



High Speed Rail (West Midlands - Crewe)

Environmental Statement

Volume 5: Technical appendices
Alternatives Report (CT-002-000)



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Department for Transport

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

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1 Introduction

1.1 Background

- 1.1.1 High Speed Two (HS2) is a new high speed railway proposed by the Government to connect major cities in Britain. Stations in London, Birmingham, Leeds, Manchester and East Midlands will be served by high speed trains running at speeds of up to 225mph (360kph). Trains will also run beyond the network to serve destinations including South Yorkshire, Liverpool, Glasgow, Edinburgh, Newcastle and York.
- 1.1.2 HS2 will be built in phases. Phase One comprises the first section of the HS2 rail network of approximately 143 miles (230km) between London and the West Midlands and is planned to become operational in 2026. It was the subject of an Environmental Statement (ES) deposited with the High Speed Rail (London – West Midlands) Bill in 2013. Subsequent ES were deposited with Additional Provisions to that Bill in 2014 and 2015. The High Speed Rail (London – West Midlands) Bill received Royal Assent in February 2017 and initial works on Phase One have commenced.
- 1.1.3 Phase Two of HS2 will extend the line to the north-west and north-east: to Manchester with connections to the West Coast Main Line (WCML) at Crewe and Golborne, and to Leeds with a connection to the East Coast Main Line approaching York, completing what is known as the ‘Y network’.
- 1.1.4 Phase Two will be constructed in two phases:
- Phase 2a (the Proposed Scheme): the western section of Phase Two between the West Midlands and Crewe, comprising approximately 36 miles (58km) of HS2 main line (including the section which would connect with and form the first part of Phase 2b) and two spurs (approximately 4 miles (6km)) south of Crewe that will allow trains to transfer between the HS2 main line and the existing WCML. Construction of the Proposed Scheme will commence in 2020, ahead of the rest of Phase Two, with operation planned to start in 2027, six years earlier than originally planned, bringing more of the benefits of HS2 to the North sooner; and
 - Phase 2b: comprising the remainder of Phase Two, between Crewe (where it would connect with the Proposed Scheme) and Manchester and between the West Midlands and Leeds. Phase 2b will be the subject of a separate hybrid Bill with construction expected to commence in 2023 and operation planned to start by 2033.
- 1.1.5 The Proposed Scheme will connect with Phase One at Fradley, to the north-east of Lichfield, and to the WCML south of Crewe, providing onward services beyond the HS2 network and between the north-west of England and Scotland.

- 1.1.6 The Proposed Scheme has been the subject of an environmental impact assessment (EIA). During the development of the Phase 2a proposals, a working draft EIA Report¹,² was consulted on to help inform the design and assessment of the Proposed Scheme.
- 1.1.7 The findings of the assessment of the Proposed Scheme are reported in an Environmental Statement (the ES), of which this Alternatives Report forms a part. The ES has been deposited alongside a hybrid Bill for Phase 2a, in accordance with the requirements of Parliamentary Standing Order 27A (SO27A)^{3,4}.
- 1.1.8 The Town and Country Planning (Environmental Impact Assessment) Regulations 2017) require an ES to include:
- "A description of the reasonable alternatives (for example in terms of development design, technology, location, size and scale) studied by the developer, which are relevant to the proposed project and its specific characteristics, and an indication of the main reasons for selecting the chosen option, including a comparison of the environmental effects."
- 1.1.9 This report describes the evolution of the Proposed Scheme, summarising its objectives and requirements, and identifies the strategic alternatives, route-wide rail and route corridor alternatives, and alternatives to main elements of the Proposed Scheme which have been studied. In each case it explains why the decisions were made, to pursue one option over another, which ultimately resulted in the Proposed Scheme.
- 1.1.10 The report has been developed for the Proposed Scheme taking into account relevant information included within the Alternatives Report appended to the Phase One ES (November 2013)⁵, a study commissioned by the Department for Transport (DfT) on rail alternatives⁶, consideration of the Phase 2a route corridor alternatives, and Government reports such as the Command Paper (November 2015)⁷ and the Supplement to the HS2 Strategic Case (November 2015)⁸.
- 1.1.11 This ES does not set out the alternatives to the proposed Y network, as they were studied in the Alternatives Report for the Phase One ES published in November 2013. A summary of the strategic alternatives to the proposed Y network is set out in Section 2.1 of this report.

¹ HS2 Ltd., (2016), *West Midlands- Crewe Working Draft Environmental Impact Assessment Report*. Available online at:

<https://www.gov.uk/government/collections/hs2-phase-2a-west-midlands-to-crewe-working-draft-environmental-impact-assessment-report>

² The EIA Directive 2014/52/EU uses the term 'Environmental Impact Assessment Report' (rather than 'Environmental Statement') to describe the documentation that presents the findings of an EIA. At the time of writing the working draft EIA Report HS2 Ltd used the term 'EIA Report' for consistency with this EU Directive. Since the publication of the working draft EIA Report this Directive has been transposed through The Town and Country Planning (Environmental Impact Assessment) Regulations 2017. The updated regulations have maintained the use of 'ES' rather than 'EIA Report', and therefore, ES has been adopted for this suite of documents.

³ House of Commons, (2015), *Standing Order 27A relating to private business (environmental assessment)*, House of Commons.

⁴ House of Lords, (2015), *Standing Orders- Private Business*, House of Lords.

⁵ HS2 Ltd., (2013), *London- West Midlands Environmental Statement – Volume 5 Technical Appendices, Alternatives report (CT-002-000)*. Available online at: <https://www.gov.uk/government/publications/hs2-phase-one-environmental-statement-volume-5-alternatives-report>

⁶ Atkins, (November 2015), *Rail Alternatives to HS2 Phase 2a. A report for the Department for Transport*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/480645/rail-alternatives-to-hs2-phase-2a.pdf

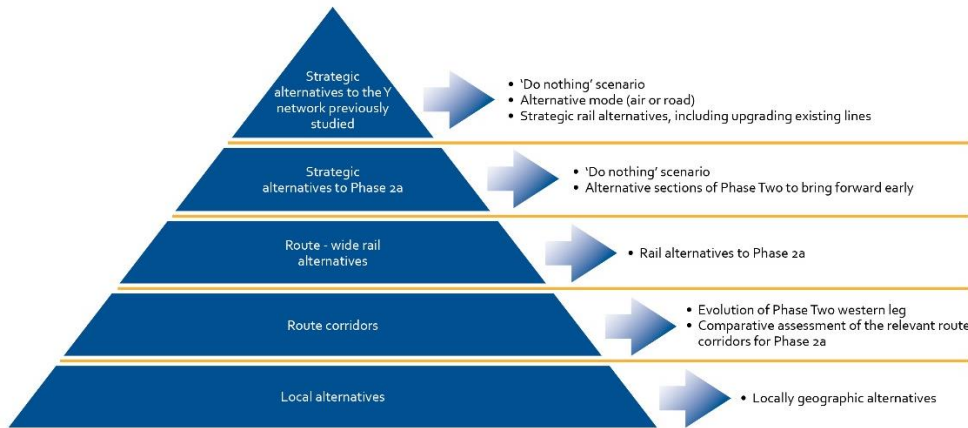
⁷ Department for Transport (DfT), (2015), *High Speed Two: East and West – The next steps to Crewe and beyond. Cm 9157*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/480712/hs2-east-and-west.pdf

⁸ Department for Transport (DfT), (2015), *Supplement to the October 2013 Strategic Case for HS2*. Available online at: <https://www.gov.uk/government/publications/hs2-supplement-to-the-october-2013-strategic-case>

1.2 Structure of this report

1.2.1 The reasonable alternatives studied by Government and HS2 Ltd are set out in accordance with the hierarchy shown in Figure 1.

Figure 1: Hierarchy of reasonable alternatives studied



1.2.2 Part I of this report presents a brief summary of the alternatives to the high speed rail network (the full Y network incorporating Phase One and Phase Two) that were outlined in more detail in the Alternatives Report appended to the Phase One ES published in November 2013.

1.2.3 Part I then discusses the reasonable strategic alternatives to the Proposed Scheme (i.e. Phase 2a only):

- 'do nothing': i.e. do not bring forward the section of high speed route between the West Midlands and Crewe (becoming operational in 2027) and instead develop all of Phase Two at the same time (becoming operational 2033); and
- alternative sections of the Phase Two route to bring forward early: consideration of alternative sections of the Phase Two route that could be brought forward earlier instead of the section between the West Midlands and Crewe (the Proposed Scheme).

1.2.4 It then sets out the rail alternatives to the Proposed Scheme, comprising a combination of a new high speed alignment, new conventional alignment, and use of the existing conventional rail network.

1.2.5 Part II of this report explains chronologically the consideration of the reasonable route corridor alternatives to the Proposed Scheme studied by Government and HS2 Ltd, and the reasoning behind the decisions taken on the proposals presented for public consultation in 2013 and 2014, including a comparison of environmental effects. It also describes the reasonable local alternatives that have been studied both before and after the route announcement in November 2015.

Part I

2 Strategic alternatives

2.1 Strategic alternatives to high speed rail previously studied

- 2.1.1 The Government has concluded that action is needed to meet the future travel needs of Britain and 'doing nothing' is not an option.
- 2.1.2 Before deciding to proceed with HS2, a wide range of options to address Britain's inter-urban transport challenges were reviewed. These included domestic aviation, new motorways, a new conventional speed rail line as well as upgrades to existing roads and railways.
- 2.1.3 The potential for capacity upgrades to the existing main rail network has been explored. The Government rejected this option as further upgrades will not provide the scale of capacity increase and connectivity benefits needed to fulfil the Government's objectives. This would also fail to meet Government objectives for future performance of the rail network and would cause considerable disruption to existing train services during construction.
- 2.1.4 Carbon emissions from air travel are significantly greater than from high speed rail. The capacity of London's airports is limited and providing for future growth in international travel will be a significant challenge without also serving additional demand from domestic air services. The Government's policy therefore is to enable and encourage more people to take the train instead of air for domestic and short-haul journeys, to achieve environmental benefits and to release capacity at airports for longer journeys.
- 2.1.5 The Government also decided not to give further consideration to major new motorways as an alternative to HS2, as high speed rail is preferable in terms of both capacity and journey times and has lower carbon emissions and environmental effects.
- 2.1.6 The cost of a new conventional speed railway would be almost as high as those of high speed rail without delivering the reduced journey times and would have only marginal environmental benefits. For these reasons, a new conventional rail line option was rejected.
- 2.1.7 Prior to the introduction of the Phase One Bill into Parliament in November 2013, the Government considered and reported on alternative configurations of its proposed high speed rail 'Y' network'. The Government's conclusions and its reasons for promoting the Y network were reported both in the Command Paper *High Speed Rail: Investing in Britain's Future*⁹ and in the ES deposited in Parliament alongside the Phase One Bill in accordance with standing orders. The Phase One Bill was enacted in February 2017.

⁹ Department for Transport (DfT), (2012), *High Speed Rail: Investing in Britain's Future – Decisions and Next Steps*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/3648/hs2-decisions-and-next-steps.pdf

2.2 Strategic alternatives to Phase 2a

Doing nothing

2.2.1 The 'do nothing' scenario implies not accelerating delivery of Phase 2a and instead delivering Phase One in 2027 and all of Phase Two in 2033. Delivering to this scenario would still help the Government deliver a range of benefits, building a stronger, more balanced economy that delivers lasting growth and better connects northern cities with faster journeys between London, bringing about widely shared prosperity. However, the Government highlighted in the *HS2 Phase 2a Strategic Outline Business Case: Strategic Case*²⁰, that doing nothing would mean that it would:

"miss the opportunity of realising some of these benefits six years earlier than the opening of the full Phase Two route in 2033. Doing nothing would mean that we did not accelerate delivery of this section of Phase Two, even though it is well developed, could be delivered early, and the costs of acceleration are outweighed by savings and additional revenue. Government believes that if there is a financially positive and affordable option to bring forward a tranche of benefits by six years, that would help rebalance the economy and unlock the growth and regeneration the country badly needs, then it would be perverse not to take it."

2.2.2 Accelerating delivery of Phase 2a will:

- deliver faster journeys between London, Crewe, Manchester, Liverpool, Preston, Warrington, Wigan and Glasgow sooner, by allowing long distance trains to run further on high speed track to Crewe before re-joining the conventional network (as opposed to using the connection to the WCML at Handsacre). Phase 2a will therefore deliver further journey time savings of up to 13 minutes in addition to the journey time savings already delivered by Phase One;
- allow passengers travelling to or from a wide range of places to connect with HS2 services given that Crewe is already a major hub on the rail network with regional and long distance connections to the wider North West, East Midlands, and North and South Wales;
- mean that the North West and Scotland will see more of the benefits of HS2 more quickly, thus bringing economic benefits sooner, helping to rebalance the economy. Some of these economic benefits will come from businesses being more accessible to one another as well as offering improved accessibility to labour markets, and affecting the overall level of labour supply; and
- relieve pressure on bottlenecks on the existing WCML at Colwich Junction and around Stafford, which will improve the reliability and performance on the existing main line.

²⁰ Department for Transport (DfT), (2015), *HS2 Phase 2a Strategic Outline Business Case: Strategic Case*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/570472/hs2-phase-2a-strategic-case.pdf

Alternatives to bringing forward the section of Phase Two between the West Midlands and Crewe (the Proposed Scheme)

- 2.2.3 The Government considered whether there were alternative sections of Phase Two that could be brought forward to become operational in 2027. Alternative sections to the Proposed Scheme (the section of Phase Two between the West Midlands and Crewe) that were studied are as follows:
- between Sheffield and Leeds;
 - the western leg between the West Midlands and Manchester; and
 - between Birmingham and the East Midlands.
- 2.2.4 The following criteria were used to determine which alternative sections of Phase Two could be brought forward:
- connectivity to Phase One;
 - delivery of clear connectivity and journey time benefits;
 - readiness of the design; and
 - ability to accelerate delivery to complete by 2027.
- 2.2.5 The Proposed Scheme has a number of advantages over other sections of Phase Two as a standalone scheme. It connects directly with Phase One allowing high speed trains to run on to Crewe from London on a dedicated high speed network. Additional rolling stock (over that used for Phase One) is not required. It improves journey times between London and the key markets of Manchester and the North West and has the potential to relieve some pressure on bottlenecks of the WCML, and to improve reliability and performance. By connecting to the conventional rail network at Crewe, the Proposed Scheme can also benefit from the existing rail connectivity at Crewe. It does not pass through any major urban areas, nor require the delivery of new stations, meaning that it can be developed and built relatively quickly.
- 2.2.6 The main reason for not proceeding with the three alternatives are as follows:
- section of Phase Two between Sheffield and Leeds: this section of the route is more complex than the Proposed Scheme as it involves the construction of new stations. Work was also underway to establish an appropriate solution to connect Sheffield and Leeds with plans for enhanced rail infrastructure in the North as part of the Northern Powerhouse Strategy and Northern Powerhouse Rail. Given the complexities of this section of route and the ongoing work required, the Government was not confident that this could be delivered to the required standards as quickly as the route between the West Midlands and Crewe which is more straightforward in engineering terms as it does not include any new stations;
 - the western leg all the way to Manchester and the WCML link at Golborne: the section of route north of Crewe to Manchester is more complex than the Proposed Scheme. It travels through an area of complex geology; potentially

included new stations and junctions¹¹; and would have required further consideration regarding links with Northern Powerhouse Rail. Further work was also required to develop a scheme that best complements the growth and development plans of Manchester. Work was also required on the Golborne link to the WCML and the proposed depot at Golborne¹². Therefore, it was concluded that these route sections could not be designed and built in time to open by 2027, unlike the section of the route between the West Midlands and Crewe;

- between Birmingham and the East Midlands: construction of this part of Phase Two is not as straightforward as the Proposed Scheme. The location and design of the route and a hub station have also been subject to further work in order to ensure that HS2 delivers the greatest benefits possible to the East Midlands. This included exploring alternative sites for an East Midlands hub station. Although all of this further work has concluded, options which may have enabled delivery of the route by 2027 could not have been developed in the time available. In addition, it would be easier to achieve good connectivity at Crewe, than it would be for an East Midlands hub, as Crewe is already well connected to the conventional rail network. Accelerating delivery of the section of route to the East Midlands would also require additional rolling stock and more trains to be run out of Euston. This could be difficult to achieve in 2027 with the proposed phased development of Euston Station.

2.2.7 As the complexities of these options would not allow for delivery of the route by 2027, they were not considered reasonable alternatives or taken any further. Consequently the section of Phase Two route between West Midlands and Crewe was taken forward.

¹¹ Since consideration of these alternatives, it has now been concluded that new stations and junctions will be required on this section of the Phase Two route.

¹² Since consideration of these alternatives, a depot at Golborne no longer forms part of the Phase Two route.

3 Route-wide rail alternatives

3.1 Rail alternatives to the Proposed Scheme

Background

3.1.1 The DfT commissioned Atkins in May 2015 to design and assess potential alternatives to building HS2 Phase 2a³³. These alternative options sought to improve journey times and capacity specifically between the northern end of HS2 Phase One and Crewe as an alternative to Phase 2a. The remit excluded the development and analysis of options that provided:

- alternative high speed alignments for Phase 2a, as this was examined by HS2 Ltd as part of their own consulted option development work;
- improvements to routes north of Crewe or to any routes not serving Crewe, as this would not provide a comparable alternative to Phase 2a;
- opening Phase 2a at a different date, as DfT do not consider this to be a sufficiently different alternative from the core Phase 2a proposal; and
- doing nothing, as this option has been separately analysed by HS2 Ltd.

3.1.2 The DfT specified that any rail alternative to Phase 2a had to be capable of delivering the HS2 programme wide objectives as set out in the 2013 HS2 Strategic Case. These are to:

- provide sufficient capacity to meet long term demand, and to improve resilience and reliability across the network; and
- improve connectivity by delivering better journey times and making travel easier.

3.1.3 To be consistent with the HS2 Strategic Case, any solutions should:

- minimise disruption to the existing network;
- use proven technology that can deliver the desired results;
- be affordable and represent good value to the tax payer; and
- minimise impacts on local communities and the environment.

3.1.4 Further to this, the DfT specified that any rail based alternative to HS2 Phase 2a also needed to meet the following Phase 2a specific objectives:

- improve connectivity and journey times for cities north of Birmingham;
- deliver benefits to northern cities earlier than originally planned under HS2 Phase Two; and

³³ Atkins, (2015), *Rail Alternatives to HS2 Phase 2a. A report for the Department for Transport*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/480645/rail-alternatives-to-hs2-phase-2a.pdf

- enable the efficient delivery of the remainder of HS2 Phase Two.

3.1.5 To meet both these network wide and Phase 2a specific objectives, the DfT specified that any Phase 2a rail alternatives must be capable of delivering:

- the Phase 2a train service specification;
- a similar level of capacity to Phase 2a; and
- an environmental impact that was no worse than Phase 2a.

3.1.6 DfT asked Atkins to develop three alternative options for assessing against HS2 Phase 2a. Within the scope of the remit above, the three shortlisted options were required to represent as wide a range of costs and solutions as possible. The DfT remitted that each option should be analysed against an agreed set of criteria in order that the alternative options could then be compared to Phase 2a. These were as follows:

- economic objective: assessing the Benefit Cost Ratio (BCR) for each option using an appraisal approach consistent with the appraisal of HS2 Phase 2a;
- capacity objective: assessing the potential route capacity each option can deliver both for high speed services, and residual classic line services, including freight; and
- supplementary objectives: assessing the level of disruption to rail services during construction, assessing the operational performance, and undertaking a high level assessment of the environmental impact of each option.

3.1.7 Each alternative option was required to be assessed against these objectives under two different network scenarios. Both of these scenarios are consistent with the way HS2 Ltd has assessed Phase 2a:

- full Y Scenario: the alternative option forms a permanent part of the long term full Y network. In this scenario the alternative option opens in 2027, between Handsacre and Crewe. From 2027 to 2033 high speed services run on the WCML north of Crewe, but from 2033 with the opening of the rest of Phase Two between Crewe and Manchester, the alternative option operates as an integral part of the full Y network.
- Crewe Standalone Scenario: the alternative option is assessed on the basis that the full Y high speed network north of Crewe is not constructed. In this scenario, the alternative opens in 2027, with high speed services using the WCML north of Crewe thereafter. This allows an appraisal of the alternative option to be undertaken as a pure increment to Phase One, with only the costs and benefits of the alternative itself captured.

Alternatives studied

Background

3.1.8 To design alternative options to Phase 2a, Atkins began by developing a long list of options that all tried, to various degrees, to overcome capacity and journey time limitations on the WCML. All of these long list options required constructing some sections of new alignment away from existing rail corridors, in order to bypass the

most constrained sections of the WCML through Colwich Junction and Stafford. Many of the routes for these sections of new alignment were either developed from proposals originally considered as part of the West Coast Route Modernisation (WCRM) delivered in 2009, or by using elements of the proposed HS2 Phase 2a alignment. Extensively upgrading the existing route entirely within the existing rail boundaries was not considered a feasible option, as the nature of the existing alignment would likely make it very difficult and costly to develop suitable alternatives that could deliver the necessary improvements to capacity and journey times, as well as avoiding disrupting existing services during construction.

- 3.1.9 Some high level analysis of the journey times, costs and capacity of the long list options was undertaken to help discard options with either low benefits and high costs, or which could not be expected to provide enough capacity to robustly support the indicative HS2 service pattern proposed to run under the Full Y. Through workshops with the DfT, Network Rail and HS2 Ltd, the long list of high level options was sifted to a shortlist of three options for further development and analysis.
- 3.1.10 The shortlisted options were deliberately chosen to provide a wide range of costs. As such they represent a range of approaches to meeting the criteria set out in the remit, and offer different cost solutions involving new high speed track, new conventional track or a combination of both.

High Cost Alternative Option: 44km of new high speed alignment

- 3.1.11 The high cost alternative option would involve constructing roughly two-thirds (44km) of the Phase 2a high speed alignment as proposed by HS2 Ltd, from Streethay Junction to a point near the village of Baldwin's Gate. At this point the Phase 2a alignment comes within less than 1km of the WCML, which provides a four track railway all the way to Crewe. An additional length of high speed alignment would link the Phase 2a route to the WCML fast lines (which run to the east of the slow lines at this point) via a flat junction.
- 3.1.12 The key elements of this option can be summarised as follows:
- 42.5km of HS2 Phase 2a alignment (from Streethay Junction to near Baldwin's Gate);
 - 1.4km of new alignment to WCML, including one small bridge crossing a minor brook;
 - new flat junction onto WCML fast lines near Baldwin's Gate, which would also need to facilitate parallel movements from the fast to the slow lines on the WCML; and
 - 18.3km running on existing WCML from Baldwin's Gate to Crewe – this section has the potential to allow 201kph (125mph) running, and under normal operation, to allocate HS2 services exclusively to the fast lines.

Low Cost Alternative Option: 18km of new conventional speed alignment

- 3.1.13 The low cost option was originally developed by the WCRM Team for inclusion in the WCRM programme delivered between 2000 and 2009. This option deliberately limited

the design of the new alignment to 225kph (140mph) in order to provide a relatively low cost option that operates at conventional line speeds.

3.1.14 This option was designed to bypass the capacity constraints of Colwich Junction, the two track section through Shugborough Tunnel, and the flat junctions immediately to the north of Shugborough Tunnel and at Stafford, as well as the speed restrictions known as the "Stafford wheel" curve.

3.1.15 The key elements of this option can be summarised as follows:

- 6.8km of new 225kph (140mph) alignment from Rugeley to Hixon;
- upgrade of 6.5km of existing WCML line between Hixon and Sandon to 225kph (140mph);
- 10.8km of new 225kph (140mph) alignment from Sandon to WCML near Norton Bridge. Key features would include:
 - crossing of the Trent and Mersey Canal and the River Trent;
 - three major bridges crossing the A34 dual carriageway, the M6 and the existing railway line between Norton Bridge and Stone; and
 - four small bridges crossing minor roads.
- a total of three new flat junctions at Hixon, Sandon and Norton Bridge, and one new grade separated junction at Colwich; and
- 26.1km running on existing WCML from Norton Bridge to Crewe – this section has the potential to allow 201kph (125mph) running and, under normal operation, to allocate HS2 services exclusively to the fast lines.

Medium Cost Alternative Option: 15km of new high speed and 11km of new conventional speed alignment

3.1.16 This medium cost alternative option was similar to the low cost option. However, rather than using new conventional speed alignment to bypass Colwich, it used roughly one third of the HS2 Phase 2a high speed alignment from Streethay Junction to a point near Moreton Farm. From this point an additional 5km of high speed alignment would be built to join the WCML Stone line via a flat junction near the site of the former level crossing at Hixon, approximately 15km from Streethay Junction.

3.1.17 From this point north the design was the same as the low cost option. The Stone Line would have been upgraded to 225kph (140mph), and a new conventional 225kph (140mph) line would have been built to link the Stone line to the WCML Crewe route just north of Norton Bridge.

3.1.18 The key elements of this option can be summarised as follows:

- 15.2km of Phase 2a alignment from Streethay Junction to Great Haywood;
- 4.8km of high speed alignment from Great Haywood to existing Stone line at Hixon, including three small bridges crossing minor roads and tracks;

- upgrade of 6.5km section of Stone line between Hixon and Sandon to 225kph (140mph);
- 10.8km of new 225kph (140mph) alignment to WCML near Norton Bridge, including:
 - a major crossing of the Trent and Mersey Canal and the River Trent;
 - three major bridges crossing the A34 dual carriageway, M6 and the existing railway line between Norton Bridge and Stone; and
 - four bridges crossing minor roads;
- 26.1km running on existing WCML from Norton Bridge to Crewe – this section has the potential to allow 201kph (125mph) running, and under normal operation, to allocate HS2 services exclusively to the fast lines; and
- three flat junctions.

Appraisal of alternatives

- 3.1.19 The findings of this appraisal are outlined in the following sections, assuming the full Y network is constructed.

Low cost and medium cost options

- 3.1.20 The Atkins report concluded that when considered as part of the full Y network the low and medium cost options do not provide the journey time improvements of the Proposed Scheme and therefore fail to deliver the same level of wider economic benefit. Both options have marginally lower BCRs compared to the Proposed Scheme.
- 3.1.21 Both these options use sections of the existing WCML. Given this, these options would have reduced spare capacity on the conventional rail network which would result from the Proposed Scheme and this will also potentially constrain future growth on the WCML and would also offer less network resilience in times of major disruption by reducing the number of alternative routes. Some conventional rail services could impact HS2 services and vice versa.
- 3.1.22 In addition, the low cost option could also cause visual and noise impacts associated with the grade separated junction near Rugeley and Colton, would bring the route close to Cannock Chase, and would possibly require overhead power lines to the north of Colwich to be realigned.
- 3.1.23 The proposed alignments of the low and medium cost options would have run approximately 1km to the north of the Pasturefields Salt Marsh Special Area of Conservation (SAC) and Site of Special Scientific Interest (SSSI). Although these alignments were considered some time ago as part of the WCRM programme, more recent work by HS2 Ltd with the Environment Agency and Natural England showed that effects on the Pasturefields SAC and SSSI could not be ruled out due to complex hydrological issues. This is because research suggested that there was a possibility that the salt marsh could be fed by brine flows located to the north of the site. There was therefore a risk that construction works associated with proposed routes to the north of Pasturefields SAC and SSSI could have interfered with groundwater flows that feed the salt marsh, which could have caused adverse effects on the site. This led

HS2 Ltd to reject potential routes to the north of Pasturefields SAC and SSSI in advice to Government because of the high risk associated with ensuring compliance with the Habitats Directive¹⁴. HS2 Ltd, the Environment Agency and Natural England are in agreement with this approach.

- 3.1.24 Given the factors outlined above, the low and medium cost options do not meet the strategic objectives of HS2. Therefore, they were not taken any further.

High cost option

- 3.1.25 The high cost option fails to deliver the same wider economic benefits and has lower journey time improvements compared to the Proposed Scheme, although it has a similar BCR.
- 3.1.26 If HS2 services are able to operate on straight sections of the WCML between Baldwin's Gate and Crewe at enhanced permissible speed of 201kph (125mph), then there is the potential for this journey time differential to the Proposed Scheme to reduce to approximately two minutes. This would increase the benefits and revenues of this option. Increasing the line speeds to 225kph (140mph) is likely to require much greater level of investment and additional costs but would also offer time savings and benefits.
- 3.1.27 If the objective was solely to provide improved journey times to Crewe, the high cost option could have been worth further consideration. However, there are other strategic objectives that need to be met by the route between Handsacre and Crewe.
- 3.1.28 This option fails to deliver the same performance and resilience benefits of the Proposed Scheme, putting further pressure on the WCML. Although the performance of high speed services under this option would be very similar to the Proposed Scheme, the remaining conventional line residual services operating on the slow lines are likely to be worse than under the Proposed Scheme. The reliability of residual passenger and freight services operating on the slow lines is likely to be lower than under the Proposed Scheme due to the higher utilisation of these lines. Compared to the Proposed Scheme, the option also offers less overall network resilience during periods of major disruptions or maintenance, as there are fewer alternative routes to divert services onto. The Proposed Scheme also provides more capacity than the high cost option, allowing more easily for future growth.
- 3.1.29 A high level assessment of the environmental impact suggests that the high cost option is likely to have a lower environmental impact than the Proposed Scheme. However, taking account of the considerations above, it has been determined that the high cost option does not meet the strategic objectives of HS2. Therefore, this option has not been taken any further.

¹⁴ Official Journal of the European Union, *Directive 92/43/EEC of 21 May 1992 on the Conservation of natural habitats and of wild fauna and flora.*

Conclusions

- 3.1.30 All three of the shortlisted alternative options provide an operable alternative to Phase 2a, either as a standalone scheme or as part of the Full Y network. However, the Government concluded¹⁵ that the alternative options:
- “ do not provide the same level of connectivity benefits for the major cities of the Midlands and the North due to lower journey time improvements;
 - do not provide as much additional capacity to meet the long term needs for the north-south railway as Phase 2a;
 - do not provide as much additional released capacity for commuters and freight on the WCML as Phase 2a, limiting the potential of the WCML to cope with increases in demand;
 - offer a less robust solution to the problem of resilience and performance, particularly on the WCML which suffers from relatively high levels of unreliability;
 - could have a greater impact on services on existing lines as construction work is carried out (the low and medium cost options only); and
 - might be worth considering if the objective was only to improve journey times to Crewe, but do not provide as good a step towards the full HS2 network.”
- 3.1.31 As these alternatives did not meet the strategic objectives of HS2, they were not taken forward. Consequently, Phase 2a emerged as the preferred scheme as it best meets the objectives of HS2.

¹⁵Department for Transport (DfT), (2015), *HS2 Phase 2a Strategic Outline Business Case: Strategic Case*. Pp36. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/570472/hs2-phase-2a-strategic-case.pdf

Part II

4 Route corridor alternatives

4.1 Background

Route development

- 4.1.1 Part II of this report describes the development of the Phase Two route since autumn 2010.
- 4.1.2 This section describes the evolution of the western leg of HS2 and the reasonable route corridor alternatives that were studied.
- 4.1.3 Consideration of sustainability (including environmental impacts) has been integral to the scheme throughout the appraisal process. Since the initial option development, HS2 Ltd has continued to develop route and station proposals that seek to minimise environmental and community impacts within the engineering and financial constraints of the scheme development.
- 4.1.4 The proposed routes presented for public consultation in July 2013, and post-consultation in 2015 as part of the refined preferred route to Crewe, have emerged from many thousands of kilometres of appraised options. The preferred route is now considered overall to best meet objectives for passenger demand, cost, ease of construction, journey time and sustainability.

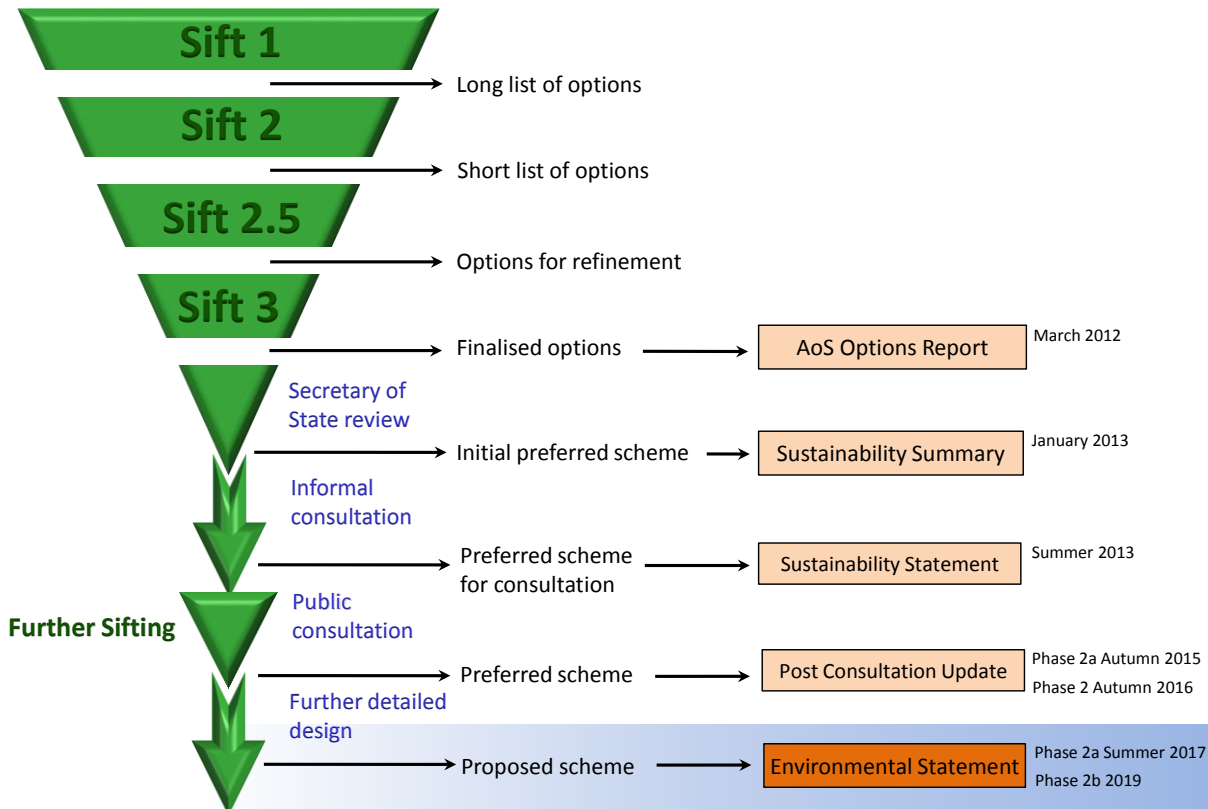
Sifting of options

- 4.1.5 The scheme has evolved through a refinement process resulting in the development of the preferred scheme. This process is referred to as sifting. The sifting process consisted of a sequentially more detailed appraisal of route options. At the end of each appraisal stage or sift, sustainability performance was formally studied alongside other cost, operational and engineering information by HS2 Ltd, who identified preferred options for progression to the next level of design. The selected options then entered the next sift for more detailed appraisal.
- 4.1.6 As part of the consideration of sustainability performance, the following environmental factors were considered: climatic factors and adaptability; greenhouse gases; landscape; townscape and cultural heritage; biodiversity and geodiversity; water resources; flood risk; air quality; noise and vibration; community integrity; accessibility; health and well-being; security and safety; economic prosperity; economic welfare; soil and land resources; waste generation; and resource use.
- 4.1.7 A summary of the sifting process and outputs is shown in Figure 2. The process started with a long list of potential options which were subject to appraisal against the initial sift criteria. The sequence of subsequent sifts aimed at reducing the number of options under consideration (e.g. by avoiding centres of population and/or key environmental features). In the later sifts, the predicted impacts of the remaining options were further mitigated by refining the vertical and/or horizontal alignments and by introducing certain structures such as 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.

- 4.1.8 At the time of publication of the Sustainability Statement in 2013, more than 1,000 route sections (over 16,000km of route) had been sifted, and over 250 potential station and depot locations reviewed. Since then, further route sections have been appraised as part of the post consultation refinements process, covering a further 9,000km of possible options.

Figure 2: The sifting process



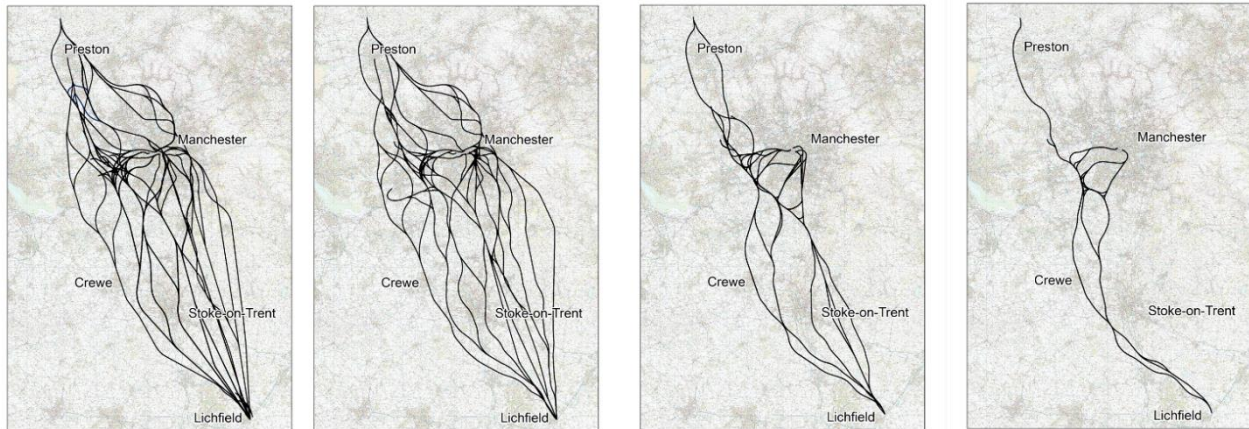
Appraisal of Sustainability options report (March 2012)

- 4.1.9 Following the announcement of the Government's preference for a Y-shaped high speed rail configuration, further work was undertaken to investigate various route, station and depot options that could deliver the western and eastern legs of the network (i.e. the Phase Two scheme). A process of sifting was utilised to refine a long list of options and route combinations, as shown in Figure 3.
- 4.1.10 The Appraisal of Sustainability (AoS) options report¹⁶ describes the output from the initial sifting process and describes the performance of those options that were considered to best meet HS2 Ltd's remit¹⁷. The report focused on 42 separate route sections for the western leg and 32 for the eastern leg, which could be used to create

¹⁶ HS2 Ltd., (March 2012), *Options for Phase 2 of the high speed network – Appraisal of Sustainability*. Available online at: <https://www.gov.uk/government/publications/options-for-phase-two-of-the-high-speed-rail-network-appraisal-of-sustainability>
¹⁷ DfT. (March 2010), *Remit for HS2 Ltd – letter from the Secretary of State to the Chairman of HS2 Ltd*. Available online at <http://assets.hs2.org.uk/sites/default/files/inserts/HS2%20Ltd%20remit%20170310.pdf>

up to 144 and 112 possible route combinations for the Manchester and Leeds legs respectively. The 74 route sections presented in the report had been sifted down from several hundred through the earlier route optioneering process described above.

Figure 3: The evolution of the options for the western leg



- 4.1.11 The report did not make any recommendation as to a preferred route option but provided information on the sustainability performance of different possible route options between common node points on a comparable basis to help Government identify a single initial Phase Two scheme.
- 4.1.12 Following the submission of advice to Government, the Secretary of State met with council leaders to discuss station options for the western leg, and separately visited areas potentially affected by the proposals.
- 4.1.13 This led to further refinement and route development. A number of design reviews were undertaken by HS2 Ltd to consider whether improvements could be made in terms of cost, simplification of construction and sustainability, often prompted by requests from the Secretary of State following the informal engagement. From these design reviews, alternatives to route sections emerged and were subject to a further level of appraisal. A similar exercise was undertaken for the eastern leg. Following this work, the Government selected its initial Phase Two scheme and outlined this in the Sustainability Summary¹⁸.

Sustainability Summary (January 2013)

- 4.1.14 The Sustainability Summary published in January 2013 described the potential impacts of the initial preferred Phase Two scheme on people and the environment. It presented the findings of the ongoing AoS work at that point in time.
- 4.1.15 The western leg of the initial preferred Phase Two scheme would ultimately connect with the WCML at two locations (Crewe and Golborne). It would include a terminus station in Manchester city centre as well as a further station at Manchester Airport. An Infrastructure Maintenance Depot at Crewe and Rolling Stock Depot near Golborne were also identified as being required¹⁹. The eastern leg is also described.

¹⁸ Temple-ERM, (January 2013), *HS2 Phase Two Initial Preferred Scheme Sustainability Summary*.

¹⁹ The maintenance facilities at Crewe have been relocated near to Stone in the form of an infrastructure maintenance base- rail. The depot at Golborne no longer forms part of the Phase Two route.

- 4.1.16 Following publication of the initial preferred Phase Two scheme in January 2013, engagement took place with a number of key stakeholders and MPs, particularly those potentially affected by the route. As a result, a small number of further refinements were made to the route. These refinements culminated in the development of the proposed Phase Two route for consultation, as described in the Sustainability Statement which was published in July 2013.

Sustainability Statement (July 2013)

- 4.1.17 The Sustainability Statement was prepared to assist with public consultation by explaining the potential sustainability benefits and adverse impacts of the proposals and alternatives studied, as well as to explain how sustainability has helped support the Phase Two scheme selection and design process.
- 4.1.18 The public consultation ran from July 2013 to January 2014, with a series of consultation events providing an opportunity for engagement with local communities, stakeholders and statutory bodies running between October 2013 and January 2014.

Sustainability Report Post Consultation Update: West Midlands to Crewe (2015)

- 4.1.19 In response to the feedback received during consultation and as a result of the experience gained from Phase One, HS2 Ltd investigated a number of areas for possible modifications to the scheme. Further scheme revisions were driven by an initiative to improve the technical performance of the design and to consider cost efficiencies.
- 4.1.20 In support of the emerging Phase One scheme proposals, HS2 Ltd prepared a series of updated standards that the design of both Phase One and Phase Two were required to meet. The requirements, which reflected developing industry best practice, aimed to ensure that HS2 is designed and built for optimal passenger comfort, as well as long-term operational considerations such as maintainability, safety and durability. The requirements are principally concerned with the camber and gradient of the track alignment, as well as the structural clearance over or under roads, other railways, watercourses and floodplains.
- 4.1.21 An independent report²⁰ of the consultation process and a summary of the issues raised were published alongside the decision document²¹. Options were developed to address the issues that were raised during consultation. These were then reappraised and those that were feasible when considered alongside other scheme requirements were progressed.
- 4.1.22 In addition other minor scheme revisions arose from route 'stitching' changes from consultation and design requirements which focused on different geographical areas.

