

LONDON- WEST MIDLANDS ENVIRONMENTAL STATEMENT

Volume 1 | Introduction to the Environmental
Statement and the Proposed Scheme

November 2013

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Department
for Transport

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

A report prepared for High Speed Two (HS2) Limited:

ARUP

ATKINS

CAPITA



ineco



PARSONS
BRINCKERHOFF



URS

High Speed Two (HS2) Limited,
Eland House,
Bressenden Place,
London SW1E 5DU

Details of how to obtain further copies are available from HS2 Ltd.

Telephone: 020 7944 4908

General email enquiries: HS2enquiries@hs2.org.uk

Website: www.hs2.org.uk

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Preface

Purpose of the Environmental Statement

This document is the Environmental Statement (ES) that accompanies the deposit of the hybrid Bill for Phase One of High Speed Two (HS2). Phase One comprises the first section of the proposed HS2 rail network, between London and the West Midlands, and is referred to in this ES as the 'Proposed Scheme'. The ES sets out the Proposed Scheme and its likely significant environmental effects. Phase Two of HS2 comprises new lines between the West Midlands, Leeds and Manchester, completing what is known as the 'Y network'. It is not the subject of this ES.

Consultation on the Environmental Statement

The public has an opportunity to comment on this ES as part of the hybrid Bill submission. The period of public consultation on the ES extends for 56 days (eight weeks) following the deposit of the hybrid Bill documents in Parliament and the first publication of the necessary newspaper notices that follow.

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Structure of the HS2 Phase One Environmental Statement

The Environmental Statement (ES) comprises:

- Non-technical summary (NTS): which provides a summary in non-technical language of the Proposed Scheme, its likely significant environmental effects, both beneficial and adverse, and the means to avoid or reduce the adverse effects;
- Volume 1: Introduction to the ES and the Proposed Scheme. This describes High Speed Two (HS2), and the environmental impact assessment process, the approach to consultation and engagement, details of the permanent features and generic construction techniques as well as a summary of main strategic and route-wide alternatives and local alternatives (prior to 2012) considered;
- Volume 2: Community forum area (CFA) reports and map books. There are 26 CFA reports and associated map books which present the likely significant environmental effects of the Proposed Scheme;
- Volume 3: Route-wide effects. This describes the effects of the Proposed Scheme on a route-wide basis;
- Volume 4: Off-route effects. This describes the off-route effects of the Proposed Scheme beyond those within the CFA descriptions in Volume 2;
- Volume 5: Appendices and map books. This contains supporting environmental information and associated map books; and
- Glossary of terms and list of abbreviations. This contains terms and abbreviations, including units of measurement used throughout the ES documentation.

Structure of this report

Volume 1, this report, comprises the following sections:

- Introduction: introduces the Proposed Scheme and its associated consent process, including the hybrid Bill and environmental impact assessment (EIA);
- Background to High Speed Two (HS2): explains the Government's case for HS2 and how the Proposed Scheme has evolved;
- Approach to consultation and engagement: describes the approach to consultation and engagement for the Environmental Statement and the process going forward;
- The Proposed Scheme: provides a summary of the Proposed Scheme's objectives, describes the route, the service pattern and other operational characteristics;
- Permanent features of the Proposed Scheme: describes the main features of the Proposed Scheme;
- Construction of the Proposed Scheme: describes the generic construction methods likely to be used;
- Environmental impact assessment: explains how the EIA has been carried out and the scope of the assessment;
- Scope and methodology: provides an outline of the appraisal adopted for each environmental topic;
- Mitigation: describes the proposed mitigation approach for each environmental topic;
- Strategic and route-wide alternatives: provides a summary of the various alternatives that have been considered at a strategic and route-wide level; and
- Local alternatives: explains what local alternatives have been considered prior to January 2012. Local alternatives considered after 2012 are reported in the Volume 2: community forum area reports.

1 Introduction

1.1 Overview of High Speed Two

- 1.1.1 High Speed Two (HS2) is a new railway network proposed by Government to provide a new link between London, the West Midlands, the East Midlands, South Yorkshire, Leeds and Manchester. Beyond the dedicated high speed network, trains will connect with and run on the existing West Coast Main Line (WCML) and the East Coast Main Line (ECML). A connection to the existing High Speed One (HS1) in London will allow services to connect to mainland Europe via the Channel Tunnel. Interchanges will also be provided with Crossrail and Great Western Main Line (GWML) services. Provision has been made for extensions to the Phase One network at a later date for a future link to Heathrow Airport.
- 1.1.2 The Government's vision for the UK's transport system is set out in the Coalition Agreement¹ and the Department for Transport's (DfT) Business Plan (2010-2015)². The Government's view is that, by improving the links that help to move goods and people around, and by targeting investment in new projects that promote growth, transport can help to build the balanced, dynamic and low-carbon economy that is essential for future prosperity.
- 1.1.3 The concept of a high speed rail network in the UK, of which HS2 is a key component, is a core element of this vision and has been under consideration for some time. The background to this and to why the Government is promoting HS2 is summarised in Section 2. Key considerations that have been taken into account include:
- future severe constraints on the capacity of existing railway infrastructure, especially the intercity rail network;
 - future growth in the demand for rail travel, including intercity, suburban and freight services, that is expected to continue in the longer term;
 - the need for additional transport capacity to facilitate economic growth;
 - the reduced carbon emissions of rail compared to other transport modes;
 - the greater connectivity benefits that could be achieved by high speed rail compared to classic rail; and
 - the advantages of building a new railway over upgrading existing lines, especially the avoidance of substantial disruption to existing services during construction.
- 1.1.4 The Government expects that HS2 will significantly increase capacity on the rail network, reducing journey times and enhancing connectivity, and regards it as a key element of its vision for sustainable economic growth.
- 1.1.5 The Government's stated aim³ for the proposed high speed rail network is to make rail increasingly the mode of choice for intercity journeys within the UK, whilst reshaping the economic geography of Britain, connecting major cities and international gateways, and thereby helping to bridge the North/South divide that has limited growth outside London and the South East. These aims would be met, not only by the high speed services

¹ Her Majesty's Government (2010), *The Coalition: our programme for government*.

² Department for Transport (2012), *Department for Transport Business Plan (2010-2015)*. Her Majesty's Stationery Office, London.

³ Department for Transport (2012), *High Speed Rail: Investing in Britain's Future – Decisions and Next Step*. Her Majesty's Stationery Office, London.

themselves, but by the opportunities provided by releasing capacity on the classic network.

- 1.1.6 HS2 Ltd was formed in January 2009 to deliver the Government's vision for the development of a national high speed rail network. As shown in Figure 1, HS2 is to be developed in two phases. In January 2012, the Government announced its intention to proceed with its strategy for a high speed rail network and confirmed its preferred route for Phase One between London and the West Midlands. In January 2013, the Government announced its initially preferred route for Phase Two between the West Midlands, Leeds and Manchester.
- 1.1.7 Phase One is the subject of this Environmental Statement (ES), and is referred to hereafter as the 'Proposed Scheme'. It will involve the construction of a new railway approximately 230km (143 miles) in length between London and the West Midlands, and will include:
- an upgraded and expanded Euston station to provide an interchange with London Underground, commuter and other National Rail services;
 - a connection to HS1, the high speed railway from London to the Channel Tunnel;
 - a new station at Old Oak Common (West London) to provide an interchange with Crossrail and GWML services;
 - provision to enable the future building of a link to Heathrow Airport;
 - an infrastructure maintenance depot (IMD) at Calvert (Buckinghamshire);
 - a new station at Birmingham Interchange with a dedicated connection (by people mover) to Birmingham International station, the National Exhibition Centre (NEC) and Birmingham Airport;
 - a rolling stock maintenance and stabling depot at Washwood Heath in Birmingham;
 - a new station in central Birmingham at Curzon Street, which will facilitate passenger interchange between Curzon Street and Moor Street station;
 - connections to the WCML, at Handsacre (Staffordshire), to provide onward services to the north-west of England and Scotland;
 - new structures and re-provision of existing structures that cross the route; and
 - practicable and cost-effective measures to mitigate adverse environmental impacts.
- 1.1.8 Construction of the Proposed Scheme is expected to take place between 2017 and 2026 (including a period of testing and commissioning). The duration, intensity and scale of construction along the route will vary over this period. Some early works are planned for 2015 and 2016 (subject to any necessary agreements or consents) but this does not affect the validity of baseline assessments for 2017. Passenger services will be provided by new high speed trains from 2026, which will travel at speeds up to 360kph (225 miles).
- 1.1.9 Phase Two of HS2 comprises new lines between West Midlands, Leeds and Manchester, completing what is known as the 'Y network'. The western route extending to Manchester is expected to have a route length of approximately 152km (95 miles). The eastern route

covering the East Midlands, South Yorkshire and Leeds is expected to have a route length of approximately 186km (116 miles). Construction is expected to commence in approximately 2023, with a period of testing from early 2031. Phase Two is expected to be operational around 2032/33.

- 1.1.10 The Proposed Scheme is designed to ensure that a link to Heathrow could be provided at a future date without disrupting HS2 services. The Government's preferred option is for this to be built as part of Phase Two. However, the Government has since taken the decision to pause work on the Heathrow Link until after the Airports Commission publishes its final report on recommended options for maintaining the country's status as an international aviation hub, which is expected in 2015.
- 1.1.11 Powers for the construction, operation and maintenance of the Proposed Scheme are being sought through the submission of a hybrid Bill to Parliament. Phase Two will be the subject of a separate hybrid Bill submission (including an ES) expected in the next Parliament.
- 1.1.12 Whilst this ES is focused on the likely significant effects of the Proposed Scheme, it is recognised that, on the assumption that Phase Two is developed, there will be some operational changes to Phase One, especially the number of trains that will run each day. Environmental effects associated with train operations have therefore been assessed using the volume of traffic expected on the Phase One infrastructure once Phase Two is operational.

Figure 1: Phase One and Two and connections to existing railway lines



1.2 Hybrid Bill procedure

- 1.2.1 A hybrid Bill affects the general public and particular individuals, and must therefore go through the Parliamentary process for both public and private bills before it can be enacted into law.
- 1.2.2 The Government uses hybrid Bills to promote major infrastructure projects. They have been used for other rail schemes, most recently for HS1, resulting in the Channel Tunnel Rail Link Act 1996⁴, and for the Crossrail Act 2008⁵. Use of primary legislation rather than promoting a development consent order under the Planning Act 2008⁶ allows the government to seek the full range of statutory powers and authorisations that a project of this size and complexity requires, including revision to the rail regulatory regime and the planning regime and provisions to enable the making of subsequent orders and regulations by way of statutory instrument.
- 1.2.3 Private Business Standing Orders of the Houses of Parliament require that the hybrid Bill, when submitted to Parliament, must be accompanied by a set of supporting documents. These documents include Plans and Sections of the Works, a Book of Reference detailing the land interests affected, an estimate of expense, and, in accordance with Standing Order 27A (SO27A)⁷, an ES describing the likely significant effects of the Proposed Scheme on the environment.
- 1.2.4 Following First Reading of the hybrid Bill and the deposit of supporting documents, the Standing Orders require a public consultation on the ES. This formal consultation will be held over a period of 56 days (eight weeks). A summary of comments on the ES will be provided to inform Second Reading of the Bill.
- 1.2.5 At Second Reading, the principles of the hybrid Bill are agreed, including the justification for a high speed railway, and a Select Committee is then set up⁸.
- 1.2.6 This is followed by a petitioning period during which those specially and directly affected by the Bill can petition⁹. These petitions are then considered by the Select Committee, which may result in amendments to the hybrid Bill. A Public Bill Committee of Members of Parliament then reviews the Bill, and may make amendments to the public elements of the Bill, after which the Bill undergoes its Report and Third Reading stage.
- 1.2.7 The Bill then transfers to the House of Lords, where a similar process is followed. The Bill returns to the Commons for consideration of any amendments made in the Lords and then receives Royal Assent, becoming an Act of Parliament¹⁰.
- 1.2.8 The Act of Parliament will grant deemed outline planning permission for the proposed works and provide powers to:
- build, operate and maintain the railway and associated works;
 - compulsorily acquire interests in the land required;

⁴ *Channel Tunnel Rail Link Act 1996*. Her Majesty's Stationery Office, London.

⁵ *Crossrail Act 2008*. Her Majesty's Stationery Office, London.

⁶ *Planning Act 2008*. Her Majesty's Stationery Office, London.

⁷ *Standing Orders 27A of the Standing orders of the House of Commons relating to private business (environmental assessment)*. London, House of Commons.

⁸ In the House of Commons, Select Committee members are Members of Parliament who have no constituency interest in the hybrid Bill.

⁹ The petitioning period will be determined during the Second Reading.

¹⁰ Parliamentary procedure is determined by Parliament and so is liable to change.

- interfere with rights of way, including the realignment of highways and waterways (permanently or temporarily);
- modify infrastructure belonging to statutory undertakers (e.g. utility companies);
- carry out works to listed buildings and buildings in Conservation Areas; and
- carry out protective works to buildings and third party infrastructure.

1.2.9 Plans and Sections accompanying the hybrid Bill show, amongst other things, the land required, both permanently and temporarily, and the limits of deviation for the construction of the Proposed Scheme.

1.2.10 The Government introduced the High Speed Rail (Preparation) Bill into Parliament in May 2013. This Bill, if enacted, will grant financial authority from Parliament to incur expenditure on preparatory work for the railway, such as design, surveying and acquiring property, before the Phase One hybrid Bill has secured Royal Assent. Royal Assent to the High Speed Rail (Preparation) Bill is expected before the end of 2013.

1.3 The need for EIA and the role of an Environmental Statement

1.3.1 The Environmental Impact Assessment (EIA) Directive (92/2011/EU)¹¹ provides for the assessment of the environmental impacts of public and private projects. The objective of the Directive is to identify and assess the likely significant environmental effects of a project, with a view to informing the decision maker as part of the development consent process.

1.3.2 SO27A requires the promoter of a hybrid Bill to prepare and deposit an ES to inform Parliament, as decision-maker, of the likely significant effects of a project on the environment. This standing order states that the ES should include:

- information set out in Part II of Schedule 4 of the Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999, since revoked and replaced by the Town and Country Planning (Environmental Impact Assessment) Regulations 2011 (the EIA Regulations)¹²; and
- as much of the information in Part I of that Schedule as is reasonably required to assess the environmental effect of the works.

1.3.3 The information required under Part II of Schedule 4 comprises (in summary):

- a description of the development including information on its site, design and size;
- a description of the measures envisaged to avoid, reduce and, if possible, remedy significant adverse effects;
- the data required to identify and assess the main effects that the development is likely to have on the environment;
- an outline of the main alternatives studied by the applicant or appellant and an indication of the main reasons for the choice made, taking into account the environmental effects; and

¹¹ European Union (EU) (2011), *Council Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment*. Strasbourg, European Parliament and European Council.

¹² *Town and Country Planning (Environmental Impact Assessment) Regulations 2011 (SI 2011 No. 1824)*. Her Majesty's Stationery Office, London.

- a non-technical summary of the information.

1.3.4 The environmental assessment reported in the Volume 2: CFA reports is based on the following:

- the permanent scheme as shown in map series CT-06, including the mitigation measures shown therein;
- the construction arrangements, including land requirements, shown on map series CT-05 and described in Volume 2: CFA reports, Section 2.3;
- the temporary and permanent land requirements shown on map series CT-05 and CT-06, and any additional land requirements outside these shown on the Parliamentary Plans that accompany the hybrid Bill. The Parliamentary Plans define the maximum extent of land over which rights and powers are sought, (and additional limits are set out in the Bill for the carrying out of safeguarding works), and in some circumstances smaller areas of land might be acquired or used;
- the approach to mitigation described in Section 9 of this document;
- the indicative construction programme shown in Volume 2: CFA reports, Section 2 and the construction durations described in the text therein;
- the operational characteristics described in Volume 2: CFA reports, Section 2.4 and in Section 4 of this document;
- the noise fence barriers shown on map series CT-06 and described in the text; and
- where there is a gap in the information available for the assessment, reasonable worst-case assumptions have been made.

1.3.5 The powers that will be acquired through the hybrid Bill process provide that in constructing or maintaining any of the scheduled works, the nominated undertaker may deviate from the Plans and Sections that accompany the hybrid Bill (the Parliamentary Plans):

- laterally to any extent within the limits of deviation for that work shown, on the Parliamentary Plans;
- vertically downwards to any extent from the level shown on the Sections; and
- vertically upwards to any extent not exceeding three metres from the level shown for that work on the sections, except for stations, depots or ventilation (intervention) shafts.

1.3.6 Given the powers provided by the hybrid Bill to deviate within the statutory limits of deviation, Volume 5: CT-005-000 includes a description of any differences to the likely significant effects that will arise and any further mitigation that will be provided, if the scheme were to be built within these limits, but not as shown on map series CT-06. The extent of changes from the scheme centre line and vertical alignment, as assessed and described in Volume 5, are those that are likely within the scope of the limits of deviation, but excludes any change that is considered unlikely or impossible.

1.4 Meeting environmental commitments after consent

- 1.4.1 In order to ensure that the environmental effects of the Proposed Scheme will not significantly exceed those assessed in the ES, the Secretary of State will establish a set of controls known as Environmental Minimum Requirements (EMR). The EMR will be contained in a suite of documents that will sit alongside the provisions set out in the hybrid Bill itself. The nominated undertaker is the body to be appointed to take forward the detailed design and implementation of the Proposed Scheme after the hybrid Bill has been enacted. The nominated undertaker will be required to comply with the EMR and the other hybrid Bill controls.
- 1.4.2 During the passage of the hybrid Bill, the Secretary of State will confirm to Parliament the scope of, and the documents forming the EMR; and will make a commitment to Parliament to take whatever steps he/she considers reasonable and necessary to secure compliance with them.
- 1.4.3 The EMR, together with the controls in the hybrid Bill, will ensure that the impacts assessed in the ES will not be exceeded, unless this results from a change in circumstances that was not foreseeable at the time the ES was prepared; or any such changes will be unlikely to have significant adverse environmental effects; or will be subject to a separate consent process and further EIA.
- 1.4.4 The EMR will also impose requirements on the nominated undertaker to use reasonable endeavours to adopt measures to reduce the adverse environmental effects reported in the ES, provided that this does not add unreasonable cost or delay to the construction or operation of the Proposed Scheme.
- 1.4.5 The EMR will include:
- general principles, in which the Secretary of State commits that the environmental effects reported in the ES are not exceeded by application of the environmental mitigation assessed in the ES;
 - a Code of Construction Practice (CoCP), which will set out measures to provide effective planning, management and control during construction;
 - an Environmental Memorandum, which is a framework for HS2 Ltd and its contractors and stakeholders, such as the Environment Agency and Natural England, to work together to ensure that the design and construction of Phase One is carried out with due regard for environmental considerations;
 - a Planning Memorandum, which will set out an agreement between the Government and the local planning authorities relating to the processing of detailed planning approvals under the provisions of the Bill, including the design and appearance of stations, bridges, viaducts, ventilation shaft headhouses, tunnel portals, noise barriers and earthworks.
 - a Heritage Memorandum, which will set out a commitment to limit the impact on the historic environment and will address the elements of the design and construction works that have a direct impact on heritage assets; and
 - undertakings and assurances given during the passage of the hybrid Bill.

1.5 HS2 and sustainability

- 1.5.1 The Government's High Speed Rail Strategy and the overall policy framework for the development of HS2 is set out in the 2012 Command Paper: Investing in Britain's Future – Decisions and Next Steps¹³.
- 1.5.2 Development of the Proposed Scheme has been influenced by the Government's commitment to sustainable development. International and national bodies have set out broad principles of sustainable development. Resolution 42/187 of the United Nations General Assembly¹⁴ defined sustainable development as meeting the needs of the present without compromising the ability of future generations to meet their own needs.
- 1.5.3 The Government's commitment to sustainable development builds on the previous Government's strategy: Securing the future¹⁵, which set out five 'guiding principles' of sustainable development, namely:
- living within the planet's environmental limits;
 - ensuring a strong, healthy and just society;
 - achieving a sustainable economy;
 - promoting good governance; and
 - using sound science responsibly.
- 1.5.4 The National Planning Policy Framework (NPPF)¹⁶ sets out the Government's strategic guidance on development planning in England and Wales. The principles of sustainable development underpin the NPPF and its associated technical guidance. It identifies three dimensions to sustainable development, namely:
- economic: contributing to building a strong, responsive and competitive economy;
 - social: supporting strong, vibrant and healthy communities, by providing the supply of housing required to meet the needs of present and future generations; and
 - environmental: contributing to protecting and enhancing our natural, built and historic environment and, as part of this, helping to improve biodiversity, use natural resources prudently, reduce waste and pollution, and mitigate and adapt to climate change (including moving to a low carbon economy).
- 1.5.5 The NPPF indicates that these factors should not be considered in isolation, because they are mutually dependent. Economic growth can secure higher social and environmental standards, whilst well-designed buildings and places can improve the lives of people and communities. Therefore, to achieve sustainable development, the NPPF requires economic, social and environmental gains to be sought jointly and simultaneously.

¹³ Department for Transport (2012), *High Speed Rail: Investing in Britain's Future – Decisions and Next Steps*. Her Majesty's Stationery Office, London.

¹⁴ UN General Assembly (1989), *Implementation of General Assembly resolutions 42/186 and 42/187: resolution / adopted by the General Assembly, 22 December 1989, A/RES/44/227*.

¹⁵ Defra (2005), *Securing the future – delivering UK sustainable development strategy (PB10589)*.

¹⁶ Department for Communities and Local Government (2012), *National Planning Policy Framework*.

- 1.5.6 Compliance with these principles has been, and remains, an important influence on the development of the Proposed Scheme. Route refinement during 2009 to 2011 was supported by an appraisal of sustainability (AoS)¹⁷. The purpose of the AoS was to ensure that environmental factors were considered in the development of route options and in the decision-making process, especially when choosing between alternatives. A similar approach is being applied to HS2 Phase Two, for which a Sustainability Statement has been completed¹⁸. This forms part of the consultation on the proposed high speed rail link from the West Midlands to Manchester and Leeds, which commenced in July 2013 and will run until January 2014.
- 1.5.7 The AoS for the Proposed Scheme used the four sustainability principles set out in the previous Government’s strategy: *Securing the future*, to assess the merits of HS2. These principles included:
- reducing greenhouse gas emissions and combating climate change;
 - protecting natural resources and enhancing the environment, including the cultural as well as natural environment;
 - creating sustainable communities; and
 - promoting sustainable consumption and production.
- 1.5.8 A series of sustainable design aims (Table 1) were developed as part of the AoS process to provide benchmark principles against which alternative routes were assessed, in order to arrive at the preferred route for the Proposed Scheme. The design aims reflected the four sustainability principles set out above.

Table 1: Sustainable design aims

Priority Number	Design Aims
Priority One	Reduce greenhouse gas emissions and combat climate change
	Design Aim 1: managing energy - The project shall consider the energy efficiency of the operation of trains and rail infrastructure, as well as the energy requirements of construction and materials, as a means of establishing low-energy priorities within the Proposed Scheme as a whole.
	Design Aim 2: managing flood risk - The project shall aim to avoid any increase in flood risk, by maintaining overall flood storage capacity (through, in order of priority, option selection that avoids floodplains, infrastructure design and flood compensation) and minimising disruption of flood flows.
Priority Two	Protect natural and cultural resources and enhance the environment
	Design Aim 3: protecting natural resources - The project shall seek to avoid direct or indirect harm to valued landscape, water and ecological resources, to mitigate adverse impacts and to enhance such resources where practicable. Measures to achieve this would be commensurate with the sensitivity of the resources and the level of their protection.
	Design Aim 4: protecting cultural resources - The project shall seek to avoid direct or indirect harm to valued historic cultural resources, to mitigate adverse impacts, and to enhance such resources where practicable. Measures to achieve this would be commensurate with the sensitivity of the resources and their level of protection.

¹⁷ Booz Temple (2011), *HS2 London to the West Midlands Appraisal of Sustainability, Volume 1: Main Report*

¹⁸ Temple, ERM (July 2013), *High Speed Rail: Consultation on the route from the West Midlands to Manchester, Leeds and beyond. Sustainability Statement, Volume 1: main report of the Appraisal of Sustainability.*

Priority Number	Design Aims
Priority Three	Create sustainable communities
	Design Aim 5: controlling noise and vibration - Where reasonably practicable, the operation of the Proposed Scheme shall result in no significant adverse noise and vibration impacts (by reference to relevant guidance and precedence) to residents and other sensitive receptors near the route or proposed stations. Measures to mitigate potential impacts would be introduced, but where such impacts are unavoidable and cannot be appropriately mitigated, the project shall define circumstances under which residential properties shall be eligible for sound insulation.
	Design Aim 6: minimising property demolition - The project would seek to avoid or, where this is not practicable, to minimise impacts due to the demolition of properties and, in particular, to minimise residential land required and demolition.
	Design Aim 7: protecting communities - The project would seek to maintain the health and amenity of residential communities potentially affected by the Proposed Scheme. This would include, where practicable, maintenance of access to services (such as health facilities, schools and places of worship) and shops, and maintenance of environmental conditions such that significant adverse effects on health and amenity are mitigated.
Priority Four	Design Aim 8: safety - the project design would seek to ensure that the travelling public and general public are not subject to increased risk of death or injury as a result of the operation of services associated with the Proposed Scheme.
	Achieve sustainable consumption and production
	Design Aim 9: optimising the land resource - The project would seek, where practicable, to use land with planning designations appropriate to development for high speed rail and its infrastructure. The project would seek to maintain and enhance land use, provided this does not compromise other sustainability aims.

1.5.9 A Sustainability Policy has also been prepared for HS2, as shown in Figure 2. The HS2 Sustainability Policy builds on the work of the AoS and the Sustainable Design Aims, setting out HS2 Ltd’s vision for sustainability. It sets out the role of the project in delivering sustainable economic growth and the commitment to balance community, economic and environmental issues in taking the project forward.

Figure 2: HS2 Sustainability Policy



Sustainability policy

HS2's purpose is to create a world class high speed rail network to support sustainable growth in the UK. It is a major opportunity to provide greater choice in the way we travel to help deliver a sustainable transport system for the UK.

Our vision is of a high speed railway network which changes the mode of choice for inter-city journeys, reinvigorates the rail network, supports the economy, creates jobs, reduces carbon emissions and provides reliable travel in a changing climate throughout the 21st century and beyond.

This policy sets out HS2 Ltd's commitment to be an exemplar project. Building this network will inevitably cause some local effects on communities, the natural and the built environment. We will strive to limit the negative impacts through design, mitigation and by challenging industry standards and we will look for environmental enhancements and benefits.

Through this policy we aim to support the following Government goals:

- Create a step change improvement in transport links between regional centres and from them to London.
- Enable more equal distribution of opportunity, connect communities and encourage regeneration.
- Stimulate sustainable economic growth through increased capacity and shorter journey times between key cities.
- Support British engineering, create job opportunities and develop skills in the UK.
- Deliver lower carbon long distance travel.
- Maximise integration of HS2 with existing UK and international transport networks.
- Encourage wellbeing and protect the environment.

What we will do

We will promote high speed rail and balance community, environmental and economic issues. We have identified key themes as a focus for our work to:

Growth and regeneration • Support sustainable economic development and the localism agenda for regeneration.

Environmental change • Seek to avoid significant adverse effects on communities, business and the natural, historic and built environment. Minimise impacts where they occur and deliver enhancements as far as practicable to ensure there is no net loss to the natural environment.

Skills and employment • Improve skills, jobs, education and the economy through our investment along the length of the route. Act as a driver for improvements in the sustainability of the engineering and construction sector. Promote diversity, openness and fairness.

Climate change • Minimise the carbon footprint of HS2 as far as practicable and deliver low carbon long distance journeys that are supported by low carbon energy.

Resilience • Build a network which is resilient for the long term and seek to minimise the combined effect of the project and climate change on the environment.

Resources and waste • Source and make efficient use of sustainable materials, maximise the proportion of material diverted from landfill and reduce waste.

Integrated transport • Engage with stakeholders to create seamless transport links with other modes and ensure accessibility for all.

How we will deliver this

To deliver our vision we will embed sustainability in our business at each phase of the project through:

A clear plan • Setting goals relevant to the stage of the project from design, through development, construction, operation, maintenance and renewal which stimulate innovation and ensure enhancements are protected for the long term. Our plan and this policy will be reviewed biennially.

Robust processes • Ensuring sustainability is integrated into our culture, procedures and processes. This will include the development of Sustainable Design and Delivery Principles as part of a process to enable us to balance the sometimes competing elements of sustainability and to understand whole life cost.

Procurement • Ensuring sustainability is integral in our procurement processes and is applied to our entire supply chain.

Innovation • Promoting sustainable construction practices, continually focussing ideas and technologies for improving sustainability.

Engagement and reporting • Engaging in dialogue about the project and working with local communities, key stakeholders and our supply chain. Openly reporting our progress in delivering the commitments we make on sustainability regularly and sharing what we learn.

HS2 is determined to ensure sustainability is embedded in the DNA of this project and that it is integrated into all of our work.



Alison Munro, Chief Executive, HS2 Ltd
April 2013

HS2/HS2/SU/POL/000/000002

- 1.5.10 In accordance with the climate change objective of the HS2 Sustainability Policy, a carbon management strategy will be developed and applied and will:
- calculate the carbon footprint of the Proposed Scheme and use this as a tool to assess the potential to reduce carbon across the design, construction and operation phase;
 - consider low carbon options in developing the detailed design of the Proposed Scheme;
 - reduce embedded carbon in construction materials and carbon emissions from construction works, where practicable;
 - reduce energy requirements of the scheme and maximise the energy efficiency of operations, if practicable;
 - use and/or generate low carbon energy, if practicable; and
 - sequester carbon¹⁹, if practicable.
- 1.5.11 This approach forms a hierarchy of actions, with avoidance generally being the most preferable option. The carbon footprint will be calculated at appropriate intervals to determine progress in carbon reduction.

1.6 The acquisition, use and return or disposal of land

- 1.6.1 The hybrid Bill will seek powers for the compulsory acquisition of land for the Proposed Scheme.
- 1.6.2 The Plans and Book of Reference will show the extent of land which the nominated undertaker may acquire permanently for the works and any additional land to be acquired or used, either temporarily or permanently, for the construction and operation of the Proposed Scheme. The nominated undertaker will notify the owners of such land. Generally the Bill will authorise the permanent acquisition of land required for construction sites, because of the length of time for which that land will be required, but unless the land is required for additional permanent use it will be offered back to the previous owners on completion of the works.
- 1.6.3 The limits of deviation enable the Proposed Scheme to deviate slightly from the centre line of the works shown on the Parliamentary Plans as may be required following detailed design, but the scheme must remain within the land shown on the Parliamentary Plans. The nominated undertaker will acquire or use less than the full extent within the limits if, following detailed design, not all of the land is required for permanent works or their construction.
- 1.6.4 Payment of compensation for land compulsorily acquired will be in accordance with the general statutory framework set out under the National Compensation Code²⁰. The general purpose of the code is to provide fair compensation for a person whose land has been compulsorily taken. Where applicable, the compensation payable will be based on

¹⁹ Carbon sequestration is the process of removing carbon from the atmosphere through a process of capture and long-term storage; for example, the planting of trees which absorb carbon through photosynthesis.

²⁰ Department for Communities and Local Government (2004), *Compulsory Purchase and Compensation: Compulsory Purchase Procedure*.

the open market value of the land (assuming it is sold by a willing seller in the absence of HS2) plus home loss payments, or basic and occupier's loss payments reflecting factors such as disturbance, reduction in the value of retained land and other losses arising as a direct and reasonable consequence of acquisition.

2 Background to High Speed Two

2.1 The need for High Speed Rail

2.1.1 The Government set out its case for High Speed rail in the January 2012 Command Paper. The main themes from the Command Paper may be summarised as follows:

- the Government's vision is for a transport system that is an engine for economic growth;
- there is a compelling case for delivering a step-change in the capacity and performance of Britain's intercity rail network to support economic growth over the coming decades. The need for additional capacity will become increasingly critical on the key north-south intercity rail routes, particularly the WCML, where capacity is forecast to be exhausted by the mid-2020s;
- the construction of a national high speed rail network between London and Birmingham, Manchester and Leeds, linked to the existing rail network, is the best means for enhancing rail capacity and performance within Britain's key north-south corridors; and
- further major upgrades to the existing lines in these corridors would not be sufficient to meet the long-term capacity needs for passengers or freight. They would also not deliver the connectivity benefits of a high speed line and would cause substantial disruption to passengers, freight users and businesses.

2.1.2 The document also concluded that:

- the route corridor on which the Proposed Scheme is based, including the approach for mitigating its impacts, is the best option for a new high speed line between London and the West Midlands;
- a phased approach should be taken to developing the Y network; and
- the technical specification for high speed rail employed by HS2 Ltd is robust, appropriate and deliverable.

2.1.3 Building new classic - instead of high speed - railways would not be significantly cheaper, and would not have significantly less impact on communities and the environment. In addition, classic railways would deliver far fewer benefits in terms of enhanced capacity and connectivity, and thereby less potential to support long-term economic growth. These themes are addressed in more detail in Sections 2.3 and 2.4. HS2 will also create the opportunity to reduce the overall carbon emissions from transport by shifting journeys to rail from other modes.

2.1.4 The updated case for HS2 is set out in the Strategic Case for HS2²¹ and the Economic Case for HS2²² reports.

²¹ Department for Transport (2013), *The Strategic Case for HS2*.

²² Department for Transport (2013), *The Economic Case for HS2*.

2.2 Evolution of High Speed Two

2.2.1 The 2012 Command Paper followed several years of analysis and development, which is described more fully in the Alternatives Report (Volume 5: Appendix CT-002-000) and summarised within Section 10. The process can be divided into two main stages:

- development of the strategic case for a high speed rail network prior to the end of 2008; and
- review of the strategic case and development of the route between London and the West Midlands following the formation of HS2 Ltd in January 2009, which resulted in the Government’s decision in January 2012 to proceed with the Proposed Scheme.

2.2.2 The first stage began with the Government’s acknowledgement in 2007 that a more strategic and sustainable approach to transport planning was required. This provided the context for work by Network Rail, which established that high speed rail should be a key element of that approach. The main milestones up to 2009 are summarised in Table 2.

Table 2: Main milestones up to 2009

Publication Date	Activity
July 2007	Rail white paper: Delivering a Sustainable Railway ²³ set out the Government’s strategy for developing a more reliable, accessible and environmentally sustainable rail network over the next 20 years.
October 2007	Command Paper: Towards a Sustainable Transport System ²⁴ which set out the Government’s framework for forward planning in the context of the Stern Review, including emission reduction pathways for greenhouse gases.
November 2008	National Networks Strategy Group established to identify the priorities for investment in national transport networks and to co-ordinate the Network Rail work.
November 2008	Delivering a Sustainable Transport System ²⁵ set out the Government’s aims and priorities for investment in nationally important transport infrastructure up to 2014.
2008/2009	Network Rail examined the case for new lines to increase rail capacity to meet long-term demand. This resulted in the publication of its New Lines Study ²⁶ , which looked at capacity constraints on existing intercity corridors and options for the construction of new high speed lines.

2.2.3 The second stage began in January 2009 with the publication of Britain’s Transport Infrastructure: High Speed Two²⁷. This document sets out the Government’s vision for the way forward for development of a high speed rail network and established HS2 Ltd to undertake this work. HS2 Ltd were tasked, in respect of Phase One, to develop:

- a proposed route for HS2, with any options as appropriate;
- options for a Heathrow International Interchange station on the GWML, with an interchange also with Crossrail;
- options for access to central London and the other cities served;

²³ Department for Transport (2007), *Delivering a sustainable railway – white paper CM 7176*. Her Majesty’s Stationery Office, London.

²⁴ Department for Transport (2007), *Towards a Sustainable Transport System: Supporting Economic Growth in a Low Carbon World*. Her Majesty’s Stationery Office, London.

²⁵ Department for Transport (2008), *Delivering a Sustainable Transport System (DaSTS)*. Her Majesty’s Stationery Office, London.

²⁶ Network Rail (2009), *Meeting the capacity challenge: The case for new lines*.

²⁷ Department for Transport (2009), *Britain’s Transport Infrastructure: High Speed Two*, Her Majesty’s Stationery Office, London.

- options for linking with HS1 and the existing rail network, including the potential for services to continental Europe;
- options for providing an intermediate parkway station between London and the West Midlands. Any such station should not be detrimental to the overall business case, and should support economic and spatial strategies; and
- financing and construction proposals.

2.2.4 In addition, in March 2009, the remit was extended “to provide advice on the potential development of a high speed line beyond the West Midlands, at the level of broad ‘corridors’...[and] to consider in particular the potential for HS2 to extend to the conurbations of Greater Manchester, West Yorkshire, the North East and Scotland²⁸”.

2.2.5 The main milestones in the development of HS2 since March 2010 are summarised in Table 3.

Table 3: Main milestones since March 2010

Date	Activity
March 2010	HS2 Ltd submitted its advice to Government in December 2009 in the document High Speed Rail – London to West Midlands and Beyond ²⁹ . This set out the business case and proposals for the high speed route between London and the West Midlands, with provision for onward running via the WCML, including options for further development and for connections to Heathrow Airport and HS1.
March 2010	The Government published its Command Paper High Speed Rail ³⁰ , which confirmed its support for a high speed Y network, and for initial development of a route between London and the West Midlands. HS2 Ltd was instructed to take this work forward, whilst options for connections to Heathrow Airport were to be the subject of a separate report by Lord Mawhinney.
March 2010	A review of the strategic alternatives to high speed rail, reported in High Speed 2 Strategic Alternatives Study – Strategic Outline Case ³¹ .
May 2010	The announcement in the Coalition Agreement by the Coalition Government confirmed its support for high speed rail.
July 2010	Lord Mawhinney ³² reported on options for connections to Heathrow Airport, favouring an interchange station or a spur (line) rather than diversion of the main high speed line.
October 2010	The Secretary of State announced the preference for the Y network over other configurations.
December 2010	The Secretary of State announced the Government’s intention to consult on its preferred strategy for HS2, which comprised the Y network, a slightly modified London-West Midlands route and connections to Heathrow Airport and HS1.
February to July 2011	A consultation was undertaken on the proposed high speed rail strategy and a preferred route for Phase One of the Y network, supported by an over-arching consultation document (High Speed Rail: Investing in Britain’s Future Consultation) and various supporting documents, including an Appraisal of Sustainability and a review of network-wide strategic alternatives to the Y network ³³ .

²⁸ Remit letter from Lord Adonis to Sir David Rowlands; (2009), www.hs2.org.uk; Accessed: July 2013

²⁹ Department for Transport (2010), *High Speed Rail London to the West Midlands and Beyond: A Report to Government by High Speed Two Limited*. Her Majesty’s Stationery Office, London.

³⁰ Department for Transport (2010), *High Speed Rail – Command Paper*. Her Majesty’s Stationery Office, London.

³¹ Atkins (2010), *High Speed 2 Strategic Alternatives Study, Strategic Outline Case*, London.

³² Department for Transport (2010), *High Speed Rail access to Heathrow: A report by Lord Mawhinney*. Her Majesty’s Stationery Office, London.

³³ Department for Transport (2011), *High Speed Rail - Investing in Britain's Future Consultation*. Her Majesty’s Stationery Office, London.

Date	Activity
Autumn 2011	In response to the feedback from consultation, various supplementary work was undertaken, including refinement of the London-West Midlands route and a review of strategic alternatives.
November 2011	Publication of the National Infrastructure Plan ³⁴ , which set out the Government's key transport objectives as (1) Keeping Britain moving by improving the capacity, performance and resilience of roads, railways and international gateways, (2) improving integration between different transport modes, (3) supporting the move to a low carbon economy, and (4) improving connectivity and capacity between main urban areas and between them and international gateways.
January 2012	The Secretary of State published the Command Paper High Speed Rail: Investing in Britain's Future – Decisions and Next Steps, together with supporting documents. The Command Paper confirmed the Government's intention to develop a Y-shaped high speed rail network, including direct links to Heathrow Airport and HS1. The network was to be brought forward in two phases, with powers sought initially for a London-West Midlands high speed line based on a refined version of the consultation route.
September 2012	Publication of the HS2 London to West Midlands EIA Scope and Methodology Report and update of the report following consultation ³⁵ .
January 2013	The Secretary of State announced the Government's intention to proceed with the planning and design of Phase Two, and published initial preferred routes for Leeds and Manchester, whilst work on the Heathrow spur was put on hold pending the report of the Davies Commission.
May 2013	Release of the Draft ES ³⁶ , Design Refinement report ³⁷ and draft CoCP ³⁸ for consultation.
July 2013	Consultation on the proposed route for Phase Two detailing the route from the West Midlands to Manchester, Leeds and beyond. Consultation documents included supporting technical information (including maps) the Sustainability Statement and quick reference factsheets ³⁹ .
September 2013	HS2 Ltd published an analysis of the potential scale, range and distribution of regional economic impacts associated with the substantial improvements to the rail network brought about by HS2 (both Phase One and Phase Two) and the use of freed-up capacity on the classic rail network ⁴⁰ .
September 2013	The HS2 Property Compensation Consultation document ⁴¹ . This describes the Government's proposals for property compensation schemes along the HS2 Phase One line of route between London and the West Midlands. The consultation period closes in December 2013.
October 2013	Publication of the Economic Case for HS2 and Strategic Case for Hs2.

2.3 Enhancing capacity and connectivity

- 2.3.1 The Government's case for a new north-south high speed rail network is primarily to ensure that the intercity rail network supports the economic development of the country by providing sufficient capacity and improved connectivity between urban centres. The need for additional capacity will become increasingly pressing on Britain's key north-south inter-urban rail routes, particularly on the WCML from the mid-2020s.
- 2.3.2 Demand for inter-regional travel within the UK, including levels of rail patronage, has been increasing in recent years. The number of passenger miles travelled on the national rail network increased from 20 billion in 1992/93, to 36 billion in 2012/13. In terms of the

³⁴ HM Treasury, Infrastructure UK (2011), *National Infrastructure Plan*. Her Majesty's Stationery Office, London.

³⁵ Arup/URS (2012), HS2 London to West Midlands EIA Scope and Methodology Report.

³⁶ HS2 Ltd (2013), *High Speed Two Phase One Draft Environmental Statement*.

³⁷ HS2 Ltd (2012), *Design Refinement Consultation*, DfT, London.

³⁸ HS2 Ltd (2013), *Draft Code of Construction Practice*.

³⁹ HS2 Ltd (2013), Phase Two Route Consultation, <http://www.hs2.org.uk/phase-two/route-consultation/document-library>, Accessed: 4 November 2013.

⁴⁰ HS2 Ltd (2013), *HS2 Regional Economic Impacts*.

⁴¹ HS2 Ltd (2013), *Property Compensation Consultation 2013 for London-West Midlands HS2 route*.

number of rail passenger journeys, there has been an increase from 976 million in 2002/03 to 1,502 million in 2012/13. This represents a 54% increase in demand in a 10 year period and is equivalent to an annual year-on-year growth rate of 4.4%. Intercity journeys increased by 65% over the same period, with journeys increasing from 77 million to 128 million. This is a 5.2% annual year-on-year growth rate. Over the same period, gross domestic products grew by 43% or 3.6% per year. This trend in passenger growth has been evident since the 1980s, reflecting rising levels of population and economic activity, and is predicted to continue despite advances in information and communications technology.

