requirements. Our phase two assumptions were:

- no further infrastructure or rolling stock depot facilities will be required to serve the spur to Heathrow and related services;
- one infrastructure maintenance depot of a similar size to the phase one depot will be required on each of the Manchester and Leeds legs;
- the rolling stock depot for phase one will need to be expanded in order to meet the operational requirements of the Y network and provide heavy maintenance for all rolling stock; and
- an additional rolling stock depot will be required on each leg of the Y network to Manchester and Leeds. These will be smaller than the eventual phase one rolling stock depot (after its enlargement to support phase two) as they will only be required to provide light maintenance.

Initial generation of ideas and sifting down to a long list

7.2.4 Based on simple criteria relating to size and broad geographical areas an initial list of options was created in co-operation with top tier local authorities and station working groups. This comprised:

- 19 options for an infrastructure maintenance depot on the Manchester leg;
- 28 options for an infrastructure maintenance depot on the Leeds leg;
- 20 options for a rolling stock maintenance depot on the Manchester leg; and
- 21 options for a rolling stock maintenance depot on the Leeds leg.

These options are presented on figures 7.1 to 7.4 and coloured to show which options were progressed as final options.

7.2.5 The first stage of sifting to a long list was undertaken based on detailed criteria which covered engineering, operational and sustainability considerations. Options were graded in terms of how well they met the criteria and an initial environmental appraisal was carried out. Options that did not meet key criteria or would not serve a route option were not progressed. Where options met most or all criteria they were compared against other options in similar areas to determine which were the more favourable options to be taken forwards.

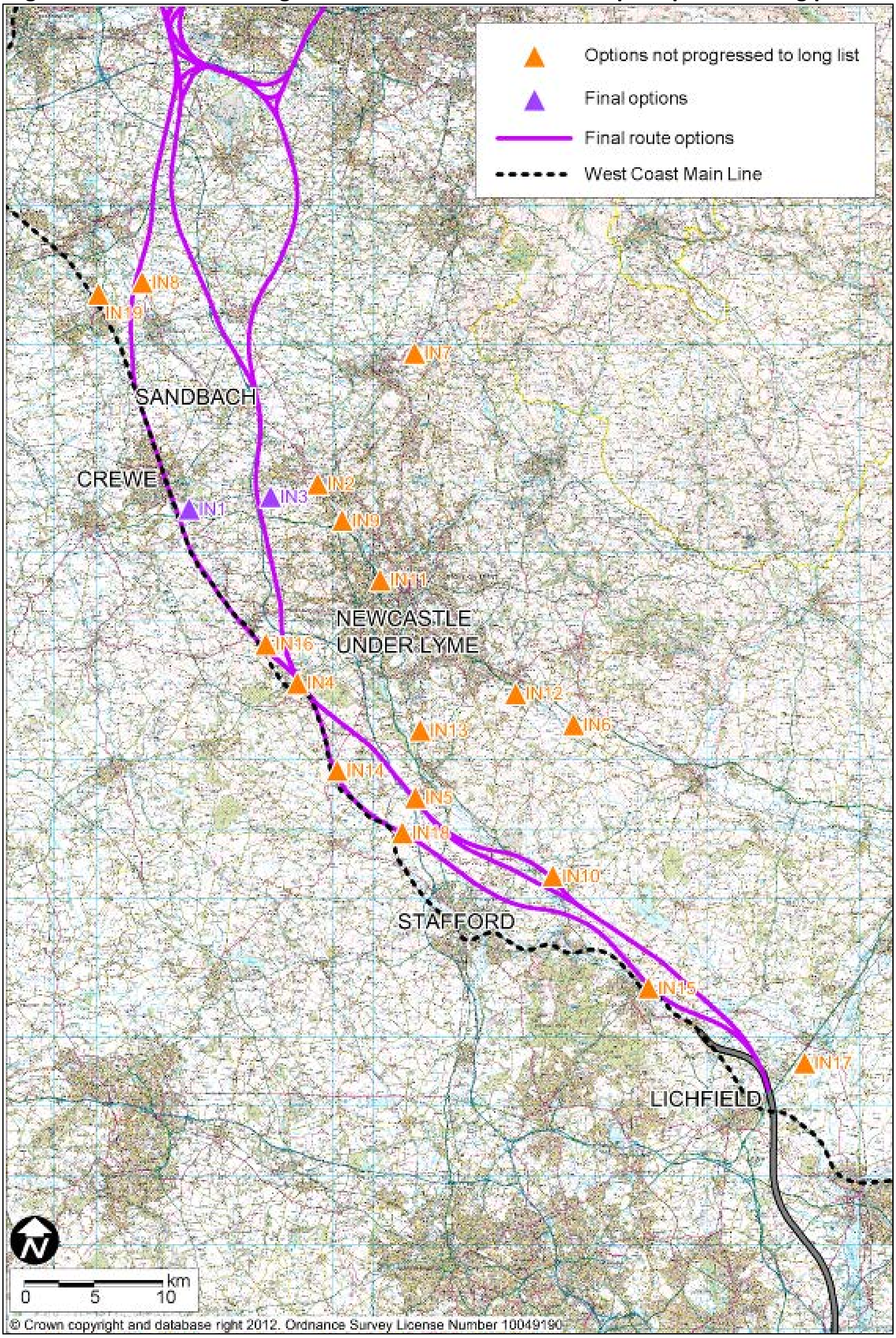
7.2.6 The long list comprised 17 options:

- three options for an infrastructure maintenance depot on the Manchester leg;
- four options for an infrastructure maintenance depot on the Leeds leg;
- six options for a rolling stock maintenance depot on the Manchester leg; and
- four options for a rolling stock maintenance depot on the Leeds leg.

Selecting options for refinement

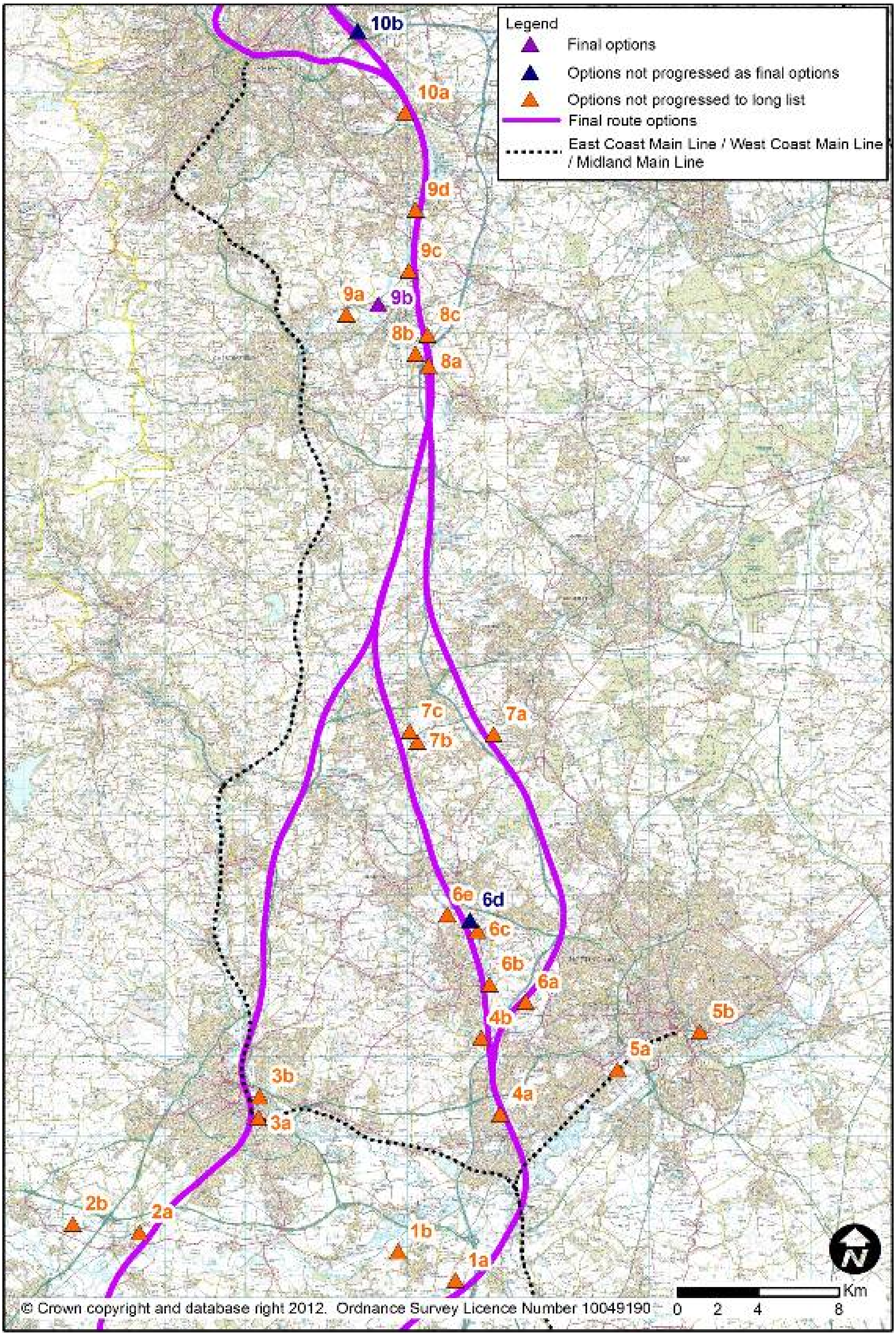
7.2.7 As explained above we followed a two stage sifting process for depots. It was not necessary to go through a short listing stage. Prior to the finalisation of options though, we decided that work on Baldwin's Gate (infrastructure maintenance depot option 4) on the Manchester leg and Woodhouse Junction (infrastructure maintenance depot option 10a) on the Leeds leg would not progress to the next stage. This was because engineering design work showed at an early stage that the sites would be inferior to other options.