²⁰ HS2 Ltd., (2016), *High Speed Two Phase 2b Crewe to Manchester, West Midlands to Leeds Response to HS2 Phase Two Consultation: Appraisal of Sustainability (Question 7)*. Available online at:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/481570/Response_to_HS2_Phase_Two_consultation_-_Appraisal_of_Sustainability.pdf

²¹ Ipsos MORI, (2014), *High Speed Rail: Investing in Britain's future. Consultation on the route from the West Midlands to Manchester, Leeds and beyond*. Available online at:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/480397/P2LoR_Ipsos_MORI_FINAL_REPORT.pdf.pdf

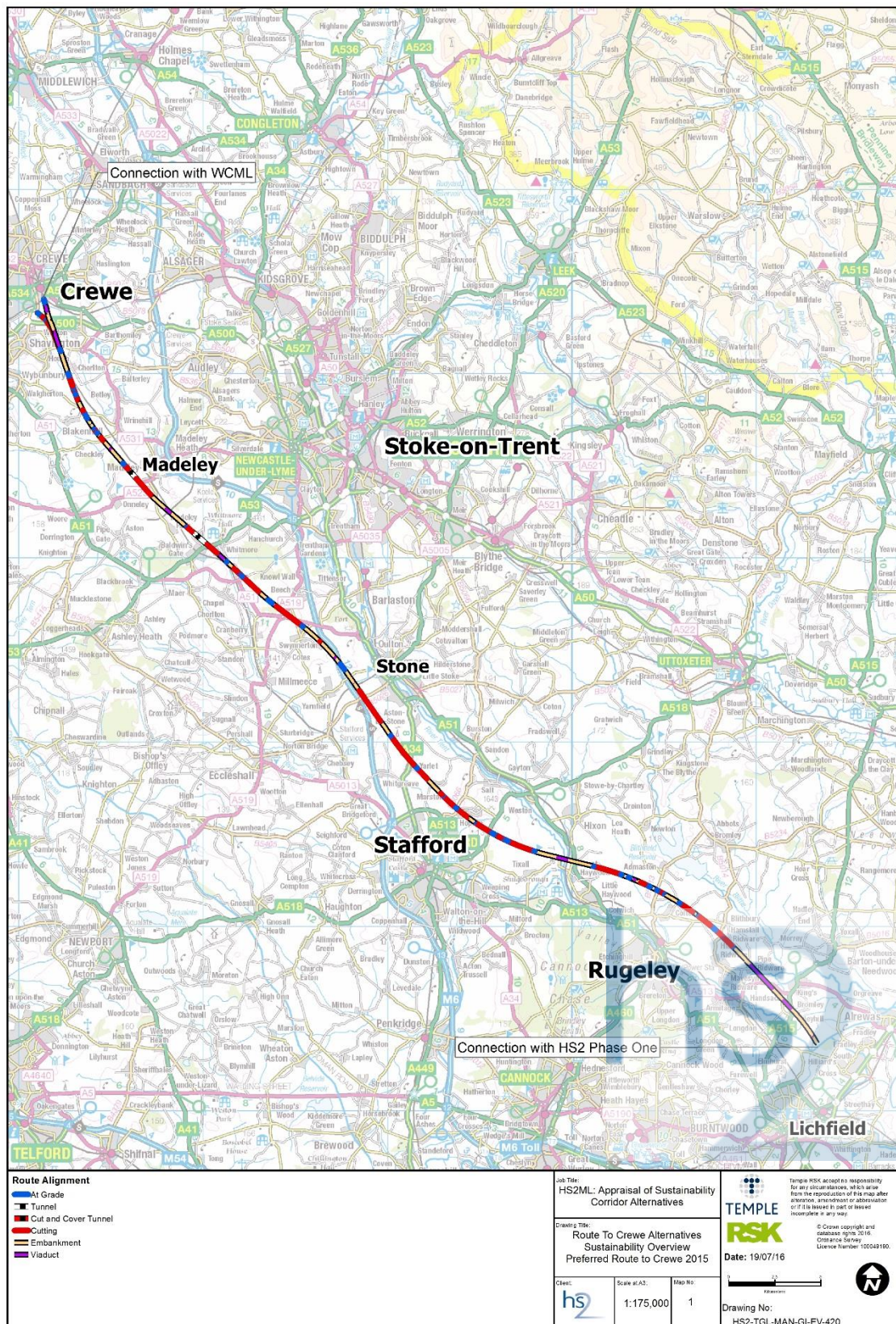
This meant that other small changes were necessary to re-join these areas into adjacent route sections to form a coherent whole scheme.

- 4.1.23 In March 2014, Sir David Higgins²², the Chairman of HS2 Ltd, recommended bringing forward development of the Phase Two route between the West Midlands and Crewe by 2027.
- 4.1.24 In November 2014 the Government published a consultation document on safeguarding the route between Fradley and Crewe. In November 2015 it published its response to the consultation, along with safeguarding directions for a 120 metre wide corridor of land to protect this part of the route from conflicting development.
- 4.1.25 In November 2015, the Government, having studied a number of options for accelerating the development of part of the route, announced its intention to bring forward the construction of the section of route connecting the West Midlands to Crewe, known as the preferred route to Crewe, shown in Figure 4. An updated Sustainability Report²³ was published documenting the post-consultation changes to the Phase Two section of route between the West Midlands and Crewe – referred to as the preferred route to Crewe.

²² HS2 Ltd., (2014), *HS2 Plus – A report by David Higgins*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/374695/HS2_Plus_-_A_report_by_David_Higgins.pdf

²³ Temple-RSK, (2015), *Sustainability Report – Phase Two Post-Consultation Update: West Midlands to Crewe*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/480667/Sustainability_Report_Phase_Two_Post-Consultation_Update_West_Midlands_Crewe.pdf

Figure 4: The preferred route to Crewe



4.2 Establishment of the Proposed Scheme via Crewe

Background

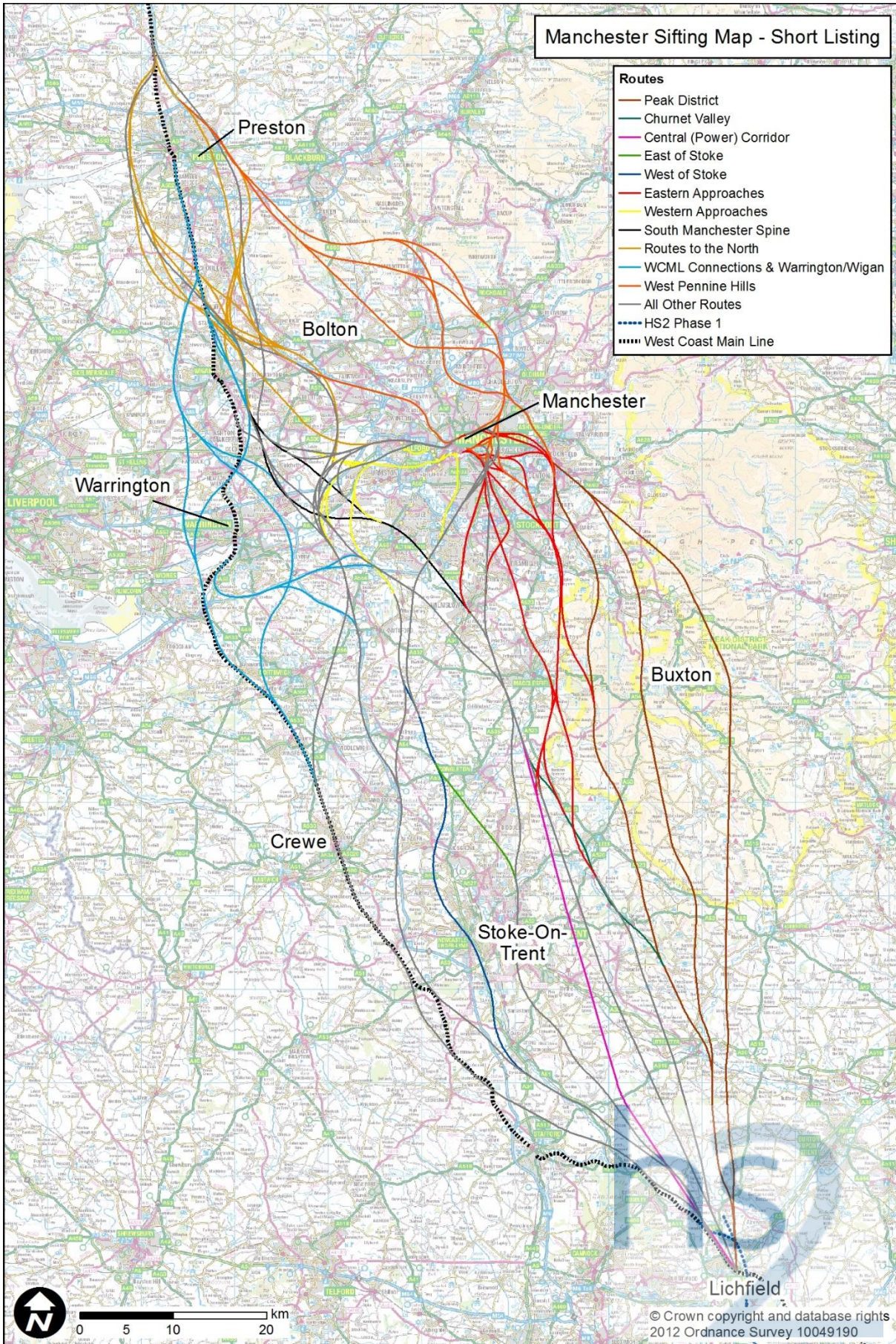
- 4.2.1 Prior to the announcement of the Consultation Route in July of 2013, the route optioning for the western leg of Phase Two was focused on establishing a preferred corridor from the West Midlands (and a connection with Phase One near Lichfield) through to Manchester.
- 4.2.2 By early 2013, an initial preferred route to Manchester via Crewe had emerged as the best overall proposition, although alternative corridors via Stoke and further to the east were also considered. The easterly corridors were largely discounted due to a combination of sustainability, cost and engineering considerations.
- 4.2.3 Following the announcement in 2014 that recommended bringing forward the development of the Phase Two route from the West Midlands through to Crewe, the 2013 Consultation Route, which included the section to Crewe, underwent a period of further refinement. An updated Sustainability Statement was published in 2015, which focused on the now established, preferred route to Crewe.
- 4.2.4 The following sections summarise the initial optioning process, starting with the short and long listing of route corridors from the West Midlands to Manchester, and progressing to the evolution of the route to Crewe and associated alternatives.

Manchester routes – short listing options

Introduction

- 4.2.5 The initial short listing of route options to Manchester was broken down into 11 groups, based on the geography and functionality offered. Each group contained a number of individual route sections that could be aggregated together in a variety of combinations to form longer routes. These are outlined in the following sections, together with the reasons why they were not progressed further. Within each group individual route options were either recommended for further refinement, or discounted on the basis of sustainability, cost, engineering and/or operational concerns. At each phase new options were also considered within the groups as the understanding of the key constraints increased and viable solutions increased.

Figure 5: Manchester routes short-listing options



Peak District group

- 4.2.6 The group comprised three routes (at the most easterly part of the route corridor) connecting Lichfield with Dunkinfield, south-east of Manchester. The group would have had a direct impact on the Peak District National Park, which would have been crossed for a substantial distance by all three routes. Opportunities for mitigation would have been limited and to avoid the National Park would have required a section of tunnel of at least 20km in length. The northern half of the group would have had a direct impact on: one Grade II* registered park and garden (Lyme Park); 14 SSSIs; one Special Protection Area (Peak District Moors – South Pennine Moors Phase 1); two SACs (South Pennine Moors, Peak District Dales); and over 20 Grade II listed structures. The southern half of the group would have had significant landscape and visual impacts. No corridors were progressed for further refinement from the Peak District group.

Churnet Valley group

- 4.2.7 The group connected east of Cheadle with Macclesfield. It would have had a direct impact on three SSSI (Churnet Valley, Dimmings Dale and Ranger). The group would have required a large viaduct to cross the Churnet Valley SSSI, resulting in significant landscape and visual impacts. Opportunities for mitigation would have been limited. One corridor was progressed for further refinement from the Churnet Valley group.

Central (Power) corridor group

- 4.2.8 The corridor comprised one route which connected Lichfield with south of Macclesfield. The corridor would have crossed one Ramsar site (Midland Meres and Mosses Phase 1); one SAC (West Midlands Mosses); one SSSI and National Nature Reserve (NNR) (Chartley Moss); and would have had a direct impact on two scheduled monuments (Blithewood Moated Site and Paynsley Hall Moated Site). The southern half of the route would have had significant landscape and visual impacts. This corridor was progressed for further refinement from the Central group.

East of Stoke group

- 4.2.9 The group comprised a single corridor connecting the north-east side of Stoke-on-Trent with Brereton Heath, just west of Congleton. This group would have required a high number of residential property demolitions, mainly at Biddulph and Norton Green. The group would have had a direct impact on one SSSI (Roe Park Woods) and an indirect impact on six SSSIs (Bagmere, Brookhouses Moss, Ford Green Reedbed, Gannister Quarry, Holly Banks, River Dane); and two Ramsar sites (Midland Meres and Mosses Phase 1 and 2). This corridor was progressed for further refinement.

West of Stoke group

- 4.2.10 The group comprised a single corridor connecting north of Stone with Over Peover, passing partly in tunnel west of Stoke-on-Trent. The group would have required a comparatively high number of residential property demolitions and a significant number of properties would have experienced noise impacts; particularly at Stone and Stoke-on-Trent. The group would have required six crossings of, and had a potential impact on, the River Trent (a major river) and would have crossed the Trent and Mersey Canal. It would have also had a direct impact on one SSSI (River Dane); two

Grade II registered parks and gardens (Rode Hall, Peover Hall); and an indirect impact on three scheduled monuments; five Grade II* listed structures; and one Grade II* registered park and garden (Trentham Gardens). No corridors were progressed for further refinement from the West of Stoke Group.

Eastern approaches group

- 4.2.11 The group comprised a number of approaches connecting core route options at Macclesfield with stations in east Manchester. Some of the approaches split to the north to connect with city centre station options. The surface routes would have required a high number of residential property demolitions and significant numbers of properties would have experienced noise impacts in south and east Manchester. The group would have crossed the Peak District National Park (two eastern-most routes only) and Reddish Vale Country Park and would have had an impact on two scheduled monuments; three Grade II* listed structures; one Grade II* registered park and garden (Adlington Hall); and two Grade II registered parks and gardens (Philips Park, Philips Park Cemetery). A number of route sections from the different approaches of this group were progressed for further refinement.

Western approaches group

- 4.2.12 The group comprised five approaches, connecting core line of route options with stations in the west of Manchester. These approaches extended north from either Lymm (two approaches), Altrincham (two approaches), or north-east of Holmes Chapel (eastern-most approach), to connect with St. George's. The group would have required a high number of residential property demolitions (Urmston, West Didsbury, and Newall Green). As such, some options were also re-designed as tunnel approaches for further refinement in the next development stage. It would have crossed one SSSI (Dunham Park). It would have also had an impact on Dunham Massey National Trust site; two Grade II* registered parks and gardens (Tatton Park, Dunham Massey); three Grade II registered parks and gardens (Alexandra Park, Wythenshawe Park, Manchester Southern Cemetery); one Grade II* listed structure (Barton Bridge), one Grade I listed structure (Church of All Saints) and one scheduled monument (Bowl Barrow). A number of route sections from the different approaches of this group were progressed for further refinement.

South Manchester spine group

- 4.2.13 The group connected Wilmslow with Wigan, linking routes from Birmingham to Manchester and the WCML. The group would have crossed one SAC (Manchester Mosses, which includes Risley Moss SSSI), a SSSI (Brookheys Covert); and would have crossed the Manchester Ship Canal with landscape and visual impacts. The group would also have had landscape and visual impacts where it crossed the Pennington Flash Country Park on viaduct. Mitigation considered included bypassing the country park (the southern-most spine route). However, a high number of residential properties would have experienced noise impacts and there would have been a high number of residential property demolitions at Golborne. A number of route sections from this group were progressed, but were later considered as part of other wider groups.

WCML, Warrington and Wigan connections group

- 4.2.14 The group connected Warrington, Wigan and the WCML with the core Birmingham to Manchester routes. The group ran from Northwich to the south, and Altrincham and Knutsford to the south-east, north to Preston. The group would have required residential property demolitions in numerous built-up areas including at Euxton, Coppull, Orrell, Abram, Hartford, and Warrington. The group would have crossed two SSSIs (Abram Flashes, Woolston Eyes); and would have had an impact on two Grade II registered parks and gardens (Tabley House, Avenham Park); and three Grade II* listed structures (Lower House Farmhouse, Lightshaw Hall, Church of All Saints). A number of route sections from this group were progressed for further refinement.

West Pennine Hills group

- 4.2.15 The group connected Manchester with north-east of Preston, with the exception of one route which would have followed the M61 corridor to Westhoughton. The group would have required a high number of residential property demolitions, particularly to the north of Manchester. It would have had a direct impact on two SSSIs, (Rochdale Canal, Red Scar and Tunbrook woods); one SAC (Rochdale Canal); two Grade II registered parks and gardens (Hoghton Tower, Heaton Park); and a National Trust site (Stubbins Estate). Opportunities for mitigation would have been limited in urban areas without extensive tunnelling. Options from this group were not progressed for further refinement.

Routes to the north of Preston group

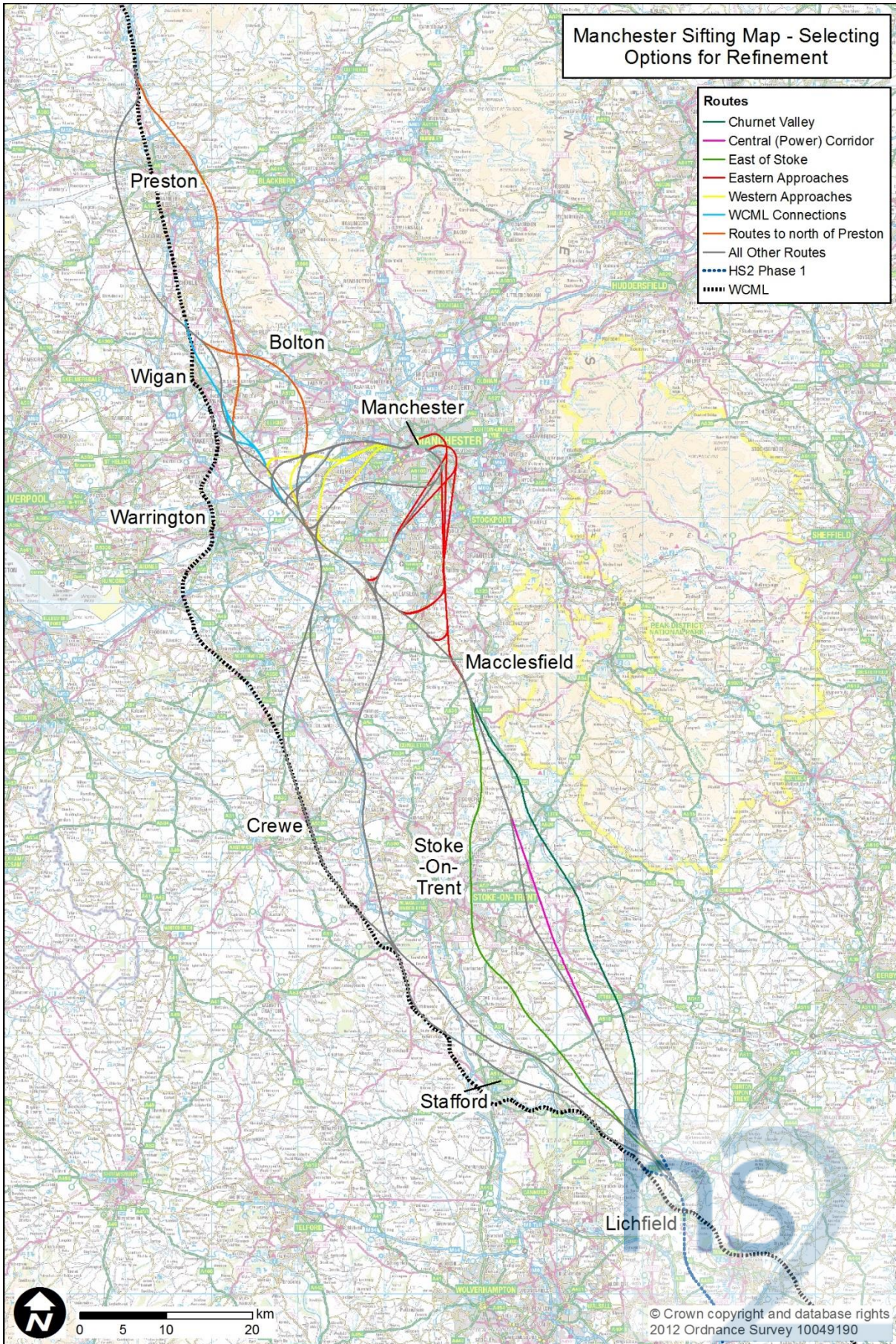
- 4.2.16 The group connected routes from Golborne and west Manchester to the WCML north of Preston, with some routes skirting around east and west of Preston. The group would have had a direct impact on three scheduled monuments (the Moat House, Bretters Farm, Moated Site at Arley Hall). It would have crossed the River Ribble, at a point 2.2km upstream of the Ribble and Alt Estuaries Ramsar site. It would also have crossed several other major rivers and canals (River Yarrow, Bridgewater Canal, Leeds and Liverpool Canal, Lancaster Canal, Millennium Ribble Link) resulting in visual impacts on users of waterway footpaths. It would have had an indirect impact on one SSSI (Red Moss); one Grade I listed structure; and 13 Grade II* listed structures. A number of route sections from this group were progressed for further refinement.

Manchester routes – options for further refinement

Introduction

- 4.2.17 Manchester route options that were subject to further refinement are shown in Figure 6. These were either route sections that were progressed from the initial sifting process or new options identified. The geographical grouping of options was not used beyond this next phase of optioneering. Those individual route sections that were progressed beyond this stage and further refined are presented in the AoS Options Report.

Figure 6: Manchester routes sifting map – selecting options for refinement



Churnet Valley group

- 4.2.18 This comprised a single corridor connecting Lichfield with Macclesfield passing to the west of Leek. The corridor would have crossed one SSSI (Churnet Valley), one area of National Trust land (Hawksmoor), two canals (Trent and Mersey Canal, Caldron Canal); and three major rivers (rivers Dane, Team and Blithe), which may have also required works. The corridor would have had a major landscape and visual impact on the surrounding area (which includes the Peak District National Park and Churnet Valley).

Central (Power) corridor group

- 4.2.19 The group comprised a short corridor passing to the east of Stoke-on-Trent, connecting Gratwich (west of Uttoxeter) to Bradshaw (west of Leek). The corridor would have directly impacted on several floodplains including crossing the Caldron Canal and River Blithe. It would have had a visual impact on open landscape at its southern extent where it passes through rural countryside.

East of Stoke group

- 4.2.20 The group comprised a single corridor connecting Lichfield with Macclesfield, passing in tunnel through Stoke-on-Trent (on the east side). The corridor would have had an impact on three conservation areas (Hilderstone, Trent and Mersey Canal, Macclesfield Canal); seven biodiversity action plan (BAP) habitats; and five ancient woodlands, and an indirect impact on seven Natura 2000 sites (within 10km). It would have also crossed one abstraction site (at Moddershall; 3,500 cubic metres/day). The corridor would have had a major visual impact on a National Trust site (Congleton Cloud) a Grade II* registered park and garden (Gawsworth Old Hall); three scheduled monuments (Gawsworth Hall Gardens, Hilderstone Hall, Moated Site at Great Hartwell Farm) and over 40 Grade II listed structures.

Eastern approaches group

- 4.2.21 The group comprised five approaches into east Manchester. All approaches diverged from a core route option between Macclesfield and Altrincham to terminate at one of three eastern city-centre station options. All of the approaches were tunnelled from the outskirts of Manchester. The group would have required a high number of residential property demolitions at Mottram St Andrews and Dean Row, and Alderley Edge; a significant number of properties would have also experienced noise impacts. There would also have been landscape and visual impacts at Alderley Edge. The group would have crossed a National Trust site (Hare Hill), and there would have been impacts on the setting of a Grade II* registered park and garden and scheduled monument (Gawsworth Old Hall).

Western approaches group

- 4.2.22 The group comprised six approaches²⁴ to terminus station options located in the west of Manchester. The group diverged from the main route at one of four locations: near the M6 crossover (west of Tatton Park); south-west of Altrincham (north of Rostherne Mere); to the north-east of Lymm; or east of Culcheth. Although all routes in this

²⁴ As noted in paragraph 4.2.14, five approaches were originally considered. However, more approaches were added as the optioneering process evolved.

group included 4-6km tunnels on the approach to the terminals, the group would have required a high number of residential property demolitions including some at Eccles (in an area of high deprivation).

- 4.2.23 The group would have crossed a National Trust site (Dunham Massey) and would have had a visual impact on the associated Grade II* registered park and garden (Dunham Massey). The group would have had an impact on one scheduled monument (a promontory fort), one Grade II* listed structure (Barton Bridge); and would have passed in proximity to two SACs (Manchester Mosses, Rixton Clay Pits). The group would have also had an indirect impact on two Ramsar sites (Rostherne Mere – also an NNR, and Midland Meres and Mosses Phase 1); and eight SSSIs (Abram Flashes, Rixton Clay Pits, Risley Moss, Holcroft Moss, Astley and Bedford Mosses, Rostherne Mere, Bryn Marsh and Ince Moss, Dunham Massey). Three approach options (the western-most three) would have crossed, and had a major visual impact on, the Manchester Ship Canal.

WCML connections group

- 4.2.24 The group ran from east of Warrington to south of Coppull, connecting the Birmingham to Manchester line of route to the WCML. The group would have crossed the Pennington Flash Country Park on viaduct and would have had a major impact on the landscape. A number of properties would have experienced noise impacts. The group would have required residential property demolitions at Hollins Green and would have had a direct impact on one scheduled monument (Haigh Sough); and an indirect impact on two SACs (Manchester Mosses, Rixton Clay Pits); and five SSSIs (Abram Flashes, Bryn Marsh and Ince Moss, Holcroft Moss, Risley Moss and Rixton Clay Pits).

Routes to north of Preston group

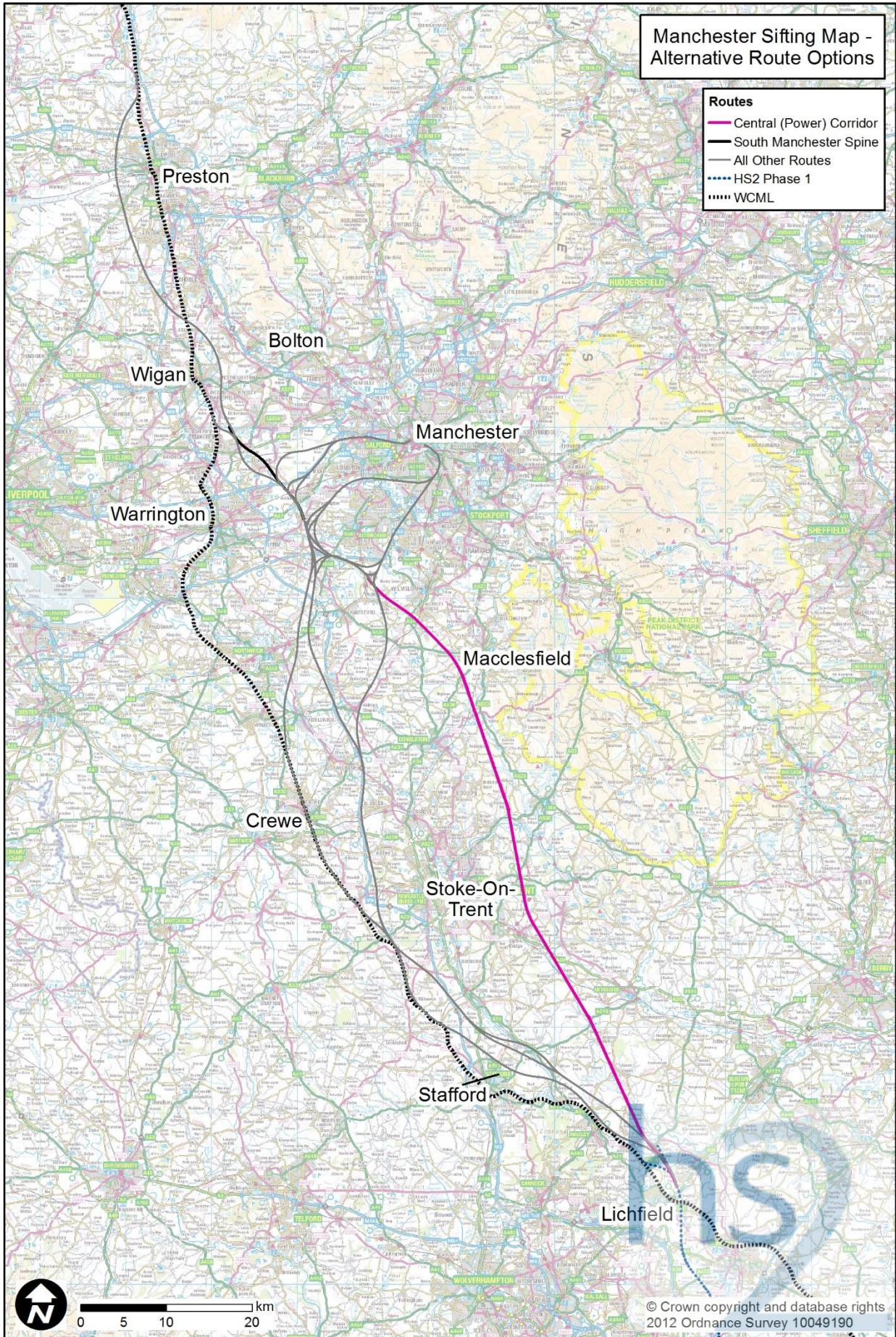
- 4.2.25 The group comprised three routes connecting with the WCML. Two of the routes originated to the south-west of Altrincham to terminate to the east and west of Aspull. The third route connected Golborne to the WCML north of Preston, running east of the M61. The group would have required residential property demolitions at Tyldesley, Horwich, Crankwood and Wheelton. The group would have had a direct impact on one SSSI (Red Scar and Tunbrook Woods); a National Trust site (Dunham Massey); Worthington Lakes Country Park; and would have had an indirect impact on two SACs (Manchester Mosses, Rixton Clay Pits); and an AONB (Forest of Bowland). The group would have also had a visual impact on the Ribble Valley, Dunham Park SSSI and Dunham Massey Grade II* Registered Park and Garden.

Alternative options not progressed to finalised option stage

Introduction

- 4.2.26 The two groups outlined below were alternatives to the preferred spine and central (power) corridor route options that emerged at the end of selection process detailed above. These groups were not progressed to a full sift i.e. to the highest level of engineering design detail and appraisal, due to the notably better performance of the final options (i.e. they were not considered reasonable alternatives). The routes are shown in Figure 7.

Figure 7: Manchester routes sifting map – alternative route options



Central (Power) corridor route

- 4.2.27 This route was the most easterly route remaining at the final options stage and is commonly referred to as the eastern route option. It connected Lichfield to Mobberley, passing to the east of Stoke-on-Trent and to the west of Leek and Macclesfield. The route would have passed within 2km of the Peak District National Park impacting on views from higher ground. There would have been five major river diversions (four affecting the River Blithe, and one affecting the River Dane) and 17km of the route, in cut or tunnel, would have crossed important aquifers. The route would have had a direct impact on approximately 20 ancient woodlands. It would also have required some residential property demolitions (with 13 at Key Green). There would have been noise impacts on some residential properties; a visual impact on Dane Valley; and an indirect impact on three scheduled monuments, four Grade II* listed structures and two Grade II* registered parks and gardens (Gawsworth Old Hall, Tatton Park).

Spine route (tunnel under Lowton)

- 4.2.28 This route was located to the northeast of Lymm and ran north-west to past Pennington Flash Country Park to terminate at Crankwood, northeast of Golborne. The route would have had a direct impact on a zone 1 source protection zone (SPZ) and public borehole at Lowton Common. It would have required 10 residential property demolitions; and there would have been vibration impacts for over 200 residents at Lowton Common. It would have had an indirect impact on Manchester Mosses SAC (that part which is Holcroft Moss SSSI).
- 4.2.29 As the alternative easterly options were discounted, a route to Manchester via a connection to the WCML at Crewe emerged as the preferred route. The remainder of this report focuses on the West Midlands to Crewe component of the Phase Two route (i.e. Phase 2a).

4.3 Alternative route corridors south of Crewe

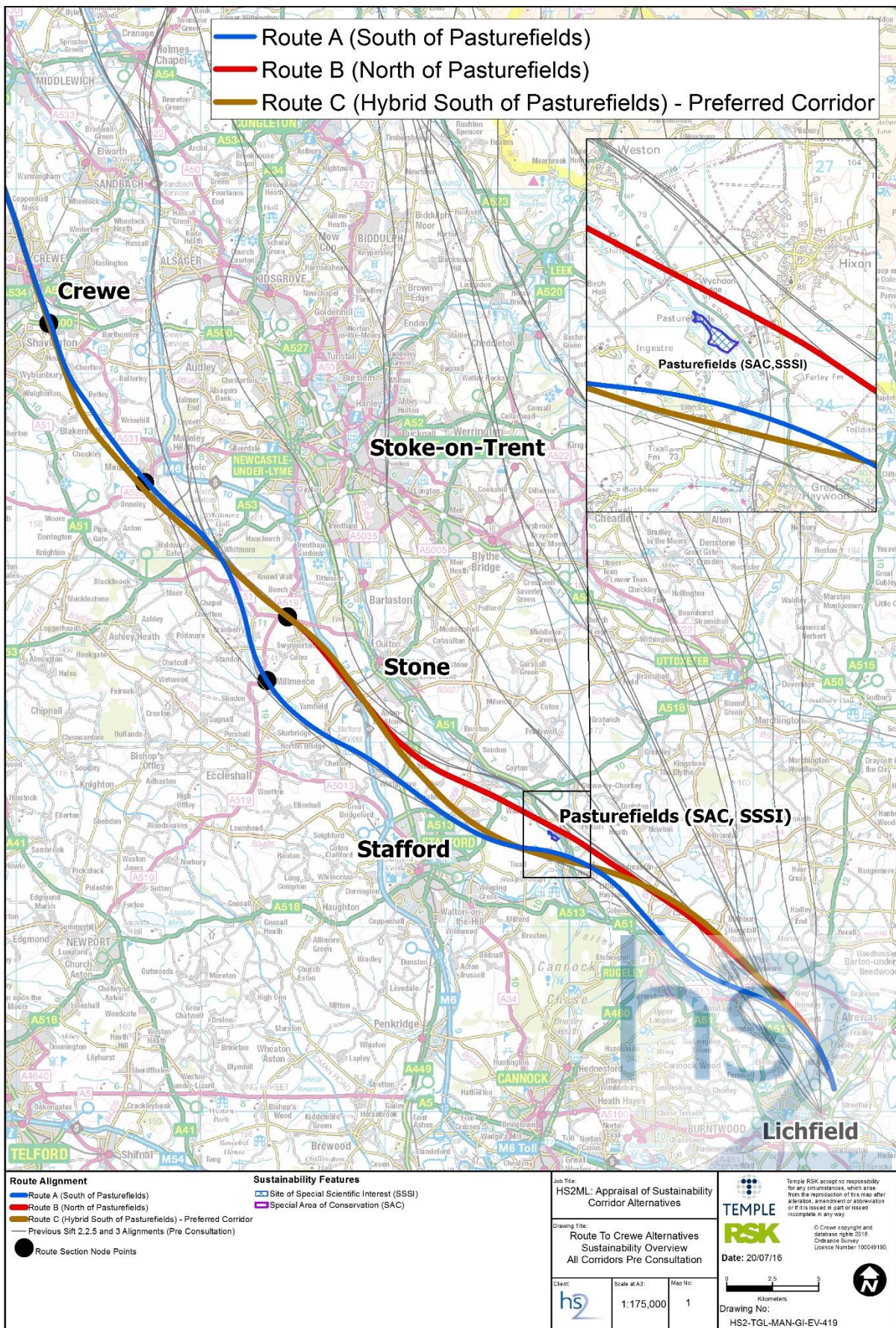
- 4.3.1 From the early work up to 2012, three potential route corridors were identified and studied, including a corridor that now forms the basis of the Proposed Scheme to Crewe. These aggregated sections were developed to the same set of engineering standards and subjected to an equivalent level of sustainability appraisal. These route corridors are shown in Figure 8.
- 4.3.2 All three route corridors commence at the proposed HS2 Phase One interface at Fradley and approach Crewe along a similar corridor to the east of both Whitmore and Madeley and passing by Chorlton alongside the existing WCML, south of Crewe.
- 4.3.3 The main variation between these pre-consultation routes is a 40-45km section of route starting immediately north of the connection point with Phase One and ending at Whitmore. The variations focused around the approach and passing of Pasturefields SAC and SSSI, north of Rugeley. Pasturefields SAC is internationally important and comprises the last remaining significant example of a natural inland salt spring with marsh habitats in the UK. Avoiding impacts to the SAC and its associated groundwater catchment area, and therefore ensuring compliance with the Habitats Directive, was one of the key considerations in determining the alignment for this section of the route.

- 4.3.4 Route corridor A provides a route that bypasses Pasturefields SAC to the south, following a similar corridor to that of the existing WCML as it passes Rugeley, approximately 900m north of Cannock Chase AONB, before heading north of Stafford and through Mill Meece, to the south of Swynnerton. This comprises the following route sections from the AoS Options Report: HSM01, HSM04, HSM08, HSM09 and part of HSM10.
- 4.3.5 Route corridor B takes a more northerly approach, up to 2km from Cannock Chase AONB and approximately 300m to the north of Pasturefields SAC. The corridor then continues north of Hopton and Hopton Heath Registered Battlefield, close to the settlements of Weston, Salt and Yarlet (passing within approximately 300m to the north of Yarlet School), before skirting the south of Stone before heading north of Swynnerton and re-joining the other corridors near to Whitmore. This route is comprised of the following route sections from the AoS Options Report: HSM03, HSM06, HSM08, HSM09 and part of HSM10.
- 4.3.6 Similarly to Route corridor B, Route corridor C takes a more northerly approach leaving the connection point with Phase One at Fradley, but then takes a southerly approach to Pasturefields SAC and SSSI, passing at a similar position to that of Route corridor A, approximately 600m north of Cannock Chase AONB. However, north of Stafford the route heads north-west, to the north of Yarlet and re-joins with Route corridor B, passing Swynnerton to the north and merging with the other options that then continue on from Whitmore towards Crewe. This route comprises options from the March 2012 report as well as a further refinement that is essentially a hybrid of options HSM01 and HSM03, MR71, HSM08, HSM09 and part of HSM10. Route corridor A and Route corridor C were 650m and 930m south of Pasturefields SAC at their closest points, respectively.

Appraisal of route corridors

- 4.3.7 Route corridor C became the basis for the initial preferred route and later the 2013 consultation route. Whilst there were a number of factors that influenced this as the preferred route corridor (including engineering and other sustainability related drivers), the avoidance of impact on the northern catchment associated with Pasturefields SAC was a key consideration.
- 4.3.8 The inland salt marsh at Pasturefields is fed by brine via a complex geohydrological mechanism. A number of studies have been undertaken, but no definitive mechanism has been discerned. The investigations indicate that the source of brine may be either at the site or to the north of the site (or both). HS2 Ltd undertook Habitat Regulations Assessment (HRA) screening in 2012. The HRA concluded that only route options to the south of Pasturefields SAC and SSSI would be likely to have no significant impact, as it is known that the source of brine does not come from the south.

Figure 8: Alternative route corridors to Crewe (pre-consultation)



- 4.3.9 Constructing the scheme to the north of Pasturefields SAC and SSSI (in an area where brine feeding the site may originate) could cause subtle alterations in the hydraulic regime, potentially deflecting its trajectory away from Pasturefields SAC and SSSI.
- 4.3.10 HS2 Ltd decided not to undertake any further investigatory work to determine the source of the brine. Investigatory boreholes could locally change conditions and although in isolation are unlikely to be significant, the extensive investigation which would have been required could have had a possible significant impact.
- 4.3.11 The Habitats Directive requires a precautionary approach to be taken. Where it is not possible to conclude that an adverse effect would not occur, alternative solutions must be considered. Where there is a satisfactory alternative that would avoid an impact, then this alternative solution must be adopted. In this case, a route to the south presented a satisfactory alternative, and the route running to the north was not studied further. HS2 Ltd, the Environment Agency and Natural England are in agreement with this approach.
- 4.3.12 Other key sustainability constraints for alternative options to both the north and south of Pasturefields SAC and SSSI included community impacts (property demolitions around Salt, Cotes Heath and Cranberry), Sandon Park (Registered Park and Garden), the Ministry of Defence Stafford development site, the Norton Bridge Junction upgrade scheme²⁵ and Hopton Registered Battlefield.

4.4 Alternative alignment to Crewe

Introduction

- 4.4.1 A number of changes were made to the consultation route on the basis of consultation feedback and other modifications made for engineering reasons. These are reported in Volume 1 and the Sustainability Report for the route to Crewe²⁶. In addition to consideration of local alternatives along this section of route, an opportunity arose to consider once again an alternative corridor via Stoke-on-Trent in order to respond to the Stoke-on-Trent City Council (STCC) proposal for an alternative alignment to the preferred route to Crewe.
- 4.4.2 The Stoke-on-Trent alternative was treated the same as any other post-consultation refinement and was compared against the preferred route to Crewe. This is described further in the following section.

Stoke-on-Trent City Council proposal for route via Stoke-on-Trent

- 4.4.3 As early as 2012, HS2 Ltd developed route options that had served the Stoke-on-Trent area, including options immediately east and west of the city (see Figure 5 and Figure 6). However, these and the associated intermediate stations serving Stoke-on-Trent were not progressed due to preferential alternative options from a cost, engineering and sustainability perspective.

²⁵ This junction upgrade scheme has since been completed.

