HS2 Phase Two
West Midlands to Crewe
Route engineering report

December 2015

CS392A

Department for Transport

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

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

Telephone: 020 7944 4908

General email enquiries: HS2enquiries@hs2.org.uk

Website: www.gov.uk/hs2

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

recycle

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

Contents

List of figures

1 Introduction

1.1 The purpose of this report

1.1.1 This report provides a detailed description of the preferred route from the West Midlands to Crewe which extends from the northernmost point of Phase One near Fradley, to a connection with the existing West Coast Main Line (WCML) at Crewe.

1.1.2 The historical work undertaken since the start of the route development in 2010 and presented to the public during a series of Phase Two consultation events in late 2013, can be found on the Department for Transport website (www.gov.uk). Additional information concerning the scheme can be found on the HS2 Ltd website.

1.1.3 The technical requirements for line of route and depot design are outlined in this report. For further information on the key issues that HS2 Ltd has considered, and the recommended changes since public consultation in 2013, please see *West Midlands to Crewe – Summary of Route Refinements*.

1.1.4 For potential impacts on communities and the environment please see *High Speed Rail: Preferred Route to Crewe Sustainability Report*.

1.2 Overview of the route

1.2.1 The preferred route from the West Midlands to Crewe forms the southern 37 miles (60km) of the Manchester leg on the Phase Two network. This section commences at Fradley, approximately 1.6 miles (2.5km) to the northeast of Lichfield and just north of the proposed Phase One connection with the WCML at Handsacre. This is a continuation of the Phase One route, taking into account the changes proposed to the hybrid Bill in 2015 (Additional Provision).

1.2.2 The preferred route would continue in a north-westerly direction, crossing mainly open countryside on a series of embankments, viaducts and cuttings, passing to the east of Rugeley and Stafford. The line continues north-west, crossing over the M6 and passing to the north of Swynnerton, and Baldwin's Gate, where it passes under a hill in twin tunnels. Continuing on a series of embankments, cuttings and viaducts, including a skewed crossing of the WCML, the route would pass under a hill in twin tunnels to the west of Madeley, before turning north to run parallel with the WCML on the approach to Crewe.

1.2.3 Just south of Crewe, the route runs adjacent to the WCML corridor where a spur on viaduct would provide a connection to the WCML in the Basford area. Passive provision for the HS2 mainline tracks to later continue towards Manchester and the North, using a tunnel under Crewe, would be allowed up to the southern eye of the tunnel. This would be located to the south of Crewe Station. An Infrastructure Maintenance Depot (IMD) would be provided in the area adjacent to the existing Basford Hall Sidings and additional maintenance loops (engineering sidings) would be provided to the south of the route, near Pipe Ridware.

1.3 The layout and content of this report

1.3.1 This report is set out as follows:

- chapter 1 (this chapter) is introductory;

- chapter 2 sets out the technical requirements and underlying assumptions;
- chapter 3 describes the line of route;
- chapter 4 describes the infrastructure maintenance depot;
- chapter 5 discusses ancillary design works;
- chapter 6 is a glossary of terms.

2 Design methodology

2.1 Design development

2.1.1 The route definition and selection process for Phase Two of HS2 commenced in Autumn 2010 with engagement of engineering and environmental consultancies to deliver the necessary technical design and appraisal input. The methodology applied was in large part the same as that applied to the route selection between London and the West Midlands, taking into account lessons learned during the development of Phase One.

2.1.2 HS2 Ltd was asked by the Government to identify a number of possible route and station options[1]. This involved a process of identifying a long list with subsequent sifting to reduce the options for consideration down to a handful of alternatives that met the remit set by the Government. At each sift, remaining options were developed and refined to a greater level of detail in order to identify the key differences between options. During these final stages, potential locations for the infrastructure maintenance depots and rolling stock depots were also developed and followed a similar sifting process.

2.1.3 The scope for the Manchester leg included Manchester city centre station locations and consideration of the potential for interchange/ intermediate station locations. Connections to the existing WCML railway would provide routes further to the North West and Scotland.

2.1.4 In July 2013 the Secretary of State for Transport published proposals for Phase Two of HS2 and initiated a seven-month period of public consultation to gather views on the route and stations proposed in the consultation.

2.1.5 Following public consultation, HS2 Ltd undertook a review of the Phase Two route and proposed a number of amendments. These amendments were a result of a thorough assessment of consultation responses [Reference Ipsos Mori Report 2015] as well as the latest design principles and the application of lessons learned from Phase One of the project.

2.1.6 Whilst HS2 Ltd were undertaking the route refinement process, the Chairman of HS2 Ltd, Sir David Higgins put forward a number of recommendations to government[2], including a proposal to accelerate the delivery of the route between the West Midlands and Crewe to realise some of the benefits of Phase Two more quickly.

2.1.7 In March 2015, the Secretary of State for Transport announced his intention to move forward with a separate hybrid Bill to deliver a route to Crewe in advance of the rest of the Phase Two Route. Building on this recommendation, HS2 Ltd has brought forward proposals for refinements to the route between the West Midlands and Crewe.

---

[1] HS2 Ltd's remit is set out in a number of publicly available remit letters from Government.
[2] "HS2 Plus" and "Rebalancing Britain" reports.

2.1.8 This report provides a detailed route description of the preferred route between the West Midlands and Crewe. For further information on the key issues that HS2 Ltd has considered, and the recommended changes, please see the West Midlands to Crewe Summary of Route Refinements. For potential impacts on communities and the environment please see the sustainability report "Sustainability report, Phase Two Post-consultation update: West Midlands to Crewe".

2.1.9 Further information on the rest of the Phase Two Route will be made available in due course.

2.2 Technical requirements for line of route

2.2.1 HS2 Ltd has developed a series of 'deliverable approach statements'. These specify the engineering, operational and performance requirements for the route, and set out the engineering design parameters.

Alignment design assumptions

2.2.2 The alignment development work was generally carried out using Ordnance Survey MasterMap data, supplemented with aerial photography and elevation information from five metre resolution terrain data and one metre resolution surface data. This mapping has been used to support the alignment design.

2.2.3 The alignment design was undertaken in accordance with the HS2 Track Alignment Design Specification. Turnouts have been specified in accordance with the HS2 Switch and Crossing Geometric Design specification.

2.2.4 Key alignment parameters from the alignment and switch and crossing specifications include:

- The alignment shall be designed to support an initial maximum operating speed of 360 kph, with the alignment footprint capable of supporting a maximum operating speed of 400kph, where topographical, train performance and sustainability issues permit;
- The line shall be designed to permit trains to maintain consistent high speeds;
- The maximum achievable speed through turnouts is 230kph;
- The maximum vertical acceleration experienced due to the effect of vertical curvature shall normally be 2.25% of g; and
- The maximum vertical curve radius shall be 56,000m.

Width of the railway

2.2.5 For the majority of its length, the new route would be a twin-track railway.

2.2.6 The separation between the centre lines of the pair of tracks would be 5.0m where 400kph running was required. The track-bed width would make provision for Overhead Line Equipment (OHLE), staff walkways, drainage, and fencing. The normal track-bed width would be 18.9m wide. This has reduced from an allowance of 22m in the Consultation Route and is consistent with assumptions on Phase One of the project.

2.2.7 For cuttings and embankments, it is assumed that the side slope of the earthworks would be 1:2.5. This is an appropriate assumption for this stage of design. In practice it may be possible to use steeper cutting slopes or apply retaining walls to reduce the fence-to-fence dimensions. In some areas, shallower cutting and embankment slopes (i.e. a wider footprint) may be required where the ground conditions are less stable.

2.2.8 Where tracks enter tunnels in two separate tunnel bores, the distance between tracks would be dependent on the tunnel diameter (see 2.2.22), but would typically be 18m instead of the usual 5m.

2.2.9 As the design develops, the land take required by the railway is expected to increase in order to accommodate highways crossings and the diversion of utilities as well as provision for environmental mitigation.

2.2.10 Further to this, the construction of HS2 would require some additional temporary land take beyond the corridor footprint, including areas for construction compounds. Worksites would also be required at areas of major works, such as entrances to tunnels.

Constructability and programming

2.2.11 At this early design stage, consideration of construction issues has generally included identifying risks and opportunities and identifying typical working methods and techniques.

2.2.12 An outline construction phase programme for the works has been created. The purpose of this programme is to inform the design of the key programme drivers so that they can be considered within the emerging design.

2.2.13 The programme reflects the current known project scope and outlines a sequence in which the scope can be delivered. The programme identifies the key program risks and opportunities in project delivery and articulates the basis for associated program contingencies.

2.2.14 Further information on the key principles of construction can be found in the draft Code of Construction Practice for Phase One.

Geotechnical assumptions

2.2.15 The geological conditions along the route are variable. At this early stage of design, a common side slope has been adopted for earth structures, as indicated in section 2.2.7. Recent work on earthwork slopes has given greater confidence in the assumption that 1:2.5 side slopes on embankments and cuttings is the most appropriate assumption for the preferred route. There are some small areas which might require shallower earthworks slopes, and some where steeper slopes could be achieved. Further work in this area will be carried out at the next stage of development to confirm these findings.

2.2.16 The following issues are typical of the influences that have been considered on route selection:

- subsidence of natural cavities, in particular salt;
- areas with a known history of landslides or unstable ground; and
- compressible deposits, including alluvium, which pose a settlement risk to loads placed on it.

2.2.17 The geology along the preferred route is varied, but there are few significant constraints or risks specifically related to the geological formations present. There are some areas along the preferred route that have been affected by coal mining. However, the risk from adjacent or underlying mine workings is considered to be low. Just to the south of Crewe there are halite deposits, which is a soluble rock. After completing the ground investigations an evaluation of risks will be made and appropriate mitigation designed into the scheme.

Structures assumptions

2.2.18 Sufficient vertical clearance has been provided within the alignment design where HS2 would cross, or be crossed by, roads and other major obstacles including other railways, rivers and canals. For short bridges, such as those used to carry the railway over local roads, or roads over the railway, bridges would likely be straightforward integral single spans. For longer structures provision of a viaduct structure has been assumed. In particular, viaducts have generally been assumed where the designed rail level would be greater than 15m above existing ground level, or where the feature to be spanned is longer than a standard bridge, for example where HS2 would cross a flood risk zone.

Tunnelling assumptions

2.2.19 The range of tunnel configurations assumed are as follows:

- twin bore, single track tunnels (with cross passages where required);
- cut and cover tunnels.

2.2.20 The tunnelling methods that have been considered are:

- tunnel boring machine (TBM) driven or mined tunnels with precast tunnel linings, with the machine type dependent on ground conditions; and
- sequentially excavated tunnels, generally utilising sprayed concrete lining (SCL) for initial ground support.