Figure 7.1 - Manchester leg infrastructure maintenance depot options sifting process



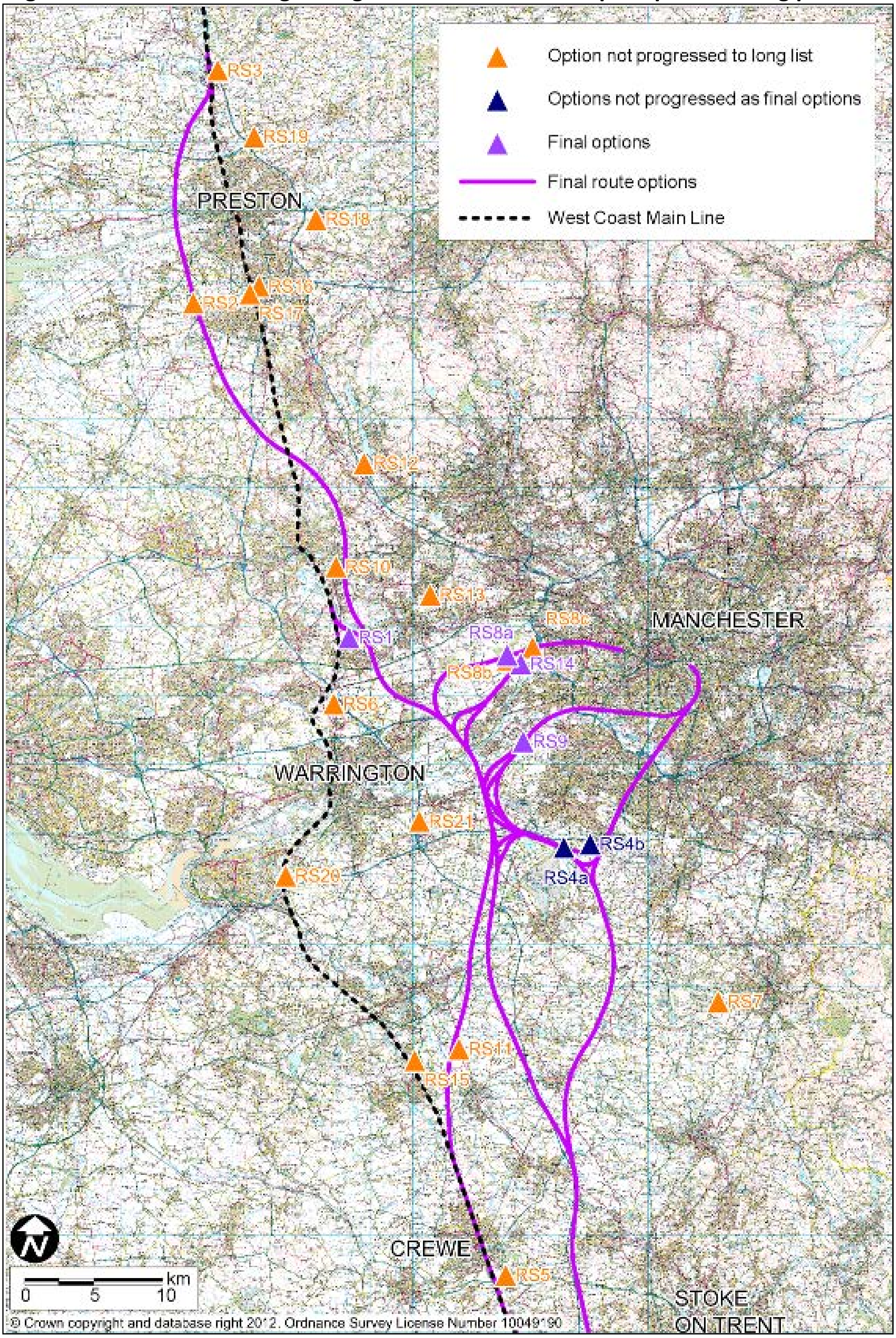
Source: HS2 Ltd

Figure 7.2 - Leeds leg infrastructure maintenance depot options sifting process



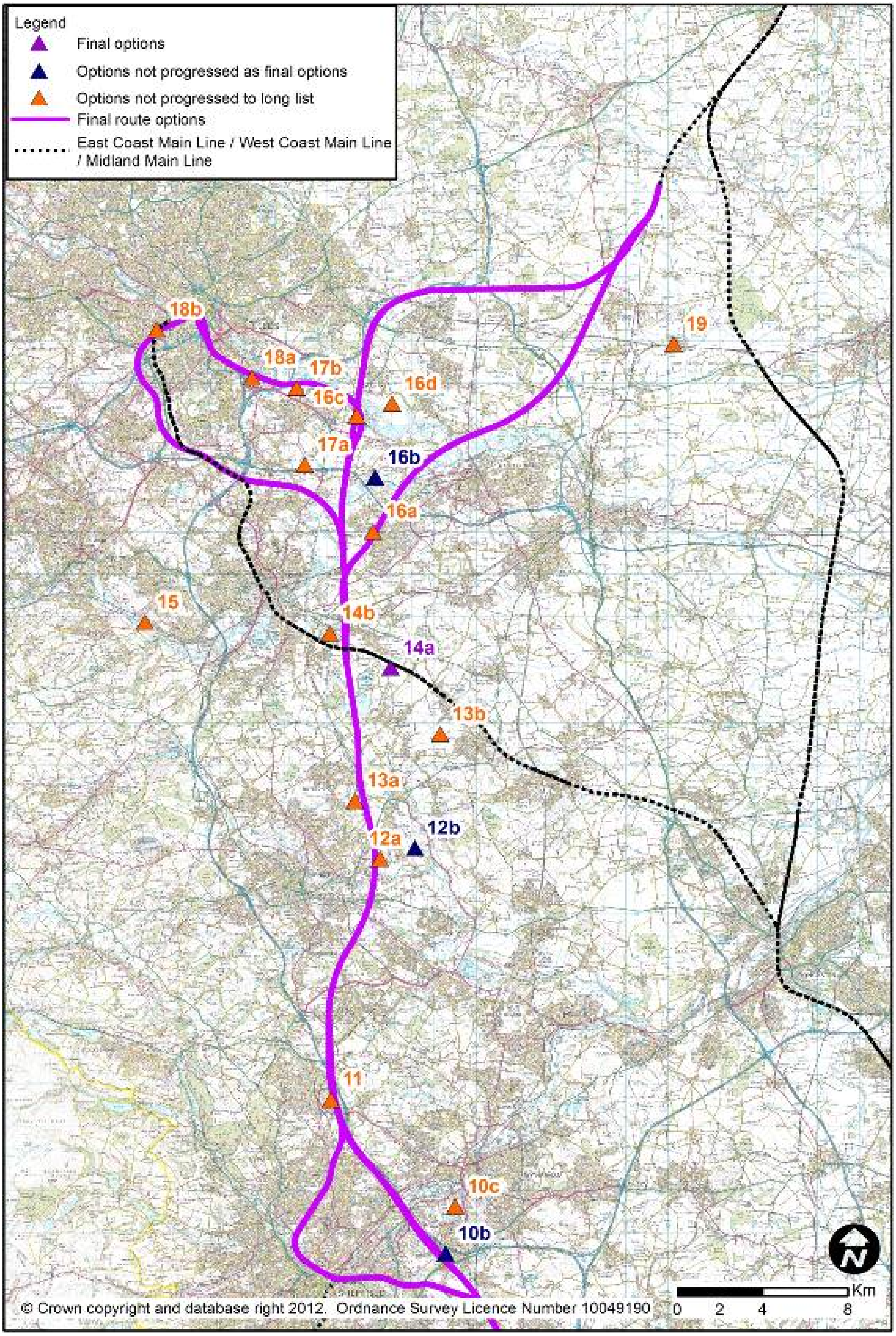
Source: HS2 Ltd

Figure 7.3 - Manchester leg rolling stock maintenance depot options sifting process



Source: HS2 Ltd

Figure 7.4 - Leeds leg rolling stock maintenance depot options sifting process



Source: HS2 Ltd

Developing and finalising our options

7.2.8 The 15 remaining options were developed further to allow for a full assessment. The aim was to establish fit for purpose rolling stock and infrastructure maintenance depots to serve each whole route option for each leg of the Y network. The most favourable option for each whole route combination was taken forwards as an option for the final report.

7.2.9 The outcome of this was one of each type of depot on the Leeds leg being taken forwards; two infrastructure maintenance options on the Manchester leg being taken forward and three rolling stock maintenance options on the Manchester leg being taken forward. In addition, one further rolling stock maintenance option, Carrington, was identified as a viable alternative to the main option that would serve a station near Manchester Piccadilly.

7.3 Proposed depot options and alternatives

Infrastructure maintenance depots

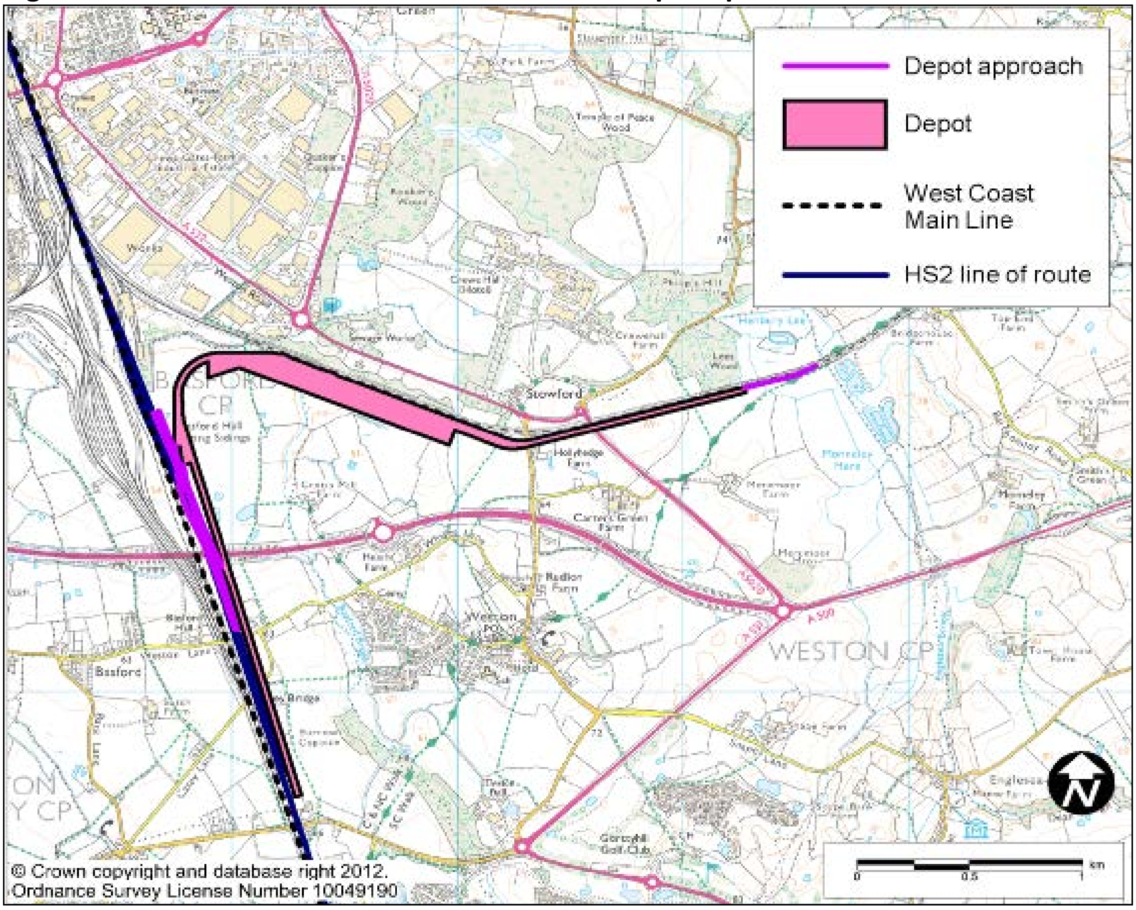
Manchester leg: Crewe

Engineering

7.3.1 This option would serve the Newcastle-under-Lyme to Crewe western route of the Manchester leg options and any Manchester city centre station option. Figure 7.5 shows the outline of the proposed site and the required approaches. The depot would be located south of the existing Crewe station and opposite the Basford Hall sidings. It would provide connection onto both directions of the existing railway line that connects to the WCML.