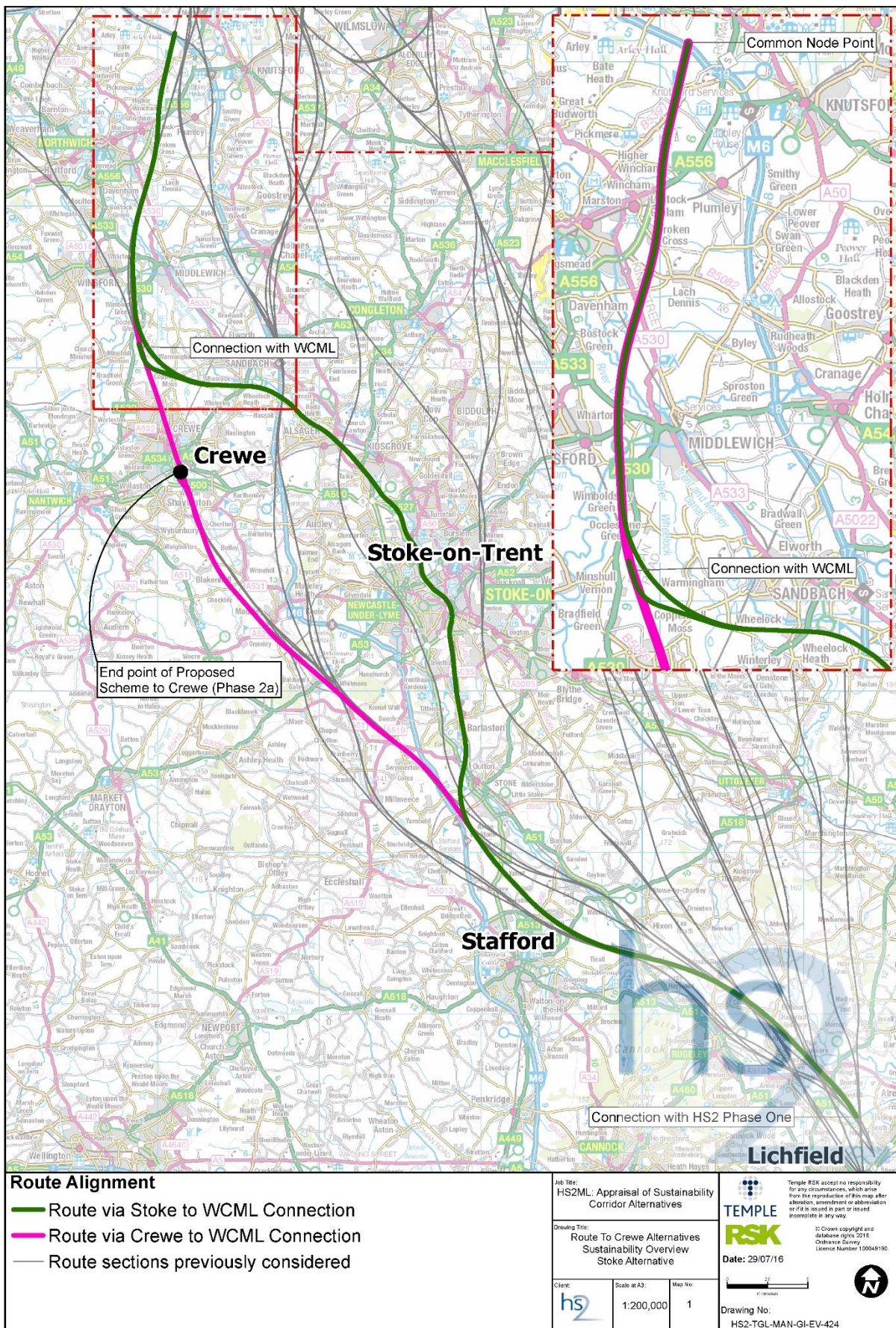
²⁶ Temple-RSK, (2015), *Sustainability Report – Phase Two Post-Consultation Update: West Midlands to Crewe*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/480667/Sustainability_Report_Phase_Two_Post-Consultation_Update_West_Midlands_Crewe.pdf

- 4.4.4 In response to public consultation in early 2014, STCC proposed a route through the city, presenting it to the Secretary of State in May 2014 and to HS2 Ltd and the DfT in June 2014.
- 4.4.5 As a result of this, HS2 Ltd applied the Phase Two engineering design standards to the STCC proposal to undertake a full sift level option for a route serving Stoke-on-Trent. The proposed option would serve Stoke-on-Trent directly using a new line through the city providing an alternative to the consultation route (see Figure 9).
- 4.4.6 The alternative corridor via Stoke-on-Trent was designed and appraised during 2014 as part of a wider refinement and optioneering review, and was subject to a detailed full sift AoS to ensure consistency and comparability with the existing consultation route via Crewe.
- 4.4.7 In order to ensure a full like-for-like comparison with the consultation route, both alignments were designed to end at the same location north of the M6 near Winterbottom. As the route of the Proposed Scheme is shorter than the routes appraised (as shown in Figure 9) there are a number of receptors and resources identified in Table 1 that are now not relevant to the Proposed Scheme.

Description of the route via Stoke-on-Trent

- 4.4.8 The STCC option followed a route between Stone and Winsford that uses the existing rail corridor through Stoke-on-Trent, employing a mix of high speed line and alterations to existing lines to accommodate the new route, and including a new Stoke station. It would re-join the consultation route alignment north of Crewe, with a junction to the WCML to allow stopping services to Liverpool and Preston. The route would be about 3km longer than the consultation route, and would also have a lower design speed in order to follow the existing corridor through Stoke-on-Trent.
- 4.4.9 West of Stone the route would bear north from the consultation route, using a new alignment across farmland. It would cross on viaduct over the River Trent and the A34 immediately north of Stone and then use an embankment up to about 14m high just to the east of Meaford and alongside the Trent and Mersey Canal. It would join the corridor of the WCML, requiring realignment of this railway as well as the removal of the Barlaston and Wedgwood level crossings. Following the WCML corridor either at grade or on embankment, the route would run alongside the Trent and Mersey Canal for some 5km.
- 4.4.10 Passing immediately east of Trentham, the route could require demolition of a number of dwellings. STCC proposed a new station on the classic network at Trentham, which was not appraised as part of the study. The route would then rise on to a viaduct across the floodplain to the east of Hanford, requiring the realignment of the canal at this point. Immediately north, STCC proposed a new station on the classic network alongside the Britannia stadium, which again was not appraised as part of the study.

Figure 9: Alternative corridor – routes to Crewe and Stoke-on-Trent

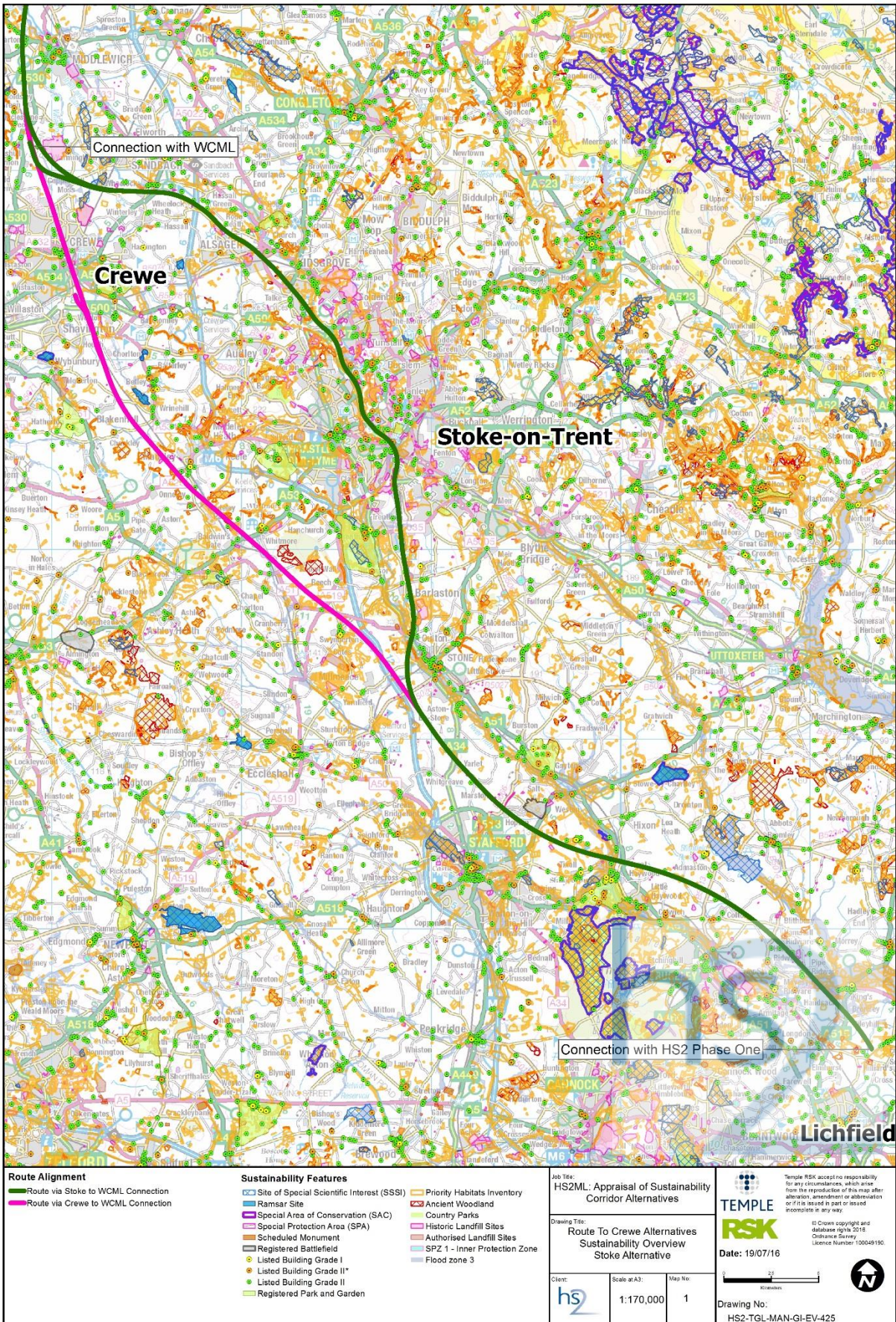


- 4.4.11 The route would then pass under the A50 and enter the industrialised southern edge of Stoke-on-Trent, east of the A500. It would diverge slightly west from the WCML at this point passing through Axiom rail land and industrial land uses east of the Whieldon Road. The route would run parallel with the WCML, passing immediately west of the existing Stoke-on-Trent station through the car park and both over and alongside the Trent and Mersey Canal. A new station, with connections to the classic network was proposed in Cliff Vale on now derelict industrial land.
- 4.4.12 The route would then continue northwards, still within the WCML corridor and east of the A500. It would pass under the A5271 at Longport where STCC proposes to relocate the existing Grade II listed station. It would pass over the A527 at Tunstall before diverging west from the WCML and entering a new 2.3km long bored tunnel under Bathpool Park and Coal Pit Hill east of Talke.
- 4.4.13 The tunnel would emerge west of Butt Lane and then pass in cutting through pockets of woodland and open countryside. The route would pass to the south of Church Lawton and along the north-east edge of Alsager within a valley and partly using a disused rail corridor. Passing under the M6, the route would run alongside the Trent and Mersey Canal. It would then pass over the A534 and south of Wheelock, directly affecting the residential community south of this village, on the Crewe Road.
- 4.4.14 South of Elworth, a grade separated junction would connect with the WCML, while the main high speed route would bear northwards towards Warrington and Winsford where it would join the consultation route alignment and continue towards Manchester and WCML connection at Golborne. With Crewe now bypassed, an alternative location for the Basford Hall Infrastructure Maintenance Depot (IMD) would be required. Proposals for this alternative location for the IMD were not developed as part of the study.

Summary of sustainability impacts

- 4.4.15 Table 1 summarises the sustainability impacts between the proposed route via Crewe and the alternative via Stoke-on-Trent. The key sustainability features are shown on Figure 10.

Figure 10: Alternative route corridor to Stoke-on-Trent – sustainability features



Appendix CT-002-000

Table 1: Alternative route corridor to Crewe and Alternative route corridor to Stoke-on-Trent – sustainability features (appraisal based on Appraisal of Sustainability methodology)²⁷

	Route to Crewe – consultation route with updated design standards applied	Alternative route via Stoke-on-Trent – WCML connection north of Crewe (via Stoke-on-Trent)
Property and community integrity	<p>Demolitions:</p> <p>Approximately 30 residential</p> <p>3 commercial</p> <p>0 community</p> <p>0 industrial</p> <p>Approximate Total: 33</p> <p>3 residential areas would experience isolation affecting a total of 7 residential properties.</p>	<p>Demolitions:</p> <p>Approximately 100 residential</p> <p>Approximately 50 commercial</p> <p>3 community</p> <p>8 industrial</p> <p>Approximate Total: 161</p> <p>3 residential areas would experience isolation affecting a total of 14 residential properties.</p>
Noise (annoyance, unmitigated scheme)	Approximately 675 properties	Approximately 1,500 properties
Landscape and visual impacts	Moderate to major landscape and visual impacts, with major impacts potentially affecting seven locations.	Moderate to major landscape and visual impacts, with major impacts potentially affecting nine locations.
Planning and development	Basford West (direct impact)	Chatterley Valley employment area (direct impact)
Cultural heritage	Moderate impact on the setting of 2 Grade II listed buildings	<p>Major impact on the Trent and Mersey Conservation Area</p> <p>Moderate impact on Meaford Conservation Area</p> <p>Moderate to major impact on the setting of 2 Grade II* listed buildings</p> <p>Major direct impact on 2 Grade II listed buildings</p> <p>Moderate to major impact on the setting of 3 Grade II listed buildings</p>
Biodiversity and wildlife	<p>51 Habitats of Principal Importance intersected for approximately 5km</p> <p>3 ancient woodlands directly impacted for a distance of approximately 675m</p>	<p>Sandbach Flashes SSSI lies directly adjacent to the proposed route. The route intersects the surface water catchment for the site potentially resulting in obstruction to the flows from the west. The route effectively separates the southern unit of the site from the rest of the complex and could result in the potential disturbance to the associated breeding bird assemblage.</p> <p>97 Habitats of Principal Importance intersected for approximately 11km.</p>

²⁷ Note: this appraisal is based on the Appraisal of Sustainability methodology for the line of route. As stated in paragraph 4.4.7, in order to ensure a full like-for-like comparison with the consultation route, both alignments were designed to end at the same location north of the M6 near Winterbottom. As the route of the Proposed Scheme is shorter than the routes appraised there are a number of receptors and resources identified that are now not relevant to the Proposed Scheme.

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	Route to Crewe – consultation route with updated design standards applied	Alternative route via Stoke-on-Trent – WCML connection north of Crewe (via Stoke-on-Trent)
		5 ancient woodlands directly impacted for a distance of approximately 500m.
Water resources and flood risk	<p>0 diversion of major watercourse</p> <p>6 diversions of minor watercourses</p> <p>3 navigable waterbody crossings</p> <p>1 crossing where line could be at risk of fluvial flooding</p> <p>Large public water supply borehole located beneath the line of route at Whitmore</p> <p>Approximately 100m of route in cut/tunnel through SPZ 2</p>	<p>1 diversion of major watercourse</p> <p>13 diversions of minor watercourses of which 4 are EA Main Rivers</p> <p>12 navigable water body crossings. At least nine of the Trent and Mersey Canal crossings may require canal re-alignment</p>
Land use resources	<p>1 active landfill site intersected</p> <p>1 historical landfill site intersected</p> <p>19km of green belt land intersected</p>	<p>2 active landfill sites intersected</p> <p>7 historical landfill sites intersected</p> <p>16km of green belt land intersected</p>

Proposed route and alternative route via Stoke-on-Trent conclusion

4.4.16 HS2 Ltd modelled a number of scenarios for services via Crewe or Stoke-on-Trent to compare their performance. This modelling shows a significant reduction in the benefits and revenues generated by the alternative Stoke-on-Trent route in comparison with the consultation route via Crewe. This is driven by a number of factors, including longer journey times to the key markets of Manchester and the North, and loss of the wider regional connectivity delivered by the proposed connection at Crewe, including to regional markets in Staffordshire, Cheshire and North Wales. The alternative Stoke-on-Trent route would also entail some significant engineering challenges. This coupled with a better sustainability performance for the route via Crewe led to the decision not to adopt the alternative Stoke-on-Trent route.

5 Local alternatives considered before November 2015

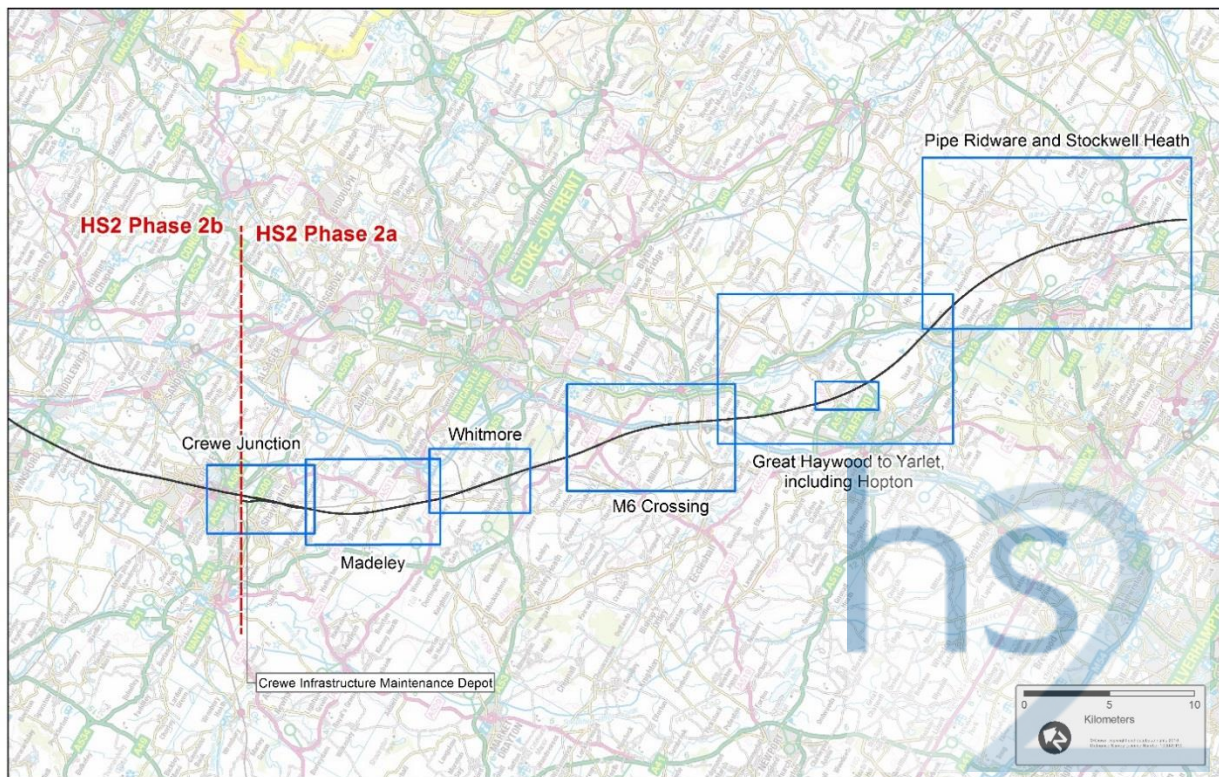
5.1 Introduction

5.1.1 Following the period of public consultation on the proposed Phase Two route between July 2013 and January 2014, route refinement work was undertaken (as described in Section 4) which examined in greater detail seven areas along the Phase 2a route.

5.1.2 Refinement was focused around the following areas (as shown in Figure 11):

- Pipe Ridware and Stockwell Heath;
- Great Haywood to Yarlet;
- Hopton;
- M6 crossing and Swynnerton;
- Whitmore Heath;
- Madeley tunnel; and
- Crewe junction.

Figure 11: Local alternatives studied before November 2015²⁸



²⁸ Figure 11 shows the previously proposed infrastructure maintenance facility at Crewe, as this was proposed during the consideration of this alternative. However since then the IMD has been relocated near to Stone, in the form of the infrastructure maintenance base - rail (IMB-R).

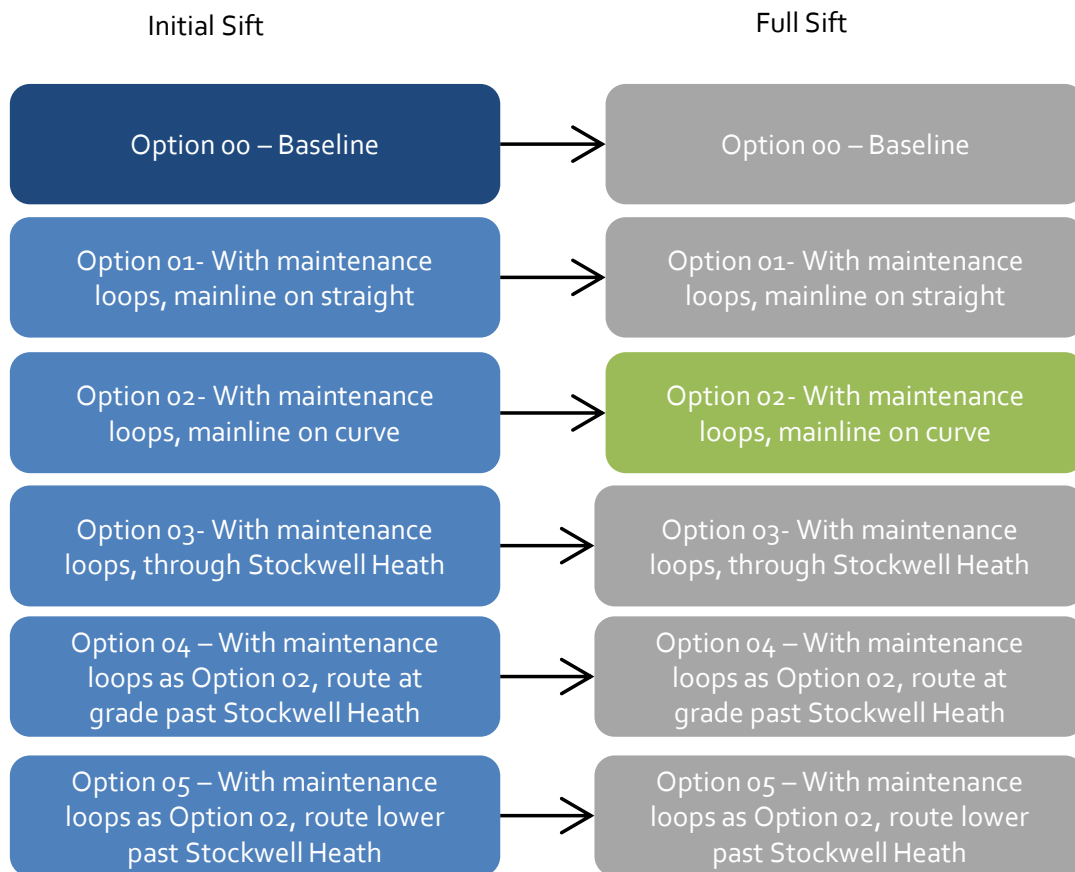
- 5.1.3 Across all seven refinement areas, 51 local alternatives or options were studied during the initial sift. Of these, 39 options were progressed to a full sift. Two further options (also studied at full sift) were developed as a response to the full sift for Whitmore Heath.
- 5.1.4 The remainder of this section provides an overview of the alternatives studied for each refinement area, the option chosen for progression and the reasons to support this decision.
- 5.1.5 A decision tree diagram shows the options progressed to full sift appraisal, with a short description of these options in the summary box underneath the diagram. The preferred refinement option in each case is highlighted in green. Further options in grey were proposed but were either not progressed or not considered the preferred option for that appraisal stage.
- 5.1.6 A route refinement baseline (RRB) option was presented as part of each package of refinements. This was the base case comparison option, which was similar to the 2013 consultation route but with updated design standards applied following consultation. This RRB option is shown in dark blue. The other options considered as part of the initial sift are shown in light blue.
- 5.1.7 Each of the options were appraised against the RRB, however the comparison of the impacts is presented below against the option that was chosen to be taken forward into the design (the preferred option).
- 5.1.8 In some instances, whilst the preferred option was chosen as the most appropriate at this stage of development, subsequent work has led to this option being revisited. Where this is the case it is noted in the relevant sections below.

Pipe Ridware and Stockwell Heath

- 5.1.9 This refinement area covered approximately 16km of the route from the connection with Phase One at Fradley to the east of Great Haywood. The primary refinement considerations were the location and height of the railway past the settlement of Stockwell Heath, landscape impacts around Pipe Ridware, and the location of the maintenance loops²⁹. Refinements to the location of the maintenance loops included more detailed design of the loops and whether, for operational purposes, they could be accommodated on a straight or curved section of the HS2 mainline. Six options were proposed in total, all of which were taken through to full sift. The options taken forward in the sift stages are shown in Figure 12 and described in the subsequent paragraphs of this section of the report. The location of the options are shown in Figure 13.

²⁹ Maintenance loops were originally proposed as part of the scheme. This was because an IMD was proposed towards the northern end of the route at Crewe and the maintenance loops were therefore required at Pipe Ridware, to enable maintenance trains to be stabled temporarily during the day when maintenance activities would have been undertaken over a number of nights, without having to return to the IMD. However, the maintenance facility (the IMB-R) will now be located more centrally in the Stone to Swynnerton community area, meaning maintenance trains will be better positioned for efficient dispatch for maintenance works across the route in both directions, avoiding the need for maintenance loops. However, at the time these alternatives were considered, the loops formed part of the scheme.

Figure 12: Local alternatives options studied for Pipe Ridware and Stockwell Heath



5.1.10 The following options were studied during the full sift:

- Option 00: the RRB would omit maintenance loops. The alignment would run in a north-easterly direction past Rileyhill, over the Bourne Brook and River Trent floodplains and east of Pipe Ridware on high viaduct. The route would then turn eastwards in cutting approximately 10m deep, passing Stockwell Heath on embankment approximately 13m high;
- Option 01: would include maintenance loops and would be on a straighter alignment than Option 00. This would require the route to be in deeper cutting south of Stockwell Heath and a slight adjustment eastwards at Blithbury. The route past Stockwell Heath would remain similar to Option 00;
- Option 02: would include maintenance loops and would be largely as Option 00 but requiring a deeper cutting and increased footprint to the south of Stockwell Heath, although with a similar horizontal alignment to Option 00;
- Option 03: would include maintenance loops and follow a straighter alignment to Option 00, diverging north from Option 00 between Blithbury and Stockwell Heath. It would run at a slightly reduced height along this section, and also through Stockwell Heath;
- Option 04: would include maintenance loops and horizontally would be similar to Option 02 but significantly lowered past Stockwell Heath, requiring very deep cuttings to both the south and north of Stockwell Heath and would run at-grade past the settlement; and

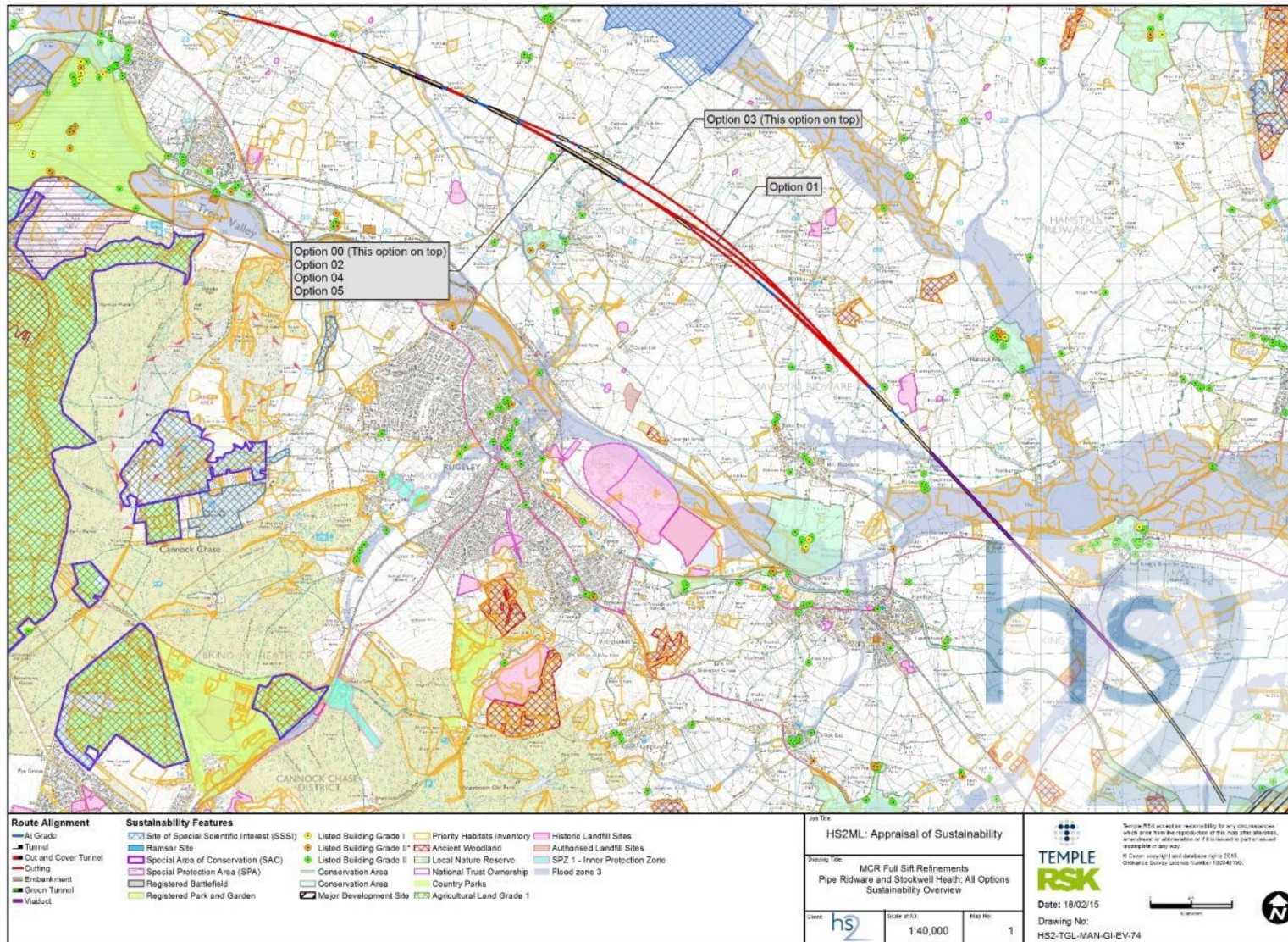
- Option 05: would include maintenance loops and horizontally would be similar to Option 02 but with the route lowered past Stockwell Heath, but higher than Option 04. As with Option 00, it would require deep cuttings to both the south and north of Stockwell Heath and would run on embankment past the settlement.

- 5.1.11 HS2 Ltd determined that Option 02 should be taken forward as the preferred option, based on consideration of sustainability, cost and engineering constraints. This option remains closest to the consultation alignment whilst including provision for maintenance loops and required slightly shallower cuttings to the south of Stockwell Heath. Noise impacts across all options were broadly similar. Whilst the reduction in height of the alignment past Stockwell Heath associated with Options 04 and 05 slightly reduced the visual impacts for residents, the route would still be in proximity to the settlement, and would also require greater depth of cuttings further to the south near Blithbury increasing landscape impacts in this area. Option 02 would also have one additional demolition when compared with Option 00 (RRB) as a result of the increased depth of cutting at Hadley Gate.
- 5.1.12 The sustainability impacts of each of the options is set out below with those of the preferred option presented first.
- 5.1.13 The preferred option, Option 02 would have moderate landscape and visual impacts overall as a result of scheme within the landscape, including the raised crossing of the Bourne Brook floodplain and sections of deeper cuttings to the south of Blithbury in order to accommodate the maintenance loops. There would be localised major visual impacts at Stockwell Heath as a result of the section of viaduct within 100m of the settlement. Deep cutting in proximity to the Grade II Listed Moreton House would have an impact on its setting.
- 5.1.14 Option 00 (RRB) would have moderate landscape and visual impacts, including those associated with the crossing of the Bourne Brook floodplain and cuttings south at Blithbury. Whilst the cuttings at Blithbury would not be as deep as with the preferred option, there is no provision within the design for maintenance loops. Similar to the preferred option there would be localised major visual impacts at Stockwell Heath as a result of the section of viaduct within 100m of the settlement, and a section of deep cutting south of the Grade II Listed Moreton House would continue to impact on its setting.
- 5.1.15 Option 01 would follow a straighter alignment to the preferred option and includes provision for maintenance loops. This option would have moderate to major landscape impacts, including the crossing of the Bourne Brook floodplain and increased impacts at Blithbury when compared to the preferred route as a result of increased depth of cuttings. Similar to the preferred route there would be localised major visual impacts at Stockwell Heath, with the alignment within 100m of the settlement on viaduct. The setting impact on the Grade II Listed Moreton House resulting from the deep cutting would remain similar to the preferred route and other options.
- 5.1.16 Option 03 would follow a straighter alignment than the other options with major landscape and visual impacts as a result of the direct impact on Stockwell Heath, including additional demolitions and severance of the settlement itself. Similar to the

preferred option, the route would include a raised crossing of the Bourne Brook floodplain although there would be some additional landscape impacts south of Blithbury. Here the route would run approximately 50m closer to Blithbury and require an increased depth of cutting than that of the preferred option. The setting impact on the Grade II Listed Moreton House resulting from the deep cutting would remain similar to the preferred route and other options.

- 5.1.17 Option 04 would have moderate landscape and visual impacts, including the raised crossing of the Bourne Brook floodplain, although the deeper cuttings south of Stockwell Heath would increase the impact on the landscape character of the area. Whilst the alignment would still be within 100m of Stockwell Heath, the visual impacts would be reduced for residents within the settlement, with the route passing at grade rather than on embankment when compared with the preferred option. The setting impact on the Grade II Listed Moreton House would remain as a result of the deep cutting in proximity to the property, similar to preferred option.
- 5.1.18 Option 05 would have moderate landscape and visual impacts, including the crossing of the Bourne Brook floodplain and increased depth of cuttings south of Stockwell Heath which would increase the impact on landscape character, when compared with the preferred option. There would be a moderate visual impact at Stockwell Heath, reduced from the preferred option, with the alignment on embankment within 100m of the settlement, although the height of embankment is approximately half that of the preferred option. There would be a setting impact on the Grade II Listed Moreton House as a result of the proximity to the deep cutting, similar to the preferred option.
- 5.1.19 Whilst Option 2 was chosen as the most appropriate at this stage of the scheme development, subsequent work has led to this option being revisited. Further information on this particular area can be found in Section 6.2.

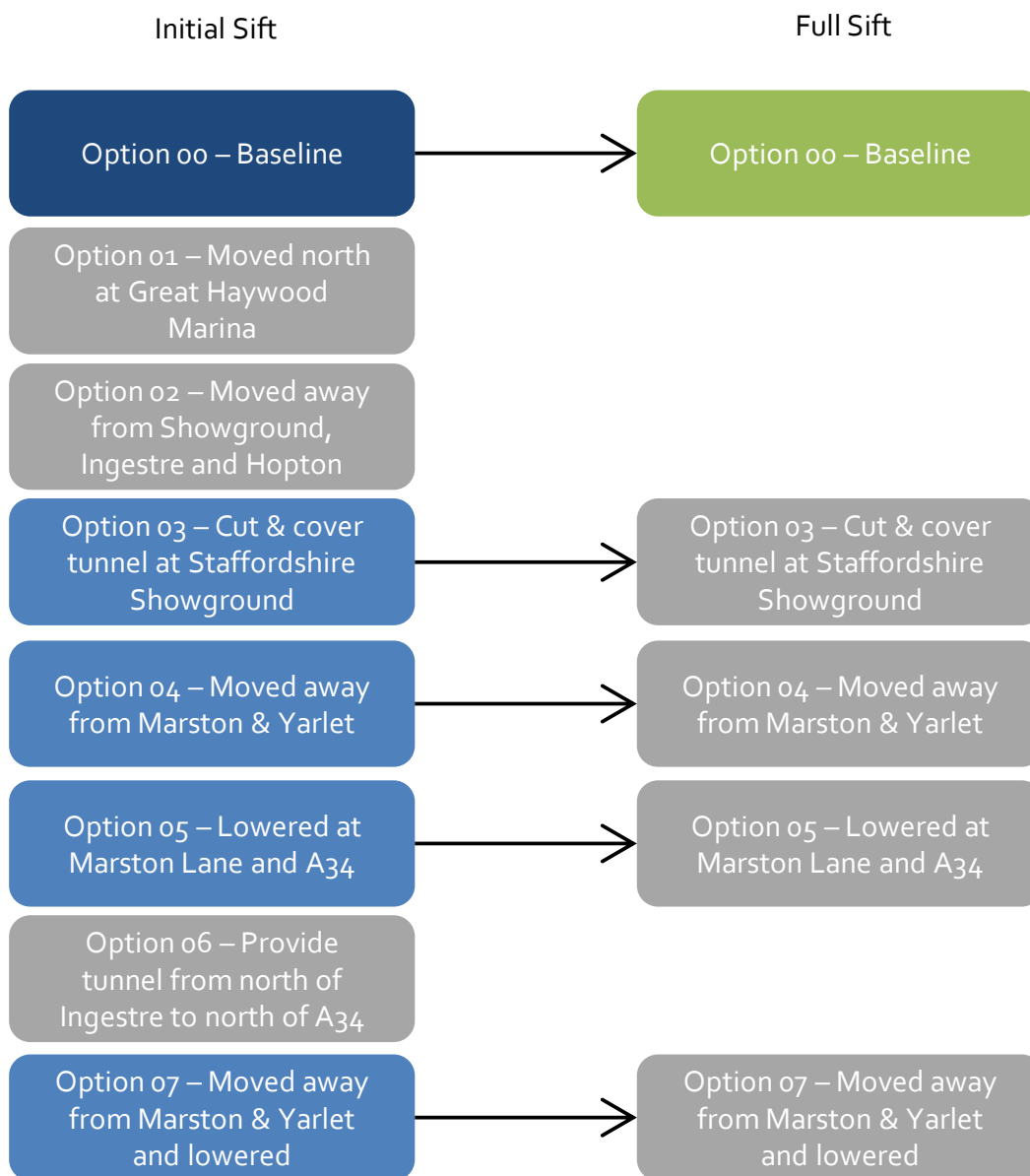
Figure 13: Local alternatives studied for Pipe Ridware and Stockwell Heath



5.2 Great Haywood to Yarlet

5.2.1 This refinement area covered approximately 14km of the route from Great Haywood to the A34 at Yarlet. The primary refinement considerations were to address the location of the route past the Staffordshire County Showground and through Hopton, the location and height of the route past Marston and Yarlet and the impacts to Great Haywood Marina, Ingestre Conservation Area and on other scattered settlements.³⁰ Eight options were proposed, with three of these not progressed past the initial sift as they were not considered reasonable on the basis of engineering, cost or sustainability grounds. The options taken forward in the sift stages are shown in Figure 14 and described in the subsequent paragraphs of this section of the report. The location of the options are shown in Figure 15.

Figure 14: Local alternatives studied for Great Haywood to Yarlet



³⁰ The options considered in this refinement area all include a green tunnel south of Hopton. It should be noted that further refinements were proposed specifically to address concerns relating to the alignment at Hopton, the details of which are set out in Section 5.4 of this report.

5.2.2 The following options were studied during the full sift:

- Option 00: the RRB. This route would begin on embankment and viaduct across the Trent and Mersey Canal (and Great Haywood Marina) before entering a long stretch of cutting through Ingestre Park Golf Club and past Staffordshire County Showground and approaching Hopton. North of the green tunnel at Hopton the route would begin to rise, passing east of Marston on a short section of embankment before running east of Yarlet and under the A34 in cutting;
- Option 03: would follow the same horizontal and vertical route as Option 00 but introduced a cut and cover tunnel at the Staffordshire County Showground;
- Option 04: would follow a similar alignment to Option 00 but moved slightly to the south (approximately 60m) at Staffordshire County Showground and slightly east (approximately 60m) at Marston and Yarlet;
- Option 05: in comparison to Option 00, was a lowered alignment north of Hopton, past Marston, Marston Lane and under the A34 but would follow a similar horizontal profile; and
- Option 07: would follow the same horizontal route as Option 04, moving the route slightly eastwards (approximately 60m) from Marston and Yarlet. However, the route would also be lower past both settlements.

5.2.3 HS2 Ltd determined that Option 00 should be taken forward as the preferred option, based on consideration of sustainability, cost and engineering constraints. The benefits of the small horizontal and vertical realignments did not deliver significant benefits nor justify the additional costs, with impacts generally very similar across all options. Whilst reducing the height of the alignment at Marston and Yarlet provided some reduction in visual impacts, and slight reduction in noise impacts, they were offset by deeper cuttings and increased landscape impacts at these locations and further to the south, including at Hopton. All options still had an impact on Staffordshire County Showground car parking area.

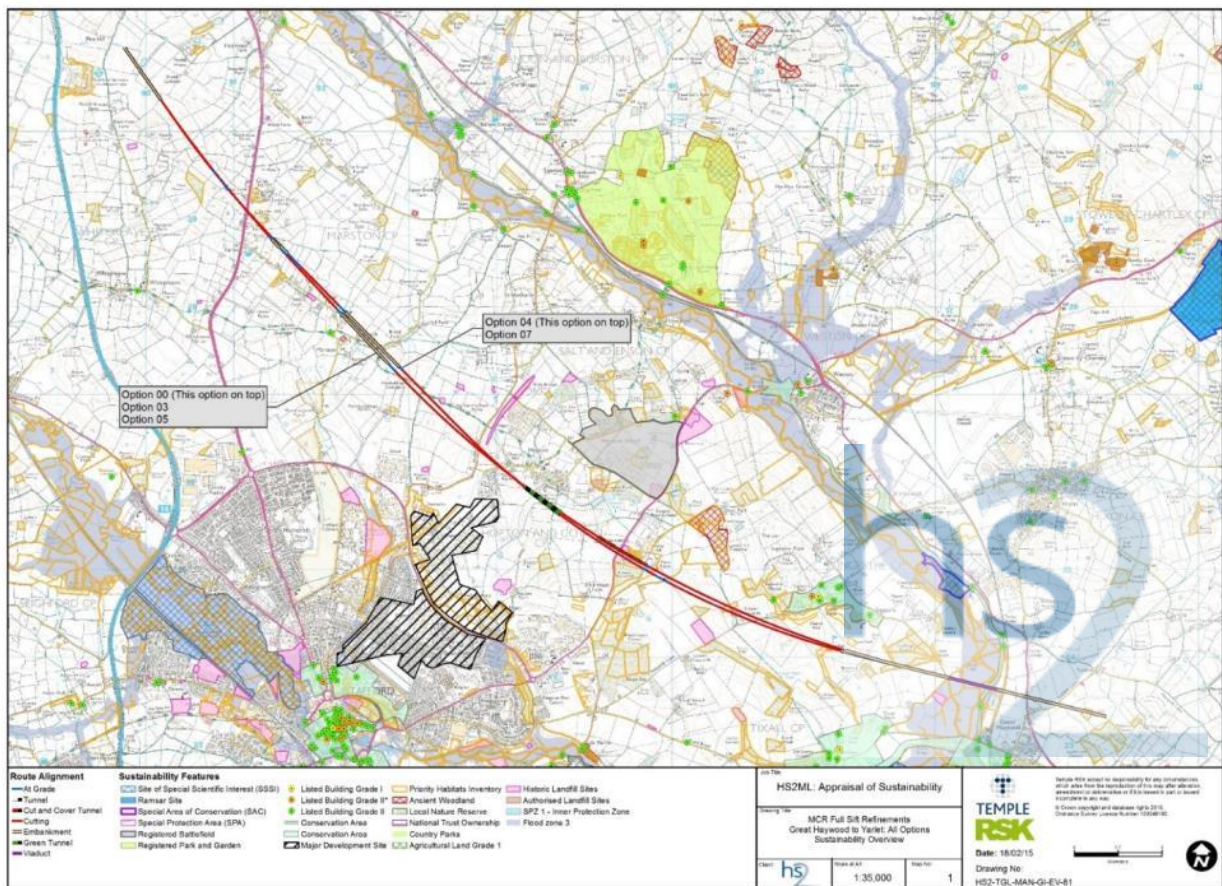
5.2.4 The sustainability impacts of each of the options is set out below with those of the preferred option presented first.