2.2.21 It is assumed that tunnels would be provided where the track alignment is at least 22m below existing ground level. The size of tunnel required would be dependent on design speed and length of tunnel. For the tunnels in the preferred route the tunnel internal diameter would be 8.8m for each bore of a twin bore tunnel.

2.2.22 Cross passages between twin bore tunnels have been assumed at a spacing of approximately 380m. Cut and cover tunnels would have a central wall between tracks, with connecting doors at 380m spacing.

2.2.23 The track spacing would widen on the approach to tunnels, to allow for the construction of twin bored tunnels or the central wall between tracks on cut and cover tunnels. This spacing would be dependent on the alignment approaching the tunnel, and would be a minimum of twice the tunnel diameter for twin bore tunnels (approximately 18m on the tunnels on the preferred route), and a minimum of 8m for cut and cover tunnels.

Cut and cover tunnels

2.2.24 Where a twin cell cut and cover tunnel is proposed, this would be formed by excavating what would be a normal cutting. In the cutting, a box structure would be constructed, before refilling over its roof slab to restore the original ground level and surface features such as footpaths or roads.

Interfaces with existing transport infrastructure

2.2.25 Where HS2 would cross the path of an existing highway or railway the route alignment design would provide sufficient vertical clearance to permit construction of a new bridge.

2.2.26 The route encounters highways, including motorways, roads and other public rights of way. Where HS2 crosses the highway, either above or below, there would often be a requirement to locally modify the highway to accommodate the HS2 structure. Where HS2 crosses beneath the highway, new bridge structures would be incorporated.

2.2.27 The route would also cross existing railway infrastructure. Where HS2 crosses this infrastructure a bridge or viaduct carrying HS2 would be provided over the existing railway.

2.2.28 There are locations along the route where significant modifications to the existing railway network would be required, such as closure and diversion of existing lines or the realignment of tracks, so that HS2 would share an existing and possibly widened corridor.

2.2.29 Where the HS2 route broadly follows an existing transport corridor there may be a requirement to permanently realign the corridor so that HS2 would share the existing and sometimes widened corridor.

Interfaces with watercourses

2.2.30 Where HS2 would cross a major watercourse, sufficient clearance would be provided to allow at least a 1m freeboard above 1:1000 year flood levels. Where a floodplain is present the floodplain would be crossed by a viaduct. At later stages of the design process, detailed flood modelling may indicate that some or part of these viaducts can be replaced by embankments. In other cases a viaduct may be extended.

2.2.31 Where HS2 crosses over smaller watercourses, culverts would be provided through the embankment crossing the watercourse. In a small number of instances the alignment is such that sufficient clearance may not be available to allow a culvert to be provided. In this instance alternative solutions would be applied such as diverting the watercourse along the line of route to a location it can be returned to a watercourse. These solutions will be developed at the next stage of the design process.

2.2.32 Where the alignment is in deep cutting a watercourse would be diverted to avoid the route, or be designed to cross HS2 in an aqueduct.

Environmental mitigation

2.2.33 Potential impacts on the environment and communities are described in the [Reference to Sustainability Report 2015]. Opportunities for environmental mitigation will be identified and proposed following the Environmental Impact Assessment (EIA) process as part of the next stage of design. This will include surveying, modelling exercises, analysis and engagement with relevant stakeholders.

2.3 Technical requirements for depots

2.3.1 Rolling Stock Depots (RSDs) would be used to stable trains overnight, for cleaning and maintenance. The preferred route between the West Midlands and Crewe does not include provision for an RSD because the Phase One facilities to be provided at Washwood Heath are deemed to be sufficient.

2.3.2 Infrastructure Maintenance Depots (IMDs) would be used as a base from which to carry out engineering activities to inspect, maintain and renew the infrastructure. The preferred route between the West Midlands and Crewe includes provision for an IMD (see Section 4).

2.3.3 The depots would be required to operate for 24 hours, seven days a week.

2.3.4 The depots would provide immediate access to the main highway network to facilitate access by large goods vehicles. Good transport links would enable a suitable and relatively local workforce, and as such, the potential for access by public transport would be considered.

Requirements for Infrastructure Maintenance Depot

2.3.5 The IMD would be configured to support all infrastructure maintenance and renewals activities along the route.

2.3.6 The IMD would provide a maintenance, servicing and stabling facility both for HS2 on-track plant (including vehicles up to GC gauge which would be too large to travel on the classic rail network) and for HS2 maintenance rescue and recovery locomotives. It would be capable of acting as an incident control centre in the event of a serious accident or incident on the HS2 route.

2.3.7 The IMD would ideally be placed close to the mid-point of the full Phase Two western leg, with direct access to the HS2 route. Access to the existing rail network to facilitate delivery of rolling stock and other materials by rail would be essential. The depot would be designed to serve both the HS2 route and the existing railway in both directions where possible. This would allow engineering trains to access and egress the depot with maximum flexibility.

2.3.8 The IMD site would have the potential to be used as a construction depot for the works, thus avoiding the need for a separate construction site.

2.3.9 A switch and crossing assembly area would be provided to enable the pre-assembly of the switch and crossing units to be installed. Areas for storage would be provided with facilities to enable forklift trucks and overhead cranes to handle materials and plant safely. The depot would also store standard components and consumables, such as provision for the storage of ballast.

2.3.10 The IMD would stable and service/maintain a variety of on-track plant and engineering supply train equipment. It would also provide strategic engineering material stores. HS2 ballast and spoil wagons would need to be able to run on and off the existing rail network, bringing supplies.

2.3.11 It is envisaged that passenger services would operate between 05:00 and 23:59 from Monday to Saturday and between 08:00 and 23:59 on Sunday. Engineering trains would normally be dispatched from the IMD to work on the railway at around midnight each night and return approximately before the closure of the maintenance window, at 04:59 Monday to Saturday and at 07:59 on Sunday. However, this may vary when responding to incidents and emergencies.

2.3.12 Provision would be made for ancillary buildings and facilities such as offices, car parking, incident control rooms, train maintenance sheds, workshops and storage.

3 Line of route

3.1 Route sections

3.1.1 This chapter describes a series of individual route sections, which combined form a continuous route from Fradley to Crewe.

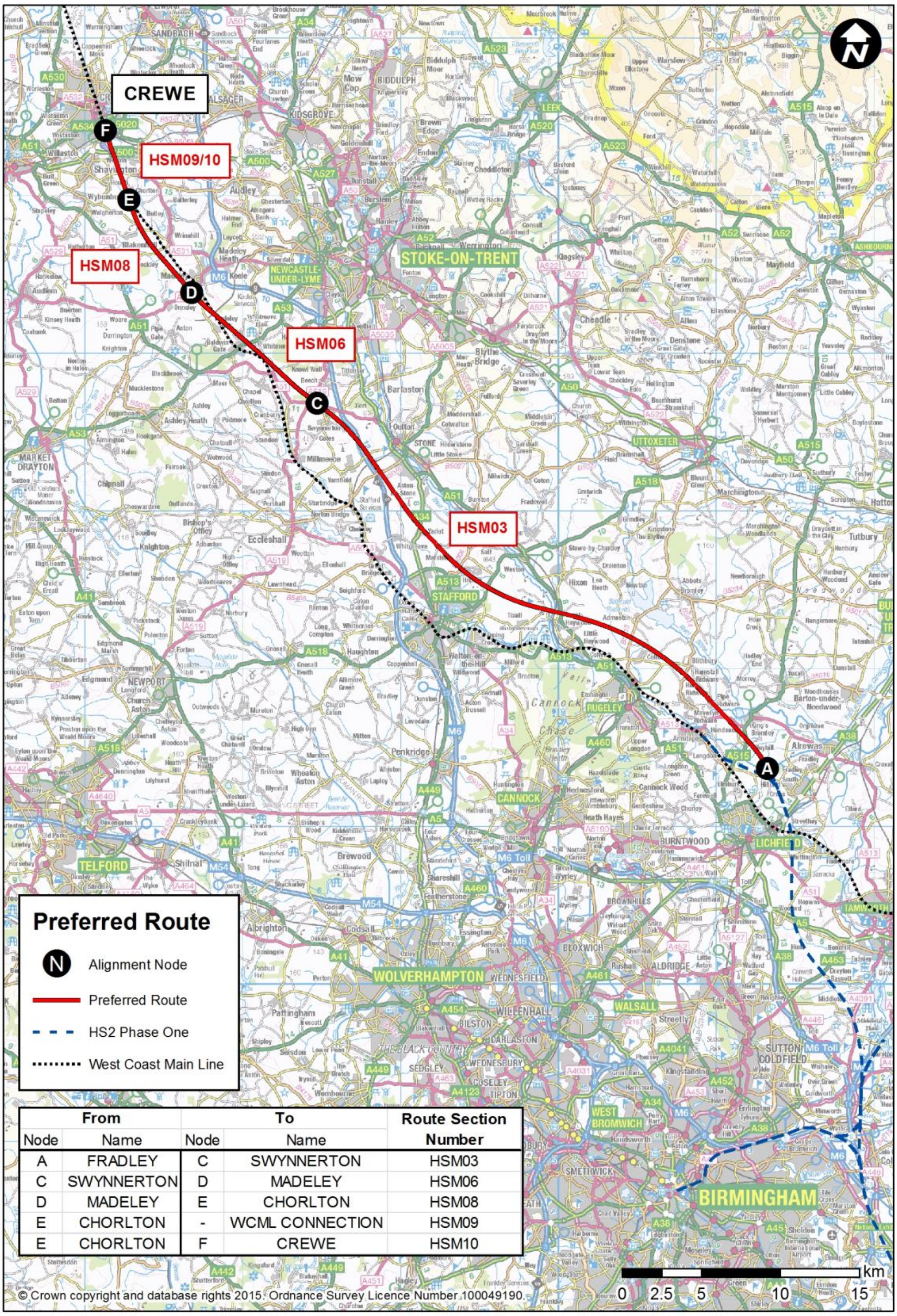
3.1.2 An update to the northernmost section of the Phase One route (London to West Midlands) was submitted as a change to the hybrid Bill in 2015. It would run in a north-south direction to the east of Lichfield in Staffordshire. North of Lichfield a grade separated junction and spur would enable services to connect into the existing WCML at Handsacre. To the north of the junction, the mainline would continue, connecting directly into the proposed Phase Two route described in this report.

3.1.3 The key plan on the previous page presents the individual route sections and provides the reader with the guide to the layout of the rest of this report. Each route section was given a reference number, such as 'HSM03', covering a discrete geographical length. The report describes these sections. The total length may need to be sub-divided in order to allow a piece of text to be read against a map on the following page; typically, each map presents about 6-7.5 miles (10 - 12 km) of route.