7.3.2 The depot would be accessible from both ends and provide access in a southerly direction to HS2 using a flat junction. Trains would then need to reverse in order to travel north on the HS2 line. The depot would be in a good location on the network: approximately half way along the route between the West Midlands and Manchester. Direct access to the A500 could be made via a new road into the site.

Figure 7.5 - Crewe infrastructure maintenance depot option



Source : HS2 Ltd

Sustainability

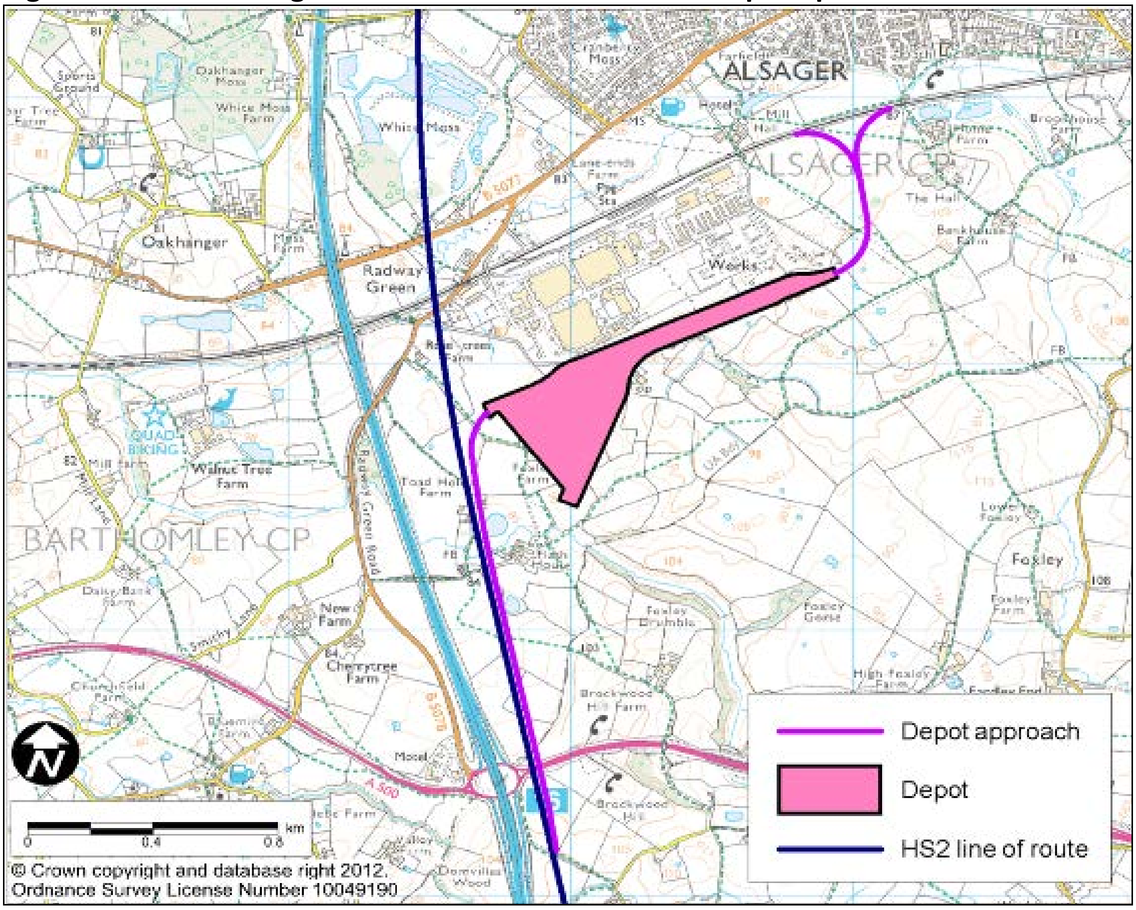
7.3.3 The depot would be on a greenfield site, but not in the Green Belt. The site is identified for rail connected industrial development and thus a depot would be supported by local planning policy. A Grade II* listed building would be indirectly affected due to the fact that it would lie within 40m from the boundary of the site. The depot structure would be on a slightly raised platform to ensure that the floodplain on which it would lie could continue to function underneath it. A number of minor roads would need to be diverted underneath this structure.

Manchester leg: West Alsager

Engineering

7.3.4 This option would serve the Newcastle-under-Lyme to Sandbach route of the Manchester leg options and any Manchester city centre station. It would be located just south of the existing railway line just to the west of Alsager. This would be a good location, just to the north of the mid point of the route between the West Midlands and Manchester. The depot would be accessible from both ends and provide access in a northerly direction to HS2 using a flat junction. A reverse move on the HS2 line would be required for access to the northern direction of HS2. The site would have good access to the A500 and M6 via a new road linking to the B5077. Figure 7.6 shows the outline of the proposed site and the required approaches.

Figure 7.6 - West Alsager infrastructure maintenance depot option



Source: HS2 Ltd

Sustainability

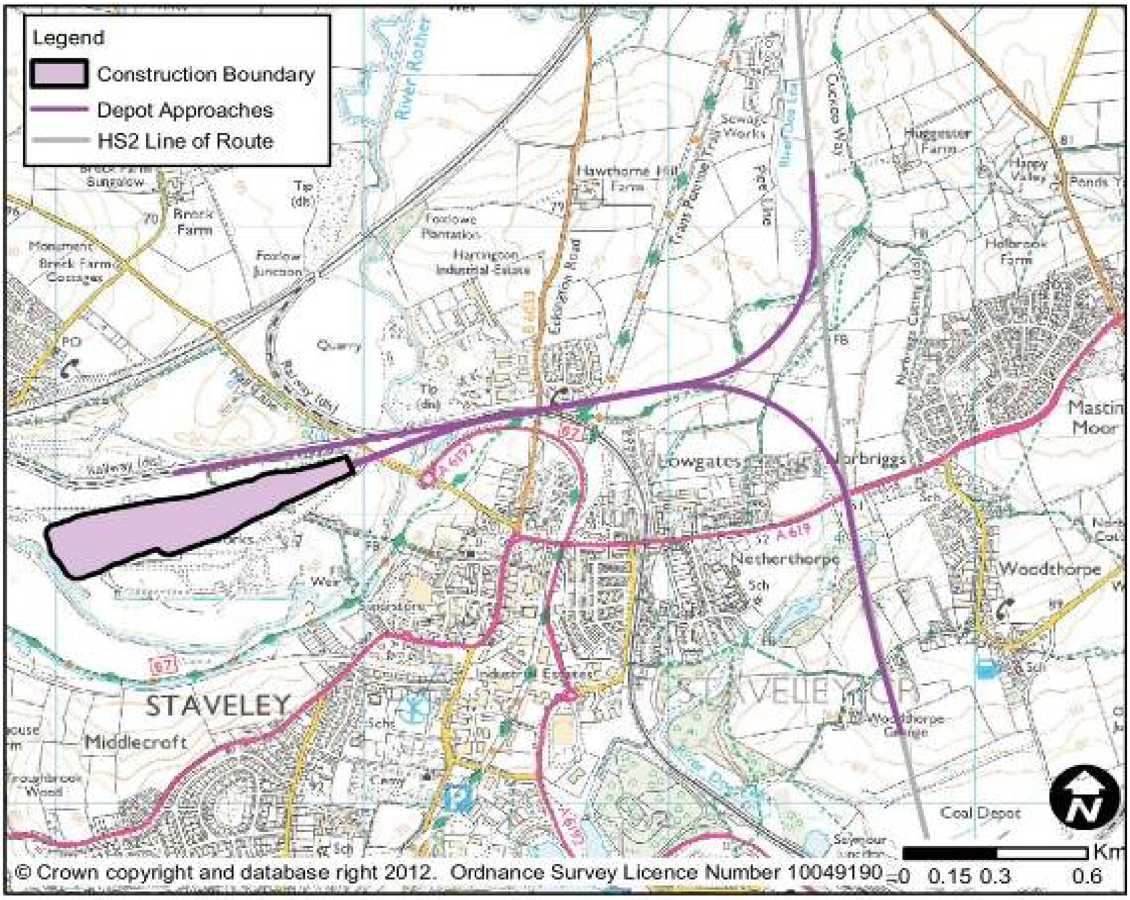
7.3.5 The site would be immediately to the south of an existing industrial site, but would be on a greenfield site itself and in the Green Belt. It is expected that two dwellings would be required to be demolished in order to build the depot and its approach.

Leeds leg: Staveley

Engineering

7.3.6 This option would serve all of the route and station combinations on the Leeds leg. The option is proposed to be located on the southern part of a large brownfield site (a former iron works). This is to the south of the existing freight railway line and on the north-west edge of the town of Staveley which is to the east of Chesterfield. The depot would allow access from the eastern end only, this would be onto the HS2 route via dedicated approach tracks and the existing railway line. Road access to the site from major roads would be via existing minor roads which would need to be upgraded as part of the construction of the depot. Figure 7.7 shows the outline of the proposed site and the required approaches.

Figure 7.7 - Staveley infrastructure maintenance depot option



Source: HS2 Ltd

Sustainability

7.3.7 This option would require a potential diversion of the River Rother and the depot would be located within its floodplain; hence replacement floodplain provision may also be required. A small number of demolitions of dwellings may be required although every effort would be made to reduce this number in future through further detailed design. Locating a depot on this brownfield site would be supportive of local planning aspirations as it is designated currently for industrial and business use.

