



HS2 London to the West Midlands Appraisal of Sustainability

Non Technical Summary

A Report for HS2 Ltd

February 2011

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1 Purpose of the Appraisal of Sustainability report

- 1.1.1 This document summarises the HS2 Appraisal of Sustainability (AoS) report, which describes how the proposed new high speed railway between London and the West Midlands would support objectives for sustainable development. Sustainable development embraces considerations of economic development and job opportunities, and effects on communities, as well as environmental considerations such as landscape, natural environment and climate change.
- 1.1.2 The Government's preference for the proposed route described here is based on how well it would fulfil a number of considerations when compared with other alternatives: its achievement of wider transport and economic objectives, its construction costs, its operational requirements, the practicalities of building it and its sustainability performance, including its environmental effects.
- 1.1.3 The proposed scheme has been developed by HS2 Ltd, a company set up by the Government. It has been developed since 2009, but now accommodates design changes from the route published in March 2010 that were made to reduce further the effect of the railway on local communities and the natural environment.
- 1.1.4 This non-technical summary, prepared by Temple Group Ltd and Booz and Co. (UK) Ltd, who undertook the AoS on behalf of HS2 Ltd, describes the proposed route at this stage of development, how sustainability issues have been considered and incorporated to assist decision making, and highlights the key sustainability impacts – both beneficial and adverse - that are envisaged at this stage.

2 Refinements of the proposed scheme

- 2.1.1 The Government's proposed route follows the same corridor as the scheme published in March 2010. It has however been modified in response to the Government's request to investigate some additional options, considering in particular how London Heathrow Airport might best be served. The Government's proposed strategy for a national high speed network includes a direct spur to Heathrow to be constructed as part of the second phase. Therefore HS2 Ltd has made provision in its plans to allow for the addition of a connection to the airport at that point.
- 2.1.2 The proposed route now also includes a direct connection to HS1 and it includes changes that mitigate particular impacts in response to the early discussions undertaken by the Secretary of State. In particular the design has been altered wherever practicable to move further away from towns and villages, and other sensitive sites. The proposed route has been lowered along much of its length to reduce its environmental impacts. Many new cuttings have been incorporated that would help to screen views of the new railway and integrate it better into the landscape. Potentially high structures such as viaducts and elevated road bridges have been avoided where possible. Some new 'green bridges' (where the alignment is lowered, covered over and re-planted) have been introduced; this would help to maintain the local outlook, reduce noise and maintain access for people and animals.

Green bridges like this one on HS1 would help to provide local mitigation for settlements [Arup]



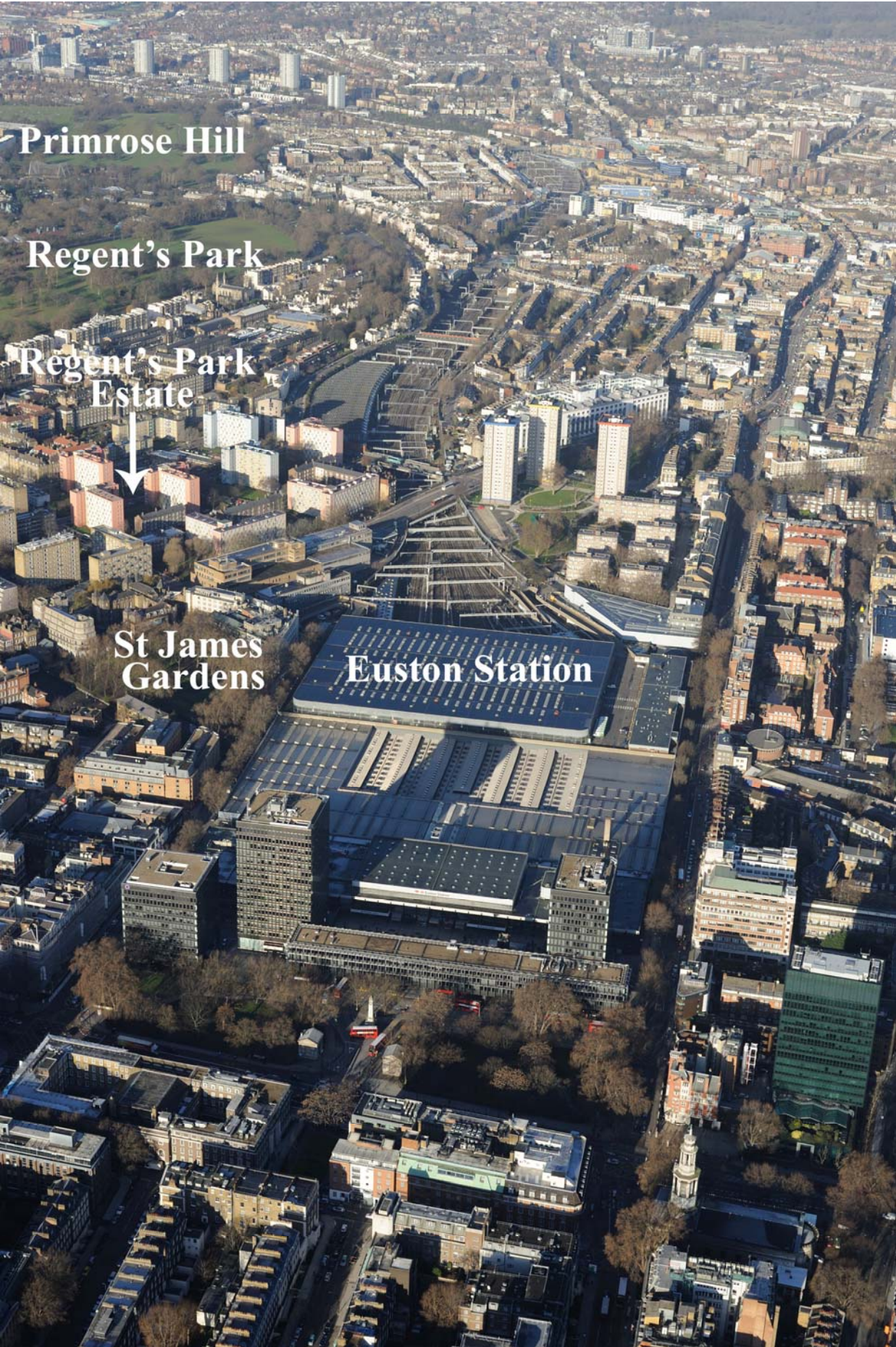
- 2.1.3 Should the scheme be taken forward, opportunities to make further reductions in the environmental impact of the proposed scheme are expected to arise as the design progresses. Public consultation provides local people, local authorities and interest groups with the opportunity to put forward their views which, amongst other things, may assist the development of the railway's design and further mitigation. Local engagement would continue as the design, approval process, construction and operation are progressed. At each stage HS2 Ltd would seek to ensure that the scheme would be constructed and operated so as to overcome or minimise adverse environmental effects locally; and would work with other organisations to realise or enhance the transport and regeneration benefits regionally and nationally.

3 Overview of the proposed scheme's potential impacts

- 3.1.1 HS2 would have a number of sustainability impacts - some beneficial, some adverse.
- 3.1.2 The proposed HS2 route and stations and the new transport opportunities that the proposed scheme would create would enhance economic competitiveness, support wider economic growth and bring about enhanced employment opportunities. In supporting economic competitiveness, the benefits to businesses which would arise directly from the faster journeys potentially enabled by HS2 are valued at some £11.0 billion over 60 years.
- 3.1.3 Further economic benefits would accrue by HS2 effectively bringing cities closer together and by encouraging businesses (as well as workforces) to cluster around HS2 and, particularly, West Coast Main Line (WCML) stations. These businesses would operate more efficiently and competitively by being closer to one another. Such benefits could be worth a further £3.0 billion over 60 years. By opening up areas to the effects of wider competition and wider markets, the proposed scheme would be expected to deliver a further £1.0 billion of benefits. There could also be economic benefits due to transport improvements encouraging more people to work, although these would be relatively minor.