3.1.4 The plan also shows that the route sections run between 'Nodes', such that the reader can identify the location they are interested in as, for instance, being 'between Node A and Node C'. These node letters appear in the title of each section. A node defines the beginning (and/or the end) of each of the route section in which the line of route is divided. Each section of line of route running from one node to another is uniquely identified with a reference number. The locations of these nodes have been chosen in order to easily appraise the line of route.

3.1.5 The plans show numbered features of interest, presented, for example, as **(4),** to allow the reader to study the route alongside a corresponding piece of text. The route sections are:

- HSM03: Fradley (A) to Swynnerton (C)
- HSM06: Swynnerton (C) to Madeley (D)
- HSM08: Madeley (D) to Chorlton (E)
- HSM09/10: Chorlton (E) to Crewe (F) and WCML Connection



From		To		Route Section Number
Node	Name	Node	Name	
A	FRADLEY	C	SWYNNERTON	HSM03
C	SWYNNERTON	D	MADELEY	HSM06
D	MADELEY	E	CHORLTON	HSM08
E	CHORLTON	-	WCML CONNECTION	HSM09
E	CHORLTON	F	CREWE	HSM10

3.2 HSM03: Fradley (A) to Swynnerton (C)

Fradley to Pipe Ridware

3.2.1 The route section between Fradley and Swynnerton would be 23.6 miles (38km) long with a design speed of 400kph.

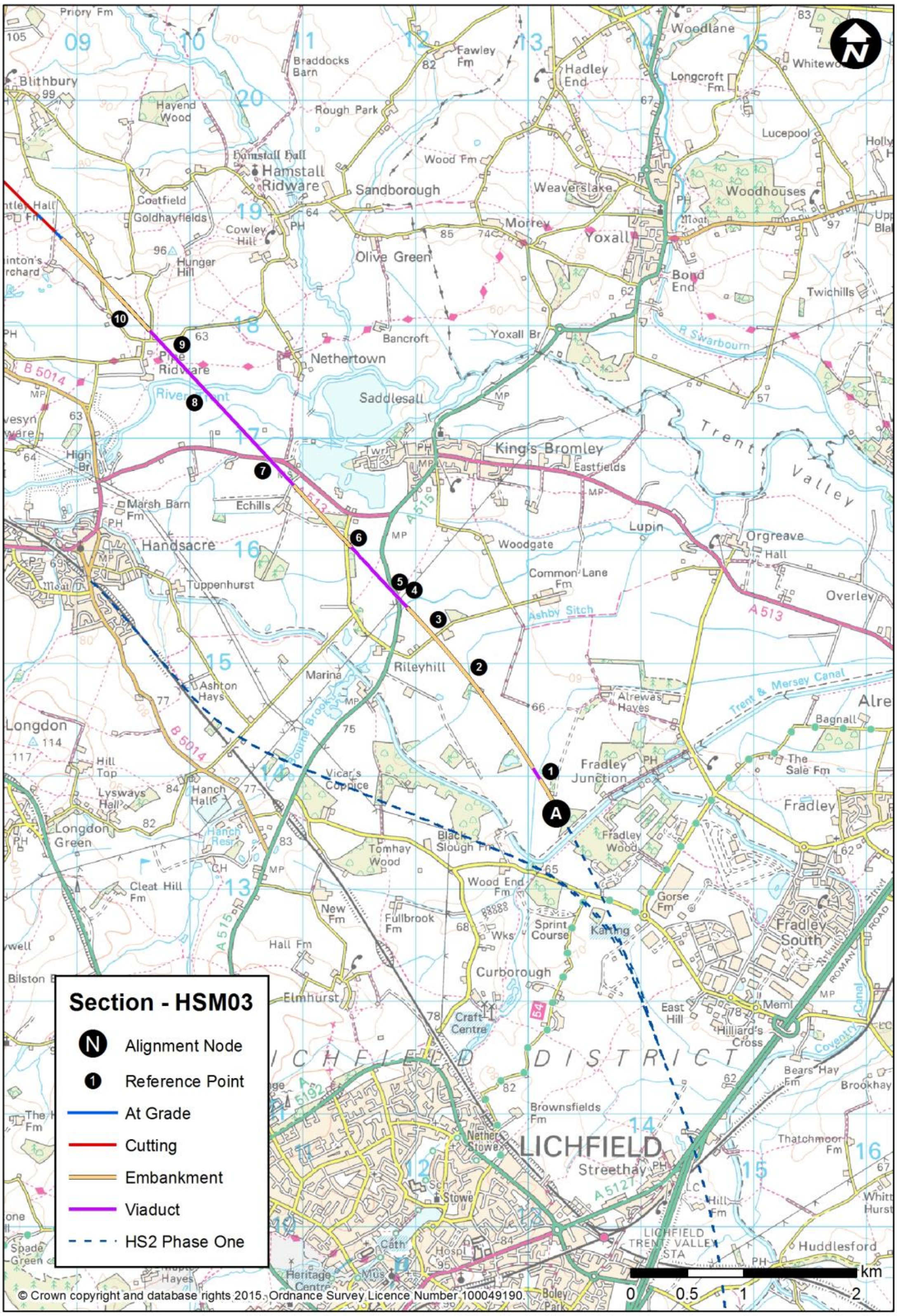
3.2.2 The preferred route would commence at the intersection point with the London to West Midlands route, just north of Fradley Wood.

3.2.3 At this location the line would be on embankment of 6m height and shortly after it would cross Curborough (Pyford) Brook **(1)**. The crossing of the Curborough (Pyford) Brook floodplain would be on a 115m long viaduct with a maximum height of 9m.

3.2.4 The route would then run on an embankment with an average height of 6m and pass over Ashby Stitch watercourse **(2)** and Common Lane **(3)** which would be realigned. The route would then cross Bourne Brook floodplain **(4)** on a 0.5 mile (0.7km) long viaduct up to 13m high. The viaduct would intersect the route of overhead power lines and over the A515 **(5)**.

3.2.5 West of Bourne Brook, the route would continue on an 11m high embankment crossing over Shaw Lane **(6)**. The route would pass through Tomlinson's Spinney and Little Spinney.

3.2.6 The route would cross the A513 **(7)**, River Trent floodplain **(8)** and a lane **(9)** at Pipe Ridware on a 1.2 mile (1.9km) long viaduct with a maximum height of 14m (average height 13m). Maintenance loops **(10)** (see Section 5.3) would be provided 200m north of this viaduct on an embankment up to 13m high. Pipewood Lane immediately north of Pipe Ridware would be realigned to avoid crossing these loops.

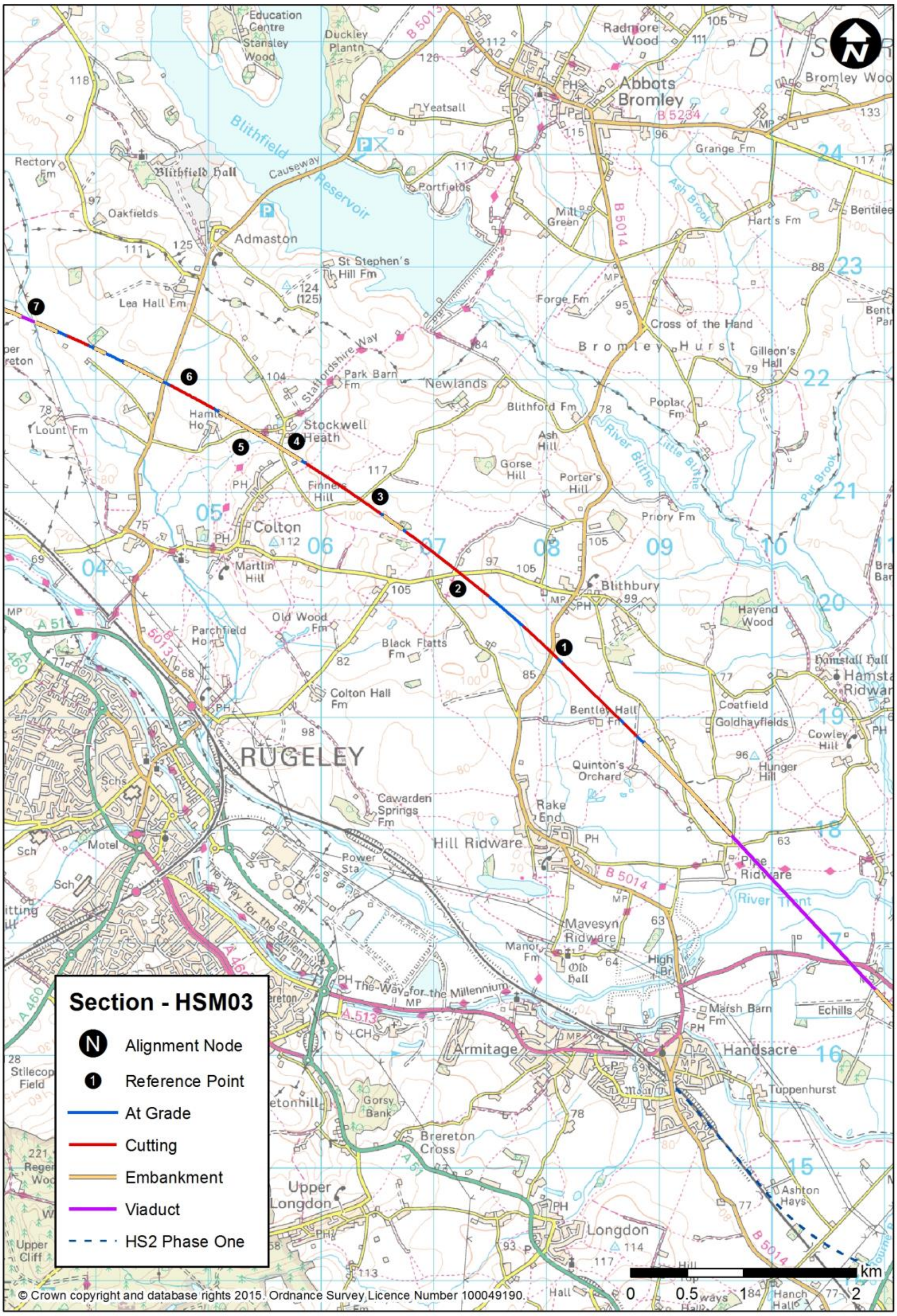

Section - HSM03
Alignment Node
Reference Point
At Grade
Cutting
Embankment
Viaduct
HS2 Phase One
© Crown copyright and database rights 2015. Ordnance Survey Licence Number 100049190.
0
0.5
1
2
km
LICHFIELD
Fradley Junction
King's Bromley
Yoxall
Handsacre
Rileyhill
Trent Valley
Longdon
Fradley
Hamstall Ridware
Pipe Ridware

Pipe Ridware to Upper Moreton

3.2.7 The route would then follow the topography for 2 miles (3km) with a series of embankments up to 3m high and cuttings up to 9m deep. The B5014 **(1)** would be realigned onto a bridge over the route. Blithbury Road **(2)** would be realigned onto a bridge over the route as well as Hadley Gate being realigned to avoid crossing HS2.