Rolling stock maintenance depots

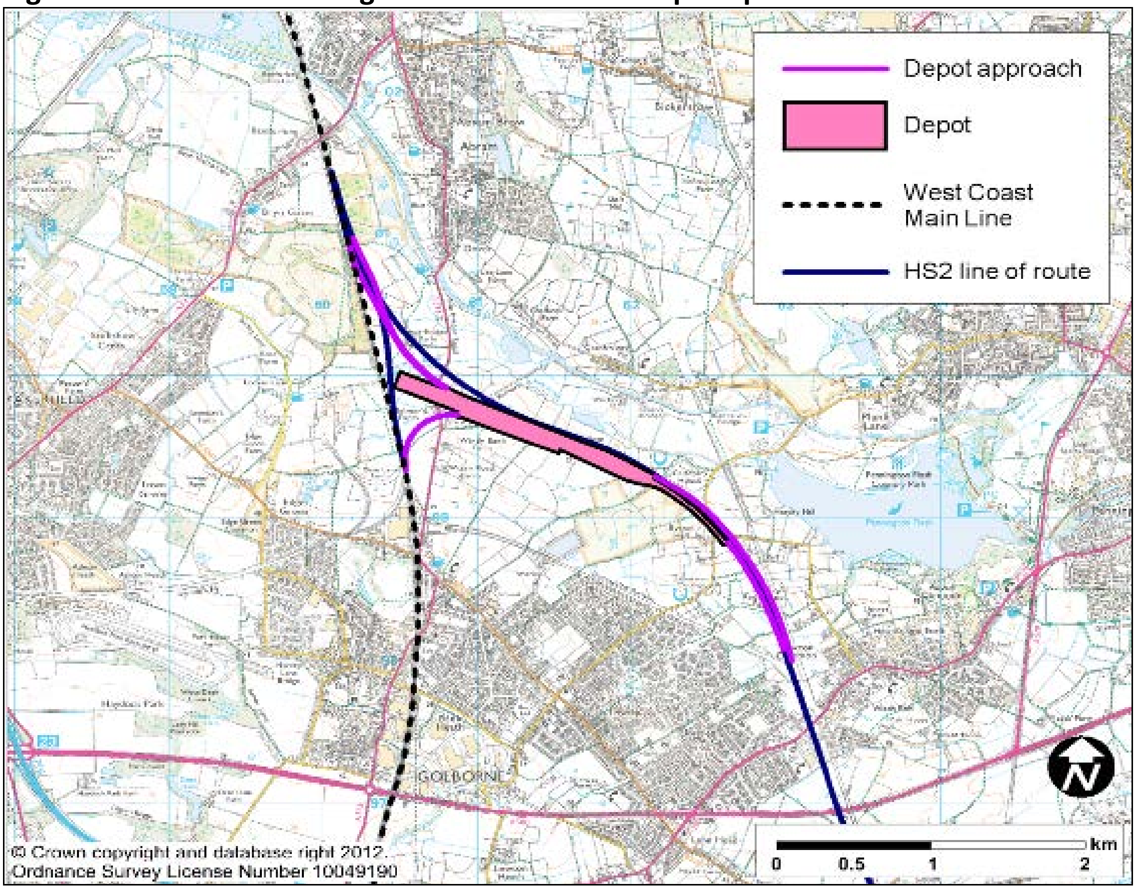
Manchester leg: Golborne

Engineering

7.3.8 This option would serve all main routes to Manchester and a city centre station near Manchester Piccadilly (via either of the approaches to the station). In order to serve a station in Salford, an additional section of route would need to be built between the approach to the station and the main line of route to enable trains to pass out of the station and travel northwards. We do not recommended this as we have developed alternative options which would serve a Salford station and thus would not require the additional cost and impacts of additional track.

7.3.9 The depot option would be located between the WCML and the proposed HS2 route shortly before it would connect to the WCML. The depot would be accessible from both ends with access to HS2 and the WCML in both directions. The depot would be in a good location to service trains terminating in Preston, Liverpool and Manchester. This option could provide direct access to the A573 and the M6 is relatively close. A new highway to connect to the A573 and a diversion of the A573 over the top of the site would be required. Figure 7.8 shows the outline of the proposed site and the required approaches.

Figure 7.8 - Golborne rolling stock maintenance depot option



Source: HS2 Ltd

Sustainability

7.3.10 The site is a relatively flat greenfield farmland site, in the Green Belt. The depot would have some impact on the setting of Lightshaw Hall, a Grade II* listed property which would lie within the boundary of the site. Seven demolitions of dwellings would be expected to be required for the construction of the depot and approaches.

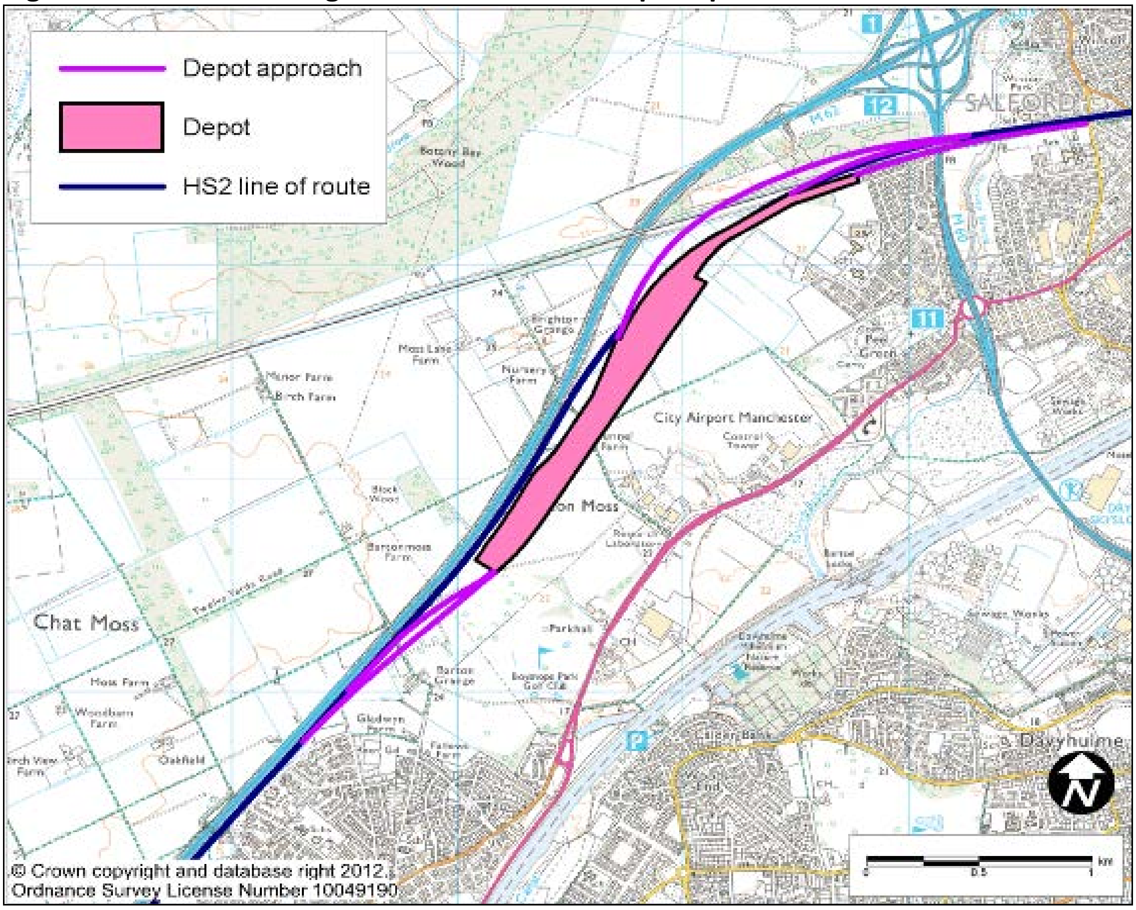
7.3.11 An SSSI (Abram Flashes) might be intersected by the new road to access the depot for approximately 500m which would mean a major impact on this site including habitat loss and fragmentation of the site. We would seek to mitigate this impact in more detailed design. In addition the depot would create an impact on the surrounding landscape of the Abram Flashes and the Leeds and Liverpool canal.

Manchester leg: Barton

Engineering

7.3.12 This option would serve any of the main line of route options and the M62 approach into a station in Salford. It would not serve any other approach routes. The option would be partly on what is currently Barton Aerodrome and partly on farmland, and adjacent to the M62 and the M62 approach into Manchester. The depot would be accessible from both ends and allow access in both directions to the M62 approach. A connection to the existing railway would be made in both directions using a grade separated junction; with the existing railway being re-aligned. A direct connection would be made with the A6144 via a new access road. Figure 7.9 shows the outline of the proposed site and the required approaches.

Figure 7.9 - Barton rolling stock maintenance depot option



Source: HS2 Ltd

Sustainability

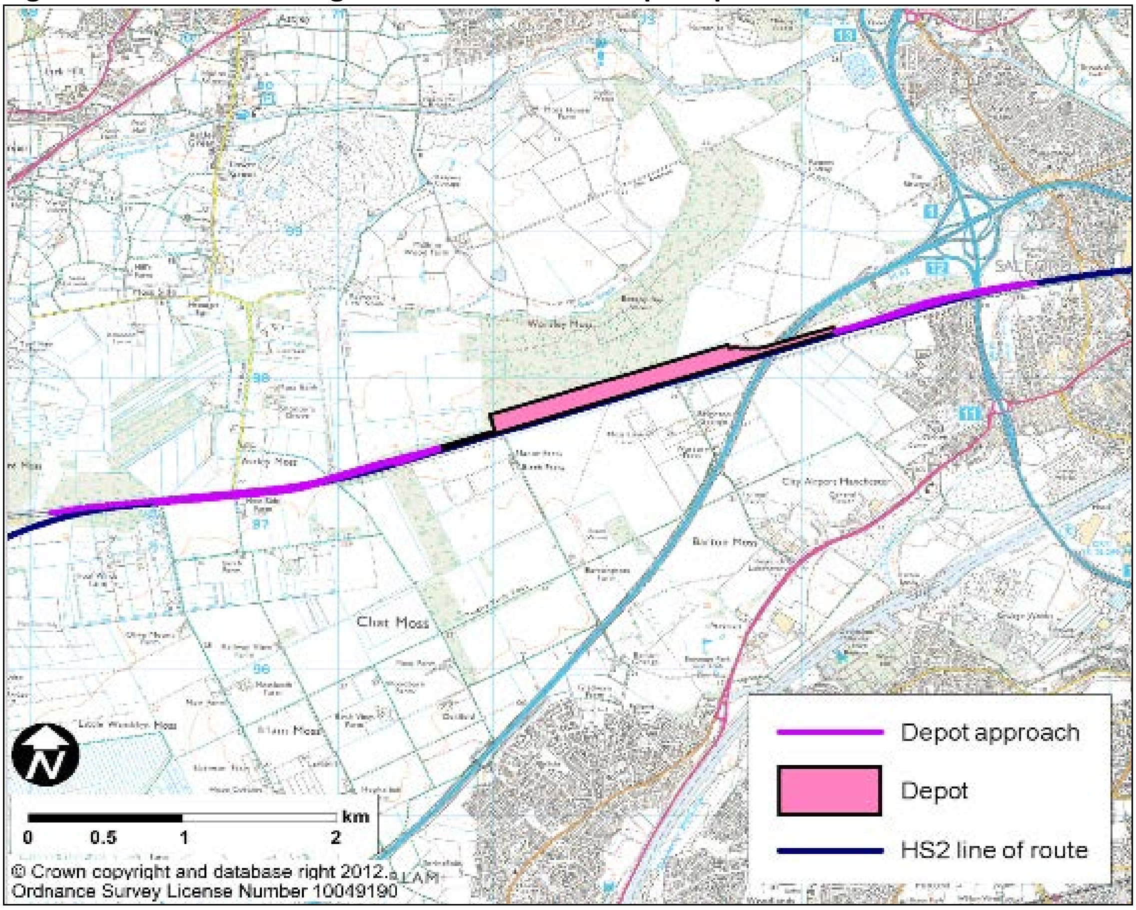
7.3.13 The option would take some Grade I agricultural land (the most fertile categorisation); and be within the Green Belt. The option would currently conflict with extant permission for the drilling of boreholes for coal bed methane and related power generating facilities. Approximately two demolitions of dwellings would be expected to be required.