- 2.3.3 The 2007 White Paper: Delivering a Sustainable Railway predicted that rail patronage would double by 2030, and identified London-Birmingham-Manchester as one of the first routes likely to require interventions beyond the WCML upgrade underway at that time.
- 2.3.4 Network Rail's New Lines Study tested the assumptions about future demand and set out the strategic business case for new high speed lines. This work predicted that the demand for travel between London, Birmingham, Manchester and Edinburgh would increase by more than 90% between 2007 and 2030.
- 2.3.5 The Britain's Transport Infrastructure – High Speed Two report confirmed that between 1997/8 and 2007/8 rail passenger miles increased by an average of 3.5% per annum and rail passenger journeys by an average of 3.8%, with the annual rate of increase becoming steeper over time. The report indicated that whilst macro-economic influences are important, this demand continues to be driven by underlying factors such as improvements to journey times and reliability, coupled with the disbenefits of using other modes of transport.
- 2.3.6 The Network Rail work in 2008/9 concluded that the WCML, Midland Main Line (MML), ECML and Chiltern Main Line (CML) would be at or near capacity by 2020. The most critical constraints would be reached initially on the WCML, despite its recent upgrade, followed by the MML and ECML (taking account of planned incremental upgrades). Recent work has confirmed the likelihood of critical capacity constraints developing on the WCML. Even when the economic downturn in 2008, the future increase in demand for rail travel is likely to outstrip capacity.
- 2.3.7 The critical prognosis for the WCML is a key influence both on the overall case for HS2 and on the more immediate benefits of Phase One. As well as carrying passengers between the major cities, the WCML is a very significant carrier of commuters into the capital and other major cities, and handles over 40% of the country's rail freight, making it the busiest mixed use railway line in Europe. Despite a major (£9 billion) upgrade over the last 10 years, and partly because of the success of the service improvements that have followed, it has reached its capacity.
- 2.3.8 The WCML carries passenger services of every type, including long distance intercity, inter-regional and commuter passenger services and freight. Congestion on the WCML has a noticeably detrimental effect on the reliability of intercity and commuter services, which regularly fail to meet their performance target and are below the national average.

- 2.3.9 Extra capacity provided in recent years has filled up more quickly than expected. Since being upgraded, the WCML has seen trip growth of 36% between 2006 and 2009⁴².
- 2.3.10 The Government's view is that further incremental upgrades to the existing north-south rail network will be insufficient to provide the necessary capacity and improved performance required to meet the country's long-term economic needs. Further incremental upgrades would result in prolonged and unacceptable disruption to the existing network. Therefore, new railways are needed. These could operate at classic speeds or at high speed. The Government has concluded that building new classic rail lines would not be significantly cheaper than new high speed lines, nor would their effects on the environment and communities be significantly less than those of high speed rail. Classic rail lines would deliver far fewer benefits in terms of enhanced connectivity and support for long-term economic growth. The Government also considers that high speed rail would have greater potential to attract travellers from air and road transport, creating opportunities to reduce carbon emissions.
- 2.3.11 Network Rail's 2011 report⁴³ demonstrated that even very major enhancement packages on the WCML would not meet the expected demand over the coming decades. This would delay, rather than eliminate, both the need for new lines and their associated strategic, economic and connectivity benefits, at the cost of significant disruption to passengers.
- 2.3.12 Journey time is a key influence on the ability of rail to compete with other modes. This has been demonstrated; for example, by the Paris and Brussels THALYS service and the East Japan 'Shinkansen' network; and by HS1, which has captured around 80% of the travel market between London and Paris through a combination of high speed and the convenience of a city-centre to city-centre service.
- 2.3.13 The work carried out by Network Rail concluded that a new line serving the London-Birmingham-Manchester corridor should be capable of high speed operation rather than the maximum speeds typically achieved on classic lines. Speed has less impact on the construction and operating costs of a railway than on its economic benefits, as measured by time saved. Whilst the cost profile for a new high speed line is about 9% higher than that for a new classic speed line, the economic benefits achieved by the reduced journey times are substantially greater.
- 2.3.14 As a result, the Government concluded that the additional benefits generated by a high speed line, compared to a classic speed line, would outweigh the additional costs by a factor of more than four to one. As well as providing substantial additional capacity in its own right, a new dedicated high speed line would release capacity on existing routes, which could be redeployed to the benefit of services such as commuters and freight. This released capacity, on top of the enhanced capacity provided by the HS2 network, represents a significant additional benefit, since the costs of congestion are felt most keenly by existing passengers and businesses.
- 2.3.15 HS2 will enable passengers to travel from London to Birmingham in forty-nine minutes rather than one hour twenty-four minutes today, and from London to Manchester in one hour, eight minutes rather than the two hours, eight minutes it takes today. The country

⁴² Department for Transport (2011), *Economic Case for HS2*.

⁴³ Network Rail (2011), *Review of Strategic Alternatives to HS2*.

will be transformed with many more people being brought to within one hour of London and two-thirds of the population brought to within two hours.

- 2.3.16 HS2 will provide new links between regional cities, and will directly connect eight of the ten largest cities in Britain: London; Manchester; Liverpool; Glasgow; Edinburgh; Newcastle; Sheffield and Leeds. At the heart of the rail network north of London, Birmingham will also have the potential to connect Bristol, Wales and the South West to the other core cities.
- 2.3.17 People will be able to meet their work commitments, make new contacts, find new jobs, and spend their time more productively when travelling. The evidence shows that people place a premium on being able to get to places quickly⁴⁴. HS2 will broaden the options available to people in terms of where to live, where to locate their business and how to travel.
- 2.3.18 Scotland will benefit from high speed services from Edinburgh and Glasgow as soon as Phase One opens. Phase Two is expected to reduce journey times by up to an hour without the need to change trains, benefitting the Scottish economy.
- 2.3.19 HS2 will also improve international connectivity. It will directly serve Manchester and Birmingham airports. The planned interchange at Old Oak Common will offer a connection on to services direct to Heathrow Airport: and the potential also remains, pending decisions after the Airports Commission's report and the strength of the supporting evidence, to provide a direct link in Phase Two from the Midlands and the North to Heathrow Airport. The HS1/ HS2 link will allow the possibility of direct trains from the HS2 network to the continent.

2.4 Generating growth

- 2.4.1 The efficient movement of people and goods is fundamental to the productive potential of an economy. Improvements in transport infrastructure enable the economy to grow by increasing the efficiency of labour and business markets through a reduction in the barriers to trade created by distance and congestion.
- 2.4.2 Improved connectivity can deliver benefits by making an area more accessible, resulting in a greater concentration of workers and firms. These benefits can help to re-balance the economy by stimulating growth in the regions. Because of its high inherent capacity, its ability to provide centre-to-centre routes and the wide range of connections it offers with other modes of transport, rail is a particularly effective means of moving large numbers of people over a range of distances.
- 2.4.3 The potential for high speed rail to facilitate improved economic growth, through benefits to agglomeration, competition and labour markets, is an important consideration for the Government. HS2 will link the majority of Britain's biggest cities, including its second and third cities, Birmingham and Manchester, increasing the productive potential of regional economies and providing an opportunity to increase their contribution to the UK economy.

⁴⁴ Wardman M, Batley R et al (2013), *Valuation of Travel time Savings for Business Passengers*, ITS Leeds,

- 2.4.4 HS2 will be the biggest infrastructure project in Europe and will have a significant impact on jobs, both directly and through its supply chain, particularly in engineering and construction. The new high speed rail stations have the potential to boost local economic growth in the short-term and to facilitate longer-term benefits by acting as a catalyst for local regeneration, as is the case with HS1.
- 2.4.5 The Y network reflects the Government's objective of ensuring that the regional economic benefits of high speed rail travel are distributed as widely as possible. Recent analysis presented in the Economic Case indicates that the economic benefits of HS2 to the regions, particularly the Midlands and the North, will be greater than those to London.
- 2.4.6 The two interchange stations incorporated within the Proposed Scheme will ensure that the connectivity benefits are spread beyond London and Birmingham. In addition, the Proposed Scheme includes a link to HS1, allowing direct access to the European rail network, which will enable HS2 to reinforce access to external destinations and markets.

2.5 Controlling greenhouse gas emissions

- 2.5.1 The Proposed Scheme has developed against a background of emerging concern about climate change, and acknowledgement of the need to provide a policy response. The Kyoto Protocol of 1997 took the lead in converting this concern into action at an international level, and was followed in the UK by the Climate Change Act 2008⁴⁵, which set statutory targets for carbon reduction.
- 2.5.2 The latest Intergovernmental Panel on Climate Change Assessment Report (AR5) was published on 27 September 2013⁴⁶. It strengthened its statement on human induced climate change from being 90% certain in the last assessment report in 2007 to 95% certain in AR5. It now also states that it is extremely likely that humans have been the dominant cause of observed warming since the mid-20th century. AR5 states that atmospheric CO₂ has increased by 40% to 391ppm (2011) since preindustrial times.
- 2.5.3 The Climate Change Act sets a legally binding target of at least an 80% cut in the UK's greenhouse gas emissions (GHG) by 2050 (from 1990 levels), and introduced a carbon budgeting system which caps emissions over a series of five-year periods. It also established the Committee on Climate Change.
- 2.5.4 The Carbon Plan (2011)⁴⁷ sets out the Government's plans for achieving the greenhouse gas emissions reductions committed to in the Climate Change Act and the first four carbon budgets. Low carbon transport is an essential part of the Carbon Plan. The Plan states that rail travel will become substantially decarbonised through increasing electrification and the use of more efficient trains and lower carbon fuels. The Plan also mentions that the high speed rail network being developed by HS2 "will transform rail capacity and connectivity to promote long-term and sustainable economic growth". Furthermore, the Plan notes that further electrification of the rail network will support low carbon modal shift in the future. In addition the freight sector will have found lower carbon ways of working, such as modal shift to rail and water.

⁴⁵ *Climate Change Act 2008*. Her Majesty's Stationery Office, London.

⁴⁶ IPCC Working Group 1 (2013) Summary for Policy Makers; www.climatechange2013.org; Accessed 4 November 2013.

⁴⁷ The Carbon Plan (2011), <https://www.gov.uk/government/publications/the-carbon-plan-reducing-greenhouse-gas-emissions--2>; Accessed 4 November 2013.

- 2.5.5 The European Union Emissions Trading System (ETS), a cap and trade system with a decreasing cap over time, is a significant policy tool available for implementing the Carbon Plan. The emissions of the UK's electricity generation sector used to power the Proposed Scheme are regulated by the EU ETS, as are EU cement and steel industries which are likely to be used in the construction of the Proposed Scheme. The emissions associated with the total carbon footprint of the Proposed Scheme will therefore be largely regulated through the EU ETS. This means that, overall, most of the Proposed Scheme's carbon emissions will not contribute to an increase in Europe-wide carbon emissions.
- 2.5.6 Additionally, GHG emissions from journeys made by road and classic diesel rail that are currently not traded within the EU ETS cap, which will be taken on the Proposed Scheme through mode shift, will become tradable within the EU ETS cap.
- 2.5.7 GHG emissions not regulated by the EU ETS, predominantly from construction, will be managed through other policy tools as part of the Climate Change Act target of at least an 80% reduction in emissions by 2050. HS2 Ltd is committed to minimising carbon emissions both in the traded and non-traded sectors by implementation of its Sustainability Policy.
- 2.5.8 Transport is a significant source of carbon emissions, however rail represents a very small proportion of total UK transport emissions. Latest UK GHG emission figures published by the Department of Energy and Climate Change (DECC) in 2013 indicate that transport accounted for 25% of overall UK GHG emissions in 2011⁴⁸ of which 91% came from road transport and 3% came from railways.
- 2.5.9 The role of transport in the UK's low carbon future includes encouraging a shift to lower-carbon modes, and was one of the considerations in rejecting modal alternatives such as increasing domestic aviation capacity. While the Government is encouraging the development of low emission road vehicles, building new motorways would still lead to significantly more transport emissions in the short-to medium term. A high speed line is likely to be one of the most carbon efficient solutions and is also considered to draw an optimum balance between carbon reduction and economic benefits. Furthermore, the carbon footprint of high speed rail is likely to be reduced in future as the energy supply is decarbonised, i.e. as Britain moves away from using gas, oil and coal-fired power stations.
- 2.5.10 The Climate Change Act 2008 also created a framework for building the UK's ability to adapt to climate change. The Act gives the Secretary of State for the Environment the power to direct Government Departments and reporting authorities, (i.e. organisations with functions of a public nature and statutory undertakers, which include major transport infrastructure companies), to produce reports on the current and future predicted impacts of climate change on their organisation and to set out proposals for adapting to this change.
- 2.5.11 The Act requires Government to develop and implement a National Adaptation Programme (NAP)⁴⁹, following the publication of a Climate Change Risk Assessment⁵⁰, to

⁴⁸ Official Statistics: Final UK Greenhouse gas emissions (5 Feb 2013), from DECC Online: <https://www.gov.uk/government/publications/final-uk-emissions-estimates>, Accessed 4 November 2013.

⁴⁹ Her Majesty's Government (2013), *The National Adaptation Programme, Making the country resilient to a changing climate*, Her Majesty's Stationery Office.

⁵⁰ Her Majesty's Government (2012), *UK Climate Change Risk Assessment: Government Report*, Her Majesty's Stationery Office.

help build this resilience. The current NAP will be reviewed every five years and will continue to set the framework for how government, businesses, communities and civil society should prepare for and adapt to climate change. As described in the NAP, the design and EIA processes are required to incorporate consideration of climate change implications. More specifically, the NAP states that "DfT is the sponsor for the High Speed 2 (HS2) rail route and has required HS2 Ltd to incorporate consideration of climate change implications in its design and Environmental Impact Assessment processes".

- 2.5.12 The Proposed Scheme has taken climate change impacts and risks into account when forming its approach to adaptation and resilience. Further information is contained within Section 9.6 and the resilience assessment reported in Volume 5: Appendix CL-003-000. In relation to the Proposed Scheme's carbon footprint and GHG assessment, further information is provided within Volume 3: Route-wide effects, Section 5. Information regarding the climate change impact assessment is described in Section 7.5.

2.6 Managing local impacts and effects

- 2.6.1 The Government acknowledges that constructing a new railway in the UK will inevitably lead to a range of adverse local impacts. However, in developing the route between London-West Midlands, impacts have been reduced as far as reasonably practicable. Environmental assessment has been integral to route development and design, initially by way of the AoS and subsequently through preparation of the ES.
- 2.6.2 Where adverse effects have been identified, options for mitigating them have been explored. Mitigation measures that are considered to be effective, reasonably practicable and affordable have been incorporated into the design and management of the Proposed Scheme. A structured approach has been adopted towards mitigation, whereby priority has been given to avoiding adverse effects. Where that is not achievable, the Proposed Scheme has sought to reduce or abate them, or to provide compensation. Further description of the approach to mitigation is provided in Section 9.
- 2.6.3 Local impacts were also identified through the consultation process, which raised a large number of environmental issues. Options for addressing these issues were considered as the alignment and design of the Proposed Scheme evolved. Further details of the consultation process are set out in Section 3.

3 Approach to consultation and engagement

3.1 Overview

3.1.1 Consultation and engagement has been undertaken to encourage a dialogue and exchange of views between HS2 Ltd, local and statutory authorities, individual members of the public and their representatives. Consultation has allowed the public to respond to design development of the Proposed Scheme and to input to decision making through an exchange of views.

3.2 Consultation and engagement to date

3.2.1 Consultation has been a major influence on the development of HS2, particularly in helping to identify and mitigate local impacts. The initial scheme developed by HS2 Ltd was subject to public consultation between February-July 2011 in response to which a range of options were examined to avoid or reduce impacts on sensitive areas; for example, by re-aligning the route or introducing measures such as green tunnels⁵¹. The benefits of such changes were weighed against their cost-effectiveness and against any implications they might have for journey time and thereby wider economic benefits. A Post Consultation Route was published in January 2012⁵², and formed the basis of the scheme that was to be assessed. Further changes were made as the design was refined and the initial conclusions of the assessment emerged.

3.2.2 A draft of the EIA Scope and Methodology Report (SMR) for the ES was issued for consultation in spring 2012 to statutory bodies, non-government organisations (NGO), local authorities and parish councils, and was available on the HS2 Ltd website, allowing comment by local interest groups and the public. As a result of the responses received through the consultation, changes were made to the draft SMR and a report on these changes provided in the consultation summary report⁵³, together with the SMR⁵⁴, which was published in September 2012. This SMR provides the framework within which the draft ES⁵⁵ was prepared.

3.2.3 During preparation of the draft ES, engagement took place with the public through community forums, with NGO through the NGO environment forum, and with local and statutory authorities through planning and national environment forums and sub groups of these. This established a process of dialogue with relevant stakeholder groups. Engagement was undertaken in order to raise awareness of the programme, relevant policies and the documents being produced, and to encourage constructive participation in the consultation process.

Environment forum

3.2.4 The national environment forum involves national representatives of environmental statutory authorities and government departments. The forum meets quarterly and

⁵¹ A cut-and-cover tunnel with soil spread on top to integrate into the landscape, thus minimising visual impacts and making the presence of a railway less noticeable. Access tracks and vegetation can be placed on the surface above the tunnel and it can be used for amenity, parkland and agricultural uses etc.

⁵² Arup (2012), *London to West Midlands Post Consultation Route Engineering*.

⁵³ Arup/URS (2012), *HS2 London to West Midlands EIA Scope and Methodology Consultation Summary Report*.

⁵⁴ Arup/URS (2012), *HS2 London to West Midlands EIA Scope and Methodology Report*.

⁵⁵ HS2 Ltd (2013), *High Speed Two Phase One Draft Environmental Statement*.

provides advice on environmental policy, including project-wide mitigation strategies and principles. Members of the forum include English Heritage, Natural England and the Environment Agency.

Non-government organisation forum

- 3.2.5 HS2 Ltd meets quarterly with the NGO environment forum to discuss technical environmental matters relating to programme, design, environmental impacts and mitigation. NGO forum members include such groups as the Campaign to Protect Rural England, the Campaign for Better Transport, the National Trust, the Wildlife Trust and the Ramblers, amongst others. The NGO forum provides the opportunity for open discussion about environmental and sustainability issues and considers how the Proposed Scheme could contribute to or enhance the environment it passes through.
- 3.2.6 The Minister of State for Transport also holds a quarterly meeting with the NGO environment forum, staggered with those undertaken by HS2 Ltd. This forum allows the Minister to check on the progress of the meetings undertaken with HS2 Ltd and to discuss the concerns and aspirations of the attendant organisations.

Planning forum

- 3.2.7 The planning forum is the main mechanism for discussion on planning matters between HS2 Ltd and the local authorities affected by the Proposed Scheme, and focuses on matters of route-wide interest. The planning forum meetings have typically taken place on a bi-monthly basis or more frequently where required. At this stage the focus of the planning forum is on the planning powers that will be contained with the hybrid Bill.
- 3.2.8 Sub-groups to the planning forum have been established to discuss technical matters on acoustics, heritage and highways associated with the hybrid Bill provisions, and the draft CoCP, in liaison with local authorities.

Community forum

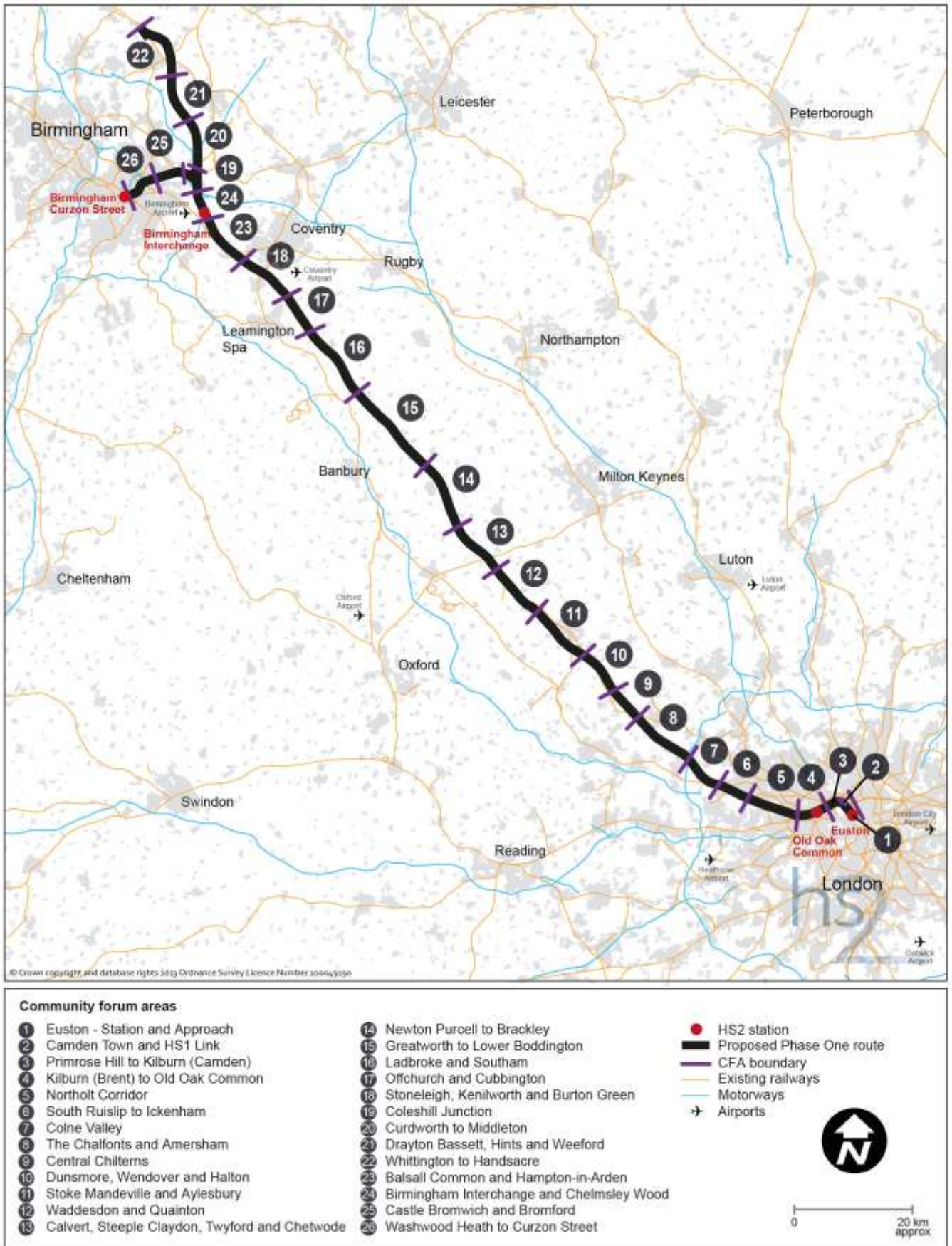
- 3.2.9 Engagement with local communities is taking place primarily through community forums, which were set up in March 2012. The main purpose of these forums includes:
- to inform local people about the Proposed Scheme and consultations and how this might affect them at a local level;
 - to consider local issues and discuss possible ways to avoid and mitigate the potential impacts, such as screening views of the rail corridor and reinstating highways and access routes; and
 - to identify possible community benefits.
- 3.2.10 These community forums are co-ordinated by community representatives and provide a structured mechanism for HS2 Ltd's engagement moving towards deposit of the hybrid Bill. They have been supplemented where necessary by meetings and engagement with organisations and individuals (including those represented on the forums), particularly in relation to specially affected groups. Community forum meetings have generally taken place on a bi-monthly basis.

3.2.11 Table 4 shows the community forum areas (CFA) that have formed the basis for public consultation. These areas are shown on Figure 3.

Table 4: List of community forum areas

Number	Name
CFA1	Euston – station and approach
CFA2	Camden Town and HS1 Link
CFA3	Primrose Hill to Kilburn (Camden)
CFA4	Kilburn (Brent) to Old Oak Common
CFA5	Northolt Corridor
CFA6	South Ruislip to Ickenham
CFA7	Colne Valley
CFA8	The Chalfonts and Amersham
CFA9	Central Chilterns
CFA10	Dunsmore, Wendover and Halton
CFA11	Stoke Mandeville and Aylesbury
CFA12	Waddesdon and Quainton
CFA13	Calvert, Steeple Claydon, Twyford and Chetwode
CFA14	Newton Purcell to Brackley
CFA15	Greatworth to Lower Boddington
CFA16	Ladbroke and Southam
CFA17	Offchurch and Cubbington
CFA18	Stoneleigh, Kenilworth and Burton Green
CFA19	Coleshill Junction
CFA20	Curdworth to Middleton
CFA21	Drayton Bassett, Hints and Weeford
CFA22	Whittington to Handsacre
CFA23	Balsall Common and Hampton-in-Arden
CFA24	Birmingham Interchange and Chelmsley Wood
CFA25	Castle Bromwich and Bromford
CFA26	Washwood Heath to Curzon Street

Figure 3: Community forum areas



Draft Environmental Statement

- 3.2.13 Consultation on the draft ES, draft CoCP and Design Refinement Report took place over an eight week period from 16 May 2013 until 11 July 2013. Copies of the draft ES were made available in public libraries and on the HS2 Ltd website. Twenty-six information events were held at community venues along the Phase One route.
- 3.2.14 Where appropriate, changes have been made to the draft ES, draft CoCP and the Proposed Scheme in response to issues raised by the consultees. A summary of these changes is provided in the Consultation Summary Report (Volume 5: Appendix CT-008-000).

3.3 Future consultation and engagement

- 3.3.1 Parliament will be undertaking a formal public consultation on the ES. Consultees will have 56 days (eight weeks) to respond to the consultation following the deposit of the hybrid Bill documents in Parliament and the first publication of the necessary newspaper notices that follows. Parliamentary officials will appoint an independent assessor who will summarise responses and provide a report to Parliament before Second Reading of the hybrid Bill.

4 The Proposed Scheme

4.1 Introduction

- 4.1.1 This section provides a summary description of the Proposed Scheme, which is shown on Figure 4 to Figure 10. Detailed route descriptions at a local level are contained within Volume 2: CFA report, Section 2.2. A description is also provided of the anticipated services and operating characteristics of the Proposed Scheme. For more information on the main permanent features described below, refer to Section 5.

4.2 Description of the Proposed Scheme

Euston

- 4.2.1 At Euston, the existing station will be upgraded and expanded to accommodate the HS2 services.
- 4.2.2 The remodelled station will extend about 75m to the west of the existing station footprint, but no further south or east. To the west, the station will extend to the eastern side of Cobourg Street and northwards across Cardington Street to Hampstead Road.
- 4.2.3 The western extension will require the demolition of some buildings on Melton Street and Cardington Street, together with buildings at the eastern ends of Euston Street, Drummond Street and Stephenson Way. The extended station and new northern entrance will also occupy the majority of St. James's Gardens.
- 4.2.4 Eleven new 415m long HS2 platforms will be accommodated below existing street level, with access provided from a street level concourse above. A new integrated rail passenger concourse will be created to serve the enlarged station, served from entrances at the front, Cobourg Street, Eversholt Street and a new northern entrance.
- 4.2.5 Thirteen of the 18 existing platforms will be retained, lengthened where necessary, in the area currently occupied by platforms 1-15. The retained platforms will be used by classic rail services. Combined with the number of HS2 platforms, the total number of platforms available at Euston rises from 18 to 24 to enable the provision of increased capacity for services to/from London.
- 4.2.6 Works will be undertaken to improve connections and facilities for existing London Underground services including Northern and Victoria lines and a new direct link to Euston Square underground station.
- 4.2.7 The widening of the rail corridor to accommodate the new station and approach will require the replacement of the existing Hampstead Road Bridge and the removal of housing, including three blocks from the northern part of the Regent's Park Estate. The classic railway lines will remain on the eastern side in the existing cutting, passing under the new Hampstead Road Bridge. The new high speed lines on the west side of the new station will also pass under this bridge, before entering the Euston tunnel.

Euston to Old Oak Common

- 4.2.8 The Euston tunnel will consist of twin-bore tunnels extending for 7.4km (4.6 miles), connected by cross passages at intervals. Commencing at Euston portal, the alignment of

the tunnels will broadly follow the existing WCML rail corridor. The tunnels will be constructed using tunnel boring machines (TBM) and segmental concrete linings.

- 4.2.9 The route will then turn in a westerly direction, passing beneath Kensal Green cemetery and the Grand Union Canal. There will be three ventilation and intervention shafts (vent shafts) connecting the tunnel to the surface, located at Adelaide Road, Alexandra Place and Salusbury Road.
- 4.2.10 The high speed station at Old Oak Common will be accommodated within a sub-surface box structure. The box will be similar in construction to Stratford International station on HS1. It will be on the site of the existing First Great Western (FGW) and Heathrow Express depots, which will be provided for at a different location⁵⁶. Six platforms will be provided for HS2 services. The track layout will be configured to provide two platforms for the HS1 connection. The station will also include eight platforms on the GWML for main line services to the west including Heathrow and Crossrail services.

HS1 Link

- 4.2.11 The HS1 Link will comprise a single-track link from the North London Line (NLL) corridor near Camden Junction to Old Oak Common and will be built to accommodate standard European trains.
- 4.2.12 From the HS1 tunnel near St. Pancras, the link will use the existing junction onto the NLL. It will pass through Camden Road station, which will continue to be used by NLL services, requiring modification of the platform arrangements. It will then continue along the NLL alignment across the Camden viaduct, passing over the Camden Market. Close to the disused Primrose Hill station, the link will enter a single-bore tunnel for 6.3km (3.9 miles), which will cross over the Euston-bound tunnel to run between the two HS2 tunnels and share the same three vent shafts. The HS1 link will emerge from tunnel at the same point as the main HS2 route at the eastern end of Old Oak Common station.

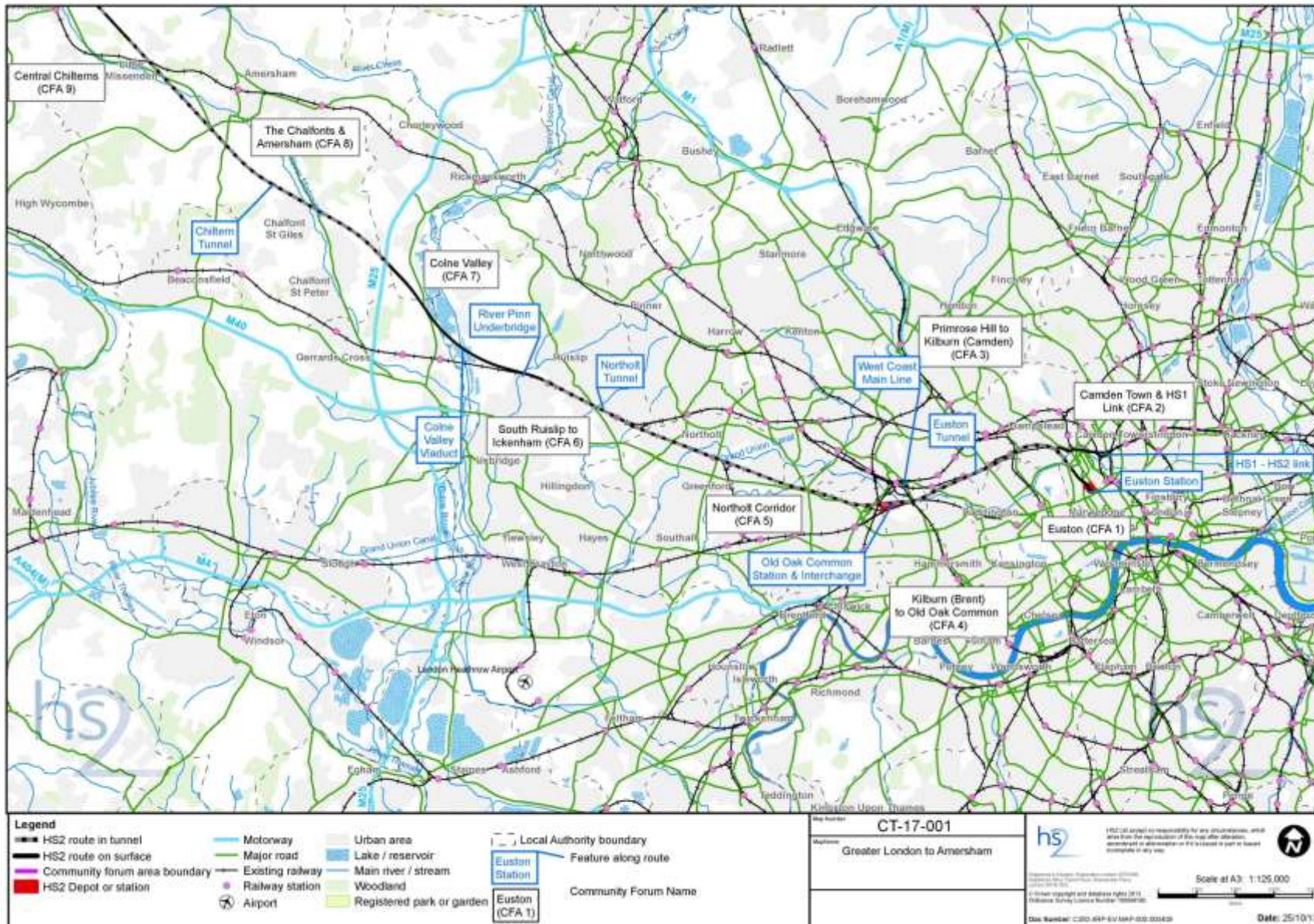
Old Oak Common to the M25

- 4.2.13 At the western end of Old Oak Common station, the route will enter twin-bore tunnels in the vicinity of Wells House Road for 0.3km (0.2 miles), which will connect to the Victoria Road crossover box⁵⁷. The route will then re-enter a twin-bore tunnel for 13.5km (8.4 miles), broadly following the alignment of the Chiltern Main Line and London Underground - Central Line.
- 4.2.14 The tunnel will require four vent shafts, located at Westgate, Greenpark Way, Mandeville Road and South Ruislip. The route will emerge at a portal south of the Ruislip Golf Course in West Ruislip, continuing on the surface with bridges across the River Pinn and Breakspear Road South passing under a realigned Harvil Road and entering the Colne Valley area. The route will then pass onto an approximately 3.4km (2.1 mile) long viaduct. On leaving the viaduct, the route will be on embankments and then in cutting, before passing into the southern portal of the Chiltern tunnel.

⁵⁶ It is proposed to ensure the continued operation of Heathrow Express, Heathrow Connect and First Great Western services by supporting the relocation of the Heathrow Express depot and First Great Western depots to a suitable site. Further information is within Volume 4: Off-route effects.

⁵⁷ A crossover box is a facility to allow a HS2 train to change tracks in the event of a problem such as a broken down train.

Figure 4: Greater London to Amersham



M25 to Little Missenden

- 4.2.15 The Chiltern tunnel will be twin-bore and 13.5km (8.4 miles) long, extending from the M25 to the north-west of Hyde Heath. After passing to the north of Chalfont St. Peter and beneath Chalfont St. Giles, the tunnel will pass beneath the Chilterns Area of Outstanding Natural Beauty (AONB) and follow the Misbourne valley to pass beneath the southern edge of Amersham until it emerges. The tunnel will require four vent shafts, which will be located in the general vicinity of Chalfont St. Peter, Chalfont St. Giles, Amersham and Little Missenden.

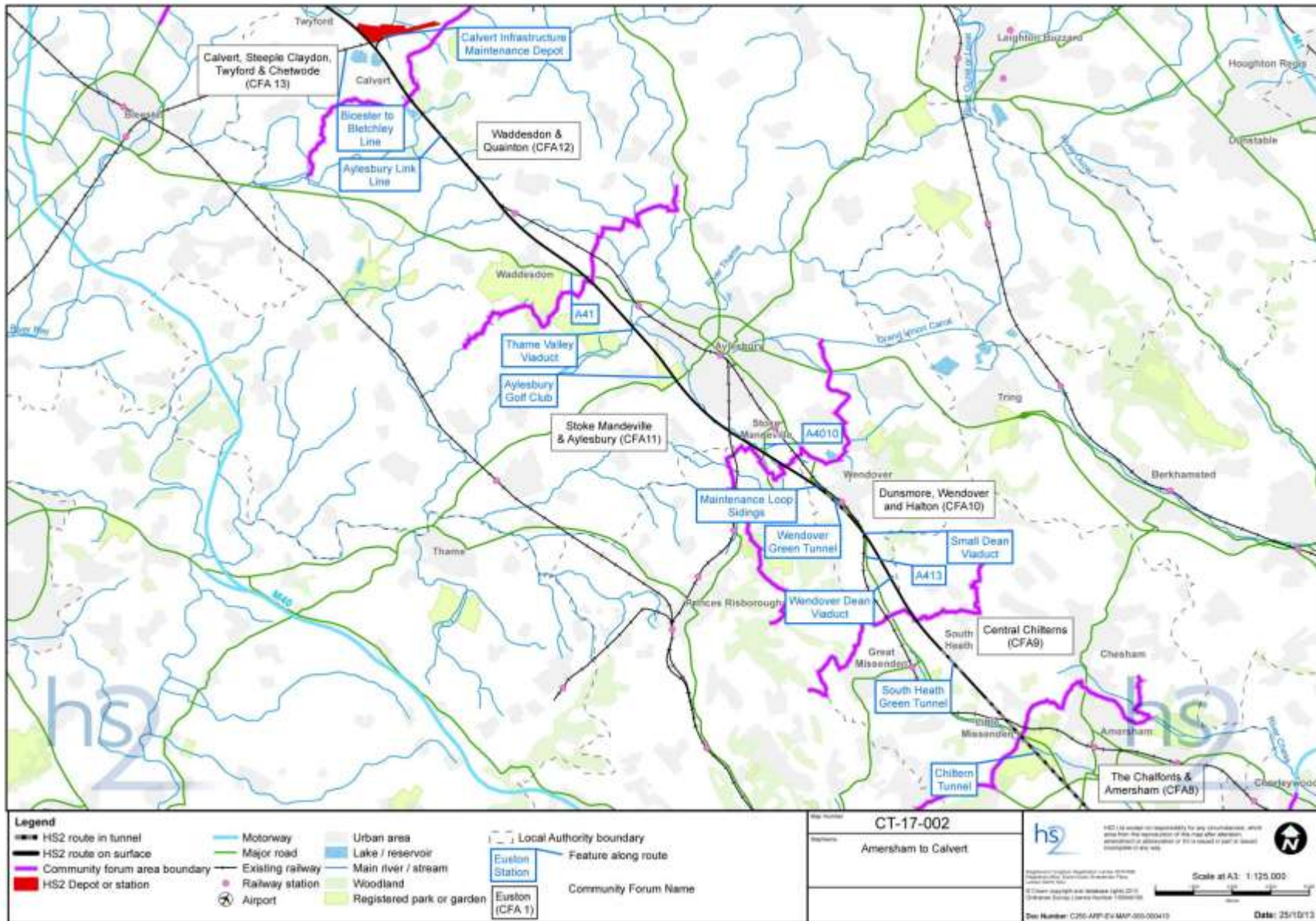
Little Missenden to Aylesbury

- 4.2.16 The route will emerge in cutting on the western side of Hyde Heath, before passing South Heath in a 1.2km (0.75 miles) long green tunnel. It will then descend towards Wendover in cutting then on viaducts to cross Wendover Dean Valley, the A413 and the Marylebone to Aylesbury Line.
- 4.2.17 The route will pass through a 1.3km (0.8 miles) long green tunnel close to Wendover, emerging in cutting before rising onto embankment as it leaves the AONB and approaches the A4010 Risborough Road. A maintenance loop (see Section 5.12) will be constructed at this location, alongside both of the HS2 tracks, to support the efficient maintenance of the railway. The route will then continue north-west, passing on the surface to the south-west of Stoke Mandeville where local highway diversions will create a new southern bypass to the town.

Aylesbury to Calvert

- 4.2.18 Continuing north-west to the west of Aylesbury, the route will pass Hartwell House and pass across the southern edge of Aylesbury Park Golf Club. It will continue in a north-west direction, generally close to ground level, with low viaducts to carry it over floodplains and watercourses. Passing under a realignment of the A41, it will then pass to the east of Waddesdon and run northwards past Quainton. Between Quainton and Calvert the route will run alongside the existing Aylesbury Link railway, before passing under the Bicester to Bletchley railway to the north of Calvert. An infrastructure maintenance depot will be located to the north-east of Calvert, with connecting chords to HS2.

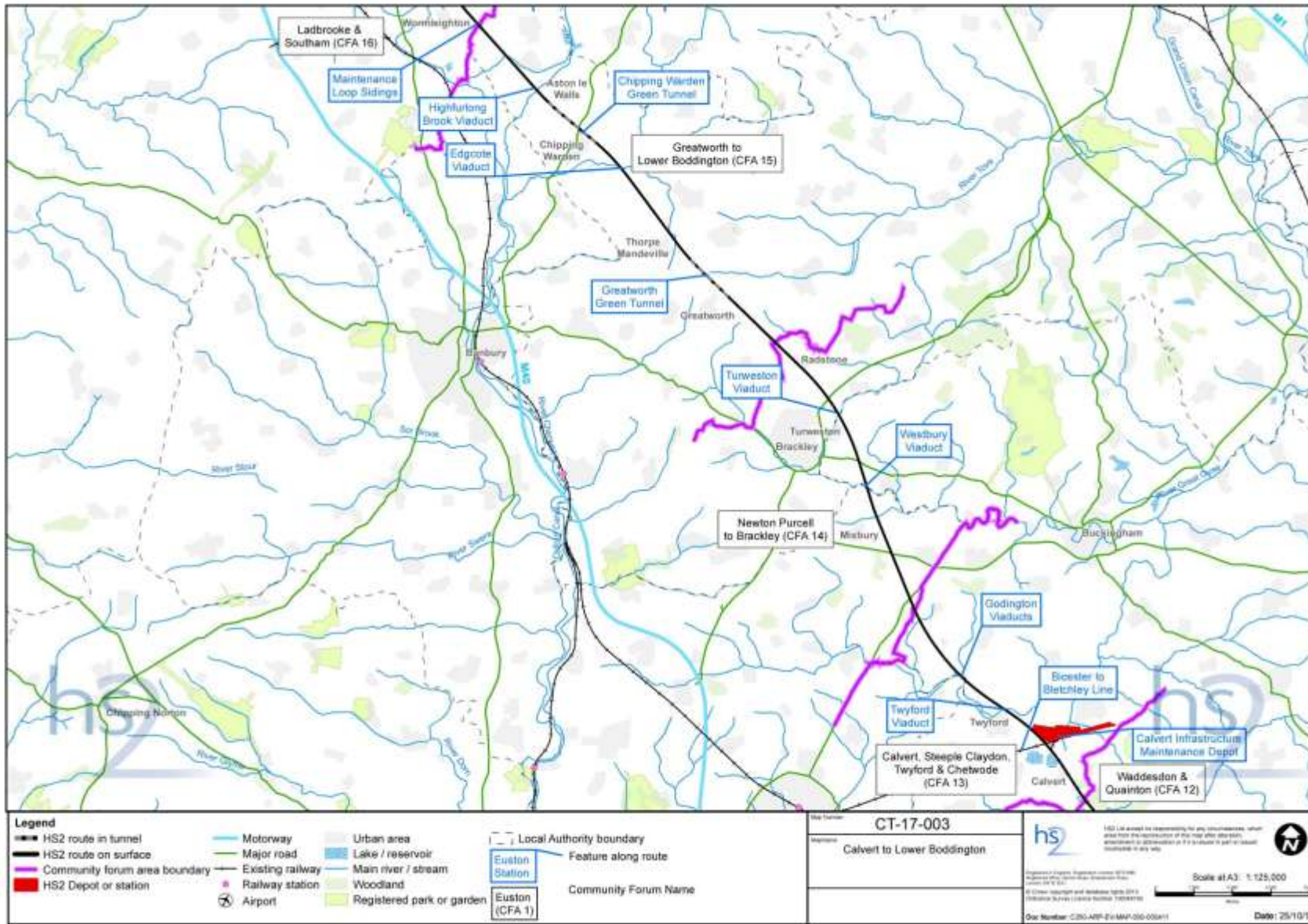
Figure 5: Amersham to Calvert



Calvert to Wormleighton

- 4.2.19 The route will continue running north of Calvert through a series of cuttings between Mixbury and Brackley, passing to the east of Turweston in a deep cutting and crossing the River Great Ouse on viaducts at two locations. Further cuttings and embankments will carry the route towards Greatworth, where it will run through a 2.1km (1.3 miles) green tunnel before passing Thorpe Mandeville and to the east of Edgcote on a viaduct. It will then pass to the east of Chipping Warden in a 2.5km (1.6 miles) green tunnel, and will cross the Highfurlong Brook on viaduct before running on embankment past Lower Boddington. A maintenance loop will be provided in a cutting near Wormleighton.