5.2.5 The preferred option, Option 00 would have moderate landscape and visual impacts due to the extent of section of cutting, embankment and viaduct, with localised visual intrusion at Hopton, Yarlet and Marston. This includes the raised embanked crossing of Ingestre Park Golf Club, in close proximity to Ingestre Conservation Area, as well as sections of deep cutting to the south and north of Hopton, although the green tunnel would help to reduce visual intrusion for the residents of Hopton looking onto the route. The high viaduct crossing of Great Haywood Marina would impact on users of the Trent and Mersey Canal, also a Conservation Area. With the alignment raised approaching and crossing the canal there would also be noise impacts for residents at Great Haywood. The route would run through part of Staffordshire County Showground, requiring land from an area of car parking associated with the showground.

- 5.2.6 Option 03 would have similar impacts to that of Option 00, the preferred option. This includes moderate landscape and visual impacts due to the presence of the scheme within the landscape, with localised visual intrusion at Hopton, Yarlet and Marston. Similarly this also includes the raised embanked crossing of Ingestre Park Golf Club, in close proximity to Ingestre Conservation Area. There would be sections of deep cutting to the south and north of Hopton, with visual intrusion for the residents of Hopton looking down the valley onto the route. The high viaduct crossing of Great Haywood Marina would continue to impact on users of the Trent and Mersey Canal, similar to the preferred option. With the alignment raised approaching and crossing the canal, there would also be noise impacts for residents of Great Haywood. At the Staffordshire County Showground there would be a marginal reduction in the amount of land required (compared to Option 00) from the car park as a result of the introduction of a cut and cover tunnel, although a small amount of land would still be required.
- 5.2.7 Option 04 would have similar impacts to the preferred option, even with the slight horizontal realignments to the south and north of Hopton. There would remain moderate landscape and visual impacts due to the presence of the scheme within the landscape, with localised visual intrusion at Hopton, Yarlet and Marston, despite the 60m shift further east. Similarly the route would cross Ingestre Park Golf Club on embankment, in close proximity to Ingestre Conservation Area, as well as sections of deep cutting to the south and north of Hopton, with visual intrusion for the residents of Hopton looking onto the route. The high viaduct crossing of Great Haywood Marina would impact on users of the Trent and Mersey Canal in a similar way to the preferred option. With the alignment raised approaching and crossing the canal, there would also be noise impacts for residents of Great Haywood, similar to the preferred option. At the Staffordshire County Showground there would be a small reduction in the amount of land required from the car park, although an impact would remain.
- 5.2.8 Option 05 would overall have similar impacts to the preferred option, although some localised changes at Marston and Yarlet. Overall there would remain moderate landscape and visual impacts due to the presence of the scheme within the landscape, with localised visual intrusion at Hopton. The reduced height of the alignment at Marston and Yarlet would reduce visual impacts for residents of these settlements, although deep cuttings at Yarlet would increase landscape impacts. The impacts at Ingestre Park Golf Club would remain similar to the preferred option with the route crossing Ingestre Park Golf Club on embankment, in close proximity to Ingestre Conservation Area, as well as sections of deep cutting to the south and north of Hopton, with visual intrusion for the residents of Hopton looking onto the railway. Similar to the preferred option, the high viaduct crossing of Great Haywood Marina would continue to impact on users of the Trent and Mersey Canal. With the alignment raised approaching and crossing the canal, there would remain noise impacts for residents of Great Haywood. At the Staffordshire County Showground there would be a small reduction in the amount of land required from the car park, although an impact would remain.
- 5.2.9 Option 07 would overall have similar impacts to the preferred option, although some localised changes at Marston and Yarlet as a result of lowering the route and moving it slightly eastwards from Marston and Yarlet. Overall there would remain moderate landscape and visual impacts due to the presence of the scheme within the landscape,

with localised visual intrusion at Hopton. The reduced height of the alignment at Marston and Yarlet, together with the 60m eastward shift would reduce visual impacts for residents of these settlements and slightly reduce noise impacts, although deep cuttings at Yarlet would increase landscape impacts. The impacts at Ingestre Park Golf Club would remain similar to the preferred option with the route crossing Ingestre Park Golf Club on embankment, in close proximity to Ingestre Conservation Area, as well as sections of deep cutting to the south and north of Hopton, with visual intrusion for the residents of Hopton looking down onto the route. Similar to the preferred option, the high viaduct crossing of Great Haywood Marina would continue to impact on users of the Trent and Mersey Canal. With the alignment raised approaching and crossing the canal, there would remain noise impacts for residents of Great Haywood. At the Staffordshire County Showground there would be a small reduction in the amount of land required from the car park, although an impact would remain.

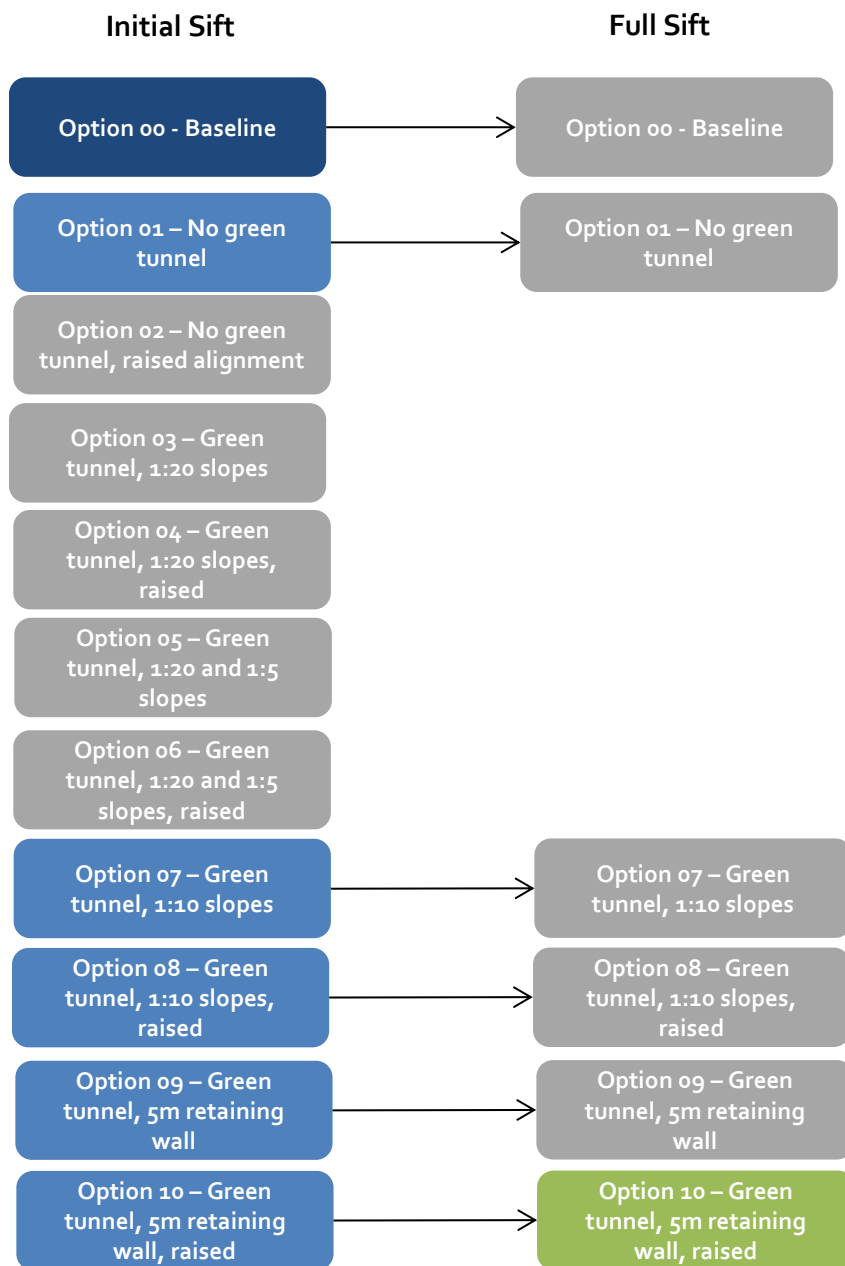
Figure 15: Local alternatives studied for Great Haywood to Yarlet



5.3 Hopton

5.3.1 This refinement area covered approximately 38km of the route, from the connection with Phase One at Fradley to north of Swynnerton. The primary refinement considerations were to address the clearance of the route over Kingston Brook south of Hopton; and to better understand the options for landscaping and mitigation associated with the green tunnel at Hopton. Whilst the route section covered 38km, the focus was on a 7km section where the variation between options took place, from Ingestre, past Hopton and through to Marston. Eleven options were proposed, of which five did not progress past the initial sift as they were not considered reasonable on the basis of engineering, cost or sustainability grounds. The options taken forward in the sift stages are shown in Figure 16 and described in the subsequent paragraphs of this section of the report. The location of the options are shown in Figure 17.

Figure 16: Local alternatives studied for Hopton



5.3.2 The following options were studied during the full sift:

- Option 00: the RRB. The alignment would approach Hopton in cutting south of Staffordshire County Showground up to approximately 17m deep. The alignment would then continue south of Hopton in a 510m long green tunnel (with no associated landscaping) before resuming in cutting under Hopton Lane and the B5066 Sandon Road, at a depth of up to approximately 20m;
- Option 01: had the same vertical and horizontal profile as Option 00 but without the section of green tunnel south of Hopton. The alignment would almost be at grade passing to the south of Hopton where the green tunnel would be located within Option 00 due to the topography in this area;
- Option 07: would follow the same horizontal and vertical profile as Option 00 and would include the 510m green tunnel but also indicative landscaped mitigation with 1:10 slopes as part of the green tunnel design. A 500m long inverted siphon would be required in crossing the Kingston Brook watercourse in this location;
- Option 08: would follow the same horizontal and vertical profile as Option 00 but the alignment would be raised by up to approximately 4m to the south of Staffordshire County Showground and approaching Hopton in order to provide improved clearance over the Kingston Brook watercourse. The 1:10 sloped landscaped green tunnel was also included but due to the raised alignment this landscaping required a greater area of land than Option 07. North of Hopton the alignment would continue in cutting but at a reduced depth of up to approximately 16m compared with the Option 00;
- Option 09: would follow the same horizontal and vertical profile as Option 00. However, south of Hopton the section of green tunnel would be replaced by a 5m high landscaped retaining wall on the north side of the alignment. This option would also require an approximately 400m long inverted siphon associated with the Kingston Brook watercourse; and
- Option 10: would follow the same horizontal and vertical profile as Option 08, with the alignment raised south of Staffordshire County Showground to navigate the Kingston Brook watercourse. The section of green tunnel would be replaced with a 5m high landscaped retaining wall on the north side of the alignment, similar to Option 09 but required an increased area of land due to the raised alignment. An approximately 200m long culvert would be required for the Kingston Brook watercourse crossing.

5.3.3 HS2 Ltd determined that Option 10 should be taken forward as the preferred option. It was progressed on the basis of providing the most viable solution to the Kingston Brook watercourse crossing whilst maintaining a comparable level of visual mitigation for the residents of Hopton to Option 00. There would be a very slight increase in noise impacts associated within the raising of the alignment to provide clearance over the Kingston Brook. This refinement included a route slightly higher than Option 00 and replaced the green tunnel proposed in Option 00 with a 5m high landscaped retaining wall. The fully landscaped green tunnel options (07 and 08) had some increased landscape and visual impacts and required similar property demolitions without providing a suitable solution for the Kingston Brook watercourse crossing.

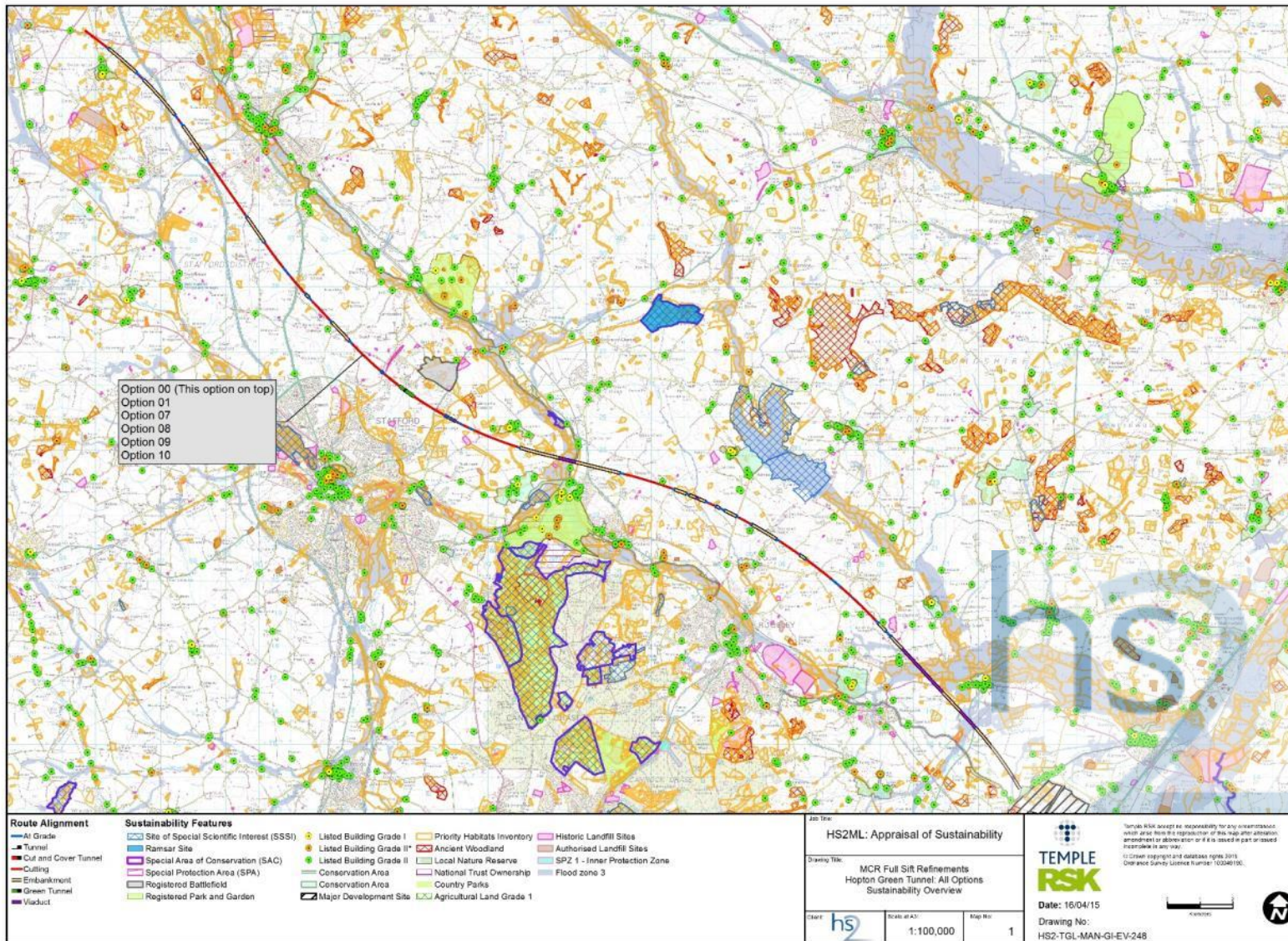
- 5.3.4 The sustainability impacts of each of the options is set out below with those of the preferred option presented first.
- 5.3.5 The preferred option, Option 10, would have moderate landscape and visual impacts for the Hopton area, with visual impacts resulting from the creation of an intrusive structure within close proximity to the village, impacting the open rural views from the elevated village. Deep cuttings to the south, near Staffordshire County Showground would require land from the car park, and north of Hopton, under the A518 and B5066, would further affect the local landscape character. Approximately 13 demolitions would be required along the 7km section near Hopton, with up to four associated with the landscaped retaining wall proposed south of the village. A culvert up to approximately 200m long may be required to alleviate hydrological concerns associated with the landscaping of the retaining wall.
- 5.3.6 Option 00 is the RRB which includes a green tunnel box structure but without any mitigation or landscaping within the design. Whilst a green tunnel would provide some form of mitigation from a visual perspective for the residents of Hopton, without the detailed design associated with this option, understanding of the potential impacts (including demolitions), was limited. Deep cuttings to the south and north of Hopton, marginally deeper than the preferred option, would continue to have an impact on the landscape character. For the 7km section there would be approximately nine demolitions. The Option 00 would require a long inverted siphon in order to address the Kingston Brook watercourse crossing, which would be undesirable from an ecological and maintenance perspective.
- 5.3.7 Option 01 would have moderate to localised major landscape and visual impacts due to the removal of the green tunnel and associated structures within the landscape to the north and south of Hopton. This would be particularly prevalent for the residents of Hopton who would look down the valley onto the railway, which would be raised relative to the local landscape and a significantly increased impact compared with the preferred option. There would be a marginal increase in noise impacts without the landscaped mitigation proposed with the preferred option. Deep cuttings to the south and north of Hopton, similar to preferred option, would have an impact on the landscape character. For the 7km section there would be approximately 9 demolitions. The hydrological solution to the Kingston Brook would be likely to involve a drop inlet culvert, which would be undesirable from an ecological and maintenance perspective.
- 5.3.8 Option 07 would have moderate landscape and visual impacts due to the creation of an intrusive landform and deep cuttings either side of the proposed green tunnel. The design of the green tunnel itself would require a greater amount of land both to the north and south of the alignment at Hopton than the preferred option, extending out to approximately 220m. Deep cuttings to the south and north of Hopton, marginally deeper than the preferred option, would have an impact on the landscape character. For the 7km section there would be approximately 9 demolitions, with noise impacts similar to the preferred option. The hydrological solution to the Kingston Brook would likely require a long inverted siphon, which would be undesirable from an ecological and maintenance perspective.
- 5.3.9 Option 08 would have moderate to localised major landscape and visual impacts due to the creation of an intrusive landform and deep cuttings either side of the proposed green tunnel, with the height of the alignment raised to provide greater clearance

over the Kingston Brook watercourse. The design of the green tunnel itself would require a greater amount of land both to the north and south of the alignment at Hopton than the preferred option, extending out to approximately 300m, with the top of the green tunnel at a similar height to houses to the north and obstructing views down the valley. Deep cuttings to the south and north of Hopton, similar to the preferred option, would have an impact on the landscape character. Approximately 13 demolitions would be required along the 7km section near Hopton, with up to four associated with the landscaped green tunnel, with noise impacts also similar to the preferred option. The hydrological solution to the Kingston Brook would likely require a drop inlet culvert, which would be undesirable from an ecological and maintenance perspective.

5.3.10 Option 09 would have moderate landscape and visual impacts due to the creation of an intrusive landform and deep cuttings. The section of green tunnel would be replaced with a landscaped retaining wall to the north of the alignment, extending out to approximately 50m with height approximately 5-8m lower than the houses to the north. Deep cuttings to the south and north of Hopton, marginally deeper than the preferred option, would have an impact on the landscape character. Approximately 13 demolitions would be required along the 7km section near Hopton, with up to four associated with the landscaped retaining wall, with noise impacts also similar to the preferred option. The hydrological solution to the Kingston Brook would be likely to require a long inverted siphon, which would be undesirable from an ecological and maintenance perspective.

5.3.11 Whilst Option 10 was chosen as the most appropriate at this stage of the scheme development, subsequent work has led to this option being revisited. Further information on this particular area can be found in Section 6.3.

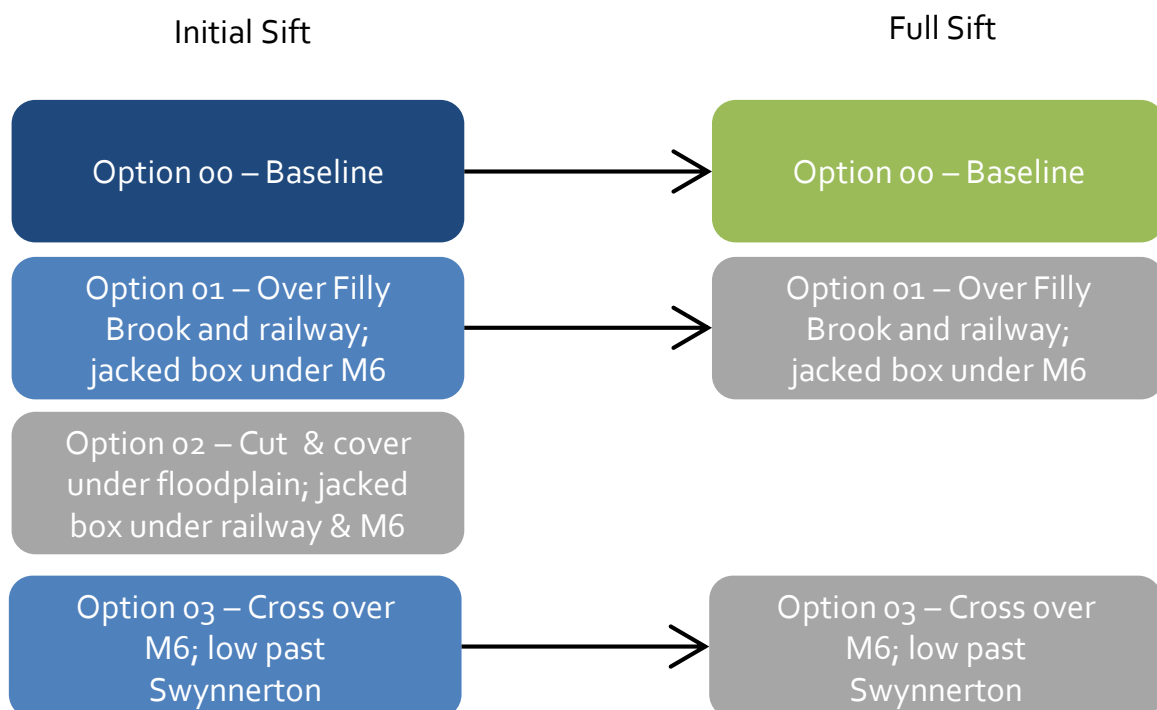
Figure 17: Local alternatives studied for Hopton



5.4 M6 crossing and Swynnerton

5.4.1 This refinement area covered approximately 10km of the route between a point south of Stone to a point to the north of Swynnerton. The primary refinement considerations were to address concerns regarding the height of the route over the M6 and past the village of Swynnerton (conservation area) without impacting on the Swynnerton water supply boreholes adjacent to the M6. Four options were proposed for this section of the route, one of which was not progressed past the initial sift as it was not considered reasonable on the basis of engineering, cost or sustainability grounds. The options taken forward in the sift stages are shown in Figure 18 and described in the subsequent paragraphs of this section of the report. The location of the options are shown in Figure 19.

Figure 18: Local alternatives studied for the M6 crossing and Swynnerton



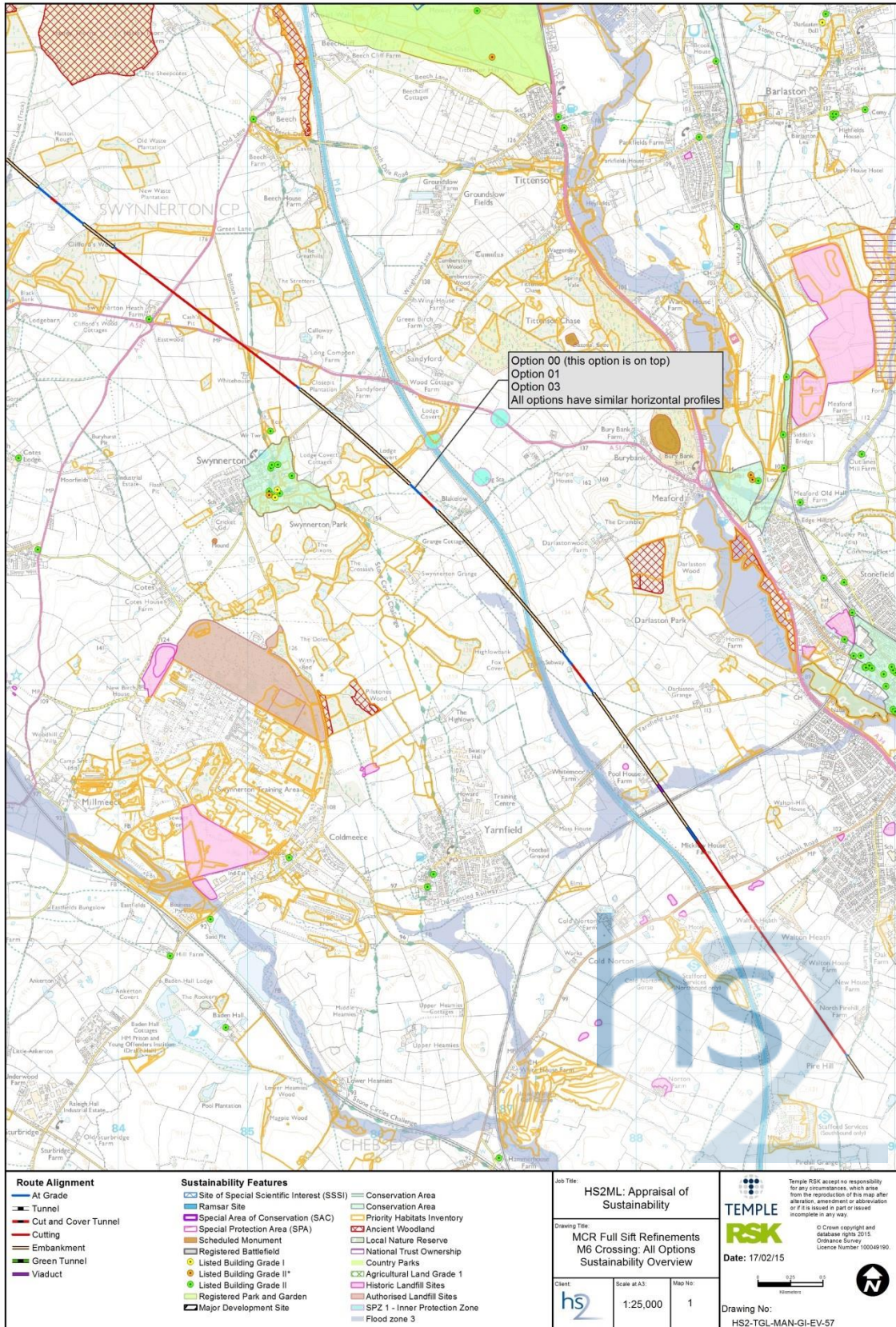
5.4.2 The following options were studied during the full sift:

- Option 00: the RRB, which ran on high embankment to cross over the M6, on embankment past Swynnerton and then dropped into cutting further north under the A51;
- Option 01: would follow the same route as Option 00 but at a reduced height. It would pass over the Filly Brook floodplain before going under the M6, continuing in deep cutting (approximately 27m) through a groundwater Source Protection Zone 2 (SPZ2) associated with Swynnerton water supply boreholes, and continuing past Swynnerton on embankment; and
- Option 03: followed the same route as Option 00. It crossed over both the Filly Brook floodplain and the M6 on viaduct, but had a slightly lower vertical

alignment approaching and passing Swynnerton variously in cutting, at grade and on embankment.

- 5.4.3 HS2 Ltd determined that Option 00 (RRB) should be progressed as the preferred option. It was progressed on the basis that the alternatives would either have similar or increased impacts on the local environment or would incur additional cost or engineering complexities without providing a practicable resolution to resolving concerns highlighted following consultation, which focused on the raised crossing over the M6.
- 5.4.4 The sustainability impacts of each of the options is set out below with those of the preferred option presented first.
- 5.4.5 The preferred option, Option 00, would have moderate landscape and visual impacts as a result of the embankment and viaduct crossing over the M6 and Filly Brook, and a section of embankment running to the east of Swynnerton, which is also a conservation area. Approximately 120m of the route would be in cutting through the area of SPZ2 associated with local Swynnerton water supply boreholes.
- 5.4.6 Whilst Option 01 would have reduced visual impacts in the vicinity of the M6 as a result of the route passing beneath the motorway, there would be an increased impact on the landscape character due to the depth and width of cutting required. By going under the M6, almost 1km of the route would need to be within cutting through the area of SPZ2 associated with the local Swynnerton water supply boreholes, creating an increased hydrological risk when compared with the preferred option. There would be a small reduction in noise impacts associated with crossing under rather than over the M6.
- 5.4.7 Option 03 would have moderate landscape and visual impacts as a result of the raised crossing over the M6. Whilst visual impacts would remain east of Swynnerton, these would be reduced slightly as a result of the lowered height of the embankments when compared with the preferred option. Approximately 350m of the route would be in cutting within the area of SPZ2, an increase compared to the preferred option. Noise impacts would be similar to the preferred option.

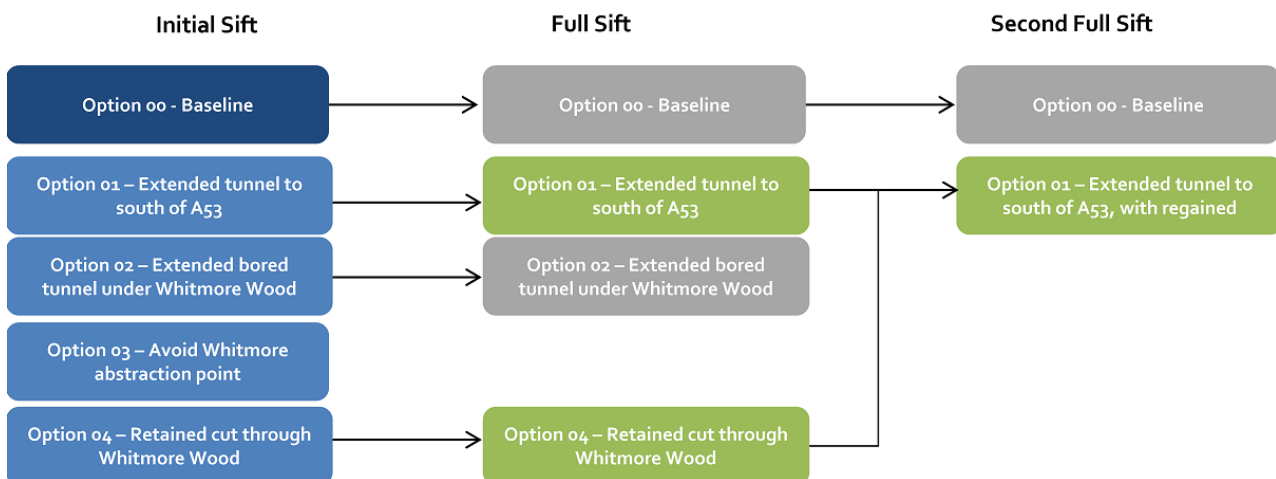
Figure 19: Local alternatives studied for the M6 crossing and Swynnerton



5.5 Whitmore Heath

5.5.1 This refinement area covered approximately 11km of the route between Swynnerton and Madeley. The primary refinement considerations were to address concerns over the tunnel portal locations, including the cut and cover tunnel approaching Whitmore Heath, and the impacts of the route on Whitmore Wood Ancient Woodland. Five options were proposed with one not progressed from the initial sift as it was not considered reasonable on the basis of engineering, cost or sustainability grounds. Of the four options progressed to a full sift HS2 Ltd determined that a hybrid of two options (Option 01 and Option 04) was progressed to a second full sift. The second sift considered the hybrid proposal against Option 00 (RRB). The options taken forward in the sift stages are shown in Figure 20 and described in the subsequent paragraphs of this section of the report. The location of the options are shown in Figure 21.

Figure 20: Local alternatives studied for Whitmore Heath



5.5.2 The following two options were taken forward to the second full sift review:

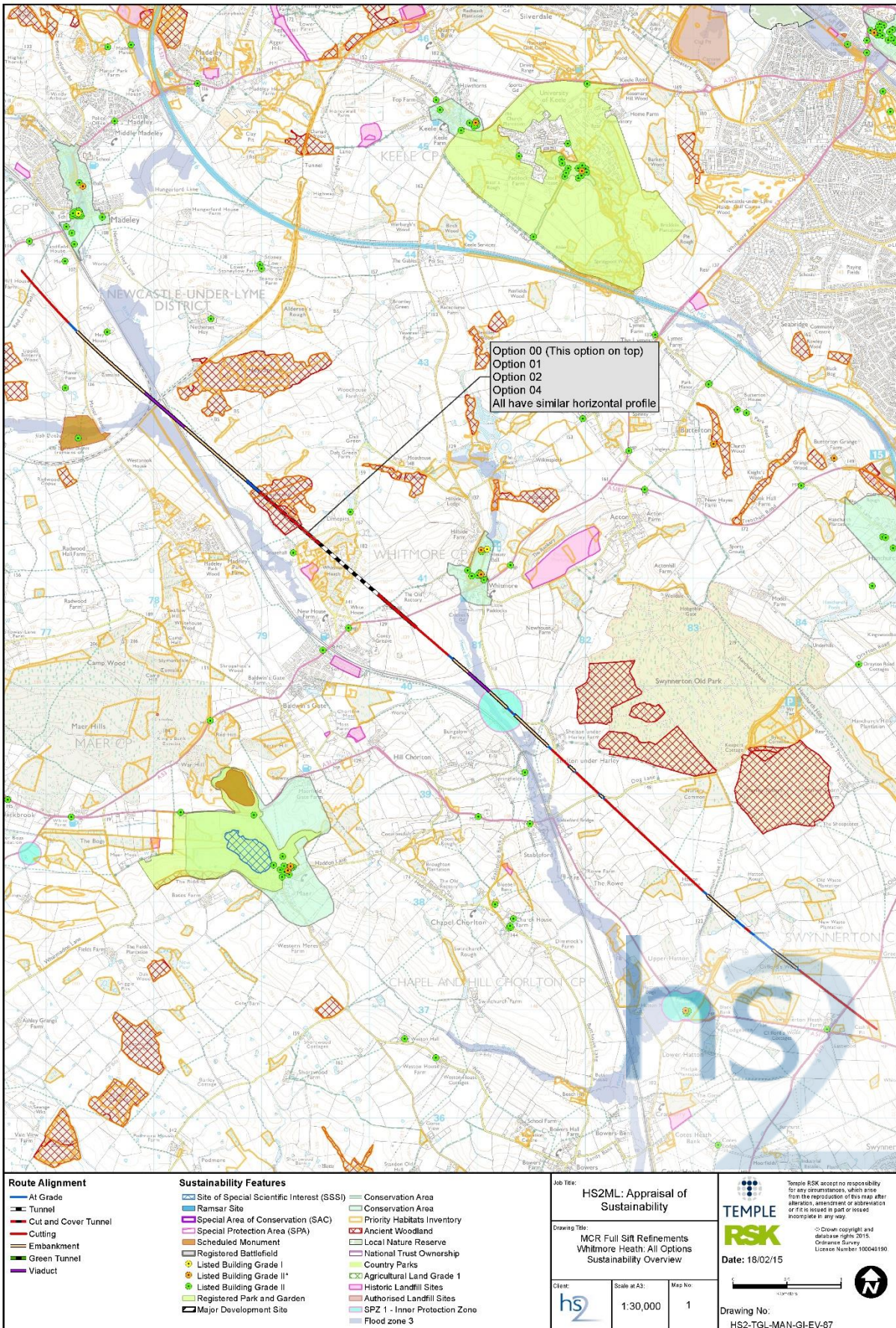
- Option 00: the RRB. This option ran north-west from Swynnerton via a series of cuttings and embankments, close to Whitmore abstraction borehole and under the A53 before entering into a twin bore tunnel under Whitmore Heath, exiting to north of the settlement in cutting through Whitmore Wood Ancient Woodland; and
- Revised Option 01 (hybrid of previous Options 01 and 04) would have a reduced length of cut and cover tunnel (by approximately 150m) south of Whitmore Heath approaching the bored tunnel, as a result of revisiting the associated costs of this infrastructure. It would also introduce a partially retained cut through Whitmore Wood to reduce the amount of land required from the ancient woodland. South of the cut and cover tunnel approaching Whitmore Heath, and further north of Whitmore Wood, the route options would be similar.

5.5.3 Option 01 (a hybrid of the previous Options 01 and 04) was recommended to be taken forward as the preferred option. It was progressed on the basis of the reduced environmental impacts associated with the introduction of the section of cut and cover tunnel south of Whitmore Heath and partially retained cut through Whitmore

Wood Ancient Woodland. Option 01 also provided a moderate cost saving compared to Option 00.

- 5.5.4 The sustainability impacts of each of the options is set out below with those of the preferred option presented first.
- 5.5.5 The preferred option, Option 01, would have adverse landscape impacts and introduction of intrusive structures including a deep cutting east of Swynnerton and a viaduct crossing over the Meece Brook. The introduction of a 350m section of cut and cover tunnel close to the A53 and immediately preceding the bored tunnel under Whitmore Heath would aim to alleviate some of the visual impacts associated previously with the deep open cutting as part of Option 00.
- 5.5.6 A deep cutting through Whitmore Wood would require land from this ancient woodland, although a partially retained cut through the woodland would reduce land required by 30% compared to Option 00. Further north, the viaduct crossing of the River Lea and WCML would adversely impact on the attractive valley landscape, and a section of embankment in proximity to the Grade II listed Hey House would impact on its setting.
- 5.5.7 Option 00 (RRB) would have similar adverse landscape impacts to Option 01, including a deep cutting east of Swynnerton and a viaduct crossing over the Meece Brook. However, this option also would have greater landscape impacts as a result of the deep open cut approaching Whitmore Heath before entering bored tunnel. This option would also require 30% more land from Whitmore Wood Ancient Woodland further north, again as result of open cut on both sides of the route through the woodland. Further north the viaduct crossing of the River Lea and WCML would continue to adversely impact on the attractive valley landscape, and a section of embankment in proximity to the Grade II listed Hey House would impact on its setting, similar to the preferred option.

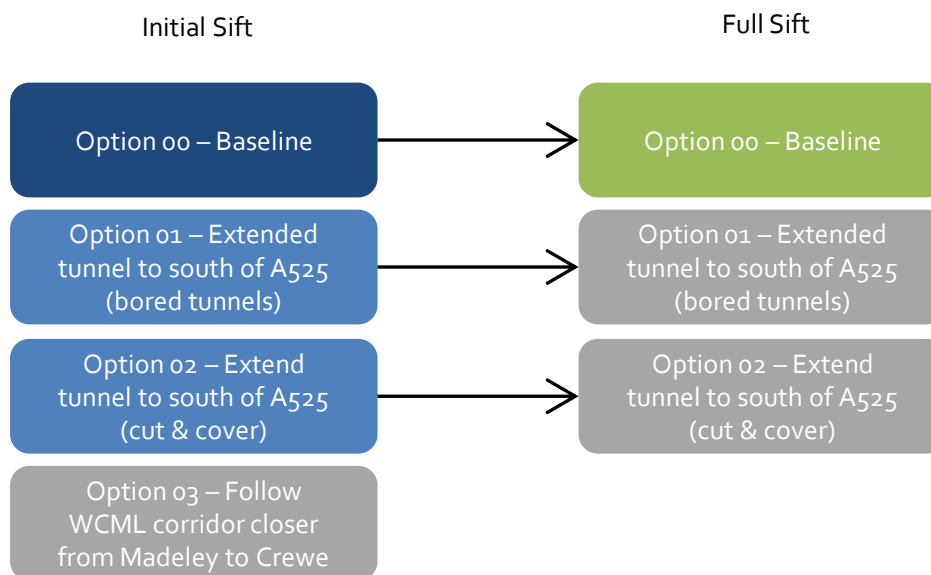
Figure 21: Local alternatives studied for Whitmore Heath



5.6 Madeley tunnel

5.6.1 This refinement area covered approximately 18km of route from north of Swynnerton to south of Chorlton. The primary refinement considerations were to address concerns over the location of the southern tunnel portal and the proposed realignment of the A525 Bar Hill Road at Madeley, direct impacts on properties along the A525 Bar Hill Road, Barhill Wood Ancient Woodland and highway at Bar Hill. A total of four options were proposed, with one not progressing past an initial sift as it was not considered reasonable on the basis of cost, engineering or sustainability grounds. The options taken forward in the sift stages are shown in Figure 22 and described in the subsequent paragraphs of this section of the report. The location of the options are shown in Figure 23.