Manchester leg: Eccles

Engineering

7.3.14 This option would serve any of the main line of route options and the Chat Moss corridor approach into a station in Salford. It would not serve any other approach routes. The option would be located north of and adjacent to the existing railway line, to the west of the M60 interchange with the M62. It would be accessible from both ends, with connections to the HS2 through route, the Chat Moss corridor approach into Manchester and the existing railway in both directions. The existing railway would need to be re-aligned to allow junctions in and out of the depot. Grade separated junctions would be required for access to both the existing railway and the HS2 route. Figure 7.10 shows the outline of the proposed site and the required approaches.

Figure 7.10 - Eccles rolling stock maintenance depot option



Source : HS2 Ltd

Sustainability

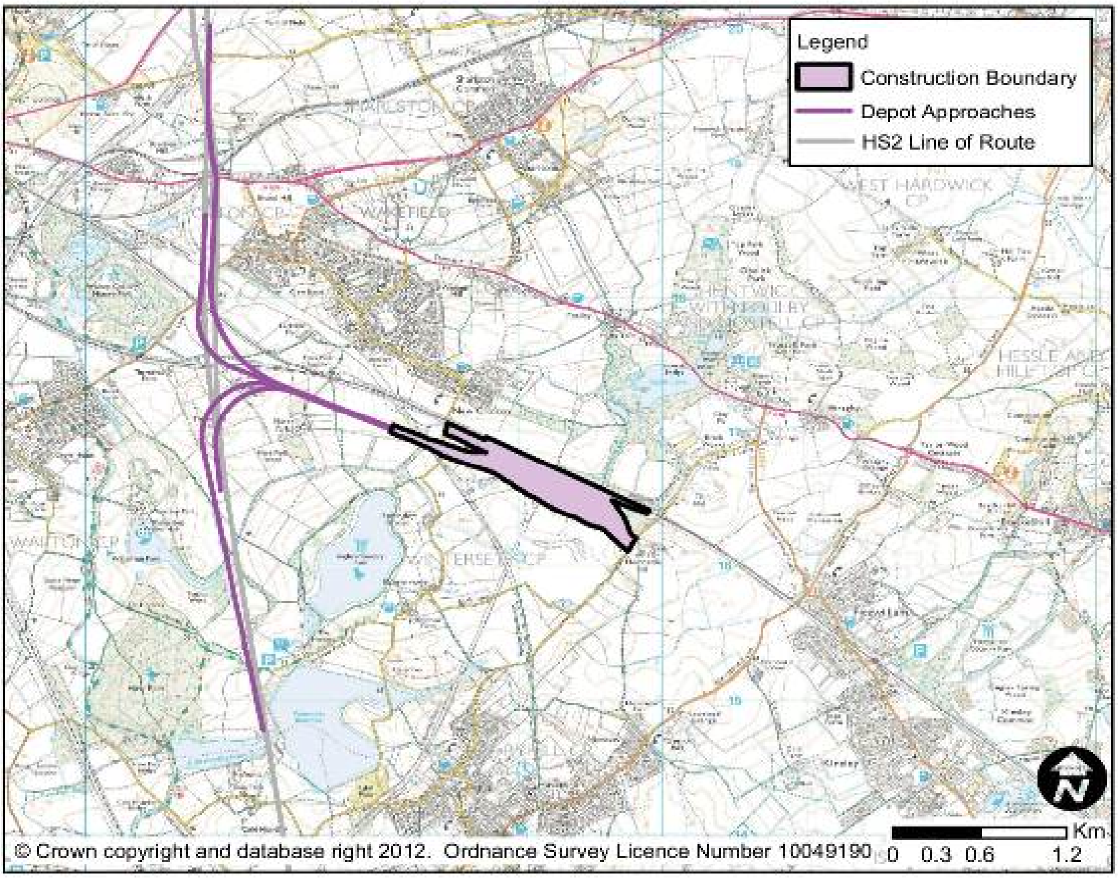
7.3.15 The construction of this option would require a new bridge over the M62 and a 1.9 mile (3km) access road from the A572 which would allow direct access to the M62. The site is currently partly Grade I agricultural land (the most fertile categorisation) and partly woodland and is designated as Green Belt. One demolition of a dwelling would be expected to be required.

Leeds leg: New Crofton

Engineering

7.3.16 This option would serve all of the route combinations on the Leeds leg. It would be located to the south-east of Wakefield and the village of New Crofton on a disused coal disposal plant adjacent to the existing railway line. This site would offer good connection to HS2 and the existing electrified rail network giving access to key classic compatible destinations. The site location south of the junction into Leeds city centre would also provide access to both Leeds and the link to the ECML. Connections to the main HS2 route would overlap with and be combined with both of the options for the junction into Leeds to the north; which would be fairly complex. Access to the A638 would be made via an existing minor road linked to the site. Figure 7.11 shows the outline of the proposed site and the required approaches.

Figure 7.11 - New Crofton rolling stock maintenance depot option



Source: HS2 Ltd

Sustainability

7.3.17 Although the option would be on a brownfield site, this is completely within the Green Belt. It is expected that there would be some impact on the landscape that a nearby country park is set within. The approach route into the depot would also impact visually on the village of New Crofton. The site is within an area currently designated as a Regeneration Priority Area. The construction of the approach would potentially require four demolitions of dwellings.

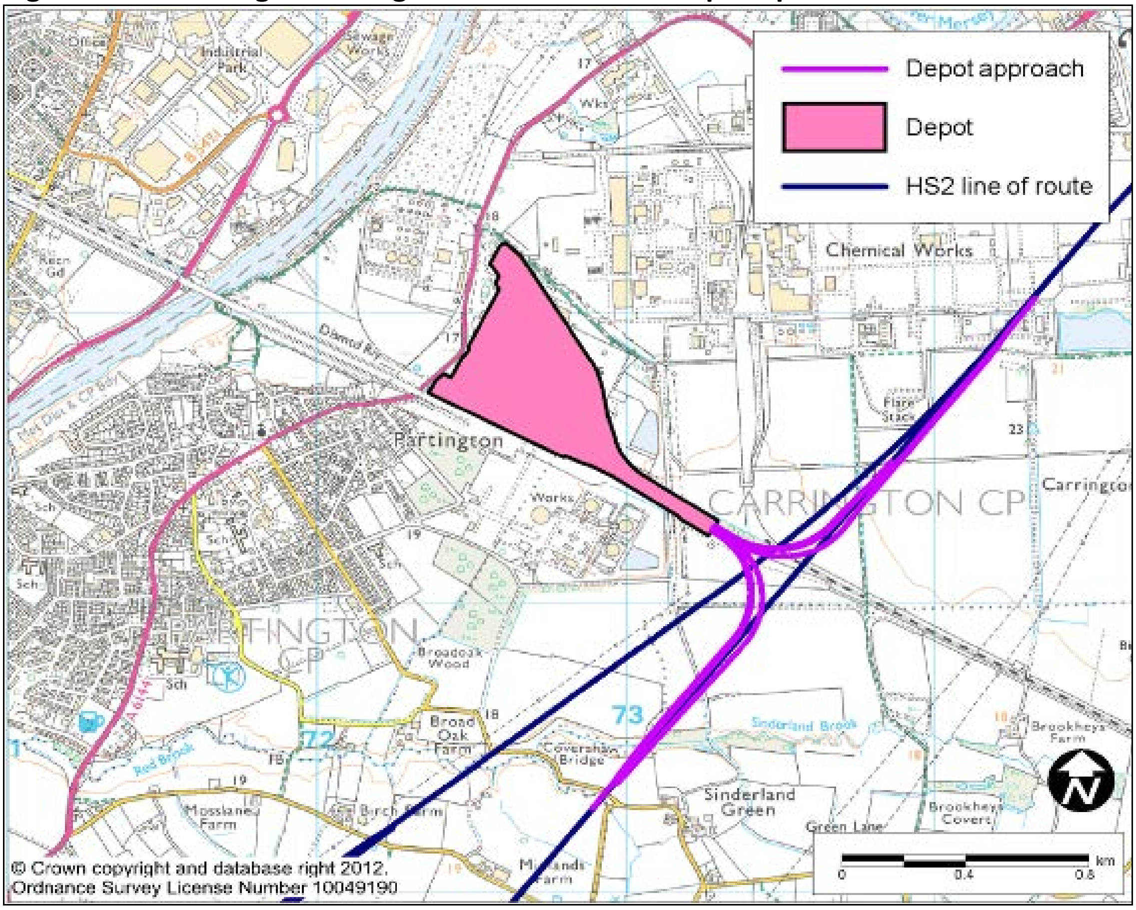
Manchester leg alternative – Carrington

Engineering

7.3.18 This option would serve any of the main route options and the Mersey and tunnel approach route into a station near Manchester Piccadilly. It would not serve any other approach routes. We give a brief overview of this option as a viable alternative to the proposed Golborne option.

7.3.19 The depot would be situated on a brownfield site that is currently part of the Carrington Industrial Estate. It would only be accessed from the southern end; which would link to the HS2 approach into Manchester in both directions using a grade separated junction. Operationally this is not optimal. The option would not provide access to the existing rail network. It would have direct access to the A6144. Figure 7.12 shows the outline of the proposed site and the required approaches.

Figure 7.12 - Carrington rolling stock maintenance depot option



Source : HS2 Ltd

Sustainability

7.3.20 The option would be in direct conflict with extant planning permission for commercial space granted for the whole site. The approach to the depot would take Green Belt land.