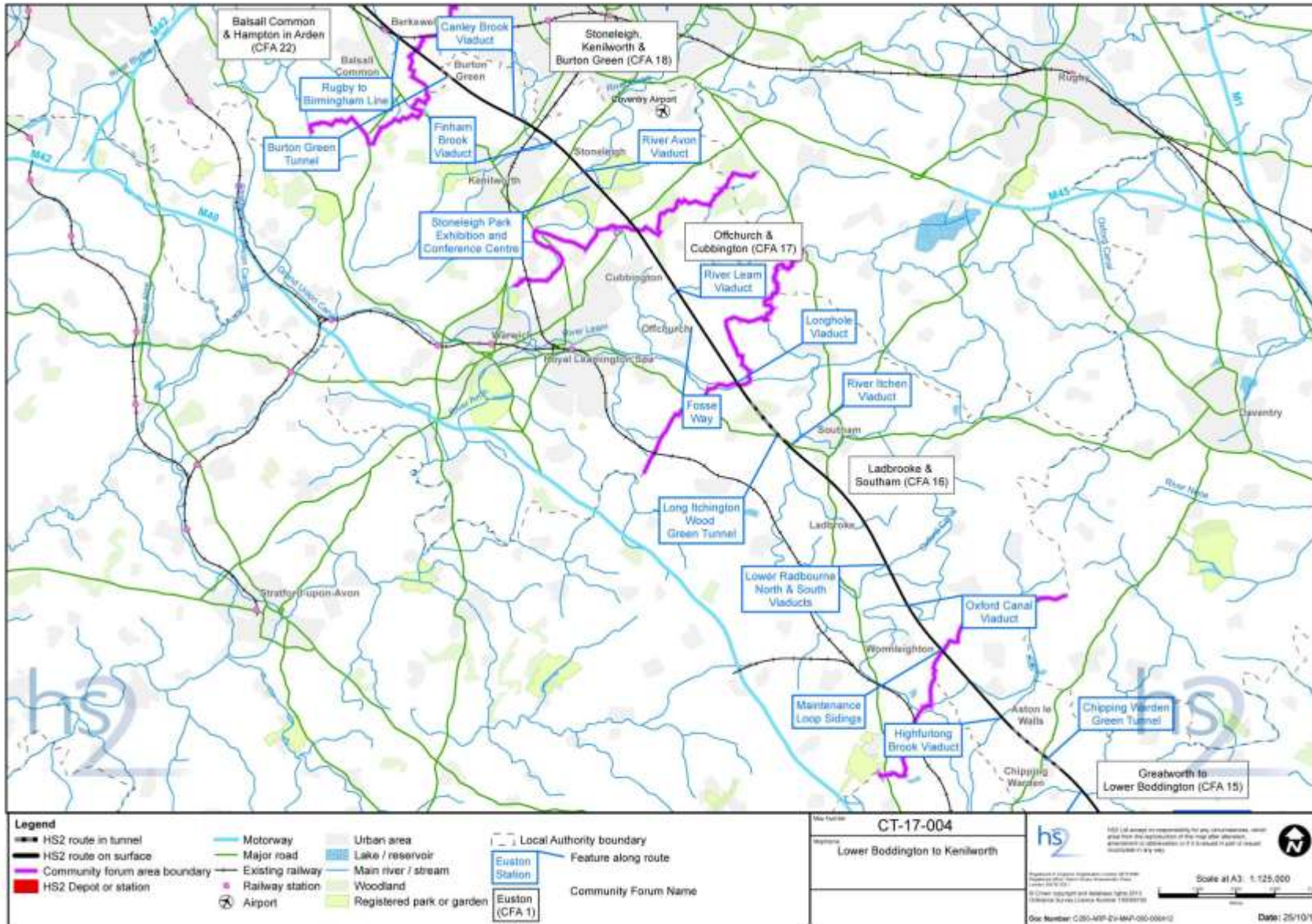
Figure 6: Calvert to Lower Boddington



Lower Boddington to Kenilworth

- 4.2.20 The route will then continue north-west generally on low embankment or at ground level, crossing the Oxford Canal on viaduct. The route continues in a north-west direction with two further viaducts at Lower Radbourne South and Lower Radbourne North. The route will then pass to the north-east of Ladbrooke and south of Southam, crossing the River Itchen on viaduct.
- 4.2.21 Approaching Long Itchington Wood, the route will enter deep cutting before entering a green tunnel for 0.4km (0.25 miles). It will then enter a twin-bore tunnel, with connecting cross-passages, for some 1.5km (0.9 miles) beneath Long Itchington and Ufton Woods. On exiting the tunnel it will cross the Grand Union Canal and enter deep cutting east of Offchurch, continuing north-west at ground level to cross the River Leam. Re-entering cutting, it will cross the southern edge of South Cubbington Wood and the eastern part of the Stoneleigh Park Exhibition and Conference Centre (formerly known as the National Agricultural Centre). It will then continue over the River Avon on viaduct and then beneath the A46 and A429, passing north-east of Kenilworth in cutting.

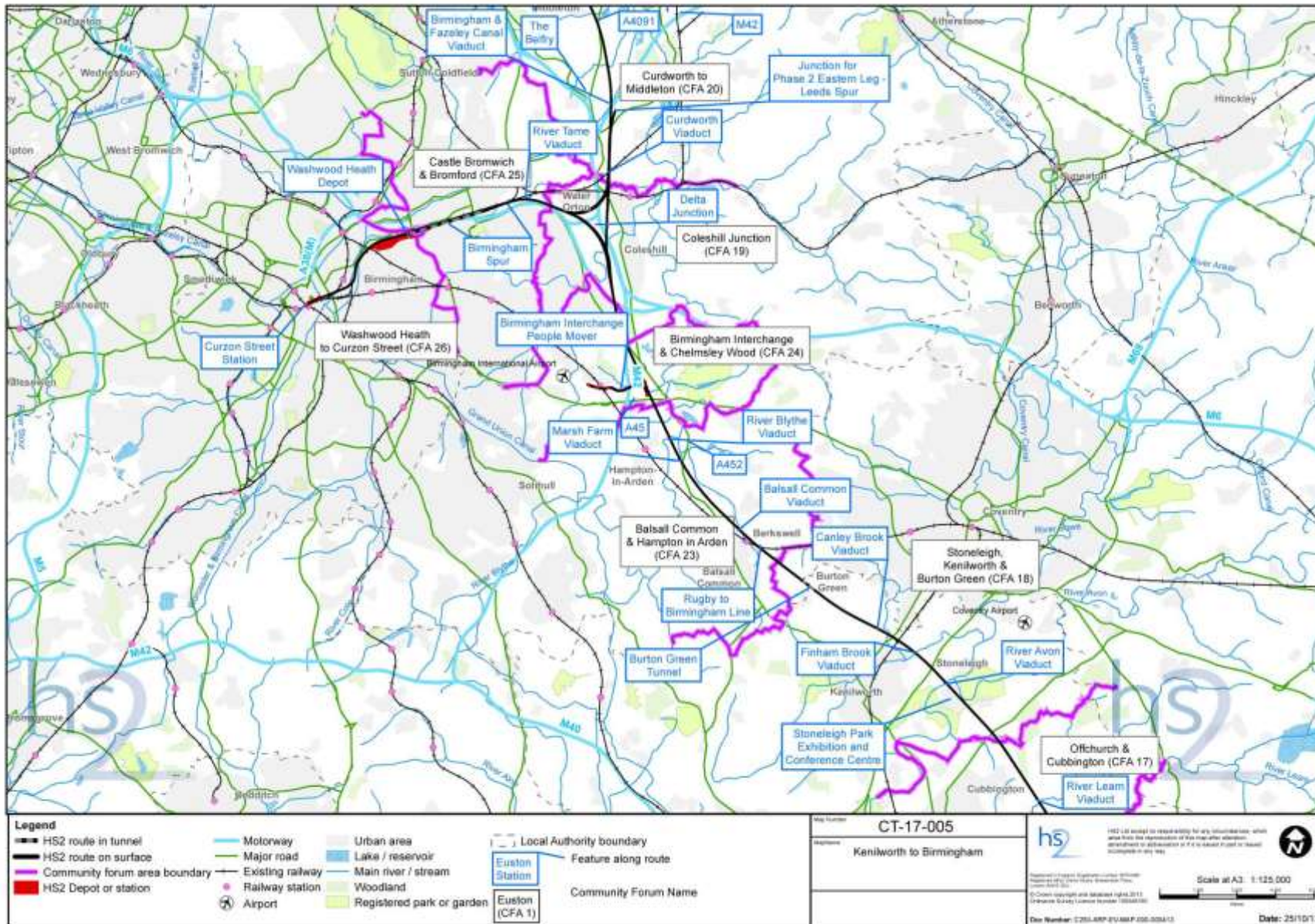
Figure 7: Lower Boddington to Kenilworth



Kenilworth to Water Orton

- 4.2.22 Beyond Kenilworth, the route will pass over Finham Brook and a realigned Canley Brook on viaduct. The route will then join a former rail corridor just south of Burton Green, through which it will pass through Burton Green in green tunnel for 0.6km (0.4 mile) then emerge in cutting. It will then continue towards Berkswell, to the north-east of Balsall Common, crossing over the Rugby to Birmingham Line, before passing to the east of Berkswell station on viaduct.
- 4.2.23 The route will then run alongside the A452 on embankment to the north of Balsall and Bradnock's Marsh. To the east of Hampton-in-Arden, the A452 and the A45 will be raised to pass over the route as it continues towards the proposed Birmingham Interchange station.
- 4.2.24 The interchange station will be located close to the NEC and just to the east of the M42. The station will consist of four platforms. A people mover will provide a direct link between the new station, the NEC, Birmingham Airport and Birmingham International station (Rugby to Birmingham Line). Road access to the station will require work to the A452, the A45, and bridges at M42, junction 6 and M6, junction 4.
- 4.2.25 South of the station the alignment will widen to four tracks, with the outer two tracks splitting again to create four platform lines and two through lines. North of the station the route will return to four tracks.
- 4.2.26 To the west of Coleshill, the route continues broadly parallel to the M42, with the outer pair of lines splitting to create two tracks into central Birmingham, whilst four tracks continue to the north crossing the River Cole, M42/M6 toll, A446 Lichfield road, Birmingham to Nuneaton railway, River Tame and the Birmingham to Derby railway on viaduct.

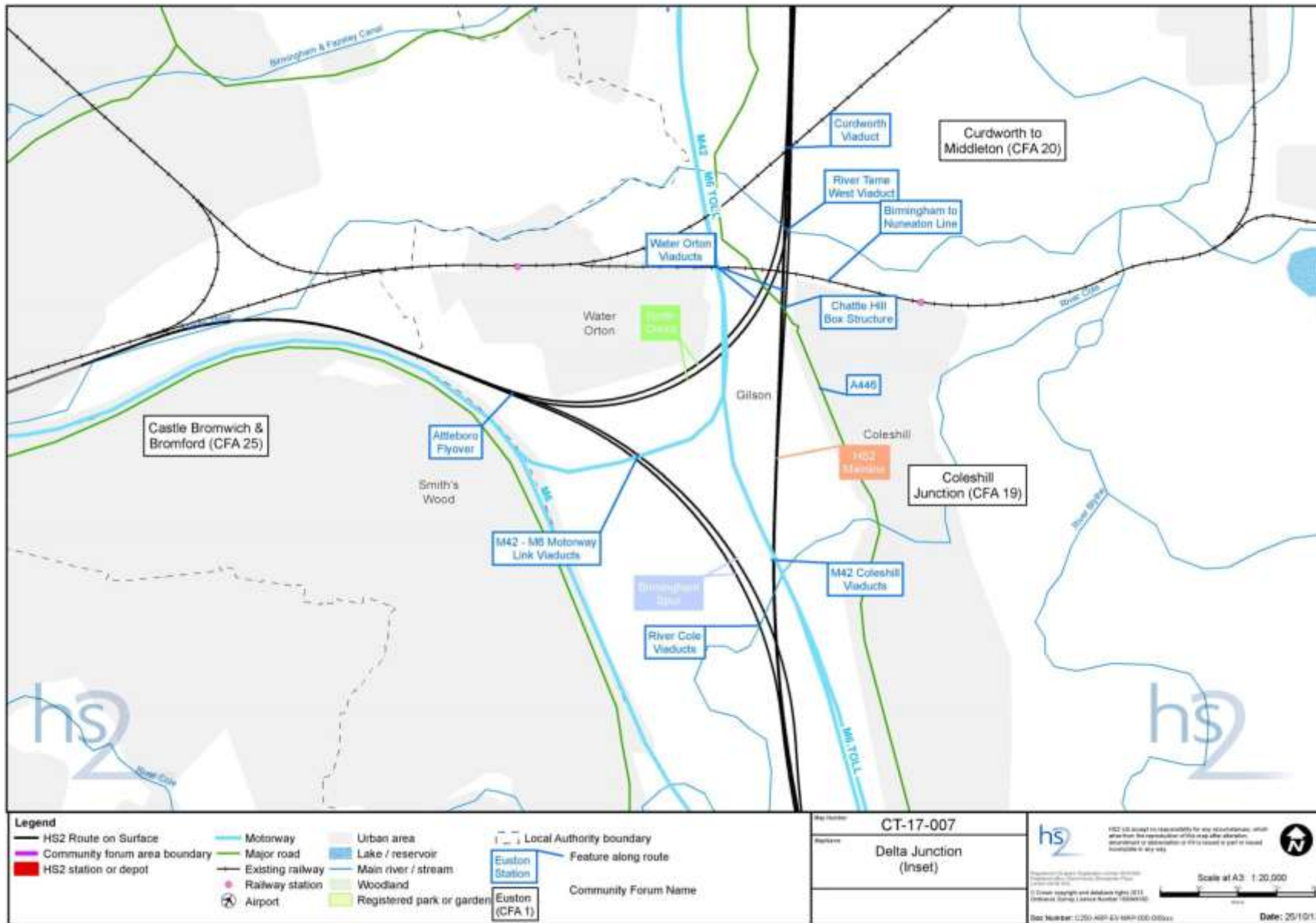
Figure 8: Kenilworth to Birmingham



Birmingham link and terminus

- 4.2.27 The spur line into central Birmingham will be carried over the River Cole and the M42/M6 link road on viaduct, before swinging west of Water Orton. A link is provided from the Birmingham Spur to the northbound main line route. This north chord runs from its connection on the Birmingham Spur in the west around the southern perimeter of Water Orton. It then crosses the M42/M6 Toll, the A446 Lichfield Road, the Birmingham to Nuneaton Line and River Tame on viaduct. It re-joins the HS2 mainline near Hams Hall Business Park.
- 4.2.28 The Birmingham spur, north chord and the HS2 mainline together make up the delta junction as shown on Figure 9. The overall form of the junction will accommodate through services between London and the route northwards, and services to and from Birmingham to the north and south respectively.

Figure 9: Delta Junction



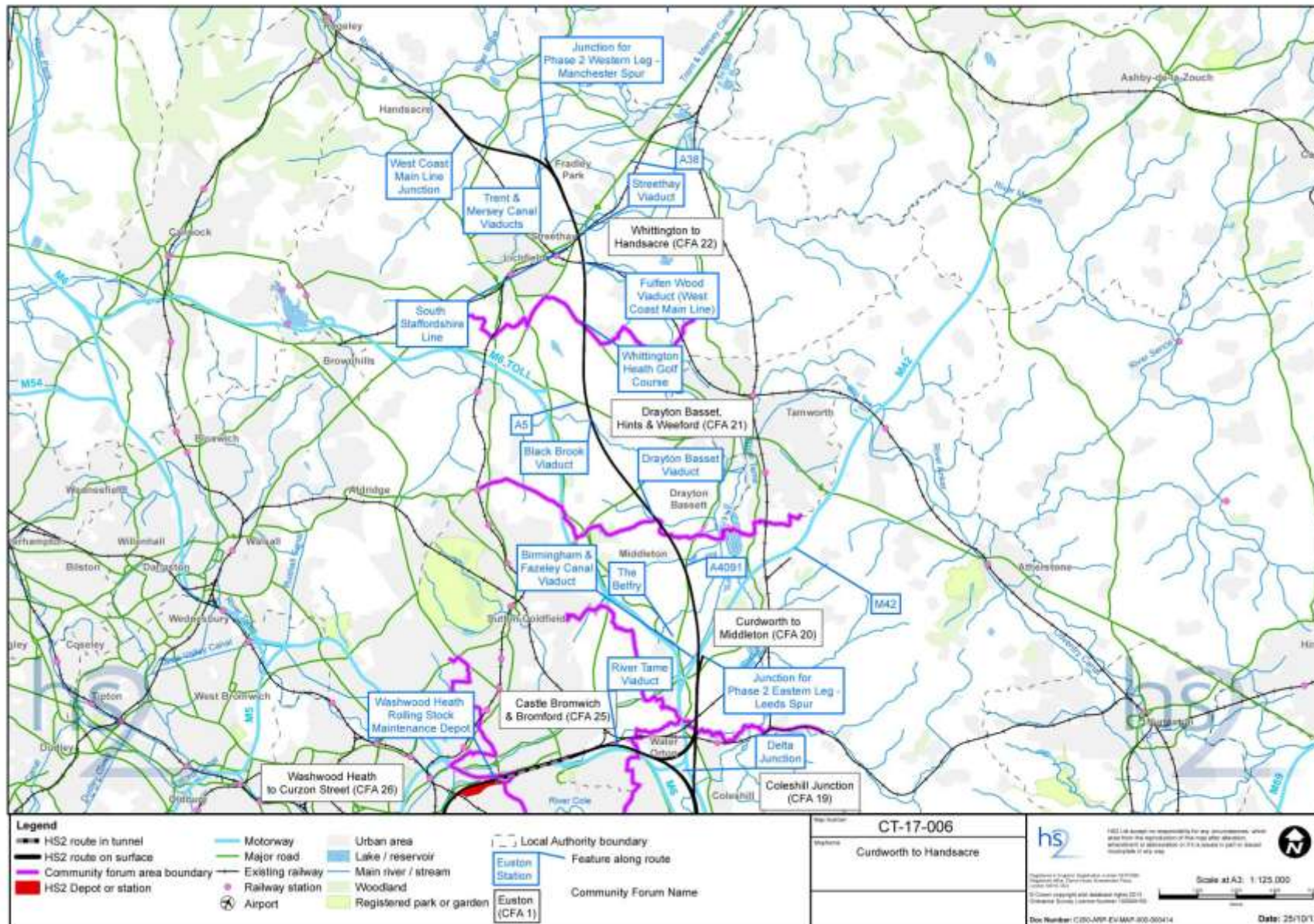
- 4.2.29 The route will run on the southern side of the existing Birmingham to Derby railway at Parkhall Local Nature Reserve, before entering a twin-bore tunnel 2.9km (1.8 miles) long to pass under the A452 Chester Road, Bromford Drive, the River Tame and the A4040 Bromford Lane/Heartlands Parkway junction. Emerging at ground level to the west of Bromford Lane, the route will follow the southern side of the existing railway to Aston Church Road. A train stabling facility and rolling stock maintenance depot for HS2 trains will be provided at Washwood Heath.
- 4.2.30 The route will then pass under the Stechford to Aston railway, and Aston Church Road, which will be re-aligned to create adequate headroom, before crossing over the Grand Union Canal and under the B4114 (Saltley viaduct). The road will require reconstruction to create the necessary headroom. From the B4114, the route will be carried on a viaduct, crossing to the northern side of the existing railway before continuing towards the proposed Birmingham Curzon Street station, which marks the western terminus of the Proposed Scheme.
- 4.2.31 The proposed Birmingham Curzon Street station, located within Birmingham Eastside, will occupy land south of Curzon Street from near Curzon Gateway in the east, to Moor Street Queensway at its western extent. Seven platforms will be provided to serve the 400m long trains. The main entrance of the station will be at the western end fronting onto Moor Street, with an additional lower eastern entrance beneath the platforms.

Water Orton to Handsacre

- 4.2.32 To the north of the delta junction, a junction will be constructed at A4097 Kingsbury Road which will allow connection to the proposed Phase Two Leeds spur and the Kingsbury Road railhead⁵⁸. The route will return to two tracks and continue north, passing over the M42 and the Birmingham and Fazeley Canal.
- 4.2.33 The route will continue northwards, passing to the east of The Belfry golf course and the village of Middleton, with viaducts carrying it across floodplains, requiring a diversion of the A4091. To the north of Middleton, the route will cross a number of watercourses on viaduct before passing in cutting to the west of Hints. Continuing northwards, the route will cross Bourne brook on viaduct before passing under the raised A5. The route will continue through the Whittington Heath Golf Course and towards Streethay, crossing a watercourse on viaduct.
- 4.2.34 The route will pass about 400m to the north-east of Streethay on a viaduct, which will carry it over the South Staffordshire railway and the A38. A junction will be constructed alongside Fradley Park, splitting the route. Two through lines will extend just to the north of the Trent and Mersey Canal to allow the connection to the proposed Phase Two Manchester spur. The other two lines will turn westwards to form a grade-separated junction with the WCML about 1km (0.5 miles) south of Handsacre.

⁵⁸ Railheads are where bulk delivery or despatch of materials or equipment will take place via the existing rail network. More information is provided in Section 6.25.

Figure 10: Curdworth to Handsacre



4.3 Services and operating characteristics

Overview

- 4.3.1 Making the most of the additional capacity created by HS2 will be crucial if its full benefits are to be realised. Railway timetables are always evolving in response to demand, and at this stage in the project it is too early to make detailed commitments about how HS2 will operate. However, a provisional service pattern has been identified in order to test the Economic Case and to provide an operational specification for the Proposed Scheme.
- 4.3.2 It is envisaged that passenger services will operate between 05:00 and 24:00 from Monday to Saturday and 08:00 and 24:00 on a Sunday. Maintenance will occur outside these hours, unless it can take place in such a way that allows trains to operate at the same time. Passenger services will start at or after 05:00 from the terminal stations and will progressively increase to the number of trains per hour in each direction on the main lines as discussed below and as detailed within the Volume 2: CFA reports. The number of services is assumed to operate every hour from 07:00 to 21:00. The number of services will progressively decrease after 21:00 and the last service will arrive at terminal stations by 24:00.
- 4.3.3 When Phase One alone is operational, the London-West Midlands route will be used by two types of service:
- services operating between London and Birmingham using standard European sized high speed trains (referred to as captive trains); and
 - services running between London and destinations north of the West Midlands, using specially designed high speed trains that are also capable of running on the existing UK rail network (referred to as classic compatible trains).
- 4.3.4 It is assumed that classic compatible high speed trains operating between London, Manchester, Liverpool and Glasgow will comprise two 200m long trains coupled together or single 200m long trains. Trains are expected to be 400m long during peak hours and a mix of 200m and 400m long trains at other times. Up to 550 passengers will be accommodated on each 200m long high speed train (i.e. up to 1,100 passengers for each two-unit train). To enable these trains to operate on the classic network, they will be equipped with a suitable train control system and will be of a reduced width and height.
- 4.3.5 The forecasted journey times from London (assuming high speed operation from London to the West Midlands, with onward running via the classic network on WCML, and station stops at Old Oak Common and elsewhere) are set out in Table 5.

Table 5: Assumed journey times for Phase One

Destination from Euston	Journey time (hours: minutes)
Solihull - Birmingham Interchange station	00:38
Birmingham - Curzon Street station	00:49
Manchester - Piccadilly station	01:40
Liverpool - Lime Street station	01:50
Preston - Preston station	01:48
Glasgow - Glasgow Central station	04:00

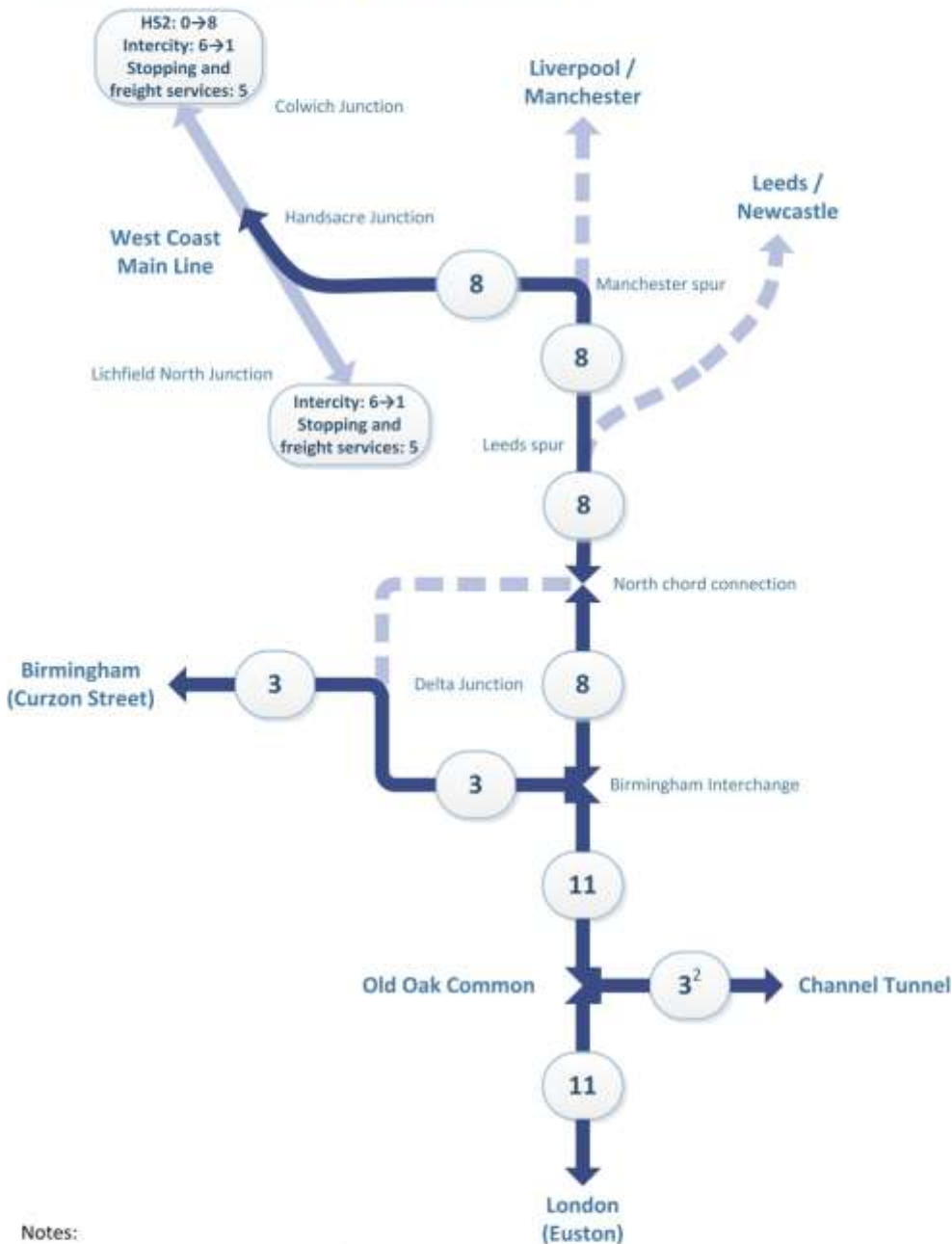
- 4.3.6 The figures below show the peak hour train flow in each direction across Phase One that have been assumed for the purpose of the ES. The currently assumed initial service pattern (year of opening) is for 11 trains per hour (tph) in each direction during peak hours (refer to Figure 11). Based on the current requirements, it is anticipated that the main route of the Proposed Scheme could operate up to 14tph in each direction during peak hours (Figure 12), increasing up to 18tph in each direction during peak hour once Phase Two becomes operational. At the delta junction between the north chord connection and the Leeds spur, there will be up to 22tph in each direction during peak hour (refer to Figure 13). The flows principally used for the sound, noise and vibration assessment are those shown for Year 15, i.e. with Phase Two operating.

Figure 11: Assumed train flow (year of opening)

Assumptions for Sound, Noise & Vibration Assessment

NB. These train flows represent a reasonable worst case for each section of line for assessment purposes only and do not represent a timetable for the Proposed Scheme.

Proposed Scheme - Year of Opening Peak hour one-way train flow per route section

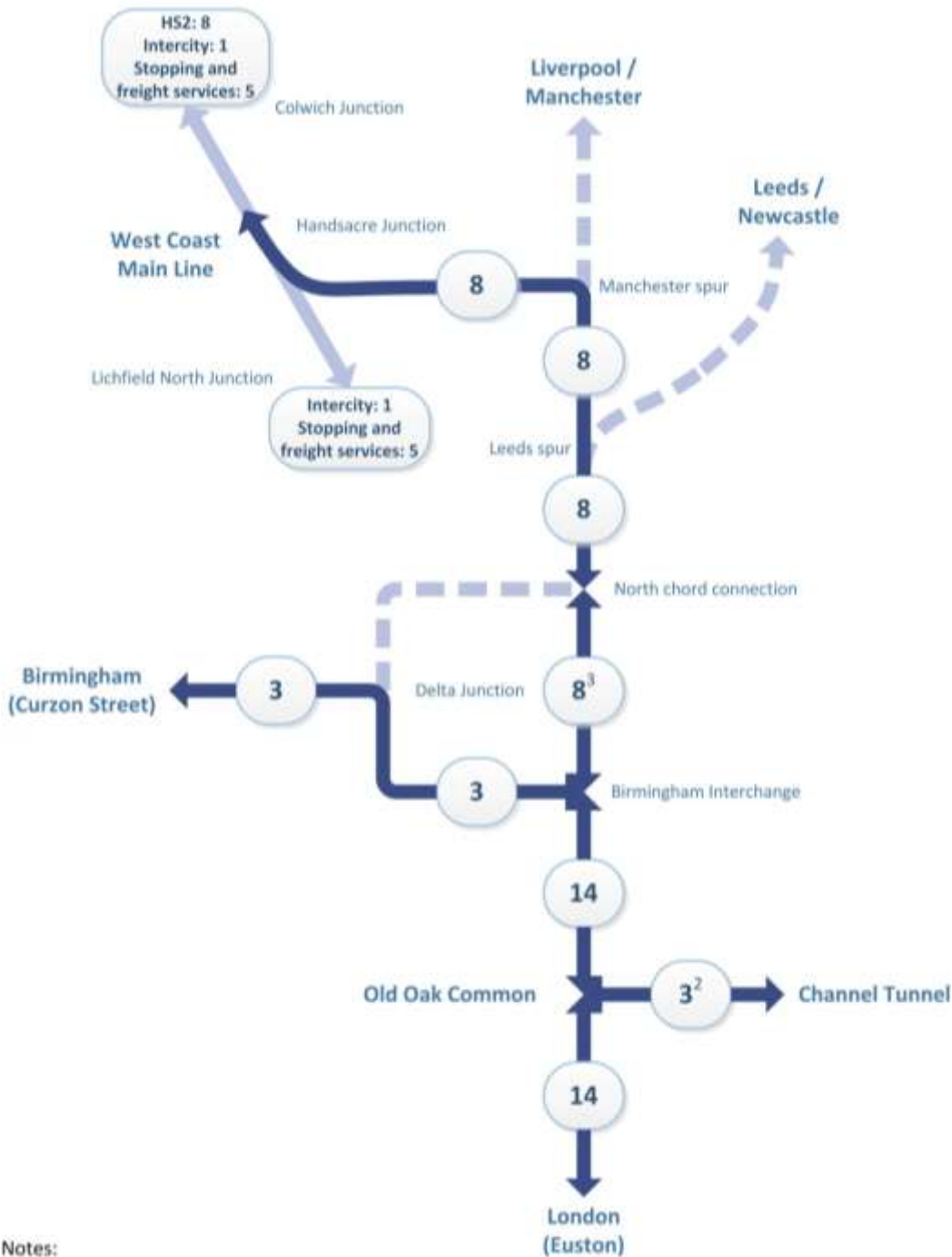


Notes:

- 1) Indicated flows are the number of trains assumed for the assessment.
- 2) Any Channel Tunnel train services continuing onto the HS2 infrastructure would substitute for services out of London (Euston)
- 3) Flows for Intercity, local stopping and freight services at Lichfield North Junction and Colwich Junction are indicated prior to and following introduction of the Proposed Scheme, e.g. x→y.

Figure 12: Assumed train flow (with growth)

Proposed Scheme - with growth
Peak hour one-way train flow per route section

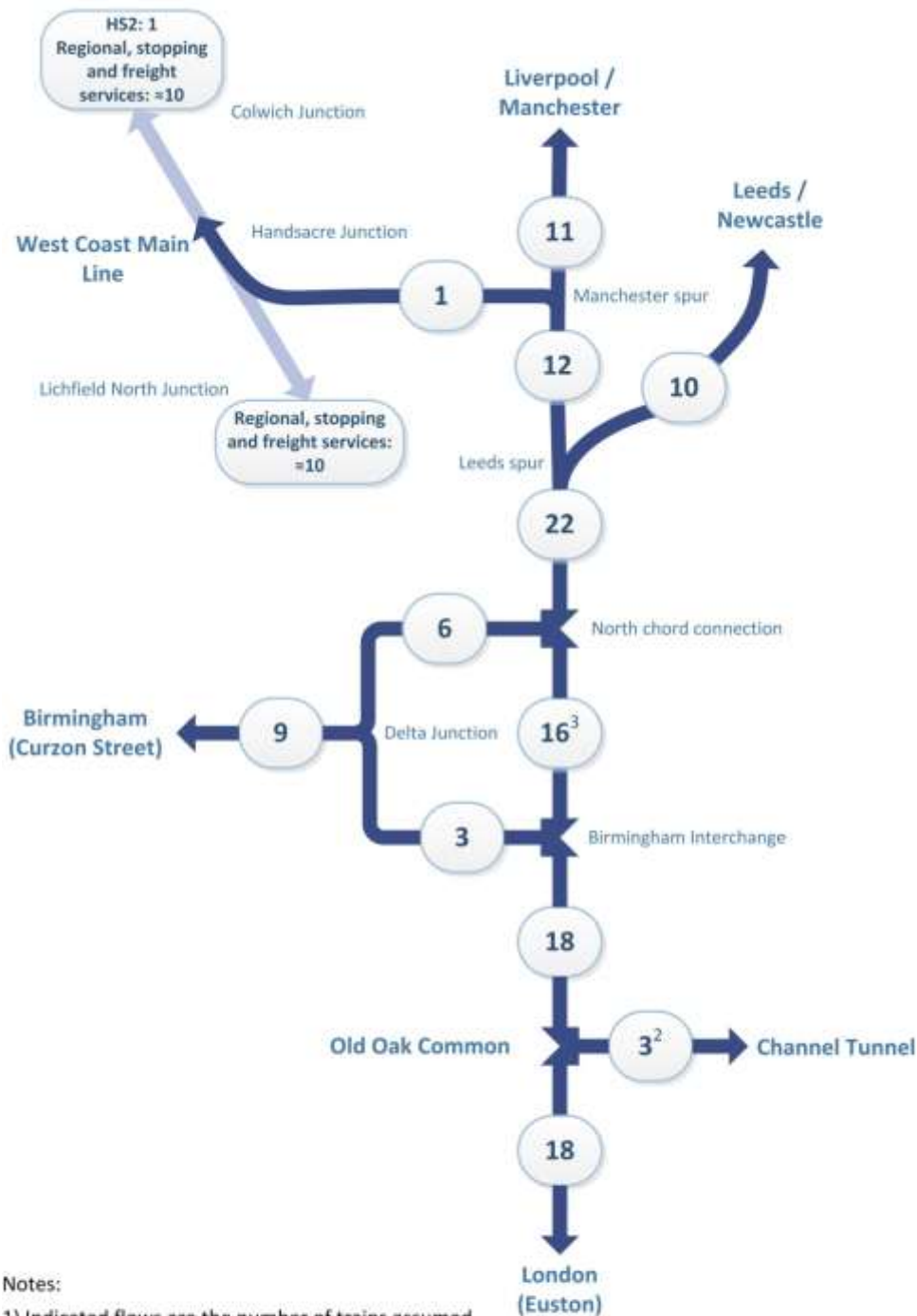


Notes:

- 1) Indicated flows are the number of trains assumed for the assessment.
- 2) Any Channel Tunnel train services continuing onto the HS2 infrastructure would substitute for services out of London (Euston)
- 3) Indicated flows are the number of trains which could operate due to capacity limitations on the West Coast Main Line.

Figure 13: Assumed train flow (year 15 with HS2 Phase Two operational)

**Proposed Scheme - Year 15 (with HS2 Phase Two)
Peak hour one-way train flow per route section**



Notes:

- 1) Indicated flows are the number of trains assumed for the assessment.
- 2) Any Channel Tunnel train services continuing onto the HS2 infrastructure would substitute for services out of London (Euston)
- 3) An additional service is created to the north when a London - Birmingham (Curzon Street) train divides into two services at Birmingham Interchange Station.
- 4) Indicative flows for regional, local stopping and freight services at Lichfield North Junction and Colwich Junction are shown following introduction of HS2 Phase Two.

- 4.3.7 Trains on the Proposed Scheme will operate at up to 360kph (225mph)⁵⁹. However, the alignment of the route has been designed to allow for train speeds of up to 400kph (250mph) in the future, should there be a commercial justification for doing so. Operation at up to 400kph will require demonstration that improved train design enables services to operate at that higher speed without giving rise to additional significant environmental effects.
- 4.3.8 The operating speeds over each section of the route are anticipated to be as follows:
- between Euston station and Old Oak Common station – up to 230kph (140mph);
 - between Old Oak Common station and the Chilterns tunnel – up to 360kph;
 - between the Chilterns tunnel and Birmingham Interchange station – up to 360kph;
 - between Birmingham Interchange station and Handsacre (junction with WCML) – up to 360kph; and
 - between Birmingham Interchange station and Curzon Street station – up to 230kph.
- 4.3.9 The technical and operational specification for the Proposed Scheme is derived from the European Union’s Technical Specification for Interoperability (TSI)⁶⁰, which defines the requirements for all new high speed railways and their connections to classic rail networks.

Operational interfaces with other rail services

- 4.3.10 The Proposed Scheme will interface with other public transport modes at numerous locations. The main points of operational interface are summarised in Table 6. All stations are assumed to offer interchange opportunities with buses, taxis, cycling and walking.

Table 6: Operational interfaces with other rail services

Location	Relationship to other transport services
Euston station	Interchange with WCML, commuter and London Underground services and other rail services which use the station (e.g. sleepers to Scotland).
HS1 connection	Section of NLL corridor to be shared with London Overground and freight services.
Old Oak Common station	Interchange with Crossrail and GWML services.
Calvert	Connection to Oxford to Bletchley Line (part of future East West Rail Line) for HS2 maintenance traffic.
Birmingham Interchange station	Interchange (by people mover) with Birmingham International station and Birmingham Airport.
Curzon Street station	Curzon Street station will be designed to take account of the proximity between Curzon Street and Moor Street stations
Handsacre	Junction with WCML for onward running by classic compatible services.

- 4.3.11 Classic compatible trains will operate over the classic rail network at speeds no greater than existing services and will use the existing traction power electrification. Any

⁵⁹ Timetables are likely to use 330kph as a basis for most trains (assumed 90% of services), and 360kph for 10% of services.

⁶⁰ European Railway Agency. Multiple Technical Specifications for Interoperability (TSI).

requirement for upgrading existing infrastructure will be relatively minor and will be implemented as part of Network Rail's routine activity.

- 4.3.12 There may be further minor works required to the classic rail network in future to accommodate growing demand for passenger and freight services, together with HS2 services. Should those works give rise to significant adverse effects likely to require further application for consents or approval, they will require assessment at that stage.

Maintenance of operational infrastructure

- 4.3.13 The main elements of the maintenance regime include:

- inspection and proactive monitoring to predict and prevent failure: this will be achieved through automatic remote condition monitoring of electrical and mechanical assets and by the frequent operation of diagnostic trains to measure track and overhead line geometry against reference tolerances. Examination of viaducts and tunnels will be carried out from rail-mounted vehicles equipped with appropriate lifts and access platforms. Maintenance staff will also access tunnels via vent shafts to undertake regular maintenance and inspection. The mechanical ventilation equipment within vent shafts and portals are only operated for limited testing periods during the daytime⁶¹, or in the event of an emergency;
- routine servicing of electrical and mechanical equipment including lineside locations such as auto transformer stations with access provided by road or from rail-mounted vehicles;
- preventative maintenance: for track will include the use of dedicated works trains for track alignment correction on the ballasted track, and grinding of rails for both ballast and slab track and other heavy duty operations. For other equipment this may include 'maintenance by replacement' whereby components are exchanged, to be serviced offline in a depot or factory;
- planned periodic heavy maintenance: this includes replacement of mechanical and electrical equipment, especially around switches and crossings;
- renewal: during the economic life of the railway, all elements of the railway system will need to be replaced on the basis of condition criteria. However, civil infrastructure such as tunnels and viaducts will be maintained in perpetuity through servicing and repair of structural elements to avoid the need for replacement; and
- obsolescence management: control and telecommunication systems and other software based elements will require replacement at more frequent intervals, depending on technological developments and obsolescence.

- 4.3.14 The assumptions underpinning the maintenance regime include:

- within the operational rail corridor maintenance will take place between the hours of 24:00-04:59 on Monday to Saturday and 24:00-07:59 on Sunday, outside passenger train operating hours;

⁶¹ For example, HS1 vent shaft fans are tested monthly.

- design, system and process will separate maintenance activity and staff from operating passenger trains;
- safe worksites⁶² will be established by isolating and earthing traction power supply from the control centre. Coordination between power and traffic control will allow quick and efficient access;
- where reasonably practicable, mechanical and electrical equipment will be located to allow servicing from a safe and secure location and without affecting operations;
- maintenance affecting services will be largely mechanised and done from rail based vehicles, including the use of mobile factory trains⁶³; and
- maintenance trains will normally be diesel powered and may have the capability of establishing a local earth, in order to maximise working time (although they will have secondary power sources for local site movements and to power work equipment).

Maintenance depots and operational staff

- 4.3.15 Infrastructure maintenance operations, including routine line checks and replacement of track and overhead line equipment (OLE), will be managed and resourced from the proposed depot at Calvert. Maintenance planning and rolling stock maintenance will be conducted from Washwood Heath.
- 4.3.16 The principal infrastructure maintenance activities will be managed and resourced from the infrastructure maintenance depot (IMD) at Calvert. Activities will include: support of rail maintenance vehicles that will carry out track inspections; rail grinding; ballast track alignment geometry correction and cleaning; overhead line maintenance; inspection of structures and earthworks. These activities already take place on the classic network and will generally occur when train services are not operating. Associated plant and material will also be stored and transported to site by rail, supported by two maintenance loop facilities, (refer to Section 5.12), located near Stoke Mandeville in Buckinghamshire and near Wormleighton in Warwickshire. The Calvert IMD will be operational 24 hours a day, 365 days a year and up to 300 maintenance staff will be required to undertake these works.
- 4.3.17 During train service hours, staff will be involved in the control and movement of trains and in a range of customer service activities.
- 4.3.18 Other maintenance and repair activities for systems such as traction power distribution or train control will largely be carried out away from the operational railway.
- 4.3.19 At Washwood Heath depot, activities will include rolling stock maintenance and routine cleaning, servicing and repairs, supported as necessary by stabling facilities. There will be two stabling yards where trains are cleaned and stabled overnight, one at the eastern side and the other in the centre of the site. The stabling yards comprise sidings where trains will be parked. Each stabling track will be up to 420m long and able to hold two train sets. The facility will be operational 24 hours a day, 365 days a year with up to 500 staff working

⁶² A 'worksite' is an area which is principally used for the purpose of construction works.

⁶³ A train that carries all necessary equipment and supplies to carry out the required maintenance activities of the track and rail corridor. The trains may be stationed at depots, or on maintenance loop sidings (allowing maintenance at night at more remote locations). It can also carry workers required for maintenance. The use of mobile factory trains avoids the need to have equipment and materials being delivered to the trackside via lorries.

in shifts either in jobs within the depot (maintenance and support staff) or to start or finish their day at the depot (e.g. train drivers).