Figure 22: Local alternatives studied for Madeley tunnel



5.6.2 The following options were studied during the full sift:

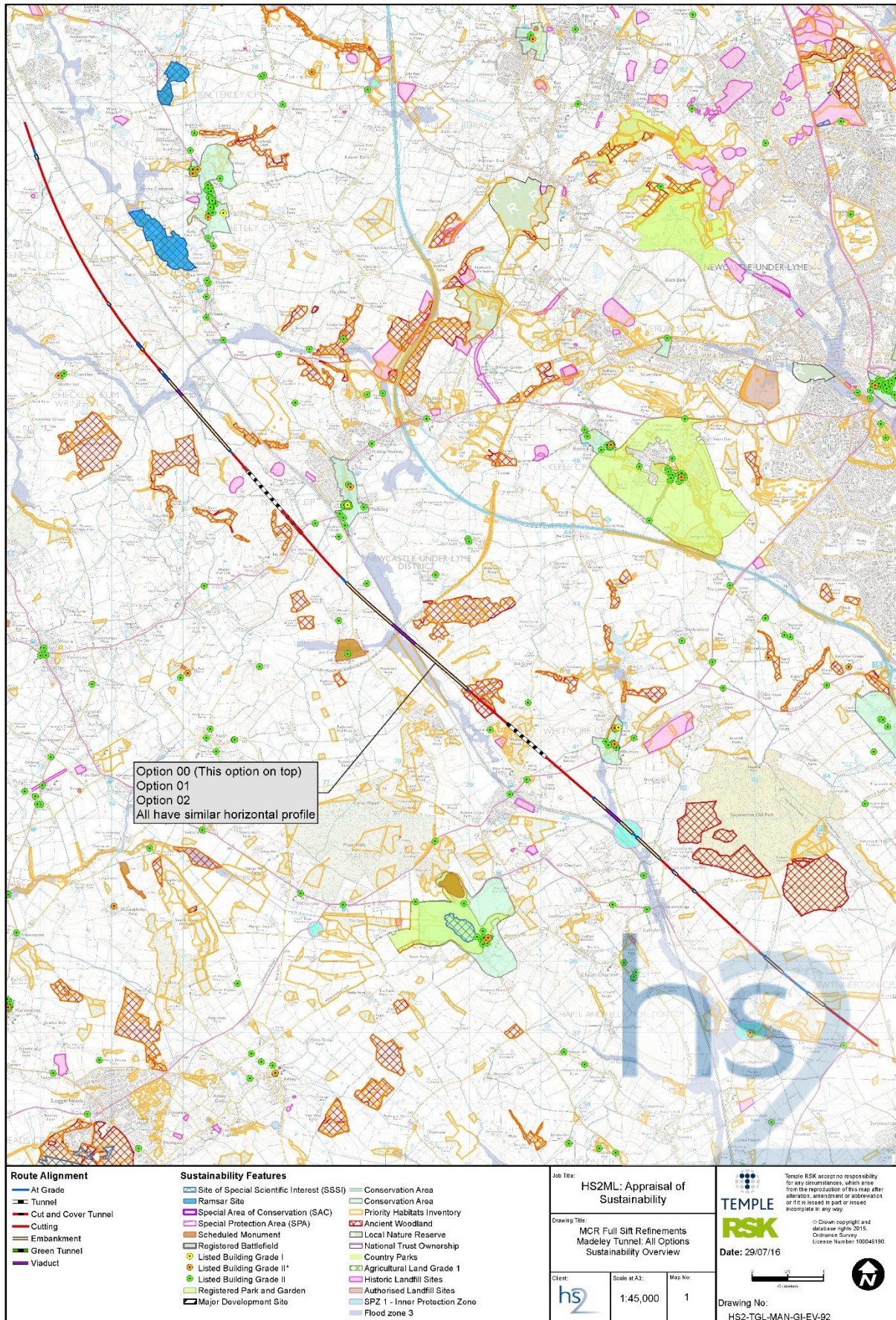
- Option 00: the RRB, would cross the WCML and River Lea on viaduct. The route would continue north-west, passing on embankment within approximately 200m of the Grade II listed Hey House; it would then descend into cutting under the A525 Bar Hill Road on the approach to Madeley tunnel;
- Option 01: would follow a similar route as Option 00 but with the tunnel extended at Madeley by approximately 400m to the south of the A525 Bar Hill Road through bored tunnel, avoiding Barhill Wood Ancient Woodland and A525 Bar Hill Road; and
- Option 02: would also follow a similar route to Option 00 but with an extended tunnel at Madeley by approximately 400m to the south of the A525 Bar Hill Road using a combination of bored tunnel and cut and cover under the A525 Bar Hill Road.

5.6.3 Based on consideration of sustainability, cost and engineering constraints, HS2 Ltd determined that Option 00 should be taken forward as the preferred option. The

extension of tunnelling (options 01 and 02) through either an additional section of bored or cut and cover tunnel close to the A525 Bar Hill Road did not deliver significant enough benefits to justify the additional cost, with little variation across the options other than the potential avoidance of two demolitions with Option 01.

- 5.6.4 The sustainability impacts of each of the options is set out below with those of the preferred option presented first.
- 5.6.5 Option 00, the preferred option, would have moderate landscape and visual impacts both to the north and south of Madeley, including a viaduct skew crossing over the River Lea and WCML, and raised crossing over the Checkley Brook. A section of embankment in proximity to the Grade II listed Hey House would impact on its setting before the route entered sections of cutting and bored tunnel west of Madeley. The bored tunnel would help to minimise noise and visual impacts for the local residents at Madeley, although the cutting approaching the tunnel portal under the A525 Bar Hill Road will require approximately two demolitions (along Bar Hill Road) and the extent of the cutting is in close proximity to Barhill Wood Ancient Woodland. To the north of the bored tunnel approximately four properties may be isolated between the route and the WCML to the east, near Wrinehill.
- 5.6.6 Option 01 would have largely similar impacts to that of the preferred option with moderate landscape and visual impacts both north and south of Madeley, including a skewed viaduct crossing over the River Lea and WCML and raised crossing over the Checkley Brook. A section of embankment in proximity to the Grade II listed Hey House would impact on its setting. West of Madeley the bored tunnel would be extended by approximately 500m to the south, compared with the preferred option. This would avoid up to two property demolitions alongside the road, compared with the preferred option. To the north of the bored tunnel, as with the preferred option, approximately four properties may be isolated between the route and the WCML to the east, near Wrinehill.
- 5.6.7 Option 02 would have largely similar impacts to that of the preferred option with moderate landscape and visual impacts both north and south of Madeley, including a skewed viaduct crossing over the River Lea and WCML and raised crossing over the Checkley Brook. A section of embankment in proximity to the Grade II listed Hey House would impact on its setting. West of Madeley the introduction of a section of cut and cover tunnel would still however require the demolition of two properties along the A525 Bar Hill Road, similar to the preferred option. To the north of the bored tunnel, as with the preferred option, approximately four properties may be isolated between the route and the WCML to the east, near Wrinehill.

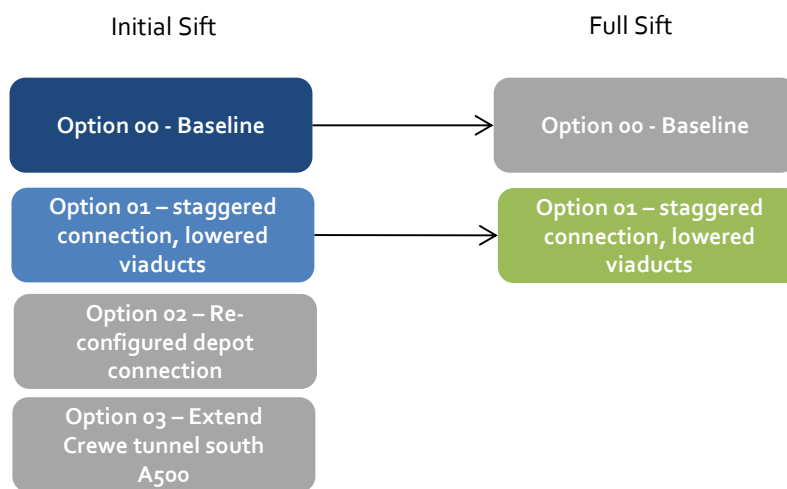
Figure 23: Local alternatives studied for Madeley tunnel



5.7 Crewe junction

5.7.1 This refinement area covered approximately 6km of the route immediately south of Chorlton to just before the tunnel portal south of Crewe (the location of the portal has since changed). The primary refinement considerations were to address concerns over the height of the viaducts at Chorlton and to determine the preferred layout of the junction to the south of Crewe and interaction with the proposed IMD³¹. Four options were proposed, of which two did not progress beyond the initial sift as they were not considered reasonable on the basis of engineering, cost or sustainability grounds. The options taken forward in the sift stages are shown in Figure 24 and described in the subsequent paragraphs of this section of the report. The location of the options are shown in Figure 25.

Figure 24: Local alternatives studied for Crewe junction



5.7.2 The following options were studied during the full sift:

- Option 00: the RRB, would include large sections of high embankment and viaduct adjacent to Chorlton in order to provide adequate clearance over or under adjacent infrastructure, including the WCML. This would approach Crewe following the existing railway (WCML) in a north-westerly direction to the west of Chorlton and the WCML and over the A500 Shavington Bypass on embankment, before continuing in cutting and then in a bored tunnel under Crewe;
- Option 01 would follow a similar route to that of Option 00 but additionally would re-address the connectivity with the WCML, staggering the connections to the existing rail network and thereby reducing the maximum height of the railway past Chorlton.

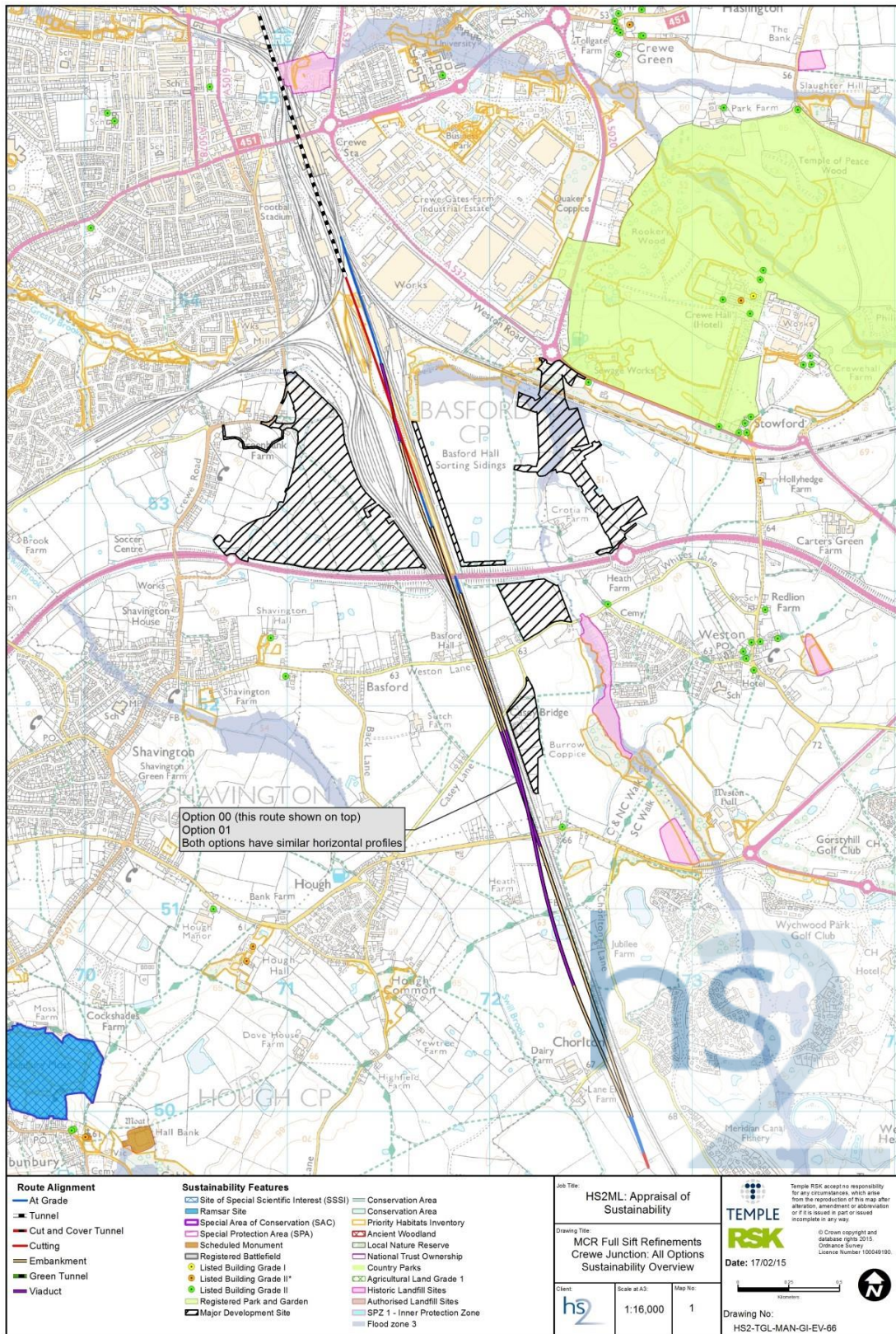
5.7.3 Option 01 was taken forward as the preferred option, based on consideration of the slightly reduced sustainability impacts, as well as the improved configuration in connectivity with the WCML. Although Option 01 extends the length of viaducts

³¹ The IMD no longer forms part of the Proposed Scheme, which now includes a maintenance facility in the form of an Infrastructure Maintenance Base-Rail (IMB-R) near Stone. However, at the time these alternatives were considered, the IMD did form part of the scheme.

further to the south, the height of railway structures and associated highways structures means that there are slightly reduced landscape and visual impacts at Chorlton and other nearby rural settlements compared with Option 00.

- 5.7.4 The sustainability impacts of each of the options is set out below with those of the preferred option presented first.
- 5.7.5 Option 01, the preferred option, would have moderate landscape and visual impacts past Chorlton and Hough as a result of sections of embankment and viaduct within a relatively flat open landscape, although the height of the structures is reduced when compared with Option 00. Whilst Chorlton is already in proximity to the WCML, with the existing railway lying between the settlement and the HS2 route, there would be some additional noise impacts for local residents. The tunnel further north would intersect a historic landfill site.
- 5.7.6 Option 00 (RRB) would follow a similar horizontal alignment to Option 01, but the configuration of the connections with the WCML would result in major landscape and visual impacts at Chorlton and Hough. This is due to the high viaducts and embankments within the relatively flat open landscape, with both the height of structures and level of impact from a visual and noise perspective greater in this area when compared with the preferred option.
- 5.7.7 Whilst Option 01 was chosen as the most appropriate at this stage of the scheme development, subsequent work has led to this option being revisited. Further information on this particular area can be found in Section 6.6.

Figure 25: Local alternatives studied for Crewe junction



6 Local alternatives considered since November 2015

6.1 Introduction

- 6.1.1 Since November 2015, as part of the design development process, a series of potentially feasible amendments to the Proposed Scheme have been identified and reviewed within workshops attended by engineering, construction, planning and environmental specialists. During the workshops, a comparison was conducted of each design option, which included consideration of:
- engineering requirements: the degree of design complexity of the alternatives and the impact this would have on construction durations and construction and operational costs;
 - cost: whether the alternatives would be more cost effective or incur additional costs; and
 - potential environmental impact: whether the alternatives would have more or less environmental impact (e.g. sound, noise and vibration and landscape and visual).
- 6.1.2 The comparison also considered, as appropriate, feedback provided through stakeholder engagement and responses to the consultation between September and November 2016 on the working draft EIA Report and the Design Refinement Consultation³².
- 6.1.3 The following sections detail the reasonable local alternatives studied and the main reasons for selecting the option to be taken forward into the Proposed Scheme. The environmental impacts of the option selected (the Proposed Scheme) are then presented, followed by the environmental impacts of the alternative options compared to those of the Proposed Scheme. Other considerations are also noted including engineering requirements and cost. In some cases a preliminary appraisal of options has been undertaken, whereby options have been considered in terms of whether they are reasonable against environmental, technical and design criteria, and should, therefore, be progressed for further consideration.
- 6.1.4 In considering the environmental impacts, all EIA topics have been taken into account, however, only those topics where there is a potential impact are reported. During the preparation of the EIA, alternatives were appraised against the baseline scheme³³, however, in accordance with the new Environmental Impact Assessment (EIA) Directive³⁴ (2014/52/EU) that was implemented by the Town and Country Planning

³² HS2 Ltd., (2015), *West Midlands to Crewe Design Refinement Consultation*. Available online at:

<https://www.gov.uk/government/consultations/hs2-phase-2a-west-midlands-to-crewe-design-refinement-consultation>

³³ For the purpose of the comparative analysis the appraisal of alternatives were undertaken against a selected baseline option, to determine if the alternative is environmentally better or worse than the baseline. The baseline option is frequently the scheme as announced by the Secretary of State in November 2015.

³⁴ Official Journal of the European Union, *Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment*.

(Environmental Impact Assessment) Regulations that came into force on 16 May 2017, the comparison is presented below against the Proposed Scheme. Detailed assessment of the Proposed Scheme is presented in the relevant Volume 2, CA Reports.

6.2 Community area 1 – Fradley to Colton

Review of the vertical alignment at Kings Bromley, Pipe Ridware and Blithbury

- 6.2.1 During the design development process since the announcement of the preferred route to Crewe in November 2015, and following the publication of the working draft EIA Report, design development of the Proposed Scheme has led to the relocation of the permanent maintenance facility from Crewe, in the South Cheshire area (CA5), to near Stone, in the Stone and Swynnerton area (CA3).
- 6.2.2 The relocation of the permanent maintenance facility means that maintenance loops at Pipe Ridware will no longer be required³⁵, therefore presenting an opportunity to consider a lower vertical alignment of a section of the route of the Proposed Scheme at Kings Bromley, Pipe Ridware and Blithbury. The sensitivity of this location, particularly the proximity of the route to residential properties at Pipe Ridware and Blithbury and the impact on local heritage settings have been key considerations in the development of these alternatives.
- 6.2.3 The following two options were taken forward to a detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered:
- Option SSo: the route would remain on the same vertical alignment as assessed in the working draft EIA Report but with the removal of the maintenance loops at Pipe Ridware. The height of the Pipe Ridware embankment being up to 16m, the Blithbury South cutting up to 4m in depth, the Blithbury Central cutting up to 12m in depth, and the Blithbury North cutting up to 12m in height. The Kings Bromley viaduct would be up to 13m, the Bourne embankment up to 14m, and the River Trent viaduct up to 17m; and
 - the vertical alignment of the route presented in Option SS1b³⁶: the vertical alignment of this route would generate an embankment of up to 8m at Pipe Ridware and depths of up to 3m at Blithbury South cutting, up to 8m at Blithbury Central cutting and up to 11m at Blithbury North cutting. The height of the Kings Bromley viaduct and Bourne embankment would both be up to

³⁵ At the time that alternatives were being considered, maintenance loops were proposed as part of the scheme. These were to be located at Pipe Ridware due to the IMD then proposed to be located towards the northern end of the route at Crewe. They were intended to enable maintenance trains to be stabled temporarily during the day when maintenance activities would be undertaken over a number of nights, without having to return to the IMD. However, the maintenance facility (the IMB-R) will now be located more centrally, near Stone, in the Stone and Swynnerton area. This will enable better positioning of maintenance trains for efficient dispatch for maintenance works across the route in both directions, avoiding the need for maintenance loops.

³⁶ Option SS1b includes a low vertical alignment and the route crossing the River Trent and Bourne Brook via two viaducts, with a central embankment. This option deals only with the vertical alignment component of the option. The viaduct and embankment component of the option are dealt with under the 'Review of the Bourne Brook and River Trent crossings (via one viaduct or two shorter viaducts)' alternative.

15.5m. The height of the River Trent viaduct would be up to 15m.

- 6.2.4 The vertical alignment of the route presented in Option SS1b was taken forward into the Proposed Scheme as on balance it presented the most favourable environmental outcome. Option SSo in comparison would present an increase in environmental impacts most notably an impact on local groundwater resources and an increase in visual and noise impacts for residences at Pipe Ridware. Option SSo would also be significantly more expensive to construct than the Proposed Scheme. The analysis of engineering, cost and potential environmental impacts associated with both options is set out below, with the impacts of the option selected presented first.

Option SS1b

- 6.2.5 Option SS1b would result in noise impacts on the residents of Blithbury including the pupils and residents of Rugeley School. The lowered alignment would significantly decrease the height of the Pipe Ridware embankment minimising visual and noise impacts on the amenity of residences at Pipe Ridware, the Grade II listed Woodhouse Farmhouse and Bentley Hall Farmhouse. It would also decrease the height of the River Trent viaduct minimising visual impacts. The reduced cutting depth of the Proposed Scheme near Blithbury would require two drop inlet culverts. This would allow groundwater resources to flow efficiently and would minimise the impact on biodiversity and potential flood risk.
- 6.2.6 Option SS1b does not introduce any technical or construction complexities, risk of safety hazards or lengthening of the construction programme.

Option SSo

- 6.2.7 In comparison to Option SS1b (the Proposed Scheme), Option SSo would result in a slight decrease in localised noise impacts for the residents of Blithbury and pupils of Rugeley School due to the increased cutting depths at Blithbury. The visual and noise impacts on residences at Pipe Ridware and the Grade II listed Woodhouse Farmhouse and Bentley Hall Farmhouse however would be greater than those associated with the Proposed Scheme. Two inverted siphons would be required to allow the existing watercourse to continue to flow downstream. The use of inverted siphons could increase the risk of material build up causing blockages and therefore flooding upstream. Inverted siphons also have the potential to impact local groundwater resources as part of the watercourse would be covered and light would be prevented from reaching existing sections of open channel. This could potentially impact the water quality, biodiversity and have implications on achieving the required Water Framework Directive (WFD) status.
- 6.2.8 Option SSo also does not introduce any technical, construction complexities or risk of safety hazards or lengthening of the construction programme. This option would, however, be significantly more expensive to construct than Option SS1b.

Embankment at Stockwell Heath and Colton

- 6.2.9 During the design development process since the announcement of the preferred route to Crewe in November 2015, further consideration was given to how the route of the Proposed Scheme would pass the villages of Stockwell Heath and Colton.

6.2.10 The following four options were taken forward to a more detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered:

- Option A3.0: the route would pass between the villages of Stockwell Heath and Colton on an embankment of approximately 900m in length and up to 10m in height. The realignment of Newlands Lane and diversion Moor Lane would be required. Moreton Brook would be diverted beneath the embankment;
- Option A3.1a: the route would pass between the villages of Stockwell Heath and Colton on a multi-span viaduct of approximately 540m in length and up to 11m in height removing the need to realign Newlands Lane and divert Moor Lane and removing the need to culvert Moreton Brook. Moor Lane would however be lowered to allow for a lower viaduct height;
- Option A3.1b: the route would pass between the villages of Stockwell Heath and Colton on a multi-span viaduct of approximately 540m in length and up to 13m in height removing the need to realign Newlands Lane and divert Moor Lane; and
- Option A3.2: the route would pass between the villages of Stockwell Heath and Colton on an embankment of approximately 580m in length and up to 8m in height. The realignment of Newlands Lane and the diversion of Moor Lane would be required. Moreton Brook would be diverted beneath the embankment.

6.2.11 Option A3.0 was taken forward into the Proposed Scheme. In comparison, Option A3.1a and Option A3.2 would provide greater environmental benefits. However, all presented significant increases in cost compared to Option A3.0, and Option A3.1a and Option A3.1b introduced significant technical complexities. The analysis of engineering, cost and potential environmental impacts associated with the options is set out below, with the impacts of the option selected presented first.

Option A3.0

6.2.12 Option A3.0 would introduce a physical and visual barrier between Colton and Stockwell Heath and would be likely to result in permanent isolation for residential properties. This option would result in noise impacts on the residents of Stockwell Heath, sever the historic landscape and result in the loss of agricultural land and loss and fragmentation of habitats. The culverts required for this option (required to divert Moreton Brook beneath the embankment) would result in hydraulic and hydro-geomorphology impacts and there would be an impact on an upstream tributary of the Moreton Brook.

6.2.13 Option A3.0 would not introduce any technical or construction complexities, risk of safety hazards or lengthening of the construction programme.

Option A3.1a

- 6.2.14 In comparison to Option A3.0 (the Proposed Scheme), Option A3.1a would require the lowering of Moor Lane resulting in severance and a reduction in accessibility during construction. It would result in significant temporary landscape and visual and noise effects during construction compared to Option A3.0. This option would reduce the loss of agricultural land and also reduce severance of the historic landscape. The need to realign Newlands Lane and to divert Moor Lane would reduce the impact on the local highway network.
- 6.2.15 This option would be significantly more expensive and complex to construct than the Proposed Scheme due to the length of the viaduct. There would also be a slight increase to the construction programme due to viaduct construction works and would be more hazardous during operation due to maintenance.

Option A3.1b

- 6.2.16 In comparison to Option A3.0 (the Proposed Scheme), Option A3.1b would increase the height of the embankments on the approach to the viaduct due to the height of the viaduct. This increase in height would require a greater portion of land therefore increasing the loss of agricultural land and would have a greater visual impact during construction when compared to Option A3.0.
- 6.2.17 This option would be significantly more expensive and complex to construct than the Proposed Scheme due to the inclusion of a viaduct. There would be a slight increase to the programme due to viaduct construction works and would be more hazardous during operation due to maintenance.

Option A3.2

- 6.2.18 In comparison to Option A3.0 (the Proposed Scheme), Option A3.2 would reduce the length and height of the embankment however the lower alignment in this option would increase the requirement for noise barriers. This lower alignment would result in improved visual impacts compared to Option 3.0.
- 6.2.19 Option A3.2 would be more expensive to construct due to the additional cut material required for transportation but would not introduce any technical or construction complexities, risk of safety hazards or lengthening of the construction programme.

Review of the Bourne Brook and River Trent crossings (via one viaduct, or two shorter viaducts)

- 6.2.20 During the design development process since the announcement of the preferred route to Crewe in November 2015, further consideration was given to how the route of the Proposed Scheme would cross the Bourne Brook and River Trent and their associated floodplains. The sensitivity of this location, particularly the visual impacts and proximity of the route to the River Trent and Bourne Brook and Tomlinson's Spinney local wildlife site (LWS) have been key considerations in the development of these alternatives.

6.2.21 As part of design for the working draft EIA Report the following four options were taken forward to a detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered:

- Option A1.0 (the route announced in November 2015 and presented in the working draft EIA Report) included the Bourne Brook viaduct (renamed as the Kings Bromley viaduct) and the River Trent viaduct, approximately 730m and 1.9km in length, respectively, with the Bourne embankment, approximately 800m in length, between the two viaducts;
- Option A1.1a included a single viaduct of approximately 2.8km in length, with a 230kph crossover, which would remove the Bourne embankment with the viaduct spanning across the Bourne Brook and the River Trent and their associated floodplains. A 230kph rail crossover would be relocated to an extended embankment to the north near Pipe Ridware which would itself extend further to the south. Due to the extension of the embankment into the River Trent floodplain, this option would increase flood levels in this location and a replacement floodplain storage area would need to be provided. Therefore this option was not taken forward for further consideration;
- Option A1.1b was developed as a minor variation to Option A1.1a and included a single viaduct of approximately 2.8km in length, with a 130kph crossover. The 130kph rail crossover would be relocated to an embankment to the north near Pipe Ridware which would extend slightly further to the south and would require additional land for earthworks. The extended embankment for this option was slightly lower than Option A1.1a due to the requirements of the lower design speed. This option was considered the preferred environmental option because of its benefits to ecology and landscape, and its reduction in the loss of floodplain when compared with Option A1.0. The single viaduct would reduce the land required at Tomlinson's Spinney reducing habitat fragmentation and severance and improve visual permeability beneath the viaduct when compared to Option A1.0. However, on balance, it was not considered that these environmental benefits were sufficient to justify the disproportionately higher cost; and
- Option A1.2 was developed as a minor variation to Option A1.0 reducing the length of both viaducts. The length of the Bourne Brook viaduct would be reduced from 730m to 720m and the River Trent viaduct from 1.9km to 895m. This change would increase the embankment length on either side of the respective viaducts. The visual impact of this option would increase due to the introduction of a series of embankments with bridges and culverts rather than the two longer viaducts spans in Option A1.0. Additional habitat loss and fragmentation at Little Spinney and the adjacent watercourse due to the extension of the embankments would result in increased impacts on ecological habitats and the construction works in the floodplain would increase the impact watercourses. This option was not taken forward for further consideration due to impact on the floodplain, habitat fragmentation and increased visual impacts on neighbouring communities.

- 6.2.22 Following the publication of the working draft EIA Report, design development of the Proposed Scheme was undertaken through detailed hydraulic modelling of the Bourne Brook and the River Trent to better define the flood zone and the potential impacts and to reduce the loss of floodplain. This resulted in the lengths of the Kings Bromley and River Trent viaducts being increased from approximately 730m to 980m and 1.9km to 1.92km respectively to avoid impacts on the floodplain.
- 6.2.23 Lengthening of the viaducts resulted in a reduction in the length of the Bourne embankment from the design presented in the working draft EIA Report, from approximately 800m to 505m. This therefore presented an opportunity to reconsider how the route of the Proposed Scheme would cross the Bourne Brook, the River Trent and the associated floodplains. This also allowed an opportunity to reduce the disruption to the local road network, including keeping Shaw Lane open (which was closed in the scheme assessed in the working draft EIA Report)³⁷.
- 6.2.24 Given this opportunity, two options, presented as new to those assessed for the working draft EIA Report, were taken forward to a more detailed appraisal where engineering, construction feasibility, cost and environmental impacts were considered:
- Option SS1: a single viaduct, approximately 3.3km in length, crossing the Bourne Brook, River Trent and associated floodplains. This option allowed the retention of Shaw Lane; and
 - Option SS1b: two viaducts, approximately 980m and 1.92km in length, crossing the Bourne Brook and the River Trent respectively. These viaducts would be separated by a central embankment approximately 505m in length. This option would also retain Shaw Lane (which will be realigned). The high pressure gas main would also be retained.
- 6.2.25 Option SS1b was taken forward into the Proposed Scheme. Whilst Option SS1 would provide greater environmental benefits, when compared to Option SS1b the benefits were not considered sufficient to justify the additional safety risk associated with the requirement to have an emergency access point on the viaduct. The analysis of engineering, cost and potential environmental impacts associated with both options is set out below, with the impacts of the option selected presented first.

Option SS1b

- 6.2.26 The construction of the Bourne embankment between the two viaducts would result in the partial loss of Tomlinson's Spinney LWS introducing habitat fragmentation by creating a barrier to wildlife movement across the route of the Proposed Scheme. The embankment would also introduce the potential for collision risk of trains with certain fauna groups e.g. bats attempting to cross the route. The Bourne embankment would result in a loss of agricultural land and sever farmland to form a prominent visual horizon feature, breaking up open space and impacting the landscape character of the

³⁷ Refer to the HS2 Ltd., (2016), West Midlands- Crewe Working Draft Environmental Impact Assessment Report – Volume 2, Community Area 1: Fradley to Colton for further information regarding the previous options considered. Available online at: <https://www.gov.uk/government/publications/hs2-phase-2a-west-midlands-to-crewe-working-draft-environmental-impact-assessment-report-volume-2-community-area-reports-and-map-books>

area. This option would also impact the historic setting and have a visual impact on historic buildings in Kings Bromley.

- 6.2.27 Option SS1b does not introduce any technical or construction complexities, risk of safety hazards or lengthening of the construction programme and allows the provision of an emergency access point on the Bourne embankment, which would represent a safe form of evacuation.

Option SS1

- 6.2.28 In comparison to Option SS1b (the Proposed Scheme), Option SS1 would reduce impacts on the Tomlinson's Spinney LWS, reduce barrier effects on wildlife and species collision risk due to the removal of the Bourne embankment. A single viaduct would reduce the impact on agricultural land and the open nature of the landscape by retaining visual permeability. This visual permeability would also reduce the visual impact on the historic buildings in Kings Bromley and upon the remains of the former landscape park to the south of the former Kings Bromley Manor.
- 6.2.29 Option SS1 introduces an additional safety risk as the emergency access point would be a stairwell from track walkway level down to ground level which would be approximately 15m high. Therefore de-trained passengers could be required to climb down to a muster point at ground level in the event of an evacuation, making this option less desirable. This option does not introduce any new construction complexities or lengthening of the construction programme.

Auto-transformer feeder station at Newlands Lane

- 6.2.30 Following publication of the working draft EIA Report, consideration has been given to the location of the auto-transformer feeder station at Newlands Lane. The auto-transformer feeder station will house the electrical equipment that will protect and control the power supply to the Proposed Scheme. The auto-transformer feeder station is required to be located at the start of a neutral section³⁸ along the route at a location with a potential grid connection to existing electrical infrastructure^{6.2.42} (see Section below on grid connection from Rugeley sub-station to the auto-transformer feeder station at Newlands Lane).
- 6.2.31 The sensitivity of this location, particularly the historic landscape and the proximity of the route of the Proposed Scheme to residential properties at Colton and Stockwell Heath, have been key considerations in the development of these alternatives.
- 6.2.32 The following four options were taken forward to a detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered:
- Option o (presented in the working draft EIA Report): the auto-transformer feeder station would be located to the north of Newlands Lane, on the southern side of the route of the Proposed Scheme, approximately 500m to the east of Colton with the western edge of the auto-transformer feeder

³⁸ A neutral section is an insulated section that prevents two differing electrical from touching, by introducing an electrical clearance (an earth section).

station within a 4m cutting;

- Option 1: the auto-transformer feeder station would be located to the south of Newlands Lane, on the southern side of the route of the Proposed Scheme approximately 800m east of Colton. The auto-transformer feeder station at this location would be within a cutting of 10m at its north-eastern corner, however a large portion of the south-western side of the facility would be located on embankment up to 8m in height;
- Option 2: the auto-transformer feeder station would be located to the south of Newlands Lane, on the west side of the route of the Proposed Scheme, approximately 600m east of Colton. The auto-transformer feeder station at this location would be within a cutting at its north eastern corner, however a large portion of the south western side of the facility would be located on embankment. The embankment would be up to 5m in height; and
- Option 3: the auto-transformer feeder station would be located south of Newlands Lane on the northern side of the route of the Proposed Scheme, approximately 900m to the north-east of Colton within the Blithbury North cutting approximately 14m deep at its north-east corner.

6.2.33 Option 3 was taken forward into the Proposed Scheme as on balance it presented the most favourable environmental outcome. Option 0 and Option 1 were not taken forward as there would be an increase in environmental impacts most notably in relation to visual and noise impacts on the amenity of residents at Colton and Stockwell Heath. Option 1 also presented an increase to land required permanently from two farm holdings. Option 2 was not taken forward as there would be an increase in environmental impacts, most notably in relation to landscape and visual, noise, and ecological habitats.

6.2.34 The analysis of engineering, cost and potential environmental impacts associated with all four options are set out below, with the impacts of the option selected presented first.

Option 3

6.2.35 Option 3 would generate an impact on the landscape character of the area due to partial severance of an ancient field pattern at the southern tip of the auto-transformer feeder station. The land required permanently for this option would extend the land required for construction of the Proposed Scheme resulting in the loss of agricultural land at Manor Farm and impact species through the potential loss of woodland and pond habitat. No views of the auto-transformer feeder station are anticipated from Stockwell Heath, due to intervening landform, and no views from Colton are anticipated due to the auto-transformer feeder station being located on the opposite side of the Blithbury North cutting. Both Colton and Stockwell Heath would be far enough away to receive minimal noise impacts.

6.2.36 Option 3 does not introduce any technical or construction complexities, risk of safety hazards or lengthening of the construction programme.

Option 0

- 6.2.37 In comparison to Option 3 (the Proposed Scheme), with Option 0, the auto-transformer feeder station would be visible from Colton and Stockwell Heath leading to an increase in visual impacts on built-heritage assets and residents within both communities. Noise impacts on the community of Colton would be potentially worse due to the auto-transformer feeder station being closer to the community. This option would slightly reduce the impact on agricultural land as the land required permanently would be located within a small parcel of land at Manor Farm. This would cause the farm to be isolated by the route of the Proposed Scheme and make it difficult to farm commercially. This option would potentially reduce the impact on ecological habitat as it does not extend the land required for construction.
- 6.2.38 Option 0 does not introduce any technical or construction complexities, risk of safety hazards or lengthening of the construction programme.

Option 1

- 6.2.39 In comparison to Option 3 (the Proposed Scheme), with Option 1, the south eastern corner of the auto-transformer feeder station would be located on embankment forming a highly visible feature. This option would also increase the visual impacts on users of Colton bridleways 31, 32 and 33 and residents on Hollow Lane and Blithbury Road. The potential noise impacts on residents within these communities would be greater as this option is closer to Colton and Stockwell Heath. This option would increase the impact on agriculture as land farmed by Manor Farm and Town End Farm would be required permanently. This option would potentially reduce the impact on ecological habitat as it does not extend the land required for construction.
- 6.2.40 Option 1 does not introduce any technical or construction complexities, risk of safety hazards or lengthening of the construction programme.

Option 2

- 6.2.41 In comparison to Option 3 (the Proposed Scheme), with Option 2, the auto-transformer feeder station would form a highly visible feature within the surrounding landscape visible from Colton and Stockwell Heath increasing the visual impact on these communities. Noise impacts on the community of Colton and properties on Blithbury Road, Hollow Lane and Hurst Wood Farm would be potentially greater due to the auto-transformer feeder station being closer to these residences. This option would increase the impact on agriculture as land owned by Manor Farm and Town End Farm would be required permanently. The additional land required in this option would also increase the impact on species habitat through the removal of mature trees.
- 6.2.42 Option 2 does not introduce any technical or construction complexities, risk of safety hazards or lengthening of the construction programme.

Grid connection from Rugeley sub-station to the auto-transformer feeder station at Newlands Lane

- 6.2.43 During the design development process since the announcement of the preferred route to Crewe in November 2015, consideration has been given to the alignment of a power line required to provide traction power³⁹ to operate the trains. The power supply required to operate the Proposed Scheme will come from the Rugeley sub-station and connect to the Proposed Scheme via the Newlands Lane auto-transformer feeder station. The auto-transformer feeder station will provide power to a number of auto-transformer stations across the route of the Proposed Scheme, which will supply the overhead line equipment.
- 6.2.44 The sensitivity of this location, particularly the historic landscape and the proximity of the power line to residential properties at Colton and Hill Ridware have been key considerations in the development of these alternatives.
- 6.2.45 The working draft EIA Report reported that two auto-transformer feeder stations would be located adjacent to the route of the Proposed Scheme, one within the Fradley to Colton area at Newlands Lane and the other within the South Cheshire area (CA5), south of Crewe. Following engagement with Scottish Power and National Grid it was deemed that providing power to the South Crewe auto-transformer feeder station would not be feasible due to constraints on capacity (see Section 2.5 in the Volume 2 CA5 South Cheshire). As such the power supply to the Newlands Lane auto-transformer feeder station will provide the full extent of traction power for the operation of the trains.
- 6.2.46 A preliminary options appraisal was undertaken of five options and three options were not taken forward for further consideration as they were not considered to be reasonable alternatives:
- Option 1 would include an overhead power line of approximately 7.8km, connecting the Newlands Lane auto-transformer feeder station into an existing 400kV pylon near Rileyhill. The route of the power line would run adjacent to the route of the Proposed Scheme and would require construction of a new substation to reduce the power from 400kV to 132kV at the auto-transformer feeder station at Newlands Lane. This option would require pylons, approximately 50m in height, to accommodate the higher voltage. Option 1 was not taken forward for further consideration. This was due to risks associated with the close proximity of the works to the construction of the overhead power line and route of the Proposed Scheme and resultant lengthening of the construction programme. Residential receptors would experience significant cumulative visual impacts from the overhead power line in combination with other elements of the Proposed Scheme;
 - Option 2 would include an overhead power line of approximately 3.6km, connecting the Newlands Lane auto-transformer feeder station into an existing 400kV pylon adjacent to Lawnmeadow Covert, north of Handsacre.

³⁹ Traction power is that provided primarily for the purpose of moving trains.

Like Option 1 this option would require the construction of a new substation to reduce the power from 400kV to 132kV. Routing the 400kV overhead power line from the grid supply point at Lawnmeadow Covert, north of Handsacre to the auto-transformer feeder station at Newlands Lane would require pylons, approximately 50m in height, to accommodate the higher voltage. During consultation in September 2016, National Grid confirmed that the construction of a substation in the required location was unviable therefore Option 2 was not taken forward for further consideration; and

- Option 5 would include an underground route of approximately 4.2km connecting the Newlands Lane auto-transformer feeder station to a grid supply point at the Rugeley sub-station where the power would be reduced from 400kV to 132kV. As the route would leave the Rugeley sub-station approximately 450m of horizontal directional drilling would be required to duct the power line beneath the River Trent and the WCML. The remaining 3.7km of the underground route would follow the alignment of Blithbury Road and Hollow Lane and connect to the Newlands Lane auto-transformer feeder station. Option 5 was not taken forward as whilst this option would result in reduced visual impacts once constructed, due to the power line being buried, there would be the potential for significant disruption to local highways during construction, to Blithbury Road and Hollow Lane associated with additional length of the route and the land required. This option would also be complex and costly due to the length of buried cables and the measures required to manage the dissipation of heat generated by the cables.

6.2.47 The following two options were taken forward to a more detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered:

- Option 3 would include an underground route of approximately 4km connecting the Newlands Land auto-transformer station to a grid supply point at the Rugeley sub-station where the current would be stepped-down from 400kV to 132kV. As the route leaves the Rugeley sub-station approximately 640m of horizontal directional drilling would be required to duct the power line beneath the River Trent and the WCML. The underground route would then proceed north beneath predominantly agricultural land for approximately 2.9km and connect to the Newlands Lane auto-transformer feeder station; and
- Option 4 would include an overhead line of approximately 4km (with approximately 30m high pylons) and underground route connecting the Newlands Lane auto-transformer feeder station to a grid supply point at the Rugeley sub-station where the power would be reduced from 400kV to 132kV at a substation located at Rugeley Power Station. As the route leaves the Rugeley sub-station approximately 640m of horizontal directional drilling would be required to duct the power line beneath the River Trent and the WCML. The underground route would then transition to a 132kV overhead power line via a cable sealing end compound located adjacent to the Cawarden

Springs Wood Local Wildlife Site (LWS). The route would proceed north as an overhead line for approximately 2.3km to a second cable sealing end compound located to the south-west of Hollow Lane where it would then proceed as an underground route for 1km and ducted beneath the route of the Proposed Scheme to connect directly into the Newlands Lane auto-transformer feeder station.

- 6.2.48 Option 4 was taken forward into the Proposed Scheme. Whilst Option 3 would provide greater environmental benefits during operation, the effects during construction would be greater and on balance the benefits expected during operation were not considered sufficient to justify the additional complexity and significant increase in cost associated with managing the heat dissipation from larger cables.
- 6.2.49 The analysis of engineering, cost and potential environmental impacts associated with both options is set out below, with the impacts of the option selected presented first.

Option 4

- 6.2.50 The visual impact of this option would impact the setting of residential properties and locally listed buildings in close proximity to the route and within the villages of Colton, Rake End and Hill Ridware. It would also impact the setting of the former Colton Hall Farm, a 19th century farmstead and the landscape character as it transverses a deer park and assumed parkland. The land required permanently would result in a minor loss of agricultural land required for the footprint of the pylons.
- 6.2.51 This option could also potentially indirectly impact the River Trent as the 450m drilled section would involve stripping and excavation in the vicinity of the upper catchment channels of the Moreton Brook. The underground section of the route would cross an historic landfill and would present a risk of contamination. Additionally, there would be impacts on a Principal aquifer and the route would cross a Mineral Safeguarding Area, and would result in a severance of mineral. The construction corridor would impact upon Cawarden Springs Wood LWS which is a deciduous woodland however the overhead power line could be designed to avoid most features of ecological value, including the LWS woodland. There would be a potential risk of bird collision with the overhead power lines.
- 6.2.52 The final section of this option includes burying approximately 1km of the power line beneath the route of the Proposed Scheme, to minimise the landscape and visual impact of this option.
- 6.2.53 The works associated with the underground section of the route introduces hazards such as working with high tension cables, breaking ground, directional drilling and an interface with existing underground cables.