Classic compatible rolling stock stabling and servicing

7.3.21 Classic compatible trains would run on the Y network before branching off onto classic lines at various points to serve various destinations. Due to the service specification that we propose, it would be necessary to provide stabling facilities to serve Glasgow, Edinburgh and Newcastle services. As this was not part of our core remit we have not yet engaged with local stakeholders specifically to identify possible sites.

7.3.22 As a minimum we would require a classic compatible train servicing facility with capacity for approximately 18 train sets close to existing railway lines and with the ability to serve both Glasgow and Edinburgh. An enhanced version of this would be a light maintenance facility for classic compatibles. In addition, near to Newcastle we would need a classic compatible train servicing facility for a maximum of 10 train sets. A total of £250 million for these is included in our cost assumptions.

7.3.23 Classic compatible trains starting/finishing the day from all other classic compatible destinations, such as York and Liverpool would be stabled in rolling stock depots on the Y network or stabling facilities at Euston station.

Maintenance and stabling infrastructure: Section summary

7.3.24 We have considered the necessary maintenance and stabling infrastructure on the Y network that would serve each of the final route options. Whichever option the Government decides to take forward, the relevant depot options would need to be developed in more detail. As set out previously, we would also need to engage with delivery partners to aide our understanding of the relevant sites and the potential further mitigation of any impacts.

7.3.25 We have included a conservative allowance for maintenance and stabling infrastructure for classic compatible trains north of the Y network. Possible sites for this infrastructure would be explored going forward with local stakeholders.

Chapter 8 – Base proposition

8.1 Introduction

8.1.1 In the previous chapters we described our option creation, development and analysis process. We set out how we reduced options through our engineering, sustainability and demand appraisal process until we were left with a small number of viable options. We described these remaining options in more detail and set out the further design and mitigation work we would do if these options were taken forward. In this chapter we take the different component parts to form a base proposition for the Y network that meets our remit set by Government. Using this base proposition we also describe choices that would bring different or additional benefits to the network but which would come at additional cost and have different impacts.

8.1.2 The base proposition was used as the basis for our analysis of the economic case. It enables us to assess the costs and benefits of the scheme at this stage in the design and development process. The benefits of the scheme are described in the updated economic case document.

8.1.3 There are many alternative options for phase two depending on Government's choices and the base proposition we describe here is not a preferred scheme.

8.2 Base proposition

8.2.1 The base proposition is set out on the schematic on Figure 8.1 with a high level overview of its sustainability performance in text box 22. The base proposition comprises the following elements:

Route to Manchester and city centre station and connection to the WCML

8.2.2 We have selected the Lichfield to Newcastle-under-Lyme northern route option with variant, and have retained both the original route (to the north of Weston) and the variant (to the south of Weston) as options. This reflects the further work and discussion that is required about Pasturefields Salt Marsh SAC. For the purposes of costs we included the variant route to the south of Weston.

8.2.3 We selected the western route option from Newcastle-under-Lyme to Crewe which enables a connection at Crewe as described in chapter 4. We included the cost of the connection in our overall costs. This would link to the Crewe to Golborne western route, which we have selected.

8.2.4 We included the Mersey and tunnel approach to a HS2 station at Manchester Piccadilly. This approach does not enable a Manchester Airport station to be served which we describe in the potential options to optimise the base proposition.

8.2.5 We selected a connection to the WCML at Golborne that would allow classic compatible HS2 trains to serve Scotland in around three hours 40 minutes. Both Edinburgh and Glasgow would be served from this route.

8.2.6 We have assumed some additional cost for the infrastructure works required on the WCML north of Golborne to enable the existing railway to operate with an increased number of trains. Further design and engagement would be required in this area.

Routes to Leeds, station options and connecting to the ECML

8.2.7 Our base proposition assumes the route via the north of Measham to an East Midlands HS2 station at Toton.

8.2.8 We included the route following the Erewash Valley to a HS2 station at Meadowhall.

8.2.9 We then included the single route option northwards to a HS2 station at Leeds New Lane via the Woodlesford corridor.

8.2.10 We have assumed a route via Garforth to a connection to the ECML at Church Fenton. Classic compatible trains would then head northwards to York and the North East.

Heathrow

8.2.11 We have included a route along the eastern side of the M25 (surface option) to a north-south orientated station at T5.

Maintenance and stabling

8.2.12 For both legs we also assume appropriate maintenance and stabling locations and have included these in our costs. Indicative locations are shown on the base proposition schematic below but would be subject to further consideration and development when a preferred selection has been made.

Journey times

8.2.13 The base proposition (with assumed stopping pattern) would enable the following journey times:

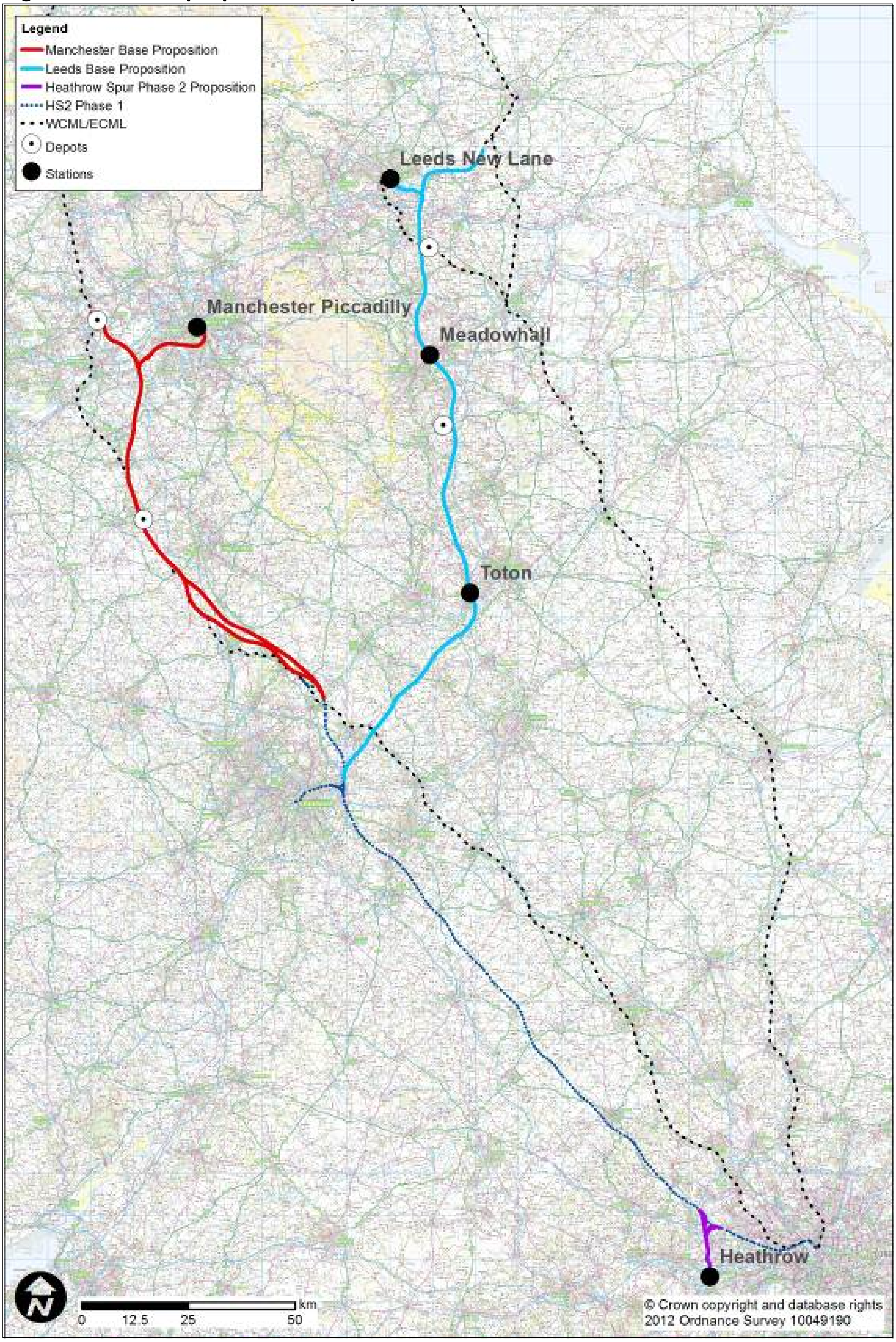
Route to Manchester and city centre station and connection to the WCML

- London to Manchester – 68 minutes
- London to Crewe – 58 minutes
- London to Liverpool – 96 minutes
- London to Scotland (Glasgow / Edinburgh) – 218 minutes (3 hrs 38 mins)
- Birmingham to Manchester – 36 minutes

Routes to Leeds, station options and connecting to the ECML

- London to East Midlands – 51 minutes
- London to South Yorkshire – 69 minutes
- London to Leeds – 82 minutes
- London to York – 83 minutes
- London to Newcastle – 138 minutes
- Birmingham to Leeds – 57 minutes

Figure 8.1 – Base proposition for phase two



Source: HS2 Ltd

22. Base proposition - sustainability performance

The sustainability performance of the base proposition is described in chapter 15 of the AoS options report. The sustainability performance, like all of the route options, reflects the extensive sifting exercise that has reduced many of the potential adverse impacts of the scheme. As a result, although impacts would occur, we have been able to limit their number, extent and severity as far as possible at this stage of design. Continuing design and appraisal will seek to reduce potential impacts further and will help us to understand better the impacts we have predicted so far.

Some of the key issues that arise with the base proposition are summarised below. Further impacts, both positive and adverse (e.g. including demolitions and noise), are set out in the AoS options report.

Manchester

The base proposition route would have potential indirect effects on Pasturefields Salt Marsh SAC and Manchester Mosses SAC. We will continue to appraise the potential impacts to this site as scheme designs are progressed and seek ways of mitigating risks, as we have done for other similar sites. The route would avoid the registered Dunham Massey Park, although it would cross some National Trust owned farmland to its west. We have sought to integrate the route into the landscape, but some more prominent structures are necessary to cross rivers, such as the Trent and Mersey Valleys and major transport features, such as the Manchester Ship Canal, resulting in landscape and visual impacts. The route would be in tunnel or deep cutting when passing close to the majority of dense built up areas but would pass close to dwellings at high speeds in a number of smaller communities. In these locations additional mitigation would be used to reduce potential noise impacts where appropriate. The proposed station at Manchester Piccadilly would potentially support an estimated 29,700 jobs and 3,100 housing units.

Leeds

The base proposition route would have potential indirect effects on the River Mease SAC, although we continue to work closely with Natural England to mitigate risks at this site. The route would be elevated along the Erewash Valley resulting in landscape and visual impacts, with distant views from the Grade I listed Hardwick Hall 2km to its east. The route would pass close to dense built up areas and smaller communities in a number of locations at high speeds. In these locations additional mitigation would be used to reduce potential noise impacts where appropriate. The proposed station at Leeds would potentially support an estimated 13,200 jobs and 1,700 housing units with the proposed stations at Meadowhall and Toton supporting further jobs and houses.