- 3.1.4 HS2 would also be expected to benefit people making commuting, leisure and other personal journeys. Over 60 years this is estimated to be worth some £6.4 billion of additional benefits. In total, when all of these factors are added together and benefits from fewer road accidents and better air quality are taken into account, economic benefits for the wider UK community from the London to West Midlands phase of the project are estimated to be £21.8 billion over 60 years.
- 3.1.5 The new railway stations would be the catalyst for new commercial enterprise and, over time, would stimulate opportunities for businesses to relocate and prosper at Euston as part of the over-site station development; at Old Oak Common where an interchange station would influence the development of the Park Royal Opportunity Area; in the West Midlands where the interchange station would support the development and connections with the National Exhibition Centre (NEC) and airport, and at Curzon Street in central Birmingham where HS2 passengers would have immediate access to the city centre's new proposed commercial quarter as well as its existing facilities.
- 3.1.6 Overall, it has been forecast that HS2 could attract some 30,000 jobs from the planned growth in employment for London and the West Midlands to the areas around the proposed HS2 stations. The scheme is also expected to provide 1,500 permanent operational employment opportunities, many of which would be new jobs. An estimated 9,000 jobs would also be created during construction. HS2 would displace a number of businesses and associated jobs, for example at Washwood Heath and Old Oak Common. However, it is likely that many of these displaced jobs would be re-established elsewhere. Close working between HS2 Ltd, local councils and local businesses would be undertaken to help to reduce the potential for adverse impacts on those affected.
- 3.1.7 As HS2 replaced some of the existing fast services on the WCML, space would be created on the WCML to allow new services for towns and cities between London and the West Midlands and additional commuter, local and regional services as well as opportunities for freight services. This would offer further stimulation to business.
- 3.1.8 Both HS2 and new services on the WCML would offer opportunities for a low carbon form of transport. The extent to which CO₂ emissions would be reduced, however, would crucially depend on how carbon-efficient electricity generation becomes in the future. It would also depend on any reduction in the number of flights (due to people switching to high speed train services) being maintained, as well as on the resulting available take-off and landing slots remaining vacant.
- 3.1.9 The redevelopment of Euston station has been recognised by the Mayor of London and Camden Council as a potential catalyst for the regeneration of the Euston area as a whole. But, in order to achieve this, substantial property demolition would be required, including some 190 dwellings on the Regent's Park Estate and some 25 further dwellings. The immediate effect of this upon the local community at Euston would be significant. HS2 Ltd would be committed to working closely and at an early stage with the London Borough of Camden and the GLA and with community groups, residents' associations and affected residents generally to ensure that effective arrangements are in place to meet the housing needs of those affected by demolition of these dwellings, and to help to address wider impacts on the local community. At Washwood Heath in Birmingham, the construction of a new train depot would require the demolition of around 30 dwellings and the loss of a number of commercial premises. A similar approach to Euston, involving close working between HS2 Ltd and Birmingham City council and with local residents and businesses would be undertaken to help to minimise disruption to this community.
- 3.1.10 Elsewhere property demolitions, although significant to those people directly affected, would be reasonably low in number given the scale of the scheme.

Aerial view of Euston station [HS2 Ltd]



- 3.1.11 There would be some localised disruption along the route during construction. The main centres of population are in the greater London and greater Birmingham areas. The route would also pass in the vicinity of a number of more dispersed villages, hamlets and isolated farmsteads in the countryside. For the purposes of construction HS2 Ltd would develop and implement a code of practice that would contractually bind the companies building the route to reduce impacts to a practicable minimum.
- 3.1.12 Similarly, during operation, railway noise would affect some people living along the proposed route. Further appraisal work has made assumptions about what could realistically be achieved through additional mitigation, such as noise barriers. On this basis, 'high' noise levels would affect fewer than 10 dwellings. Approximately 150 properties would be likely to experience levels of noise which would qualify for noise insulation payments under existing statutory compensation arrangements. There would be up to 4,700 dwellings identified on the proposed route corridor that would be likely to experience a noise change of 3 decibels or more (3dB being a just perceptible change in total noise over an assessment period) that results in a daytime noise level of 50 decibels or more (referred to in this document as a 'noticeable' noise change).
- 3.1.13 Experience from HS1 and other high speed railways shows that potentially significant effects from vibration and ground-borne noise (audible vibration) in properties over tunnels can be avoided. HS2 Ltd is committed to ensuring that no significant effects occur over tunnels through London and the Chilterns.

Cuttings, like those used on HS1, would help to screen views [Arup]



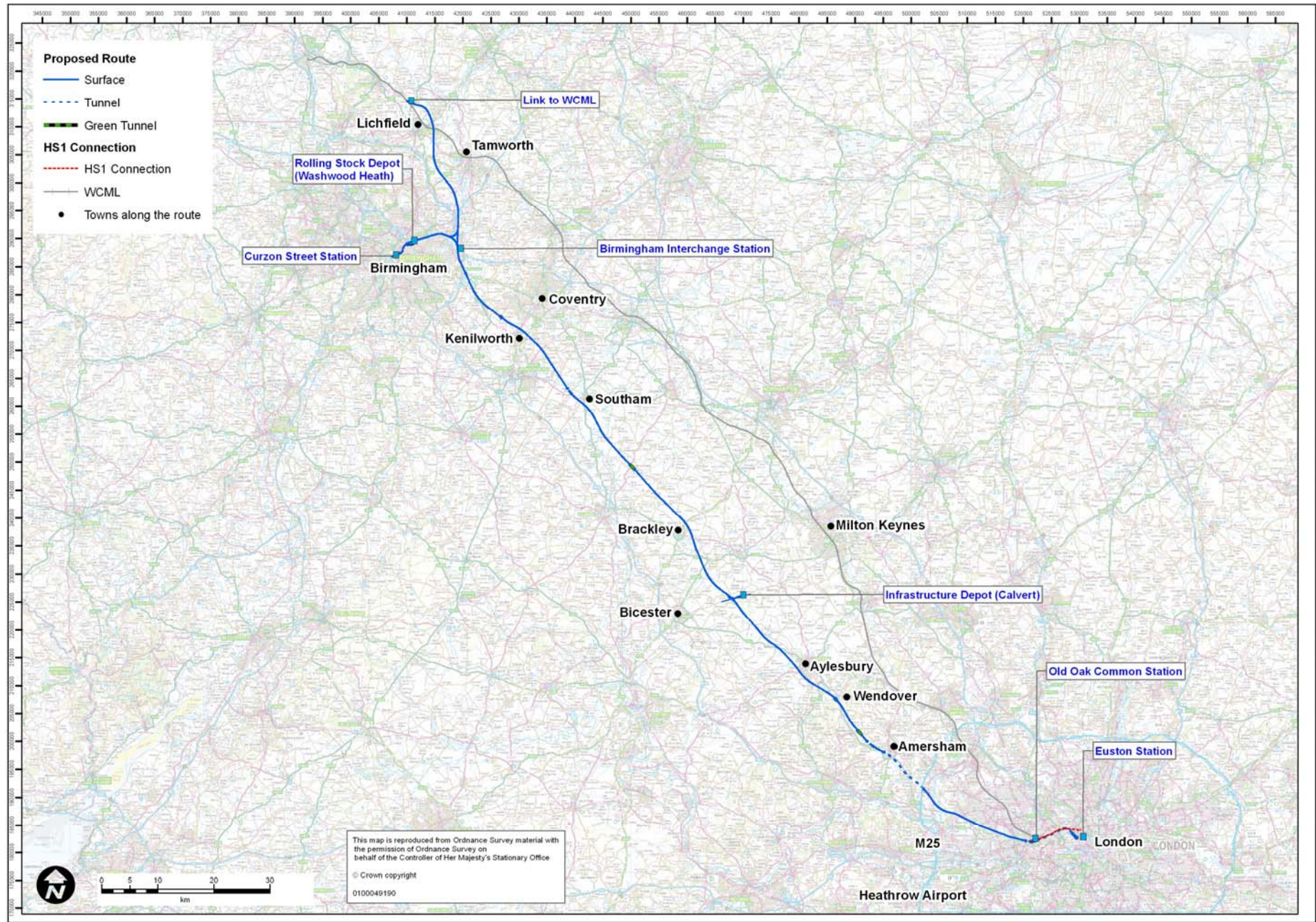
- 3.1.14 The proposed route between London and the West Midlands would include some 225km of new railway, passing through a variety of metropolitan, suburban and rural areas. Surface sections have been located alongside existing railways and roads over some 55km. Tunnels, totalling some 29km, would be provided to pass through hilly ground and to avoid the densest population in London. The proposed route has been lowered in places and 90km would be in deep or very deep cutting. Some 2km of cutting near to certain villages in rural areas would be covered for environmental benefits to form 'green bridges'.

Elsewhere, approximately 85km of the proposed route would be at ground level or on embankment and 21km would be on viaduct.