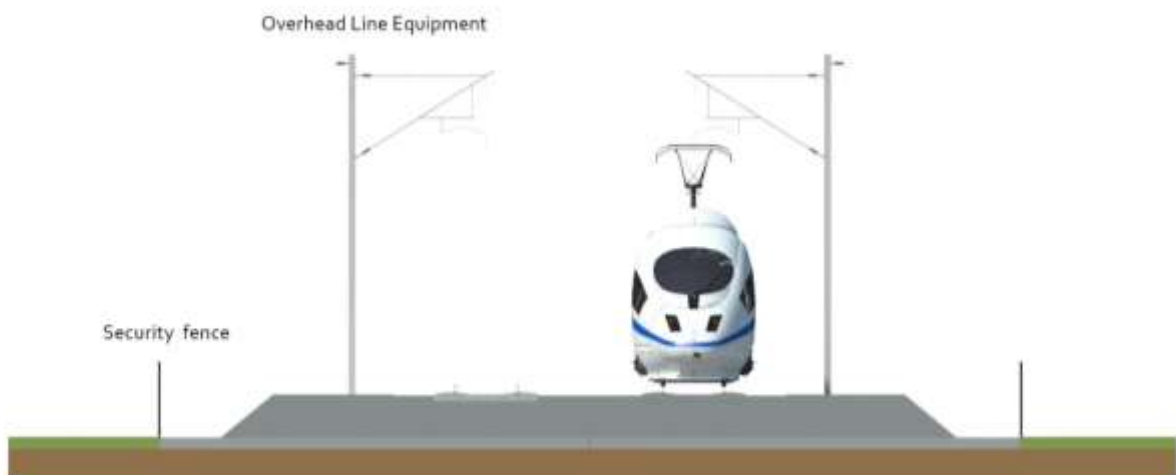
- 4.3.20 Stabling and service preparation will take place at other locations on the Proposed Scheme in order to reduce the number of empty train movements at the beginning and end of service. Stabling and servicing of classic compatible trains will be required at existing depot facilities at Liverpool (Edge Hill), Manchester (Longsight and Longsight International) and Glasgow (Polmadie). Further information is provided within Volume 4: Off-route effects report.
- 4.3.21 Overall, the Proposed Scheme is estimated to support around 2,200 jobs directly for the operation of stations and trains, infrastructure and maintenance. Additional employment will be created by the provision of other facilities at stations (e.g. retailing) and through the supply chain.

5 Permanent features of the Proposed Scheme

5.1 Rail corridor

- 5.1.1 In most locations the route will comprise two railway tracks, one for northbound and one for southbound services. The railway infrastructure will have an overall width of approximately 19m from fence line to fence line when at grade⁶⁴. However, the width of the rail corridor may vary along its length in order to accommodate the topography and cuttings and embankments. The rail corridor will encompass the two tracks, associated overhead line equipment (OLE), track drainage, electricity cables, cable ducting, line-side walkways and noise fence barriers, where required. The rail corridor will be continuously fenced, with the type of fencing used at each location dependent on the functional requirements and its context (e.g. whether in an urban or rural setting).
- 5.1.2 An indicative cross section through a two-track rail corridor at ground level is shown in Figure 14.

Figure 14: Indicative two-track rail corridor



- 5.1.3 In some locations the railway corridor will be wider to accommodate four or six tracks. This will be necessary:
- where the rail corridor approaches a station (e.g. Euston station and approach, CFA1);
 - where trains need to slow down and access a station, without impeding through trains (e.g. on either side of Birmingham Interchange station, CFA24);
 - for sections of the route where different lines converge;

⁶⁴ On the same level. For example, when a railway line is on the current ground level.

- where maintenance loops are required (e.g. Greatworth to Lower Boddington, CFA15); and
- on the approach to the depots, where additional track work will be provided for trains to enter/exit the depot facilities (e.g. Calvert, Steeple Claydon, Twyford and Chetwode, CFA13, Washwood Heath to Curzon Street, CFA26).

5.2 Cuttings and embankments

- 5.2.1 Cuttings will be formed by excavation in areas where the local topography is at a higher level than the desired route alignment, whilst embankments will be formed by placing fill material where the local topography is lower than the desired route alignment. Embankments will also be used where the route crosses valleys and is not otherwise on bridges or viaducts.
- 5.2.2 The angle of side slopes for cuttings and embankments, and therefore the overall width of the works, will depend on local ground conditions and topography, and on the quality of excavated material. In general, embankment slopes will be 1:2.5, i.e. for each metre of depth or height, the width of each slope will be 2.5 times larger. Slopes will be steepened or retaining walls will be used where space is limited; for example, in urban areas and the approaches to structures, or where the area of land required needs to be reduced.
- 5.2.3 Slopes will generally be top-soiled and seeded, but in favourable geological conditions cuttings may be excavated at steeper gradients and allowed to weather naturally. In unfavourable geological conditions, stabilising elements and/or drainage may be incorporated within slopes. Where land is to be returned to agricultural use, arable slopes will be re-graded to no steeper than 1:8, although steeper grades may be adopted for pastoral use.
- 5.2.4 Priority will be given to reusing material excavated from the Proposed Scheme in the engineering earthworks to form embankments, and environmental mitigation earthworks along the route. This will assist in reducing the need for the off-site disposal of surplus excavated material⁶⁵, and its associated environmental effects. This approach will also reduce the impact of the Proposed Scheme by making best use of the excavated material to significantly reduce the need to import material.
- 5.2.5 An illustration of an embankment is shown on Figure 15 and an illustration of a cutting is shown in Figure 16.

⁶⁵ Excavated material will become surplus if its irrecoverable physical, chemical or bio-chemical quality precludes its use in the Proposed Scheme, if there is more material available than fulfils the requirements of the Proposed Scheme, or if the requirement for a type of material is too far away from the point of arising to make its use practicable.

Figure 15: Generic embankment illustration

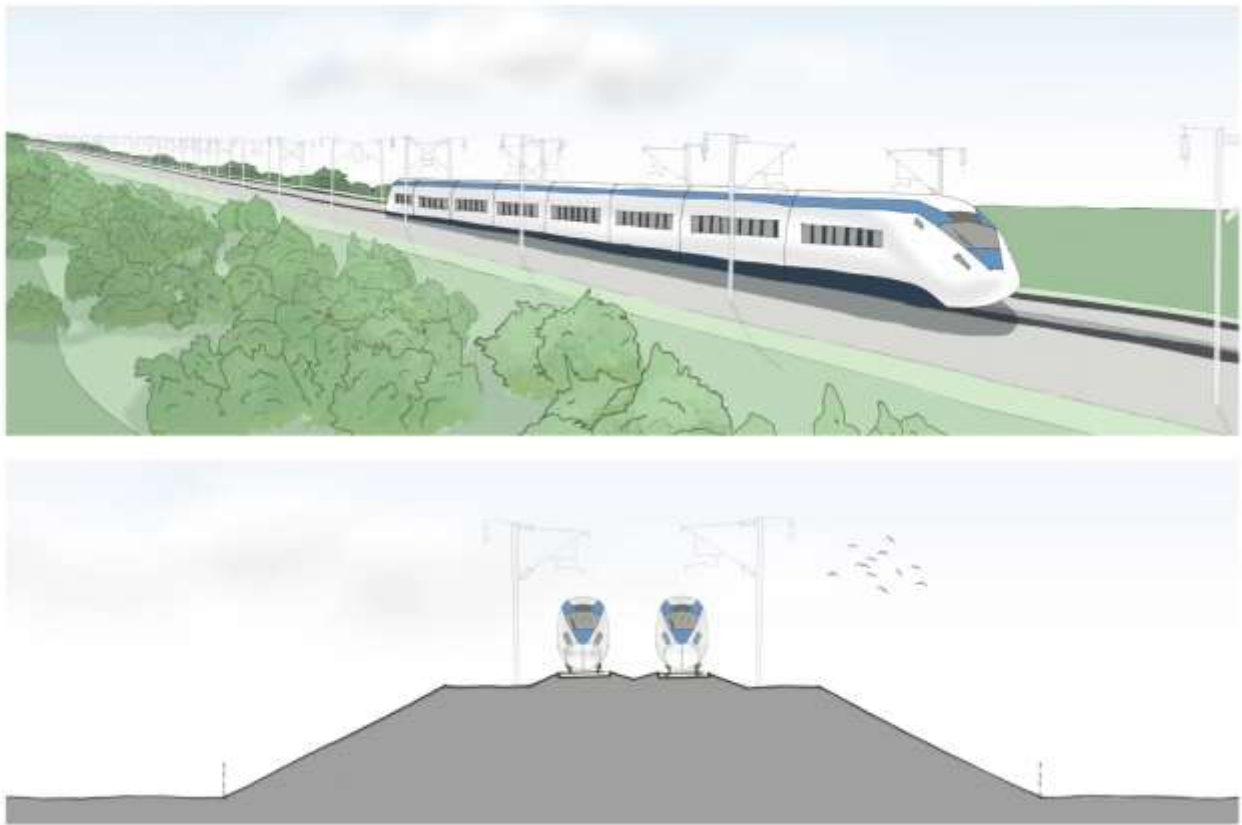
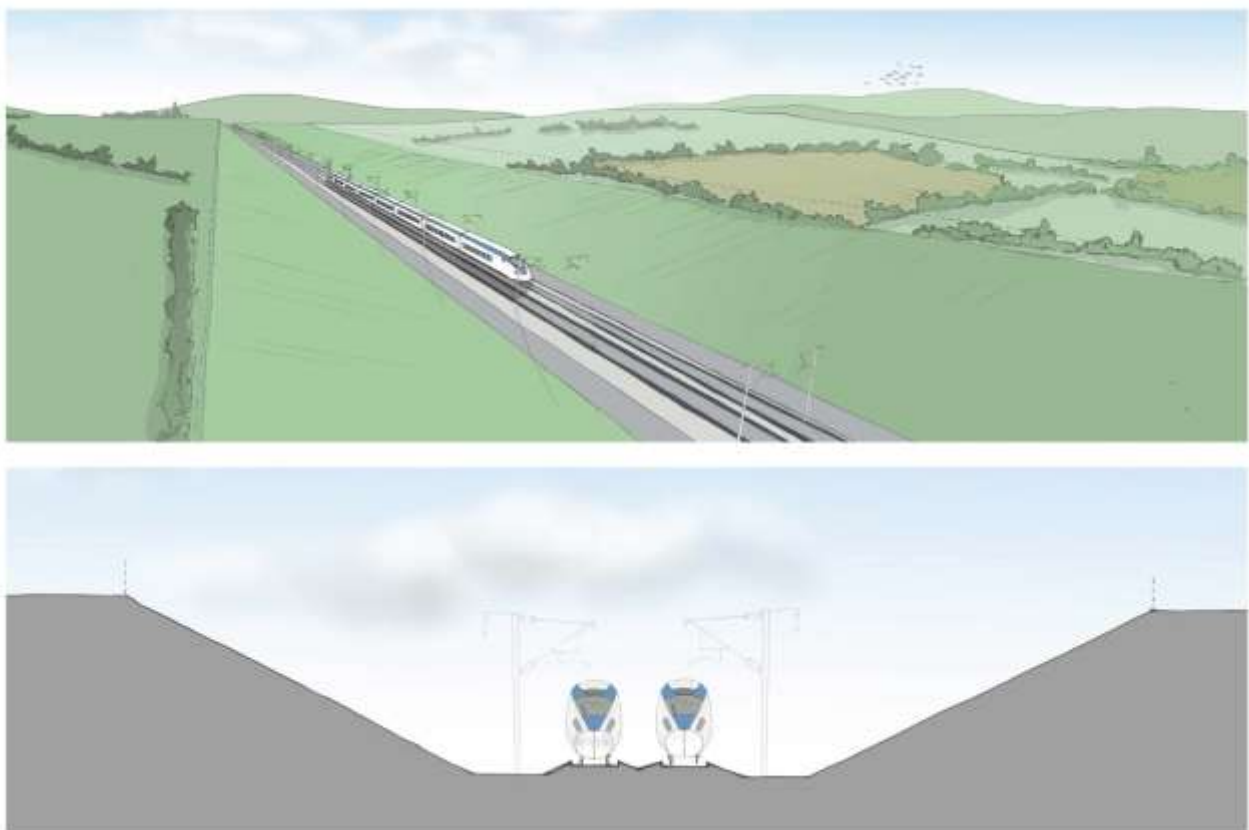


Figure 16: Generic cutting illustration



5.3 Drainage and watercourse realignments

Railway drainage

- 5.3.1 Drainage parallel to the railway will generally comprise filter drains feeding balancing ponds at intervals along the route. These ponds are of two types: attenuation ponds and infiltration ponds. Attenuation ponds will attenuate peak flows so that run-off generated from the railway track discharges at an agreed rate to a nearby watercourse, thereby reducing the risk of localised flooding. Infiltration ponds will allow run-off to be absorbed into the ground where conditions are suitable. Many of the ponds will be a hybrid combining features of both types.
- 5.3.2 Balancing ponds will typically be unlined and have banks with a varying profile. Their size will depend on drainage requirements, but could be up to 1.5ha. They will not be designed to hold water permanently, but will be dry most of the time, except following intense rainfall events. They will be designed to accommodate a one in 100 year annual rainfall probability event, with an allowance for climate change. For most of the time these ponds will resemble depressions in the ground rather than actual ponds.
- 5.3.3 Within built-up areas, surface water run-off will be discharged to the urban drainage system (usually a surface water or combined sewer) at a controlled rate.

Buildings and facilities drainage

- 5.3.4 Sewage from stations, the IMD at Calvert, the stabling facility at Washwood Heath and other manned facilities will be discharged into adjacent sewers, where available with appropriate capacity. In specific cases, on-site treatment or collection of foul effluent may be necessary.
- 5.3.5 Surface water run-off from stations, other buildings and areas of hardstanding (e.g. accesses and parking), will be infiltrated to ground or will be attenuated to discharge at agreed rates to nearby watercourses and sewers. The design will employ sustainable drainage systems, rainwater harvesting and grey water recycling facilities, where reasonably practicable, to manage surface water run-off and improve discharge water quality. Where necessary, the drainage system will also incorporate pollution control devices such as oil and silt traps.

Land drainage

- 5.3.6 New structures will be required to carry the railway over existing watercourses, ranging from box or pipe culverts⁶⁶ to underbridges⁶⁷. Culvert lengths will be minimised where possible and designed to a one in 100 year annual rainfall probability event, including an allowance for climate change. Bridge soffits will be raised above the one in 100 year annual rainfall probability event, including allowances for climate change and freeboard⁶⁸.

⁶⁶ A tunnel (pipe or box shaped) that carries a stream or open drain under a road or railway.

⁶⁷ Underbridges are bridges carrying the Proposed Scheme over other features.

⁶⁸ The height from the maximum design level of a watercourse to a) the adjacent banks of an open channel, to provide a factor of safety against flooding; or b) the soffit (underside) of any culvert or bridge above, to minimise the risk of blockage by floating debris, etc.

Watercourse realignment

- 5.3.7 Realignment of watercourses will be required in some cases. Channel flows will be designed and maintained in consultation with the relevant regulatory authority. The methods to divert watercourses are described in more detail in Section 6.g.
- 5.3.8 Rivers and streams will be reinstated, where reasonably practicable, with a natural looking appearance, having consideration for the requirements of the Water Framework Directive (WFD). Appropriate access will be provided to realigned watercourses to allow for maintenance.

5.4 Highways (roads) and public rights of way

- 5.4.1 New, diverted or realigned roads and public rights of way (PRoW, i.e. footpaths, bridleways and byways), will be constructed to the appropriate standard for each location. These include Design Manual for Roads and Bridges (DMRB)⁶⁹, Manual for Streets (MfS)⁷⁰ and local authority design standards. The shortest practicable route for realignment consistent with design and safety requirements will normally be adopted. Road and PRoW realignments will be designed, to blend into their surroundings as far as possible, and to retain the existing character of the route.
- 5.4.2 New or enhanced vehicular access will be required at various points to allow access to the Proposed Scheme. Facilities such as stations, the IMD, substations and the train stabling facility will require access at all times. Emergency access will be required to vent shafts and tunnel portals, whilst occasional access will be required for maintenance purposes to features such as balancing ponds, structures, landscaped areas and line-side equipment.

5.5 Tunnels

- 5.5.1 Tunnels will be constructed at a number of locations along the route, as described within Volume 2: CFA reports, Section 2.2. Three methods of construction will be used: bored and mined, which leave the original surface features intact; and cut-and-cover, which requires temporary disruption at the surface whilst the tunnel is constructed, followed by the reinstatement of surface conditions. All tunnels will have portals (i.e. exit/entrance structures) whilst longer tunnels will require cross passages and vent shafts. The different tunnel types and features are described below.

Bored tunnels

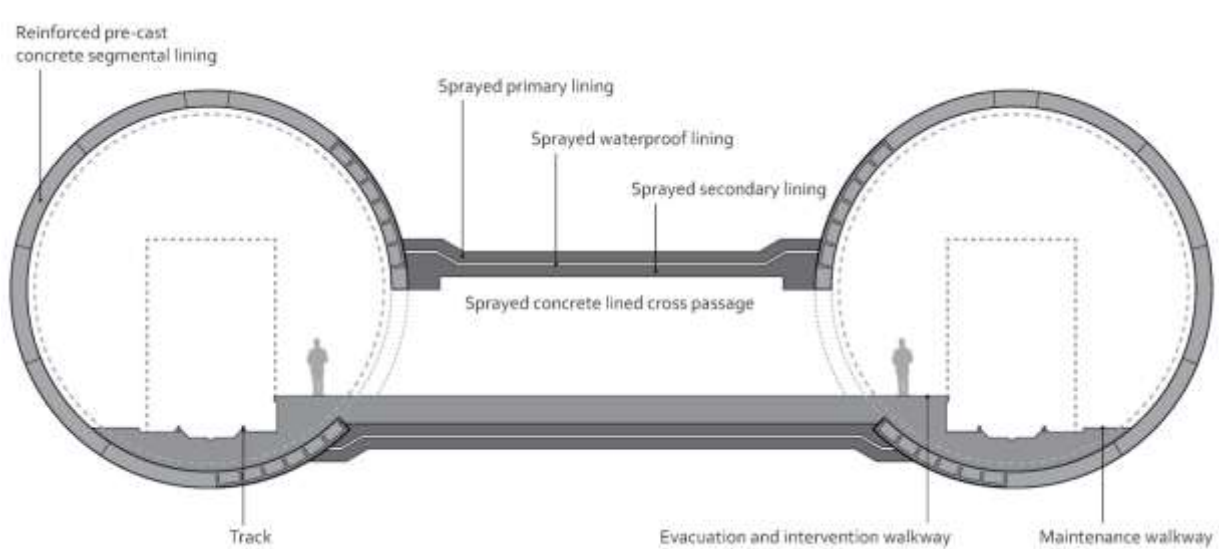
- 5.5.2 Bored tunnels will generally be constructed where the depth between the railway and existing ground is such that open excavation is not practical, and where the tunnel length is sufficient to make the use of tunnelling equipment viable. Bored tunnels are proposed at Euston, HS1-HS2 Link, Old Oak Common, Northolt, Chiltern and Bromford.
- 5.5.3 With the exception of the HS1-HS2 Link tunnel, which is a single-bore, single-track tunnel, all bored tunnels will have two parallel bores, each containing a single rail track, known as a twin-bore tunnel.

⁶⁹ Department for Transport (2012), *Design manual for roads and bridges*. Highways Agency. UK.

⁷⁰ Department for Transport (2007), *Manual for Streets*. Thomas Telford publishing. London

- 5.5.4 Tunnel bores will usually have an internal diameter of between 7.55m-8.8m. They will be approximately one tunnel diameter apart, except where they approach the portals, and will be connected by cross passages at intervals.
- 5.5.5 Bored tunnels will be constructed using a tunnel boring machine (TBM). Further detail about the nature and operation of TBM is provided in Section 6.12.
- 5.5.6 A cross section of a typical twin-bore tunnel is shown in Figure 17.

Figure 17: Cross section of typical twin-bore tunnel



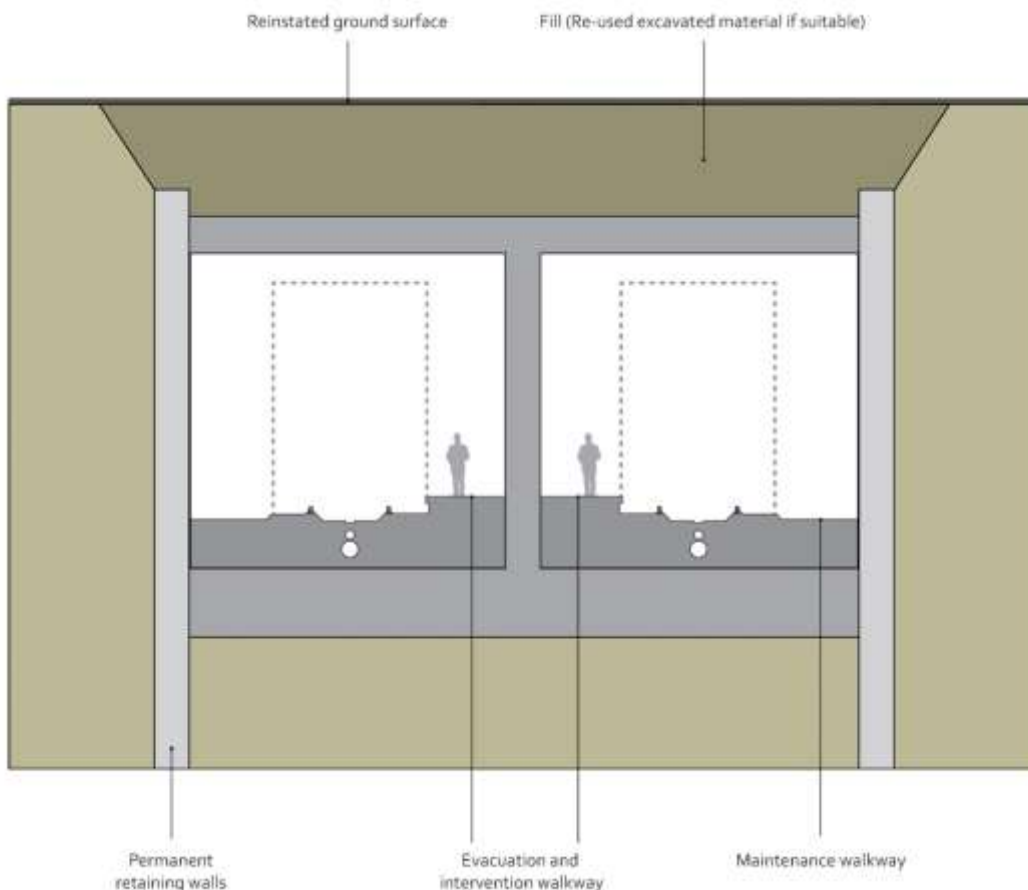
Mined tunnels/sprayed concrete lined tunnels

- 5.5.7 Mined tunnelling/sprayed concrete lined (SCL) techniques will be used on shorter sections of tunnels and cross passages, and where the tunnel geometry is complex. Mined/SCL tunnels will have a slightly larger internal dimension than bored tunnels. Mined/SCL tunnels are excavated in stages, with excavated faces stabilised with sprayed concrete and other support measures.
- 5.5.8 A section of the tunnel at Long Itchington Wood will be mined.

Green tunnels

- 5.5.9 A green tunnel is constructed using a cut-and-cover method. It is built by excavating the ground, building a structural box, and then restoring the land over the top. Soil will be spread on top to integrate it with the landscape, thus minimising visual impacts and making the presence of a railway less noticeable. Roads, PRow and access tracks can be replaced over the completed tunnel, vegetation can be replanted and the land returned to its former use.
- 5.5.10 Green tunnels are proposed near South Heath, Wendover, Greatworth, Chipping Warden, Long Itchington Wood and Burton Green.
- 5.5.11 A diagram showing a cross section of a typical green tunnel is shown in Figure 18.

Figure 18: Cross section of a typical green tunnel



5.6 Portals

5.6.1 All tunnels will have portals at each entry/exit. Portals will take different forms, depending on ground conditions, local topography, train speeds and whether they need to accommodate a TBM during construction.

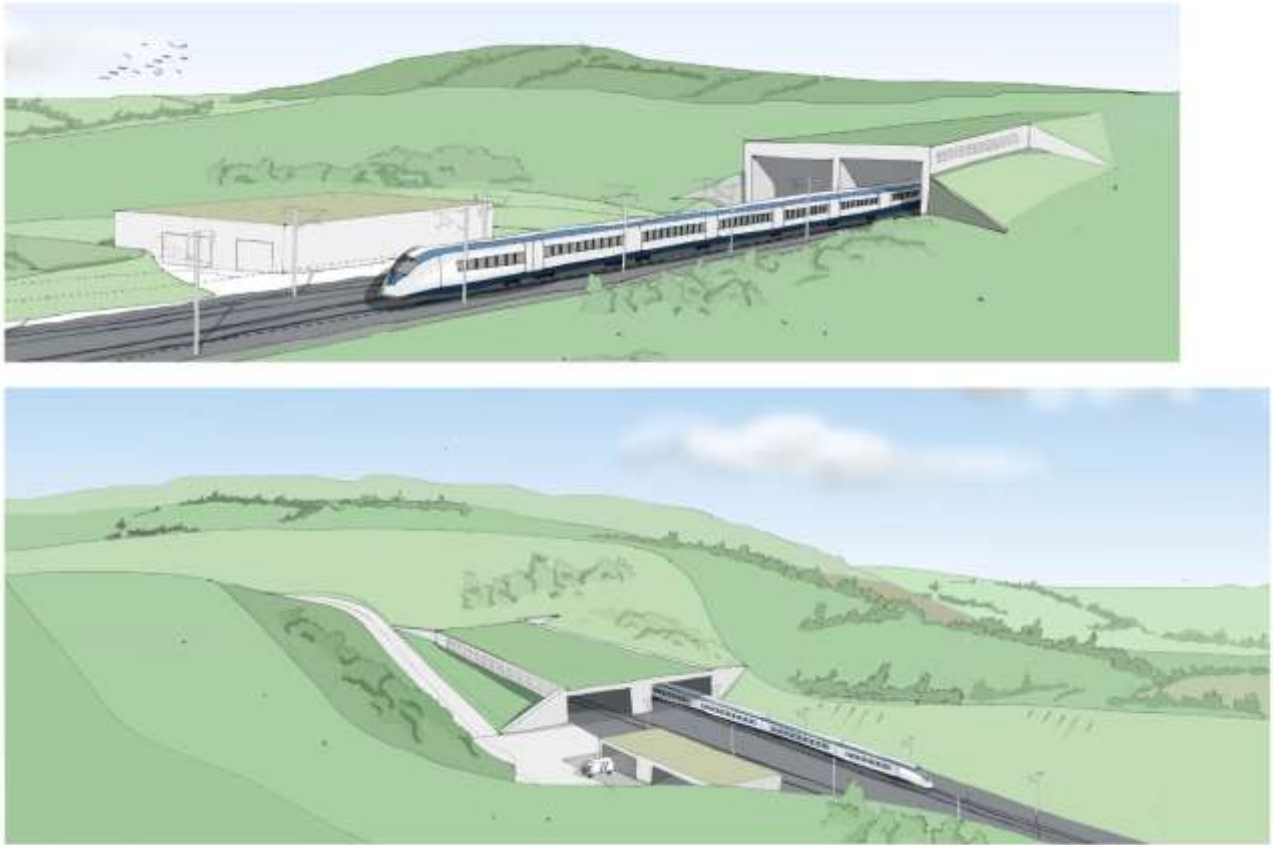
5.6.2 Tunnel portals may incorporate some or all of the following features:

- porous portal (i.e. tapered, perforated, reinforced concrete structures, to reduce noise and air pressure effects as trains enter or exit the tunnel);
- mechanical ventilation⁷¹;
- surface buildings housing services such as power, telecommunications, water supply, fire safety, drainage and ventilation equipment;
- storage tanks;
- road access for emergency services;
- escape routes;
- a 550m² area for passengers in the event of an emergency; and
- parking and hardstanding for service vehicles.

⁷¹ These fans will be switched off under normal conditions, but will be activated in the event of a stalled train or a fire, and for maintenance purposes. It is likely that this equipment will only operate for limited testing periods during the daytime.

5.6.3 A visualisation of a green tunnel and portal in a rural location is illustrated in Figure 19.

Figure 19: Generic illustration of a green tunnel



5.7 Ventilation and intervention (vent) shafts

- 5.7.1 Vent shafts to the surface will be spaced every 2km-3km (1.2-1.9 miles). The vent shafts will provide access for maintenance, pressure relief from the rail tunnels and emergency intervention, and will require mechanical ventilation for smoke extraction purposes in the event of fire. They will incorporate both lifts and stairs, terminating at ground level in headhouses, which will accommodate ventilation fans, lift winding gear and other plant, together with emergency access doors. The design and external appearance of headhouses will be approved by relevant local authorities in order to fit in to the local surroundings.
- 5.7.2 An illustration of a typical vent shaft and headhouse in an urban location is shown in Figure 20. Possible examples of a headhouse in a rural location are shown in Figure 21.

Figure 20: Ventilation shaft and headhouse in an urban location

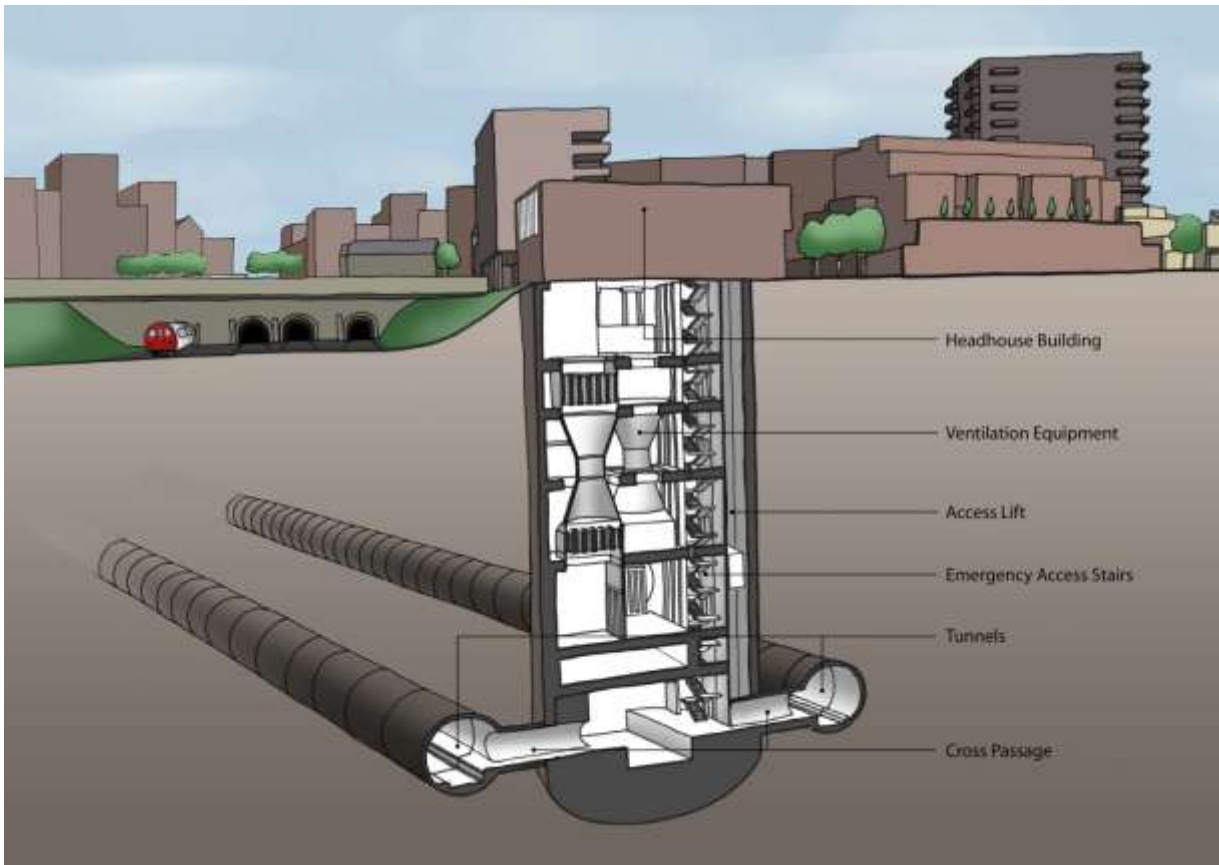
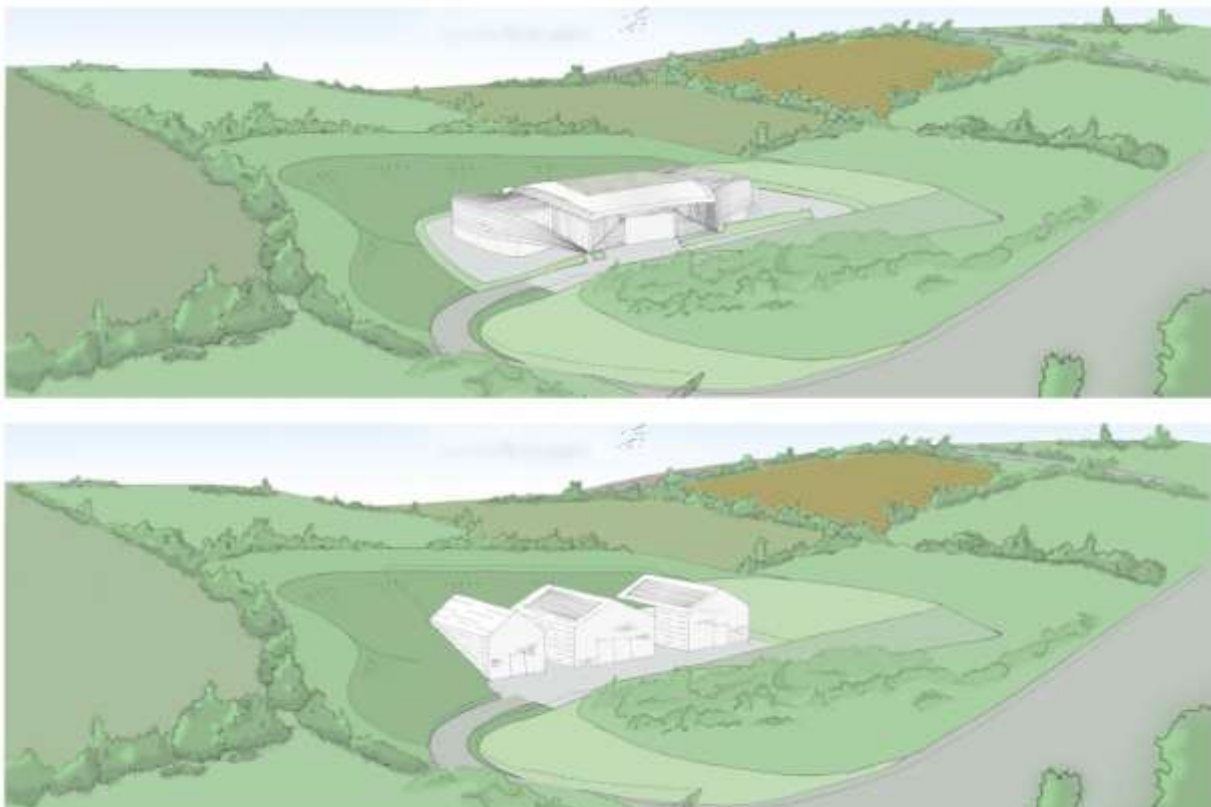


Figure 21: Generic rural headhouse illustration



- 5.7.3 Ventilation equipment and control cabinets will be required within some or all of the tunnels. For tunnels with shafts, axial fans⁷² will normally be installed into the shafts. These will supply or extract air to/from the tunnels either via louvres⁷³ at the headhouses or, where required to control noise, through the roof of the headhouse. Piston effect pressure relief may also be provided via these shafts, or, again where required to control noise, through the roof of the headhouse.
- 5.7.4 Under normal operating conditions, air will be pushed out of the vent shafts as each train approaches and will be drawn in after each train has passed. If a train stalls in the tunnel, the fans will be used to eject warm air at some shafts or portals, whilst drawing in ambient air at others. In the event of a fire, the fans will be used in a similar way to eject smoke and supply fresh air.
- 5.7.5 For tunnels without shafts, and in some tunnels in addition to shafts, ventilation will be provided by jet fans⁷⁴ located within the tunnel, providing ventilation from one portal to the other. These fans will be switched off under normal conditions, but will be activated in the event of an emergency and for periodic testing.

5.8 Cross passages

- 5.8.1 Tunnels longer than 1km (0.6 miles) will have cross passage evacuation escape routes between individual twin-bore tunnels and access routes from the surface. These will be used for rescue, maintenance and evacuation purposes. The cross passages will be a minimum of 1.5m wide and 2.25m high. Additional cross passages for the sole use of emergency services will be provided at each vent shaft. These will be a minimum of 2.3m wide and 2.3m high. Cross passage doors will be provided every 500m in the central wall of green tunnels.

5.9 Viaducts

- 5.9.1 Viaducts will generally be built where a crossing of more than 45m in length is needed or to provide a continuous elevated route across undulating terrain, existing roads or floodplains where embankments would not be a practical or effective solution. The height of the viaduct will be determined by the route alignment, the topography and the feature being crossed.
- 5.9.2 Viaducts will be constructed of reinforced/pre-stressed concrete or weathering steel beams with reinforced concrete slab. They will typically include a solid 1.4m (above rail level) safety barrier located close to the rail. This is to allow, if necessary, staff on to the viaduct whilst the railway is in operation. The safety barrier will also act as a noise barrier and is termed a 'low level' barrier.
- 5.9.3 Where further noise mitigation is required to avoid or reduce significant noise effects, three further levels of mitigation have been incorporated where necessary. The first is to provide acoustic absorption in the railway side of the 1.4m low level barrier. The second is

⁷² A fan consisting of a rotating arrangement of vanes or blades which act on the air. The rotating assembly known as the impeller or rotor is contained within a housing. Air is drawn in through the inlet over the motor and through the outlet in to the tunnel. Axial fans produce air flows with high volume and low pressure.

⁷³ Louvres are framed opening in a wall fitted with fixed or moveable horizontal slats for admitting air and or light.

⁷⁴ Axial fans with a free standing inlet and outlet, mounted on the walls of a tunnel and used to control the movement of air in the tunnel.

to provide a 3m (above rail level) acoustically absorptive parapet noise barrier. The third is to increase the height of the parapet noise barrier to 4m above rail.

5.9.4 The height of the viaducts will depend on local ground conditions and on the clearances required by any transport modes being crossed. Intermediate piers are likely to be of reinforced concrete construction on pad or piled foundations⁷⁵, subject to ground conditions or the construction methodology. Abutments will be constructed of reinforced concrete on pad or piled foundations. Viaducts will be designed to a one in 100 annual rainfall probability event, including allowances for climate change and freeboard.

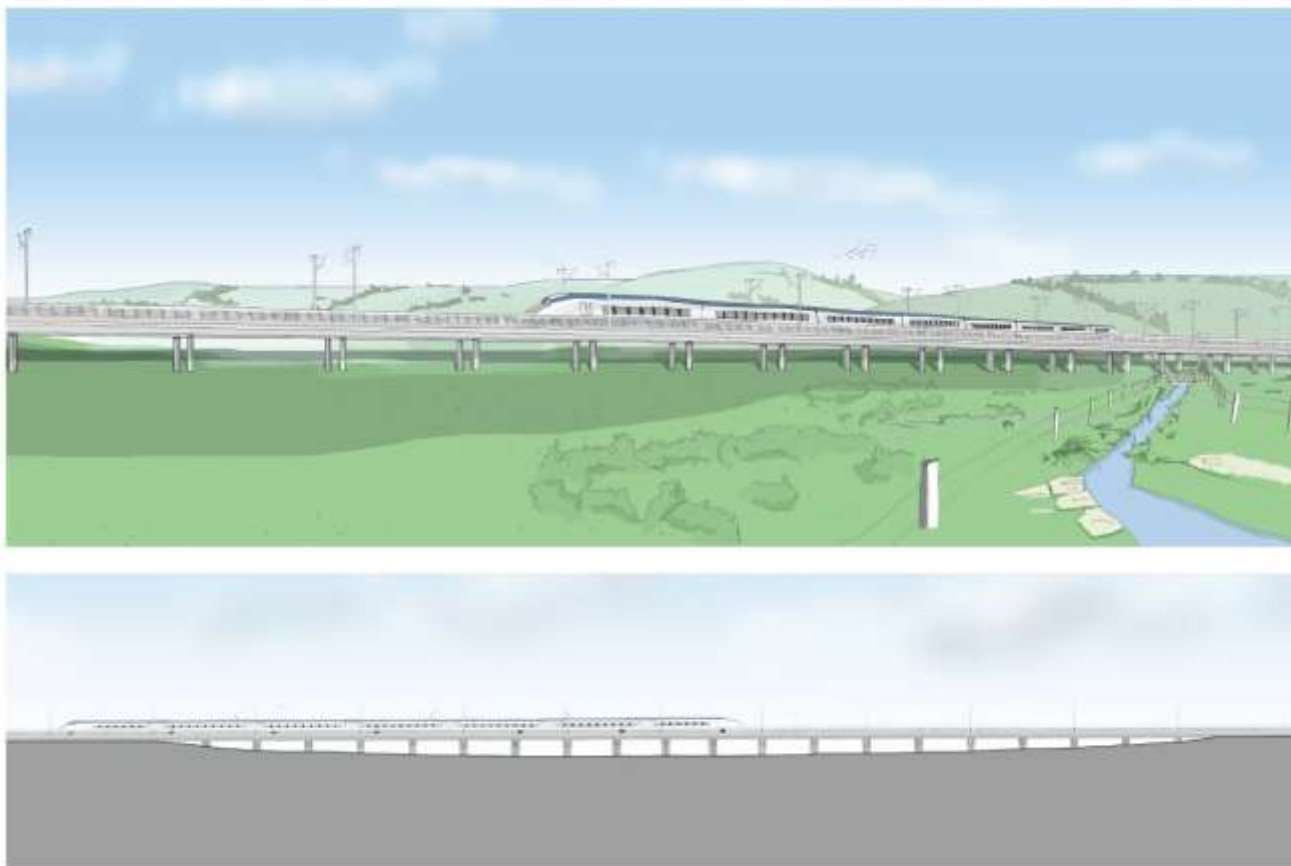
5.9.5 Illustration of a high and low level viaduct is shown in Figure 22 and Figure 23.

Figure 22: Generic illustration of a high viaduct



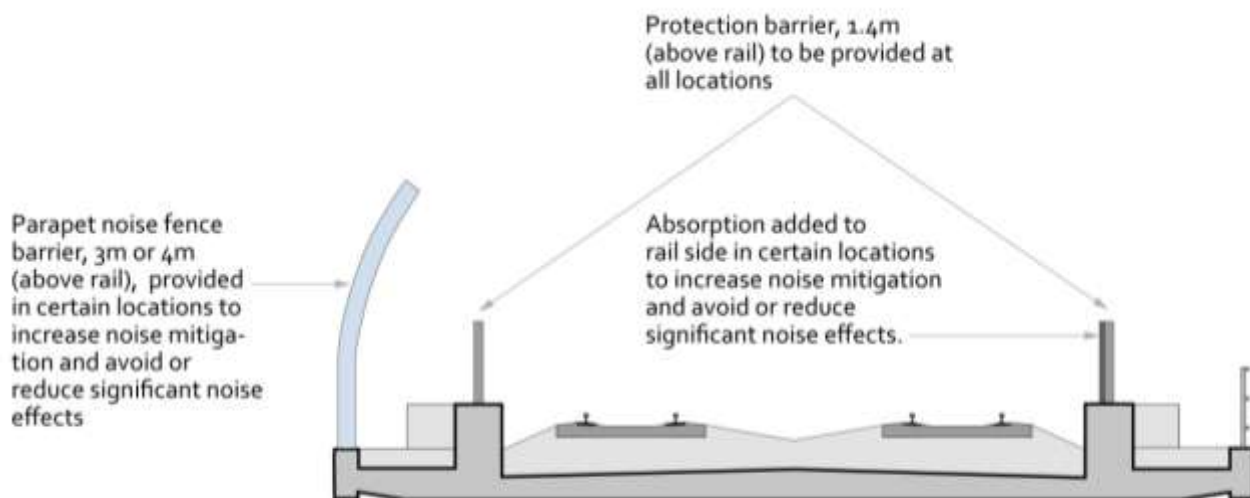
⁷⁵ Pad foundations – A foundation structure that spreads the imposed loads over a sufficient area to reduce stress on foundation material. Often described as shallow foundations. Piled foundation – Deeper foundations such as piles, and diaphragm walls, where loads are distributed through the ground at depth by drilled or driven structures. Often described as embedded or deep foundations.