Heathrow
The base proposition route would have potential indirect effects on the South West London Water Bodies SPA and Ramsar site, which could add to other associated risks from the phase one scheme. Our ongoing HRA work continues to better understand these risks and seek ways of mitigating them where necessary. Potential impacts on the River Colne, with associated impacts on flooding would also continue to be a focus of ongoing design.

Costs

8.2.14 We used the base proposition to calculate the costs of the Y network at this stage in the design process. The costs are set out in table 8.1 and table 8.2 below. The costs of phase one as announced in January 2012 are summarised in table 8.3.

8.2.15 The capital construction cost of the phase one London to West Midlands infrastructure is estimated at between £15.4 billion and £17.3 billion, with a mean value of £16.3 billion. This includes construction risk and an additional £4.2 billion to cover additional risks in line with HM Treasury guidance on adjusting for optimism bias.[18]

8.2.16 The mean phase two capital construction cost is approximately £17.1 billion within a cost range of £15.7 billion to £18.7 billion. As above this includes further construction risk and an additional £4.2 billion to cover additional risks in line with the HM Treasury guidance.

8.2.17 Our current estimate for the full Y network is, therefore, estimated at between £30.9 billion and £36 billion, with a mean value of £33.4 billion.

Optimism bias

8.2.18 For the base proposition routes, we have continued with the approach from phase one of using values from our location specific and programme wide quantitative risk assessment (QRA) coupled with an appropriate additional provision for optimism bias.

8.2.19 The phase two location-specific risks total £960 million and the programme-level risks are valued at £1.24 billion. The total construction risk estimate is therefore £2.20 billion, which is equivalent to 21% of the estimated phase two cost excluding provision for optimism bias factors.

8.2.20 We have reviewed the optimism bias factors that contribute to calculation of the additional risk provision for phase two. We have made changes that reflect that

[18] Optimism bias is the tendency of project planners to be optimistic about the costs. HM Treasury guidance states that when planning Government funded projects, an allowance to compensate for this tendency must be included. This is referred to as an “allowance for optimism bias”.

this is phase two of the scheme and therefore there is a different weighting of risks than in phase one. The design complexity weighting has been reduced on the grounds that the design of the Y contains nothing as intrinsically complex as phase one. The legislation/regulation weighting has been reduced on the grounds that this was a greater risk for phase one.

8.2.21 The detailed commentary that supports the optimism bias factor weightings for phase two is in the *HS2 Cost and Risk Model* report. This results in additional provision of 33% of the total estimated scheme cost for phase two.

8.2.22 There is a total risk provision of £6.43 billion within the phase two cost estimate, equivalent to an additional 61% of scheme costs.

Table 8.1 - Full Y network cost estimate

Item	Cost £m	Includes
Rail systems	1,430	Track, ballast, fencing, drainage, junctions
Control systems	445	Signalling control and telecommunications
Traction power systems	485	Overhead line equipment and power supply
Stations[19]	2,275	Phase one stations, plus Toton, Meadowhall, Leeds New Lane, Manchester Piccadilly and Heathrow T5
Civil works	2,325	Earthworks, retaining walls and roads
Structures	2,300	Bridges and viaducts
Tunnels	2,390	Twin and single bore tunnels
Utilities	300	Relocation of utilities e.g. water, power
Additional items	470	People mover and rail reconstruction work (phase one)
Contractor administration costs	1,665	Preparatory work, site supervision, testing, training, spare equipment
Total Construction Cost	**14,085**	**Excluding risk**
Environmental mitigation	450	Additional environmental mitigation
Land costs / compensation	1,835	Land acquisition / compensation plus scheme administration (as assessed at Sept 2011)
Depot facilities	1,265	Phase one provision, plus two light maintenance rolling stock depots and two infrastructure maintenance depots and a provision for stabling
Provisional sum	320	Allowance for emerging requirements from concept of operations work
Project overheads	895	Client and project management costs
Design	1,300	All design costs and topographical / ground investigation surveys
Existing rail interface costs	210	Possession management, compensation for operational disruption
Statutory charges	210	Consultation and planning consent related costs
Construction risk	4,415	Route section and route-wide construction risks from the Quantified Risk Analysis
Additional scheme risk provision	8,415	Provision for external risks in line with HM Treasury Supplementary Green Book Guidance
Total	**33,400**	**At Q2 2011 prices**

Source: HS2 Ltd

[19] Stations as defined here are station buildings, facilities, and utility diversions and any station specific requirements such as connectivity with other stations or transport systems, car parking, facilities, construction difficulties.

Table 8.2 - Phase two cost estimate

Item	Cost £m	Includes
Rail systems	920	Track, ballast, fencing, drainage, junctions
Control systems	300	Signalling control and telecommunications
Traction power systems	300	Overhead line equipment and power supply
Stations[2]	600	Toton, Meadowhall, Leeds New Lane, Manchester Piccadilly and Heathrow T5
Civil works	1,740	Earthworks, retaining walls and roads
Structures	1,510	Bridges and viaducts
Tunnels	980	Twin and single bore tunnels
Utilities	180	Relocation of utilities e.g. water, power
Additional items		None
Contractor administration costs	890	Preparatory work, site supervision, testing, training, spare equipment
Total Construction Cost	**7,420**	**Excluding risk**
Environmental mitigation	200	Additional environmental mitigation
Land costs / compensation	870	Land acquisition / compensation plus scheme administration
Depot facilities	765	Two light maintenance rolling stock depots, two infrastructure maintenance depots and a provision for stabling
Provisional sum	95	Allowance for emerging requirements from concept of operations work
Project overheads	460	Client and project management costs
Design	700	All design costs and topographical / ground investigation surveys
Existing rail interface costs	20	Possession management, compensation for operational disruption
Statutory charges	140	Consultation and planning consent related costs
Construction risk	2,200	Route section and route-wide construction risks from the Quantified Risk Analysis
Additional scheme risk provision	4,250	Provision for external risks in line with HM Treasury Supplementary Green Book Guidance
Total	**17,120**	**At Q2 2011 prices**

Source: HS2 Ltd

Table 8.3 - London to West Midlands phase one cost estimate as announced

Item	Cost £m	Includes
Total Construction Cost	6,665	Excluding risk
Construction risk	2,215	Route section and route-wide construction risks from the Quantified Risk Analysis
Additional scheme risk provision	4,165	Provision for external risks in line with HM Treasury Supplementary Green Book Guidance
Environmental mitigation	250	Additional environmental mitigation
Land costs / compensation	965	Land acquisition / compensation plus scheme administration (as assessed at Sept 2011)
Depot facilities	500	Main rolling stock depot, London stabling, depot relocations (HEX and IEP) and infrastructure maintenance depot
HS2 Costs	1,520	Provisional sum, Project overheads, design, Existing rail interface costs, Statutory charges
Total	**16,280**	**At Q2 2011 prices**

Source: HS2 Ltd

Adding to the base proposition

8.2.23 We described in chapters 4 and 5 a number of alternative options and some potential additional options to the Y network. There are two described which would potentially add to the overall business case or, in the case of connecting with the WCML further north would bring a further journey time benefit to services to Scotland, but would both come with additional costs and impacts. These are costs over the baseline set out in the tables above.

8.2.24 We focus on describing these two options as they provide a genuinely different proposition. In chapters 4, 5 and 6 we described the effect of making different station and route choices. However, these would be changes to the base proposition rather than additions to it. Going forwards as Government considers the options presented in this report further we will be able to advise on the effect different decisions will have on the overall business case for the scheme.

Manchester interchange

8.2.25 We described the potential benefits of including an additional Manchester interchange station which would serve Manchester Airport in chapter 4. This would require an alternative route via a station near to the Airport and an alternative approach into Manchester Piccadilly that, in order to avoid a number of impacts, would include additional tunnelling. The effect would therefore be to add around £650 million (PV) to the overall costs including the addition of a station. This could however deliver benefits in the region of £700 million (PV) and revenue in the region of £500 million (PV). Some of this benefit reflects the faster route into Manchester Piccadilly that would save around two minutes on the overall journey time for any non-stopping services. Given that services would stop at the Airport station en route to Manchester Piccadilly this would however create a journey time penalty to some services. The additional stop would add five minutes to overall journey time. This would reduce the benefits of the faster approach into Manchester Piccadilly.

8.2.26 Therefore, the benefits of an additional interchange station at Manchester Airport are finely balanced and would add to the overall cost of the scheme. The relative merits of a Manchester Airport interchange station would be potentially improved if, as noted above, private sector or others contribute to the costs of the station infrastructure.

Connecting to the WCML further north

8.2.27 In chapter 4 we noted the potential benefit of connecting to the WCML further north than the base assumption of Golborne. There would be potential value in both connecting at Preston and serving the Preston and surrounding market. Alternatively there would also potentially be benefit in not stopping at Preston and securing instead a significant journey time improvement for services to Scotland. As we described, the further north that the high speed line runs the quicker the journey time to Scotland but this would come with a significant additional cost. We estimate that the cost of connecting in the north of Preston would be in the region of £2 billion with potential additional infrastructure costs to the existing railway. We have therefore not included this connection in our base assumption.

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List of supporting documents

Record of stakeholder engagement for phase two of the high speed rail network
A summary by HS2 Ltd of the approach to engagement with key stakeholders between May 2010 and March 2012 on the HS2 legs to Manchester, Leeds and Heathrow.

Options for phase two of the high speed rail network – approach to design
A report to Government by HS2 Ltd which presents the common approach to design applied to each of the legs of the 'Y' and the Heathrow spur. It also serves as an introduction to the engineering reports carried out by Arup Group Ltd and Mott McDonald, Scott Wilson and Grimshaw (MSG).

Engineering options report – West Midlands to Manchester
This report for HS2 Ltd by Mott McDonalds, Scott Wilson and Grimshaws (MSG) presents the findings of the route engineering study for high speed rail between Birmingham and Manchester.

Engineering options report – West Midlands to Leeds
This report for HS2 Ltd by Arup Group Limited presents the findings of the route engineering study for high speed rail between Birmingham and Leeds.

Engineering options report – Heathrow
This report for HS2 Ltd by Arup Group Limited presents the findings of the route engineering study for a high speed rail spur to Heathrow.

Options for phase two of the high speed rail network - Appraisal of Sustainability
This report for HS2 Ltd by Temple-ERM describes how the proposals for the HS2 legs to Manchester, Leeds and Heathrow support objectives for sustainable development.