Option 3

- 6.2.54 In comparison to Option 4 (the Proposed Scheme), once constructed Option 3 would reduce the visual impacts on residential properties and the impact on landscape character. The impacts on the setting of the listed buildings would be avoided and the risk of bird collision with the overhead power lines would be removed.

- 6.2.55 With this option the burying of cables would increase the loss of agricultural land and the impact on farm holdings construction during construction, although land would be restored during operation of the Proposed Scheme. An area of Cawarden Brick and Tile Company would be impacted which could result in a disruption to the business operations. The impact of directional drilling on water resources are comparable to the Proposed Scheme. The removal of woodland within Cawarden Springs Wood LWS and hedgerows would be required during construction presenting a greater impact on biodiversity compared to the Proposed Scheme.
- 6.2.56 Option 3 would be significantly more complex and costly than the Proposed Scheme due to the increased length of larger buried cables required to manage the heat dissipation.

Pylons vs wooden poles

- 6.2.57 Following the decision to take Option 4 forward into the Proposed Scheme, consideration was given to the form of the structure that would carry the overhead power line in order to reduce the visual impact associated with the route. The options included, wooden poles, approximately 15m in height, and steel pylons, approximately 26m in height.
- 6.2.58 Wooden poles would better integrate into the landscape than steel pylons, due to their size, colour and material. This would result in a lower visual impact on nearby residential receptors and reduce the setting impact on heritage assets, such as Colton Hall Farm (ruins of a 14th century manor house). There would, however, be an increase in the impact on one farm holding, due to reduced spacing between the wooden poles making it more difficult to manoeuvre machinery.
- 6.2.59 The wooden pole option has been taken forward into the Proposed Scheme as it provides greater environmental benefits when compared with the steel pylons.

Borrow pits

- 6.2.60 During the design development process since the announcement of the preferred route to Crewe in November 2015, further consideration has been given to the way in which the Proposed Scheme would acquire high quality material (usually comprising sand and gravel) to construct embankments. This material will be provided, in part, through excavation of cuttings and other earthworks along the route of the Proposed Scheme, where the quality is appropriate. However, at some locations along the route there is insufficient high quality material for use in railway embankment construction. The use of borrow pits close to the route of the Proposed Scheme would enable high quality material and aggregate to be extracted and processed and backfilled locally and transported largely on site haul routes, lowering HGV movements and reducing impacts on the local road network and communities. Section 6.10 of Volume 1 of this ES presents an overview of the alternatives to using borrow pits.
- 6.2.61 Three areas proposed for potential borrow pits within the Fradley to Colton area were initially identified using plans showing suitable geology combined with requirements for excavated material where the largest shortfalls of material occurred along the route of the Proposed Scheme. Selection criteria also included areas of mineral resource identified by Staffordshire County Council (SCC) and avoidance, where

reasonably practicable, of residential properties, environmentally sensitive receptors, major services and diversions. The sensitivity of the River Trent valley, particularly the historic landscape, local water resources and the proximity of the borrow pits to residential properties have been key considerations in the development of these alternatives.

Area One: Kings Bromley South

6.2.62 A detailed appraisal was undertaken for two options , where engineering and construction feasibility, and environmental impacts were considered:

- Option A-1: the borrow pit would be located to the south side of the route of the Proposed Scheme, approximately 350m south of Common Lane; and
- Option A-2: the borrow pit would be located to the north side of the route of the Proposed Scheme, approximately 300m south of Common Lane.

6.2.63 Option A-2 has been taken forward into the Proposed Scheme as on balance it presented the most favourable environmental outcome. Option A-1 in comparison would present an increase in environmental impacts most notably to Ashby Sitch, Rice's Spinney and noise and visual amenity impacts to local residents.

6.2.64 Option A-2 was subsequently modified following further analysis of volume requirements and due to uncertainties around material depth and quantity. This also, included further avoidance of environmental sensitivities and construction complexities. The modified Option A-2 incorporated a portion of the footprint from Option A-1. The analysis of engineering and potential environmental impacts associated with both options is set out below, with the impacts of the option selected presented first.

Option A-2

6.2.65 The first iteration of Option A-2 would have an impact on buried archaeological remains and the amenity of residents of Barn Farm, Common Lane Farm and recreational receptors using Kings Bromley Footpath 0.392 would be impacted due to associated noise and visual intrusion. Following analysis of the excavated material required, this option did not fully meet the volume requirements that are expected to be required based on estimates of suitability and depth of material at this location.

6.2.66 The footprint of this option was subsequently modified to meet volume requirements and to consider avoidance of environmental sensitivities. The refined option represents an improvement for local residents by moving the borrow pit further from Barn Farm, and a reduction in the number of buried archaeological assets to be removed. The increase in land associated with the extended footprint included a portion of the land contained in Option A-1 therefore extending the borrow pit either side of the route of the Proposed Scheme. This change would generate an increase in impacts on the landscape character, the removal of landscape features and an increase in visual receptors affected.

Option A-1

6.2.67 In comparison to Option A-2 (the Proposed Scheme), Option A-1 presents an increase in environmental impacts. This option would result in the diversion of Ashby Sitch, a watercourse which flows through the site. Construction noise impacts would be anticipated on residents of properties in Rileyhill and visual amenity impacts on the users of Common Lane Farm, Barn Farm and residents of Common Farm. There would be temporary impacts on the archaeological setting of the Trent and Mersey Canal Conservation Area due to associated construction traffic movements, and a further loss of woodland habitat at Rice's Spinney. The landform in this area is flat therefore further removal of the woodland would reduce screening.

Area Two: Kings Bromley North

6.2.68 A detailed appraisal was undertaken for two options, where engineering and construction feasibility, cost and environmental impacts were considered:

- Option B-1: the borrow pit would be located on the south side of the route of the Proposed Scheme, approximately 1.4km west of Kings Bromley; and
- Option B-2: the borrow pit would be located on the north side of the route of the Proposed Scheme, approximately 600m west of Kings Bromley.

6.2.69 Following further analysis of volume requirements and due to uncertainties around material depth and quantity at this stage, both options have been taken forward and included into the Proposed Scheme. The analysis of engineering and potential environmental impacts associated with both options is set out below.

Option B-1

6.2.70 Option B-1 would result in impacts on ecology, the residential amenity of properties on Shaw Lane, and buried archaeological remains. This option would increase flood risk as part of the borrow pit is within the floodplain associated with Bourne Brook and may affect the base flow of this watercourse. There would also be impacts on the amenity of residents of Echills Farm, located approximately 200m to the north, due to isolation, visual intrusion and cumulative effects associated with construction of the route of the Proposed Scheme.

6.2.71 As a result of design refinement to this option an offset of approximately 150m was introduced to reduce impacts on Echills Farm. A 25m buffer was also applied to reduce potential impacts on bat species using the woodland located to the north-west of the option.

Option B-2

6.2.72 This option would increase flood risk as the borrow pit is located within the floodplain associated with the Bourne Brook. There would also be amenity impacts on the residents of Kings Bromley due to noise and visual impacts during construction. This option would also have the potential to impact on buried archaeological remains. The Trent Valley, where the majority of fluvioglacial sands and gravels required for embankment fill are found, has a greater potential to contain protected archaeological and palaeoenvironmental remains as these areas are likely to have

originated as seasonal outwash deposits at the edge of the late-Devensian ice-sheet. By excavating this material there is a higher risk of impacting archaeological assets.

- 6.2.73 As a result of design refinement to this option an offset was introduced to reduce impacts on grazing land used by Pipe Hall Farm.

Area Three: Blithbury

- 6.2.74 A detailed appraisal was undertaken of three options, where engineering and construction feasibility, cost and environmental impacts were considered:

- Option C-1: the borrow pit would be located on the south side of the route of the Proposed Scheme, located adjacent to Quintons Orchard Farm and Bentley Hall Farm;
- Option C-2: the borrow pit would be located on the south side of the route of the Proposed Scheme, approximately 50m north of Bentley Fall Farm; and
- Option C-3: the borrow pit would be located on the north side of the route of the Proposed Scheme, approximately 400m north-east of Pipe Ridware.

- 6.2.75 Option C-3 has been taken forward into the Proposed Scheme as on balance it presented the most favourable environmental outcome. Option C-1 and Option C-2 in comparison would both present an increase in environmental impacts, most notably in relation to amenity impacts on Bentley Hall Farm, Bentley Hall Cottage and Quintons Orchard Farm. The analysis of engineering, cost and potential environmental impacts associated with all three options is set out below, with the impacts of the option selected presented first.

Option C-3

- 6.2.76 Option C-3 is located within the River Trent floodplain and would therefore present impacts on flood risk and cultural heritage in this location. This option also has the potential to impact on the amenity of residents of Nethertown relating to noise and visual intrusion and would result in the loss of agricultural land currently used for grazing.

- 6.2.77 Data obtained through ground investigation provided more certainty about the suitability and location of the resource available within this option. This information significantly reduced the risk associated with finding better quality material and therefore the footprint of this option was reduced and the depth increased. This design development further increased the distance between the borrow pit and Nethertown therefore reducing impacts on amenity. The loss of agricultural land was also reduced by moving the boundary of the borrow pit out of a key grazing field.

Option C-1

- 6.2.78 Option C-1 would impact the surface water flow and would increase the risk of flooding in the area. It would also impact the historical setting of two Grade II listed buildings, Bentley Hall Farm and Bentley Hall Cottage. The proximity of these residences and Quintons Orchard Farm would result in amenity impacts on these residences relating to noise, visual intrusion and isolation.

Option C-2

- 6.2.79 Option C-2 would require the diversion of an unnamed watercourse increasing the impact on water resources and would have an impact on ecology by reducing ecological connectivity. The two Grade II listed buildings, Bentley Hall Farm and Bentley Hall Cottage would be impacted through changes in their setting due to noise, visual intrusion and isolation.

6.3 Community area 2 – Colwich to Yarlet

Route alignment at Moreton House

- 6.3.1 During the design development process since the announcement of the preferred route to Crewe in November 2015, further consideration has been given to the route of the Proposed Scheme and its proximity to the Grade II listed Moreton House. Options to realign the route as it passes Moreton House have been a key consideration in the development of the design. Since the development of these alternatives, it has been confirmed that Moreton House is occupied by Mayfield Children's Home, which is used as a residential home for young people with autism and learning difficulties.
- 6.3.2 A preliminary options appraisal was undertaken of seven options, of which five options were not taken forward for further consideration as they were not considered to be reasonable alternatives:
- Options A4.1a would include a cutting, up to 18m in depth and over 100m in width, approximately 60m south of Moreton House. The horizontal alignment would increase the available space for construction of the route, an accommodation access overbridge and a landscape bund. In moving the alignment south, it would increase the noise and visual impacts on Moreton Grange and its neighbouring properties, and therefore was not taken forward for further consideration;
 - Option A4.2 would include a cutting, up to 11m in depth, approximately 40m south of Moreton House. This option would require an increase in the height of the embankment, adjacent to Moreton Grange and its neighbouring properties, with subsequent increases to noise and visual impacts, so this option was not taken forward for further consideration;
 - Option A4.1b would combine elements of Options A4.1a and A4.2, and would include a cutting approximately 115m in width and up to approximately 11m in depth, approximately 60m from Moreton House at the closest point. However, in moving the route further south from Moreton House, this option would bring the route closer to Moreton Grange Farm and associated residential properties, so this option was not taken forward for further consideration;
 - Option A4.3a considered the use of a technique known as 'soil nailing', which would allow the steepening of slopes, and reduce the amount of land required for the Proposed Scheme. However, there were concerns that this technique may not be effective for the whole lifetime of the project, which would lead to

increased risk of failure of the slopes, so this option was not taken forward for further consideration; and

- Option A4.4 would include a green bridge, approximately 35m in width, located to the south of Moreton House, to help integrate the route into the surrounding landscape and to reduce impacts upon the setting of Moreton House. However, further analysis indicated that the area of land between the green bridge and Moreton House would be insufficient to integrate the green bridge into the surrounding landscape. Furthermore, the green bridge would be complex and expensive to construct, together with the additional costs associated with maintenance and the level of inspection that would be required. It was, therefore, considered that it would be preferable to consider landscape mitigation associated with the other options, so this option was not taken forward for further consideration.

6.3.3 The following two options were taken forward to a more detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered:

- Option A4.0: the route would pass through Moreton in a cutting approximately 115m in width and up to approximately 19m in depth, approximately 40m from Moreton House at the closest point. A realigned access road to Moreton House would cross the cutting on the Colwich Bridleway 23 accommodation overbridge and run parallel to the route, resulting in the demolition of one building associated with Moreton House Farm. The Moreton auto-transformer station would be located on the southern side of the route of the Proposed Scheme; and
- Option A4.3b: the route would pass through Moreton in a cutting approximately 115m in width and up to 19m in depth, approximately 40m from Moreton House at the closest point. A retaining wall would be provided on the northern side of the cutting, approximately 210m in length and up to 10m in height, to reduce the width of the cutting to the south-east of Moreton House. A realigned access road to Moreton House would cross the cutting on the Colwich Bridleway 23 accommodation overbridge and would run parallel to the route and adjacent to a building associated with Moreton House Farm. The Moreton auto-transformer station would be located on the northern side of the route of the Proposed Scheme.

6.3.4 Option A4.3b was taken forward into the Proposed Scheme as, on balance, it presented the most favourable environmental outcome. Option A4.0 in comparison would present an increase in environmental impacts. Most notably impacts on Moreton House Farm, where one of its buildings would require demolition and an increase in noise and visual impacts, associated with the auto-transformer station, for residents at Moreton Grange and neighbouring properties.

6.3.5 The analysis of engineering, cost and potential environmental impacts associated with both options is set out below, with the impacts of the option selected presented first.

Option A4.3b

- 6.3.6 Option A4.3b would result in land, to the south of Moreton House being required permanently. This would result in the loss of formal gardens, including the removal of a 'ha-ha'⁴⁰. The construction of a retaining wall would reduce the width of the cutting and the area of land required to the south of Moreton House. Access to Moreton House would be maintained via a realigned access road. No demolitions would be required with this option. With the auto-transformer station being located on the northern side of the route, the Moreton North embankment would provide visual and acoustic screening for residents at Moreton Grange and its neighbouring properties.
- 6.3.7 Option A4.3b would introduce construction risks and complexities, associated with the retaining wall.

Option A4.o

- 6.3.8 In comparison to Option A4.3b (the Proposed Scheme), Option A4.o would result in a wider cutting, therefore requiring more land permanently. The wider cutting would require the access road to Moreton House to be realigned further north. This realignment would require the demolition of a residential property, associated with Moreton House Farm. The auto-transformer station would be located to the south of Moreton North embankment, approximately 50m north-west of Moreton Grange. Compared with Option 4.3b, residents at Moreton Grange and its neighbouring properties would be subject to increased noise and visual impacts associated with the auto-transformer station.
- 6.3.9 Option A4.o does not introduce any technical or construction complexities, risk of safety hazards or lengthening of the construction programme. The volume of traffic movements required to remove material from the cutting would be greater.

Route alignment at Ingestre Park Golf Club

- 6.3.10 During the design development process since the announcement of the preferred route to Crewe in November 2015, further consideration has been given to the route of the Proposed Scheme as it passes through Ingestre Park Golf Club. There is a deep cutting in this location, and opportunities to reduce the depth and width of the cutting were considered in order to reduce the impact on the golf club and the wider landscape.
- 6.3.11 The following four options were subject to a detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered:
- Option A5.0: the route would pass to the south of Ingestre, on an embankment before entering a cutting, approximately 1.5km in length, up to 110m in width and up to 21m in depth;
 - Option A5.1: the route would pass to the south of Ingestre, on an embankment before entering a cut-and-cover green tunnel, approximately 1.5km in length, including portals, and up to 17m in depth. The landscape would be reinstated

⁴⁰ A sunken ditch designed to prevent animals from entering the garden. It marks the southern boundary of the formal gardens at Moreton House.

above the route of the Proposed Scheme;

- Option A5.2: the route would pass to the south of Ingestre, on an embankment before entering a cutting, approximately 1.6km in length, up to 85m in width and up to 12m in depth. The raised alignment would reduce the depth and footprint of the cutting; and
- Option A5.3: the route would pass to the south of Ingestre, on an embankment before entering a cutting approximately 1.6km in length, up to 108m in width and up to 15m in depth. This option has been refined from Option A5.0 to provide sufficient clearances at watercourse crossings to the north-west, and the Macclesfield to Colwich Line at the Great Haywood viaduct, to the south-east.

- 6.3.12 Option A5.3 was taken forward into the Proposed Scheme. Whilst Option A5.1 would provide greater environmental benefits, when compared to Option A5.3 the significant technical complexities associated with a cut-and-cover tunnel outweighed the environmental benefits. Option A5.0, in comparison to Option A5.3, would present an increase in environmental impacts, most notably an impact upon the local groundwater regime resulting from a deeper cutting; and therefore a drop inlet culvert would be required, which would potentially impact upon the hydromorphology and groundwater. This option would also be more expensive to construct and maintain than Option A5.3. Option A5.2 in comparison to Option A5.3 would have a higher alignment resulting in less of an impact on hydromorphology and groundwater but makes the route more visible and thus would have a greater visual impact.
- 6.3.13 The analysis of engineering, cost and potential environmental impacts associated with all four options is set out below, with the impacts of the option selected presented first.

Option A5.3

- 6.3.14 Option A5.3 would require the permanent acquisition of land from Ingestre Park Golf Club for the alignment of the route, thereby impairing the operation of this facility. There would be an impact on the historic landscape character in the area, most notably around Ingestre and Tixall. There would also be an impact on the setting of Ingestre Conservation Area (including Ingestre parkland) and a small number of listed buildings. This option would result in the loss of ecological habitat, including the southern tip of Lionlodge Covert, a local wildlife site featuring an inland salt meadow and with a potential impact on protected species. There would potentially be impacts upon the local groundwater regime resulting from the deep cutting, however there is sufficient clearance for a regular culvert, thereby avoiding the need for a drop inlet culvert.
- 6.3.15 Option A5.3 does not introduce any technical or construction complexities, risk of safety hazards or lengthening of the construction programme.

Option A5.0

- 6.3.16 In comparison with Option A5.3 (the Proposed Scheme), Option A5.0 would result in a slight increase in the potential impact on the local groundwater regime resulting from

a deeper cutting. A drop inlet culvert would be required, which would potentially impact upon the hydromorphology and groundwater within the immediate locality, and would result in significant additional maintenance requirements and costs when compared to Option A5.3.

- 6.3.17 Option A5.0 would not introduce any technical or construction complexities, risk of safety hazards or lengthening of the construction programme. Owing to the increased cutting depth, this option would be significantly more expensive to construct and maintain than the Proposed Scheme, due to the volume of excavated material to be removed and corresponding traffic movements would be increased compared to Option A5.3.

Option A5.1

- 6.3.18 In comparison with Option A5.3 (the Proposed Scheme), Option A5.1 would require the construction of a cut-and cover tunnel, porous portals and associated infrastructure. This option would allow the landscape to be reinstated above the tunnel and thereby reduce the setting impacts on the historic landscape and Ingestre Conservation Area, compared with Option 5.3. Similarly, noise impacts would be significantly reduced at Ingestre. The tunnel would largely pass beneath Ingestre Park Golf Club, reducing the land permanently required and the loss of land within the golf course compared to Option 5.3. Impacts on agricultural land and holdings would therefore be reduced.

- 6.3.19 The volume of material being removed for the tunnel and the corresponding traffic movements would be greater than Option 5.3. The tunnelling through this area would also increase the risk to groundwater resources. This option introduces significantly greater technical and construction complexities than Option 5.3, which would be more expensive to construct than the Proposed Scheme and the costs of maintenance would be higher due to the need to maintain the headhouse and ventilation equipment and the increased level of inspection that would be required. This option would also increase the construction risks and lengthen the construction programme.

Option A5.2

- 6.3.20 In comparison with Option A5.3 (the Proposed Scheme), Option A5.2 would result in a slight decrease in the potential impact upon the local groundwater regime resulting from a shallower cutting. The width of the cutting would be less than Option A5.3, resulting in slightly reduced impacts on the operation of Ingestre Park Golf Club, and the land required. The raised alignment of this option would increase both the visibility of the route and associated overhead line equipment, and thereby the potential for impacts upon the landscape character. Overall, this option would result in greater landscape and visual impacts than the Proposed Scheme.
- 6.3.21 Option A5.2 is slightly less expensive to construct than the Proposed Scheme and does not introduce any technical or construction complexities, risk of safety hazards or lengthening of the construction programme. However, owing to the reduced cutting depth, the volume of excavated material to be removed would be reduced when compared to Option A5.3.

Route alignment at Hopton

- 6.3.22 During the design development process since the announcement of the preferred route to Crewe in November 2015, further consideration has been given to the route of the Proposed Scheme, the impact on residents of Hopton and to ensure there is sufficient clearance over an unnamed watercourse (a tributary of the Kingston Brook). In this area, the route of the Proposed Scheme would pass on embankment, which would support landscape earthworks and a retaining wall forming a false cutting, then continue into cutting, south-west of the majority of properties located in Hopton.
- 6.3.23 A preliminary options appraisal was undertaken of six options and one option was not taken forward for further consideration as it was not considered to be a reasonable alternative. This option (Option A6.2) would follow a similar alignment to Option A6.1 and included a green tunnel, approximately 530m in length, with landscaped earthworks required to tie in to the adjacent earthworks, to the south-east of Hopton. The land required permanently for the landscape earthworks would result in the loss of agricultural land holdings and demolition of several residential properties on the south-east of Hopton. This would be a highly complex and expensive option, together with the additional costs required to maintain a headhouse and ventilation equipment and the increased level of inspection that would be required. This option would also increase the construction risk and length of construction programme. As such, this option was not taken forward for further consideration.
- 6.3.24 The following five options were taken forward to a more detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered:
- Option A6.0: the route would be partially located within a false cutting⁴¹ with retaining wall on the northern side of the route, up to 4m in height, with the unnamed watercourse (a tributary of the Kingston Brook) crossing beneath the route, in a culvert (initially this was a drop inlet culvert). To the south-east of Hopton, the route would be in a cutting, approximately 100m in width and up to 16m in depth;
 - Option A6.1: the route would be partially located within a false cutting with a retaining wall on the northern side of the route, up to 4m in height, with the route alignment raised by approximately 2m to allow sufficient clearance for an unnamed watercourse (a tributary of the Kingston Brook) to cross beneath the route in a culvert;
 - Option A6.3a: the route would be located within a green tunnel of approximately 700m in length, including portals, and up to 10m in depth. An unnamed watercourse (a tributary of the Kingston Brook) would cross beneath the route in a drop inlet culvert or inverted siphon;
 - Option A6.3b: the route would be partially located within a false cutting, with a retaining wall on the northern side of the route, up to 4m in height. The cutting

⁴¹ A means of screening a linear feature by forming a landscape earthwork alongside it, above existing ground level, to create the visual impression that the feature is situated in a cutting below ground level.

would be up to 21m in depth at an unnamed watercourse (a tributary of the Kingston Brook), with the watercourse crossing beneath the route in a drop inlet or inverted siphon; and

- Option A6.4: the route would pass through the south of Hopton in a cut-and-cover tunnel, approximately 2.1km in length, including portals, and up to 15m in depth. The landscape and an unnamed watercourse (a tributary of the Kingston Brook), would be reinstated above the Proposed Scheme. The watercourse would be reinstated on its existing alignment in a concrete channel.

- 6.3.25 Option A6.o was taken forward into the Proposed Scheme. Whilst Option A6.4 in comparison would provide greater environmental benefits, on balance they were outweighed by the significant technical complexities associated with a cut-and-cover tunnel. Option A6.3b in comparison to Option A6.o would also provide greater environmental benefits, however, this option would present greater technical and construction complexities. Option A6.1 in comparison to Option A6.o would present an increase in environmental impacts, most notably an increase in landscape and visual impacts for residents of Hopton. Option A6.3a, in comparison to Option A6.o, would present an increase in environmental impacts, most notably noise, landscape and visual impacts during the construction of the tunnel, and the residual impacts upon the landscape resulting from the mounded tunnel covering and visual impacts associated with the tunnel and porous portals.
- 6.3.26 The analysis of engineering, cost and potential environmental impacts associated with all five options is set out below, with the impacts of the option selected presented first.

Option A6.o

- 6.3.27 Option A6.o would introduce significant flood risk due to the large existing surface water flow path through this area, and would increase the risk to groundwater resources. This option would require the demolition of five properties. An unnamed watercourse (a tributary of the Kingston Brook) would cross beneath the route in a culvert, without the need to raise the route alignment.
- 6.3.28 Option A6.o would not introduce any technical or construction complexities, risk of safety hazards or lengthening of the construction programme.

Option A6.1

- 6.3.29 In comparison to Option A6.o (the Proposed Scheme), Option A6.1 would result in improvements to water quality and flood risk by increasing the clearance over the tributary of the Kingston Brook. More land would be required for the construction and operation, increasing the number of potential demolitions. The reduced cutting depth, in comparison to Option A6.o, would increase the noise and visual impact at properties on the southern edge of Hopton.
- 6.3.30 Option A6.1 would not introduce any technical or construction complexities. The reduced cutting depth associated with this option would present a reduction in the construction traffic numbers associated with removal of excavated material.

Option A6.3a

- 6.3.31 In comparison to Option A6.o (the Proposed Scheme), Option A6.3a would require the formation of a cut-and-cover tunnel, porous portals and associated infrastructure which would result in significantly more land required temporarily. It would also result in significant temporary landscape, visual and noise effects during construction, compared to Option A6.o. The tunnel depth would not be enough to reinstate the existing ground level, and would need to be re-landscaped, thereby creating an artificial mound. There would be significant obstruction to the overland flow path due to infilling at the B5066 Sandon Road, compared with Option A6.o. The reduced depth introduces the requirement for an inverted siphon at the unnamed watercourse (a tributary of the Kingston Brook), which would result in increased maintenance requirements and costs. There would also be significant noise benefits from the route being in tunnel at this location, compared to Option A6.o.
- 6.3.32 The volume of material being removed for the tunnel and the corresponding traffic movements required would be greater than Option A6.o. The tunnel through this area would also increase the risk to groundwater resources. This option introduces significantly greater technical and construction complexities when compared to Option A6.o, which would also increase the construction risks and lengthen the construction programme. This option would be significantly more expensive to construct than the Proposed Scheme and the costs of maintenance would be higher due to the need to maintain the headhouse and ventilation equipment and the increased level of inspection that would be required

Option A6.3b

- 6.3.33 In comparison to Option A6.o (the Proposed Scheme), Option A6.3b would result in a slight reduction to the visual impacts. Due to the increased cutting depth, and the presence of a false cutting, the route would be less prominent in the view from properties along the southern edge of Hopton. However, to the west of Hopton, visual impacts would increase slightly, owing to the deepening of the cutting. This option would present a reduction by one in the number of properties to be demolished. As a result of lowering the alignment, the unnamed watercourse (a tributary of the Kingston Brook) would cross the route in a drop inlet culvert or inverted siphon, which would result in additional maintenance and construction costs.
- 6.3.34 Option A6.3b does not introduce any technical or construction complexities, risk of safety hazards or lengthening of the construction programme.

Option A6.4

- 6.3.35 In comparison to Option A6.o (the Proposed Scheme), Option A6.4 would require the formation of a cut-and-cover tunnel, porous portals and associated infrastructure which would result in significantly more land required temporarily, compared to Option A6.o. The depth of the tunnel would allow the landscape to be reinstated to existing ground level. It would also enable the unnamed watercourse to retain its existing alignment, above the tunnel. In addition, Hopton Lane would be reinstated on its existing alignment. There would be significant noise, visual, landscape and community benefits from the route being in tunnel at this location.

6.3.36 The volume of material being removed for the tunnel and the corresponding traffic movements would be greater than Option A6.o. The tunnel through this area would also increase the risk to groundwater resources. This option introduces significantly greater technical and construction complexities, which would also increase the construction risks and lengthen the construction programme.

Route alignment between Staffordshire County Showground and Yarlet (including Hopton and Marston)

6.3.37 During the design development process since the announcement of the preferred route to Crewe in November 2015, further consideration has been given to the route of the Proposed Scheme between Staffordshire County Showground and Yarlet. Options to realign the route as it passes through Hopton and close to the settlements of Marston and Yarlet have been considered. The sensitivity of this location, particularly the historic landscape and the proximity of the route to residential properties at Hopton, Yarlet and Marston, Moreton House and the Staffordshire County Showground, have been key considerations in the development of these alternatives.

6.3.38 A preliminary options appraisal was undertaken of eight options of which two options were not taken forward for further consideration as they were not considered to be reasonable alternatives:

- Option B5-7.2b included a bored tunnel from Ingestre to Hopton, approximately 4.25km in length. The tunnel portal would be located within Ingestre Park Golf Club, which due to the scale of construction works would result in a significant loss of elements of the high value historic landscape within Tixall and Ingestre, including the setting of Ingestre Hall and the Capability Brown landscape, and would likely result in the loss of the majority of the golf club. This option would also add significant additional cost to the project. As such this option was not taken forward for further consideration; and
- Option B5-7.4a presented a minor variation to alignment in Option B5-7.4b. There were no significant differences between two options and the impacts would likely to be the similar, however Option B5-7.4a would be located slightly closer to Pasturefields Special Area for Conservation (SAC) and Site of Special Scientific Interest (SSSI), so was not taken forward for further consideration.

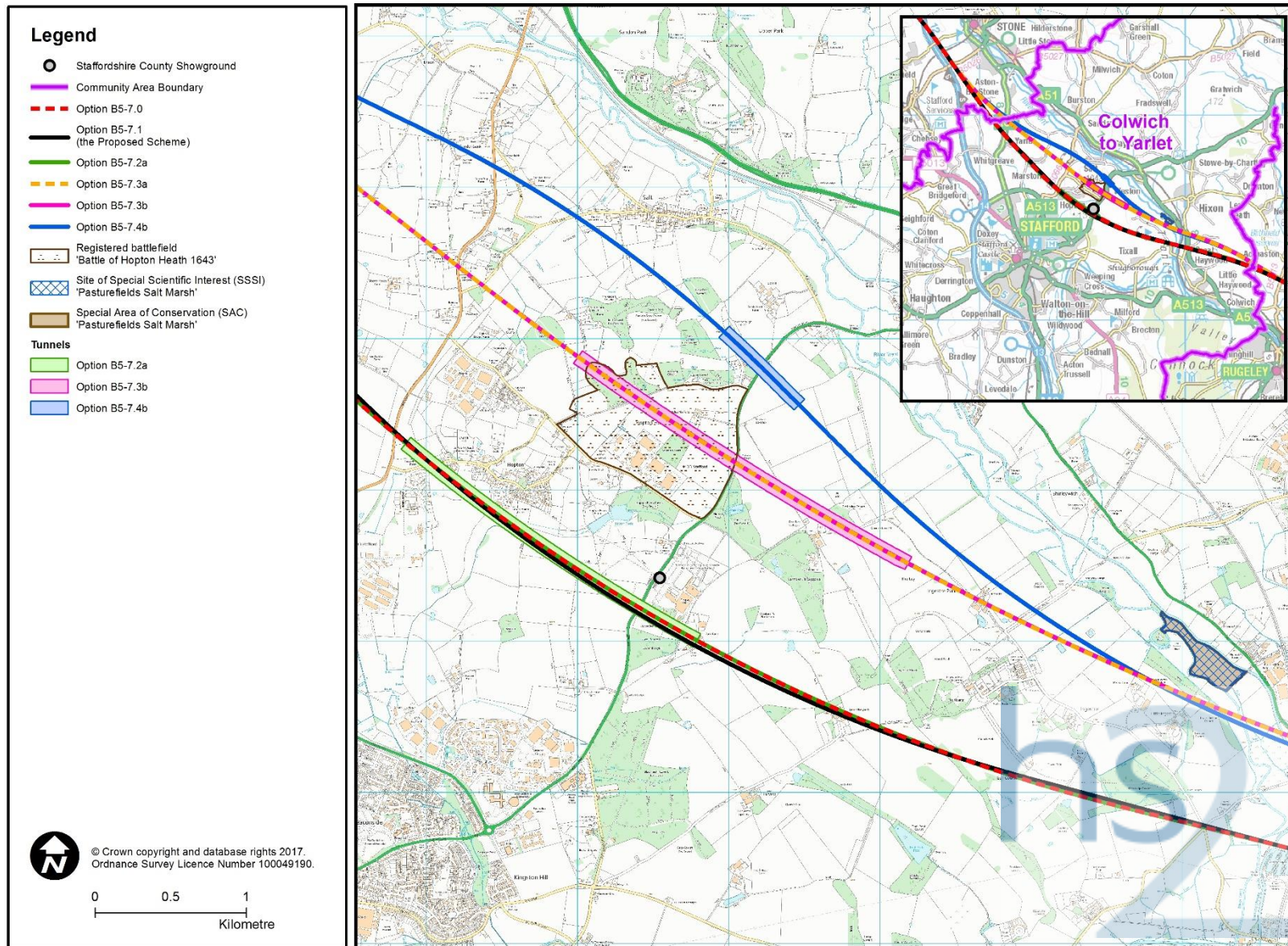
6.3.39 The following six options, as illustrated in Figure 26, were taken forward to a more detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered:

- Option B5-7.o: the route would be located approximately 20m from the southern boundary of the Staffordshire County Showground, approximately 20m from the southern edge of the properties in Hopton, approximately 30m from the northern edge of properties in Marston, and approximately 20m from the northern edge of Yarlet. This option covers a distance of approximately 11km;

- Option B5-7.1: the route would follow a similar alignment to Option B5-7.0 and would be located approximately 30m from the southern boundary of the Staffordshire County Showground, approximately 30m from the southern edge of properties in Hopton, approximately 40m from the northern edge of properties in Marston, approximately 30m north from the northern edge of properties in Yarlet, and approximately 200m south-west of Yarlet School. This option covers a distance of approximately 11km;
- Option B5-7.2a: the route would pass under Hopton and the Staffordshire County Showground in a bored tunnel approximately 2km in length. The route would follow the same horizontal alignment as Option B5-7.1, covering a distance of approximately 11km;
- Option B5-7.3a: the route would be located away from Hopton, Marston and Yarlet, and would be located approximately 100m north of Little Ingestre. The route would pass through Hopton Heath registered battlefield and would be located approximately 150m to the south of Pasturefields SAC and SSSI and approximately 1km to the south-west of Salt. This option covers a distance of approximately 21km;
- Option B5-7.3b: the route would be located to the north-east of Hopton, Marston and Yarlet, and would be located approximately 50m north of Little Ingestre. The route would pass under Hopton Heath Registered Battlefield in a bored tunnel, approximately 2.2km in length and would be located approximately 150m to the south of Pasturefields SAC and SSSI, which is located approximately 1km to the south-west of Salt. This option covers a distance of approximately 21km; and
- Option B5-7.4b: the route would be located to the north-east of Hopton, Marston and Yarlet, and would be located approximately 50m north of Little Ingestre. The route would pass just under the north-east corner of Hopton Heath Registered Battlefield, in a bored tunnel of approximately 500m in length and approximately 150m to the south of Pasturefields SAC and SSSI, which is located approximately 250m to the south-west of Salt. This option covers a distance of approximately 21km.

6.3.40 Option B5-7.1 was taken forward into the Proposed Scheme. Whilst Option B5-7.2a would provide greater environmental benefits, when compared to Option B5-7.1 it was outweighed by the significant technical complexities associated with a bored tunnel. Option B5-7.0 in comparison to Option B5-7.1 would present a slight increase in environmental impacts, notably the demolition of a building within Staffordshire County Showground. Options B5-7.3a and B5-7.3b, in comparison to Option B5-7.1, would present an increase in environmental impacts, most notably the partial loss of Hopton Heath Registered Battlefield; noise, landscape and visual impacts in and around Ingestre; and potential impacts upon springs that support the saltmarsh at Pasturefields SAC and SSSI. Option B5-7.4b, in comparison to Option B5-7.1, would present an increase in environmental impacts, most notably the setting of the Hopton Heath registered battlefield.

Figure 26: Options considered as part of the appraisal



Option B5-7.1

- 6.3.41 Option B5-7.1 would result in the need to demolish properties and would introduce visual, noise and amenity impacts in Hopton, Marston and Yarlet. The land required permanently would result in the loss of land within Ingestre Park Golf Club and the loss of land within Staffordshire County Showground. This option would result in the loss of agricultural land and holdings and of ecological habitat, including the southern part of Lionlodge Covert local wildlife site (LWS). There would be an impact on the historic landscape character in the area and on the setting of Ingestre Conservation Area (including Ingestre parkland) and a small number of listed buildings. The route would cross an historic landfill in the location of Staffordshire County Showground which would present a risk of contamination. There would also be potential impacts on a number of watercourses and tributaries and the need to divert/realign local roads and PRoW could result in increased journey times and delay. This option would impact on a strategic residential development site, between Hopton and Marston, identified within the adopted Plan for Stafford Borough 2014.
- 6.3.42 This option is located approximately 700m from the Hopton Heath Registered Battlefield and 900m from Pasturefields SAC and SSSI.
- 6.3.43 Option B5-7.1 does not introduce any technical or construction complexities, risk of safety hazards or lengthening of the construction programme.

Option B5-7.0

- 6.3.44 In comparison to Option B5-7.1 (the Proposed Scheme), Option B5-7.0 is located closer to the Showground, requiring demolition of a building within Staffordshire County Showground, thereby increasing the number of demolitions. The loss of part of the Staffordshire County Showground may affect the viability of some of the businesses located with the showground and events at this location. There would be an increase in noise and visual impacts upon properties between Hopton and Yarlet. This option would impact on a strategic residential development site, between Hopton and Marston, identified within the adopted Plan for Stafford Borough 2014. This option is located approximately 650m from the Hopton Heath registered battlefield and 900m from Pasturefields SAC and SSSI.
- 6.3.45 Option B5-7.0 does not introduce any technical or construction complexities, risk of safety hazards or lengthening of the construction programme.

Option B5-7.2a

- 6.3.46 In comparison to Option B5-7.1 (the Proposed Scheme), Option B5-7.2a would require significantly more land during construction and would result in increased temporary historic setting, landscape, visual and noise impacts during construction. Once constructed, this option would reduce impacts on the historic landscape and on the settlements of Hopton, Marston and Yarlet. There would be significant noise benefits from the route being in tunnel at Hopton, where noise impacts would be removed; but noise impacts would remain largely unchanged elsewhere. The bored tunnel would pass beneath the historic landfill in the location of Staffordshire County Showground avoiding the risk of contamination. There would be a slight reduction in the number of properties requiring demolition, and avoidance of the Staffordshire County Showground. Impacts on agricultural land and holdings would be reduced as would

traffic impacts, as there would be less severance of Hopton, fewer impacts on the A518 Weston Road and a reduced need to temporarily divert PRoW. The large cutting at the B5066 Sandon Road would introduce significant flood risk due to the large existing surface water flow path and tunnelling through this area and would increase the risk to groundwater resources. This option would impact on a strategic residential development site, between Hopton and Marston, identified within the adopted Plan for Stafford Borough 2014. This option is located approximately 650m from the Hopton Heath registered battlefield and 600m from Pasturefields SAC and SSSI.

- 6.3.47 The volume of material being removed for the tunnel and the corresponding traffic movements would be greater than Option B5-7.1. The tunnel through this area would also increase the risk to groundwater resources. This option introduces significantly greater technical and construction complexities than Option B5-7.1, which would also increase the construction risks and lengthen the construction programme.

Option B5-7.3a

- 6.3.48 In comparison to Option B5-7.1 (the Proposed Scheme), Option B5-7.3a would result in the partial loss of Hopton Heath registered battlefield, a designated heritage asset, and the setting of the remaining area of the battlefield would be impacted. There would also be a visual impact on the Capability Brown landscape lying to the north-west of Ingestre Hall. This option would be approximately 50m south of Pasturefields SAC and SSSI, significantly closer than Option B5-7.1. The brine flow feeding Pasturefields SAC and SSSI is from the north, rather than the south. However, due to the proximity of Pasturefields at this location, there could be a potential risk for increased flood waters (freshwater) during a flood event, which could alter the salinity of the water that supports Pasturefields SAC and SSSI saltmarsh vegetation. Visual and noise impacts would additionally be introduced on residential properties at Little Ingestre resulting from the shift in the alignment, and the increased length of the viaduct crossing the Macclesfield to Colwich Line, the Trent and Mersey Canal and the River Trent.
- 6.3.49 In comparison with Option B5-7.1, Option B5-7.3a would result in a significant reduction in the number of residential and commercial properties requiring demolition, and the loss of Ingestre Park Golf Club would be avoided. Land required within the Staffordshire County Showground would also be reduced, so the businesses located within it would be unaffected. This option would significantly reduce visual and noise impacts to Moreton House and Moreton Grange, and would maintain the setting of these buildings, and others in close proximity, including Ingestre Conservation Area. The realignment of the route would be further north from Hopton, Marston and Yarlet and therefore would result in significantly reduced visual, noise and amenity impacts on residential properties. This option would also reduce the impacts on agricultural land and holdings and the historic link between Ingestre and Tixall parks would be maintained. This option would avoid any impact on a strategic residential development site, between Hopton and Marston, identified within the adopted Plan for Stafford Borough 2014, as the option would run to the north-east.
- 6.3.50 Option B5-7.3a does not introduce any technical or construction complexities, risk of safety hazards or lengthening of the construction programme.

Option B5-7.3b

- 6.3.51 In comparison to Option B5-7.1 (the Proposed Scheme), Option B5-7.3b would require significantly more land during construction. It would also result in an increase in historic setting, landscape, visual and noise impacts during construction, compared to Option B5-7.1. There would be a partial loss of Hopton Heath registered battlefield (albeit less than Option B5-7.3a), which would impact on the setting of the remaining area of the battlefield, and the Capability Brown landscape lying to the north-west of Ingestre Hall, and the rural setting of Salt. As with Option 5-7.3a, the viaduct over the Macclesfield to Colwich Line and the River Trent would increase the impact on the setting of the area. This option would be approximately 50m south of Pasturefields SAC and SSSI, which is significantly closer than Option B5-7.1. The brine flow feeding Pasturefields SAC and SSSI is from the north, rather than the south. However, due to the proximity of Pasturefields at this location, there could be a potential risk for increased flood waters (freshwater) during a flood event, which could alter the salinity of the water that supports Pasturefields SAC and SSSI saltmarsh vegetation. This option would increase the visual and noise impacts on residential properties at Little Ingestre.
- 6.3.52 This option would significantly reduce visual and noise impacts and marginally reduce the number of properties requiring demolition. This option would remove visual and noise impacts at Moreton House and Moreton Grange. Ingestre Park Golf Club would be avoided and the amount of land required permanently within the Staffordshire County Showground would be reduced. Once constructed, this option would reduce impacts on the settlements of Hopton, Marston and Yarlet. There would be significant reductions, and removal of impact on the setting of a number of listed buildings and the Ingestre Conservation Area. The historic link between Ingestre and Tixall parks would be maintained. This option would reduce the impacts on agricultural land and holdings. Impacts on highways would be reduced, as there would be less severance of Hopton, fewer impacts on the A518 Weston Road and a reduced need to temporarily divert PRow. This option would avoid any impact on a strategic residential development site, between Hopton and Marston, identified within the adopted Plan for Stafford Borough 2014, as the option would run to the north-east.
- 6.3.53 The volume of material being removed for the tunnel and the corresponding construction traffic movements would be greater than Option B5-7.1. The tunnel through this area would also increase the risk to groundwater resources. This option introduces significantly greater technical and construction complexities than Option B5-7.1, which would also increase the construction risks and lengthen the construction programme.