Figure 23: Generic illustration of a low viaduct



5.9.6 A cross section of a viaduct showing the increasing levels of noise barrier provision is shown in Figure 24.

Figure 24: Cross section of a viaduct



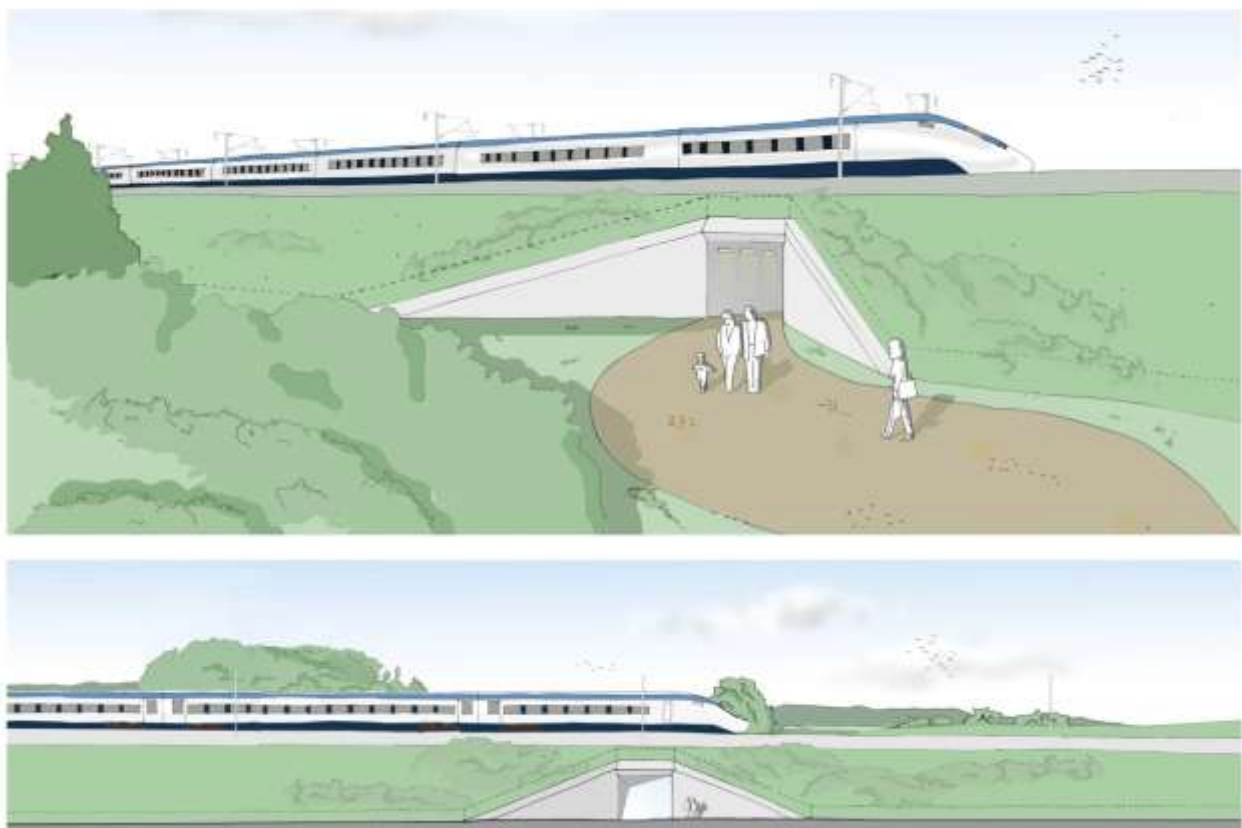
5.10 Bridges

- 5.10.1 Bridges are required where the route passes over or under a feature such as a PRoW, road, river or other railway. The height of the bridge will be determined by the route alignment, the topography and the feature being crossed.
- 5.10.2 Overbridges (i.e. bridges over the proposed route) will be constructed of concrete or weathering steel beams with reinforced concrete slab. Typical height clearances will be 7.15m (i.e. rail level to the underside of the bridge). In certain locations; for example, over the approach to Euston station, bespoke designs using steel trusses or other forms will be used to overcome space or construction constraints.
- 5.10.3 Intermediate piers are likely to be of reinforced concrete construction on pad or piled foundations, subject to ground conditions.
- 5.10.4 Parapets (i.e. the barrier along each side of the bridge) will be solid, with a height of 1.8m over the route and 1.5m on side spans in the case of multi-span structures.
- 5.10.5 Underbridges (i.e. bridges carrying the Proposed Scheme over other features) are likely to be constructed of pre-cast concrete. Clearances will vary as required by the type of feature being crossed. For watercourses, underbridges will be designed to a one in 100 annual rainfall probability event, including allowances for climate change and freeboard.
- 5.10.6 Where required, noise barriers will be integrated into the design of underbridges in the same way as described in Section 5.9.
- 5.10.7 An illustration of a single-span overbridge is shown in Figure 25. An illustration of a pedestrian underpass is shown in Figure 26.

Figure 25: Generic single-span bridge illustration



Figure 26: Generic pedestrian underpass illustration



5.11 Stations

- 5.11.1 The London terminus of the Proposed Scheme will be located at Euston and the Birmingham terminus will be located at Curzon Street. There will be two intermediate stations: Old Oak Common and Birmingham Interchange.
- 5.11.2 The four proposed stations have individual design requirements. However, they share a number of functional characteristics. In simple terms, their typical layout will consist of a platform level, providing access to/from the proposed high speed trains and other services, and a concourse level, providing the main circulation space and including a ticket hall, retail and refreshment facilities.
- 5.11.3 Pedestrian access will lead to an external forecourt, with a taxi rank, cycle facilities and bus stops. Connections will be provided to other transport modes as necessary via escalators, lifts and walkways.
- 5.11.4 Further information on the station designs and layout is provided in Volume 2: Euston Station and Approach (CFA1); Old Oak Common (CFA4); Birmingham Interchange and Chemsley Wood (CFA24); and Washwood Heath to Curzon Street (CFA26).
- 5.11.5 The design of these stations will offer opportunities to integrate with local development plans and strategies. More detail regarding over-site development is contained in Section 7.6.

5.12 Maintenance loop sidings

- 5.12.1 Maintenance loop sidings are proposed at Stoke Mandeville and Wormleighton.
- 5.12.2 At these locations, two additional tracks will be provided alongside the main track, extending for approximately 1.2km (0.75 miles). The loop sidings enable maintenance trains to be stabled temporarily without returning to the Calvert IMD. When maintenance activities are being undertaken over a number of nights, the maintenance train may be stabled on the loop sidings during the day, allowing work to be undertaken at night.
- 5.12.3 If necessary, the additional tracks could also be used to keep the main tracks clear in the event that a passenger train were to develop a fault such that it was unable to continue unassisted to its destination.

5.13 Depots

Calvert infrastructure maintenance depot

- 5.13.1 The infrastructure maintenance depot (IMD) at Calvert will include:
- exchange tracks for trains travelling to and from the classic and high speed networks;
 - stabling facilities for rail-mounted plant and equipment;
 - storage areas for materials, spare parts and plant;
 - a workshop and tracks to support maintenance trains and mobile plant; and
 - fuelling facilities.

5.13.2 Further information on the operational maintenance regime and staffing is provided in Section 4.3. Further information on Calvert IMD is provided in Volume 2: Calvert, Steeple Claydon, Twyford and Chetwode report (CFA13).

5.13.3 An aerial visualisation of Calvert IMD is shown in Figure 27.

Figure 27: Aerial visualisation of the proposed Calvert infrastructure maintenance depot



Washwood Heath depot

5.13.4 The Washwood Heath depot will provide train maintenance, servicing and stabling facilities for the HS2 captive and classic compatible trains, plus communications facilities. The depot provides:

- stabling, i.e. the parking of trains whilst out of service;
- servicing of trains, including cleaning, refilling water tanks and emptying toilet tanks;
- light and heavy maintenance of the trains; and
- a route-wide network control centre⁷⁶.

5.13.5 Further information on the operational maintenance regime and staffing are provided in Section 4.3. Further information on the Washwood Heath depot is provided in Volume 2: Washwood Heath and Curzon Street report (CFA26).

⁷⁶ The network control centre primary purpose will be to supervise and control activities on the railway.

5.13.6 An aerial visualisation of Washwood Heath depot is shown in Figure 28.

Figure 28: Aerial visualisation of the proposed Washwood Heath depot



5.14 Noise barriers

- 5.14.1 To avoid or reduce significant airborne noise effects, the Proposed Scheme incorporates noise barriers, generally in the form of landscape earthworks, noise fence barriers and/or low-level barriers on viaducts and underbridges. Noise barrier locations are shown in Volume 5: Map Book SV-05.
- 5.14.2 For surface, embankment and cutting sections of the route, the assessment has generally been based on noise barriers having a noise reduction performance equivalent to a noise fence barrier with a top level 3m above the top of the rail, that is acoustically absorbent on the railway side, and located 5m to the side of the outer rail. In practice, barriers may differ from this description, but will provide the same acoustic performance. For example, where noise barriers are in the form of landscape earthworks they will need to be higher above rail level to achieve similar noise attenuation to a 3m barrier because the crest of the earthwork will be further than 5m from the outer rail.
- 5.14.3 The Proposed Scheme incorporates low-level noise barriers into the design of viaducts. Where needed to avoid or reduce significant airborne noise effects, these barriers are designed to provide noise reduction that is equivalent to a 2m high absorptive noise barrier located on the parapet of the viaduct. Locating these low-level barriers close to the rail also reduces visual impact and limits the mass of the viaduct itself.

- 5.14.4 To avoid or reduce significant adverse operational noise effects, further mitigation is envisaged in certain locations as set out in the Volume 2: CFA reports. Generally this will be achieved by providing higher noise barriers (i.e. higher than a 3m noise fence barrier located 5m from the nearest rail), or another barrier that will provide the equivalent noise reduction. For viaducts further mitigation is provided by taller parapet noise fence barriers.
- 5.14.5 Noise effects are reduced in other locations along the line, (for example, landscape character areas), by the landscape earthworks provided to avoid or reduce significant visual effects and by engineering structures such as cuttings and safety fences on viaducts (where noise barriers are not required). An example of a noise fence barrier is shown in Figure 29.

Figure 29: Photograph of an example of a noise fence barrier



Source: © Troika

5.15 Site restoration and landscape treatment

- 5.15.1 On completion of construction, all temporary plant, materials, equipment, buildings, access roads and vehicles will be removed from the site, allowing the land to be restored. This land will generally be returned to its previous use, where this is reasonably practicable and subject to landowner agreement.
- 5.15.2 Land that was formerly under agriculture or forestry use will be restored to that use. Some additional/adjacent areas may undergo restoration. This may include the provision of

compensatory and replacement habitat for wildlife species/habitats or areas of valued landscape character adversely affected during construction. These areas will be established and monitored to maintain the long-term conservation status of the species/habitat in each case.

- 5.15.3 Landscaped design solutions can provide multiple benefits, including visual screening, noise mitigation, habitat creation, and the protection and enhancement of heritage assets. Planting strategies will specify tree and shrub species of local provenance. Section 9 further describes the approach to mitigation.

5.16 Track

- 5.16.1 The railway tracks will either be ballasted, whereby the rail is fastened to concrete sleepers supported by stone ballast; or, will be ballastless, whereby the rails are supported on a continuous concrete structure known as slab track.
- 5.16.2 In general, ballasted track requires more frequent maintenance but generates less airborne noise than slab track. However, it is possible to treat slab track at selected locations so that its acoustic properties are equivalent to ballasted track.
- 5.16.3 For tunnels and surface sections of the route, significant ground-borne noise or vibration effects will be avoided or reduced through the design of the track and track-bed.
- 5.16.4 The choice of track form at different locations will be informed by further modelling and investigation of the ground conditions along the route. For the purpose of the assessment (e.g. in relation to construction methods and noise and vibration), an assumption has been made that slab track will be used in bored tunnels and that whichever is the worst-case effect between ballast and slab will be used elsewhere⁷⁷.

5.17 Power supply

- 5.17.1 A diagram which illustrates the power supply for high speed trains is shown in Figure 30.
- 5.17.2 Power will be supplied from the National Grid 400kV or 275kV network via feeder stations, which will be located at approximately 50-70km (31-43.5 miles) intervals along the route. These feeder stations will require dedicated areas of land and will be located close to where National Grid power lines cross the route.
- 5.17.3 Feeder stations are proposed at Ickenham, Quainton and Burton Green.
- 5.17.4 Each feeder station will comprise two distinct and separate compounds: a National Grid substation; and an HS2 auto-transformer feeder station.
- 5.17.5 The National Grid substation contains 400/275kV switchgear⁷⁸, super-grid traction transformers and ancillary equipment. The compound will require road access, will be fenced and will need at least one large electrical pylon, although most structures and buildings within the compound will otherwise be of modest height. The National Grid compounds will typically require approximately 3.9ha of land.

⁷⁷ For noise and vibration it is assumed that if used on surface sections of route, slab track would be treated such that the adverse airborne noise effects would be no worse than for ballast track.

⁷⁸ Switchgear is electrical equipment used to control and isolate the flow of electricity to a circuit.

- 5.17.6 The auto-transformer feeder stations are expected to contain 25kV switchgear, traction transformers, load balancers⁷⁹ and ancillary equipment. They will be located close to the National Grid compounds, adjacent to the route and will be incorporated within the overall railway corridor. Each auto-transformer feeder station will occupy approximately 2.75ha of land, will require road access and will be located every 10-15km (6.3-9.3 miles).
- 5.17.7 Auto-transformer stations will be provided along the route at approximately 5km (3 miles) intervals. They will accommodate switchgear and associated equipment, including cabinets for the communications system, and will require road access. They will occupy approximately 0.1-0.2ha.
- 5.17.8 In addition to the auto-transformer stations, two other types of traction power⁸⁰ substation are required along the route: mid-point auto-transformer stations and express feeder auto-transformer stations.
- 5.17.9 Mid-point auto-transformer stations are located approximately halfway between auto-transformer feeder stations at a point where the overhead line is sectioned to create two supply areas. A mid-point auto-transformer station is effectively two auto-transformer stations located on the same site, with each auto-transformer station connected to each supply section, and will generally require approximately 0.1ha of land.
- 5.17.10 Express feeder auto-transformer stations are required to improve the voltage level along the line. They will be located approximately 12km-15km (7.5-9.4 miles) on each side of the auto-transformer feeder stations. An express feeder auto-transformer station is a mid-point auto-transformer station that is connected locally to the overhead line and to the remote auto-transformer feeder station via express feeder cables, and will typically require approximately 0.4ha of land.
- 5.17.11 Power will be transmitted to the trains through an overhead line contact system. OLE will comprise steel masts and cantilever supports, portal frames where appropriate and contact wires to transmit the current to the train pantographs⁸¹ and catenary support wires⁸². The masts and frames will usually be around 8.5m high and will be spaced at 45-55m intervals along the track.
- 5.17.12 In addition to the traction power supply, electrical power will be required for other purposes, including lighting and the operation of equipment in tunnels, shafts, stations and depots. Arrangements will be made with the local power distribution company, or District Network Operator, for auxiliary power supplies at each location where they are required.

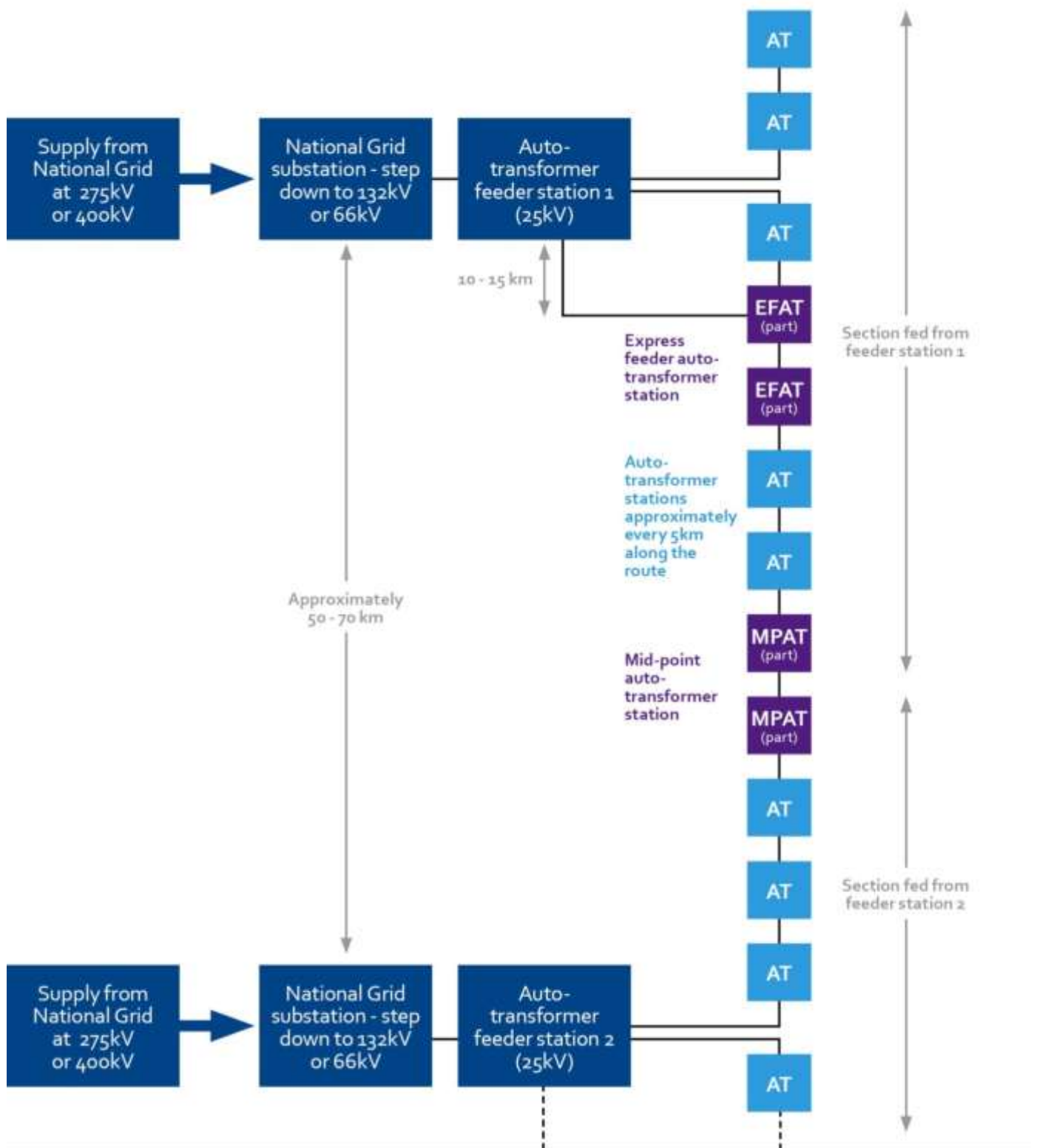
⁷⁹ Electrical equipment used to balance the electrical loads so that the unbalance is kept within acceptable limits set by the supply authority.

⁸⁰ Power provided primarily for the purpose of moving trains.

⁸¹ A device mounted on the roof of train to provide an electrical connection between the train and the overhead contact wire.

⁸² A system of wires used to support the contact wire at the correct height above the track.

Figure 30: Power supply process diagram



5.18 Train control and telecommunications

- 5.18.1 The train control system will be a computer-based interlocking system, controlled from a route-wide network control centre at Washwood Heath depot. It will not require traditional trackside signals for its operation. The associated line-side equipment will include cable troughs, marker boards and cabinets, generally no more than 1-3m high. Some control equipment will also be housed within equipment rooms at stations.
- 5.18.2 The route will use radio communications as part of its railway operations and train control systems. This will require radio antennae to be mounted on short extension poles fixed to the OLE masts, approximately every 2km (1.3 miles). The antennae will typically be up to 10m above track level. The associated radio transmission equipment will be mounted at the pole base. An optical fibre cable network, with cables laid in troughs beside the track, will provide a communications backbone linking all line-side equipment, stations and the control centre.

6 Construction of the Proposed Scheme

6.1 Introduction

6.1.1 This section provides an overview of the typical activities and methods that are anticipated to be adopted during construction.

6.2 Construction land requirements

6.2.1 During the construction period, land will be required temporarily for the following purposes:

- construction compounds, worksites and the access to them;
- diversion/realignment of roads, PRow and private accesses, or provision of temporary alternative routes;
- diversion/realignment of railways;
- diversion/realignment of watercourses;
- diversion/realignment of utilities;
- temporary storage of topsoil and excavated material; and
- road and railheads⁸³ for the movement of excavated material and delivery of construction materials and plant.

6.2.2 Land for the temporary storage of excavated material will be required during the earthworks stage, mainly at locations where large volumes of excavated material arise, such as tunnel portals and deep excavations. Temporary material stockpiles will be required at certain sections of the route to limit the distances over which such materials need to be transported. On completion of the works these areas will generally be returned to their previous use, where this is reasonably practicable and subject to landowner agreement.

6.3 Environmental controls during construction

Overview

6.3.1 All contractors will be required to comply with the environmental management regime for the Proposed Scheme, which will comprise of the CoCP and a series of local environmental management plans (LEMP).

6.3.2 Site-specific control measures at a local level will be included within the LEMP, which will be developed during the Parliamentary process and detailed design stage in consultation with the relevant stakeholders. As the Proposed Scheme extends across 28 local authorities and engages with a wide range of stakeholders, the CoCP is intended to provide a framework to ensure a consistent approach.

⁸³ Roadheads are where bulk delivery or despatch of materials or equipment will take place via the public highway network. Railheads are where bulk delivery or despatch of materials or equipment will take place via the existing rail network.

6.3.3 The draft CoCP is presented in Volume 5: Appendix CT-003-000/1. This section summarises its key elements.

Purpose of the Code of Construction Practice

6.3.4 The draft CoCP sets out a series of proposed measures and standards of work, which will be applied by the nominated undertaker and its contractors throughout the construction period to provide:

- effective planning, management and control during construction to control potential impacts; and
- the mechanisms to engage with the local community and their representatives throughout the construction period.

6.3.5 The nominated undertaker and its contractors will comply as a minimum with applicable environmental legislation at the time of construction, together with any additional environmental controls imposed by the hybrid Bill, except where such legislation has been dis-applied. For this reason the applicable statutory requirements are not repeated within the CoCP. Further guidance on specific activities, such as soil handling and dust management, will be based on industry good practice as set out in the CoCP.

Environmental management system

6.3.6 The nominated undertaker will develop an environmental management system (EMS) in accordance with BS EN ISO 14001⁸⁴. The EMS provides the process by which environmental management both within its organisation and in relation to its operations is undertaken to ensure that the relevant findings of the ES are addressed through the construction phase. The EMS will set out:

- the procedures to be implemented to plan and monitor compliance with environmental legislation;
- the key environmental aspects of the work and how they will be managed;
- staff competence and awareness requirements and how these are to be achieved and maintained;
- record keeping arrangements;
- the procedures to be implemented to monitor compliance with the environmental provisions in the hybrid Bill; and
- the procedure to monitor compliance and the effectiveness of the measures included within the CoCP.

Lead contractors environmental management system

6.3.7 The nominated undertaker will require each of its lead contractors⁸⁵ to have an EMS certified to BS EN ISO 14001. Their EMS will include roles and responsibilities, together with appropriate control measures and monitoring systems to be employed during planning and construction of the works for all relevant topic areas. Where the lead

⁸⁴ British Standards Institute (2004), *BS EN ISO 14001:2004 Environmental management systems*.

⁸⁵ A lead contractor is a construction company that is directly contracted for the works by the nominated undertaker.

contractor is a joint venture, the EMS will be certified to cover the activities of the joint venture.

- 6.3.8 As part of their EMS, lead contractors will be required to plan their works in advance to ensure that, in so far as is reasonably practicable, measures to reduce environmental effects are integrated into the construction methods and that commitments from the ES and hybrid Bill are complied with. The works will also be subject to approval processes set out in the draft CoCP by the nominated undertaker (e.g. suitability of construction phase plans) and by any statutory consents required.
- 6.3.9 The lead contractors' EMS will cover the activities of all their contractors. The lead contractors will also be required to coordinate with other contractors and relevant parties relevant to their works. This will be documented in their EMS, as appropriate.
- 6.3.10 The lead contractors' EMS will include procedures to monitor compliance with the project's environmental requirements, together with provisions for any corrective actions required. The detailed provisions of the lead contractors' EMS will be subject to review and acceptance as being suitable by the nominated undertaker.

Enforcement and local environmental management plans

- 6.3.11 The general requirements set out in the CoCP will be applicable to the whole of the Proposed Scheme and will apply to each construction contract let by the nominated undertaker. These requirements will be supplemented by a LEMP for each relevant local authority area.
- 6.3.12 The LEMP will set out how the Proposed Scheme will adapt and deliver the required environmental and community protection measures within each local authority area, through a series of topic specific measures that reflect the general requirements of the CoCP.

Monitoring

- 6.3.13 The lead contractors will undertake the necessary monitoring for each environmental topic to comply with the requirements of the CoCP, the relevant LEMP, any additional consent requirements and their EMS. Aspects to be monitored will include the impact of the works and the effectiveness of mitigation measures, and any actions that may be necessary for compliance will be identified.

Considerate Constructors Scheme

- 6.3.14 Lead contractors will be required to sign up and adhere to the Considerate Constructors Scheme⁸⁶. The Considerate Constructors Scheme is a UK-wide initiative that promotes good practice on worksites through its codes of considerate practice, which commit registered sites to be considerate and good neighbours, as well as being respectful, environmentally conscious, responsible and accountable.

Community relations

- 6.3.15 The nominated undertaker and its contractors will produce and implement a stakeholder engagement framework and provide appropriately experienced community relations

⁸⁶Considerate Constructors Scheme, www.ccscheme.org.uk, Accessed: 1 July 2013.

personnel to implement it, to provide appropriate information and to be the first point of contact to resolve community issues. The nominated undertaker will take reasonable steps to engage with the community, particularly focusing on those members who may be affected by construction impacts, including local residents, businesses, land owners and community resources, and the specific needs of protected groups (as defined in the Equalities Act 2010)⁸⁷.

- 6.3.16 Regular meetings will be held at community forum locations between the lead contractor, the nominated undertaker, local authority and representatives of the local community or other stakeholders to discuss construction issues and the forthcoming programme of works. The nominated undertaker and its contractors will provide support for local businesses, land owners, voluntary and community organisations that may be affected by the works will be provided by the nominated undertaker, and will consider local employment, apprenticeships and educational initiatives when recruiting staff.

Advance notice of works

- 6.3.17 The nominated undertaker and its contractors will ensure that local residents, occupiers, businesses, local authorities and parish councils affected by the works, as identified in the ES, are informed in advance of work taking place using the methods identified in the framework. The notifications will detail the estimated duration and nature of the works, and the proposed working hours. In the case of works required in response to an emergency, the local authority, parish council, local residents, businesses and community resources will be advised as soon as reasonably practicable. All notifications will include the community helpline number.
- 6.3.18 Information on the works will also be available on the HS2 website and at appropriate locations along the route, which will be identified in the LEMP.

Core working hours

- 6.3.19 The contractors will seek to obtain consents from the relevant local authority under Section 61 of the Control of Pollution Act 1974⁸⁸ for the proposed works. Applications will include details on proposed working hours.
- 6.3.20 The draft CoCP outlines the anticipated working hours. Core working hours will be from 08:00-18:00 on weekdays (excluding bank holidays) and from 08:00-13:00 on Saturdays. The nominated undertaker will require its contractors to adhere to these core working hours for each site as far as reasonably practicable, or unless otherwise permitted under Section 61 of the Control of Pollution Act.
- 6.3.21 Guidance on-site specific variations to core hours and/or additional hours likely to be required will be included within the LEMP following consultation with the relevant local authority.
- 6.3.22 Except in the case of an emergency, any work required to be undertaken outside of core hours (not including repairs or maintenance) will be agreed with the local authority prior to undertaking the works under Section 61 of the Control of Pollution Act within the framework set out by the LEMP and the draft CoCP.

⁸⁷ *Equalities Act 2010*. Her Majesty's Stationery Office, London.

⁸⁸ *Control of Pollution Act 1974*. Her Majesty's Stationery Office, London.

Start up and close down periods

- 6.3.23 To maximise productivity within the core hours, the nominated undertaker's contractors will require a period of up to one hour before and up to one hour after core working hours for start-up and close down of activities. This will include, but not be limited to, deliveries, movement to place of work, unloading, maintenance and general preparation works. It will not include operation of plant or machinery likely to cause a disturbance to local residents or businesses. These periods will not be considered an extension of core working hours.

Additional working hours

- 6.3.24 Tunnelling and directly associated activities (such as removal of excavated material, supply of materials and maintenance of tunnelling equipment) will be carried out on a 24 hour day, seven day week basis. Where reasonably practicable, material will be stockpiled within the worksite for removal during core working hours.
- 6.3.25 Work within existing stations, track laying activities and work requiring possession of major transport infrastructure may be undertaken during night-time, Saturday afternoon, Sunday and/or bank holiday working, for reasons of safety or operational necessity, and will often involve consecutive nights work over weekend possessions or for longer periods. Activities outside core working hours that could give rise to disturbance will be kept to a reasonably practicable minimum.
- 6.3.26 Operations such as earthworks are season and weather dependent. In these instances the nominated undertaker's contractors will seek to extend the core working hours and/or days for such operations to take advantage of daylight hours, with the consent of the relevant local authority.
- 6.3.27 Certain other specific construction activities will require extended working hours for reasons of engineering practicability. These activities include, but are not limited to, major concrete pours and piling/diaphragm wall works. Surveys, e.g. for wildlife or engineering purposes, may also need to be carried out outside of core working hours.
- 6.3.28 In the case of work required in response to an emergency or which if not completed would be unsafe or harmful to the works, staff, public or local environment, the relevant local authority will be informed as soon as reasonably practicable of the reasons for, and likely duration of, these works. This information will also be made available to the HS2 Ltd helpline. This may be necessary, for example, where pouring concrete takes longer than planned due to equipment failure, or where unexpectedly poor ground conditions, encountered whilst excavating, require immediate stabilisation.

Abnormal deliveries

- 6.3.29 Abnormal loads or those that require a police escort may be delivered outside core working hours subject to the requirements and approval of the relevant authorities.

Management of construction traffic

- 6.3.30 Vehicles accessing the construction compounds and the worksites can be divided into three broad categories:
- heavy goods vehicles (HGV): articulated lorries for plant and materials, concrete

trucks, bulk tipper trucks, abnormal/oversize loads;

- light goods vehicles: pickups and small tipper trucks, vans, cars; and
- rail vehicles: used in the construction of works immediately adjacent to or over the existing rail network, or used to deliver material to or from the site.

- 6.3.31 Construction vehicles carrying materials, plant, other equipment or workforce, or that are empty will travel on public roads and via the rail network, as well as within the construction area between worksites. Wherever reasonably practicable, the rail network will be used in preference to public roads. The construction compounds will provide the interface between construction areas and the public roads or rail network. Movements between the construction compounds and the worksites will be on designated haul roads within the construction area, often along the line of the new railway or parallel to it.
- 6.3.32 The transport assessment assesses the impact of construction traffic on the transport network at a local and regional level. Its findings will inform the traffic management plans that will be implemented during construction in consultation with the local traffic and highway authorities and the emergency services. Measures to be considered in these plans include the following, as appropriate:
- site boundaries and the main access/egress points for worksites and compounds;
 - temporary and permanent closures, diversions or realignments of highways (i.e. roads and PRoW); and
 - the proposed traffic management and logistics strategies.
- 6.3.33 Lead contractors will be required to ensure that impacts on the local community from construction traffic are minimised and that public access is maintained where reasonably practicable. Traffic impacts will be reduced by identifying clear controls on vehicle types and hours of operation, and agreed routes for large goods vehicles. Highway works required to accommodate construction traffic will be identified. The number of private car trips to and from each site (both workforce and visitors) will be reduced by encouraging alternative modes of transport or vehicle sharing.
- 6.3.34 The measures in the CoCP will include clear controls on vehicle types, hours of site operation and routes for HGV, to reduce the impact of road based construction traffic. Construction workforce travel plans will be prepared by the lead contractors with the aim of encouraging the use of sustainable modes of transport and discouraging workforce commuting by private car, to reduce the impact of workforce travel on local residents and businesses. Generic and site-specific traffic management measures will be implemented on relevant roads, PRoW and other points of access as necessary.

Handling of construction material and waste

Excavated material

- 6.3.35 Construction of the Proposed Scheme will generate significant quantities of excavated material. As described in Section 5.2, the nominated undertaker will use excavated material in the construction of the Proposed Scheme, wherever feasible, thereby reducing the need for imported materials and the off-site disposal of surplus excavated material.

- 6.3.36 The majority of excavated material that will be generated across the Proposed Scheme will be reused as engineering fill material or in the environmental mitigation earthworks of the Proposed Scheme.
- 6.3.37 For the surplus excavated material which cannot be beneficially reused for the earthworks of the Proposed Scheme, the nominated undertaker will seek to provide surplus excavated material for:
- use in other local construction projects where opportunities arise at the time of construction; and/or
 - use for restoration of mineral sites, where the transportation of that material does not result in significant environmental effects.
- 6.3.38 Where the transportation of that material would result in significant environmental effects sustainable placement will be used.
- 6.3.39 Sustainable placement is the on-site placement for disposal of surplus excavated material to avoid causing environmental effects (e.g. transport) that would otherwise be associated with the off-site disposal of that material.
- 6.3.40 Sites for sustainable placement have been selected on the basis of their suitability for the disposal of surplus excavated material.
- 6.3.41 Surplus excavated material that displays hazardous properties will be unsuitable for use within the design of the Proposed Scheme or sustainable placement and will be disposed to landfill as hazardous waste⁸⁹.

Waste management

- 6.3.42 The main waste streams likely to arise during the overall construction phases will include:
- surplus excavated material from earthworks and tunnelling activities;
 - demolition waste;
 - construction waste; and
 - waste generated by occupants of worker accommodation sites.
- 6.3.43 Waste management will be based on the principles of the waste hierarchy, whereby priority is given to the prevention of waste generation, followed (where this is not possible) by reuse, recycling and recovery respectively. Disposal to landfill will be undertaken only as a last resort.
- 6.3.44 The principal objectives of sustainable resource and waste management are to use material resources more efficiently, to reduce waste at source and to reduce the quantity of waste that requires final disposal to landfill. 'Designing-out waste' principles will be applied to control the quantity of waste generated. An integrated earthworks design approach has been developed in order to minimise the quantity of excavated material

⁸⁹ Class U2 material will be disposed directly to hazardous landfill.

generated and use that which is generated to satisfy the necessary engineering and environmental mitigation requirements for the Proposed Scheme.

6.3.45 A site waste management plan (SWMP) will be prepared and maintained by the nominated undertaker's lead contractors in order to identify the specific types and quantities of waste likely to arise during the construction process.

6.3.46 Further information regarding excavated material and waste management is given in the draft CoCP.

Noise and vibration strategy

6.3.47 Construction noise and vibration will be controlled and managed in accordance with the draft CoCP. The principles of these control and management processes are:

- Best Practicable Means (BPM) as defined by the Control of Pollution Act and Environmental Protection Act 1990⁹⁰ will be applied during construction activities to minimise noise (including vibration) at neighbouring residential properties;
- as part of BPM, mitigation measures are applied in the following order:
 - noise and vibration control at source: for example, the selection of quiet and low vibration equipment, review of construction methodology to consider quieter methods, location of equipment on-site, control of working hours, the provision of acoustic enclosures and the use of less intrusive alarms, such as broadband vehicle reversing warnings; and then
 - screening: for example, local screening of equipment or perimeter hoarding;
- where, despite the implementation of BPM, the noise exposure exceeds the criteria defined in the draft CoCP, noise insulation or ultimately temporary re-housing will be offered in accordance with the Section 13.2 of the draft CoCP which sets out the noise insulation and temporary re-housing policy;
- lead contractors will seek to obtain prior consent from the relevant local authority under Section 61 of the Control of Pollution Act for the proposed construction works. The consent application will set out BPM measures to minimise construction noise, including control of working hours, and provide a further assessment of construction noise and vibration including confirmation of noise insulation or ultimately temporary re-housing provision;
- contractors will undertake and report such monitoring as is necessary to assure and demonstrate compliance with all noise and vibration commitments. Monitoring data will be provided regularly to and be reviewed by the nominated undertaker and will be made available to the local authorities; and
- contractors will be required to comply with the terms of the draft CoCP and appropriate action will be taken by the nominated undertaker as required to ensure compliance.

⁹⁰ *Environmental Protection Act 1990*. Her Majesty's Stationery Office, London.

- 6.3.48 In addition to this mitigation, taller screening as described in the draft CoCP⁹¹ has been assumed, as required to avoid or further reduce along edge of the construction site boundary.
- 6.3.49 Noise insulation will be offered for qualifying buildings as defined in the draft CoCP's Noise Insulation and Temporary Re-housing Policy. Noise insulation or ultimately temporary re-housing will avoid residents being significantly affected⁹² by levels of construction noise inside their dwellings. The assessment reported in this section provides an estimate of the buildings that are likely to qualify for such measures.
- 6.3.50 Qualification for noise insulation and temporary re-housing will be identified as part of seeking prior consent from the local authorities under Section 61 of the Control of Pollution Act. Qualifying buildings will be identified early enough so that noise insulation can be installed, or temporary re-housing provided, before the start of the works predicted to exceed noise insulation or temporary re-housing criteria. Noise insulation, where required, will be installed as early as possible to reduce internal sound levels from construction activities and also when the Proposed Scheme comes into operation.

Ground settlement

- 6.3.51 Excavation for the tunnels, shafts cross passages, station boxes and other below ground structures will potentially lead to small ground movements at the surface and below ground. The amount of ground movement will depend on a number of factors including depth and volume of works below ground, soil and groundwater conditions and the presence and nature of building foundations/third party assets. In most cases this will have no visible impact on property/third party assets. Very rarely these ground movements may affect properties/third party assets. Techniques for controlling settlement of buildings and protecting buildings from irreparable damage are well developed, based on other tunnelling projects such as the Jubilee line extension, the Channel Tunnel Rail Link and Crossrail. Appropriate techniques will be implemented in order to control and limit, as far as reasonably practicable, the effects of settlement.
- 6.3.52 The nominated undertaker will assess potential settlement along the route of the railway and include the risk of damage to all buildings within the zone affected by settlement. Depending on the level of risk, either no action will be required, buildings will be monitored during construction, or special protective measures will be implemented where required to protect the buildings.
- 6.3.53 Measures to reduce settlement and requirements with regards to surveys and monitoring will form part of the EMR.

Extreme weather events

- 6.3.54 The nominated undertaker's contractors will pay due consideration to the impacts of extreme weather events and related conditions during construction. The contractors will use a short to medium range weather forecasting service from the Met Office or other

⁹¹ As described in the draft CoCP, provided as necessary by solid temporary hoarding, temporary earth stockpiles, screening close to the activities or other means to provide equivalent noise reduction.

⁹² Information is provided in the emerging National Planning Practice Guidance – Noise <http://planningguidance.planningportal.gov.uk>, e.g. the table summarising the noise exposure hierarchy.

approved meteorological data and weather forecast provider to inform short to medium-term programme management, environmental control and impact mitigation measures.

6.3.55 The lead contractor will ensure that appropriate measures within the draft CoCP are implemented and, as appropriate, additional measures to ensure the resilience of the proposed mitigation of impacts during extreme weather events.

6.3.56 The lead contractors' EMS should consider all measures deemed necessary and appropriate to manage extreme weather events and should specifically cover training of personnel and prevention and monitoring arrangements. As appropriate, method statements should also consider extreme weather events where risks have been identified.

6.4 Advance works

6.4.1 Advance works required before construction commences will generally include:

- further detailed site investigations and surveys;
- further detailed environmental surveys;
- advance mitigation works including, where appropriate, contamination remediation, habitat creation and translocation, archaeology and built heritage survey and investigation;
- site establishment and temporary fence construction; and
- utility diversions.

Further detailed site investigations and surveys

6.4.2 Prior to construction, additional investigations will be required to define each worksite⁹³ and construction compound and to plan its layout. Surveys are likely to include:

- ground investigations, such as drilling boreholes to confirm geotechnical parameters; and
- topographical surveys in order to map ground contours and existing surface features.

Further detailed environmental surveys

6.4.3 Further detailed, site specific environmental surveys will also be undertaken, which will include:

- ecological surveys to confirm the baseline in areas where no access has been possible to date, and to inform licence applications and proposed habitat/species translocation works;
- archaeological and built heritage evaluation surveys to confirm the character of assets and to inform the design of detailed mitigation strategies. Evaluation works may include desk-based research and historic building, geophysical and/or trial trenching surveys;

⁹³ A 'worksite' is an area which is principally used for the purpose of construction works.

- hydrological and hydrogeological surveys to confirm flooding potential, water quality and groundwater conditions;
- geotechnical investigations to confirm ground and groundwater conditions; and
- contaminated land surveys, including boreholes, probe holes and trial pits, supported by soil and groundwater sampling and testing for a suite of relevant chemicals, in order to confirm any possible contamination sources and pathways, and any remediation works that may be required.

Advance mitigation works

Contamination remediation

6.4.4 Where surveys identify that soil contamination is present, further works, including remediation may be required. These will include the following activities:

- groundwater monitoring;
- ground gas monitoring and sampling where contamination from landfill gases is occurring;
- remediation works, including excavation, soil treatment using methods such as soil-washing, bioremediation and stabilisation, provision of capping layers or ground barriers to prevent the migration of contaminants or ground gasses and installation of venting systems for ground gasses; and
- off-site disposal of unsuitable soils.

Habitat creation and species/habitat translocation

6.4.5 Most of the areas identified for the provision of ecological compensation are outside the extent of the construction works. Some areas identified for the translocation of protected or notable species will need to be created in advance, while others may already be suitable as receptor sites.

6.4.6 These works include, but are not limited to, the planting of new grassland or woodland habitats, the creation of new ponds, hibernacula⁹⁴ or basking features, and the construction of artificial badger setts.

6.4.7 Where translocation or relocation of protected species is required, this process may take up to two years prior to construction.

6.4.8 Where translocation of habitats from within the land required for construction is proposed, there will be a requirement for prior soil testing at the receptor site and subsequent soil stripping to prepare receptor sites for the translocation of woodland soils or species rich grassland. In addition, small amounts of soil may be removed from the donor site to better establish the species composition within the seed bank.

Archaeological and built heritage works

6.4.9 Where evaluation works have identified the need for detailed archaeological and built heritage mitigation, a programme of investigation works will be developed, as set out in

⁹⁴ Artificial created habitat for translocation of animals that hibernate.

Section 8 of the draft CoCP. Mitigation may include; for example, historic building recording, archaeological excavation, palaeo-environmental boreholes and the in-situ preservation of assets.

Site establishment and temporary fencing

- 6.4.10 Temporary security fencing will be erected on land required during construction, including construction compounds (refer to Section 6.6). Further information relating to site establishment is discussed in Section 6.7.

Utility diversions

- 6.4.11 Prior to construction, a number of utility diversions will be required, including water, gas mains, sewers, telecommunication equipment, electricity and fuel pipelines. The major utility diversions are described within Volume 2: CFA reports, Section 2.3.
- 6.4.12 A condition survey is likely to be undertaken prior to diversion, and some utilities may also require additional strengthening or replacement.
- 6.4.13 Discussions with utility providers are underway to confirm whether utility infrastructure will need to be positioned away from the area of work; protected from the works by means of a concrete slab or similar; or have sufficient clearance from the works that they will not be affected.
- 6.4.14 Where excavation or piling may be required within the exclusion zones for high pressure mains, high voltage cables or fuel mains, an appropriate approach will be agreed with the relevant statutory undertaker, (i.e. utility company), including protective measures.
- 6.4.15 Subject to the agreement of the statutory undertaker and local authorities, ground penetrating radar surveys⁹⁵ will be carried out and trial holes excavated to identify if underground utilities are in their expected locations.
- 6.4.16 Some utility works will require temporary realignment of PRoW. As detailed in Section 6.3, this will be managed through a traffic management plan.
- 6.4.17 In some places there is the need to amend the height and/or location of pylon towers for overhead line electricity cables. This will require the erection of temporary towers to carry the cables whilst the new or amended towers are being built. It will also require new power cables to be installed and tensioned, and these cabling works will require works at a number of towers either side of those to be amended. In between these towers the cabling works is unlikely to require works to be undertaken at ground level, although access will be required and the Volume 2: CFA report drawings show the access routes. However, at ground level between towers, where re-cabling is being undertaken, there may be some restrictions to access as a precautionary measure other than at residential properties.