- 3.1.15 The Chiltern Hills, much of which is designated as an area of outstanding natural beauty (AONB), would be crossed predominantly in tunnel and deep cutting with short elevated sections variously on embankment and viaduct to the south of Wendover where the route would be in close proximity to the A413 and Chiltern Railway. Some visual impact would be inevitable but of the 20.5km of railway through the AONB, all but 2km would be either in tunnel, in cutting and/or alongside the A413 main road. Extensive tree planting, as well as the creation of planted earth mounds or 'bunds' would help to further screen views and integrate the railway into the landscape.
- 3.1.16 Refinements to the proposed route have ensured that no Grade I and II* listed buildings would be demolished, although the setting of three Grade II* buildings would be likely to be affected. Fifteen Grade II listed buildings would need to be demolished. Some listed structures in the Euston area would need to be relocated and the design of Euston Station and its associated over-site development would need to take into account the setting of Euston Gardens and the northern part of the Bloomsbury Conservation Area.
- 3.1.17 Three Registered Parks and Gardens would be physically impacted. However in each case further route refinement has been undertaken to limit the landtake and effects upon the settings of these features.
- 3.1.18 Two protected sites of archaeological importance would be physically impacted. These scheduled monuments, Grim's Ditch in the Chilterns and a Roman villa site in the vicinity of Edgcote would be subject to prior archaeological investigation and academic study, in line with Government guidance.
- 3.1.19 The proposed new railway would present a significant opportunity to reinforce and enhance biodiversity. It would provide a green corridor to be colonised by plants and animals, and could link with and form connections between existing habitats. There would, however, be adverse effects at a number of sites.
- 3.1.20 No internationally protected sites of ecological interest would be adversely affected and impacts to nationally protected sites would be restricted to a small number of locations. Partial landtake would be required from two sites of special scientific interest (SSSI). A number of locally designated sites and important habitats, such as ancient woodlands, would be physically impacted. Where sites of ecological interest and local importance are considered likely to be affected, further work would be undertaken during more detailed design, and management plans would be drawn up and implemented to help minimise the adverse effects on biodiversity.
- 3.1.21 Where the proposed route would cross rivers it has been designed to take account of future flood risks by the inclusion of structures to bridge these areas. In some places, the proposed route would pass in tunnel through important ground water resources. Construction techniques would be implemented to reduce such risks to a practicable minimum.
- 3.1.22 The proposed new railway would make good use of land that has had a previous industrial or railway use. However, some productive agricultural land would be lost. Although the most important Grade 1 land would not be affected, the proposed route would pass across Grade 2 agricultural land for some 20km. Further work would be undertaken during later design stages to seek to reduce agricultural landtake and severance.
- 3.1.23 Construction of the proposed scheme would generate and consume large quantities of materials. HS2 Ltd would seek to re-use as much of this as possible within the scheme design, for embankments and landscape proposals. Opportunities would be sought to use any surplus spoil within other schemes and proposals; disposal to landfill would be used as a last resort.

4 Description of the proposed scheme

- 4.1.1 Travelling from London to the West Midlands, the proposed scheme would run from a new and expanded London Euston station to a connection with the WCML, allowing high speed trains to join the existing network near Lichfield. Central Birmingham would be accessed via a spur into a new terminus station.
- 4.1.2 There would also be new interchange stations at Old Oak Common in west London and on the eastern outskirts of Birmingham. The station at Old Oak Common would allow people to transfer between HS2 and services to Heathrow (via Crossrail and Heathrow Express) and South Wales and the west of England (via the Great Western Main Line).
- 4.1.3 Between Euston and Old Oak Common the scheme would be in tunnel and would require three emergency intervention and ventilation shafts, one approximately every 2km. These would service the HS2 tunnels, as well as the HS1 link which would run broadly parallel with them. The line through Old Oak Common station would be in an open box structure and would then follow the Northolt corridor, a 14km stretch between Park Royal (just beyond Old Oak Common) and West Ruislip Station. The route would be on the surface alongside the existing London Underground Central Line to Ruislip. It would follow this route as far as West Ruislip having now also converged with the Chiltern Line corridor. Beyond West Ruislip station, the proposed scheme would diverge north-westwards across the Colne Valley towards the Chilterns.
- 4.1.4 Junctions at Northolt, West Ruislip and at a location between the Colne Valley and the M25 would be included in the designs where the proposed route passes to the north of Heathrow. These would allow the extension of a direct spur to Heathrow to be constructed as part of the second phase of the Government's proposed strategy for a national high speed network.
- 4.1.5 The proposed scheme would be in tunnel under the south-eastern part of the Chilterns, entering just to the east of the M25 and emerging to the west of Amersham. It would follow the A413 corridor mostly in cutting before passing to the south-west of Wendover and Aylesbury. The surface route would continue across Buckinghamshire and the north-east corner of Oxfordshire into Northamptonshire, passing to the east of Brackley.
- 4.1.6 The scheme would pass to the east of Banbury and to the south-west of Southam and between Coventry and Kenilworth before passing to the north-east of Balsall Common to join the M42 corridor near junction 6 (A45).
- 4.1.7 An interchange station on the outskirts of Birmingham would provide a connection to the NEC and to Birmingham International Airport. At Water Orton (north of Coleshill), a junction would provide the spur into central Birmingham. The spur line would follow the existing rail corridor into central Birmingham where a new terminus station would be provided at Curzon Street. It would also provide access to a train maintenance depot in the Washwood Heath area.
- 4.1.8 The main HS2 line would continue north from Water Orton passing to the west of Tamworth and to the east of Lichfield before linking into the WCML.



Aerial view of proposed Washwood Heath depot site [HS2 Ltd]

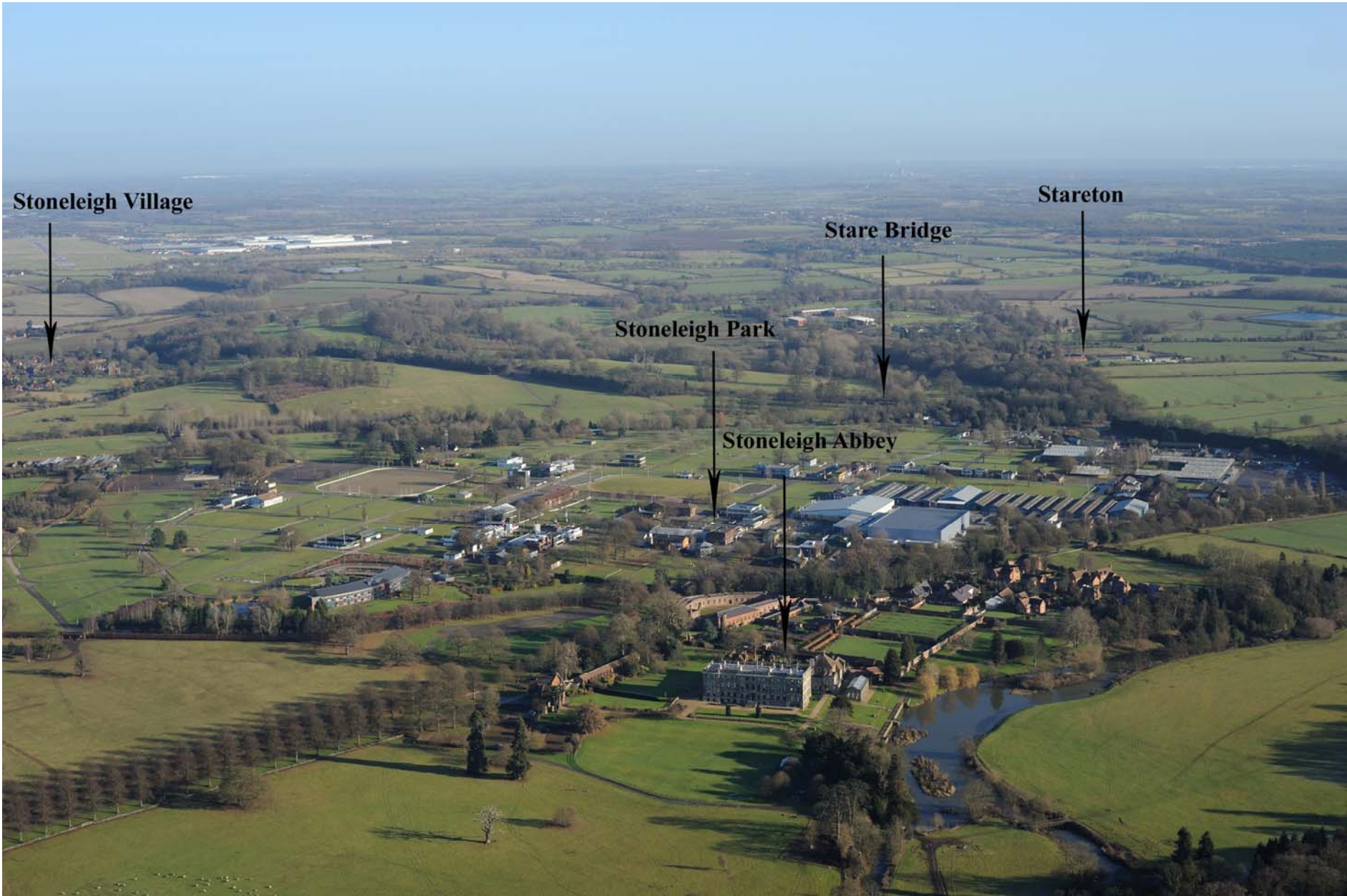


Changes incorporated within the proposed route from that published in March 2010

The proposed scheme incorporates a number of changes to the one published in March 2010 that help to reduce its environmental impacts.