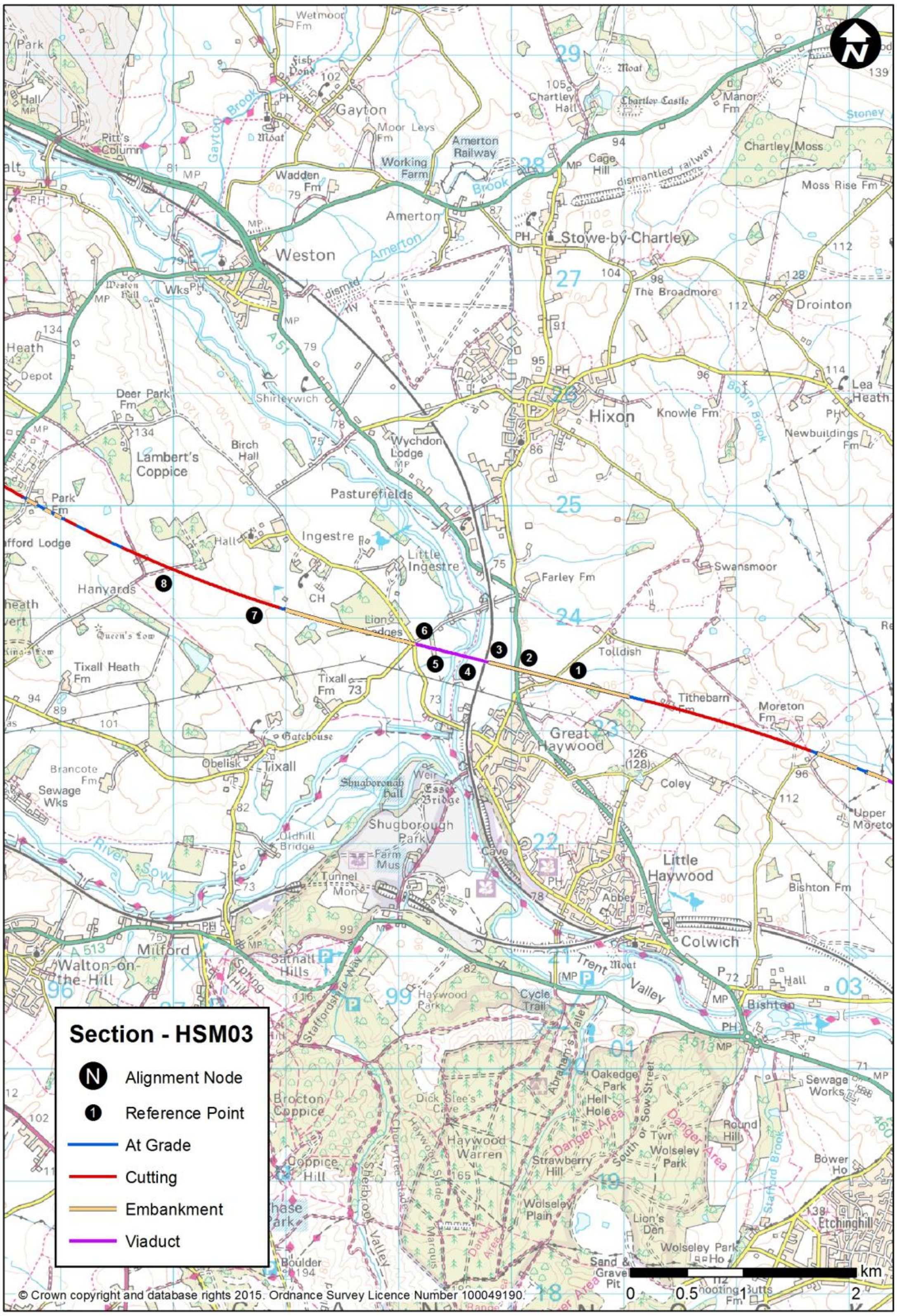
3.2.8 The route would then cross a small valley on an embankment with a maximum height of 12m. Newlands Lane **(3)** would be realigned onto a bridge over the route. The route would pass between Colton and Stockwell Heath on an embankment with a maximum height of 12m. Newlands Lane **(4)** and Moor Lane **(5)** would be combined to form a single crossing under HS2.

3.2.9 The route would then descend towards Moreton Brook initially in a cutting up to 8m deep passing under the realigned B5013 **(6)**. For the next 2 miles (3km) the route follows the topography with a series of embankments up to 3m high and cuttings up to 4m deep. The route would pass under overhead power lines and cross the Moreton Brook **(7)** floodplain on a 130m long viaduct at a height of 7m.


Section - HSM03
Alignment Node
Reference Point
At Grade
Cutting
Embankment
Viaduct
HS2 Phase One
RUGELEY
Abbots Bromley
Blithfield Reservoir
Colton
Stockwell Heath
Admaston
Blithbury
Hill Ridware
Mavesyn Ridware
Armitage
Handsacre
Longdon
Upper Longdon
km
0
0.5
1
2
© Crown copyright and database rights 2015. Ordnance Survey Licence Number 100049190.

Upper Moreton to Hanyards

3.2.10 The route would pass into a cutting with a maximum depth of 19m and then be on an embankment up to 12m high passing over Tolldish Lane **(1)** and the A51 **(2)** to Stoke-on-Trent. The route would cross the Stone to Rugeley railway line **(3)**, the Trent and Mersey Canal **(4)** and the River Trent **(5)** floodplain on a 0.4 mile (0.7km) long viaduct with a maximum height of 12m (average height 10m). At the crossroads **(6)** Hoomill Lane and Trent Walk would be realigned to avoid the route and Mill Lane would be diverted to pass under the viaduct. The route would continue on an embankment (up to 11m high) then passing into a cutting up to 17m deep through Ingestre Park golf course **(7)** and under Hanyards Lane **(8)**.

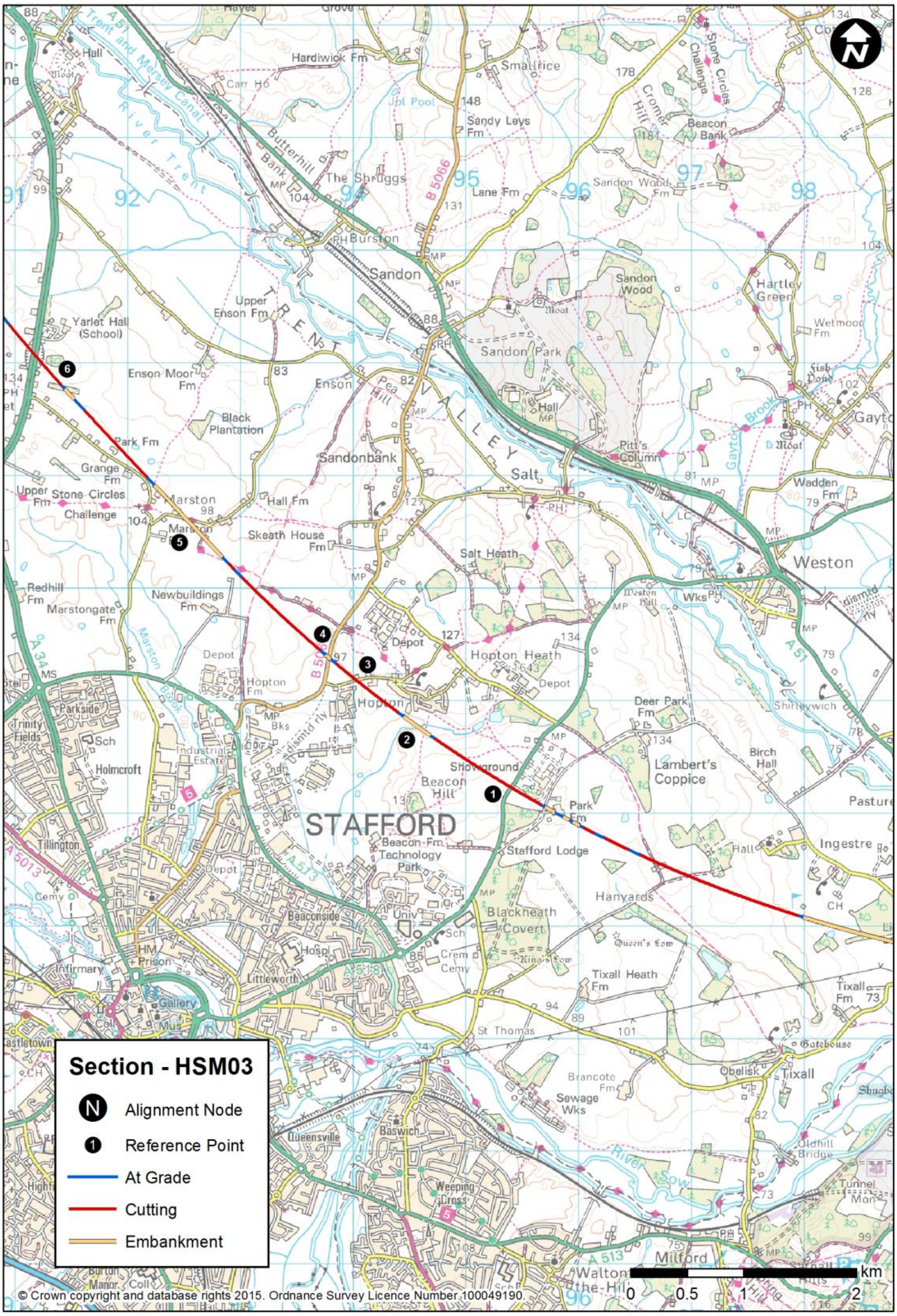

Section - HSM03
Alignment Node
Reference Point
At Grade
Cutting
Embankment
Viaduct
© Crown copyright and database rights 2015. Ordnance Survey Licence Number 100049190.
0
0.5
1
2
km

Hanyards to A34

3.2.11 Following a short section with a series of embankments (up to 3m high) and at grade sections the route would pass into a cutting for the next 0.7 miles (1.1km) with a maximum depth of 13m. The route would pass under the A518 **(1)** immediately south of the Staffordshire County Showground.