6.5 Overview of the construction works

- 6.5.1 The construction works along and adjoining the route will comprise two broad types of construction work:
- civil engineering works, including: establishment of construction compounds; site

⁹⁵ A non-destructive survey technique used to identify underground features (often utilities services) using radio waves.

preparation and enabling works; main earthworks and structural works; site restoration; and removal of construction compounds; and

- railway installation works, including: establishment of construction compounds; infrastructure installation; connections to utilities; changes to the existing rail network; and removal of construction compounds.

6.5.2 There are also locations where the existing railway network will need to be modified, which could involve a combination of civil engineering and/or railway installation works.

6.6 Construction compounds

6.6.1 Construction compounds will be required at various places along the route, and will generally be sited alongside or adjacent to the relevant works. Each Volume 2: CFA report identifies the location of the compounds within its area.

6.6.2 There will be two types of construction compounds: main construction compounds and satellite construction compounds. Main construction compounds will act as strategic hubs for core project management activities (i.e. engineering, planning and construction delivery) and for office based construction personnel. They will include offices, storage for materials (such as aggregates, structural steel, steel reinforcement) and laydown areas, and maintenance and parking facilities (for site plant, lorries and staff cars), together with the main welfare facilities for construction personnel. Workers' sleeping accommodation may be provided at some of these sites (and these are indicated in the CFA reports where they are expected to occur). Main sites will typically require approximately 3ha of land and will support up to 260 construction personnel. There will be 31 main construction compounds along the route.

6.6.3 Satellite construction compounds will generally be smaller, providing office accommodation for a limited number of construction personnel. They will include local storage for plant and materials, welfare facilities, and limited car parking for construction personnel. The satellite construction compounds will require approximately 0.5ha of land and will support up to 100 construction personnel. There will be 299 satellite construction compounds along the route.

6.6.4 Some construction compounds may act as the points of entry to the main construction worksites from the public highway. Some will also act as interfaces with the existing rail network for receipt and/or disposal of materials by rail.

6.6.5 Construction compounds will also serve areas used for major stockpiling of materials such as top soil, for roadheads or railheads and to facilitate transfer of materials to and from the site. In other places the compound may contain construction works such as vent shafts or bridge/viaduct piers. In these situations the CFA reports describe the use of the compound and associated area and any resulting significant environmental effects.

6.6.6 Buildings within compounds will generally be temporary modular units that will be positioned to maximise construction space and limit the area of land required. In urban areas, or elsewhere where there is limited space, it may be necessary to stack these units.

6.6.7 The siting of construction compounds has been influenced by a number of factors, including:

- proximity to major construction activities;
- proximity to main roads and rail/bus routes;
- avoiding proximity to sensitive receptors;
- easy accessibility for local workforce;
- suitable existing topography with minimal requirement for site preparation works;
- proximity of existing utilities for ease of establishing temporary services;
- ease of establishing and maintaining security;
- adequate space; and
- the existing use of the site.

6.6.8 Where reasonably practicable, temporary connections for construction compounds will be made locally to existing utility services (i.e. electricity, water, data, foul sewers and surface water drainage), to reduce the need for generators, storage tanks and associated traffic movements.

6.6.9 Security fencing or hoardings will be provided around the perimeter of each construction compound. Within compounds, areas for offices, welfare and storage will generally be demarcated and secured with fences and gates. Fence type and construction will depend on factors such as the level of security required, the likelihood of intruders, and the degree of visual impact. Lighting of construction compounds will seek to reduce light pollution to the surrounding area, in accordance with the requirements of the draft CoCP. Construction compounds, including any areas used for access, will be returned to the most appropriate use as soon as reasonably practicable after completion of the works.

6.6.10 Some of the construction compounds will be used to manage demobilisation/testing and commissioning of the railway after 2026.

6.7 Site clearance, enabling works and site mobilisation

6.7.1 All areas of land required permanently and temporarily for the works will be cleared.

6.7.2 Prior to excavation, vegetation or structures will be removed or demolished as necessary and the resulting waste material recovered or removed to a permitted landfill site. Topsoil will be stripped down to the top of the subsoil layer and stored appropriately. Should subsoil need to be removed, this will also be stored appropriately. The surfaces of stockpiled material will be formed to prevent degradation of the material and will be managed to control weed growth. As far as reasonably practicable, stockpiles will be kept away from sensitive features (including natural and historic features), watercourses and surface drains. Elsewhere, stockpiles may be located near the site boundary, where they can help to provide temporary screening.

6.7.3 Tree and hedgerow removal will be undertaken outside the bird nesting season, and site clearance for non-critical design elements will be phased accordingly.

- 6.7.4 Demolition will be carried out by conventional methods (e.g. boom-mounted hydraulic breakers⁹⁶, cutters etc.), and will use best practicable means to maximise the recovery of materials for reuse and recycling. As described in the draft CoCP, prior to demolition, surveys will be carried out to check for asbestos and any other hazardous materials, and these materials will be removed by a specialist contractor. Where it is agreed with the local authority that there is no best practicable means to reduce predicted or measured vibration, a condition survey of building foundations/third party assets will also be undertaken prior to and after the relevant works.
- 6.7.5 Activities described as 'advance works' may also be undertaken during this stage of construction.

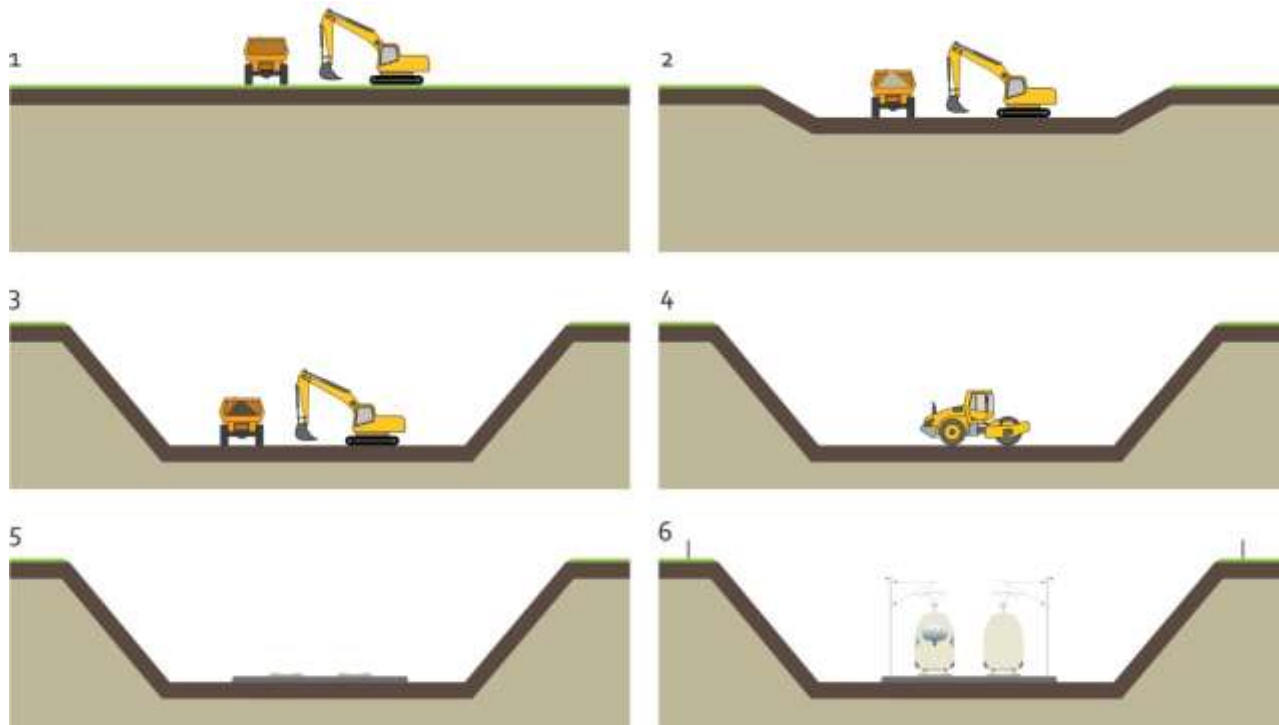
6.8 Cuttings and embankments

Cuttings

- 6.8.1 Cuttings will be excavated using excavators, graders and scrapers, and the resulting material will be reused as fill in embankments if suitable.
- 6.8.2 Where reasonably practicable, excavated material arising from the excavation of cuttings will be used to construct embankments, landscape earthworks and noise bunds. In most cases, the construction of cuttings and embankments will therefore be interdependent, and this is reflected in the sequencing described below.
- 6.8.3 Cuttings will generally be constructed in the following sequence:
- removal of vegetation and installation of surface water drainage;
 - stripping of topsoil and subsoil and construction of temporary material stockpiles, which will be appropriately located and sloped to facilitate surface water run-off and subsequent re-soiling work;
 - sequential excavation of the cutting in layers;
 - transportation of excavated material to embankment worksite(s), where practical, or temporary stockpiling of excavated material, and, where necessary, processing of material to improve its suitability for further use; and
 - re-soiling and seeding of the final slope profile. If the slope angle is steeper than that which would normally be adopted to ensure stability, additional measures will be required prior to re-soiling and seeding; for example the construction of retaining structures, soil nailing or slope drainage, either alone or in combination.
- 6.8.4 An illustration of a generic construction sequence for a cutting is shown in Figure 31.

⁹⁶ Demolition hammers or shears fitted to hydraulic excavator plant. Often on long-reach booms to increase the demolition reach.

Figure 31: Illustration of a generic construction sequence for a cutting



6.8.5 Temporary stockpiling of excavated material may be required where it cannot be placed directly into its permanent location. Granular materials produced from excavations (e.g. gravels), may need to be processed through crushing and/or screening, to ensure that the material is acceptable for use as drainage, structural fill, backfill or capping material.

Embankments

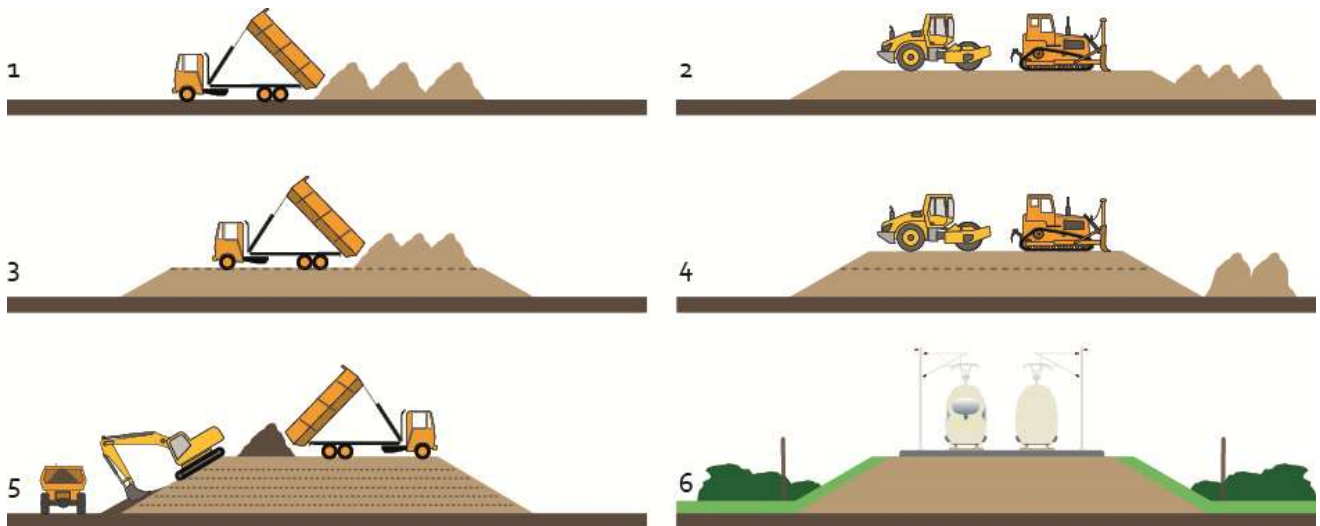
6.8.6 Earthworks will include the bulk excavation of material and placing of that material to create the route alignment. Embankments may be built in stages, commencing early in the construction programme, in order to allow settlement to occur. Binders (e.g. lime and/or cement) may be used selectively to improve the quality of the fill.

6.8.7 Embankments will typically be constructed in the following sequence:

- spreading, levelling and compacting of excavated material in layers over the area required;
- installation of slope drainage, where necessary, to manage run-off and prevent siltation of waterways or water-bodies;
- trimming and re-soiling of slopes to the required profile; and
- subsoil and topsoil will then be placed to the required depth, which will be determined by the proposed use (e.g. as grassland, planted with trees and shrubs or returned to agriculture).

6.8.8 An illustration of a generic construction sequence for an embankment is shown in Figure 32.

Figure 32: Illustration of a generic construction sequence for an embankment



6.9 Drainage and watercourse realignment

- 6.9.1 Construction will require both temporary and permanent drainage works, including track drainage, culverts, balancing ponds and watercourse realignments. These will involve standard earthmoving techniques and equipment (e.g. backhoe excavators), and may use materials such as pre-cast concrete chambers, plastic pipes and filter drains.
- 6.9.2 Smaller culverts are likely to be constructed using pre-cast concrete units, lifted into place by a crane onto a prepared bed of granular material and sealed. Headwalls (i.e. the walls around the mouth of the culvert) may be constructed in-situ from reinforced concrete. Larger culverts may be constructed in-situ in reinforced concrete or from prefabricated units.
- 6.9.3 Where watercourse realignments are required, soft engineering techniques will be used where possible (e.g. pre-seeded geotextile mats and vegetation rolls). However, in certain situations techniques such as piling may be required.
- 6.9.4 Watercourses will generally be realigned to avoid impacts from the Proposed Scheme. Where the route would otherwise need to cross watercourses several times, a single realigned channel could represent a more sustainable solution⁹⁷. Minor realignment will be required in many cases to reduce the length of watercourses that need to be culverted or bridged.
- 6.9.5 Watercourses that require horizontal realignment will generally be constructed in the following sequence:
- temporary fencing of the route for realignment;
 - excavation of the realigned channel to the required level, leaving existing ground

⁹⁷ An example of where there is multiple crossing of watercourses is near Nash Lee Lane (see Volume 2: Stoke Mandeville and Aylesbury, CFA 11).

at each end (a 'plug'), or installation of sheet pile walling⁹⁸, sufficient to prevent inflow from the existing watercourse;

- stabilisation of side slopes and channel;
- lining of channel invert, if required;
- if necessary, sealing with clay or constructing a concrete base and walls;
- removal of plugs or sheet pile walls, allowing water to flow into the realigned channel;
- sealing up the ends of the original watercourse and backfilling the channel with suitable material; and
- landscaping or finishing as required.

6.9.6 Where areas of surface water are affected by the Proposed Scheme, this may require a crossing and a horizontal realignment of the surface water flow path. Vertical and horizontal realignment below existing bed level may be undertaken using drop inlet culverts⁹⁹ and inverted siphons¹⁰⁰. Pumping may also be necessary in some situations. The choice of method will reflect the sensitivity and size of the flood risk, the availability of land and other physical or environmental constraints.

6.9.7 Site activities and working methods will be managed so as to protect the quality of surface water and groundwater from adverse effects. The quality, rate and volume of run-off will be controlled. Monitoring systems will be employed during the construction works. Emergency procedures will be implemented in the case of any pollution incidents.

6.10 Highways (roads) and public rights of way

6.10.1 Where the works cross existing roads or PRoW and continued use of the highway is not possible, these routes will either be closed and the traffic diverted onto other existing highways, or new crossings will be built. New crossings will either be built on the line of the existing road or PRoW (termed 'online'), thereby requiring its closure during construction, or alongside or nearby (termed 'offline').

6.10.2 The choice between whether new crossings will be online or offline will depend on factors such as safety, traffic flows, physical or environmental constraints and the presence (or otherwise) of public utilities.

6.10.3 Online crossings will usually be constructed in the following sequence:

- construction of the temporary layout, if needed;
- temporary realignment of traffic and utilities (if they cannot be retained in their original location) and closure of the existing route;

⁹⁸ Embedded retaining wall utilising standard steel profiles. Used in temporary or permanent conditions. Installed by vibration, impact or push/jack techniques.

⁹⁹ Drop inlet - A form of culvert used on sloping ground where the water level has to be lowered to pass under the Proposed Scheme, other railways or road access. Constructed using either an open cascade (a series of steps down the side of a cutting between an adjacent watercourse) or enclosed chamber on the upstream side only.

¹⁰⁰ A form of culvert used on level ground where the water level has to be lowered to pass under HS2, other railway or a road access; constructed using enclosed chambers on both sides of the route.

- construction of the new road or PRoW and installation of associated utilities; and
- re-direction of traffic back onto the existing alignment.

6.10.4 Offline diversions will generally be constructed in the following sequence:

- construction of the new permanent road or PRoW;
- diversion of utilities onto the new alignment; and
- switching traffic onto the new alignment and closure of the existing route.

6.10.5 Works to existing roads, including temporary diversions, will be carried out in consultation with the relevant highway authority. These will involve standard drainage and earthworks techniques, the laying of capping and sub-base materials and paving. Generally, plant will include excavators, dump trucks, bulldozers, rollers, graders and paving machines.

6.10.6 Similarly, smaller-scale works to existing PRoW will be carried out in consultation with the relevant highway authority.

6.11 Piling

6.11.1 Deep foundations will be required where ground conditions cannot meet the necessary loading or settlement requirements. Deep foundations are usually required for viaduct and bridge piers and abutments, retaining walls and other large structures, such as the new stations and depots. Piles and diaphragm walls¹⁰¹ are the most common form of deep foundation.

6.11.2 To ensure the stability of the heavy plant used for piling and diaphragm walling, it will be necessary to lay a piling mat of suitable material as a working platform. Typically, a piling mat consists of compacted crushed or granular material laid on a geotextile membrane¹⁰². The existing ground surface will be levelled and the material placed in layers of suitable thickness and compacted.

6.11.3 A number of techniques will be used to form deep foundation support. The choice of pile type and installation method will generally be dictated by factors such as loads, ground conditions, proximity of sensitive receptors and speed of installation. Where piling takes place in areas of contaminated soil, precautions will be taken to prevent soil or groundwater migrating downwards into aquifers.

6.11.4 Diaphragm walls involve the construction of reinforced concrete walls within the ground using bentonite slurry as a temporary support medium.

6.11.5 Where displacement piles are used (i.e. steel sheet piling driven into the ground), vibratory or silent piling systems will be preferred.

6.11.6 Continuous flight auger piles are constructed using a hollow stemmed piling auger. The auger is screwed into the ground to the required depth, then concrete is forced down the hollow stem as the auger is extracted. The required steel reinforcement cage is then

¹⁰¹ A rectangular (in plan) foundation structure used to carry horizontal and vertical loads. Can be installed by excavation using a grab or hydromill. The excavated trench is supported using a bentonite support fluid.

¹⁰² Synthetic (generally) fabric used in conjunction with earthworks. Can be used to provide filter or reinforcement properties.

craned into the bore using a vibrating tool, if required. The use of continuous flight auger piles can be restricted by such factors as diameter, depth or by the design of the steel cage.

6.11.7 Bored piles are often referred to as large diameter auger piles which are used to produce larger diameter and deeper piles with more complex steel reinforcement cages. The pile is formed by progressively boring, with the soil being 'spun off' the auger when it is extracted. The stability of the bore in the upper sections is usually maintained by a casing. Lower down the pile the material may be self-supporting (e.g. clay) or may require a bentonite support fluid. Once the bore is complete, the steel reinforcement cage is fixed and lowered into the bore and concrete is then placed inside.

6.11.8 A photograph of an example of a piling rig is shown in Figure 33.

Figure 33: Photograph of an example of a piling rig



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6.12 Tunnels

Tunnel boring machines

6.12.1 Excavation of tunnels is generally undertaken by a tunnel boring machine (TBM). A photograph of a TBM is shown in Figure 34.

Figure 34: Photograph of a typical tunnel boring machine



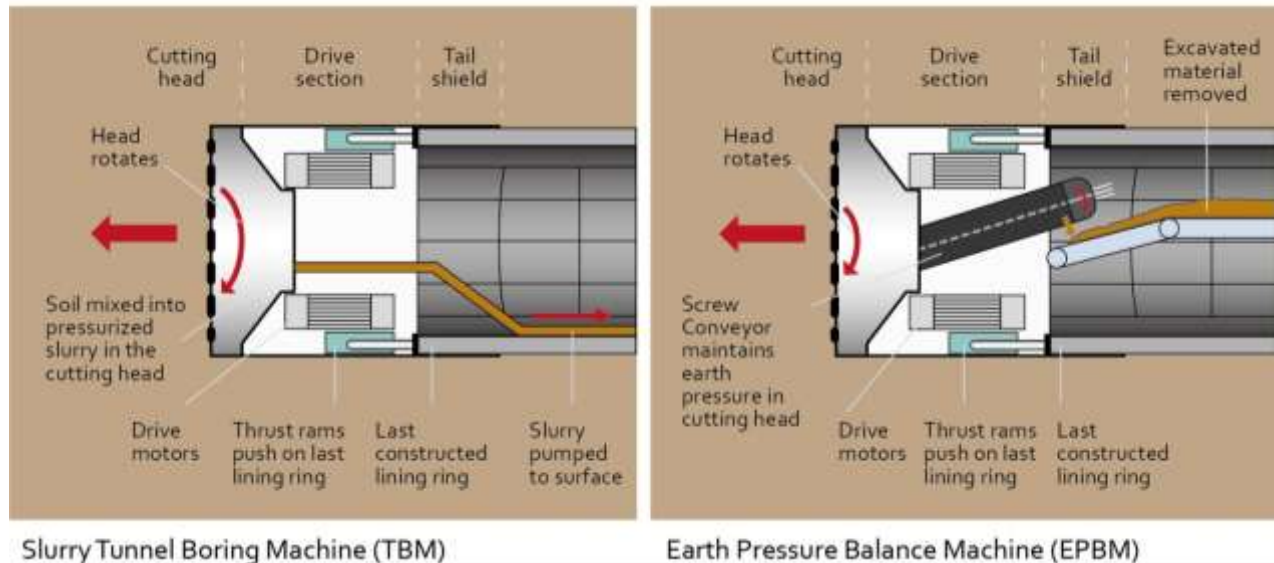
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- 6.12.2 A modern TBM consists of a rotating head called a cutter head, followed by a main bearing, a thrust system and trailing support mechanisms. The type of machine used depends on ground conditions and the amount of groundwater present. In soft ground, three main types of TBM can be used:
- earth pressure balance machine (EPBM);
 - slurry shield; or
 - open face.
- 6.12.3 A slurry shield TBM is used where the groundwater table and pressure are higher and there is very wet ground. An EPBM can be used in a wider range of ground types. Both systems use mixing and backfilling systems to maintain optimal pressure and to ensure a stable face in soft ground. Open face TBM are used when the ground is more stable and self-supporting.
- 6.12.4 All of these types of TBM work by using thrust cylinders to advance forward by pushing off against concrete segments and support the ground by maintaining a balance between the earth and the pressure of the machine. The rate of material removed is determined by the rate of machine advance, thereby maintaining a stable environment.
- 6.12.5 As the TBM is moved forward the tunnel lining is erected and back grouted. A temporary construction railway may be laid in sequence behind the TBM to supply the machines with tunnel lining segments and personnel, using rail mounted vehicles. This railway will

generally be twin tracked to enable two-way traffic and servicing of cross passage construction.

6.12.6 A cross section of a slurry shield and EPBM TBM is shown in Figure 35.

Figure 35: Cross section of a slurry shield and earth pressure balance machine



Bored tunnels

6.12.7 The linings of bored tunnels will typically comprise pre-cast reinforced concrete segments, back-grouted and sealed with gaskets to limit the ingress of groundwater. Ground treatment works, e.g. dewatering or grouting, may be required prior to and during excavation.

6.12.8 For particular tunnel features such as junctions with cross passages, possible construction methods include special cast iron or pre-cast concrete segments. These may be excavated using small machinery and lined with cast iron segments, pre-cast concrete segments or sprayed concrete.

6.12.9 Most twin-bore tunnels are constructed using two TBM at a time. The tunnels at Long Itchington Wood and Bromford will be bored in single drives, with the TBM starting at one portal and emerging at the other portal or at an intermediate vent shaft.

6.12.10 A twin-bored tunnel using a single TBM, including the construction of tunnel portals, will be constructed in the following sequence:

- site clearance, enabling works and worksite establishment;
- excavation, commencing with stripping of topsoil, followed by removal of any hardstandings;
- one portal will act as the drive portal at the start of the tunnel, from where the TBM will be launched, whilst the other portal will act as a reception portal from where the TBM will be recovered once boring is complete;
- the TBM and associated support plant and equipment, such as conveyors and

grout plant, will be delivered and erected on-site. At the drive portal, or supporting construction compound, a concrete batching plant and pre-cast concrete facility may also be installed;

- once the TBM is assembled, the portal headwall will be broken out and the TBM moved into position;
- tunnelling will be a continuous process, with excavated material removed by conveyor to a local stockpile and the pre-cast concrete tunnel segments delivered as the TBM advances. Depending on the type of TBM, excavated material can also be transported from the tunnel by slurry pipes;
- materials, such as tunnel lining segments, are usually transported from the portal or supporting construction compound to the TBM by a temporary, low speed construction railway¹⁰³;
- as the TBM approaches the reception portal, the portal headwall will be broken out ready for the TBM to break through, for which de-watering may be required;
- once the first tunnel drive is completed, the TBM and associated tunnelling train will be dismantled, lifted out of the reception portal, loaded onto trucks and taken back around via the road network to the drive portal. It will then be reassembled to commence the second drive;
- the process detailed above will be repeated for the second drive;
- as the second bore progresses, cross passages between the bores will be constructed;
- once the second tunnel drive is completed, the TBM, tunnelling train and other associated plant will be dismantled and removed from site; and
- on completion of the tunnelling works, the remaining in-situ concrete works to the base slab, together with the tunnel headhouse slab over the tunnel portal, will be constructed. The headhouse building will be erected and fitted out internally.

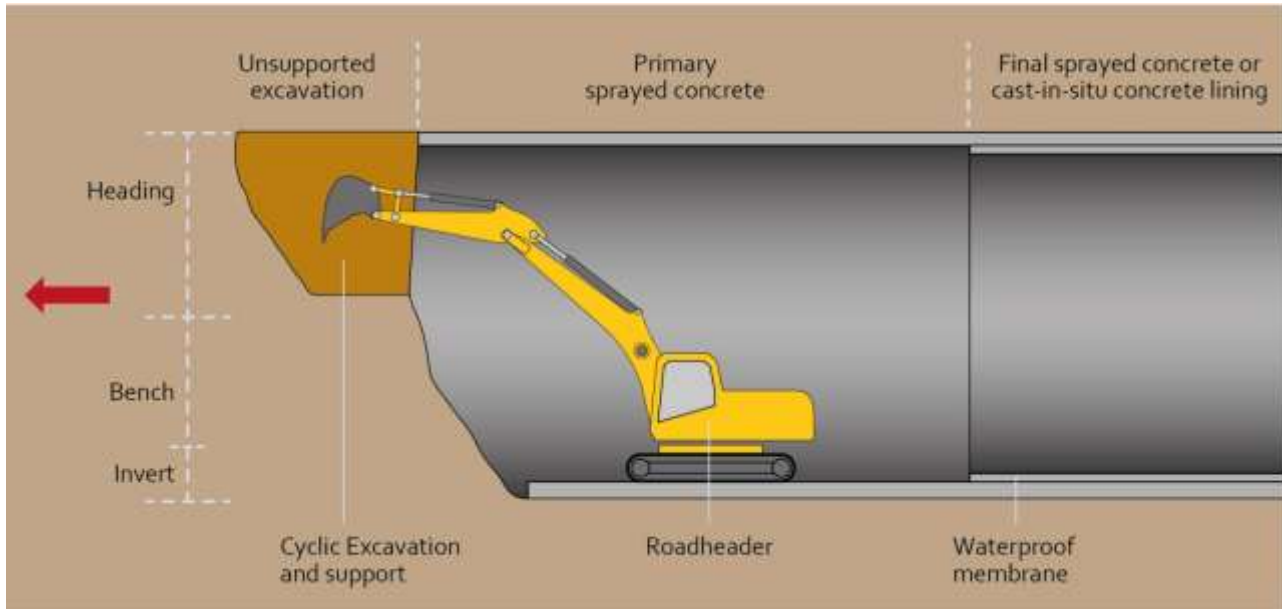
6.12.11 The sequence for a single-bore tunnel will be similar, but will not require a second drive or the construction of cross passages.

Mined tunnels

6.12.12 Tunnels may be mined using roadheaders and/or excavators depending on the groundwater, ground conditions and length of drives. In soft ground or fractured rock, tunnels may be mined using conventional methods. Following a short advance excavation, primary support is installed, which may comprise rock bolts and sprayed concrete in rocky conditions or sprayed concrete for clays and soils. This initial excavation is then sequentially enlarged by cyclic excavation and lining to form the required tunnel geometry. Figure 36 shows how conventional mined excavation may be undertaken.

¹⁰³ Ground-borne noise and vibration will be controlled by the design and maintenance.

Figure 36: Mined excavation by conventional methods



Green tunnels

- 6.12.13 Green tunnels will be constructed using a cut-and-cover method. Construction will involve excavation, construction of a box structure and backfilling with fill material and soil. The land surface above will be graded to match the natural terrain and landscaped or restored to the original or some alternative use.
- 6.12.14 Two main construction methods are likely to be used. For the first option an excavation is created from the surface in a conventional manner and may include installation of a temporary retaining wall. Once the final depth is reached, the tunnel floor is built, followed by the walls and roof. Finally, the entire structure is buried and the surface restored. Where possible, reinstatement will be carried out using stored material from the cut or excavation stage.
- 6.12.15 Option one will be constructed in the following sequence:
- site clearance, enabling works and worksite establishment;
 - excavation of material to the required depth. Side slopes may be strengthened to allow them to be cut at steeper gradients, reducing the area of land required and the potential import and export of materials. Alternatively, temporary retaining structures may be designed to further reduce the extent of excavation and the area of land required for construction and/or operation;
 - construction of the reinforced concrete 'box' structure. Scaffolding, falsework¹⁰⁴, formwork¹⁰⁵, steel reinforcement and other materials will be placed using cranes. Concrete delivered by mixer trucks will be placed either directly within the excavation or by concrete pumps located at ground level;

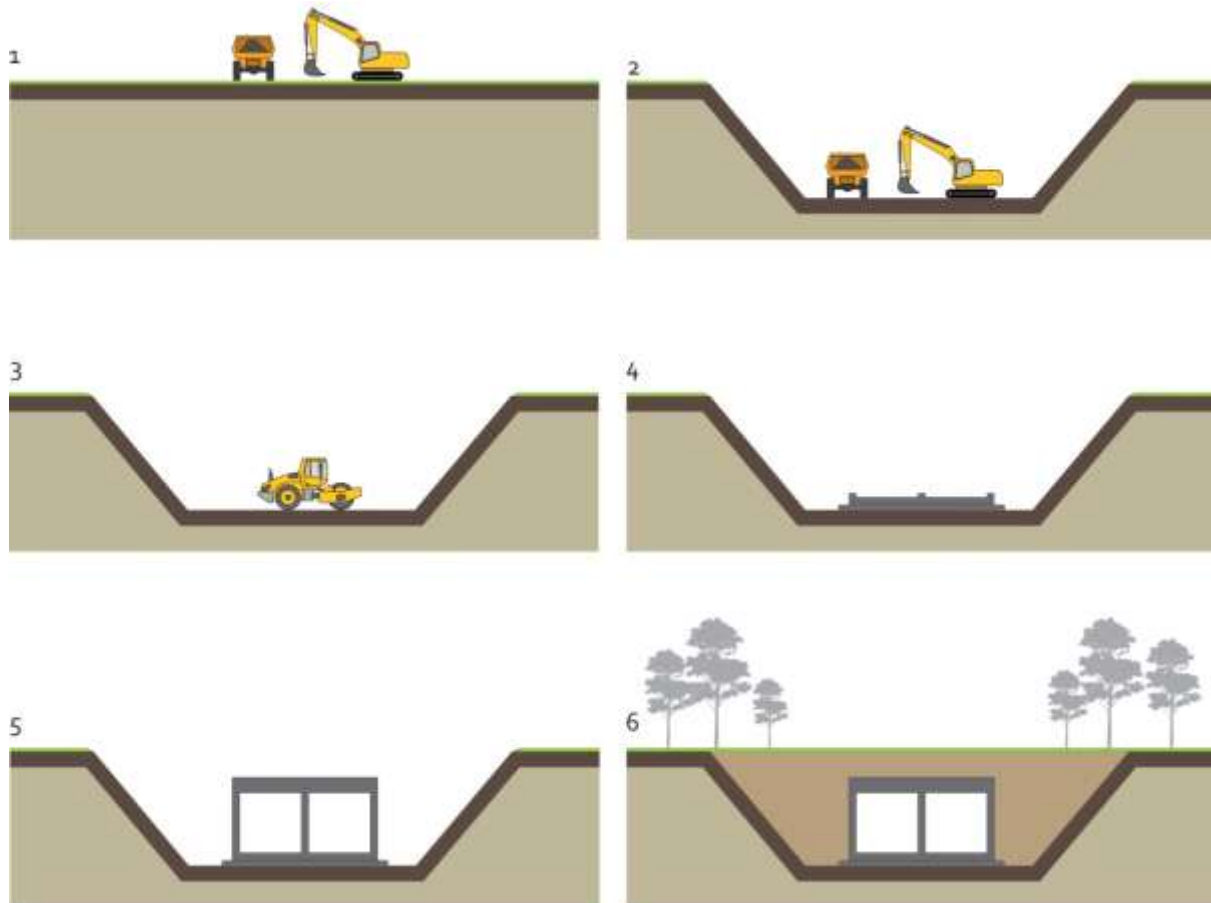
¹⁰⁴ Temporary equipment used to support the permanent works e.g. scaffolding.

¹⁰⁵ Equipment used to form a concrete element, supporting the 'wet' concrete.

- backfilling around the sides and across the top of the structure, to suit the intended land use, and completion of landscaping;
- diversion and installation of utilities and laying of road surfacing as required; and
- removal of temporary works, including any road and PRoW diversion/realignments.

6.12.16 An illustration of this construction sequence is shown in Figure 37.

Figure 37: Option one - cut-and-cover construction method



6.12.17 For the second option, the walls will be constructed first using diaphragm walling¹⁰⁶ or bored piling, followed by excavation and construction of the roof. Excavation of the tunnel is then undertaken beneath the roof slab from the open ends of the box.

6.12.18 Where space limitations restrict the width of an open excavation with side slopes, as is the case for part of the Burton Green, green tunnel, this method is likely to be adopted.

6.12.19 Option two will be constructed in the following sequence:

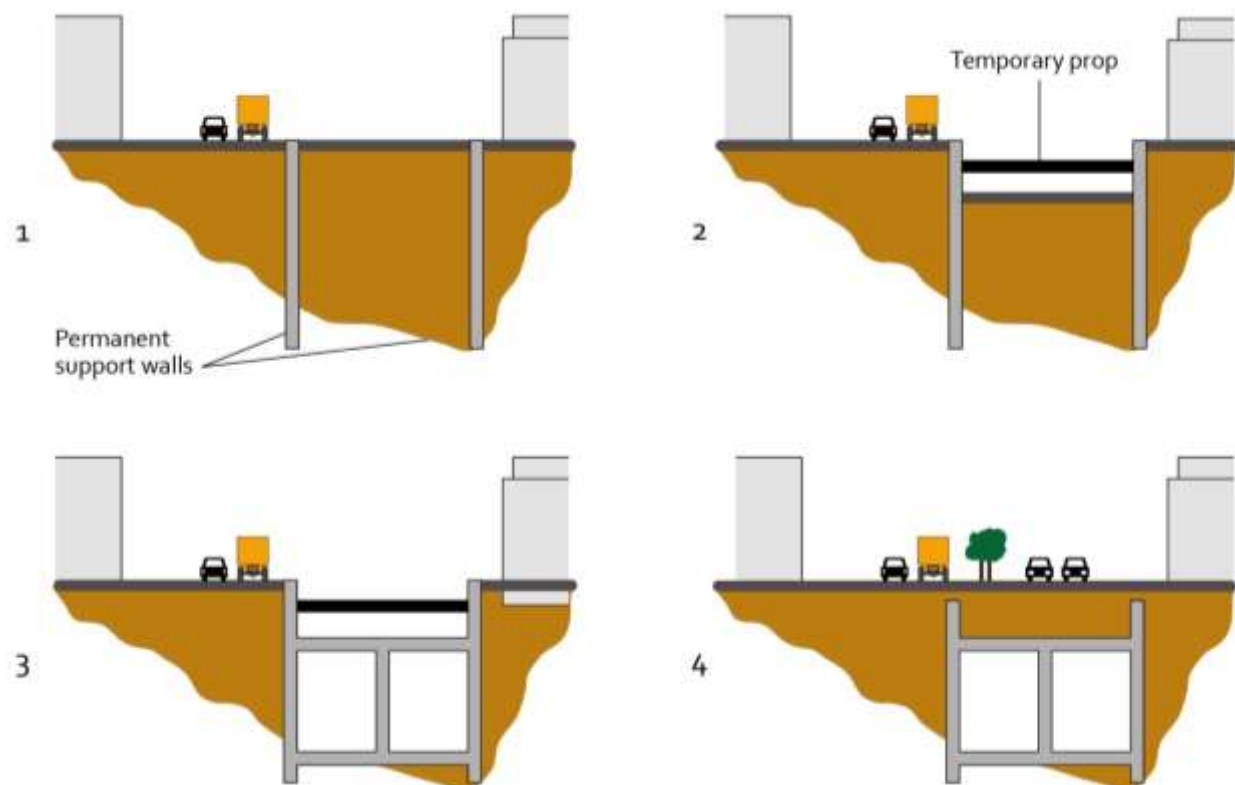
- construction of walls before the main excavation, with vertical retaining panels (i.e. piles, diaphragm walls) installed along the perimeter of the intended excavation from the surface downwards;

¹⁰⁶ Embedded walls inserted into the ground which can be used as foundation walls, groundwater barriers or to isolate portions of contaminated ground.

- excavation down to the level of the roof slab of the intended structure, which may require the propping of retaining walls if installed;
- construction of the tunnel roof, whereby the roof slab is put in place and connected to the perimeter retaining wall, followed by backfilling and reinstatement of the surface;
- excavation and construction of the floors below roof level;
- excavation beneath the roof slab by means of a ramp formed at the portal end. If temporary props are required the excavation is executed in stages, with these being installed progressively;
- on completion of the excavation, the permanent base slab is cast and, when cured, any temporary props are removed;
- diversion and installation of utilities and laying of road surfacing as required; and
- removal of temporary works, including any road and PRow diversion/realignments.

6.12.20 An illustration of this construction sequence is shown in Figure 38.

Figure 38: Option two - cut-and-cover construction method



6.13 Portals

- 6.13.1 In rural locations, portals will typically be constructed by open excavation, with soil and rock slopes benched (i.e. cut in steps) and reinforced as necessary, with reinforced concrete headwalls and wing walls¹⁰⁷ formed around the tunnel entrances. In urban locations, and where space is restricted, portals will utilise embedded retaining wall structures.
- 6.13.2 Where excavation is relatively shallow, portals will be constructed by open cut. For deeper excavations, diaphragm wall or contiguous bored pile¹⁰⁸ techniques will be used, requiring support by propping beams or a cover slab for the deepest excavations. Where portals are required to accommodate a TBM, a slab up to 120m long will also be required to allow the back-up equipment or the TBM to be established.

6.14 Ventilation and intervention (vent) shafts

- 6.14.1 Vent shaft construction will be undertaken during tunnelling. The methods for constructing vent shafts will depend on local ground and groundwater conditions, the depth of shaft and whether there is any need to access the TBM during construction. Possible techniques include:
- diaphragm walling or bored piling;
 - caisson construction (i.e. using a watertight retaining structure or enclosure from which groundwater can be pumped out to maintain dry working conditions), with a pre-cast concrete segmental lining; or
 - open excavation with pre-cast concrete segmental or sprayed concrete linings (or a mix of both).
- 6.14.2 Vent shafts will generally be constructed in the following sequence:
- site clearance, enabling works and worksite establishment;
 - construction of the vent shafts;
 - construction of the remaining shaft internal works and installation of mechanical and electrical machinery;
 - if the shaft is offline (i.e. not directly over the tunnel), it will be connected to the main tunnel by constructing short connecting tunnels using sprayed concrete lining techniques or similar; and
 - following installation of the ventilation equipment and construction of the headhouse over the shaft, the site will be landscaped.

6.15 Cross passages

- 6.15.1 Cross passages will be constructed once both tunnel drives have passed the location of the cross passage. The method of constructing the cross passages will comprise reinforcement and treatment of the ground, if required, followed by excavation,

¹⁰⁷ A wall often projecting from the sides of a bridge used to retain the approach embankment.

¹⁰⁸ Closely spaced bored piles which are used to form an underground wall, for the construction of a deep basement or green tunnel.

application of sprayed concrete, installation of waterproof lining and then a secondary layer of concrete either sprayed or cast in-situ, and installation of base slabs. Depending on ground and groundwater conditions, cross passages may require some form of treatment (e.g. injection of grout) to exclude groundwater and aid support during excavation.

6.15.2 Cross passages will typically be constructed in the following sequence:

- installation of special hybrid concrete /spheroidal graphite iron segments in each tunnel where cross passages are to be located, during the tunnel driving;
- ground improvement and/or de-watering to prevent groundwater ingress;
- installation of spiles (e.g. steel pipes) at the crown of each cross passage, if required, to provide physical support and removal of specified segments of tunnel;
- construction of concrete collars connected to the lining of segmented sections;
- excavation of earth at pre-defined stages and application of sprayed concrete to provide temporary support;
- on completion of excavation works, application of sprayed waterproof lining and permanent sprayed concrete lining or cast in-situ concrete; and
- casting and installation of base slabs.

6.16 Viaducts

6.16.1 The construction methods likely to be used for viaduct decks include the following:

- launched construction, in which a reinforced concrete deck is constructed in sections then launched over the piers, before the next section of deck is constructed behind and the process repeated;
- in-situ construction, in which the entire deck is constructed in reinforced concrete on temporary falsework, which is then removed; and
- beam and deck construction, where deck or portions of the deck are built off-site and placed in position by a crane. The deck is made of either structural steel beams/girders or pre-stressed concrete beams, with a concrete deck acting compositely with the primary beams to enhance structural efficiency.

6.16.2 The choice between these options will depend on the geometry of the structure, the opportunity to construct falsework, which will vary depending on ground conditions, the type of feature being crossed, and the time available to undertake the work.

6.16.3 Launched construction may be used for longer viaducts. This method is made more economic by the incorporation of regular geometry (span arrangements and horizontal alignment).

6.16.4 In-situ construction is more economic for low, bespoke, shorter span structures with high degrees of geometric complexity.

- 6.16.5 The beam and deck solution is convenient for bridging over obstructions, e.g. railways or rivers, especially where construction headroom is restricted.
- 6.16.6 Viaducts will generally be constructed in the following sequence:
- installation of construction access and working platform;
 - construction of foundations and piers from the platform, installation of concrete piles, excavation for pile caps and construction of pile caps and support piers, followed by backfilling of excavations;
 - construction of abutments, including excavation and construction of pile mat, installation of piles, construction of the abutment base, wall and backfilling; and
 - construction of the deck using either launched, in-situ construction or beam and deck solution.
- 6.16.7 An illustration of this construction sequence is shown in Figure 39.