- Minor changes on the route in the Northolt area would help to reduce landtake from properties next to the route and to avoid the need to reconstruct one of the road bridges over the railway at Hanger Lane, a major road junction between the A40 and the North Circular Road (A406). A new surface proposal in this area would see the HS2 tracks pass under the Chiltern Line junction, which is to be remodeled as part of the Chiltern Line upgrade (Evergreen 3 Scheme). The new Chiltern Line would pass over HS2 on a low viaduct.
- Between Old Amersham and Little Missenden, the cutting would be covered to form a green bridge so allowing continued access over the railway and minimising visual impacts. It would also now largely preserve the landscape and wider setting of the historic stately home of Shardeloes. The short tunnel north of Little Missenden would be lengthened slightly.
- Past South Heath in the Chilterns, the proposed route has been lowered by about 5m and covered by a 900m long green bridge, screening the most densely populated part of the village from noise, maintaining views south of the village, avoiding raised bridge structures over the railway and mitigating noise and visual impacts on a number of dispersed farms and houses.
- Near Aylesbury the proposed route past Hartwell House has moved eastwards by 75m to 85m to reduce impacts on views from the stately home. This route would avoid some of the more mature trees and would be easier to integrate into the landform. The realignment would bring the line slightly closer to the outskirts of Aylesbury.
- The proposed route has moved eastwards away from Mixbury to pass in deep cutting east of Turweston and further east of Brackley and Greatworth. It would be a little closer to Radstone but in deeper cutting. This would help to reduce noise and visual impacts at Mixbury, Turweston, Brackley and Greatworth and would avoid the proposed development area north and east of Brackley. It would, however, now affect a SSSI on a disused railway that was previously avoided.
- Between Greatworth and Wormleighton the proposed route has moved some 100m north-east, thus avoiding the impacts on the Grade I listed Edgcote House and its ornamental lake, but now physically impacting the site of a protected Roman villa. A new green bridge at Chipping Warden is now also proposed.
- The proposed route has moved eastwards away from the village of Ladbroke to a position halfway between Ladbroke and Southam. It avoids the flood plain and with it, the need for a lengthy elevated viaduct across the open valley. Although now closer to Southam, the surface alignment would be easier to screen using earth bunds that better fit this rural location.
- Near Kenilworth, the proposed alignment has been lowered by some 5m to 10m and moved slightly westwards. This would greatly reduce severance of the historic parkland at Stoneleigh and maintain the outlook of the protected monument of Stare Bridge. The route moves further away from Stoneleigh Village, but closer to the eastern edge of Kenilworth and Cubbington, requiring more detailed noise and landscape mitigation. The proposed route now avoids the historic hamlet of Stareton and reduces landtake from Long Itchington and Ufton Woods SSSI. It would, however, demolish a listed building; and it would have a bigger impact on the Stoneleigh Park Exhibition and Conference Centre.
- At Burton Green, a lowered alignment and the introduction of a green bridge would reduce impacts on the village and provide noise and visual mitigation.
- Between the village of Hints in Staffordshire and HS2's connection with the WCML, the proposed route has been moved eastwards, further away from Lichfield. This would reduce potential noise and visual impacts. The proposed connection of HS2 with the WCML has been moved some 1.5km northwards.

Aerial view of Stoneleigh Park [HS2 Ltd]



5 The Appraisal of Sustainability (AoS) process

- 5.1.1 To determine the extent to which the proposed scheme may be considered a sustainable development it was necessary first to define 'sustainability' as it is relevant to high speed rail. The AoS process has adapted for its own use the four sustainable development priorities from the *UK Sustainable Development Strategy: Securing the Future*¹. These have formed the overarching structure for considering sustainability impacts.
- 5.1.2 The AoS then used a series of increasingly more detailed issues, objectives and criteria that further defined the concept of sustainability and helped to appraise the impacts and benefits of the scheme. The four main sustainability headings and their underlying issues and objectives are shown below. These were discussed and agreed with government departments and key environmental bodies at the commencement of the AoS.

Key sustainability issue	Sustainability objective
1. Reducing greenhouse gas emissions and combating climate change	
Climatic factors and adaptability	<ul style="list-style-type: none"> Improve resilience of rail network against extreme weather events
Greenhouse gases	<ul style="list-style-type: none"> Contribute to the reduction of greenhouse gas emissions by facilitating modal shift from road and air to rail Reduce relative contribution made by rail to greenhouse gas emissions by promoting energy efficient technologies
2. Natural and cultural resource protection and environmental enhancement	
Landscape and townscape	<ul style="list-style-type: none"> Maintain and enhance existing landscape character Maintain and enhance existing townscape character
Cultural heritage	<ul style="list-style-type: none"> Preserve and protect archaeological assets Preserve and protect historic buildings Preserve and protect historic landscapes
Biodiversity	<ul style="list-style-type: none"> Maintain and enhance biodiversity
Water resources	<ul style="list-style-type: none"> Protect surface water resources Protect groundwater resources
Flood risk	<ul style="list-style-type: none"> Conserve and enhance the capacity of flood plains
3. Creating sustainable communities	
Air quality	<ul style="list-style-type: none"> Maintain and enhance local air quality
Noise and vibration	<ul style="list-style-type: none"> Maintain and enhance the local noise environment Maintain the local vibration environment
Community integrity	<ul style="list-style-type: none"> Maintain and enhance community integrity
Accessibility	<ul style="list-style-type: none"> Maintain and enhance pedestrian access Maintain and enhance access to public transport Maintain and enhance public transport interchange
Health and well-being	<ul style="list-style-type: none"> Maintain and improve mental well-being Maintain and improve physical health Reduce health inequalities

¹ *Securing the Future*, produced by the previous Government, provided the policy framework for consideration of sustainability issues throughout the course of the HS2 scheme design.

Key sustainability issue	Sustainability objective
Security and safety	<ul style="list-style-type: none"> Contribute to the reduction of road traffic accidents Protect against crime and fear of crime
Economic prosperity	<ul style="list-style-type: none"> Support economic competitiveness and make efficient use of public funds Support wider economic growth and maintain and enhance employment opportunities
Economic welfare	<ul style="list-style-type: none"> Support wider economic welfare growth Support planned developments Maintain and enhance regeneration
4. Sustainable Consumption and Production	
Soil and land resources	<ul style="list-style-type: none"> Maintain and enhance land resources Encourage the use of brownfield sites
Waste generation	<ul style="list-style-type: none"> Prevent and minimise waste production
Resource use	<ul style="list-style-type: none"> Conserve and protect primary material resources

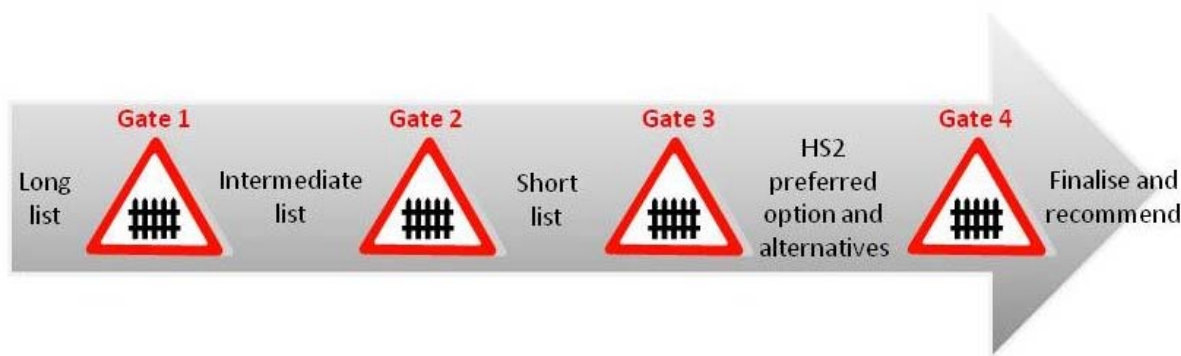
6 The AoS and consideration of alternatives

6.1 Strategic and route alternatives

- 6.1.1 The Government considers that increasing demand will create a need over the next twenty to thirty years for additional capacity to cater for inter-city journeys between London and the major conurbations in the Midlands and the North. It does not, however, believe transferring rail demand to road travel or domestic aviation to be an appropriate solution. It also considers that the benefits of a new high speed rail network would be significantly greater than those offered by any other option. These matters are described in more detail within *High Speed Rail Strategic Alternatives Study: Strategic Alternatives to the proposed Y Network*.
- 6.1.2 The Government's proposed scheme is the product of some two years of work by HS2 Ltd to examine a large number of possible alternative routes and stations. This preference reflects its strategic transport and economic merits, its operational capabilities, the practicalities and costs of building it, its sustainability performance and its overall environmental impacts. The main alternatives that have been considered are reported in the consultation document, *High Speed Rail: Investing in Britain's Future*.

6.2 AoS support to option development

- 6.2.1 A large number of possible options were developed for HS2, including termini in London and the West Midlands and approaches to these, lines of route between them, and stations in between. Work on HS2 culminated at the end of 2009 in the identification of a scheme between London and the West Midlands, which HS2 Ltd preferred because of the clearest overall benefits it was considered to offer. A number of possible alternatives and additions to this scheme were also proposed.
- 6.2.2 However, to get to this stage, a detailed sifting of options was required. This involved a successive reduction in the number of options over three stages, marked by a series of 'gates' at which HS2 Ltd agreed on options which merited further appraisal.