HS2 Cost and risk model report
A report by HS2 Ltd which describes the costs of the HS2 project, the work carried out in reaching our cost conclusions and the approach to risk in the cost model.

List of acronyms

Descriptions of acronyms are included in the *Glossary of terms*

AA	Appropriate Assessment
AONB	Area of Outstanding Natural Beauty
AoS	Appraisal of Sustainability
BAP	Biodiversity Action Plan
BCR	Benefit Cost Ratio
CPRE	Campaign to Protect Rural England
DfT	Department for Transport
ECML	East Coast Main Line
EHS	Exceptional Hardship Scheme
ERTMS	European Rail Traffic Management System
EU	European Union
GDP	Gross Domestic Product
GWML	Great Western Main Line
HRA	Habitats Regulation Assessment
HS1	High Speed 1
HS2	High Speed 2
IMD	Infrastructure Maintenance Depot
kph	kilometres per hour
LEP	Local Enterprise Partnership
MML	Midland Main Line
mph	miles per hour
NET	Nottingham Express Transit
NNR	National Nature Reserve
NRTS	National Rail Travel Survey
PRT	Personal Rapid Transit
PV	Present Value
QRA	Quantitative Risk Assessment
RSD	Rolling Stock Maintenance Depot
SAC	Special Area of Conservation
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
SYPTE	South Yorkshire Passenger Transport Executive
T5	Heathrow Terminal 5
TfL	Transport for London
tph	trains per hour
WCML	West Coast Main Line
WebTAG	Web based Transport Appraisal Guidance

Glossary of terms

Agricultural land - the quality of agricultural land in England and Wales is assessed according to a system devised by the Ministry of Agriculture, Fisheries and Food / the Department of Environment, Food and Rural Affairs, revised and published in 1989 and known as the Agricultural Land Classification (ALC). This is the nationally applicable system for land use planning and development control. The top two grades are Grade 1 agricultural land and Grade 2 agricultural land.

Ancient Woodland – land that has been continually wooded since at least 1600 and which has never been cleared or replanted.

Appraisal of Sustainability (AoS) – a HS2 Ltd report which describes how high speed rail would support objectives for sustainable development.

Area of Outstanding Natural Beauty (AONB) – statutory designation intended to conserve and enhance the ecology, natural heritage and landscape value of an area of countryside. AONBs have equivalent status to National Parks and are designated under the *National Parks and Access to the Countryside Act 1949*.

BAA Airports Limited – the owner and operator of Heathrow airport.

Benefit Cost Ratio (BCR) – the net benefit of a scheme divided by the net cost to Government.

Biodiversity Action Plans (BAP) – an internationally recognised program addressing threatened species and habitats, designed to protect and restore biological systems.

Birmingham Interchange Station – interchange station on the HS2 London to West Midlands route which will provide access to Birmingham international railway station, the National Exhibition Centre and Birmingham Airport.

captive fleet – the fleet of trains (rolling stock) that will be designed to run only on the high speed network These trains would not be able to run on the rest of the existing (classic) UK rail network.

Classic compatible trains – a European high speed standard train which can also run on existing UK rail lines, also known as the "classic network".

conservation area – an area of special architectural or historic interest, designated under the *Planning (Listed Buildings and Conservation Areas) Act 1990*, whose character and appearance is desirable to preserve and enhance.

country parks – designated under the *Countryside Act 1968*.

Crossrail – a new east-west railway under central London linking Maidenhead and Heathrow Airport in the west to Shenfield and Abbey Wood in the east.

cut and cover – a method of constructing a section of railway that will eventually sit below the surface. The ground is excavated from above, and a tunnel constructed by building a roof over the top. This can be built upon or restored to its original state afterwards.

Department for Transport (DfT) – Government department responsible for transport policy in the UK.

development partners – location-specific key stakeholders who have been involved on a regular basis in the development and assessment of options, mainly for stations, for the HS2 legs to Leeds, Manchester and Heathrow.

East Coast Main Line (ECML) – an intercity rail route in the UK providing passenger services between London and Edinburgh via Peterborough, Doncaster, Wakefield, Leeds, York, Darlington and Newcastle.

English Heritage – the Government's statutory adviser on the historic environment. Officially known as the Historic Buildings and Monuments Commission for England, English Heritage is an executive non-departmental public body sponsored by the Department for Culture, Media and Sport, with principal powers and responsibilities set out in the National Heritage Act (1983).

Environment Agency – a non-departmental public body whose principal aims are to protect and improve the environment and promote sustainable development. The Environment Agency plays a central role in delivery the environmental priorities of the Government.

Environmental Impact Assessment (EIA) – assessment of the potential environmental impacts of a proposed development or project.

Exceptional Hardship Scheme (EHS) – compensation scheme introduced by the Government in order to assist those living on or close to the proposed route who wish to sell their properties before a final decision is made on the project.

Flood Risk Zone – before considering development, land or property that lies within a Flood Risk Zone needs to be identified. The Environment Agency produces indicative floodplain maps which indicate which areas are at high, medium or low risk of flooding.

grade separated junction – a junction where one or more routes cross other routes at a different level by being raised above or below them. This could apply to either railways or highways.

Grade 1 agricultural land – excellent quality agricultural land with no or very minor limitations to agricultural use.

Grade 2 agricultural land – very good agricultural land, with minor limitations that could affect crop yield, cultivations or harvesting.

Grade I listed building – a listed building of exceptional interest, sometimes considered to be internationally important.

Grade II listed building – nationally important buildings that are of special interest.

Grade II* listed building – a listed building of particular importance, of more than special interest.

Great Western Main Line (GWML) – main line railway that runs westwards from London Paddington station to the west of England and south Wales.

Green Belt – land designated in the UK for controlling urban growth and preventing the coalescence of main urban areas.

green tunnel – where earth is built-up around and over a section of the rail line to reduce its environmental impacts. This is constructed using a cut and cover method.

Habitats Regulation Assessment (HRA) – the Habitats Directive (enacted in the UK through the *Conservation of Species and Habitats Regulations 2010*) requires the competent authority to assess the effects of development on Natura 2000 sites.

High Speed One (HS1) – the Channel Tunnel Rail Link from St Pancras International station to the Channel Tunnel.

High Speed Two Limited (HS2 Ltd) – a company wholly owned by the Department for Transport responsible for developing and promoting HS2 London to West Midlands and preparing proposals for HS2 to Leeds, Manchester and Heathrow.

Historic Battlefields – the English Heritage Register of Historic Battlefields offers protection for English battlefields and promotes a better understanding of their significance.

hybrid bill – public bill initiated by the Government as part of the Parliamentary procedure required for authorising major projects where a large number of private interests may be affected.

inalienable land – the National Trust Acts grants the National Trust the unique statutory power to declare land inalienable. This prevents the land from being sold or mortgaged against the Trust's wishes without special parliamentary procedure.

infrastructure maintenance depot – base for maintenance of infrastructure associated with the proposed high speed rail line, including track, signalling equipment, cuttings and embankments.

listed buildings - a building of special architectural and historic interest brought under the consideration of the planning system by English Heritage. A listed building may not be demolished, extended or altered without special permission (listed building consent) from the local planning authority, who would typically consult English Heritage.

Midland Main Line (MML) - the present-day line links London St. Pancras International to Sheffield in northern England via Luton, Bedford, Kettering, Leicester, Derby, Nottingham and Chesterfield.

National Nature Reserve (NNR) – conservation designation by Natural England. These sites are a selection of the very best parts of England's Sites of Special Scientific Interest.

National parks - areas of relatively undeveloped and scenic landscape designated under the *National Parks and Access to the Countryside Act 1949*.

National Trust - a UK conservation charity protecting historic places and green spaces and opening up for everyone.

Natura 2000 sites – Natura 2000 is the collective terms for special areas of conservation, special protection areas, Ramsar sites and sites of community importance.

Natural England - the Government's advisor on the natural environment who provides practical advice, grounded in science, on how best to safeguard England's natural wealth for the benefit of everyone.

Network Rail – owner and operator who runs, maintains and develop's Britain's rail tracks, signalling, bridges, tunnels, level crossings, viaducts and selected rail stations. Network Rail owns and manages Birmingham New Street station, Leeds station, Liverpool Lime Street station and Manchester Piccadilly station.

pair-wise comparisons – the process of comparing two station options that are in close proximity and in a similar context, or two sections of route that begin and end at the same point but differ in how they get there. Pair-wise comparisons were used by HS2 Ltd throughout the sifting process to develop final options.

personal rapid transit (PRT) system - a system that consists of small light passenger vehicles running on elevated guide ways under computer control.

phase one / phase one route – the phase one route of HS2 between London to West Midlands, due to open in 2026, which will include a link to the West Coast Main Line and HS1. This route was announced by the Secretary of State for Transport in January 2012. Phase one will include new stations at Birmingham interchange and Birmingham Curzon Street, as well as an upgrade of Euston station.

phase two / phase two route – proposed second phase of HS2 which would link West Midlands to Manchester and Leeds, including stations in South Yorkshire and the East Midlands and connections to the West Coast Main Line and East Coast Main Line. Phase two would also include a direct link to Heathrow Airport.

Ramsar site – designated under the *Convention on Wetlands of International Importance*, agreed in Ramsar, Iran in 1971. The Convention covers all aspects of wetland conservation and wise use, recognising wetlands as ecosystems that are extremely important for biodiversity conservation in general and for the well-being of human communities.

Registered Park and Garden – a landscape of note that must be treated with special care.

rolling stock depot – depot used to service and maintain trains operating on the proposed route.

Scheduled Monument – important sites and monuments which have been given legal protection by being placed on a schedule by English Heritage.

sifting – the process used by HS2 Ltd to develop options to meet the remit. Initial options were narrowed down through stages to the final options presented in the report.

Site of Special Scientific Interest (SSSI) – conservation designation denoting an area of particular ecological or geological importance. These areas require protection from damaging development on account of their flora, fauna, geological and/or physiological features.

Special Area of Conservation (SAC) – designated under Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (the EU "Habitats Directive") as areas identified as best representing the range and variety of habitats and (non-bird) species.

spur – a railway line which branches off the main through route.

Strategic Environmental Assessment (SEA) – approach to incorporating and addressing environmental considerations within long-term strategic policies or plans.

The Wildlife Trusts - the largest UK voluntary organisation dedicated to protecting wildlife and wild places.

Transport for London (TfL) – TfL was created in 2000 and is the integrated body responsible for London's transport system.

West Coast Main Line (WCML) – intercity railway route in the UK connecting London, Birmingham, Manchester, Liverpool and Glasgow.

Y network – the proposed national high speed rail network linking London to Birmingham, Manchester and Leeds, and including stops in the East Midlands and South Yorkshire, as well as direct links to the HS1 line and into Heathrow Airport.