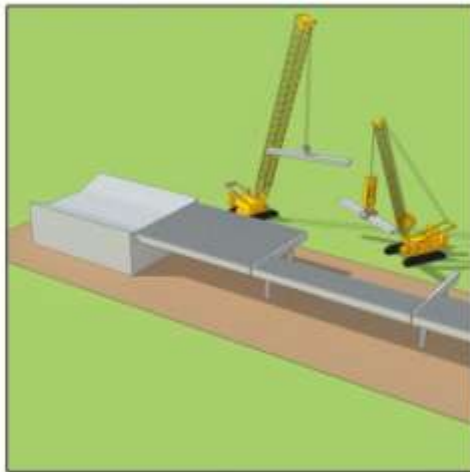
Figure 39: Generic viaduct construction sequence



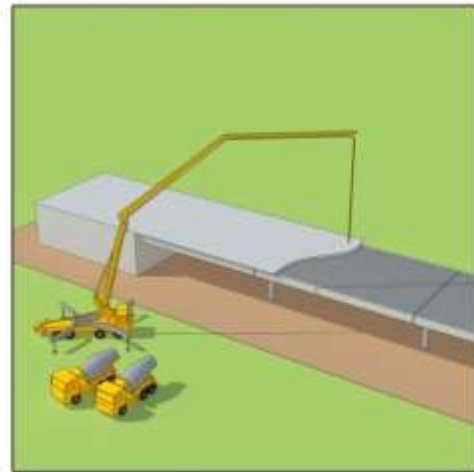
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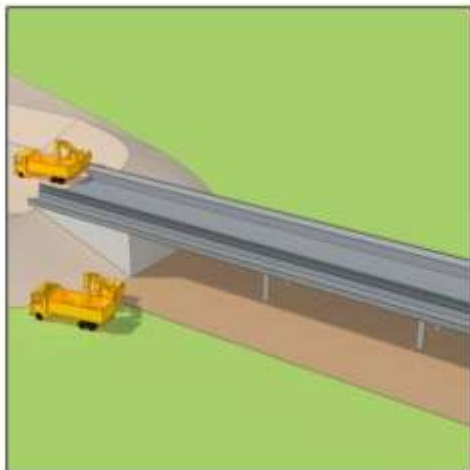
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- 6.16.8 For in-situ construction, the following sequence will be repeated until the viaduct deck is completed:
- installation of falsework and formwork, reinforcement and stressing tendons¹⁰⁹;
 - casting the concrete deck;
 - post-tensioning of the structure; and
 - removal of formwork and falsework gantry and their installation for the next span.
- 6.16.9 For launched construction, the following sequence will be repeated until the viaduct deck is completed:
- installation of a temporary intermediate pier in some instances (e.g. where the permanent spans exceed 40m);
 - off-site construction of launch formwork, which will be delivered to site in 10-30m components;
 - establishment of a concrete casting yard behind the abutment wall at each end of the viaduct;
 - setting up of formwork in the casting yard;
 - assembly of the deck section launching nose;
 - installation of superstructure formwork with an antifriction layer on supports;
 - fixing of sliding equipment on the pier heads;
 - fixing of the first section of deck reinforcement, placing of tendons and pouring of concrete, followed by attachment of the launching nose to the front of the deck section; and
 - forward launching of the deck section using hydraulic jacks.
- 6.16.10 On completion of deck launching, final post-tensioning will be installed to the deck and the temporary supports removed.
- 6.16.11 For the beam and deck solution, the following sequence will be repeated until the viaduct deck is completed:
- placing the precast/steel beams by means of cranes;
 - placing the precast permanent soffit slabs, reinforcement and tendons;
 - concreting the top slab; and
 - post-tensioning connections between beams.

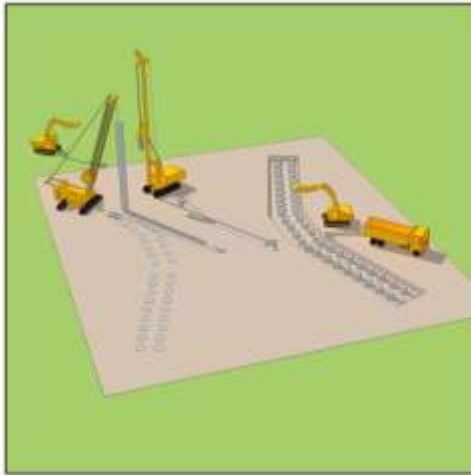
¹⁰⁹ High yield steel bar used to apply a compressive force to concrete such that under service conditions there is no net tension within the element.

6.17 Bridges

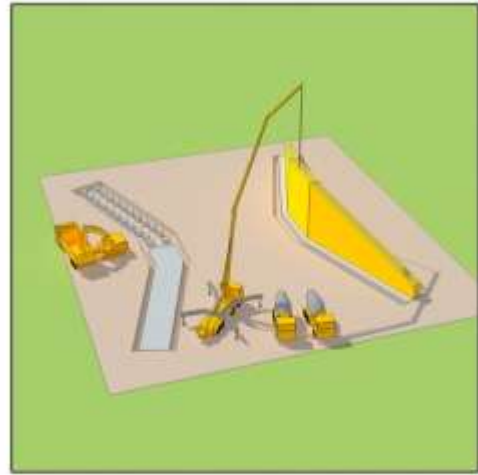
- 6.17.1 Bridges to carry the railway over rivers or other features (underbridge), or to carry those features over the railway (overbridge), will generally be constructed in advance of the main earthworks.
- 6.17.2 An overbridge and underbridge construction sequence are generally the same and comprise of the following steps:
- excavation and installation of foundations;
 - construction of piers, abutments and wing walls;
 - backfilling of abutments and wing walls¹¹⁰;
 - installation of bearings and deck beams;
 - casting of the deck slab; and
 - installation of parapets, expansion joints and finishes.
- 6.17.3 An illustration of a generic overbridge construction sequence is shown in Figure 40. An illustration of a generic underbridge construction sequence is shown in Figure 41.

¹¹⁰ For integral bridges the backfilling operation will generally take place after the deck is constructed.

Figure 40: Generic overbridge construction sequence



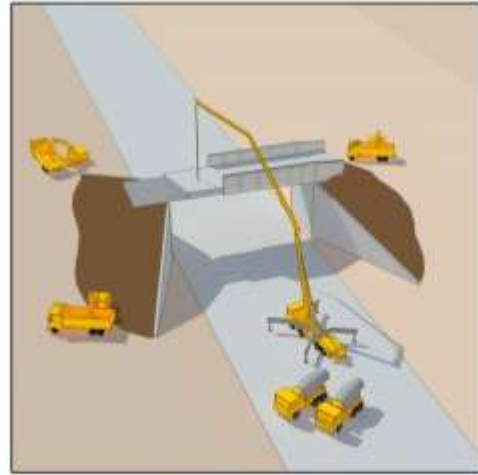
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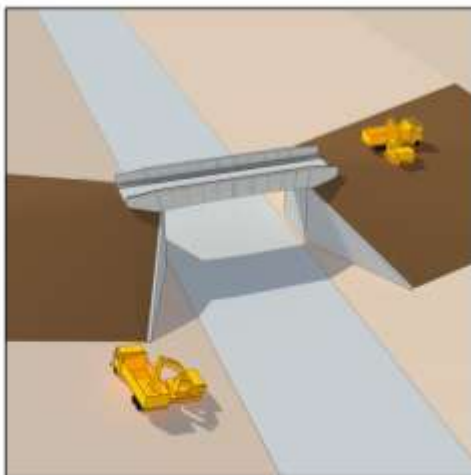
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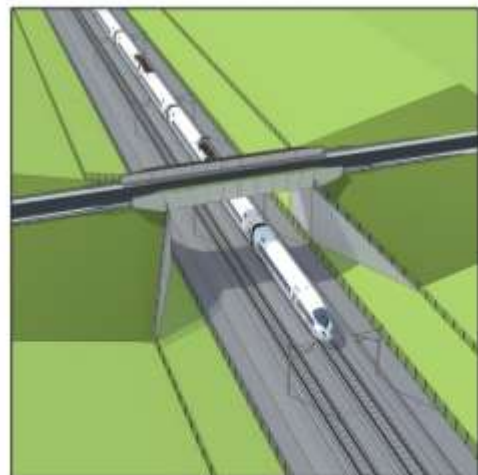
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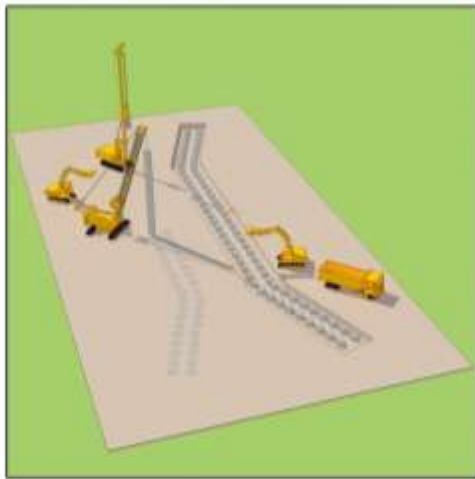


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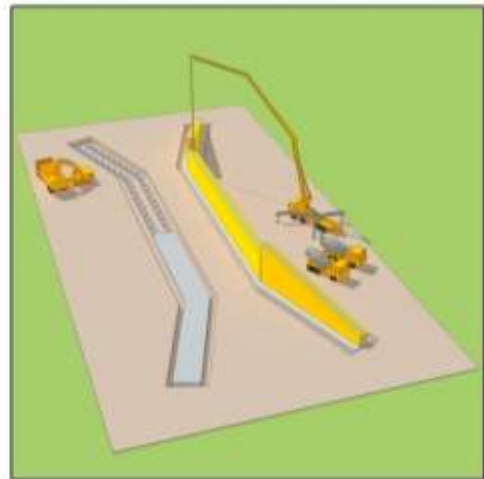


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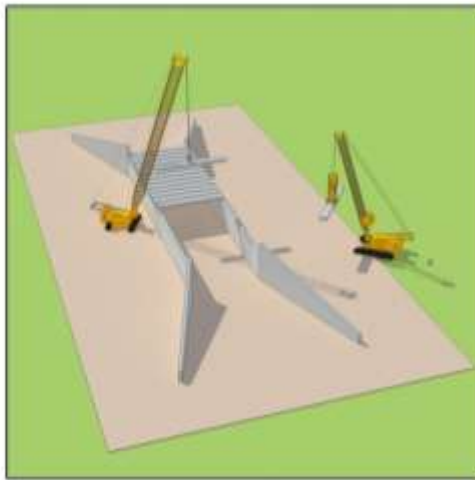
Figure 41: Generic underbridge construction sequence



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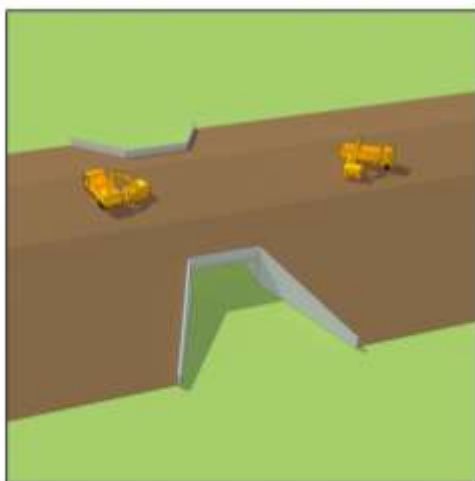
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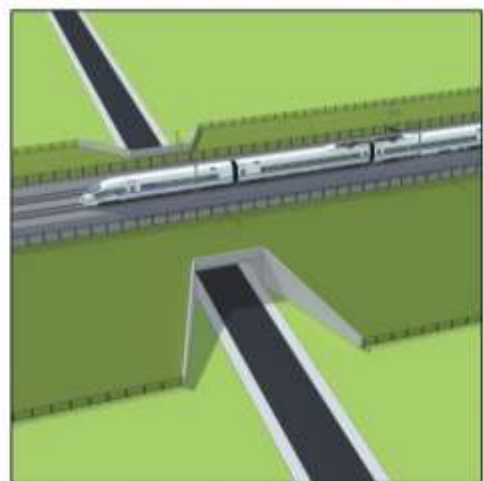
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6.18 Stations

6.18.1 The construction methods to be used for stations and related built facilities will vary according to their specific purpose and location. Construction of stations is described in the following Volume 2: CFA reports:

- Euston: Euston-Station and Approach (CFA₁);
- Old Oak Common: Kilburn (Brent) to Old Oak Common (CFA₄);
- Birmingham Interchange: Birmingham Interchange and Chelmsley Wood (CFA₂₄); and
- Curzon Street: Washwood Heath to Curzon Street (CFA₂₆).

6.19 Depots

6.19.1 Construction details for the Calvert IMD are described in Volume 2: Calvert, Steeple Claydon, Twyford and Chetwode report (CFA₁₃). Construction of the Washwood Heath depot is described in Volume 2: Washwood Heath to Curzon Street report (CFA₂₆).

6.20 Noise barriers and bunds

6.20.1 Earth bunds used for noise mitigation will be constructed in the same way as embankments, as described in Section 6.8. Bunds will be designed with a flat top for the construction of environmental barriers, where required. On completion of the bund, top soiling and landscaping will be undertaken.

6.20.2 Noise fence barriers will be installed in-situ or as pre-fabricated panels. On completion of the barrier, top soiling and landscaping will be undertaken.

6.21 Site restoration and landscape treatment

6.21.1 Landscape mitigation such as planting will be established at the earliest reasonably practicable opportunity during construction. Planting away from the route will be undertaken to reduce adverse landscape and visual effects, and to increase habitat and biodiversity value.

6.21.2 Following completion of the main construction works, site restoration will take place. This will involve the removal of temporary structures, plant, materials and equipment. Any required infilling (e.g. to construct a green tunnel) will be completed, followed by landscaping. Where appropriate, the engineered embankments and/or cuttings will be reshaped to integrate the alignment sympathetically into the character of the surrounding landscape.

6.21.3 The remainder of the permanent fencing will be erected as part of the landscaping works. Additional information regarding the approach to mitigation is contained within Section 9.

6.22 Track

6.22.1 The railway tracks will either be laid on crushed stone (i.e. ballasted track) or on concrete (i.e. slab track).

6.22.2 Ballasted track will generally be constructed in the following sequence:

- laying and compaction of the sub ballast layer;
- laying and compaction of the ballast layer;
- placement of sleepers at regular intervals on the ballast;
- installation of rails on the sleepers;
- pre-stressing the rails and welding of the joints; and
- tamping and alignment of the track to final position.

6.22.3 Slab track construction will use either pre-cast or cast-in-situ concrete elements to support the track, instead of ballast.

6.22.4 Slab track will usually be constructed in the following sequence:

- construction of the hydraulic bound layer¹¹¹;
- placement of the track slab on the hydraulic bound layer. This could be constructed with pre-cast elements or in-situ concrete;
- installation of rails;
- pre-stressing the rails and welding of the joints; and
- adjustment of the track to final position.

6.22.5 For both types of track, it is expected that the sections of completed line can be used for delivery of materials such as ballast, sleepers and rails to the point of installation.

6.23 Power supply

6.23.1 Access for construction of the traction power supply system will be via the local road network, although some elements may be delivered from the rail corridor.

6.23.2 Construction of the equipment compounds or feeder stations will begin with installation of the construction compound and security fencing, followed by the forming of concrete foundations and slabs, including under-slab ducts.

6.23.3 Road access will be suitably designed to take delivery of the plant and equipment required at each location. This may require widening part of the planned route from the nearest public highway and installation of a suitable foundation for craneage.

6.23.4 Secondary fit-out for traction power and associated prefabricated switch rooms will then take place. The switch rooms will contain switchgear, power filters, power compensators, controls, battery backup and nominal infrastructure services.

6.23.5 Switch rooms and external transformers will be off-loaded by crane or slid from large vehicles, with the largest elements being delivered first.

¹¹¹ Soil type materials (granular or cohesive) improved by the addition of various cementitious/asphaltic materials. Can be produced in-situ or elsewhere.

- 6.23.6 As the traction power switchgear is vulnerable to condensation, which can cause deterioration, temporary power will be provided to maintain switch room heaters and frost protection to the transformers until the new main switchgear power is installed.
- 6.23.7 Where traction power provision is incorporated into the combined tunnel ventilation and intervention points, its installation will be integrated into the construction of these features.
- 6.23.8 Where construction phasing allows, the OLE will be installed by specialised rail-mounted machines. The masts supporting the OLE will require foundations e.g. concrete pads or monopiles¹¹², pre-cast piles¹¹³ or steel screw piles¹¹⁴ with reinforced concrete pile caps¹¹⁵. The masts will be lifted into place and bolted to the foundations from rail-mounted equipment, followed by installation of the OLE.
- 6.23.9 Installation of the power supply system will be co-ordinated and timed to achieve phased 'powering on' milestones for each section of the Proposed Scheme, so as to reduce the risk of prior deterioration of switchgear and exposed electrical components.

6.24 Train control and telecommunications

- 6.24.1 Train control and telecommunication equipment will generally be installed after track laying and the OLE system. This will involve the laying of cabling into the route-wide trough system, the installation of line-side cabinets and signage.
- 6.24.2 Construction of the line-side telecommunications equipment will be carried out from within the railway corridor and will require no additional land or access.
- 6.24.3 The radio mast antennae will be installed at the same time as the OLE masts from within the railway corridor. The equipment will be delivered to site from rail mounted vehicles and lifted into place onto the foundations, with the workforce travelling on a rail mounted vehicle.
- 6.24.4 Where further fit-out is required, the workforce will access the equipment from the permanent points of maintenance access for the rail corridor.
- 6.24.5 Final installation of telecommunications systems will occur during the testing and commissioning phase.

6.25 Interfaces with the classic rail network during construction

- 6.25.1 The construction of the Proposed Scheme will involve physical and operational changes to the National Rail network.
- 6.25.2 Temporary railheads, served by the National Rail network, will be required at several locations for the import of materials and export of construction waste, and to provide access for track-laying equipment. Railheads will be used as the delivery location for bulk rail borne materials such as ballast, rails, sleepers etc. Facilities at these railheads will

¹¹² A single large diameter pile with significant vertical and lateral load carrying capacity. Used as an alternative to a pile group.

¹¹³ Drive pile produced from pre-cast concrete.

¹¹⁴ Displacement pile screwed into the ground in order to transfer vertical load into the ground.

¹¹⁵ Concrete structure used to link a number of discrete pile elements into a single arrangement to support significant loads that the individual pile element are not capable of supporting.

include offices, storage, a rail marshalling yard and pre-assembly depot and rail reception maintenance loops.

- 6.25.3 Sites identified for such railheads include West Ruislip (South Ruislip to Ickenham, CFA 6), Calvert (Calvert, Steeple Claydon, Twyford and Chetwode, CFA 13) and Kingsbury Road (Curdworth to Middleton, CFA 20), Willesden Euro terminal and Streethay. More information is provided in the Volume 2: CFA reports.
- 6.25.4 The main points of interface with the National Rail network during the construction phase are summarised in Table 7.

Table 7: Construction interfaces with the National Rail network

Location	Summary of work
Euston station	To be modified to provide a total of 24 platforms. This will include 11 new platforms for HS2 services and 13 of the existing 18 platforms will be retained for classic rail services. Existing concourse to be rebuilt. Works to improve connections and facilities for London Underground users. Works also include new and replacement of overbridges.
North London Line	To be partially reconstructed to form the HS1 link.
Old Oak Common	Work to GWML to accommodate a new interchange station serving the Proposed Scheme and GWML. The Acton and Northolt Line will no longer connect to GWML.
Northolt tunnel	Construction of a tunnel beneath the Acton and Northolt Line.
West Ruislip	Work alongside the Marylebone to Aylesbury Line.
Amersham / Little Missenden	Construction of a tunnel beneath the Marylebone to Aylesbury Line.
Wendover	Construction of a viaduct over the Marylebone to Aylesbury Line.
South of Aylesbury	Proposed Scheme to run under the Princes Risborough to Aylesbury Line.
Calvert	The Proposed Scheme to run alongside the Aylesbury Link between Quainton Road and Claydon, with a number of new bridge crossings of both railways. Part of the Aylesbury Link between Quainton Road and Claydon to be moved to new alignment to make room for the Proposed Scheme. The Proposed Scheme access to IMD from south to cross under the Bicester to Bletchley Line. Construction of a bridge beneath the Bicester to Bletchley Line (the future East-West Rail Line being developed by Network Rail).
North of Kenilworth	Construction of new bridges to carry the Coventry to Leamington Spa Line over the Proposed Scheme and to carry the Proposed Scheme over the Rugby to Birmingham Line.
Berkswell	Construction of a viaduct to carry the Proposed Scheme over the Rugby to Birmingham Line adjacent to Berkswell station.
Birmingham International station	A new station at Birmingham Interchange with a dedicated connection (by a people mover) over Rugby to Birmingham Line to the NEC, Birmingham International station and Birmingham Airport.
Water Orton / Coleshill Parkway	Construction of a viaduct to carry the Proposed Scheme's main line and Birmingham/North spur over the Birmingham to Nuneaton Line.
Water Orton / Kingsbury Junction	Construction of a viaduct to carry the route over the Birmingham to Tamworth Line.
Hams Hall	Construction of viaducts to carry the Proposed Scheme's main line and Phase Two Leeds spur over the Birmingham and Derby Line. New crossover and turnouts will be required on the Birmingham and Derby Line to cater for the Kingsbury Road railhead connection.

Location	Summary of work
East of Lichfield Trent Valley station	Construction of a viaduct to carry the Proposed Scheme over the WCML.
North-east of Lichfield Trent Valley station	Construction of a bridge to carry the Proposed Scheme over the South Staffordshire Line.
Streethay	Connection to the South Staffordshire Line (and secondary connection south of Lichfield to the WCML) for construction maintenance loops to import earthworks material for embankment construction.
Handsacre	Alterations to the WCML to accommodate a grade-separated junction.
Lichfield to Colwich	Improvement works to the existing WCML, including installation of new signalling equipment, some additional turnouts to allow trains to switch tracks, some minor alterations to overhead line electrification to accommodate the track alterations and the provision of ancillary line-side equipment associated with the above.
Existing Rail corridor between castle Bromwich and Curzon St.	Parallel running with Birmingham and Derby Line, and the Birmingham to Nuneaton Line, including the Proposed Scheme viaduct crossing over these lines at Duddeston together with the Proposed Scheme crossings under the Stechford and Aston Line and over the Birmingham and Aston Line.

6.26 System testing and commissioning

- 6.26.1 The railway will be fully tested to ensure it can operate safely and reliably. Testing and commissioning of the Proposed Scheme will be aligned to the construction programme, moving through commissioning into trial operation in stages. The period of testing, commissioning and trial operation is expected to extend over four years, commencing by 2022 and completing in 2026.
- 6.26.2 Five commissioning stages are currently planned:
- stage 1 – Birmingham/Handsacre to Ruislip;
 - stage 2 – Ruislip to Old Oak Common;
 - stage 3 – Old Oak Common to HS1;
 - stage 4 – Old Oak Common to Euston; and
 - stage 5 – Euston Station.
- 6.26.3 Testing and commissioning will start on the section of route closest to the Washwood Heath depot, so that rail systems can be integrated with the trains at the earliest opportunity.
- 6.26.4 Within each stage the testing and commissioning programme will be divided into a number of phases as further defined below.
- 6.26.5 At the end of each phase of testing a certificate will be issued to confirm that the tests have been successfully completed and that the next phase can start. The phases include:
- phase 1: off-site testing – factory tests;
 - phase 2: on-site testing – static tests;
 - phase 3: on-site testing – commissioning;

- phase 4: on-site testing – integration tests;
- phase 5: on-site testing – migration tests;
- phase 6: rolling stock acceptance tests;
- phase 7: performance and operational tests; and
- phase 8: handover and acceptance.

- 6.26.6 Each of the systems to be tested will be broken down into commissioning lots. Each commissioning lot will be subjected to each test phase in sequence and is the smallest element that will be subjected to formal inspection. When breaking down the systems due regard will be taken of the interfaces and dependencies between the systems and between the commissioning lots within each system. This will allow for the test sequence logic and test programme to be developed.
- 6.26.7 Rolling stock acceptance tests will take place once a sufficient length of route has been commissioned, and will be followed by performance tests involving multiple trains to confirm operability. At the same time, the classic compatible trains will be tested and commissioned on classic infrastructure. Final installation of telecommunications systems will also occur during the testing and commissioning phase.
- 6.26.8 Trial operations will allow operational procedures to be tested and refined alongside the training of staff.

7 Environmental impact assessment

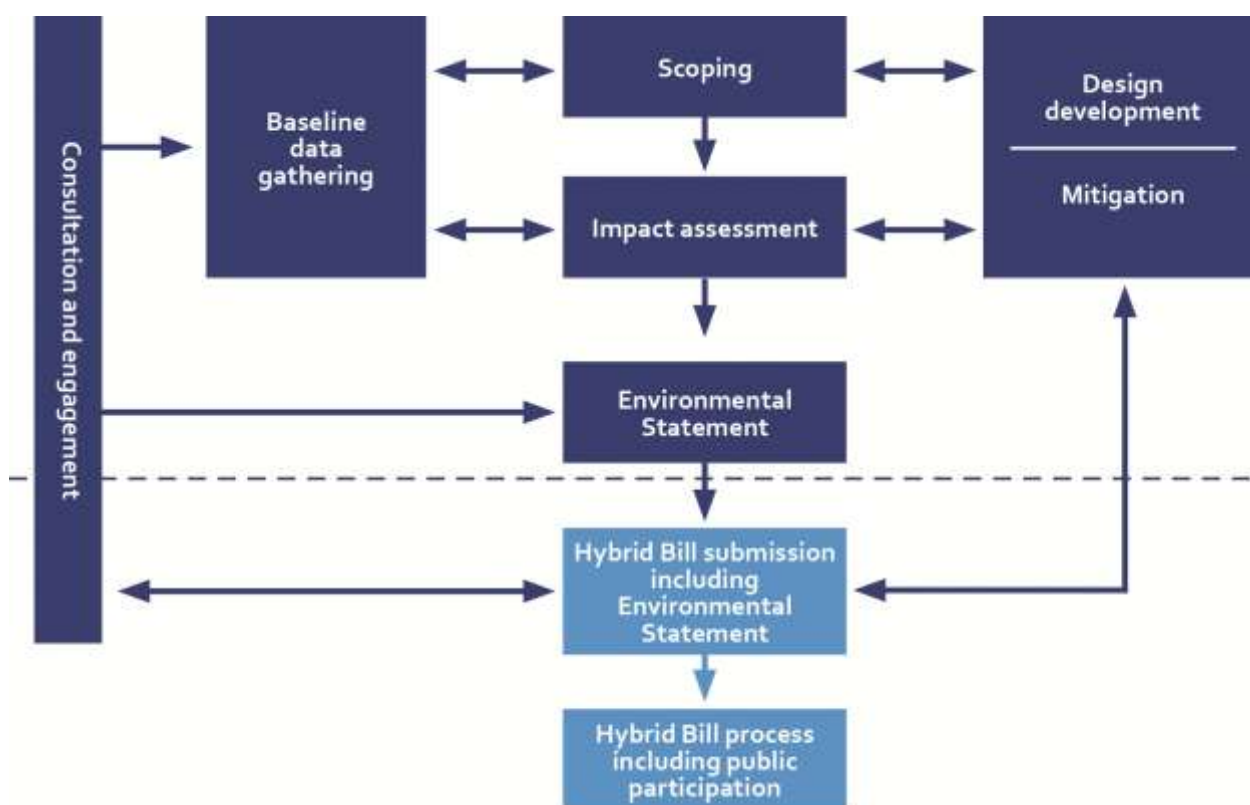
7.1 Overview

7.1.1 The purpose of EIA is to identify the likely significant effects of a proposed development on the environment. In simple terms, it does this by identifying the current (baseline) conditions, anticipating how these may change in the future, and predicting the potential impacts of the development across a range of topics. This section describes the general approach adopted for the EIA of the Proposed Scheme. Further information on the scope and methodology approach for each topic is summarised in Section 8.

Preparation of the Environmental Statement

7.1.2 The main steps in the preparation of the ES are set out below and are summarised in Figure 42.

Figure 42: Environmental assessment process for Phase One



Scoping

7.1.3 The scoping phase established the overall scope and methodology for the assessment, including the range of environmental topics to be addressed, and included an initial round of stakeholder consultation. Initial scoping was carried out on an informal basis, as set out in the SMR (Volume 5: Appendix CT-001-000/1), which was finalised through consultation with local authorities, a wide range of environmental organisations and the public. An addendum to the SMR (Volume 5: Appendix CT-001-000/2), has since been produced which highlights any subsequent changes to methodology, legislation and/or best practice guidance.

Baseline data gathering

- 7.1.4 Baseline studies have established the current baseline conditions, i.e. the environmental conditions that exist in the vicinity of the Proposed Scheme and across the study areas for each topic. These studies comprised desk-top research to gather and evaluate previous environmental work and publicly available information, together with new environmental surveys and consultation with local groups. Relevant policies, guidelines and legislation, together with industry-accepted practice, were also identified at this stage.
- 7.1.5 Where appropriate, the current baseline has been extrapolated into the future to take account of predicted or anticipated variations due to factors such as changing climatic conditions (based on trends within the UKCP09 projections),¹¹⁶ policy, legislation, advances in technology and future developments. This is known as the future baseline. Future baseline conditions may also be altered by other developments. The identification of future developments includes those that may occur before or during the construction of the Proposed Scheme, with the potential to result in significant impacts and resultant effects.
- 7.1.6 Due to the inevitable uncertainty of predicting effects based on future baseline conditions, a reasonable worst-case approach has been adopted.
- 7.1.7 Where future development may introduce new environmental receptors¹¹⁷ that could be significantly affected, these have been addressed in the assessment. In the event that the anticipated development does not take place, any mitigation proposed can be amended at a later date to reflect the change from the future baseline position.

Impact assessment

- 7.1.8 Assessment of the impacts and effects of the Proposed Scheme has been undertaken in accordance with the methodology outlined for each environmental topic in the SMR and SMR Addendum. This is also summarised within Section 8. The assessment has identified the likely significant effects, the measures envisaged to mitigate adverse effects, and the likely significant residual effects (i.e. following mitigation), during the construction and operation phase.
- 7.1.9 The ES has taken account of relevant policies, guidelines, legislation and industry accepted practice in assessing impacts for each environmental topic (e.g. in defining thresholds of significance), as well as the experience and professional judgement of specialists.

Mitigation

- 7.1.10 Mitigation measures have been identified throughout the development and assessment of the Proposed Scheme. More information on the approach to mitigation is set out in Section 9.

¹¹⁶ UKCP09 (2009), *UKCP09 Climate Change Projections Report*, <http://ukclimateprojections.defra.gov.uk/22566>, Accessed: 1 July 2013.

¹¹⁷ Receptors are defined as a component of the natural or built environment (such as human beings, water, air, a building, or a plant) that is affected by an impact of construction and/or operation of a proposed development. An example of a new receptor being created by future development would be residents moving into a new housing development in proximity to the route.

Consultation and engagement

- 7.1.11 Stakeholder engagement and public consultation has taken place throughout the design process and preparation of the ES; details are provided in Section 3.

Environmental Statement preparation

- 7.1.12 Following publication of the draft ES for public consultation, further assessment has been undertaken and consideration has been given to consultation responses. In addition, development of the scheme design and construction strategy has been on-going, together with further environmental baseline surveys and the identification and incorporation of mitigation. These activities have all fed into the ES.

7.2 Scope of the assessment

- 7.2.1 This section describes the years and time periods at which the Proposed Scheme is assessed (the temporal scope), the area over which impacts and effects are considered (the geographic scope) and the topics considered (the technical scope).

Temporal scope for assessment scenarios

- 7.2.2 The assessment considers impacts and resultant effects arising from construction and operation of the Proposed Scheme. The main construction works are expected to take place between 2017 and 2026 (including a period of testing and commissioning), although the duration, intensity and scale of construction along the route will vary over this period. The Proposed Scheme is expected to become operational in 2026. Topics have generally assessed the period of maximum intensity over the construction period and compared it to a defined baseline year. Some early works are planned for 2015 and 2016 (subject to any necessary agreements or consents) but this does not affect the validity of baseline assessments for 2017.
- 7.2.3 The maximum level of operational activity (i.e. the number and frequency of trains and passengers) using the Proposed Scheme will be reached after the opening of Phase Two, which is expected in 2032/33. Therefore, consideration has been given to the implications of the operational rail traffic and passenger numbers associated with Phase Two for relevant environmental topics. These topics include traffic and transport, sound, noise and vibration and air quality (in so far as transport-related emissions are concerned). The noise and vibration implications for receptors along the route, and any transport implications associated with passenger movements at stations and on other modes, have been assessed on the basis of the operational assumptions set out in Section 4.3.
- 7.2.4 In evaluating the future use of HS2, road and air travel, the increasing travel demand has been capped at 2036, i.e. the demand does not increase after that time. Sensitivity assessment shows that this is a pessimistic scenario in that applying a later demand cap would result in more passenger journeys on HS2 and greater modal shift from other transport modes.
- 7.2.5 The EIA compares the future transport and passenger movement patterns resulting from HS2 Phase One with the predicted transport and passenger movements without HS2, otherwise known as the 'do minimum case' (or 'future baseline' case).

- 7.2.6 The do minimum case refers to the future that would exist if the Proposed Scheme were not developed. This scenario takes account of other changes to transport infrastructure including:
- electrification of the MML from St Pancras, thereby providing increased capacity and faster journey times to the East Midlands;
 - use of Intercity Express Rolling Stock on the ECML, resulting in increased capacity and faster journey times;
 - improvements to WCML infrastructure and the WCML timetable to provide additional trains and faster running speeds;
 - development of the Northern Hub to provide faster and more frequent services across the north of England;
 - development of the East West Rail scheme between Oxford and Milton Keynes to provide new local services and faster cross country services; and
 - planned transport improvements as described in the transport assessment set out in Volume 5: TR-001-000.

Geographic scope

- 7.2.7 The geographic scope reflects the distance over which significant changes to the environment are likely to occur. This distance is influenced by the physical extent of the works, the nature of the baseline environment and the manner in which the effects are propagated. It takes account of both the land required permanently for rail infrastructure and the additional land required temporarily for construction.
- 7.2.8 Each of the environmental topics identifies the area within which impacts and effects have been assessed. This is summarised in Section 8 and further explained within the SMR and SMR Addendum.
- 7.2.9 The reporting of local environmental effects is presented in Volume 2: CFA reports. Volume 2 is split into 26 CFA reports, each of which is based on a distinct geographical area, as shown in Section 3.2.
- 7.2.10 The assessment of environmental effects which cover a wider geographical area is reported in Volume 3. These route-wide effects have been considered at a regional or national level. The assessment of effects that may occur at locations remote from the Proposed Scheme (i.e. off-route effects) is presented in Volume 4.
- 7.2.11 The ES does not address environmental effects that may occur outside the UK (i.e. trans-boundary effects). The only such effects that are likely to be relevant relate to changes in international travel that may occur once the Proposed Scheme becomes operational. These changes include additional high speed services using HS1, together with possible impacts on other international modes of transport, such as air. Such changes are very difficult to anticipate, due to the many variables involved (e.g. relative pricing between modes). However, the changes are unlikely to result in significant environmental effects.

Technical scope

- 7.2.12 The technical scope refers to the environmental topics that have been addressed in the assessment.
- 7.2.13 The environmental aspects set out in Schedule 4 of the EIA Regulations have been refined and adapted with reference to current practice for rail and other linear transport projects. As a result, the following environmental topics have been assessed:
- Agriculture, forestry and soils;
 - Air quality;
 - Climate;
 - Community;
 - Cultural heritage;
 - Ecology;
 - Electromagnetic interference;
 - Land quality;
 - Landscape and visual;
 - Socio-economics;
 - Sound, noise and vibration;
 - Traffic and transport;
 - Waste and material resources; and
 - Water resources and flood risk.
- 7.2.14 These topics have been evaluated during the scoping process in order to determine the extent to which they require inclusion/consideration within the ES, having regard to whether they are likely to give rise to significant effects. As part of this process, it was determined that all topics, with the exception of electromagnetic interference, could give rise to significant effects.

Electromagnetic interference

- 7.2.15 Since potential electromagnetic effects can be 'designed out' of the Proposed Scheme, specific assessment was not required as part of the EIA. Further explanation is provided in Volume 5: Appendix EM-001-000 and summarised below.
- 7.2.16 High voltage electrical equipment creates electromagnetic fields (EMF), which can potentially have implications for human health and may cause electromagnetic interference (EMI) to other electric/electronic equipment (e.g. communications) or infrastructure (e.g. power lines). In addition, features such as tower cranes can cause temporary interference to TV reception.
- 7.2.17 The main potential source of EMI associated with the Proposed Scheme will be the traction power system, comprising the OLE along the route and supporting infrastructure such as feeder stations. In addition, the railway communications system will generate radio signals.

- 7.2.18 The railway's own operating systems will need to be immune to EMI and radio interference, whilst levels of exposure for passengers and staff must be acceptable. This will be achieved by ensuring that all electrical equipment complies with the relevant standards for electromagnetic compatibility (EMC) and personal protection, e.g. BS EN 50121-5-2006¹¹⁸ and BS EN 50122-1-2011¹¹⁹ and ICNIRP (International Commission on Non-Ionising Radiation Protection) guidance¹²⁰.
- 7.2.19 Electromagnetic fields extend over relatively short distances. On the assumption that acceptable levels are achieved on the railway itself, any residual risk to nearby receptors (e.g. residential properties, businesses or communications infrastructure) will be insignificant.
- 7.2.20 Equipment used during construction of the Proposed Scheme will also comply with applicable standards for EMF and EMC. Assuming that this equipment is installed, operated and maintained correctly, levels of electromagnetic emissions are unlikely to exceed the acceptable limits for workers or the public, or to cause EMI. Power supplies used for construction are generally insufficient to cause any significant EMI.
- 7.2.21 Tower cranes will be used at some locations (e.g. the proposed stations). If complaints about interference are received (e.g. in relation to TV reception), appropriate remedial action will be taken to restore signal integrity at affected properties (e.g. by replacing aerials or boosting signal strength). However, the likelihood of such effects is decreasing as more people switch to digital or cable networks.

7.3 Impacts and effects

- 7.3.1 The ES identifies both beneficial and adverse impacts on environmental resources or receptors, and assesses whether the resulting effects are considered to be significant. The likelihood that an impact will give rise to a significant environmental effect depends on a number of factors, such as the magnitude of the impact and the sensitivity of the receiving environment. Whilst the ES focuses on the reporting of significant effects, it also assesses the level of impact that gives rise to them and explains how adverse impacts will be mitigated.
- 7.3.2 The predicted impacts and effects have generally been classified according to whether they are beneficial, adverse or negligible. They have been further categorised as low/minor, medium/moderate or high/major. Whilst the definition of each category varies by topic, as shown in the SMR and SMR Addendum, these terms have generally been defined as follows, unless otherwise specified:
- beneficial: advantageous or positive change to an environmental resource or receptor;
 - adverse: detrimental or negative change to an environmental resource or receptor;
 - negligible: imperceptible impacts to an environmental resource or receptor;

¹¹⁸ British Standards Institute (2006), *BS EN 50121-5-2006 Railway Applications, Electromagnetic Compatibility*.

¹¹⁹ British Standards Institute (2011), *BS EN 50122-1-2011 Railway Applications, Fixed installations – Electrical safety, earthing and the return circuit. Part 1: Protective provisions against electric shock*.

¹²⁰ International Commission on non-ionizing radiation protection (1998), *ICNIRP Guidelines*.

- low impact/minor effect: slight, very short-term and/or highly localised impact;
- medium impact/moderate effect: limited impact (by extent, duration and/or magnitude); and
- high impact/ major effect: considerable impact (by extent, duration and/or magnitude) of more than local importance or in breach of recognised standards, policy or legislation.

7.3.3 The duration of impacts have been defined as either temporary or permanent. They can occur either directly or indirectly. Direct impacts are those that will arise directly from construction or operation of the Proposed Scheme (e.g. due to the land required or to train movements). Indirect impacts are those that arise from consequential changes associated with the Proposed Scheme (e.g. the impacts of traffic flows around stations). Examples of such consequential changes and where these are reported in the ES, are listed below:

- consequential changes to rail services on other lines, especially on the WCML between London and Birmingham and the Chiltern Line, as a result of intercity services transferring onto HS2. This is called 'released capacity' on those lines (Volume 3: Route-wide effects);
- passenger access to and from stations and interchanges (Volume 4: Off-route effects);
- the socio-economic benefits resulting from the operation of Phase One, both locally in the cities served by HS2 services and in the wider region (Volume 3: Route-wide effects, Section 11);
- the changed traffic flows on highways resulting from people's decisions to travel on HS2 rather than by road (Volume 3: Route-wide effects, Section 13);
- the changes to numbers of aircraft movements as a result of people's decision to travel by rail rather than by air (refer to greenhouse gas assessment in Volume 3: Route-wide effects, Section 5);
- the use of stabling depots that currently serve WCML, north of Birmingham (Volume 4: Off-route effects); and
- works to the WCML infrastructure required to facilitate the new HS2 services (Volume 4: Off-route effects).

7.3.4 Variations to the definition of impacts that have been developed since the publication of the SMR are described in the SMR Addendum. Where it is not possible to quantify impacts or their consequential effects, qualitative assessments have been carried out, based on professional judgement. Where uncertainty exists, and assumptions have had to be made, these are explained in Section 8.

7.3.5 Effects deemed to be significant have been evaluated against recognised standards and accepted criteria for each environmental topic, where these are available. Where no recognised standards or criteria exist, professional judgement has been used, taking account of factors such as:

- spatial extent (e.g. local, district, regional, national or international);
- magnitude;
- duration (whether short, medium or long-term);
- frequency of occurrence;
- nature of the effect (whether direct or indirect, permanent or reversible);
- whether it occurs in isolation, is cumulative or interactive;
- sensitivity and number of receptors affected;
- value of a resource affected;
- performance against environmental quality standards; and
- compatibility with environmental policies.

7.4 Cumulative effects

- 7.4.1 Cumulative effects are those that result from a combination of a number of individual effects. They may result either from a combination of effects arising from the Proposed Scheme (intra-project effects) or from an interaction between the effects of the Proposed Scheme with the effects of other reasonably foreseeable developments that are likely to be under construction or to have been completed at the same time (inter-project effects).
- 7.4.2 Cumulative effects can be either temporary or permanent and can broadly arise from the following:
- a number of individual environmental impacts (e.g. noise, dust and traffic) on a receptor that, in combination, are likely to have a significant effect;
 - the accumulation of individual effects on a type of receptor (e.g. an ecological species) which when summed in a regional context or across the Proposed Scheme, are likely to result in an effect of greater significance than the sum of the individual effects; and
 - the effects from other developments in the vicinity of the Proposed Scheme (during their construction and/or operation), which when combined with the effects of the Proposed Scheme are likely to have an incrementally significant effect on the receptors that experience both effects.
- 7.4.3 Where developments are expected to be completed before construction of the Proposed Scheme, effects arising from them have been considered through extrapolation of existing conditions as part of the future baseline.
- 7.4.4 Developments expected to be completed between 2017 and 2026 (i.e. before the Proposed Scheme is operational), may give rise to cumulative construction effects. However, smaller projects of this type are unlikely to give rise to significant cumulative effects, as the scale of their construction impact, in combination with the Proposed Scheme, will not generate any noticeable increases in effects.
- 7.4.5 People living in developments to be completed before 2017 are included as receptors of construction of the Proposed Scheme and those in development to be completed before 2026 are included as receptors of the operational effects of the Proposed Scheme.