3.2.12 The route would cross Kingston Brook on an embankment with a maximum height of 4m. To mitigate the impact on the village of Hopton a false cutting (landscaped retaining wall) **(2)** 0.3 miles (0.5km) long would be provided. The route would then pass back into cutting (up to 16m deep) for the next 0.45 miles (0.72km). Hopton Lane **(3)** would be realigned to Sandon Road (B5066) to avoid the route, and Sandon Road **(4)** realigned onto a bridge to pass over the route.

3.2.13 The route would pass back into cutting (up to 14m deep) for the next 0.6 miles (0.96km) before following the ground profile for the next 0.4 miles (2km) with a series of embankments (up to 9m high) and cuttings (up to 5m deep). The route would pass over Marston Lane **(5)**, and then under the A34 **(6)** in a cutting 16m deep.


Section - HSM03
N Alignment Node
1 Reference Point
At Grade
Cutting
Embankment
STAFFORD
0 0.5 1 2 km
© Crown copyright and database rights 2015. Ordnance Survey Licence Number 100049190.

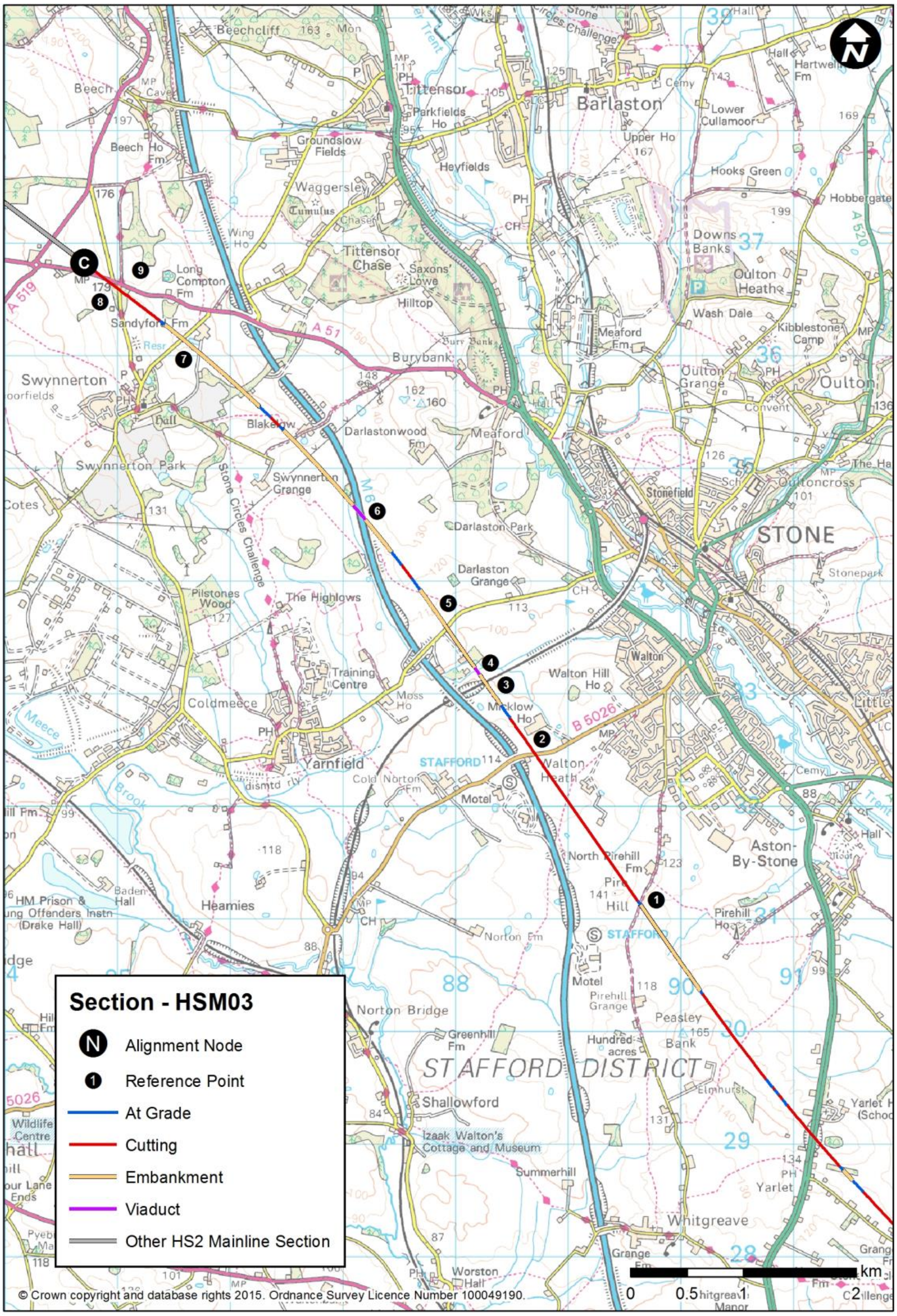
A34 to Swynnerton

3.2.14 Emerging from a cutting the route would be at ground level before passing into a cutting up to 16m deep. The route would move onto an embankment (maximum height 18m) and pass under Pirehill Lane **(1)** which would be realigned onto a bridge over the route. The route would then follow the slope down towards Filly Brook in a cutting (up to 13m deep). Eccleshall Road (B5026) **(2)** would be realigned onto a bridge over the route.

3.2.15 For the next 1.6 miles (2.6km) the route would run within 500m of the M6. The route would be on embankment (up to 7m high), crossing over the Norton Bridge to Stone railway **(3)** and then the Filly Brook **(4)** floodplain on a 80m long viaduct with a height of 10m. Yarnfield Lane **(5)** would be realigned under the route.

3.2.16 After a section of cutting up to 2m deep the route would rise onto embankment and cross the M6 **(6)** on a 170m viaduct, up to 15m high, and under the route of overhead power lines. An embankment (up to 17m high) would follow with the route passing under Tittensor Road **(7)** which would be realigned onto a bridge and over the route. Bottom Lane **(8)** and the A51 **(9)** would both be realigned to avoid crossing the route.

3.2.17 At Swynnerton the route would continue along section HSM06 to Madeley.


Section - HSM03
Alignment Node
Reference Point
At Grade
Cutting
Embankment
Viaduct
Other HS2 Mainline Section
© Crown copyright and database rights 2015. Ordnance Survey Licence Number 100049190.

3.3 HSM06: Swynnerton (C) to Madeley (D)

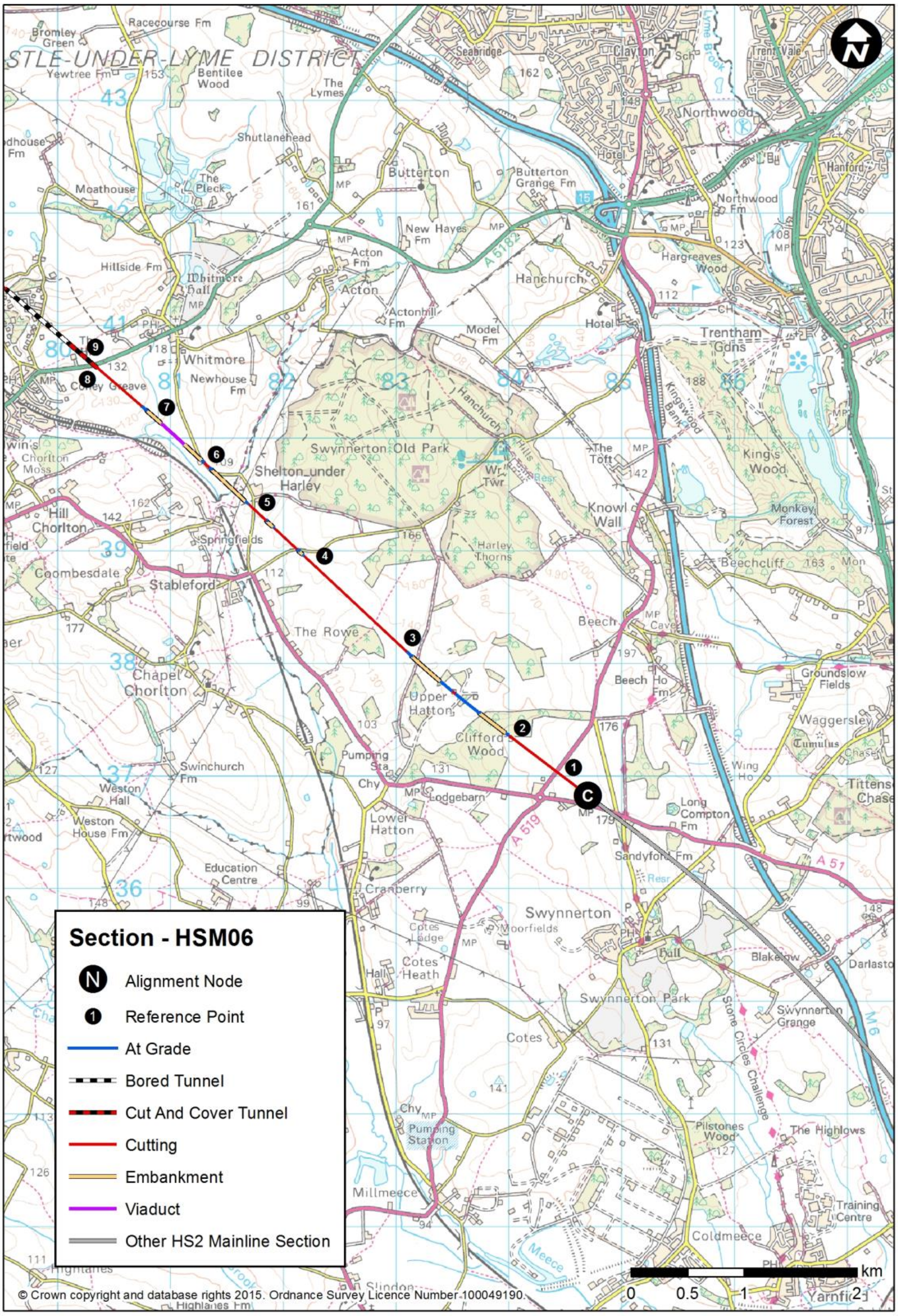
Swynnerton to Whitmore

3.3.1 The route section between Swynnerton and Madeley would be 6.6 miles (10.6km) long. The design speed would be 400kph.

3.3.2 The route would descend following the ground profile for the next 2.5 miles (4km), firstly passing under the A519 **(1)** in a cutting with a maximum depth of 16m. The route would then be on a short section of embankment 10m high through Clifford's Wood **(2)**. A short section on embankment (maximum height 9m) crossing over Common Lane **(3)** would lead to a section of cutting with a maximum depth of 10m.