- 6.2.3 The AoS has provided input to the development and evaluation of options at each stage by highlighting their relative performance against the stated sustainability objectives.
- 6.2.4 It was important to feed in appraisal information to the design at the right level of detail and at the right time. At the outset, designs amounted to a large number of possible line options. The AoS provided fundamental information about environmental and community features along the notional routes and gave information about the relative importance of the main features and the impacts on them. As a result, sustainability considerations contributed to the decisions about which routes and station options should be taken forward for further appraisal.
- 6.2.5 At the next stage more detailed designs were developed showing more precisely where route options passed, whether these were on embankment, viaduct, cutting, tunnel or at grade. This supported a more detailed appraisal of most of the sustainability issues where information was available.
- 6.2.6 Following publication of the HS2 Summary Report in March 2010, HS2 Ltd has undertaken several rounds of further design work and option comparison, prompted by requests from both the previous Government and the current Government. Sustainability impacts have continued to be a key consideration in this work, and indeed have prompted much of this work in the first place.

7 Mitigating impacts

- 7.1.1 During the options sifting process, the AoS process helped to bring about specific changes to certain options; for example: speed considerations on the approaches into London to limit noise impacts; avoidance of properties and key features such as listed buildings and SSSIs along the line of route; and through the Chilterns where route options were modified to reduce possible adverse impacts on landscape. It is expected that continued refinement would enable these and other impacts to be reduced further.
- 7.1.2 If the proposed scheme is taken forward, the design would be developed further. This would allow more detailed mitigation proposals and confirmation of specific construction techniques. Such mitigation options cannot be identified in full or committed to at this stage, since they rely on design detail that has not yet been developed. However, such mitigation options, examples of which are given in the main report, are all measures that have been applied successfully on other rail schemes, including HS1. HS2 Ltd would look to build on experience and best practice both on HS1 and other more recent rail projects.
- 7.1.3 The next four sections summarise the main sustainability effects of HS2 under the headings of climate change, natural and cultural resources, sustainable communities and sustainable consumption and production.

8 HS2 and climate change

- 8.1.1 The appraisal considered climatic factors in two ways: the impact that a changing climate might have on HS2 and the impact HS2 itself might have on climate change.

8.2 Resilience to climate change

- 8.2.1 The future climate in Britain over the next 50 years or so, when HS2 could be in operation, is likely to be different from now – with generally hotter, drier summers and warmer, wetter winters combined with a possible increase in extreme weather events. To help ensure the climate resilience of HS2, it would be designed, built and operated to take account of projected impacts of climate change over the scheme's operational lifespan. In particular, in areas already likely to flood now and increasingly so in the future, HS2 would be constructed on viaduct. Additional protection would be given to particularly vulnerable parts of the network such as tunnel entrances and electricity supply locations.

8.3 Greenhouse gases

- 8.3.1 The rail sector is a relatively small contributor to greenhouse gases and gives rise to some of the lowest per-passenger CO₂ emissions compared with other transport modes. The impact of HS2 on climate change would depend on the amount of CO₂ it would produce, both from construction and operation, compared with the amount it would save by attracting people away from more carbon polluting forms of transport. This is very difficult to predict as it relies heavily on other factors beyond the control of HS2. Relatively modest CO₂ savings would be likely to come from people moving from road to rail. However, the biggest CO₂ savings would come from attracting air passengers to HS2, as air domestic travel gives rise to very high CO₂ emissions. Because of the faster journeys that would be offered by HS2 on the high speed leg between London and the West Midlands, some people making journeys between London and Manchester or Glasgow would use the train in preference to flying. A reduction in emissions would, however, only be realised if the number of domestic flights was reduced as a result and if the landing and take-off slots that were freed up were not then used for wholly new international flights (i.e. not displaced from other airports).
- 8.3.2 Were HS2 to extend further north, journeys would become even quicker which would encourage more air passengers to switch to high speed rail. As a result the potential carbon benefits of HS2 would be expected to be greater.
- 8.3.3 The way that electricity used to power the trains would be generated is also a consideration. The Government has ambitious plans to increase the contribution of renewables and nuclear generation at the expense of burning fossil fuels, such as coal and gas. Depending on how successful this is, it would have a significant influence on how much CO₂ HS2 produces.
- 8.3.4 Taking all of these into account, HS2 could result in either an increase or a decrease in CO₂. At worst, over 60 years HS2 could result in an overall increase in CO₂ emissions of 24 million tonnes; at best it could result in an overall decrease of 27 million tonnes. Whichever scenario takes shape, the contribution of HS2 would be insignificant when compared to other transport, especially conventional road vehicle emissions in the UK.

9 HS2 and the natural and cultural environment

9.1 Landscape, townscape and cultural heritage

- 9.1.1 Along the proposed route of HS2 between London and the West Midlands there are areas of dense urban development including historic quarters and suburbs. And there are areas of countryside, including the broad valley of the River Colne, the Chiltern Hills, the agricultural expanse of the Vale of Aylesbury, the Northamptonshire Uplands that extend north from the Cotswolds and the wooded farmland of Dunsmore and Arden around Coventry.
- 9.1.2 A key landscape impact from HS2 would occur in the Chiltern Hills, much of which are designated an AONB. These extend for some 75km between Hitchin in the north and the River Thames in the south. Any direct route between London and the West Midlands would inevitably need to pass through this area. Considerable work was undertaken initially to ensure any adverse changes to this nationally protected landscape would be minimised. As a result, some 6.5km of the proposed route would be in tunnel, over 5km would be alongside the A413, and over 9km would be in cutting, which would reduce views of the scheme.

Cuttings would help to integrate HS2 into the landscape [Arup]



- 9.1.3 A number of refinements to the scheme design have further reduced potential impacts; for example lowering the proposed route so that it sits more within the landscape, and introducing 'green bridges' at Little Missenden and South Heath. Overall, of the 20.5km of railway through the AONB all but 2km would benefit from being in tunnel, cutting and/or existing transport corridor. Extensive tree planting, as well as the creation of planted earth

bunds, carefully blended into the landform, would help to screen views and integrate the railway into the landscape.

- 9.1.4 Within the Chilterns a protected Iron Age bank and ditch known as Grim's Ditch would be directly affected. Further north-west, near Banbury, realignment of the scheme to reduce its impacts on the Grade I listed Edgcote House has resulted in the route impacting the protected site of a Roman villa.
- 9.1.5 Impacts on townscape would generally be avoided with few areas of particular note potentially affected. At Euston a large new station would involve a major change within an area where numerous listed buildings and conservation areas reflect the area's long history of settlement and its importance as a railway terminus. A large number of demolitions would be required and this, together with a new station building, would result in townscape change that could affect views from conservation areas. This could result in both adverse and beneficial change, depending on the design of any new structures and the location and setting of the existing buildings potentially affected. With the removal of certain buildings, such as the existing station concourse, and the implementation of high quality and sensitive redevelopment there is potential for enhancement of the local setting.
- 9.1.6 Direct adverse impacts would include loss of some locally important features, such as the majority of St James Gardens and six Grade II listed buildings and structures. The Euston Square Gardens in front of the existing station would be retained, as would the Grade II* listed 194a Euston Road, although it would be very close to the new station and, as it is attached to the Grade II listed 9 Melton Street which would be demolished, would require very careful protection during construction. The new station concourse would offer opportunities to create a more open route through an area severed by the existing station building.
- 9.1.7 The London Borough of Camden has set out a vision for wider change in this area and proposes to use a new station as a springboard for local regeneration. This would be expected to yield substantial improvements through the redevelopment of more run-down parts around the station, and there is a clear opportunity to ensure that HS2 both develops in harmony with these and stimulates positive townscape change.
- 9.1.8 The proposed new buildings and compounds constructed over the ventilation shafts for the London tunnels would give rise to some visual impacts for nearby residents, but the sites are generally amidst industrial land uses and/or close to existing railway. Over the Chilterns tunnel, there is greater scope to vary the location of shaft site compounds. The areas currently proposed have been selected to minimise environmental impact but further work would be undertaken to refine these locations and layouts.
- 9.1.9 West of Old Oak Common the new surface route would run on the north side of the existing Northolt corridor. The widening of the rail corridor would be needed in places. A focus of recent attention by HS2 Ltd has been to reduce potential landtake as far as possible, but a number of demolitions between here and West Ruislip would still be required.
- 9.1.10 Several protected stately homes and grounds lie near to the proposed route, and considerable work has been undertaken to mitigate potential impacts to these. Shardeloes near Amersham, Hartwell House near Aylesbury and Stoneleigh Abbey near Kenilworth, would all now be protected through changes in the alignment and, at Shardeloes, the use of a green bridge structure over the railway. At Stoneleigh, the revised alignment would now avoid the village of Stareton, and, although closer to the listed and scheduled Stare Bridge, the bridge would be well screened by woodland. The connection between the bridge and Stoneleigh village would also now be maintained. However, a Grade II listed building would be demolished.
- 9.1.11 A Grade II listed barn at Lavender Hall Farm in Berkswell would be likely to be demolished, with potential adverse impacts on the settings and context of the Grade II* listed Lavender

Hall farmhouse. A Grade II* listed farmhouse at Hampton in Arden, is close to the proposed car park for Birmingham Interchange Station, and construction would need to be carefully managed to minimise potential impacts on this building. Impacts on the setting of this building would occur however.