Option B5-7.4b

- 6.3.54 In comparison to Option B5-7.1 (the Proposed Scheme), Option B5-7.4b would result in significantly more land temporarily. It would also result in significantly increased historic setting, landscape, visual and noise effects during construction. With this option, there would be an impact on the setting of Hopton Heath registered battlefield and the lengthening of the viaduct over the Macclesfield to Colwich Line and River Trent would also increase the impact on the setting of the area. The route would be approximately 50m south of Pasturefields SAC and SSSI, which is significantly closer than Option B5-7.1. The brine flow feeding Pasturefields SAC and

SSSI is from the north, rather than the south. However, due to the proximity of Pasturefields at this location, there could be a potential risk for increased flood waters (freshwater) during a flood event, which could alter the salinity of the water that supports Pasturefields SAC and SSSI saltmarsh vegetation.

- 6.3.55 Compared to Option B5-7.1, Option B5-7.4b would increase the impacts on agricultural land and holdings and as the route would be significantly closer to Salt, would potentially result in visual and noise impacts on residential properties. The area around Salt is a proposed MSA, and this option would result in a severance of mineral resources. Transport impacts would also be introduced on Salt Road and Church Lane.
- 6.3.56 Option B5-7.4b would reduce visual and noise impacts and marginally reduce the number of properties requiring demolition. This option would remove visual and noise impacts at Moreton House and Moreton Grange. Ingestre Park Golf Club would be avoided and the amount of land required permanently within the Staffordshire County Showground would be reduced. This option would remove the impact on the setting of a number of listed buildings and the Ingestre Conservation area. The historic link between Ingestre and Tixall parks would be maintained. This option would reduce the impacts on agricultural land and holdings. This option would avoid any impact on a strategic residential development site, between Hopton and Marston, identified within the adopted Plan for Stafford Borough 2014, as the option would run to the north-east.
- 6.3.57 The volume of material being removed for the tunnel and the corresponding traffic movements required would be greater than Option B5-7.1. The tunnel through this area would also increase the risk to groundwater resources. This option introduces significantly greater technical and construction complexities than Option B5-7.1, which would also increase the construction risks and lengthen the construction programme.

6.4 Community area 3 –Stone and Swynnerton

Stone railhead and Stone railhead main compound

- 6.4.1 During the design development process since the announcement of the preferred route to Crewe in November 2015, further consideration has been given to the location of a temporary railhead facility and associated compound to serve the construction works for the Proposed Scheme. The railhead and associated compound will be required to accommodate rail systems construction works, as well as allow receipt and stabling of construction trains.
- 6.4.2 A preliminary options appraisal was undertaken of eight options, of which four options were not taken forward for further consideration as they were not considered to be reasonable alternatives:
- Option 1 included a railhead and associated compound located to the east of Yarnfield and west of the M6, positioned on the western side of the Norton Bridge to Stone Railway. The railhead would encroach on the residential areas of Yarnfield and Cold Norton, as well as requiring a significant amount of agricultural land. As such this option was not taken forward for further consideration;

- Option 4 included a railhead and associated compound located in the Whitmore Heath to Madeley area (CA4), positioned between the proposed tunnels at Madeley and Whitmore, 1km south-east of Madeley. A railhead at this location would require the demolition of Hey House, a Grade II listed building, as well as the demolition of Madeley Cemetery. This option would also introduce construction risks, which would potentially lengthen the construction programme due to the positioning of the railhead between two tunnels. As such this option was not taken forward for further consideration;
- Option 6 included a railhead and associated compound located to the west of Stone and east of the HS2 main line, positioned to the south of the Norton Bridge to Stone Railway. The railhead would be located on land approved for up to 500 residential properties between the Norton Bridge to Stone Railway and the B5026 Eccleshall Road (reference 13/19002/OUT) and would also be close to residential properties in Stone and Walton. The railhead at this location would also require the demolition of Walton House Farm and associated outbuildings. As such this option was not taken forward for further consideration; and
- Option 7 included a railhead and associated compound located to the west of Stone and east of the HS2 main line, positioned north of the Norton Bridge to Stone Railway. The railhead would result in the loss of Stone Golf Club and would require sidings that would encroach on the residential areas of Stone. As such this option was not taken forward for further consideration.

6.4.3 In addition, the use of Kingsbury railhead, located in the Curdworth to Middleton area (CFA 20) in Phase One, positioned east of the M42 and north of the A409 Kingsbury Road, was considered. This option would require the construction of the Proposed Scheme from a railhead and associated compound approximately 20km south of the start of Phase 2a. A railhead at this location would be unfeasible for the construction of the Proposed Scheme within the project timescales. As such this option was also not taken forward for further consideration.

6.4.4 The following four options were taken forward to a more detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered. Consideration was given to a further option identified at Aldersey's Rough as a result of stakeholder feedback following the working draft EIA Report consultation and is reported below:

- Option 2: a railhead and associated compound would be located to the west of Stone, on land isolated between the M6 and the HS2 main line, north of the Norton Bridge to Stone Railway. This option would enable a direct southbound connection into the HS2 main line, requiring a headshunt adjacent to the HS2 main line to enable northbound access. Connections in both directions to the Norton Bridge to Stone Railway would be provided via 1km long railway sidings in a north-east direction towards Stone. Vehicular access to the railhead and associated compound within this option would be potentially gained via the M6 as well as the local road network;

- Option 3: a railhead and associated compound located to the south-west of Stone, on land isolated between the M6 and the HS2 main line, south of the Norton Bridge to Stone Railway. This option would provide connection to the Norton Bridge to Stone Railway in both directions on the southern side via 1km long railway sidings in a north-easterly direction towards Stone. This option would enable a direct northbound connection into the HS2 main line, requiring a headshunt adjacent to the HS2 main line to enable southbound access. Vehicular access to the railhead and associated compound within this option would be potentially gained via the M6, as well as the local road network;
- Option 5: a railhead and associated compound located in the South Cheshire area (CA5), south of Crewe in the west Basford area. This option would provide a southbound connection into the HS2 main line via 2km long railway sidings and a connection into the WCML in both directions at Basford Hall. Vehicular access to the railhead and associated compound within this option would be gained via the local road network; and
- Option 8: a railhead and associated compound located to the west of Stone, on land isolated between the M6 and the HS2 main line, north and south of the Norton Bridge to Stone Railway. The railhead would provide connection to the Norton Bridge to Stone Railway in both directions on the southern side via 1km long railway sidings in a north-easterly direction towards Stone. This option would also enable direct connections into the HS2 main line in both directions, with vehicular access to the railhead and associated compound made via connections to the M6 as well as the local road network, namely Yarnfield Lane.

6.4.5 As a result of stakeholder feedback following the working draft EIA Report consultation, consideration was given to a further option named Aldersey's Rough, Madeley. Under this option a railhead and associated compound would be located in the Whitmore Heath to Madeley area (CA4), at a location adjacent to Aldersey's Rough, 1km south-east of Madeley, with connections to the HS2 mainline and WCML positioned between the proposed tunnels at Madeley and Whitmore. This option would require the re-commissioning and upgrade of 2.5km of the out of use Stoke to Market Drayton Railway (also known as the Silverdale line of the Stoke to Market Drayton Railway) to provide connections into the HS2 infrastructure via two separate reception tracks approximately 1km in length. Connections into the existing WCML would also be facilitated by two separate reception tracks approximately 1.2km in length, with road access to the compound potentially gained via the M6.

6.4.6 Option 8 was taken forward into the Proposed Scheme. Option 3 and Aldersey's Rough in comparison would present an increase in environmental impacts and construction complexities. During construction, Option 3 would generate a significant amount of excavated material due to the topography of the site and the excavation required, this would make Option 3 significantly more expensive to construct than Option 8 and would be environmentally worse in comparison. Option 3 would only be capable of connecting directly into the HS2 main line in one direction, restricting the effectiveness of the railhead during construction of the Proposed Scheme.

- 6.4.7 Aldersey's Rough would likely introduce significant landscape and visual impacts on local residential receptors as a result of the significant amount of land required for construction. Areas of ancient woodland would also be directly impacted and some of the rail connections would be located within the flood zone of River Lea increasing flood risk in the area. This option would be likely to require large quantities of earthworks and highlights key construction risks, with the potential to impact the project timescales due to the positioning of the railhead between two tunnels.
- 6.4.8 Option 2 was considered to be environmentally comparable to Option 8. However, due to a constrained layout, this option would only be capable of connecting directly into the HS2 main line in one direction, restricting the effectiveness of the railhead and associated compound. Option 5 was considered to provide greater environmental benefits when compared with Option 8, however, these benefits were not considered sufficient to justify the significant lengthening of the construction programme due to the location of the railhead and realignment works to the existing road network.
- 6.4.9 The analysis of engineering, cost and potential environmental impacts associated with all five options is set out below, with the impacts of the option selected presented first.

Option 8

- 6.4.10 This option would impact on the landscape character of the area, particularly the setting of Darlaston Park, and would result in visual impacts during construction on the residential properties to the edge of Walton and Yarnfield. There would be an impact on agricultural land and holdings and the likely sterilisation of mineral associated with a mineral safeguarding area. This option would result in the loss of ecological habitats and there would be a potential impact on species.
- 6.4.11 This option would require the widening of the existing rail embankment, which is currently within the flood zone, and as such, compensatory storage areas would likely be required. Filly Brook, on the eastern side of the M6, would require works to culvert the watercourse along the railway sidings adjacent to the Norton Bridge to Stone Railway. There would also be an impact on heritage assets. This option would impact on a minor area of a committed development for up to 500 residential properties between the Norton Bridge to Stone Railway and the B5026 Eccleshall Road (reference 13/19002/OUT) due to the presence of the railway sidings adjacent to the Norton Bridge to Stone Railway. There would be an impact on a historic landfill, and therefore, this option presents a risk of contamination. At the time of the appraisal it was also considered that this option would require the temporary closure of Yarnfield Lane for up to three years during construction with traffic being diverted onto the B5026 Eccleshall Road, which has the potential to result in congestion and delays and impact on businesses that use Yarnfield Lane, such as Stone Golf Club and The Wayfarer. However, further development of the access arrangements to and from the railhead have been undertaken following the outcome of this appraisal which have mitigated these impacts. An offline realignment of Yarnfield Lane has been incorporated into the design, allowing it to remain open during both construction and operation of the Proposed Scheme. The findings of this appraisal are presented later in this section.

- 6.4.12 Option 8 does not introduce any technical or construction complexities, risk of safety hazards, or lengthening of the construction programme.

Option 2

- 6.4.13 In comparison to Option 8 (the Proposed Scheme), the impact on agricultural land and holdings would be reduced as would the loss of ecological habitats and the potential impact on species. With this option the committed residential development between the Norton Bridge to Stone Railway and the B5026 Eccleshall Road (reference 13/19002/OUT) would be avoided. The MSA would also be avoided.
- 6.4.14 With this option there would be an increase in construction traffic associated with the movement of materials off-site to construct the railhead. There would be an impact on two historic landfills, and therefore, the risk of contamination would be increased.
- 6.4.15 Due to a constricted layout, this option would only be capable of connecting directly into the HS2 main line in a southbound direction, restricting the effectiveness of the railhead and associated compound for the construction of the Proposed Scheme.

Option 3

- 6.4.16 In comparison to Option 8 (the Proposed Scheme), Option 3 presented an increase in the impact on agricultural land and holdings due to an increase in the number of commercial agricultural holdings affected. This option would reduce the loss of ecological habitats and potential impact on biodiversity and a reduction in surface water effects due to a lesser extent of Filly Brook and associated floodplain affected. There would be reduced transport impacts with this option as there would not be a requirement to potentially provide a temporary closure of Yarnfield Lane. During construction there would be a significant increase in excavated material removed from site due to the topography of the site and the excavation required. As with Option 8, Option 3 would potentially impact on a minor area of a committed development for up to 500 residential properties between the Norton Bridge to Stone Railway and the B5026 Eccleshall Road (reference 13/19002/OUT) during construction of the railway sidings adjacent to the Norton Bridge to Stone Railway. The MSA would also be avoided and there would be no impact on historic landfills.
- 6.4.17 Due to a constricted layout, this option would only be capable of connecting directly into the HS2 main line in a northbound direction, restricting the effectiveness of the railhead and associated compound for the construction of the Proposed Scheme. A significant increase in excavation work would be required to establish the railhead within the existing topography, as well as potential waste storage and reinstatement complexities. This option would also be substantially more expensive to construct than Option 8 due to the level of excavation required and the design of this option to work within the ground levels proposed.

Option 5

- 6.4.18 In comparison to Option 8 (the Proposed Scheme), Option 5 would reduce the impact on landscape character and visual impacts, due to the isolated urban nature of the location. There would still, however, be visual impacts on residential properties in proximity to the railhead. There would be a reduced impact on surface water, groundwater and ecological habitats and the potential impact on species would also

be reduced. There would also be a reduced impact on agricultural land and holdings. There would be a reduction in construction traffic as the need to move material off-site would be minimised.

- 6.4.19 This option would require an extensive area of land at Basford West, which would impact on a committed development for general industry, storage and distribution and a separate application for residential development, offices and local amenity facilities (reference 14/0378N). This option would result in the need to demolish a number of residential properties. This option would result in the likely sterilisation of mineral associated with two MSAs. This option would result in the need for the closure of the newly built B5071 Jacks Mills Way, which has the potential to result in congestion and delays.
- 6.4.20 Due to the location at the northern extent of the Proposed Scheme, the railhead in this option would only be able to facilitate the construction of the Proposed Scheme in one direction, placing significant restrictions on the construction programme.

Aldersey's Rough, Madeley

- 6.4.21 In comparison to Option 8 (the Proposed Scheme), this option would require an extensive area of land currently not required or directly impacted by the Proposed Scheme. This option would give rise to visual effects, with likely impacts on a number of residential receptors in the local area and recreational receptors using two PRoW. The railhead and associated road and rail connections within this option would be likely to give rise to an increase in the landscape character effects on the local landscape character within Hey Sprink Ancient Redlands and Woodland LCA. This is in an area, located away from the route of the Proposed Scheme, which is currently not affected.
- 6.4.22 This option would see increased effects on biodiversity in the area with the likely partial loss of Hey Sprink Ancient Woodland adjacent to the proposed railhead compound location at its westernmost extent during the construction of the connections into the HS2 main line. This option would also impact directly on other wooded areas, including Aldersey's Rough, that are considered likely to be deemed of ancient woodland status due to the fragmented nature of the wooded areas in proximity to Hey Sprink. Re-commissioning and upgrading of the existing Stoke to Market Drayton Railway would be likely to be required and would be likely to have an impact on ecology in the area. Connection sidings to the west of the route and north of the Stoke to Market Drayton Railway would be located within the floodplain of the River Lea resulting in increased flood risk of the surrounding area and residential properties along Manor Road. Vehicular access to the M6 would require considerable upgrade works to the M6, as well as having likely impacts on the local road network due to connections to the railhead facility.
- 6.4.23 This option would have associated key construction risks, with the potential to impact the project timescales due to the positioning of the railhead between two tunnels in the Whitmore Heath to Madeley area (CA4). To enable this option to be viable large amounts of earthworks and the reinstatement of the out of use Stoke to Market Drayton Railway would be required. This would restrict connections to the WCML to one direction. Alternative options to provide connections in both directions would be likely to require significant earthworks. The out of use Stoke to Market Drayton

Railway would further limit the connections into the WCML and the HS2 main line requiring substantial upgrade works to enable the provision of two track widths.

Location of the permanent maintenance facility

- 6.4.24 During the design development process since the announcement of the preferred route to Crewe in November 2015, further consideration has been given to the location and operating requirements of a permanent maintenance facility for the Proposed Scheme to optimise the maintenance regime. The working draft EIA Report included reference to a permanent maintenance facility that would be provided in the South Cheshire area (CA5), which would operate as a base for maintenance activities to support the railway infrastructure. Since the publication of the working draft EIA Report and the design refinement consultation, further work has been undertaken to consider the location of the permanent maintenance facility.
- 6.4.25 The following two options were assessed on the basis of engineering and construction feasibility, cost and environmental impacts:
- Stone: a permanent maintenance facility located near Stone, sharing the same footprint and core infrastructure as the proposed Stone railhead. The maintenance facility, in the form of an IMB-R, would be situated on land between the HS2 main line and the M6, between the Norton Bridge to Stone Railway and the M6 Meaford viaduct, with sidings connecting into the Norton Bridge to Stone Railway; and
 - Basford, Crewe (the scheme as assessed in the working draft EIA Report): a permanent maintenance facility located at Crewe. The maintenance facility would be situated in the west Basford area, with access spurs from the WCML via the proposed Basford Hall sidings and connection to the HS2 main line east of Hough.
- 6.4.26 The option near Stone was taken forward into the Proposed Scheme. Basford, in comparison to Stone, would be significantly more expensive to construct requiring the development of a second rail connected facility, the requirement for maintenance loops at Pipe Ridware and realignment works to the existing road network.
- 6.4.27 The analysis of engineering, cost and potential environmental impacts associated with both options are set out below, with the impacts of the option selected presented first.

Stone

- 6.4.28 This option would share the same footprint and the core infrastructure as the Stone railhead, and as a result would not introduce any additional significant environmental effects during construction. During operation, this option would introduce landscape and visual effects to nearby residential receptors including areas of Stone, Walton and Yarnfield. This option would also permanently affect commercial agricultural land holdings as well as impacting on a minor area of a committed development for up to 500 residential properties between the Norton Bridge to Stone Railway and the B5026 Eccleshall Road (reference 13/19002/OUT) due to the presence of the railway sidings adjacent to the Norton Bridge to Stone Railway.

- 6.4.29 This option would strategically position the permanent maintenance facility in the middle section of the Phase 2a Proposed Scheme enabling access to the HS2 main line in both directions. For the final Phase Two scheme (with the route from Crewe extended to Manchester and Golborne), this location would be ideally positioned between the northern ends of the route and the maintenance facilities proposed for Phase One. The positioning of a permanent maintenance facility in this location would enable maintenance activities to be undertaken along the Proposed Scheme efficiently due to its location in the middle section, making efficient use of the maintenance period when the railway is not operating.
- 6.4.30 A permanent maintenance facility, sharing the same footprint as the Stone railhead, would remove the cost of restoring the Stone railhead and enable the ongoing use of infrastructure including buildings, utilities connections, rail sidings, connections to the conventional railway and M6 and environmental mitigation. Sharing of these elements would avoid the cost and environmental impact of providing these facilities separately and reduce the overall area of land required by the Proposed Scheme.
- 6.4.31 Maintenance loops located at Pipe Ridware, in the Fradley to Colton area (CA1), would also no longer be required with this option, enabling the height of the route of the Proposed Scheme in that area to be lowered, reducing visual impacts on local residential properties and impacts on the setting of listed buildings. Lowering the alignment in this area would also reduce costs and reduce the area of land required to operate and maintain the Proposed Scheme (Volume 2: Community area 1, Fradley to Colton).
- 6.4.32 The option near Stone does not introduce any additional technical or construction complexities, risk of safety hazards, or lengthening of the construction programme.

Basford, Crewe

- 6.4.33 In comparison to Stone (the Proposed Scheme), the Basford option would require extensive works to the local road network to maintain accessibility, which would have the potential to result in congestion and delays. Required works would include the replacement of the existing A500 Shavington Road viaduct and Weston Lane overbridge, the permanent closure of the B5071 Jack Mills Way, and an extension of the proposed Newcastle Road overbridge.
- 6.4.34 The land required for the implementation of a permanent maintenance facility at this location would also impact on an approved planning application at Basford West for general industry, storage and distribution and a separate application for residential development, offices and local amenity facilities (reference 14/0378N).
- 6.4.35 Due to the location at the northern extent of the Proposed Scheme, a permanent maintenance facility at this location would only be able to maintain the Phase 2a Proposed Scheme in one direction, resulting in increased travel times during periods of maintenance with decreased efficiency in comparison to a permanent maintenance facility situated in the middle section of the route. For the final Phase Two scheme (with the route from Crewe extended to Manchester and Golborne), this location would be approximately 30km north of the optimum position between the northern ends of the route and the maintenance facilities proposed for Phase One, lengthening travel times during periods of maintenance to the southern end of the Phase 2a scheme, and necessitating maintenance loops at Pipe Ridware.

- 6.4.36 The Basford option would be significantly more expensive to construct than the Stone option as a result of having two rail connected facilities, one temporary and one permanent, as well as the need for maintenance loops at Pipe Ridware.

Stone railhead and IMB-R access arrangements

- 6.4.37 Following consultation on the working draft EIA Report and the further analysis of traffic surveys and modelling, further consideration has been given to the access arrangements to serve the temporary railhead and the IMB-R at Stone in order to minimise the disruption to the local road network, including Yarnfield Lane. The responses received to the working draft EIA consultation demonstrated the importance of Yarnfield Lane as a primary transport link between Yarnfield and Stone. It was also identified that the link between Yarnfield and Stone is important due to the facilities and community services shared between those communities. Options to address the temporary closure of Yarnfield Lane and to provide access to the Stone railhead and IMB-R via the M6 to reduce traffic impacts on local roads have been considered.
- 6.4.38 A preliminary options appraisal was undertaken of six options, and the following four options were not taken forward for further consideration as they were not considered to be reasonable alternatives:
- Option 1: This option involved the permanent closure of Yarnfield Lane with site access to the Stone railhead and IMB-R via the closed section of Yarnfield Lane. A diversion would be put in place for users of Yarnfield Lane adjacent to the western side of the M6, connecting into the B5026 Eccleshall Road. The access arrangements in this option were deemed unfeasible from a traffic perspective, as access to the Stone railhead and IMB-R would be required from the local road network, which would result in significant traffic and community impacts as well as the permanent closure of Yarnfield Lane during construction. As such this option was not taken forward for further consideration;
 - Option 1B: This option involved access arrangements to the Stone railhead and IMB-R via Yarnfield Lane. A temporary closure of a section of Yarnfield Lane for approximately one year and six months between the M6 and the HS2 main line would be required, with users diverted via the existing road network during the realignment works. Yarnfield Lane would be reinstated via a new vertical alignment underneath the HS2 main line to connect back in with the existing Yarnfield Lane on the eastern side of the Proposed Scheme. The access arrangements in this option were also deemed unfeasible from a traffic perspective due to the temporary closure of Yarnfield Lane as well as access to the Stone railhead and IMB-R gained via the local road network, resulting in significant traffic and community impacts. As such this option was not taken forward for further consideration;
 - Option 3: This option consisted of access arrangements to the Stone railhead and IMB-R via the M6. A temporary closure of a section of Yarnfield Lane for approximately one year and six months between the M6 and the HS2 main line would be required, with users diverted via the existing road network. Access from the M6 would be provided via a permanent southbound junction off the

M6, as well as a temporary northbound junction off the M6 during the construction phase. This option included slip roads that were not compliant with relevant highway standards for both the permanent and temporary accesses off the M6, and would also require the closure of Yarnfield Lane for long periods due to the online vertical realignment, temporarily severing the communities of Yarnfield and Stone, as well as putting significant pressures on the local road network. As such this option was not taken forward for further consideration; and

- Option 4: This option included access arrangements to the Stone railhead and IMB-R via a southbound connection off the M6. A temporary closure of a section of Yarnfield Lane for approximately one year and six months between the M6 and the HS2 main line would be required with users diverted via the existing road network. Access from the M6 southbound would tie in with the existing Yarnfield Lane. This option also included slip roads that were not compliant with relevant highway standards for the permanent southbound access off the M6, and would also require the closure of Yarnfield Lane for long periods due to the online realignment of the lane underneath the HS2 main line, temporarily severing the communities of Yarnfield and Stone, as well as putting significant pressures on the local road network. As such this option was not taken forward for further consideration.

6.4.39 The following two options were taken forward to a more detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered:

- Option 2: New northbound and southbound accesses off the M6 located to the north of the existing Norton Bridge to Stone Railway. The northbound slip roads would only be used during the construction period with access restricted for vehicles to the Stone railhead and IMB-R as well as retaining the existing emergency access, connecting up with Yarnfield Lane. The southbound slip road would be permanent and would be used during construction and as access for the railhead and IMB-R during operation. Access from the M6 via the southbound slip roads would include security control features within the railhead and IMB-R, as well as security controls located at the northbound access point, prior to accessing Yarnfield Lane, restricting access to unauthorised vehicles. Yarnfield Lane would be realigned, crossing over the M6 on a new bridge. The southbound slip road would run under the realigned Yarnfield Lane. The existing Yarnfield Lane would remain open during construction and would only be closed for a short period of time to allow connections to the new realigned Yarnfield Lane. Following construction and connection of the realigned Yarnfield Lane, the disconnected section of road would be removed; and
- Option 5: This option is a further development of the option presented in the working draft EIA Report with consideration given to the duration of the temporary closure of Yarnfield Land and access from the M6. In this option new northbound and southbound accesses off the M6, located to the north of the existing Norton Bridge to Stone Railway, would be required. The

northbound slip road would be used during the construction period for construction traffic and would be retained permanently to provide emergency access. The southbound slip road would be permanent and used by construction traffic during construction and would then provide access to the railhead and IMB-R. Both northbound and southbound slip roads would include security control features, restricting access to unauthorised vehicles. Yarnfield Lane would remain on its current alignment over the M6, before being realigned underneath the HS2 main line requiring a temporary closure of this section during construction for approximately one year and six months (as opposed to up to three years stated in the working draft EIA Report). Both the northbound and southbound slip roads would be located on the northern side of Yarnfield Lane.

6.4.40 Option 2 was taken forward into the Proposed Scheme as, on balance, it presented the most favourable environmental outcome with significant improvements in comparison to Option 5 through retaining the use of Yarnfield Lane for public access throughout construction and operation of the Proposed Scheme and mitigating severance of communities. Option 5, in comparison, would present significant reductions in cost and construction programme timescales, however, it would present an increase in environmental impacts. Most notably these included community and traffic impacts as a result of temporary road closures across Yarnfield Lane for approximately one year and six months, which would cause congestion on the local road network.

6.4.41 The analysis of engineering, cost and potential environmental impacts associated with both options is set out below, with the impacts of the option selected presented first.

Option 2

6.4.42 This option would maintain Yarnfield Lane as a primary transport link between Yarnfield and Stone via an offline realignment of Yarnfield Lane. As such this would maintain access to facilities and community services shared between those communities.

6.4.43 During construction there would be amenity impacts on local residential properties with the realigned Yarnfield Lane causing significant visual effects on Whitemoor Farm, properties on Moss Lane and on the outskirts of Yarnfield, as well as a negative impact on the rural landscape character of the area west of the M6. Construction air quality impacts would also be experienced at Whitemoor Farm. However, the realignment of Yarnfield Lane would reduce the visual, air quality and noise impacts at Whitemoor Farm during the operational phase due to the location north of its existing alignment. This option would include the loss of ecological habitats potentially supporting protected species, as well as encroaching on Filly Brook on the western side of the M6. This option would also temporarily require agricultural land for the M6 northbound connections.

6.4.44 Option 2 has construction complexities associated with the realignment of Yarnfield Lane over the M6, with the new alignment adjacent to the existing crossing with limited working area.

Option 5

- 6.4.45 In comparison to Option 2 (the Proposed Scheme), Option 5 would temporarily remove an important transport link between Yarnfield and Stone, and as such, access to shared facilities and services. The closure of Yarnfield Lane would result in the need to divert traffic, resulting in congestion and delays. This option would increase the amount of land required, largely due to the temporary northbound slip road alignment, resulting in increased impacts on agricultural land and ecological habitats, as well as having a greater impact on Filly Brook, crossing the watercourse and requiring temporary culverting of this watercourse. A reduction in the visual effects would be evident during the construction phase on Whitemoor Farm, residential properties along Moss Lane and properties along the outskirts of Yarnfield due to the retention of the existing Yarnfield Lane over the M6. There would be an increased impact on the rural landscape character due to the increased land required during construction of the northbound temporary slip roads west of the M6. The temporary closure of Yarnfield Lane during the construction phase would also result in reduced amenity effects at residential properties that line this section of the lane due to a temporary reduction in traffic emissions, dust and noise.
- 6.4.46 Option 5 does not introduce any technical or construction complexities or risk of safety hazards, and presents a reduction to the construction programme when compared to Option 2. Option 5 would also present significant cost savings in comparison to Option 2 as there would be no need to realign Yarnfield Lane and the existing structure over the M6 would be retained.

Bent Lane (North) diversion

- 6.4.47 During the design development process since (issue with demolitions the announcement of the preferred route to Crewe in November 2015, further consideration has been given to the diversion of Bent Lane, located to the south-west of Swynnerton Old Park. The sensitivities at this location, particularly the proximity to Swynnerton Old Park, maintaining access to Whitmore village, and reducing the impact on the community of Shelton under Harley have been key considerations in the development of these alternatives.
- 6.4.48 The following two options were taken forward to a detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered:
- Option 1 (route announced in November 2015): Bent Lane (North) diversion would continue from Dog Lane on the northern side of the HS2 main line in a westerly direction for approximately 400m before passing approximately 150m north of Shelton under Harley. The diversion would then continue in a south-westerly direction into the Whitmore Heath to Madeley area for approximately 450m before reconnecting into the existing Bent Lane; and
 - Option 2: Bent Lane (North) diversion would continue from Dog Lane on the northern side of the HS2 main line in a westerly direction for approximately 500m before passing adjacent to and to the south of Shelton under Harley. This option would then continue on the existing Bent Lane alignment for

approximately 250m into the Whitmore Heath to Madeley area, remaining north of the Proposed Scheme.

- 6.4.49 Option 2 was taken forward into the Proposed Scheme as, on balance, it presented the most favourable environmental outcome. Option 1, in comparison, would present an increase in environmental impacts, most notably an increase in landscape and visual effects, as well as agricultural, biodiversity and community impacts in the Shelton under Harley area.
- 6.4.50 The analysis of engineering, cost and potential environmental impacts associated with both options is set out below, with the impacts of the option selected presented first.

Option 2

- 6.4.51 This option would require demolition of properties in Shelton under Harley as a result of the construction of Bent Lane diversion. This option would generate impacts on the agricultural holding at Shelton under Harley due to loss of land both during construction and operation. Construction works within this option would likely impact directly and indirectly on protected species within Swynnerton Old Park. This option is also located within a groundwater source protection zone (SPZ) 1 of Severn Trent Water's public abstraction boreholes and construction would likely impact on groundwater quality in the area.
- 6.4.52 Option 2 does not introduce any technical or construction complexities, risk of safety hazards, or lengthening of the construction programme.

Option 1

- 6.4.53 In comparison to Option 2 (the Proposed Scheme), Option 1 would require an increase in the number of demolitions in Shelton under Harley as a result of the construction of Bent Lane diversion. A greater amount of land would also be required, thereby resulting in a greater loss of habitats including direct loss and fragmentation of hedgerows. This option would be closer to the sensitive habitats of Swynnerton Old Park, and therefore, may cause disturbance to the flora and fauna of these habitats through both construction and operation. This option would result in increased permanent impacts on the open rural landscape character of the park, including the historic context, and would increase visual amenity impacts on residential properties in Shelton under Harley and Swynnerton Old Park. The diversion of Bent Lane within this option would significantly increase severance of Shelton under Harley Farm from its agricultural land holding, as well as an increase in the impact on non-motorised users of Bent Lane. Option 2 is also within SPZ 1 of the Severn Trent Water's public abstraction boreholes, albeit further away having less of an impact in comparison to Option 2 on groundwater quality in the area.
- 6.4.54 Option 1 does not introduce any technical or construction complexities, risk of safety hazards, or lengthening of the construction programme.

6.5 Community area 4 – Whitmore Heath to Madeley

- 6.5.1 During the design development process since the announcement of the preferred route to Crewe in November 2015, further consideration has been given to the route of the Proposed Scheme between Whitmore Heath and Madeley. The sensitivity of this location, particularly the residential communities in and around Whitmore Heath,

Baldwin's Gate and Madeley, potential for traffic and transportation disruptions, landscape character, presence of ancient woodland, and impacts on agricultural land and farm holdings, have been key considerations in the development of these alternatives.

6.5.2 A detailed appraisal of engineering and construction feasibility, cost and environmental impacts were considered for the following four options:

- Option D9-11.0a: as the route passes beneath Whitmore Heath it would be in a cut and cover tunnel for approximately 240m in length, which would continue into a twin bore tunnel, for approximately 690m in length and a depth of up to 50m. The southern portal would be located where the route crosses the A53 Newcastle Road requiring realignment over an overbridge. The northern portal would be located where the route crosses Snape Hall Road, which would be permanently closed at either side of the route of the Proposed Scheme. On leaving the tunnel, the route would continue through a section of Whitmore Wood, an area of ancient woodland, in a cutting up to 13m in depth with a retaining wall on the north-east side. The route would then continue on embankment and pass over the River Lea, the WCML, the Stoke to Market Drayton Railway and the Madeley Chord on a viaduct approximately 785m in length and up to 17m in height. The route would pass underneath Manor Road and the A525 Bar Hill Road which would both be realigned and cross the route on overbridges. The route would then continue in a twin bore tunnel for approximately 670m and a depth of up to 38m as it passes under Bar Hill;
- Option D9-11.0b: as the route passes beneath Whitmore Heath it would be in a twin bore tunnel, for approximately 1.4km in length and a depth of up to 60m. The southern portal would be located approximately 265m south-east of the A53 Newcastle Road and the northern portal would be located immediately north of Snape Hall Road. On leaving the tunnel the route would continue through a section of Whitmore Wood in a cutting up to 20m in depth with a retaining wall on the north-east side. The route would then continue on embankment and pass over the River Lea, the WCML, the Stoke to Market Drayton Railway and the Madeley Chord on a viaduct approximately 570m in length and up to 21m in height. The route would pass underneath Manor Road which would be realigned and cross the route on an overbridge. The route would then continue in a twin bore tunnel for approximately 1.2km and a depth of up to 51m as it passes under Bar Hill. The southern portal of Madeley tunnel would be located immediately south of the A525 Bar Hill Road;
- Option D9-11.1: the route would pass beneath Whitmore Heath and the WCML in a twin bore tunnel, approximately 1.9km in length and a depth of up to approximately 43m. The southern portal would be located immediately south of the A53 Newcastle Road and the northern portal would be located north of where the route would cross the WCML. On leaving the tunnel the route would continue in a cutting up to 16m in depth prior to passing over the River Lea on a viaduct approximately 100m in length and up to 7m in height. The route would pass underneath Manor Road which would be realigned and cross the route on an overbridge. The route would then continue in a twin bore tunnel

for approximately 1.3km and a depth of up to 30m as it passes under Bar Hill. The southern portal of Madeley tunnel would be located immediately south of the A525 Bar Hill Road; and

- Option D9-11.3: the route would pass beneath Whitmore Heath, Whitmore Wood, the WCML, the River Lea and Bar Hill in a twin bore tunnel, approximately 6.4km in length and a depth of up to approximately 75m. The southern tunnel portal would be located approximately 265m south-east of the A53 Newcastle Road and the northern portal would be located approximately 150m south-west of Bower End Farm. Due to the length of tunnel, two vent shafts would be required to provide ventilation and emergency access. One vent shaft would be located between Whitmore Heath and Whitmore Wood and the other would be located south-east of Manor Road.

6.5.3 The preferred option taken forward into the Proposed Scheme was Option D9-11.0a. Although each of the alternative options provide some environmental benefits in comparison to Option D9-11.0a, the benefits were not considered sufficient to justify the significant additional cost associated with each of them.

6.5.4 The analysis of engineering, cost and potential environmental impacts associated with all four options is set out below, with the impacts of the option selected presented first.

Option D9-11.0a

6.5.5 Option D9-11.0a would result in the need to demolish properties and would introduce visual, noise and visual amenity impacts in Whitmore Heath and Bar Hill. This option would result in the loss of agricultural land and holdings and the loss and fragmentation of ecological habitat, including approximately 6.0ha (34%) of ancient woodland at Whitmore Wood and 0.2ha (4%) of ancient woodland at Barhill Wood. There would be an impact on the local landscape character in the area, most notably around the A53 Newcastle Road, Whitmore Wood and Barhill Wood.

6.5.6 There would be impacts on cultural heritage including visual intrusion on the scheduled monument of Old Madeley Manor, an impact on the setting of the Grade II listed Hey House and visual intrusion on other Grade II listed buildings, including a cluster within Madeley Conservation Area. The route would cross a number of historic landfills and therefore presents a risk of contamination.

6.5.7 Additionally there would be impacts on a number of watercourses and tributaries and the tunnels have the potential to impact upon groundwater abstractions and springs. The route is in immediate vicinity to the Severn Trent Water Whitmore groundwater boreholes and encroaches into the Source Protection Zone (SPZ). Most of the route through this section is within a MSA.

6.5.8 Option D9-11.0a involves complex construction activities associated with the two twin bore tunnels, tunnel fit out, pumping stations and construction of tunnel porous portals. There would be high maintenance requirements during operation associated with tunnel drainage and mechanical, electrical and plumbing systems. Three highway realignments would be required (A53 Newcastle Road, Manor Road and A525 Bar Hill Road) and Snape Hall Road would be permanently closed on either side of the northern porous portal of Whitmore Heath tunnel. There would also be a number of

temporary and permanent PRow diversions. The construction of the River Lea viaduct over the WCML would also require railway possessions and would result in disruption to rail services.

Option D9-11.ob

- 6.5.9 In comparison to Option D9-11.0a (the Proposed Scheme), Option D9-11.ob would present a reduction in landscape effects at Whitmore. There would however be increased land required for construction and operation of the Proposed Scheme at Whitmore Wood. This would result in increased effects on biodiversity and landscape character. Sound, noise and vibration impacts would be reduced due to a shifting works away from Whitmore Heath. However, tunnelling works would encroach further into the SPZ. There would be no demolition of properties in Whitmore Heath and no likely amenity effects on residents along the A53 Newcastle Road.
- 6.5.10 Impacts on landscape character would be reduced at Bar Hill, although the removal of a pond would still be necessary. The loss of 0.2ha (4%) of Barhill Wood would be avoided, sound and vibration effects to properties along Bar Hill road would be reduced, less agricultural land would be impacted and there would be hydrological benefits including removing the need for an aqueduct at Barhill Wood. This option would avoid demolition of properties on the A525 Bar Hill Road and there would be no realignment of the A525 Bar Hill Road and associated isolation effects. This option would also avoid the disruption of a commercial shoot at Bar Hill Farm during construction.
- 6.5.11 This option would generate less construction traffic as there would be no highway works to the A53 Newcastle Road, Heath Road, the A525 Bar Hill Road and Red Lane and would result in fewer diversions of PRow and Snape Hall Road would no longer be closed during operation.
- 6.5.12 Construction of Option D9-11.ob would be less complex than the Proposed Scheme due to the reduced highway and drainage works. However, due to the longer tunnels, this option would be significantly more expensive to construct and the costs of maintenance during operation would be higher. Railway possessions at the WCML and potential disruptions to rail services would be same as for Option D9-11.0a.

Option D9-11.1

- 6.5.13 In comparison to Option D9-11.0a (the Proposed Scheme), Option D9-11.1 presents environmental benefits such as avoidance of Whitmore Wood and demolitions at Whitmore Heath. There would be a reduction in sound, noise and vibration impacts to properties in Whitmore Heath and along the A525 Bar Hill Road. Properties in Whitmore Heath would have reduced amenity effects and impacts associated with Barhill Wood would also be minimised.
- 6.5.14 Visual amenity impacts to Madeley Park properties and landscape character would be increased. Whitmore Wood would be unaffected with no loss of trees, and therefore landscape character impacts here would be removed. There would be reduced landscape impacts on Barhill Wood, the A525 Bar Hill Road, and nearby residential properties. However, landscape impacts would instead be generated to Manor Farm, Manor Cottages and Bar Hill House. Reduced amenity impacts would be experienced by Moor Hall Farm and Bower End Farm. This option would require two demolitions.

- 6.5.15 There would be an increased effect on cultural heritage receptors with this option. Although the route is moved away from the Grade II listed Hey House it would pass in close proximity to Grade II listed Manor Farmhouse and to the Old Madeley Manor scheduled monument.
- 6.5.16 This option would generate less construction traffic than Option D9-11.0a and there would be a significant reduction in highway works. This option would be less complex to construct when compared to Option D9-11.0a due to significantly reduced highways works and by avoiding any operational disruption to the WCML. However there would be insufficient clearance for the Stoke to Market Drayton Railway to remain viable, and this option would be significantly more expensive to construct than Option D9-11.0a.

Option D9-11.3

- 6.5.17 In comparison to Option D9-11.0a (the Proposed Scheme), Option D9-11.3 would avoid the need to demolish properties along this section, reduce loss of agricultural land and reduce community isolation effects and transport impacts. There would be a reduction in noise, visual and amenity impacts to residents at Whitmore Heath and Bar Hill during construction. Visual impacts on the local landscape character during construction and operation between Whitmore Heath and Bar Hill would also be significantly reduced. Direct impacts on watercourses, including unnamed watercourses at Snape Hall Road and Whitmore Wood and a tributary of the River Lea, would be avoided.
- 6.5.18 Whitmore Wood and Barhill Wood would be avoided and therefore there would be no loss or fragmentation of ancient woodland and no operational disturbance upon these habitats. Similarly, effects on all cultural heritage assets within this area would be reduced, however, given the proximity of a tunnel vent shaft to Hey House it is likely that there would still be effects on the setting of this Grade II listed building.
- 6.5.19 With this option there would be an increase in excavated material associated with the longer tunnel which would correspond with an increase in construction traffic. The risk to groundwater resources and intrusion into the groundwater SPZ at Whitmore would be increased due to longer tunnelling works.
- 6.5.20 Construction of Option D9-11.3 would be significantly less complex than Option D9-11.0a. Highways works would be significantly reduced and operational disruption to the WCML would be avoided. However, due to the increase in length of the bored tunnel, this option would be significantly more expensive to construct and the costs of maintenance during operation would be higher.