3.3.3 The route would then descend towards the Meece Brook passing onto two short sections of embankment with a maximum height of 5m and two short sections of cutting (up to 5m deep). The route would then be on an embankment with a maximum height of 6m and would pass under the route of overhead power lines. Dog Lane **(4)** would be realigned along the eastern side of the route to Bent Lane **(5)**. The route would cross Bent Lane **(6)** which would be realigned.

3.3.4 The route would cross the Meece Brook floodplain on a viaduct **(7)** 270m long with a maximum height of 10m. After a short length of embankment (maximum height 8m) the route would pass into a cutting and under the A53 **(8)** in a cut and cover tunnel **(9)**.

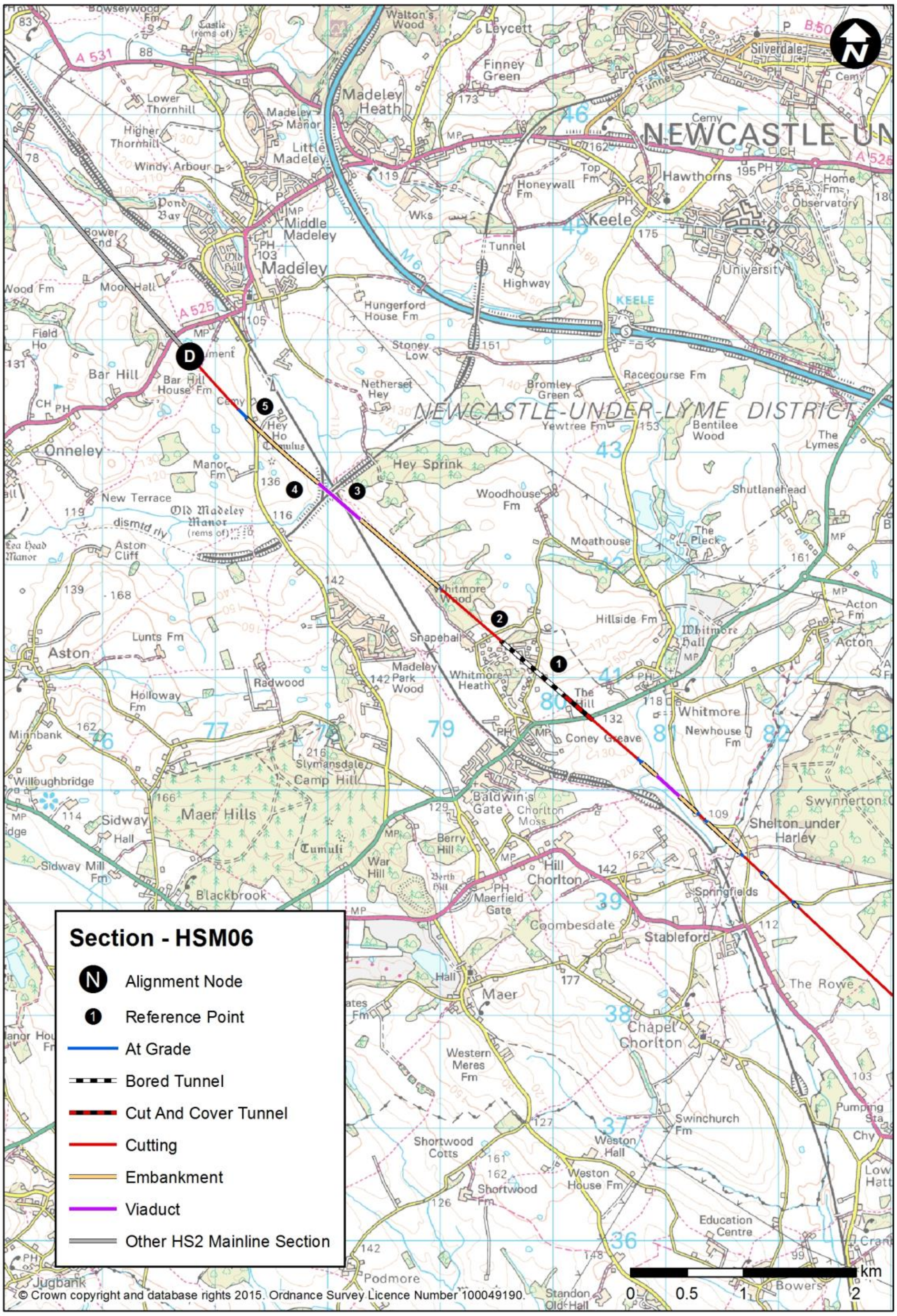

Section - HSM06
Alignment Node
Reference Point
At Grade
Bored Tunnel
Cut And Cover Tunnel
Cutting
Embankment
Viaduct
Other HS2 Mainline Section
0
0.5
1
2
km
© Crown copyright and database rights 2015. Ordnance Survey Licence Number 100049190.

Whitmore to Madeley

3.3.5 The route would be in a cut and cover tunnel from the south of the A53 before entering a 0.4 mile (0.7km) long twin tunnel **(1)** under Whitmore Heath. North of the tunnel the route would be in cutting up to 15m deep passing under Snape Hall Road **(2)** and through Whitmore Wood before following the hillside down towards Madeley on an embankment up to 14m high. Through Whitmore Wood (ancient woodland) the cutting would be fully retained on the eastern side to reduce the footprint through the wood. The route would cross over the WCML **(3)**, the currently disused Silverdale to Madeley railway **(4)** and the River Lea floodplain on a viaduct 490m long with a maximum height of 16m.

3.3.6 The route would continue on an embankment (maximum height 13m) crossing under Manor Road **(5)** which would be realigned onto a bridge over HS2. To the south-west of Madeley the route would pass into a cutting with a maximum depth of 5m. Red Lane will be realigned to avoid the route.

3.3.7 At Madeley the route would continue along section HSM08 to Chorlton.


Section - HSM06
Alignment Node
Reference Point
At Grade
Bored Tunnel
Cut And Cover Tunnel
Cutting
Embankment
Viaduct
Other HS2 Mainline Section
NEWCASTLE-UNDER-LYME DISTRICT
Madeley
Keele
Whitmore
Baldwin's Gate
Maer Hills
Hey Sprink
Onneley
Stableford
Chapel Chorlton
0 0.5 1 2 km
© Crown copyright and database rights 2015. Ordnance Survey Licence Number 100049190.

3.4 HSM08: Madeley (D) to Chorlton (E)

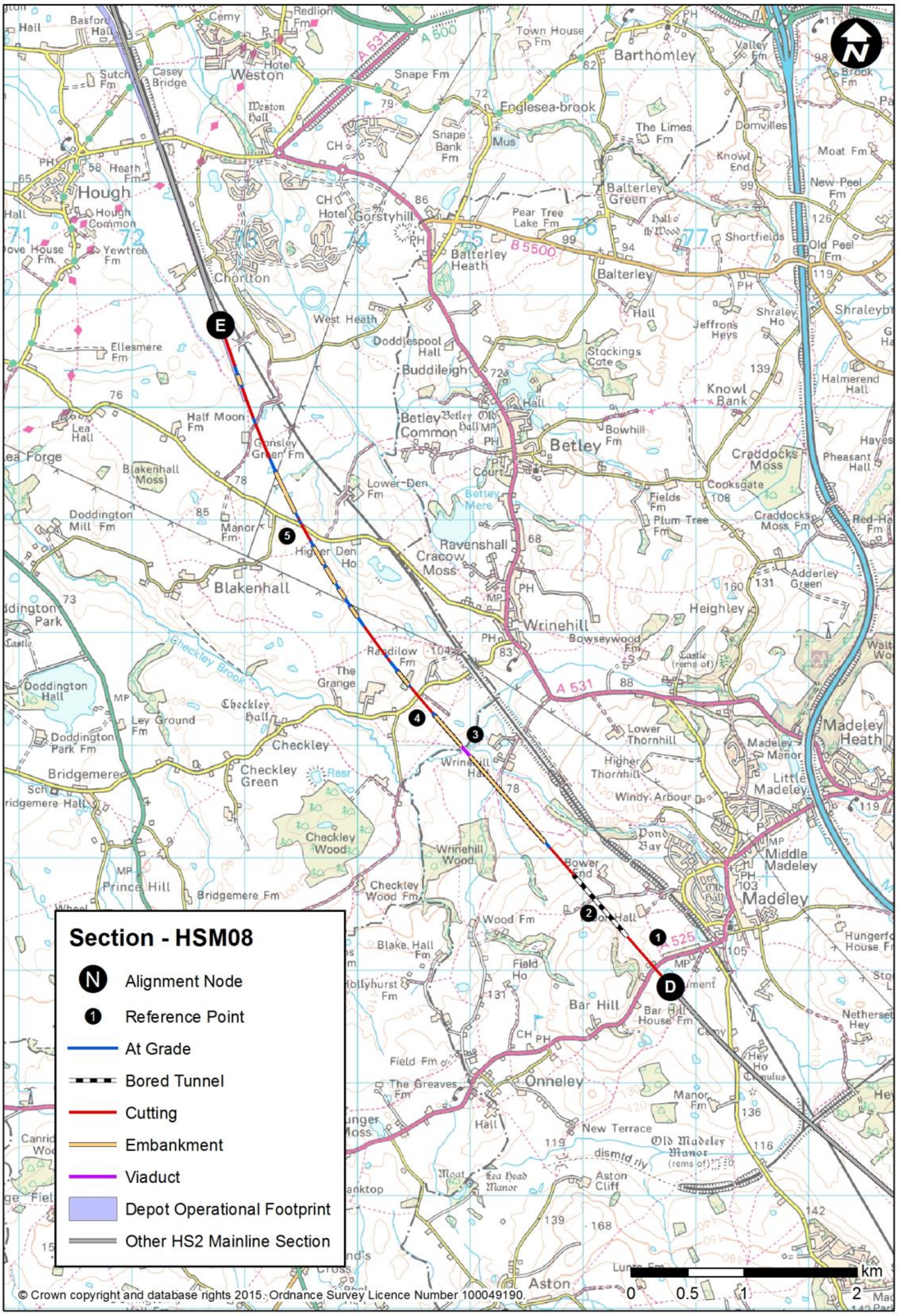
3.4.1 The route between Madeley and Chorlton would be 4.5 miles (7.2km) long. The design speed would be 400kph.

3.4.2 The route would run to the west of the WCML for the next 6.2 miles (10km) to Crewe. To achieve the required speed of 400kph the route would not be parallel to the existing railway until a point 3.1 miles (5km) south of Crewe.

3.4.3 The route would pass under Bar Hill (A525) **(1)** in a cutting leading to the southern portal of a 0.4 mile (0.7km) long twin tunnel **(2)**. On leaving the cutting north of the tunnel the route would be on an embankment (maximum height 11m) and would cross Checkley Brook **(3)** on a viaduct 120m long and 12m high.