- 9.1.12 In Birmingham the Curzon Street terminus lies within a townscape whose immediate character has declined in recent years. HS2 would result in a number of demolitions, including three Grade II listed buildings, as well as some modern structures. However, the area is subject to extensive redevelopment as part of the Birmingham Eastside proposals. These would be significantly affected by HS2, but this could result in improvements to the townscape were the two schemes to be coordinated; indeed the City Council has commissioned a new Masterplan to reconfigure proposals around HS2.

9.2 Wildlife and biodiversity

- 9.2.1 Early route development has managed to avoid most potential impacts on designated habitats and sites. No sites of international significance would be adversely affected and impacts to nationally protected sites would be restricted to just a few locations: river crossings at the Colne Valley and River Blythe would have small impacts on SSSIs here, but designs would seek to minimise these. The potential impact previously envisaged at Long Itchington and Ufton Wood SSSI would now be largely avoided through extension of the proposed tunnel beneath them. However, south of Radstone, a realignment to take the proposed route away from settlements results in it crossing in cutting the southern end of the Helmdon Disused Railway SSSI. There could be minor landtake from Sheephouse Wood SSSI.
- 9.2.2 A number of impacts on local and regional sites are also likely, including some loss of ancient woodland in the Chilterns. As the design develops it would seek to reduce these effects.
- 9.2.3 Landscape mitigation involving planting over two million trees, as well as other opportunities for habitat creation and extension, would result in benefits for wildlife that would help offset some of these adverse effects.

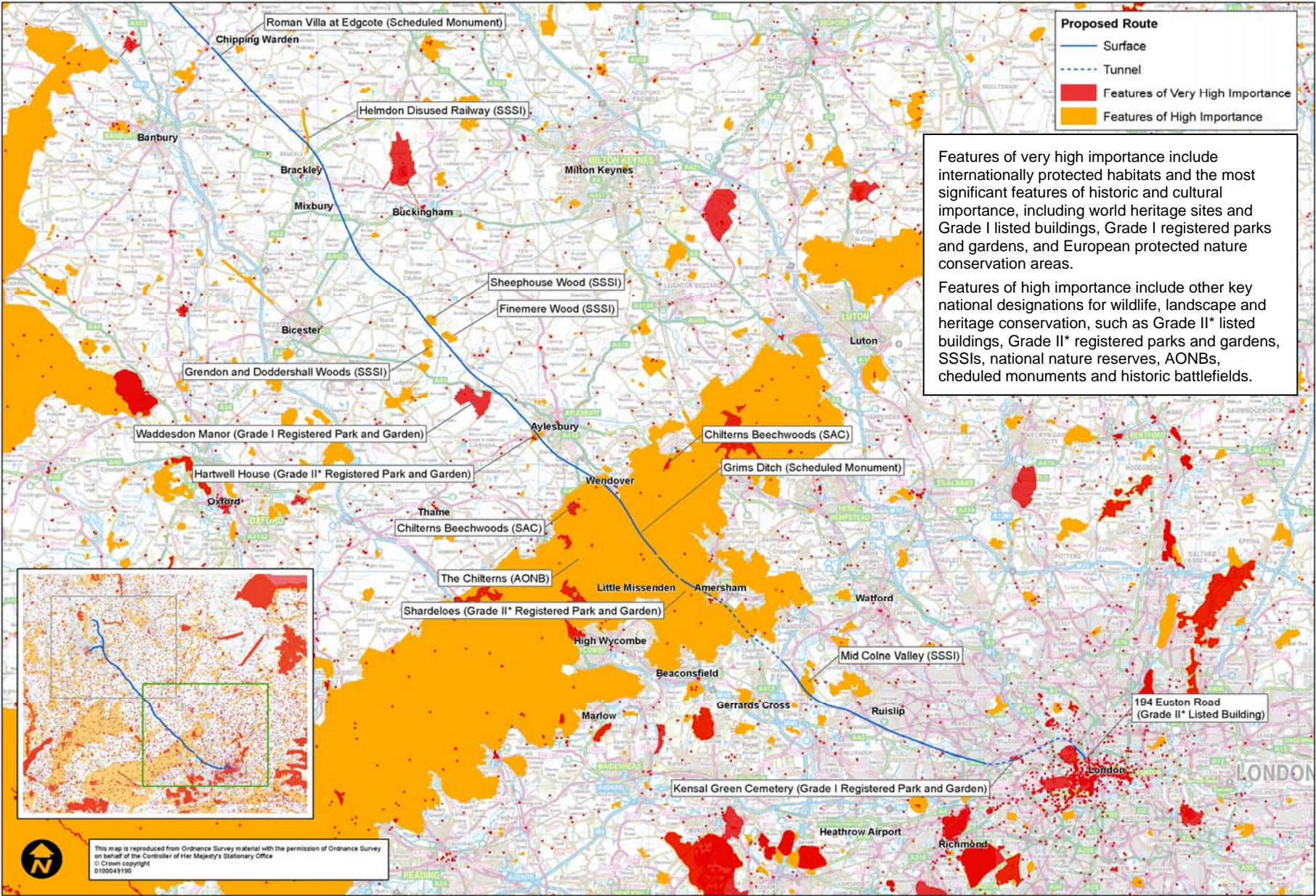
A tunnel like this on HS1 would take the proposed scheme beneath Long Itchington and Ufton Wood [Arup]



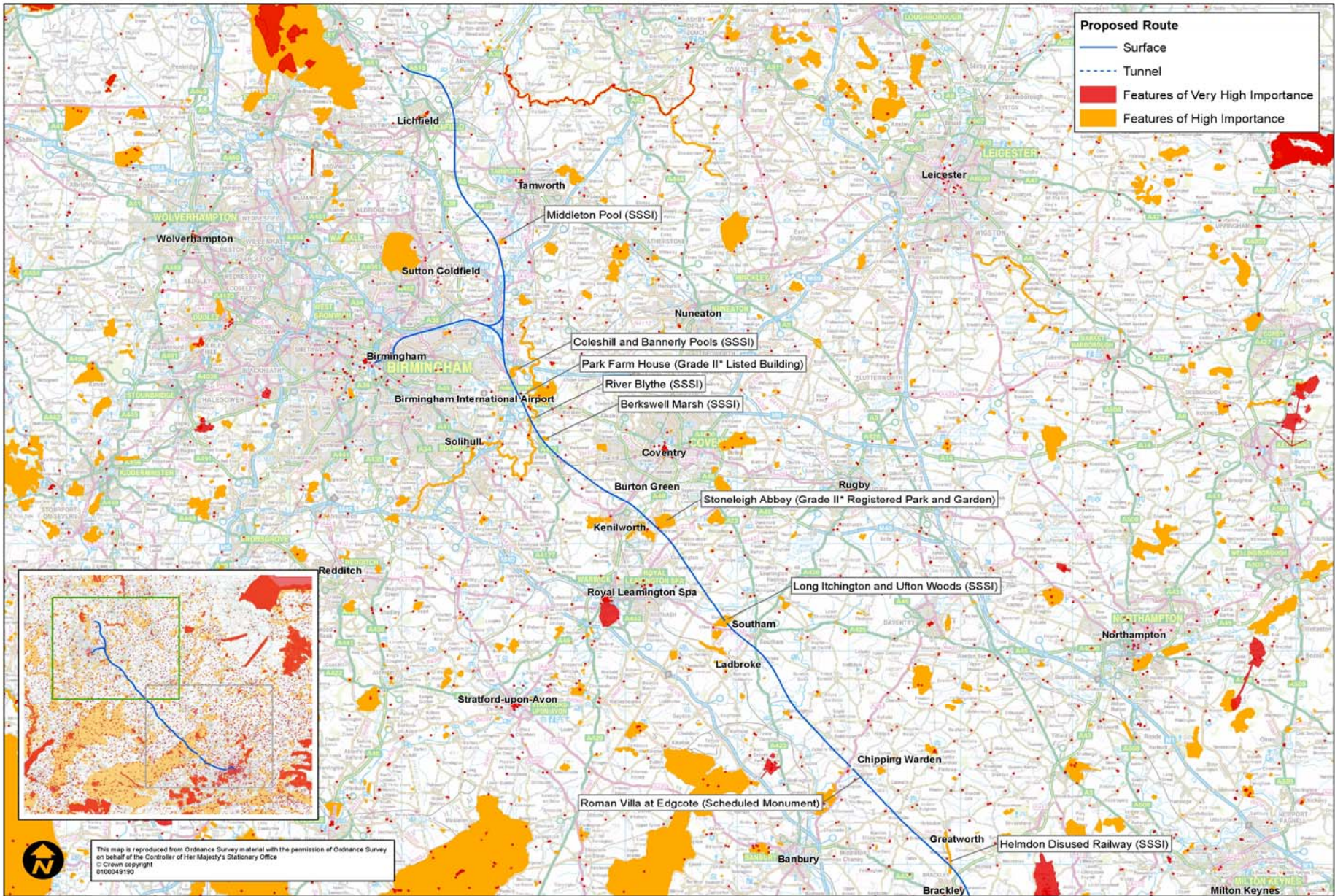
9.3 Water and flooding

- 9.3.1 Direct impacts on water resources such as rivers, streams, lakes and underground water supplies (aquifers) have been avoided where possible. But these features are numerous between London and the West Midlands and are difficult to avoid completely. It is possible that adverse impacts may arise at locations where rivers would be crossed. Where the proposed route could interrupt flows into rivers, river diversions would be undertaken; for example for short sections of the Colne, the Cole, the Tame and the Rea. The necessary protective action would be taken in order to avoid or minimise any adverse impact on water quality.
- 9.3.2 Passage of the proposed scheme over or through aquifers or areas with vulnerable groundwater would require careful management and mitigation in accordance with current best practice. This would be the case in particular across the Colne Valley, and between Brackley and Kenilworth, where there are important aquifers.
- 9.3.3 HS2 would also cross areas that are at a relatively high risk of flooding. The railway would be raised onto low piers to ensure flood water is not impeded or diverted and that the scheme does not increase flood risk to other areas and communities. In total the proposed route passes across 16km of the highest flood risk areas.