Route alignment from the A525 Bar Hill Road to Wrinehill Wood

- 6.5.21 During the design development process since the announcement of the preferred route to Crewe in November 2015, further consideration has been given to the route of the Proposed Scheme between north of the A525 Bar Hill Road and Wrinehill Wood. The option to replace the twin bore tunnel beneath Bar Hill with a cutting has been considered. The sensitivity of this location, particularly the proximity of the route to residential properties at Bar Hill, landscape character, ecological receptors, including Barhill Wood, and the effects of construction activities, including traffic, have been key considerations in the development of these alternatives.

- 6.5.22 A preliminary appraisal of three variations of the depth of cutting was undertaken. It was concluded that the environmental impacts associated with all three depths (up to 36m, 32m and 28m) were broadly similar with the cutting depth of up to 32m being marginally better overall, therefore, this option was taken forward for further consideration.
- 6.5.23 The following two options were taken forward to a more detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered:
- Option 0: the route would pass beneath the A525 Bar Hill road overbridge within Madeley cutting before entering the southern porous portal of Madeley tunnel. Madeley tunnel would be a twin bore tunnel approximately 670m in length with a depth of up to 38m. The route would then emerge from the northern porous portal of Madeley tunnel before continuing onto the Checkley South embankment; and
 - Option 2: a cutting, approximately 180m in width and a depth of up to 32m, would extend approximately 1.4km from north of the A525 Bar Hill Road towards Wrinehill Wood culvert. Bower End Lane would cross over the cutting on an overbridge. As a consequence of changing the vertical alignment of the route, the A525 Bar Hill Road would become an underbridge rather than an overbridge and there would be changes to the drainage infrastructure. The track spacing would be reduced by up to 13m (from 18m to 5m) in the vicinity of the River Lea to north of Checkley Brook.
- 6.5.24 Option 0 was taken forward into the Proposed Scheme as on balance it presented the most favourable environmental outcome. Option 2 in comparison had significant cost savings and engineering benefits, however, on balance these were not considered sufficient to justify the additional environmental impacts during construction and operation most notably visual impacts, ecological impacts, impacts to agricultural land holdings and heritage assets.
- 6.5.25 The analysis of engineering, cost and potential environmental impacts associated with both options is set out below, with the impacts of the option selected presented first.
- Option 0*
- 6.5.26 Option 0 would result in the demolition of properties, generate noise impacts in Bar Hill, introduce construction activities associated with 24-hour tunnelling works, and generate amenity impacts at Madeley. This option would result in the loss of agricultural land and holdings and of ecological habitat, including 0.15ha (3%) of Barhill Wood. A number of surface water flows would be intercepted and channelled into Bar Hill aqueduct. The tunnel would also run through a Principal aquifer and have the potential to impact upon groundwater abstractions and springs.
- 6.5.27 Construction of the tunnel would generate a large number of construction vehicles. The presence of the tunnel porous portals and associated infrastructure would impact on the landscape character in the area, most notably around Bar Hill and Wrinehill, and would introduce visual impacts on a number of residential properties and users of the PRow network. The route would cross historic landfills located at Beechfields and

Bower End Farm and therefore presents a risk of contamination. The route would also cross an MSA.

- 6.5.28 Option o would involve complex construction activities associated with bored tunnels, tunnel fit out, pumping stations and construction of tunnel porous portals. There would be high maintenance requirements during operation associated with tunnel drainage and mechanical, electrical and plumbing systems.

Option 2

- 6.5.29 In comparison to Option o (the Proposed Scheme), with Option 2, whilst some residential properties would experience a reduced visual impact, there would generally be an increase in visual impact on receptors close to the route and across a wider area such as in elevated locations to the south-east and properties south of Madeley. There would be an impact on landscape character between Bar Hill and Wrinehill, however the impact on landscape character around the A525 Bar Hill Road and at Wrinehill would be reduced.
- 6.5.30 Barhill Wood would be avoided by this option, however, there would be an increase in impacts on ecological receptors due to the presence of the cutting. Impacts on agricultural land and holdings would be increased due to additional land required for the cutting which would also increase impacts on heritage assets. This option would increase the impacts on surface and groundwater as the cutting presents a greater barrier to surface and groundwater flow.
- 6.5.31 Option 2 would marginally reduce the number of properties to be demolished when compared to Option o and there would be no requirement for 24-hour tunnelling works during construction which would therefore reduce construction noise impacts on residential properties in Bar Hill. There would also be a reduction in the number of construction vehicles associated with this option.
- 6.5.32 The construction of the cutting in Option 2 would be significantly less complex than the construction of bored tunnel in Option o and would reduce the risk of safety hazards. This option would also potentially reduce the construction programme as construction of the cutting could take place from a number of work sites. Some material from this cutting would be suitable for use within the Proposed Scheme and as such would reduce the requirement to obtain fill materials from other sources.

Madeley Bridleway 1 (Red Lane)

- 6.5.33 During the design development process since the announcement of the preferred route to Crewe in November 2015, further consideration has been given to the design of Madeley Bridleway 1 (Red Lane) where the lane crosses the route of the Proposed Scheme. The historic sensitivity of this route, which connects Madeley to Aston, two settlements of probable medieval origin, the safety of users being diverted onto the A525 Bar Hill Road and the landscape and ecological connectivity of the surrounding area, have been the key considerations in the development of these alternatives.
- 6.5.34 The following two options were taken forward to a more detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered:
- Option 1: maintaining Madeley Bridleway 1 (Red Lane) on its existing

alignment on an accommodation green overbridge where it crosses the route of the Proposed Scheme. The bridge would provide ecological connectivity across the route; and

- Option 2 (the scheme as assessed in the working draft EIA Report): a permanent diversion of Madeley Bridleway 1 (Red Lane) for approximately 500m along the south-west of the route of the Proposed Scheme, crossing the route on the A525 Bar Hill overbridge to join the realigned A525 Bar Hill Road.

6.5.35 Option 1 has been taken forward into the Proposed Scheme as on balance it presented the most favourable environmental outcome. Option 2 in comparison would present cost savings and engineering benefits, however, on balance these were not considered sufficient to justify the additional environmental impacts during construction and operation.

6.5.36 The analysis of engineering, cost and potential environmental impacts associated with both options is set out below, with the impacts of the option selected presented first.

Option 1

6.5.37 Option 1 would maintain the historic alignment of the lane and avoid users being diverted onto the A525 Bar Hill Road to the north-west. The green overbridge would provide ecological connectivity across the route and the continuous hedgerow would retain some of the character of the existing route. This option would additionally maintain use of the bridleway for access to agricultural land.

Option 2

6.5.38 In comparison to Option 1 (the Proposed Scheme), Option 2 would not provide any ecological connectivity. The permanent diversion of Madeley Bridleway 1 (Red Lane) would alter the historic route and divert users to the A525 Bar Hill Road, a distance increase of 500m on the original route. Severance effects on agricultural land would also be worsened.

6.5.39 The construction of this option would be less complex and have a reduced cost as the overbridge would be replaced by an at-grade diversion of Madeley Bridleway 1 (Red Lane) over the A525 Bar Hill Road.

Borrow pit within Whitmore Heath to Madeley area

6.5.40 During the design development process since the announcement of the preferred route to Crewe in November 2015, further consideration has been given to the way in which the Proposed Scheme will acquire high quality aggregate (usually comprising sand and gravel) to construct embankments. This material will be provided, in part, through excavation of cuttings and other earthworks along the route of the Proposed Scheme, where the quality is appropriate. However, at some locations along the route there is insufficient high quality material for use in railway embankment construction. The use of borrow pits close to the route of the Proposed Scheme would enable aggregate to be extracted and processed and backfilled locally and transported largely on site haul routes lowering HGV movements and reducing impacts on the local road network and communities. Section 6.10 of Volume 1 of this ES presents an overview of the alternatives to using borrow pits.

- 6.5.41 During the design development process a requirement was identified for a borrow pit in the section of the route covering the Whitmore Heath to Madeley or South Cheshire area (CA5). Two options were proposed for a potential borrow pit in the area, a combination of three borrow pit locations (two located in the South Cheshire area (CA5) and one located in the Whitmore Heath to Madeley area) and one borrow pit located in the Whitmore Heath to Madeley area. The option taken forward into the Proposed Scheme was a refined option located in the South Cheshire area (CA5) as it would be less complex to construct and reduce the requirement to transport materials over longer distances. Details of the options considered is provided within the Volume 2: Community area 5, South Cheshire.
- 6.5.42 Subsequent to further analysis of construction traffic data, it was determined that a borrow pit would also be required to support construction within the Whitmore Heath to Madeley area. The borrow pit in the Whitmore Heath to Madeley area which has been taken forward into the Proposed Scheme is located north of the proposed River Lea viaduct and occupies a 40ha area of agricultural land associated with Netherset Hey Farm. The area is bordered by the River Lea and WCML to the west, Netherset Hey Lane to the east, the Stoke to Market Drayton Railway to the south and Netherset Industrial Estate to the north.
- 6.5.43 This location was identified using plans showing suitable geology combined with requirements for excavated material where the largest shortfalls of material occurred along the route of the Proposed Scheme. Selection criteria also included areas of mineral resource identified by Staffordshire County Council (SCC) and avoidance, where reasonably practicable, of residential properties, environmentally sensitive receptors, major services and diversions.
- 6.5.44 The presence of the borrow pit would increase the landscape and visual effects during construction. It would result in the temporary loss of agricultural land associated with Netherset Hey Farm holding.
- 6.5.45 The proximity of the borrow pit to the River Lea means that there would be the potential for baseflow to be impacted during excavation and dewatering activities. A minor tributary running through the site would also have to be temporarily diverted.
- 6.5.46 There are engineering benefits associated with this borrow pit as it sits within a larger area that has previously been promoted by the landowner for mineral extraction but was not included in the Minerals Local Plan for Staffordshire 2015 to 2030. Despite offering a significant resource, the area was not identified as a preferred site within this plan due to the absence of satisfactory road access, impacts to soil and impacts upon the local landscape. The intention by HS2 Ltd to predominantly use the on-site haul routes and to restore this area to the former ground levels and agricultural land-use would reduce the potential adverse impacts previously identified by SCC. The use of this area also avoids the need to deplete other preferred mineral resources within the SCC area.

6.6 Community area 5 – South Cheshire

- 6.6.1 The working draft EIA Report included a permanent maintenance facility in the South Cheshire area that would operate as a base for maintenance activities to support the railway infrastructure. Following a review of the alternatives and the consideration of the responses from the Design Refinement Consultation, the Secretary of State for

Transport has concluded that the permanent maintenance facility will be relocated near to Stone, within the Stone and Swynnerton area (CA3), in the form of the Stone IMB-R.

- 6.6.2 A permanent maintenance facility located at Crewe would only enable access to the Proposed Scheme in one direction, resulting in increased travel times during periods of maintenance with decreased efficiency in comparison to a permanent maintenance facility situated in the middle section of the route. For the final Phase Two scheme (with the route from Crewe extended to Manchester and Golborne), a permanent maintenance facility at Crewe would be approximately 30km north of the ideal position between the northern ends of the route and the maintenance facilities proposed for Phase One, making travel times during periods of maintenance to the southern end of the Phase 2a scheme longer, and necessitating maintenance loops at Pipe Ridware, in the Fradley to Colton area (CA1).
- 6.6.3 Locating the permanent maintenance facility near to Stone would result in cost savings and provide an effective maintenance strategy across the Proposed Scheme, as well as for the proposed HS2 Phase 2b scheme, as the IMB-R would be strategically positioned in the middle section of the Proposed Scheme and would enable access to the route in both directions. This option would make use of severed land between the M6 and the route of the Proposed Scheme, reducing the environmental impact that would result from the use of two separate areas of similar footprint. Maintenance loops located at Pipe Ridware, would also not be required enabling the height of the route of the Proposed Scheme in that area to be lowered, further reducing any environmental impacts.
- 6.6.4 The relocation of the permanent maintenance facility would avoid the disruption to the local road network, including the A500 Shavington Bypass, Weston Lane and the B5071 Jack Mills Way, which would no longer be required to be stopped up. The need to sterilise approved planning applications for commercial and residential development would also be avoided as would the need to demolish up to 40 residential properties at the Basford West Development Site off the B5071 Jack Mills Way.
- 6.6.5 Details of the options considered and the environmental impacts associated with the location of the Stone IMB-R are provided in Volume 2: Community area 3, Stone and Swynnerton.

HS2 spurs (crossing of and connection to the WCML)

- 6.6.6 During the design development process since the announcement of the preferred route to Crewe in November 2015, further consideration has been given to where the HS2 spurs would need to connect into the existing WCML infrastructure. This has included consideration of positioning the HS2 spurs in the optimum location and options relating to the best layout to connect into the WCML.
- 6.6.7 The route announced in November 2015 showed the HS2 main line running on viaduct over the entrance to the Basford freight yard at a similar level to the existing A500 Shavington Bypass, then dropping down to go through the Basford freight sidings, before dropping further to the retained cutting (which would connect into a tunnel portal and a tunnel – part of the proposed HS2 Phase 2b) in between the conventional rail lines at Crewe South Junction. The northbound spur diverged from the HS2 main

line near Weston Lane to the south of Crewe, before passing over or through some of the existing Basford Hall sidings, over the top of the HS2 main line and joining to the WCML just south of Crewe South Junction. The southbound spur diverged from the WCML near Weston Lane, before passing over a realigned line of the WCML on a viaduct near Newcastle Road and connecting to the HS2 main line near Chorlton.

- 6.6.8 In reviewing this part of the design in further detail it was considered that there were complex engineering and interfacing operational issues which required additional assessment. The proposed location of the crossing and connection into the WCML would result in an impact, during construction of the Proposed Scheme, on the operation of the WCML and Network Rail's regionally important freight and maintenance operations at Basford Hall, resulting in the permanent loss of land and loss of rail access to some sidings. The proposed location would additionally require major changes to the surrounding road network. This would incur significant expense to the project.
- 6.6.9 The importance of the interface with existing railway infrastructure, including Network Rail's freight operations at Basford Hall, and the need to reduce disruption, during construction and operation on the WCML, has been instrumental in considering the design in this area. Disruption to the surrounding road network and the proximity of the Proposed Scheme to Chorlton has also been an important consideration.
- 6.6.10 More detailed work on construction planning has shown that it would be less disruptive during the construction period to relocate the retained cutting (which would connect into a tunnel portal and a tunnel (part of the proposed HS2 Phase 2b) to the south of the A500 Shavington Bypass; simplifying the civil engineering works required with the previous design and removing the need to relocate the existing rail freight sidings.
- 6.6.11 A preliminary options appraisal was undertaken of 24 options, which considered different configurations of the following design proposals:
- relocating the retained cutting;
 - online and offline construction of the HS2 spurs;
 - the HS2 spurs crossing underneath and over the top of the WCML before connecting into the WCML; and
 - the HS2 spurs connecting into the WCML south or north of the Basford Hall Junction.
- 6.6.12 Of the 24 options considered, 20 options were not taken forward for further consideration as they were not considered to be reasonable alternatives for the following reasons:
- Options 1a, 1b, 2a, 2b, 3a, and 3b proposed online construction of the HS2 spurs connection into the WCML, which would result in a significant lengthening of the construction programme and disruption to passengers using the WCML;
 - Options 1b, 1d, 2b, 2d, 3b, and 3d proposed that the HS2 spurs would cross

underneath the WCML before connecting into the WCML, which would result in a significant lengthening of the construction programme;

- Options 1h, 1j, 2a, 2b, 2g, 2h, 3a, 3b, 3c, and 3d proposed that the HS2 spurs connection into the WCML would be located south of the Basford Hall Junction. Due to the operational requirements of the WCML, a grade separated solution is required to avoid having a detrimental impact on existing services using the WCML. Therefore, the WCML connections must be located north of Basford Hall Junction;
- Option 1e and 1f represented a refinement to Option 1c; however, investigations into both options offered no technical improvement to Option 1c and as such these options were not taken forward for further consideration; and
- Option 2e and 2i represented a refinement to Option 2c; however, investigations into both options offered no technical improvement to Option 2c and as such these options were not taken forward for further consideration.

6.6.13 The following four options were taken forward to a more detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered:

- the route announced in November 2015: the retained cutting would be located immediately south of Crewe Station. The HS2 main line would be positioned to the west of the existing WCML. The HS2 northbound spur would connect into the WCML north of the A500 Shavington Bypass having crossed over the HS2 main line. The HS2 southbound spur would connect into the WCML just north of the A500 Shavington Bypass. The HS2 main line would approach the retained cutting on viaduct;
- Option 1c: the retained cutting would be located south of the A500 Shavington Bypass. The HS2 main line would be positioned to the west of the existing WCML. All tracks on the existing WCML, between Lower Den Farm overbridge and Chorlton Lane, would be realigned onto a new section of the WCML. The HS2 spurs would diverge from the HS2 main line near Checkley Lane, cross over the new section of the WCML on viaduct, before connecting into the existing WCML near the A500 Shavington Bypass. The existing WCML corridor would increase by 40m to the east of its existing location;
- Option 2c: the retained cutting would be located south of the A500 Shavington Bypass. The HS2 main line would be positioned to the west of the existing WCML. A new section of the WCML would be constructed offline and carry a realigned WCML track and two extended tracks, which would provide access to the Basford Hall sidings. The new section would be located to the west of the existing WCML between the Blakenhall Bridleway 8 accommodation overbridge and Crewe South portal retained cutting. The HS2 spurs would diverge from the HS2 main line near Checkley Lane, cross over the new section of the WCML on viaduct, and connect into the WCML south of the A500 Shavington Bypass; and

- Option 3e: the retained cutting would be located south of the A500 Shavington Bypass. The HS2 main line would be positioned to the west of the existing WCML. All tracks on the existing WCML would be realigned between Lower Den Farm overbridge and Weston Lane. Two existing tracks would be extended between the Basford Hall sidings and Lower Den Farm overbridge. The HS2 spurs would diverge from the HS2 main line near Checkley Lane, cross over the realigned WCML tracks and new freight tracks on viaduct, before connecting into the existing WCML south of Casey Lane. The existing WCML corridor would increase by 40m to the east of its existing location.

- 6.6.14 Option 2c was taken forward into the Proposed Scheme as, on balance, it presented the most favourable environmental outcome. The route announced in November 2015, in comparison to Option 2c, would create greater environmental impacts, most notably visual effects for residents along Newcastle Road and in Chorlton. During construction, the announced option would introduce complex engineering and interfacing operational issues, in particular, a significant impact on the operation of the WCML and the depot at Basford Hall, and demolition and reconstruction of bridges on the A500 Shavington Bypass and Weston Lane. Option 1c, in comparison to Option 2c, would present an increase in environmental impacts, most notably visual effects for residents along Mill Lane, Den Lane, and in Chorlton. Construction of Option 1c would also have a significant impact on historic assets to the east of the WCML. Option 3e, in comparison to Option 2c, would present an increase in environmental impacts, most notably visual effects for residents along Mill Lane, Den Lane, and in Chorlton. Construction of Option 3e would also have a detrimental impact on surface water quality, increase the complexity and duration of the programme, and incur significantly higher costs.
- 6.6.15 The analysis of engineering, cost and potential environmental impacts associated with all four options is set out below, with the impacts of the option selected presented first.

Option 2c

- 6.6.16 During construction and operation, this option would introduce significant visual effects to communities and residential properties on both sides of the rail corridor, in particular, Chorlton, Wychwood Park, Casey Lane, Newcastle Road, and Weston Lane. The operational effects would change the landscape character of the area and visual effects arising from changes to the road network would be significant to the residential receptors listed above.
- 6.6.17 During construction, a number of historic assets and ecological receptors would be directly impacted. Construction works would also affect the historic landscape character to the south of the Proposed Scheme and Checkley Lane (a historic incised country lane). There would also be considerable disruption to agricultural holdings and potential impacts on Gresty Brook/Basford Brook (WFD designated waterbody) due to the potential release of sediment and pollutant runoff to the watercourse, most notably as a result of extensions to existing WCML culverts. Additionally, there is potential for a surface water abstraction point and two licensed groundwater abstractions to be affected.

- 6.6.18 Option 2c does not introduce any technical or construction complexities, risks of safety hazards, or lengthening of the construction programme.

The route announced in November 2015

- 6.6.19 In comparison to Option 2c (the Proposed Scheme), embankments and viaducts proposed as part of this option would increase the visual effects on communities and residential properties, particularly properties along Newcastle Road and some residential areas of Chorlton. During construction, there would be the potential for two businesses to be demolished. During operation, receptors in Basford and Chorlton would receive higher noise levels. However, this option would reduce impacts on the surface water environment due to lower levels of infrastructure required for surface water crossings.
- 6.6.20 The route announced in November 2015 would introduce complex engineering and interfacing operational issues. During construction, there would be a significant impact on the operation of the WCML and Network Rail's regionally important freight and maintenance operations at Basford Hall.
- 6.6.21 This option would additionally require major changes to the surrounding road network, including reconstructed bridges on the A500 Shavington Bypass and Weston Lane, adding significant cost in comparison to Option 2c. The additional construction traffic generated by these works would have a significant impact on local road users.

Option 1c

- 6.6.22 In comparison to Option 2c (the Proposed Scheme), Option 1c presents a slight increase in visual effects on communities and residential properties along the route during construction and operation, particularly properties within Chorlton. This option would likely require the demolition of Bridge Cottage (Chorlton Lane), a commercial property off Newcastle Road, and Casey Bridge Farm. The southern viaduct structure would be closer to residential properties at the junction of Mill Lane and Den Lane; these receptors would, therefore, experience greater visual effects. There would be direct adverse physical effects on historic assets from construction works to the eastern side of the WCML. Construction works to the WCML would create greater visual effects on the Grade II listed Basford Bridge Cottage. The increase in the WCML corridor to the east would require additional land for construction of the Proposed Scheme, resulting in amenity impacts on properties to east of the existing WCML along Weston Lane, Casey Lane, and Newcastle Road.
- 6.6.23 Option 1c would introduce some construction complexities with the works required to connect to the WCML fast lines, however, this option would avoid any impacts on the Basford Hall sidings.

Option 3e

- 6.6.24 In comparison to Option 2c (the Proposed Scheme), Option 3e presents an increase in visual effects for communities and residential properties along the route, particularly properties within Chorlton during construction and operation. Construction activities would have a slightly greater effect on receptors that lie on the eastern aspect of the WCML, especially properties within Wychwood Park, along Newcastle Road, and Jubilee Farm. It is likely that Option 3e would require the demolition of Bridge Cottage

(Chorlton Lane), a commercial property off Newcastle Road, and Casey Bridge Farm. However, there would likely be less disruption during the construction phase to receptors located alongside the existing WCML east of Wychwood Park, including Lower Den Farm. The additional viaduct structures would generate additional visual effects during construction and operation due to their height, extents, and positioning. This would have an increased impact on residential receptors, particularly on the western fringes of Wychwood Park and the junction of Den Lane and Mill Lane. The construction and operational impacts associated with this option would result in a moderate deterioration to waterbodies in the southern area of Wistaston Brook catchment based on a potentially significant increase in water channel disturbance. Dwellings in Chorlton may be subject to increases in noise and vibration as a result of construction works and the alignment of infrastructure moving further east.

- 6.6.25 Option 3e would introduce some construction complexities with the works required to connect to the WCML and the viaducts, which would significantly lengthen the construction programme. The cost of this option is significantly higher than that of the Option 2c.

Retention of the A500 Shavington Bypass Bridge and Weston Lane Bridge and relocation of the retained cut

- 6.6.26 During the design development following the publication of the working draft EIA Report, further consideration has been given to need to demolish and reconstruct the A500 Shavington Bypass Bridge and Weston Lane Bridge in order to minimise the disruption of the local highway network. As part of this the location of the retained cutting (which would connect into a tunnel portal and a tunnel – part of the proposed HS2 Phase 2b) was also considered.

- 6.6.27 The following three options were taken forward to a detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered:

- Option 1 (presented in the working draft EIA Report): the route of the HS2 main line would be lowered on its approach to Crewe and the retained cutting located approximately 650m south of the A500 Shavington Bypass. The A500 Shavington Bypass would need to be realigned and the existing bridge would need to be demolished and reconstructed, however, the Weston Lane overbridge would be retained;
- Option 2: the route of the HS2 main line would approach Crewe from the south in a retained cutting located approximately 1km south of the A500 Shavington Bypass (approximately 350m further south than Option 1). The HS2 main line would be vertically realigned to pass beneath the A500 Shavington Bypass in tunnel. The A500 Shavington Bypass and Weston Lane would not require any realignment and the bridges would be retained; and
- Option 3: the route of the HS2 main line would be horizontally realigned on its approach to Crewe and the retained cutting would be moved approximately 30m south of the A500 Shavington Bypass (approximately 620m further north than Option 1), increasing its length by approximately 950m when compared with the Proposed Scheme. The route would pass between the A500

Shavington Bypass Bridge piers, which would be retained. This option would require the realignment of Weston Lane and a new overbridge.

6.6.28 Option 2 was taken forward into the Proposed Scheme as it avoided disruption to the local highway network associated with the demolition of the A500 Shavington Bypass bridge and Weston Lane bridge, resulted in significant cost savings and presented the most favourable environmental outcome. Option 1, in comparison to Option 2, would present an increase in environmental impacts, most notably associated within the realignment of the A500 Shavington Bypass, including construction related noise and air quality impacts, visual impacts, and the removal of sensitive ecological habitats. Option 3, in comparison to Option 2, would also present an increase in environmental impacts, most notably impacts on heritage assets and amenity impacts on residents along Newcastle Road, Weston Lane, and Larch Avenue due to construction activities. Option 1 and Option 3 would be significantly more expensive to construct and require longer construction programmes than Option 2.

6.6.29 The analysis of engineering, cost and potential environmental impacts associated with all three options is set out below, with the impacts of the option selected presented first.

Option 2

6.6.30 This option would introduce visual, noise, and amenity impacts in Chorlton and along Newcastle Road, Weston Lane, Larch Avenue, and Casey Lane due to the proximity of the retained cutting in these locations. There would be an impact on historic assets in the area, most notably along the existing WCML, which includes the Historic Environment Record (HER) listed Grand Junction Railway and Basford Hall Junction. This option would result in the loss of agricultural land and holdings and the loss of ecological habitat, in particular hedgerow corridors and existing ponds, which may impact on protected species. This option has the potential to result in loss or deterioration of a spring near Basford House due to potential changes in groundwater levels. This option runs adjacent to the WCML and there is a possibility that the land may be affected by contaminant migration through shallow sand and gravel deposits.

6.6.31 Option 2 does not introduce any technical or construction complexities, risks of safety hazards, or lengthening of the construction programme.

Option 1

6.6.32 In comparison to Option 2 (the Proposed Scheme), Option 1 would result in a substantial increase in construction related traffic on the local road network and demolition waste arising from removal of the existing A500 Shavington Bypass Bridge. There is potential for construction-related noise and air quality impacts from the construction of the off-line bridge and removal of the existing bridge. This option would introduce additional impacts on heritage assets, in particular the Grade II listed Shavington Hall, ecological habitats, and agricultural land and holdings. The presence of the realigned A500 Shavington Bypass on high embankments would lead to impacts on landscape character and visual impacts on residential properties south of the A500 Shavington Bypass between Basford and Weston, particularly residential properties along Weston Lane and Larch Avenue.

- 6.6.33 This option would introduce construction complexities associated with realignment of the A500 Shavington Bypass, which would increase the length of the construction programme and would be significantly more expensive to construct than Option 2.

Option 3

- 6.6.34 In comparison to Option 2 (the Proposed Scheme), Option 3 would introduce additional potential impacts on heritage assets, most notably the former Basford Hall and potential buried features, and amenity impacts to properties along Weston Lane, Larch Avenue, and Newcastle Road as a result of construction activity associated with the retained cutting. The requirement for a new overbridge at Weston Lane would have a detrimental impact on residential properties along Weston Lane, including the demolition of two properties. There will be more land required for construction of the Proposed Scheme due to the retained cutting ending nearer Crewe and further west. Therefore, there would be more direct impacts on agricultural land and holdings, species-rich hedgerows, veteran trees, and existing ponds, which could support protected species and habitats. This movement west, compared to the Proposed Scheme, could result in isolation of habitats and protected species during the construction phase by reducing ecological connectivity. The reduced length of route adjacent to the WCML may reduce the risk of contaminant migration, which is considered an improvement compared to the Proposed Scheme.
- 6.6.35 This option would add construction complexity due to the increase in length of the retained cutting and a new bridge at Weston Lane, which would lengthen the construction programme and result in significant additional cost.

Connection of the Proposed Scheme with the WCML at Betley Road Junction

- 6.6.36 During the design development process since the announcement of the preferred route to Crewe in November 2015, further consideration has been given to optimising existing passenger and freight services along the WCML and facilitating the connection of the HS2 main line with the WCML. In order to facilitate the connection of HS2 to the WCML south of Crewe station, modifications to the WCML would be required, including relocating the connection to Basford Hall sidings (Basford Hall Junction) at Betley Road Junction, north of Den Lane. The modifications would maintain access to the Basford Hall sidings, currently being used by freight vehicles only, so that it does not bring operational risks as a result of the HS2 connection. The sensitivity of this location, particularly the proximity of any works to properties in the locality and land required for the construction of the Proposed Scheme have been key considerations in the development of these alternatives.
- 6.6.37 A preliminary options appraisal was undertaken of nine options, five options were not taken forward for further consideration as they were not considered to be reasonable alternatives:
- Option 2a: This option would introduce replacement parallel crossovers at Betley Road Junction enabling movements for rail vehicles between the Basford Hall independent lines and WCML with crossover speeds of 40mph (64kph). This option would result in significant construction works to existing infrastructure and would also have a detrimental impact on the operation of

the WCML due to the low speed for the crossovers at that location where WCML lines have greater line speed. As such, this option was not taken forward for further consideration;

- Option 2b: This option is a minor variation to Option 2a. The crossover speeds would all be 50mph (80kph). The impacts were deemed to be the same as Option 2a, as such, Option 2b was not taken forward for further consideration;
- Option 3a: This option would introduce replacement single crossovers at Betley Road Junction enabling movements for vehicles between the Basford Hall independent lines from the WCML on the slow lines at 75mph (120kph). However, the single crossover connecting the slow and fast lines on the WCML would have an operating speed of 40mph (64kph), which would have a detrimental impact on the operation of the WCML and on journey times. As such, Option 3a was not taken forward for further consideration;
- Option 3b: This option is a minor variation to Option 3a. A single crossover would connect the slow and fast lines on the WCML with an operating speed of 50mph (80kph) and reduced speed of 25mph (40kph) between the fast lines. The impacts were deemed to be similar to Option 3a, as such; Option 3b was not taken forward for further consideration; and
- Option 3d: This option is a minor variation to Option 3a. A single crossover would connect the slow and fast lines on the WCML with an operating speed of 75mph (120kph). A single crossover would connect the Basford Hall independent lines with an operating speed of 75mph (120kph). With this option there would not be a connection between the fast lines at Betley Road Junction, which would bring significant operational impact and risks for maintenance. As such; Option 3d was not taken forward for further consideration.

6.6.38 The following four options were taken forward to a more detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered:

- Option 1 (the option presented in the working draft EIA Report): This option would introduce replacement parallel crossovers at Betley Road Junction enabling movements for vehicles between the Basford Hall independent lines and WCML with crossover speeds of 75mph (120kph). This option would require full re-construction of the WCML over a length of approximately 1.7km, as a result, the Lower Den Farm accommodation bridge and Den Lane overbridge would require realignment and re-construction;
- Option 3c: This option was a minor variation to Option 3e. This option would introduce replacement single crossovers enabling movements for vehicles between the Basford Hall independent lines and WCML slow lines at 75mph (120kph), movements between the WCML fast and slow lines of 60mph (97kph), and movements between the fast lines at 25mph (40kph). A single crossover would connect the Basford Hall independent lines with an operating speed of 75mph (120kph). Track modification works would be completed within the existing WCML corridor; however, this option would require

approximately 550m of a realigned track north of the junction and realignment of the Lower Den Farm overbridge;

- Option 3e: This option would introduce replacement single crossovers enabling movements for vehicles between the Basford Hall independent lines from the WCML at 75mph (120kph) with a reduced speed of 25mph (40kph) between the fast lines on the WCML. Track modification works would be completed within the existing WCML corridor; however, this option would require approximately 960m of a realigned track north of the junction and realignment of the Lower Den Farm overbridge; and
- Option 4: This option would introduce replacement parallel crossovers enabling movements for vehicles between the Basford Hall independent lines and WCML slow lines at 75mph (120kph). Two single crossovers would connect the slow and fast lines on the WCML with an operating speed of 60mph (97kph), and reduced speed of 25mph (40kph) between fast lines on the WCML. Track modification works would be completed within the existing WCML corridor; however, this option would require approximately 550m of a realigned track north of the junction and realignment of the Lower Den Farm overbridge.

6.6.39 Option 3e was taken forward into the Proposed Scheme as, as on balance, it presented the most favourable environmental and operational outcome. Option 1, in comparison to Option 3e, would present an increase in environmental impacts, most notably, severance and amenity impacts for residents along Den Lane as a result of construction activities. Option 1 would also lengthen the construction programme and be significantly more expensive to construct than Option 3e. Option 3c and Option 4 were considered to be environmentally similar to Option 3; however, both options would introduce technical complexities to the operation of existing infrastructure.

6.6.40 The analysis of engineering, cost and potential environmental impacts associated with all four options is set out below, with the impacts of the option selected presented first.

Option 3e

6.6.41 This option would result in visual, noise, and amenity impacts to Lower Den Farm and some properties along Den Lane as a result of the demolition of the existing Lower Den Farm overbridge and construction of the Blakenhall Bridleway 8 accommodation overbridge. Access to Lower Den Farm would be maintained at all times. A temporary diversion of Blakenhall Bridleway 8 would be required and would cause disruption to users during the construction period.

6.6.42 Option 3e does not introduce any technical or construction complexities, risks of safety hazards, or lengthening of the construction programme.

Option 1

6.6.43 In comparison to Option 3e (the Proposed Scheme), the construction works associated with Option 1 would be substantial. Modification and realignment works associated with the WCML would be required outside the existing WCML corridor. The realignment and reconstruction of Den Lane Bridge would generate extensive

earthworks, and in turn, generate high levels of construction traffic and associated noise impacts. This would lead to severance issues for residents, businesses and road users of Den Lane. Construction activities would introduce localised effects on landscape character and potentially impact on surrounding ecological habitats, which may support protected species.

- 6.6.44 Option 1 would introduce some construction complexities with the works associated with modifications to the WCML and reconstruction of two bridges. This would significantly lengthen the construction programme and would be significantly more expensive to construct than the Proposed Scheme.

Option 3c

- 6.6.45 In comparison to Option 3e (the Proposed Scheme), Option 3c was considered to be environmentally similar. The most notable environmental impacts included visual, noise, and amenity impacts to Lower Den Farm and some properties along Den Lane as a result of the demolition of the existing Lower Den Farm accommodation bridge and construction of the Blakenhall Bridleway 8 accommodation overbridge.
- 6.6.46 Option 3c introduced technical complexities to the existing WCML and Basford Hall independent lines that would present an operational risk.

Option 4

- 6.6.47 In comparison to Option 3e (the Proposed Scheme), Option 4 was considered to be environmentally similar. The most notable environmental impacts included visual, noise, and amenity impacts to Lower Den Farm and some properties along Den Lane as a result of the demolition of the existing Lower Den Farm accommodation bridge and construction of the Blakenhall Bridleway 8 accommodation overbridge.
- 6.6.48 Option 4 introduced technical complexities to the existing WCML and Basford Hall independent lines that present a risk to existing infrastructure that powers the lines.

Grid connection from Crewe sub-station to the South Crewe auto-transformer feeder station

- 6.6.49 During the design development process since the announcement of the preferred route to Crewe in November 2015, further consideration has been given to the alignment of a power line required to provide power to operate the trains. The working draft EIA Report included two auto-transformer feeder stations located adjacent to the route, one within the South Cheshire area, at Newcastle Road, and the other within the Fradley to Colton area (CA1).
- 6.6.50 Following continued engagement with Scottish Power and National Grid it was deemed that the power supply to an auto-transformer feeder station located in the South Cheshire area, for any option considered, would not be feasible due to constraints on capacity. The most suitable alternative identified, which has been taken forward into the Proposed Scheme, would be to upgrade the auto-transformer feeder station at Newlands Lane, located within the Fradley to Colton area (CA1), to enable it to supply power to a greater length of track. There will, therefore, be no auto-transformer feeder station located within the South Cheshire area.

- 6.6.51 Details of the options considered and the environmental impacts associated with the grid connection from Rugeley sub-station to the auto-transformer feeder station at Newlands are provided in Volume 2: Community area 1, Fradley to Colton.

Borrow pit

- 6.6.52 During the design development process since the announcement of the preferred route to Crewe in November 2015, further consideration has been given to the way in which the Proposed Scheme would acquire high quality material (usually comprising sand and gravel) to construct railway embankments. This material will be provided, in part, through excavation of cuttings and other earthworks along the route of the Proposed Scheme, where the quality is appropriate. However, at some locations along the route there is insufficient high quality material for use in railway embankment construction. The use of borrow pits close to the route of the Proposed Scheme would enable high quality material and aggregate to be extracted and processed and backfilled locally and transported largely on site haul routes, lowering HGV movements and reducing impacts on the local road network and communities.
- 6.6.53 During the design development process a requirement was identified for a borrow pit in the section of the route covering the Whitmore Heath to Madeley (CA₄) or South Cheshire area. Two options were proposed for a potential borrow pit in the area, both of which are described here. These were identified using plans showing suitable geology combined with requirements for excavated material showing where the largest shortfalls of material occurred along the route of the Proposed Scheme. Selection criteria also included mineral resource areas identified by the local minerals planning authority and avoidance, where reasonably practicable, of residential properties, environmentally sensitive receptors, major services and diversions.
- 6.6.54 The following two options were taken forward to a detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered:
- Option CA₅-BP-A-1: This option includes a combination of three borrow pit locations (known as CA₅-BP-A-1-a, CA₅-BP-A-1-b, and CA₅-BP-A-1-c); two would be located in the South Cheshire area and one in the Whitmore Heath to Madeley area (CA₄). CA₅-BP-A-1-a would be located west of Wrinehill, between Randilow Farm to the south-east, Lower Den Farm to the north-west, the WCML to the north-east, and route of the Proposed Scheme to the south-west. CA₅-BP-A-1-b would be located south of Wrinehill, between Randilow Farm to north-west, Wrinehill Hall to the south-east, the WCML to the north-east, and route of the Proposed Scheme to the south-west. CA₅-BP-A-1-c would be located west of Madeley, overlying the route of the Proposed Scheme, north-west of the proposed Madeley tunnel portal. CA₅-BP-A-1-a and CA₅-BP-A-1-b would be 5m deep, whilst CA₅-BP-A-1-c would be 8m deep.
 - Option CA₅-BP-A-2: This option would be located in the Whitmore Heath to Madeley area (CA₄), in the same location as CA₅-BP-A-1-c. The location lies west of Madeley and overlies the route of the Proposed Scheme, north-west of the proposed Madeley tunnel portal. This option would be 20m deep.

- 6.6.55 Option CA5-BP-A-1 was taken forward into the Proposed Scheme. Whilst Option CA5-BP-A-2 would provide greater environmental benefits, when compared with Option CA5-BP-A-1, the benefits were not considered sufficient to justify the complexity and risk of hazards during construction that Option CA5-BP-A-2 presented.
- 6.6.56 The footprint of Option CA5-BP-A-1 was subsequently modified in order to further avoid environmental sensitivities and construction complexities, such that only one of the three initial locations (CA5-BP-A-1-a) was taken forward. The depth of CA5-BP-A-1-a would be increased to 13m. This would reduce any significant isolation effects on Randilow Farm and avoid demolition of Randilow Cottage. Any environmental risks associated with Barhill Wood and any complexities associated with its proximity to the proposed Madeley tunnel would also be removed. The boundary was modified to reduce the amount of agricultural land required, provide a greater buffer distance from Randilow Farm in order to reduce isolation and amenity effects at this property, and reduce the proximity to Betley Mere SSSI. Exclusion zones would be required in proximity to existing road and rail infrastructure.
- 6.6.57 The analysis of engineering, cost and potential environmental impacts associated with the first iteration of Option CA5-BP-A-1 and Option CA5-BP-A-2 is set out below, with the impacts of the option selected presented first.

Option CA5-BP-A-1

- 6.6.58 The first iteration of Option CA5-BP-A-1 would require land for construction of the borrow pit from the three separate locations, which would result in a significant negative impact on biodiversity, potentially impacting on environmental designations, most notably Betley Mere SSSI and ancient woodland at Barhill Wood, protected habitats, and habitats that could support protected species. This iteration would cross a number of surface water pathways and has the potential to significantly impact on a number of aquifers, springs, and licensed abstraction points. There would also be moderately significant landscape, agricultural, cultural heritage, land quality and community impacts. Significant isolation and amenity effects would be experienced at Randilow Farm and potentially the demolition of Randilow Cottage. The subsequent iteration reduces these impacts.

Option CA5-BP-A-2

- 6.6.59 In comparison to the first iteration of Option CA5-BP-A-1 (the Proposed Scheme), Option CA5-BP-A-2 would avoid any potential impacts on the Betley Mere SSSI, and the amount of land required is significantly smaller than that of the Proposed Scheme, which would avoid impacting on a number of protected habitats and species. However, with a greater cutting depth, there would likely be implications for groundwater flow and potential water quality impacts, with potential impacts on aquifers, nearby springs, and abstraction points. There would also be reduced impacts on landscape, agricultural, cultural heritage, land quality and community receptors as a result of the reduced amount of land required when compared with the Proposed Scheme.
- 6.6.60 Option CA5-BP-A-2 would be significantly more complex than the Proposed Scheme primarily due to its proximity to the proposed Madeley tunnel. A borrow pit in this location would introduce construction complexities that would significantly lengthen

the construction programme and would significantly increase the requirement for transportation of materials.

Further work undertaken post appraisal

- 6.6.61 Subsequent to further analysis of construction traffic data, it was determined that a borrow pit would also be required to support construction within the Whitmore Heath to Madeley area (CA4). Discussion of this location is presented within the Volume 2: Community area 4, Whitmore Heath to Madeley.
- 6.6.62 Further work in the form of a hydrological assessment has also been undertaken to consider the likely impact on the Betley Mere SSSI arising from extraction of material from the borrow pit. If it cannot be confirmed that there is no hydrological connectivity between the proposed borrow pit and Betley Mere SSSI measures will be implemented during construction, to ensure that there will be no significant impact to the flow or quality of groundwater and surface water reaching Betley Mere. This would include the provision of a one metre vertical buffer between the base of the borrow pit excavation and groundwater levels (or alternative methods of avoidance agreed with the relevant stakeholders).

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