3.4.4 For the next 2 miles (3.3km) the route would be in a series of cuttings (maximum depth 9m) and embankments (maximum height 6m). Checkley Lane **(4)** and Den Lane **(5)** would be realigned onto a bridge over the route. The route would pass under two routes of overhead power lines.

3.4.5 At Chorlton the route would continue along section HSM09/10 towards Crewe.


Section - HSM08
Alignment Node
Reference Point
At Grade
Bored Tunnel
Cutting
Embankment
Viaduct
Depot Operational Footprint
Other HS2 Mainline Section
© Crown copyright and database rights 2015. Ordnance Survey Licence Number 100049190.
0
0.5
1
2
km

3.5 HSM09/10: Chorlton (E) to Crewe (F) and WCML Connection

Chorlton to Crewe

3.5.1 This section would provide a connecting spur between the HS2 route and the WCML south of Crewe station. The design speed of the junction on the HS2 route would be 230kph and on the WCML would be 200kph. Both junctions would be grade separated.

3.5.2 The HS2 route would run on the west side of the WCML between Chorlton and Crewe.

3.5.3 The route would be on an embankment rising up to a maximum height of 11m to the north of Chorlton Lane **(1).** The route would cross Newcastle Road **(2)**, Casey Lane **(3)**, Weston Lane **(4)** and the A500 (**5**), with the roads realigned onto crossings over or under the route.

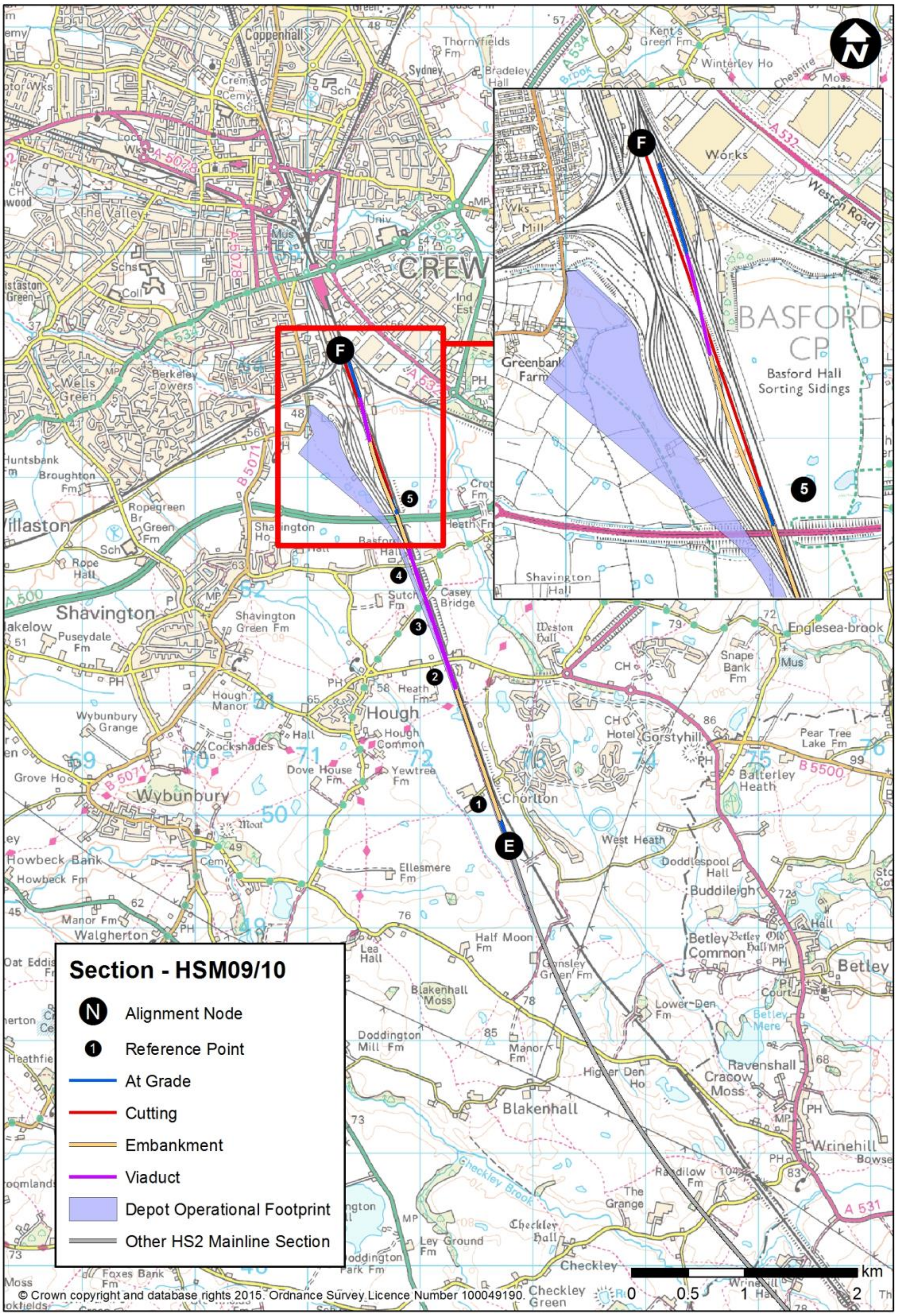
3.5.4 The route would then rise onto a viaduct, with a maximum height of 10m, to pass over the connection to Basford Hall sidings. The tracks for the mainline would terminate just north of the A500. Passive provision for the route to continue, in the form of a fully retained cutting to the start of the tunnel under Crewe would be constructed.

3.5.5 The down line (northbound) spur onto the WCML would pass at grade over the mainline cutting to join the WCML approximately 0.5 miles (0.8km) south of the existing Crewe station.

3.5.6 The up line (southbound) spur onto the WCML would cross over a diverted section of the WCML, at a maximum height of 10m, and connect down into the WCML at a location just north of the A500.

3.5.7 Alterations to the existing rail layout of the WCML would be required, including moving the junction for Basford Hall sidings to the south. Extensive temporary works would be required during construction to maintain the operation of existing lines.

3.5.8 An IMD site has been identified alongside Basford Hall sidings, and is described in Section 4. A separate spur and headshunt would connect the HS2 mainline to this depot.


Section - HSM09/10
Alignment Node
Reference Point
At Grade
Cutting
Embankment
Viaduct
Depot Operational Footprint
Other HS2 Mainline Section
© Crown copyright and database rights 2015. Ordnance Survey Licence Number 100049190.
Basford Hall Sorting Sidings
km
0
0.5
1
2

4 Depots

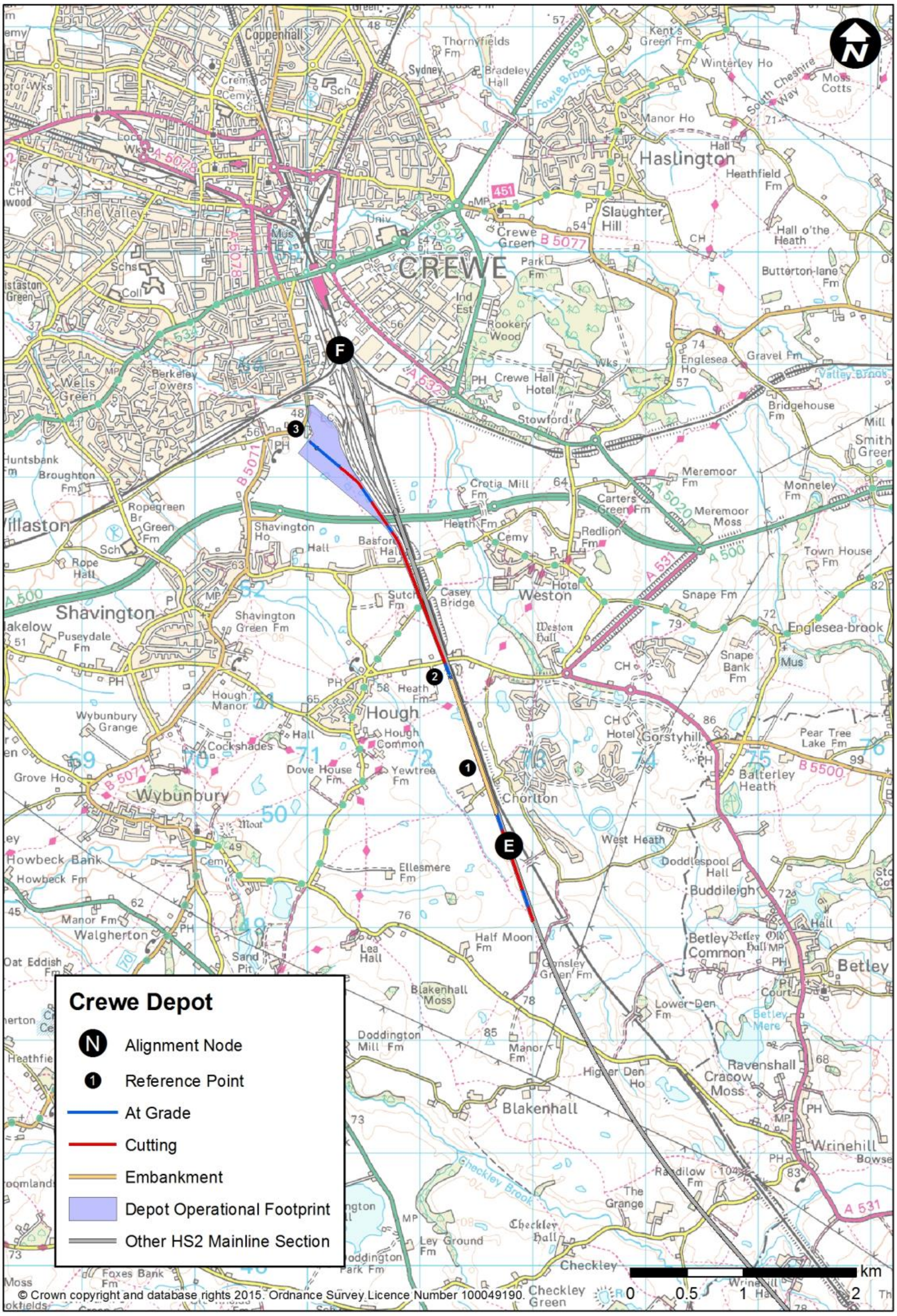
4.1 Infrastructure Maintenance Depot

4.1.1 The proposed IMD would be located approximately 0.9 miles (1.5km) south9west of Crewe, to the west of the WCML and Network Rail sidings at Basford Hall. The depot would be situated on 37ha of relatively level land alongside the existing sidings. A section of the depot would cross Gresty Brook and its floodplain. Previously farmland, the Basford West area has been earmarked as a major development site by the Local Authority.