Key sustainability features along the proposed scheme (south)



Key sustainability features along the proposed scheme (north)



10 HS2 and Sustainable Communities

10.1 Impacts on properties

- 10.1.1 Private home-owners whose properties would need to be demolished to make way for the proposed scheme would be compensated through compulsory purchase procedures. The main area of demolition would be at Euston with approximately 190 residential dwellings in the Regents Park Estate affected by the loss of four blocks of flats. Approximately 25 further dwellings and a community hall in the area would also be demolished and a large part of St James Gardens would be lost. Residents of some further 170 dwellings would have their living conditions potentially affected by proximity to the railway. People living here are in a relatively more deprived part of the country and this is likely to make them and the communities they live in particularly vulnerable to these impacts. HS2 Ltd would be committed to working closely and at an early stage with the London Borough of Camden and the GLA and with community groups, residents' associations and affected residents generally to ensure that effective arrangements are in place to meet the housing needs of those affected by demolition of these dwellings, and to help to address wider impacts on the local community. Agreement of a joint ambition for the Euston area would form part of this work, and would include, amongst other things, replacement of the open space lost at St James Gardens.
- 10.1.2 Approximately 20 demolitions, including an estimated seven dwellings, would be required to construct the vent shaft at Alexandra Place West.
- 10.1.3 At Old Oak Common, approximately 25 dwellings would be at risk of landtake from shallow tunnels to the west of the railway lands, although it may be possible to avoid these. Other communities affected by potential demolitions include those along the route between Old Oak Common and West Ruislip where around 15 residential properties would be demolished.
- 10.1.4 Along the route between the M25 and M42, through Buckinghamshire, Northamptonshire, Oxfordshire and Warwickshire, residential demolitions are limited to approximately 35.
- 10.1.5 In Birmingham, 32 dwellings would be demolished for a new depot along with a number of commercial properties, which would require close working between HS2 Ltd, the local authority and local residential and business community. Five student accommodation blocks would be demolished within central Birmingham to make way for the new terminus station at Curzon Street.
- 10.1.6 In a few places the route of HS2 could impose a sense of isolation for residents where properties become 'islanded' by HS2 in combination with roads and other railways, although physical access to these areas would be maintained. Recent revisions to the scheme design have significantly mitigated these impacts. Residual impacts remain in the West Midlands in the Hampton-in Arden and Water Orton areas, where approximately 40 and 30 dwellings respectively would be affected. These are already subject to significant levels of physical isolation from existing roads

Aerial view of proposed Curzon Street station site [HS2 Ltd]



10.2 Environmental impacts on people

- 10.2.1 The most densely populated areas occur in London and its north and west outskirts, and in Birmingham and its outskirts. Other key settlements near the proposed scheme include Amersham, Wendover, Aylesbury, Brackley, Leamington and Kenilworth. In total, some 7,400 dwellings are located within 100m of the proposed surface route. Many would be largely unaffected by the scheme, but at this stage of the appraisal, these dwellings are considered to be at a risk of disturbance, particularly during construction. As such HS2 Ltd would use control measures consistent with best practice to ensure that impacts from construction activity, such as noise or dust, were kept as low as possible.
- 10.2.2 Similarly, during operation, railway noise could affect people living along the proposed route. Further appraisal work has made assumptions about what could realistically be achieved through additional mitigation, such as noise barriers and bunds. On this basis 'high' noise levels (i.e. greater than an equivalent average of 73dB(A)²) would affect fewer than 10 dwellings. In addition, it is considered that approximately 150 properties would be likely to qualify for noise insulation i.e. secondary glazing and ventilation or grant to implement such mitigation. There are up to 4,700 dwellings identified on the proposed route corridor that would be likely to experience a noticeable (although not necessarily significant) noise change, meaning both a noise increase of 3dB(A)³ or more and a resultant daytime noise level of 50dB(A)⁴ or more. Determination of significant effects would be undertaken during formal environmental impact assessment were the scheme to be progressed further.
- 10.2.3 Experience from HS1 and other high speed railways has shown that potentially significant effects from vibration and ground-borne noise (audible vibration) in properties over tunnels can be avoided. Using specially designed and mounted tracks such impacts are not expected in residential areas in London. For the Chilterns tunnels, mitigation of potentially adverse effects at dwellings closest to the tunnel and at certain other sensitive facilities would be more challenging, due to the faster trains through these areas and the nature of the chalk geology. But again, major project experience suggests that mitigation would be possible and HS2 Ltd is committed to ensuring that no such impacts occur.
- 10.2.4 In terms of air quality, HS2 would be electrically powered and so would not directly result in air pollution; impacts at the power stations used to generate the additional electricity for the service would not be significant. There is a risk that, at HS2 stations, increases in road traffic might cause more local air pollution, but this is not expected to be significant as most stations would have good public transport links. Change in the number of vehicles on motorways as a result of people opting to travel by train in preference to car would not be sufficient to have any noticeable impact on air quality.

10.3 Access to public transport

- 10.3.1 As well as people in London and Birmingham, those in Liverpool, Manchester and Glasgow would also have access to HS2 from the day of opening through connection to the WCML, representing a significant proportion of the UK population. Other people would benefit from the new services that are anticipated on the WCML between Lichfield and London to fill the slots vacated by current fast inter-city services.
- 10.3.2 At Euston there would be an interchange with other surface rail, as well as with London Underground and bus services. At Old Oak Common a major new interchange would allow access to Crossrail and, as a result, to Heathrow, as well as domestic and international

² Total equivalent ('average') daytime noise levels ($L_{Aeq,18hr}$)

³ 3dB is a just perceptible change in total noise over an assessment period.

⁴ 50dB(A) is based on a World Health Organisation threshold, below which few people would be expected to be 'moderately annoyed'.

surface rail and underground rail services. Birmingham Interchange would offer access to aviation, bus and rail services. Birmingham Curzon Street would offer interchange with rail, bus and proposed future metro services. The scheme may also offer opportunities to improve existing interchange arrangements at HS2 stations by providing enhanced passenger facilities, traveller information, more station staff and other aspects to improve the interchange experience.

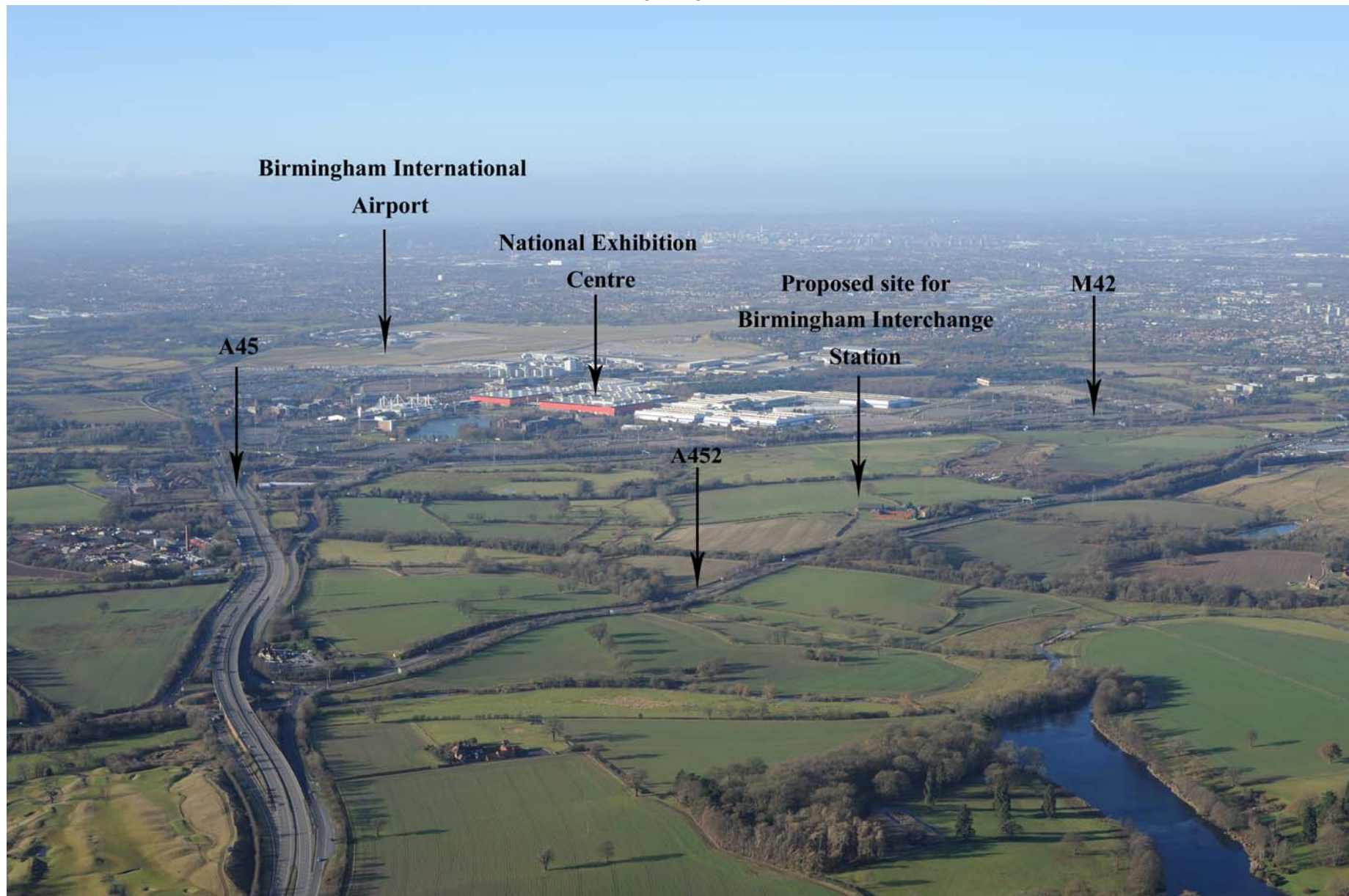
10.4 Health and well-being

- 10.4.1 Effects on people's health and well-being, both beneficial and adverse, would potentially result from other impacts – chiefly environmental impacts, property impacts and socio-economic impacts.
- 10.4.2 Benefits would stem from improvements in accessibility (described above) and through the economic prosperity and welfare brought about by the scheme (described below). In addition, journeys would be expected to be more enjoyable, as they become quicker (on a new HS2 service) and less crowded (on existing services). All of these benefits could have secondary benefits for health and well-being.
- 10.4.3 Risks to health and well-being would stem from single issues such as demolitions or operational noise, or where these different impacts cumulatively affect people. This risk is considered to be highest around Euston station, where demolitions on the Regents Park Estate would affect a community with a high level of dependencies on local services or social infrastructure. A commitment to careful and sensitive management to ensure that this impact is minimised would be required. Local authority plans for the improvement and development of this area, supported by HS2, are likely to see eventual wider improvements.
- 10.4.4 Apart from these general matters, particular risks may arise for individuals or groups at relevant locations, such as elderly or disabled persons who may be disproportionately vulnerable to health-associated impacts. The locations of people within these categories cannot be known at this stage, but the risk of differential impacts would be addressed through further stages of appraisal and assessment.

10.5 Economic impacts

- 10.5.1 HS2 would enhance economic competitiveness, support wider economic growth and bring about enhanced employment opportunities. In supporting economic competitiveness, the potential benefits to businesses arising directly from the faster journeys enabled by HS2 are valued at some £11.0 billion over 60 years.
- 10.5.2 HS2 would also free up space on the WCML for new rail services. This would benefit business, especially for trips originating in London, which would give rise to a little over a third of these benefits; about a quarter of the benefits would derive from trips commencing in the North-west and about a fifth from trips originating in the West Midlands.
- 10.5.3 There is potential for HS2 to encourage businesses, directly and indirectly, to grow and prosper around locations served by improved rail services. Businesses in London and Birmingham would be able to draw on a workforce from a wider area to the benefit of both the businesses and the workforce.
- 10.5.4 Further economic benefits could accrue by HS2 effectively bringing cities closer together. It could also result from the clustering of businesses (as well as workforces) around HS2 and, particularly, WCML stations, and which would operate more efficiently and competitively by being close to one another. These benefits could be worth a further £3.0 billion over 60 years. By opening up areas to the effects of wider competition and wider markets, a further £1.0 billion of benefits could accrue.

Aerial view of proposed Birmingham interchange station site [HS2 Ltd]



- 10.5.5 HS2 would also be expected to benefit people making commuting, leisure and other personal journeys. Over 60 years this is estimated to be worth some £6.4 billion of additional benefits. In total, when these are added to business and other benefits to the economy, and benefits from reduced accidents and better air quality are taken into account, gross economic benefits for the wider UK community are estimated to be £21.8 billion over 60 years.
- 10.5.6 HS2 stations within or near areas of deprivation would bring about some local job opportunities. But greater employment opportunities would derive from the regeneration stimulated around the HS2 stations. These opportunities would provide greatest benefit for residents outside the immediate station catchment rather than the existing local residents, particularly at Euston and Birmingham Curzon Street. Enhanced commuter services on the WCML and better connections with London and Birmingham would, similarly, support local development around stations and the social and economic benefits that this results in.
- 10.5.7 The best regeneration opportunity would be around the proposed Old Oak Common station, where wider access to Heathrow, central London and London Docklands through the interchange with Crossrail, would be a particular incentive for local development and growth.
- 10.5.8 At Curzon Street, the proposed new station and railway would conflict with developments currently planned within Birmingham Eastside, including the major office, retail and leisure proposals, and new facilities for Birmingham City University. However, the city council is revising the Masterplan for Eastside to take account of HS2, which would see significant overall benefits building on the regeneration stimulated by a new high speed service.
- 10.5.9 In supporting planned employment growth in London and the West Midlands, the potential for some 30,000 jobs around HS2 stations (2,000 at Euston; 20,000 at Old Oak Common; 3,800 at Birmingham Interchange and 4,500 at Curzon Street) has been forecast.
- 10.5.10 The proposed scheme is also expected to provide the equivalent of 1,500 permanent jobs, including an estimated 250 at Euston, 90 at Old Oak Common, 250 at the maintenance depot at Calvert, 300 at the rolling stock depot at Washwood Heath and 120 at Birmingham Curzon Street station. An estimated 9,000 jobs would also be created during construction. For operational employment, it is not clear at this stage what proportion represents new job opportunities in the rail sector.
- 10.5.11 HS2 would displace a number of businesses and associated jobs, for example at Washwood Heath and Old Oak Common. However, it is likely that many of these displaced jobs would be re-established elsewhere. Close working between HS2 Ltd, local councils and local businesses would be undertaken to reduce the potential for adverse impacts on those affected.

11 HS2 and sustainable consumption and production

- 11.1.1 HS2 would affect the land resource both adversely and beneficially. It would result in a number of previously developed 'brownfield' sites, totalling at least 146 hectares in extent, being brought back to productive use, with others potentially be identified through more detailed study at a later stage.
- 11.1.2 Although it would affect none of the most productive Grade 1 farmland, it would cross some 20km of slightly less productive Grade 2 farmland. Further work will be undertaken during later design stages to examine how as much as possible of the agricultural land affected by the proposed route could remain in production. The only significant impact to green belt is likely to arise around the Birmingham Interchange Station, where an area would be lost to accommodate the station and associated facilities. In terms of the waste generated by the scheme, mostly during its construction, almost two million cubic metres of spoil would arise

from tunnel excavation. HS2 Ltd would seek to re-use as much of this as possible within the scheme design, for embankments and landscape proposals. Opportunities would be sought to use any residual spoil within other schemes and proposals; disposal to landfill would be used as a last resort.

12 Further mitigation and monitoring

- 12.1.1 The mitigation of adverse impacts has been fundamental to HS2 Ltd since work to identify and design a proposed scheme commenced in spring 2009. In the development of HS2 to date, mitigation has focused on avoiding impacts (mostly through option selection and through the use of tunnels and changes in horizontal and vertical alignment) and minimising impacts; for example, through reducing the width of the rail corridor within sensitive environments to minimise landtake. As the general alignment becomes fixed and the design more detailed, further opportunities to mitigate would be sought through the abatement of impacts (for example through the use of noise barriers or landscape planting), the remediation of impacts (for example by recreating habitat that becomes damaged) or through compensation (for example by compensating business losses following land acquisition or by creating new habitat elsewhere).
- 12.1.2 HS2's impacts would be assessed in detail as part of the environmental impact assessment that would be undertaken if, following consultation, a decision is taken to proceed with high speed rail and once a preferred route is confirmed by Government. The impacts would be monitored as part of the routine project planning process.