4.1.2 The depot would comply fully with the HS2 design criteria and specifications outlined in section 2.3, except that it would be single ended, i.e. access to the depot from the mainline is achieved only from one end of the depot.

4.1.3 The connection from the WCML to the existing sidings would be moved south. A connection from the HS2 route to the south (HSM10) to the IMD would be provided between Chorlton Lane **(1)** and Newcastle Road **(2)**. A headshunt would be provided to the south of these connections to provide access onto and from HS2 to the north. Access to the depot from the WCML would also be provided. A new highway access to the depot would be constructed from Gresty Road **(3)**.

4.1.4 Construction of the depot in this location would use standard methods.


Crewe Depot
Alignment Node
Reference Point
At Grade
Cutting
Embankment
Depot Operational Footprint
Other HS2 Mainline Section
© Crown copyright and database rights 2015. Ordnance Survey Licence Number 100049190.
0
0.5
1
2
km

5 Ancillary design works

5.1 Tunnel portals

5.1.1 Tunnel portals will be required on all tunnels, both bored and cut-and-cover, and fulfil a number of purposes. These include:

- a structure to retain the surrounding ground at the entrance of the tunnel;
- emergency intervention access to the tunnels from the surface;
- emergency passenger evacuation where evacuation via the portal is part of the emergency strategy;
- reducing noise and air pressure effects as trains enter or exit the tunnel.

5.1.2 Tunnel portals would incorporate some or all of the following features:

- porous portals (see 5.1.3);
- building housing services such as power, telecommunications, water supply, fire safety, drainage and ventilation equipment to service the tunnel in what is generally known as a 'headhouse'; and
- parking for service vehicles.

5.1.3 Work has been carried out on Phase One of HS2 to assess the requirements for porous tunnel portals. Porous portals would be provided at the ends of tunnels to mitigate the effects of pressure waves created by trains entering or exiting tunnels at high speed. For speeds in excess of 225kph porous portals should be provided. The length of these porous portals is dependent on a number of factors, however the overall length of the portals is dependent principally on the line speed, the diameter and the length of the tunnel. Using the findings of work done on Phase One, the length of these portals is estimated to be 150m for the tunnels on the preferred route.

5.1.4 Tunnel portals would take different forms, depending on ground conditions, local terrain and train speeds. In rural locations, portals would typically be constructed in open excavation, with soil and rock slopes benched (i.e. cut in steps) and reinforced as necessary, and reinforced concrete headwalls and wing walls around the tunnel entrances. In urban locations, and where space is restricted, portals would utilise earth retaining structures.

5.1.5 Where excavation is relatively shallow, tunnel portals would be constructed by open cut. For deeper excavations, diaphragm wall or contiguous bored pile techniques would be utilised, requiring support by propping beams or a cover slab for the deepest excavations.

5.1.6 A minimum rescue area of 550m^2 for emergency services would be provided at both portals for tunnels longer than 1km, and at one portal for those shorter than 1km.

5.1.7 The function of the headhouse would be to accommodate ventilation fans, lift winding gear and other plant, together with operation and emergency access/egress. The headhouse structures would generally be a single-storey building of four to five metres in height depending on whether air intakes to fans are required.

5.2 Ventilation shafts

5.2.1 Typically, tunnels would have vertical shafts for ventilation, maintenance, pressure relief and emergency intervention located at 1.2 miles – 1.8 miles (2km – 3km) intervals. The preferred route includes two tunnels, both of which are less than 1.2 miles long and therefore do not require an intermediate ventilation shaft.

5.3 Maintenance loops or sidings

5.3.1 Maintenance loops are a series of sidings used to provide stabling for maintenance trains required for operational maintenance work, and failed trains that cannot readily be pushed to the next station so allowing the line to be cleared with limited delay. Depots can be used for this purpose however, due to the nature of the lengths between depots and stations on this high speed network, it is necessary to provide loops between these locations to allow quick start up of work when the limited engineering hours commence. Assessment of requirements in this respect indicate that such berthing facilities should be supplied on the network, be they stations, depots or loops, at intervals of no more than approximately 37 miles (60km) along the route.

5.3.2 Ideally, the layout of maintenance loops would comprise of two loops or sidings, one either side of the mainline. Each of these loops would be approximately 0.9 miles (1.4km) long. Crossovers would also be provided at either end of the maintenance loops to allow for operational movements.

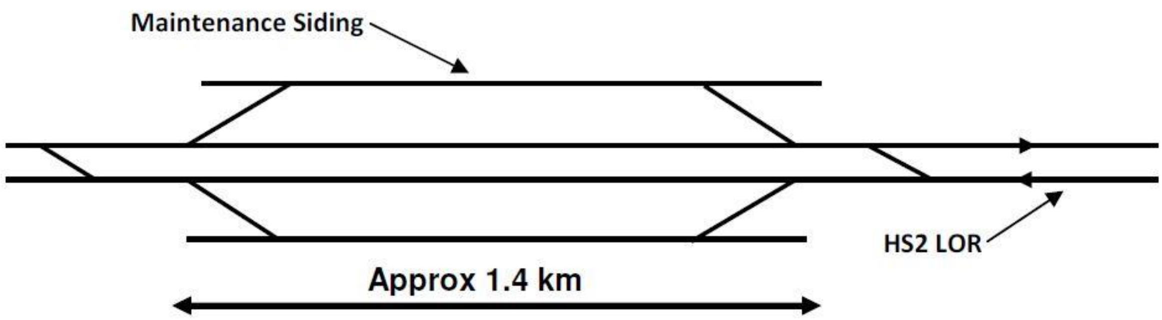


Figure 1 - Maintenance loop: typical plan configuration

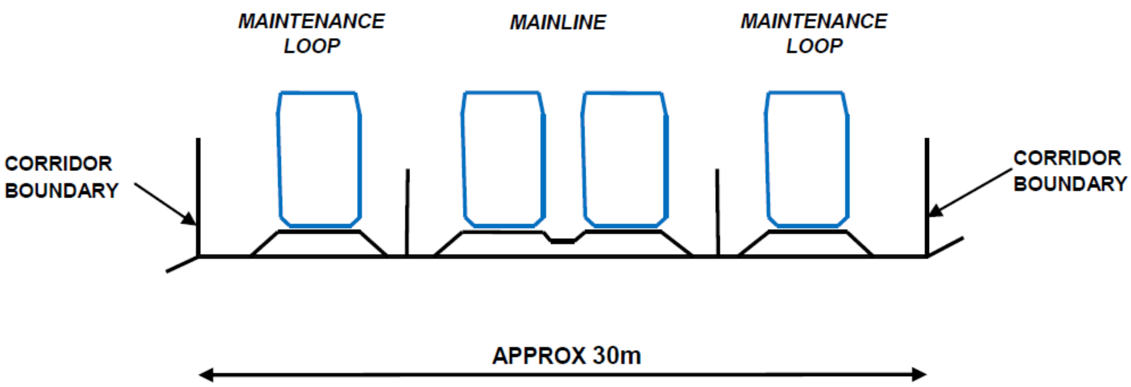


Figure 2 - Maintenance loop: typical cross-section

5.3.3 Vehicular access would be provided along the length of each loop as well as parking facilities. A road rail access point may also be incorporated.

5.3.4 On the preferred route, loops would be located at Pipe Ridware as per the layout shown above (see 3.2.6).

5.4 Further works

5.4.1 The scheme design is still at a preliminary stage and further work will be required to incorporate other aspects of railway infrastructure. This will be done at later stages of the design process, and will include:

- power supply and overhead line electrification;
- signalling and other railway systems;
- drainage and drainage attenuation; and
- accesses to the railway for maintenance.

Glossary of terms

Aqueduct – A bridgelike structure which carries a river or canal over an obstacle.

Classic rail network – Existing UK rail lines.

Crossovers – two parallel railway tracks that are connected by a pair of switches allowing a train to pass from one set of tracks to another, i.e. where a train can transition between two parallel tracks.

Culvert – a tunnel carrying stream or open drain under a road or railway.

Engineering hours – the hours during the night when passenger services are not running and engineering work can be carried out on the tracks.

Floodplain – area of land surrounding a watercourse which will be subject to flooding.

Freeboard – The height between a given level of water in a river or lake to the underside of a bridge crossing the water.

g – A unit of acceleration equal to the acceleration of gravity at the earth's surface.

GC Gauge – gauge is the shape beyond which a vehicle is not to be built, or within which a structure is not to intrude. GC Gauge is an intermediate shape between a vehicle gauge and a structure gauge, defining limits that a vehicle should conform to in a limited range of operating conditions.

Grade separated junction – a junction where one or more routes cross other routes at a different level by being raised above or below them. This could apply to either to railways or highways.

Headshunt – Dead end tracks to allow trains to stop and change direction.

High Speed Two (HS2) Limited (HS2 Ltd) – a company wholly owned by the Department for Transport responsible for developing and promoting HS2 London to West Midlands and preparing proposals for HS2 to Leeds and Manchester.

Infrastructure Maintenance Depot (IMD) – Base for maintenance of infrastructure associated with the proposed high speed rail line, including track, power, signalling equipment, cuttings and embankments.

Maintenance loop – sidings to allow the berthing of engineering or failed trains alongside the Mainline.

Network Rail – owner and operator who runs, maintains and develops Britain's rail tracks, signalling, bridges, tunnels, level crossings, viaducts and selected rail stations. Network Rail owns and manages Birmingham New Street station, Liverpool Lime Street station and Manchester Piccadilly station.

OHLE – Overhead Line Equipment, the cables above the trains which carry the electricity supply for the trains.

Phase One – the HS2 route from London to the West Midlands.

Rolling Stock Depot (RSD) – Depot used to service and maintain trains operating on the preferred route.

Side slopes – The sloped ground forming the sides of an embankment or cutting.

Sprayed Concrete Lining (SCL) – A method for the construction of tunnels, by spraying concrete immediately on the exposed ground to retain it.

Spur –a railway line which branches off the main through route.

Switch and Crossing (S&C) – A rail junction (or set of points) allowing a train to pass from one set of tracks to another, i.e. where a single set of railway tracks split into two sets of tracks.

Tunnel boring machine (TBM) – A machine used to construct tunnels.

Tunnel bore – The circular hole through the ground forming a tunnel.

Tunnel portal – the entrance to a tunnel.

Turnouts – Another name for a Switch and Crossing. A rail junction (or set of points) allowing a train to pass from one set of tracks to another, i.e. where a single set of railway tracks split into two sets of tracks.

Twin tunnel – two tunnels constructed side by side spaced slightly apart, one of which will take the northbound track and one the southbound track.

West Coast Main Line (WCML) – Intercity railway route in the UK connecting London, Birmingham, Manchester, Liverpool and Glasgow.