- 7.4.6 Developments that may be completed after 2026 have generally not been taken into account. This is because development planning generally does not extend so far into the future and even where such developments can be identified, there is generally insufficient information available for an assessment of cumulative effects. In these cases it is assumed that the planning process for those developments will take the Proposed Scheme into account (and will therefore consider any cumulative effects at that time).
- 7.4.7 Committed developments are defined as developments which have planning permission or for which sites have been allocated in adopted development plans, which are on or close to the Proposed Scheme. Planning applications yet to be determined and sites where proposed allocations in development plans are yet to be adopted, are termed proposed developments and have not been included in the assessment. A list of committed and proposed developments is contained within Volume 5: Appendix CT-004-000¹²¹. Committed developments are also shown on Map CT-13-00. The Volume 2: CFA reports set out the committed developments that have been considered in determining the future baseline and/or in assessing the cumulative effects for each topic.

Phase One and Phase Two

- 7.4.8 A summary of the total combined impacts that may result from Phase One and Phase Two of HS2, focusing on those environmental topics that can be quantified, is presented in Volume 3: Route-wide effects. Statistics are presented on Phase One and Phase Two alone and in combination (both Phase One and Phase Two) for property and settlements, employment and housing, noise, cultural heritage, biodiversity and wildlife, land use resource, waste and material use.
- 7.4.9 Phase One statistics are based on assessments undertaken as part of this EIA and on the assessments prepared in support of the AoS report for Phase One. Phase Two statistics are drawn from the Phase Two Sustainability Statement.
- 7.4.10 The operational effects of the Proposed Scheme are being assessed on the assumption that Phase Two will also be open, so as to provide a reasonable worst-case basis on which to assess effects such as those relating to train noise and traffic movements at stations. In this sense, these effects are cumulative, in that they reflect the combined operation of both phases of HS2.

7.5 Climate change

- 7.5.1 The ES has assessed climate change in three ways:
- a climate (greenhouse gas) assessment, reported in Volume 3: Route-wide effects, Section 5 and Volume 5: Appendix CL-002-000;
 - a high level climate change resilience assessment, which uses climate change risk assessment techniques to assess the resilience of the Proposed Scheme, reported in Volume 5: Appendix CL-003-000; and
 - a climate change impacts assessment, which includes consideration of the combined impacts of the Proposed Scheme and potential climate change on the

¹²¹ An assessment of committed and proposed development was undertaken up to 31 August 2013.

receiving environment and community, based on trends within the UKCP09 projections.

7.5.2 The approach to this assessment has been informed by good practice and guidance from the European Union¹²² and the Institute of Environmental Management and Assessment (IEMA)^{123 124}, however, a number of challenges have been encountered. These include:

- establishing a future baseline that considers climate change for each topic. This is particularly difficult except in relation to flood risk because of the complexity of the interactions between climate change, the natural environment and human activity; and
- isolating the Proposed Scheme's impact on the receiving environment and community within the broader context of climate change.

Climate change trends

7.5.3 The trends within the UKCP09 climate change projections indicate changes to long-term, seasonal averages such as warmer and drier summers, milder and wetter winters, an increase in annual average temperature, and fewer days with frost.

7.5.4 Climate change is also expected to result in more extreme weather, including more very hot days, more intense rainfall, and an increase in dry spells. In addition, the probability of short periods of intense cold weather and of more frequent storms and high winds is also likely to increase but with a higher level of uncertainty. These changes in climatic averages and extreme weather events are likely to become more pronounced during the operation phase of the Proposed Scheme.

Climate change impact assessment

7.5.5 Each environmental topic has used the broad descriptions of changes to long-term, seasonal averages and extreme weather events to undertake preliminary qualitative consideration of the combined effects of climate change and the Proposed Scheme for both the construction and operation phase of the Proposed Scheme. This approach was based on professional judgement and the methodology described in Section 6(A) of the SMR Addendum (Volume 5: Appendix CT-001-000/2).

7.5.6 On the basis of preliminary consideration, all topics, with the exception of water resources and flood risk, have concluded that it is not possible to robustly incorporate climate change trends into the future baseline, nor undertake detailed assessment of the combined effects of climate change on the Proposed Scheme at the local level.

7.5.7 Outcomes of the preliminary consideration for all topics are contained in Volume 5: Appendix CT-009-000 and are summarised as follows:

- agriculture, forestry and soils: climate change impacts have been considered primarily in terms of potential direct and indirect effects on the soil resource which,

¹²² European Union (EU) (2013), Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment.

¹²³ Institute of Environmental Management and Assessment (2010), IEMA Principles Series: Climate Change Mitigation and EIA, IEMA; EIA and Climate Change, <http://www.iema.net/eia-climate-change>, Accessed: 3 October 2013.

¹²⁴ Institute of Environmental Management and Assessment (2010), IEMA Principles Series: Climate Change Adaptation and EIA, <http://www.iema.net/eia-climate-change>, Accessed: 3 October 2013.

amongst other key functions, underpins the production of food and timber. Whilst most impacts of the Proposed Scheme on agriculture, forestry and soil resources will occur during the construction phase, climate change effects on the soil resource are likely to extend beyond this phase. However, there is insufficiently detailed evidence at the local level to be able to incorporate these future possible effects in the assessment and determine how, in combination, they may affect the impacts of the Proposed Scheme on agriculture, forestry and soil resources;

- air quality: there is no definitive evidence about how climate change may affect the future baseline for air quality at the local level. Therefore it has not been possible to evaluate the Proposed Scheme's impact on future air quality with climate change. Having considered this, it has been assumed that there are no additional effects arising from the in combination effects of climate change, air quality and the Proposed Scheme;
- community: there is insufficient detailed evidence at the local level about how potential climate change impacts will affect communities along the Proposed Scheme during construction and operation. Having considered this, it is not possible to incorporate these future possible impacts and changes into the assessment and determine how, in combination, this may affect the impacts of the Proposed Scheme on community resources;
- cultural heritage: climate change effects include a series of complex interrelations between environmental, social and economic factors including asset type, fragility, soil type, drainage, current and future land use and management regimes which are difficult to predict with certainty. Having considered this, it is not feasible to incorporate these future potential impacts and changes into the assessment and determine how, in combination, they may affect the impacts of the Proposed Scheme on cultural heritage resources;
- ecology: potential climate change impacts include a series of complex and dynamic biological interrelations between animals and plants and the ecological features in which they live which makes them difficult to predict with certainty. Having considered this, it is not feasible to incorporate these future potential impacts and changes into the assessment and determine how, in combination, they may affect the impacts of the Proposed Scheme at the local level. Information on the potential impacts of climate change for ecological resources, based on a route-wide assessment, is contained in Volume 3: Route-wide effects;
- land quality: whilst climate change has the potential to bring about changes in the groundwater regime (groundwater depths and gradients) and in landfill gassing regimes, there is insufficiently detailed evidence to predict with certainty the impact that climate change will have on the assessment and remediation of contaminated land. Therefore, it is not considered feasible to incorporate climate change factors meaningfully into the assessment. However, the detailed assessment of contamination and the detailed design of remediation will need to consider potential changes in the groundwater or landfill gassing regimes, and other potential effects, to ensure that remediation designs are resilient;
- landscape and visual: potential climate change impacts include a series of complex

interrelations between environmental, social and economic factors including plant species and provenance, soil type, drainage, and current and future land use and management regimes which are difficult to predict robustly. Having considered this, it is not feasible to incorporate these future potential impacts and changes into the assessment and determine how, in combination, they may affect the impacts of the Proposed Scheme on landscape resources;

- socio-economics: there is insufficiently detailed evidence about how potential climate change impacts will affect socio-economic resources along the Proposed Scheme during construction and operation. Having considered this, it has not been possible to incorporate these future potential impacts and changes into the assessment at the local level and determine how, in combination, they may affect the impacts of the Proposed Scheme on socio-economic resources;
- sound, noise and vibration: potential climate change impacts are unlikely to affect baseline sound levels or forecast sound levels from the Proposed Scheme. However, overall increases in ambient temperature may increase the need for, or regularity of, opening windows for ventilation and cooling of residential property. The assessment of effects has taken account of open windows;
- traffic and transport: current projections indicate that climate change is likely to have an influence on the future baseline against which the Proposed Scheme has been assessed. For example, an increase in the frequency of extreme weather events, such as more intense rainfall events and very hot weather may affect traffic and transport resources, the community and travelling public. However, there is insufficiently detailed evidence about how climate change will affect future traffic patterns and transport users during construction and operation. Therefore it has not been possible to determine how climate change may affect the Proposed Scheme's impacts on traffic and transport resources;
- waste and material resources: current projections indicate that there may be potential climate change impacts on waste and material resources. However, these are not considered to have any significant direct impact and hence are not considered further within the assessment; and
- water resources and flood risk: for the assessment of flood risk consideration of climate change has been incorporated within the future baseline based on future projections specified in the NPPF and its technical guidance¹²⁵. Further details are given in Section 8.12. The outcome of this assessment is detailed within Volume 2: CFA reports, Section 13 and Volume 5: Appendix WR-001-000.

7.6 Over-site development

7.6.1 Over-site development (OSD) is development that can be built over and around the permanent operational structures of the Proposed Scheme and is not related to the operation of HS2. The hybrid Bill does not seek approval for any OSD. The assumption is that any such development will be applied for and determined through the normal planning process if it is brought forward.

¹²⁵ Department for Communities and Local Government (2012), *Technical Guidance to the National Planning Policy Framework*.

- 7.6.2 The hybrid Bill contains ancillary works (e.g. additional foundations and columns and deck structures) which if constructed as part of and at the same time as construction of the Proposed scheme will enable OSD to take place in future.
- 7.6.3 This ES only assesses the environmental effects of the works authorised by the hybrid Bill; it does not assess the effects of any future OSD. However, any works required to facilitate OSD that have been included within the scope of the hybrid Bill, have been assessed in the ES.
- 7.6.4 The hybrid Bill will contain a provision requiring that where a building is wholly or substantially demolished for the purposes of the Proposed Scheme, any later planning application for its replacement must be accompanied by an environmental assessment if (a) the affected building is listed in the schedule accompanying the hybrid Bill, or (b) is not so listed, but its replacement is likely to have significant effects on the environment.
- 7.6.5 Consequently, where a planning application is made for a replacement building (i.e. the OSD) in the circumstances cited above, an ES will be required to accompany the relevant planning application, even if it would not otherwise be required under the EIA Regulations. Such an ES will include a cumulative assessment of the OSD with the Proposed Scheme in place.

7.7 General assumptions and limitations

- 7.7.1 During the preparation of an ES, there are sometimes circumstances in which the information available to inform the assessment process is limited. For example, there is inevitably some uncertainty in predicting future baseline conditions, impacts and effects, especially since the Proposed Scheme will not be due to begin operating until 2026.
- 7.7.2 In addition, it has not been possible to access all land required to carry out fully comprehensive surveys. This applies to agriculture, forestry and soils, community, cultural heritage, ecology, land quality, landscape and visual, socio-economics, sound, noise and vibration, traffic and transport and water resources and flood risk. Nevertheless, it is considered that the baseline is sufficiently robust to allow the assessment of the likely significant environmental effects of the Proposed Scheme.
- 7.7.3 Where relevant for each environmental topic, key assumptions made in undertaking the assessment have been explained, and their consequences on the completeness or potential accuracy of the conclusions have been identified. Section 8 provides a description of assumptions. Local assumptions and limitations are detailed within the Volume 2: CFA reports.

8 Scope and methodology summary for environmental topics

This section provides a summary of the scope and methodology of the EIA topics. The full scope and methodology is contained within the SMR (Volume 5: Appendix CT-001-000/1) and the SMR Addendum (Volume 5: Appendix CT-001-000/2). For each environmental topic there is also a summary of the key assumptions and limitations underpinning the assessment methodology. A summary of climate change assessment is described in Section 7.5.

Any variations from the standard scope, methodology and assumptions which may apply to specific community forum areas are described within the relevant Volume 2: CFA reports.

8.1 Agriculture, forestry and soils

Scope

- 8.1.1 The assessment considers the effects on agricultural and forestry resources, including soils taking account of their Agricultural Land Classification (ALC) and their other functions, and the physical and operational effects on the farm and rural enterprises using those resources. Such effects may result directly from land required (both temporarily and permanently) for the construction and operation of the Proposed Scheme, and indirectly from impacts such as severance or pollution.
- 8.1.2 Effects have been identified for all agricultural and forestry land that will be required for the construction and operation of the Proposed Scheme, and for all holdings that include such land.
- 8.1.3 Most effects on agriculture, forestry and soils will arise during the construction phase and will be either temporary or permanent. Temporary effects include land that will be used during construction and restored to its former condition using conserved soil resources on completion of construction, the severance of land during construction, and the initial effects of construction noise on adjacent agricultural activities. Permanent effects will be those that remain following the construction of the Proposed Scheme, including the land permanently required, and the permanent severance of land and effects on farm infrastructure. Operational impacts consider primarily the effects of operational noise on agricultural and related enterprises and the on-going management of operational railway land.

Baseline

- 8.1.4 Information on current agricultural land quality has been derived from an interpretation of geological, topographical, soil, agro-climatic and existing detailed and predictive ALC information. This ALC information has been augmented by field survey to validate its findings where required and where access was available. Desktop research has also been used to identify relevant agri-environmental schemes and woodlands. Details of land use and farming practices have been obtained primarily from interviews with landowners and businesses.

Methodology

- 8.1.5 Significant effects have been derived from the interaction between the magnitude of impact, the sensitivity of the affected resource/receptor and the relative scarcity or abundance of the resource/receptor in the locality. Impact magnitude is essentially a matter of its extent, duration or severity (e.g. the proportion of a holding subject to land required for construction and/or operation). Sensitivity reflects the resilience of a soil resource or business to accommodate change, whilst scarcity relates to the relative preponderance of a resource/receptor (e.g. best and most versatile (BMV) land in the locality or a niche business).
- 8.1.6 The areas of land required to construct and operate the Proposed Scheme have been calculated on the basis of the maximum extent of the permanent infrastructure and temporary works (including soil storage areas), as shown in the hybrid Bill plans.

Assumptions and limitations

- 8.1.7 The assessment assumes that agricultural land required for temporary purposes during construction, which is to be re-instated as agricultural land, will be restored to its pre-existing quality by following good practice for soil handling, storage and placement, and will be returned to its original landowner.
- 8.1.8 It is also assumed that all agricultural soil resources generated by the Proposed Scheme will be used appropriately and on-site to fulfil one or more of the recognised functions of soil. The assessment assumes that all displaced ancient woodland soils will be translocated to form the basis of new woodland planting and that other woodland soils will be reused as appropriate, including as the basis for new woodland planting.
- 8.1.9 The assessment assumes that land required for environmental mitigation measures will no longer be available for agricultural use, which is a worst-case assumption, although such land may be managed on a low input basis by agricultural interests.
- 8.1.10 It is assumed that farm buildings and dwellings to be demolished as part of the Proposed Scheme will not be replaced. Compensation for such loss will be available, but the decision to replace such buildings will rest with the affected party. The assessment also assumes that severed land will continue to be used by the holding where access is available to that land, and that, where required, new field accesses to severed parcels of land will be created from public highways.
- 8.1.11 Whilst there has been a high level of participation by land owners and occupiers in the farm impact survey, the assessment is limited where such participation has not taken place. In such cases, baseline information on farm holdings has been derived from publically available sources and observations from public vantage points.

8.2 Air quality

Scope

- 8.2.1 The air quality assessment considers potential effects from the construction phase (e.g. fugitive dust and emissions from diesel locomotives and HGV) and the operational scheme. Operational effects on air quality that have been considered include direct emissions from new buildings (mainly from heating plant) and indirect emissions from

road traffic associated with changes in the highway network or traffic generation around stations and depots.

- 8.2.2 The assessment has considered three key pollutants: nitrogen dioxide (NO₂) and fine particulates (PM₁₀ and PM_{2.5}). Traffic effects have been assessed for the peak years during the construction period and for the year of opening for operational effects.
- 8.2.3 The spatial scope of the assessment has reflected the area over which effects are likely to be measurable, ranging from the immediate vicinity of the works (e.g. for dust emissions) to air quality management areas and the local authorities within which local air quality is monitored and managed. The relevant extent of the highway network to be assessed for traffic emissions has been derived from the criteria in the DMRB.

Baseline

- 8.2.4 Information on current air quality has been obtained primarily from:
- local authority air quality review and assessment reports;
 - monitoring data available from the national Automatic Urban and Rural Network (AURN);
 - the London Air Quality Network and West Midlands Air Quality Group websites;
 - Department of Environment, Food and Rural Affairs (Defra) Air Information Resource website; and
 - the UK Air Pollution Information System.
- 8.2.5 In a few instances, specific background air quality monitoring has been undertaken for the assessment.

Methodology

- 8.2.6 The assessment of effects from dust during construction has been undertaken using an approach developed from the guidance produced by the Institute of air quality management¹²⁶. This guidance assigns the scale of an effect according to the scale of the construction works and the number, proximity and sensitivity of the receptors. The effect is a combination of the likelihood of significant levels of dust occurring at receptors (i.e. dust impacts) and the extent of inconvenience or annoyance that may be caused, and as such is an assessment of risk (the probability of an event happening combined with the severity of it).
- 8.2.7 In a development of the guidance applied here, the magnitude of the impact is determined first, followed by the significance of the effect at the receptor(s). The assessment assumes that dust control measures would be applied to the construction activities, through the CoCP, so that dust levels at receptors are kept as low as reasonably practicable. For other types of receptors (such as nature conservation sites), the determination of the level of effect takes account of the potential level of impact, the sensitivity of the receptor to dust impacts, and the importance of the receptor.

¹²⁶ Institute of Air Quality Management (2011), *Guidance on the assessment of impacts of construction on air quality and the determination of their significance*.

- 8.2.8 Effects relating to emissions from diesel locomotives (mainly during construction) have been assessed in accordance with Defra guidance.
- 8.2.9 The level of effects on individual receptors (e.g. residential properties close to roads) has been identified on the basis of EU/UK air quality limit values and objectives, in accordance with the descriptors used in the EPUK guidance *Development Control: Planning for Air Quality (2010)*¹²⁷. A number of qualifying factors have been taken into account in categorising overall effects on local air quality (e.g. the number of receptors affected and the degree of variance from the limit values/objectives).
- 8.2.10 Traffic-related effects have been identified initially using the air quality screening tool within the DMRB, supplemented where necessary by dispersion modelling. Dispersion modelling of point sources (e.g. combustion emissions from energy centres) has also been carried out where appropriate. The likelihood of nitrogen deposition on sensitive sites (e.g. protected habitats) has been assessed in accordance with the DMRB.

Assumptions and limitations

- 8.2.11 Assumptions necessary to undertake the air quality assessment are set out in the SMR and the SMR Addendum, individual sections in Volume 2 and appendices presented in Volume 5.

8.3 Community

Scope

- 8.3.1 The community assessment addresses the likely effects on residential properties (and their occupants), community facilities (and their users), and communities as a whole. Effects may result from:
- land used for the Proposed Scheme or its construction;
 - real or perceived isolation of residential properties or community facilities due to physical or visual barriers;
 - changes in levels of amenity (e.g. as a consequence of the combination of significant residual effects from air quality, noise and vibration, views or HGV construction traffic); and
 - the temporary presence of construction workers (See Volume 5: Appendix CM-002-000).
- 8.3.2 Effects relating to the severance of PRoW (public footpaths and bridleways) and highway and pedestrian diversions, are assessed under traffic and transport. However, where PRoW are a 'promoted' destination in their own right as a recreational resource, they have been considered within the community assessment. Where impacts on open space and PRoW are considered, these have been informed by open space and PRoW usage surveys.
- 8.3.3 Where open space is privately owned and not available for use by the general public, it has been excluded from the assessment (e.g. woodlands on farmland). However, where land is

¹²⁷ Environmental Protection UK (2010), *Development Control: Planning for Air Quality*.

privately owned but open for public use (e.g. parks or gardens surrounding country houses) it has been included in the assessment.

- 8.3.4 The community assessment reports on all significant community effects as well as those effects which are not significant but are considered to be of importance in the study area.

Baseline

- 8.3.5 Information has been collected on the current location and use of community resources and on the social characteristics of the communities that may be affected. Sources of information have included the following:

- published sources such as Census data and Office for National Statistics - Neighbourhood Statistics;
- existing studies such as open space and housing needs surveys;
- data from other relevant assessment topics;
- specific supplementary surveys (e.g. of open space or PRoW use); and
- consultation with community organisations, user groups and local/national government.

- 8.3.6 Community resources are mentioned expressly in the environmental baseline only where they contribute to the local context or where they may be affected by the Proposed Scheme. Consequently, not all community resources within the study area are mentioned.

Methodology

- 8.3.7 The assessment has drawn on relevant guidance and on experience from comparable projects. Effects have been derived from the interaction between the magnitude of impacts (which broadly reflect their severity, duration or extent) and the sensitivity of the resources and receptors (which broadly reflects their ability to accommodate impacts without fundamentally changing their functionality or amenity).
- 8.3.8 Whilst this is essentially a qualitative exercise, it has been based on quantitative inputs wherever possible (e.g. predicted changes in noise levels, numbers of properties affected or percentage of open space displaced by land required for construction and/or operation). Opportunities to mitigate community effects have been identified during the course of scheme development and consultation, and where commitments have been made (e.g. to provide replacement open space) these have been taken into account.
- 8.3.9 The assessment also draws on other assessment topics where necessary to identify the primary sources of community impacts. Although the level and intensity of proposed construction will vary during the construction period, the assessment focuses on the construction activities and durations which could lead to the greatest potential impact.
- 8.3.10 The spatial scope of the assessment varies, depending on the nature of the receptors and the impacts being considered. Whilst effects associated with construction or the land used for construction and/or operation are confined to the immediate vicinity of the route, effects resulting from a combination of impacts or relating to the overall functionality of a community will typically apply to wider areas such as neighbourhoods or parishes.

- 8.3.11 The assessment considers the construction phase (2017-2026) and the first year of operation (2026), with one exception. For the assessment of amenity effects, the operational noise assessment is based on the service frequency associated with Phase Two, which would not commence until some years later. For other topics, it is generally assumed that effects are unlikely to persist into the future, as communities adjust to the presence of the Proposed Scheme and as new or replacement community facilities will have been provided where necessary.
- 8.3.12 The assessment methodology excludes, for the purposes of reporting amenity and isolation effects, residential properties where the total number of dwellings affected is fewer than five. Impacts on individual properties does not constitute a significant community effect. There are a number of individual properties scattered along the route where impacts may be experienced from other topics, such as sound, noise and vibration. These impacts are reflected in other topic assessments where relevant.
- 8.3.13 Residential properties affected by the Proposed Scheme have been grouped together either by street, hamlet or village. In some circumstances other topics, such as sound, noise and vibration, may have grouped residential properties differently.
- 8.3.14 The number of residential properties that will experience a significant amenity effect is approximate, and may not correspond to the number of properties that will experience individual noise, traffic, visual or air quality effects.

Assumptions and limitations

- 8.3.15 Key assumptions underlying the assessment include:
- The different assessments within the community section (i.e. residential property and community infrastructure affected by land required for construction and/or operation of the Proposed Scheme; isolation; and changes in amenity) are not directly comparable in terms of determining significance of effect. Assessments are considered in aggregate as part of the community wide analysis that is presented in the community sections (cumulative section) in the Volume 2: CFA reports; and
 - Professional judgement was provided by other topics (i.e. sound, noise and vibration, landscape and visual and air quality), to inform the community amenity assessment. Any significant effects identified through professional judgement have been used in the same way as assessment findings derived through technical assessment.
- 8.3.16 A more detailed set of assumptions is provided in the community and socio-economic – detailed methodology guide technical note which forms part of the SMR Addendum.

8.4 Cultural heritage

Scope

- 8.4.1 The assessment has considered impacts on archaeological and palaeo-environmental remains, historic landscapes and buildings, and the built environment, known collectively as heritage assets. Both designated and non-designated assets have been considered. Effects have been considered from both construction and operation of the Proposed

Scheme, for example as a result of the land required for construction or visual intrusion in to the setting of assets.

- 8.4.2 The definition of the study area for heritage assets has differed for urban and rural areas. Within urban areas, the study area has comprised the land required for construction (both temporary and permanent), plus 250m on either side. Within rural areas, the study area has comprised the land required for construction plus 500m on either side.
- 8.4.3 For an appraisal of the settings of designated assets, the study area has taken account of the ZTV and has been extended up to 2km (1.3 miles) from the centre line of the Proposed Scheme. Within urban areas, to ensure that the assessment of the setting of designated assets remains both proportionate and appropriate, a degree of professional judgement has been applied to determine the extent of the study area.

Baseline

- 8.4.4 Information about heritage assets has been obtained from a range of sources, including registers of designated historic assets held by English Heritage, historic environment records, historic landscape character mapping, conservation area appraisals, historic maps and aerial photography; and from specific surveys and research such as light detection and ranging (LiDAR) surveys, site reconnaissance visits, field-walking and geophysical surveys. Survey work was discussed with English Heritage and local authority archaeologists on a case-by-case basis.

Methodology

- 8.4.5 There is no specific national guidance on the methodology for heritage impact assessments. However, DMRB Volume 11 (Environmental Assessment) provides an approach to highway schemes. The assessment has also taken account of the draft guidance on heritage impact assessments for Cultural World Heritage Sites (International Council on Monuments and Sites)¹²⁸, and a range of guidance from English Heritage.
- 8.4.6 National planning policy requires that impacts on heritage assets are assessed in relation to the significance of the asset. This significance can be reflected in a range of ways; for example, evidential or historical, and can also be influenced by its setting.
- 8.4.7 Effects on the significance of heritage assets have been assessed on the basis of the type and magnitude of impact, and the severity of the effects; for example, whether it involves removal of the asset or intrusion into its setting. Appropriate mitigation measures have been identified and taken into account.

Assumptions and limitations

- 8.4.8 Access was not obtained to all of the land where survey was proposed. The method used for the selection of areas for evaluation survey is set out in the technical note on risk based approach to archaeological assessment (refer to SMR Addendum).
- 8.4.9 It has been assumed that all construction activity within the land required, temporarily or permanently, for the Proposed Scheme, will result in the removal of archaeological assets. Opportunities for the preservation of archaeological assets in-situ have not, unless

¹²⁸ International Council on Monuments and Sites (ICOMOS) (2010), *Guidance on Heritage Impact assessments for Cultural World Heritage Properties*.

explicitly identified in the ES, been considered. Surveys to confirm or update the cultural heritage baseline from that presented in the ES will be required prior to construction. It is assumed that access will be available for these surveys and that the programme of investigation and recording as set out in the Heritage Memorandum will apply to these works.

- 8.4.10 The assessment of impacts has taken account of incorporated mitigation such as noise fence barriers, landscaping and planting. This mitigation includes measures set out in the draft CoCP, including methods for managing ground movements on heritage assets (draft CoCP, Section 10). As such, all assets within the predicted 10mm settlement contour¹²⁹ and/or where predicted ground movements cause a change in ground slope that exceeds 1:500, have been assessed in the baseline. Impacts relating to ground movements are reported in this assessment. No significant effects are expected with respect to buildings of historic interest falling outside the 10mm ground settlement contour and/or with a predicted change in ground slope of less than 1:500. However, further assessment, monitoring measures and surveys may be undertaken on selected historic buildings up to the relevant distance (100m from shafts and 50m from most other construction works).
- 8.4.11 Other assumptions and limitations of the cultural heritage impact assessment include:
- the LiDAR data does not encompass the entire Proposed Scheme; and
 - planting as a means of visual screening for heritage assets; for example built heritage, will not be fully effective until maturity.

8.5 Ecology

Scope

- 8.5.1 The ecological impact assessment considers all ecological receptors which have the potential to be affected by the construction and/or operation of the Proposed Scheme. The assessment includes the consideration of effects arising from habitat loss, fragmentation of sites, severance of ecological corridors and networks, noise and visual disturbance, barrier effects to movement of fauna, lighting, changes in water quality and quantity, air pollution, and mortality as a result of collisions with trains.
- 8.5.2 The scope is limited to effects on the 'ecological value' of receptors. The social and economic value of ecological receptors such as nature reserves is considered separately in the community and socio-economic sections of the ES.
- 8.5.3 The spatial scope of the assessment has depends on the ecological receptor under consideration and the magnitude and nature of the potential impacts. For all ecological receptors this has, as a minimum, included areas located within and adjacent to the land required for the construction of the Proposed Scheme. More information on the spatial scope of individual aspects is provided within the SMR and SMR Addendum.

Baseline

- 8.5.4 Existing biological data for the Proposed Scheme have been obtained from relevant Local Biological Records Centres and from national and local specialist data sources, such as

¹²⁹ The 10mm settlement contour is the area in which ground settlement is estimated to be 10mm in depth.

Butterfly Conservation and bat groups. National and Local Biodiversity Action Plans and ancient woodland inventories has also been consulted. The geographic extents of search areas have varied, based on the likely value and mobility of the receptor involved. Further information on the final search areas is provided within the SMR Addendum.

- 8.5.5 A wide range of field surveys have been conducted to inform the ES. The survey methodologies used have been based on standard approaches, and the extent and scope of surveys conducted has varied widely based on the species/habitat involved. Details of survey methodologies and any deviation from these for specific locations are detailed within the SMR and SMR Addendum.

Methodology

- 8.5.6 The ecological impact assessment has been guided by the methodology provided by the Chartered Institute of Ecology and Environmental Management (IEEM)¹³⁰.
- 8.5.7 Each potential ecological receptor has been assigned a value according to one of the following geographical frames of reference: international; national; regional; county/metropolitan; district/borough; local/parish; and negligible. Individual effects considered to be significant at the local/parish level or below are as a general rule only reported in Volume 2: CFA reports in relation to designated sites and European protected species. Potential cumulative and in-combination effects of multiple local/parish level effects are considered within Volume 3: Route-wide effects. Lists of local/parish level effects are provided within Volume 5: Appendices EC-005-001, EC-005-002, EC-005-003, and EC-005-004.
- 8.5.8 In line with the IEEM approach, the evaluation of species receptors has been based on the distribution and status of the species concerned, rather than only the legal protection.

Assumptions and limitations

- 8.5.9 Access was not obtained to all of the land where surveys were proposed. In addition, delays to access have meant that some surveys could not be conducted or were not conducted according to the method laid out within the field survey methods and standards technical note included in the SMR Addendum. Therefore, in order to ensure that all likely significant effects of the Proposed Scheme have been identified, where baseline information is incomplete, a precautionary approach to valuation has been adopted, assuming a reasonable worst case.
- 8.5.10 Where precautionary valuations have been necessary, they have been based on all available information. This has included consideration of available field and desk study data (including aerial photography), a comparison with similar habitat areas occurring in the wider local area, and a qualitative consideration against any factors that indicate suitability for the particular habitat or species in question. The degree of precaution built into the assessment for each receptor reflects the level of confidence in the existing data available. Further details are provided in the ecological assessment methodology technical note, included in the SMR Addendum.

¹³⁰ Chartered Institute of Ecology and Environmental Management (2006) *Guidelines for Ecological Impact Assessment in the United Kingdom*. IEEM, Winchester.

- 8.5.11 The ecological assessment of off-route effects is based largely on information available from existing sources, recognising the constraints of such an approach. These are reported within Volume 4: Off-route effects.
- 8.5.12 Other assumptions made for the purpose of the ecological impact assessment include the following:
- all habitats and features within the land required for the construction of the Proposed Scheme will be lost. The re-instatement and landscaping of these areas on completion of construction are considered as part of the proposed 'other mitigation measures'¹³¹, described in the Volume 2: CFA reports;
 - all construction activity will occur concurrently across the entire length of the Proposed Scheme and will start at the beginning of the construction period. This represents a worst-case scenario;
 - the expansion in the range of otter will continue and by the time the Proposed Scheme is operational otter will be present in all watercourses suitable for the species;
 - the operator will ensure provision of on-going management of all mitigation and compensatory habitat creation, either directly or through suitable legal and financial agreements with third parties; and
 - the operator will commit to monitoring of both habitats and species in order to ensure that predictions of effects are accurate and that mitigation/compensation is successful.

8.6 Land quality

Scope

- 8.6.1 The assessment has considered potential effects associated both with the disturbance of contaminated land and with any ground contamination that could occur as a result of the Proposed Scheme. The main potential for impacts will occur during the construction phase from disturbance of pre-existing contamination. Operational sources have also been considered (e.g. leaks or spillages within depots from line-side equipment or from trains). In addition, the assessment has considered any areas of geological significance; for example, associated with geological Site of Special Scientific Interest (SSSI), local geological sites (LGS) and mineral resources or mining activity.
- 8.6.2 Potentially contaminated sites have been identified within the footprint of the Proposed Scheme and within 250m of the boundary of the construction works. The possibility of disturbance to contamination causing impacts to occur at greater distances from the route (e.g. via pathways such as watercourses or aquifers) has also been considered where appropriate.
- 8.6.3 Land contamination issues are closely linked with those involving water resources and waste. Issues regarding groundwater resources not related to land contamination are

¹³¹ For the purposes of the ecological impact assessment 'other mitigation measures' is the term used to describe all mitigation, compensation and enhancement provided in addition to that which is inherent to the engineering design of the Proposed Scheme.

addressed in Section 8.12, water resources and flood risk and Volume 2: CFA reports, Section 13. Issues regarding the disposal of waste materials, including contaminated soils, are addressed in Volume 3: Route-wide effects, Section 14.

Baseline

- 8.6.4 Baseline information has been obtained from a combination of desktop sources, site visits and previous ground investigations. Desktop sources have included published geological/hydrogeological mapping, information from the Environment Agency (particularly for existing and historic landfill sites), historical mapping and local authority data. Site visits have been targeted at locations where a greater potential for current or historic contamination has been identified.

Methodology

- 8.6.5 In line with the Environment Agency guidance document CLR 11¹³², a conceptual site model (CSM) and risk assessment approach has been used. The CSM model provides an initial understanding of the types of contaminants that may be present, the receptors (i.e. people and the wider environment) that may be affected and the likely pathways by which contamination could spread.
- 8.6.6 This source/pathway/receptor model has been used to predict the degree of risk of pre-existing contamination posing hazards to the environment at each location, prior to, during and following construction (once any remediation has been carried out). The significance of effects has been derived from the change in level of risk, taking account of the sensitivity of the receiving environment.
- 8.6.7 The remediation of existing contamination, as part of the construction works, has been regarded as beneficial.
- 8.6.8 Different methods of assessment and significance criteria have been used for geological conservation sites and minerals/mining areas, which take into account the degree of impact that the construction may have on such sites, and their sensitivity and importance.

Assumptions and limitations

- 8.6.9 Much of the assessment is dependent on existing sources of information from third parties. Although this data has been critically reviewed, there may nevertheless be limitations as to its accuracy and completeness.
- 8.6.10 No site specific intrusive site investigations have been undertaken as part of the baseline data collection. Investigations will be undertaken during the detailed design process in order to provide contamination data for risk assessments and, where necessary, for detailed remediation design.

8.7 Landscape and visual

Scope

- 8.7.1 The assessment has considered effects on landscape character and on visual receptors within the study area. Effects have been identified from the construction phase and the

¹³² Environment Agency (2004), *Model Procedures for the Management of Land Contamination CLR 11*.

completed scheme at year of opening and at year of opening plus 15 and 60 years. The longer term assessments take account of the increased mitigation achieved as landscaping matures.

- 8.7.2 Effects on local landscape character, views and receptors are reported in Volume 2: CFA reports. Effects on the Chilterns AONB as a whole study area are reported in Volume 3: Route-wide effects.
- 8.7.3 A zone of theoretical visibility (ZTV) has been prepared to aid understanding of the potential visibility of the Proposed Scheme during both construction and operation. This helps to determine the study area for the landscape and visual assessment and also supports the assessment of effects on the setting of cultural heritage assets. The ZTV shows the extent to which elements of the Proposed Scheme may be visible, but does not show the extent over which landscape and visual effects may be experienced, since the latter requires consideration of the extent to which visibility of the Proposed Scheme would beneficially or adversely affect a view from a particular receptor.
- 8.7.4 The process for producing the ZTV is described in full in the zone of theoretical visibility production methodology technical note, which is contained with the SMR Addendum. The ZTV is based on visibility of the Proposed Scheme from the eye height of someone standing at ground level and takes account of the following factors:
- the existing topography;
 - existing buildings, excluding any which will be demolished as part of the construction of the Proposed Scheme; and
 - existing tree cover, excluding any trees which will be removed as part of the construction of the Proposed Scheme. Thin bands of trees narrower than 10m are also excluded as, during winter, these will provide only minimal screening.
- 8.7.5 The ZTV for the construction phase takes account of the tops of activities or structures that will be present during construction, including:
- construction plant along the route, in compounds, at tunnel portals, green tunnels, ventilation shafts, headhouses, stations, depots, road diversions and any other known works;
 - temporary fencing and hoarding;
 - temporary stockpile of materials;
 - welfare facilities and storage;
 - structures being demolished; and
 - new permanent structures under construction.
- 8.7.6 Very tall construction plant (e.g. cranes) are excluded from the ZTV, since they rarely give rise to significant effects if they are the only elements visible.
- 8.7.7 The ZTV for the operation phase shows the visibility of the high speed trains and permanent structures, including:

- station buildings;
- permanent depots;
- ventilation shafts and headhouses;
- road/pedestrian diversions and bridges; and
- fencing and noise fence barriers.

- 8.7.8 Overhead line equipment (OLE) is excluded from the model on the basis that this rarely gives rise to significant effects if it is the only element visible.
- 8.7.9 The ZTV for year 15 of operation (2041) illustrates how planting proposed along the route will reduce visibility of the Proposed Scheme.
- 8.7.10 Landscape character and visual receptors within 500m of the Proposed Scheme have generally been considered. However, this study area has been varied locally to take account of variations in visibility as indicated by the ZTV (e.g. with views likely to be more limited in urban areas and more extensive in open countryside).

Baseline

- 8.7.11 Baseline information has been obtained from a combination of desktop research and fieldwork. Desktop sources have included published landscape character assessments, the Character of England map and local development frameworks.
- 8.7.12 Fieldwork was used to identify landscape character areas and visual receptors. The work has been carried out in both summer and winter, and has been accompanied by a comprehensive photographic record.

Methodology

- 8.7.13 The assessment has taken account of relevant guidance such as the GLVIA (3rd edition)¹³³ and DMRB Volume 11, Section 3, Part 5. The desktop and field studies have been used to identify a series of landscape character areas along the route. The condition, tranquillity and value of each character area have been assessed, from which an evaluation of sensitivity has been made. The significance of landscape effects has been derived from the interaction between the magnitude of change (e.g. extent of land required for construction and/or operation or loss of features within a character area) and its sensitivity.
- 8.7.14 The assessment views have been agreed during the course of consultation, so as to be representative of the range of views experienced by the relevant receptor groups in each location. The significance of visual effects has been derived from the interaction between the magnitude of change to these views and the sensitivity of receptors. Impacts on selected views have been illustrated by preparing verified photomontages from locations agreed with the statutory consultees or through visualisations.

¹³³ Landscape Institute (2013), *Guidelines for Landscape and Visual Impact Assessment (3rd Edition)*.

Assumptions and limitations

- 8.7.15 Assumptions necessary to undertake the landscape and visual assessment are set out in the SMR and the SMR Addendum, in individual sections in Volume 2 and in appendices presented in Volume 5.

8.8 Socio-economics

Scope

- 8.8.1 The potential socio-economic effects of the Proposed Scheme relate to three main areas: employment, businesses and the economy. Effects on employment levels are reported at a route-wide level within Volume 3, whilst effects on the local economy are reported by CFA within Volume 2. Wider economic benefits are reported within Volume 3: Route-wide effects.
- 8.8.2 The effects can be beneficial (e.g. through direct job creation or via procurement of goods and services from local businesses) or adverse (e.g. due to land required for construction and/or operation requiring the relocation of businesses). The assessment has considered effects arising during the construction and operation phase.
- 8.8.3 The route-wide assessment identifies effects resulting from land required for construction and/or operation, amenity effects (e.g. as a consequence of the combination of significant residual effects from air quality, noise and vibration, views or HGV construction traffic) and isolation effects on existing businesses and organisations, together with potential opportunities for construction and operational employment.

Baseline

- 8.8.4 Baseline information has been obtained for a series of 'benchmark areas', which are termed demographic character areas in Volume 2: CFA Reports. These relate to the areas across which economic functions and data can be readily understood. Data have been collected within these areas for a range of socio-economic indicators, including demographics, employment, labour supply, and where applicable, economic policy. Sources have included official national data sets, Chambers of Commerce, Local Government, individual businesses and commercial property data sets.

Methodology

- 8.8.5 The assessment has drawn on guidance such as the Treasury Green Book¹³⁴, DfT WebTAG guidance¹³⁵ HCA Employment Density Guide¹³⁶ and the English Partnerships Additionality Guide¹³⁷.
- 8.8.6 The magnitude of effects has been assessed from the interaction between the magnitude of impacts (e.g. their spatial extent and duration) and the sensitivity of the receptor (essentially the ability of a business, economy or market to absorb adverse change or to respond to beneficial change) taking into consideration the strength of the local economy and the availability of alternative premises.

¹³⁴ HM Treasury (2003), *The Green Book: Appraisal and Evaluation in Central Government*, London, Her Majesty's Stationery Office.

¹³⁵ Department for Transport (2013), WebTAG Home, Transport Analysis Guidance; <http://www.dft.gov.uk/webtag/> and www.webtag.org.uk, Accessed: 1 July 2013.

¹³⁶ Homes and Communities Agency (HCA) (2010), *Employment Density Guide*.

¹³⁷ English Partnerships (2008), *Additionality Guide, A standard approach to Assessing Additional Effects of Projects (3rd Edition)*.

Assumptions and limitations

8.8.7 Key assumptions underlying the assessment include:

- loss of trade within a business can be considered as a loss of turnover and represented as a change in employment at the affected business (assuming that there is a positive relationship between growth/contraction in a business's turnover and growth/contraction in employment at that business);
- for businesses affected by land required for the Proposed Scheme, it is assumed that the employment within these resources will either be lost or will be relocated. For resources affected by isolation and/or changes in amenity, the employment implications are less clear. Whilst impacts are assessed and reported at an individual resource level, any employment implications are assessed at route-wide level;
- an indicative rate of successful business relocations for businesses on land required for the Proposed Scheme of 88% has been assumed, and that no employment at these businesses will be lost. The rate of closure of directly affected businesses is therefore assumed to be 12% and it is assumed employment within these businesses would be lost¹³⁸;
- it is assumed that a business experiencing an adverse effect on trade due to isolation or changes in amenity can adopt a number of strategies before reducing employment (e.g. cancel/postpone investment in premises/stock/machinery, reduce staff working hours, cancel/postpone plans to expand business, temporary laying-off staff, renegotiate loans or mortgage, increase marketing or advertising activity etc.). Any reduction in employment has been calculated by estimating the total employment of the business(es) affected, then, based on the business activity/sector type, by applying a percentage to represent the likely proportion of employment which could be significantly affected by changes in amenity or isolation;
- it is assumed that the demand for and supply of construction labour in the rail sector will remain largely the same up to the commencement of the Proposed Scheme; and
- operational employment on the classic network is assumed to remain the same as present as released capacity is utilised by new services.

8.8.8 A more detailed set of assumptions are provided in the community and socio-economic – detailed methodology guide technical note which forms part of the SMR Addendum.

8.9 Sound, noise and vibration

Scope

8.9.1 The assessment of sound, noise and vibration considers the likely significant noise and vibration effects arising from the construction and operation of the Proposed Scheme on:

¹³⁸ Research undertaken by London Development Agency (LDA) in relation to businesses required to relocate due to land requirements for the London 2012 Olympics, (30th June 2008), *Request for Information/Freedom of Information Act by Mr Julian Cheyne, FOI291*.

- 8.9.2 people, primarily where they live ('residential receptors') in terms of a) on an individual dwelling basis and b) on a community basis, including any shared community open areas¹³⁹; and
- community facilities such as schools, hospitals, places of worship, and also commercial properties such as offices and hotels, collectively described as 'non-residential receptors' and 'quiet areas'¹⁴⁰.
- 8.9.3 The term 'sound' describes the acoustic conditions which people experience as a part of their everyday lives. The assessment considers how those conditions may change through time and how sound levels and the acoustic character of community areas is likely to be modified through the introduction of the Proposed Scheme. Noise is defined as unwanted sound and hence adverse effects are termed noise effects rather than sound effects, and mitigation is, for example, termed 'noise' barriers.
- 8.9.4 In this assessment significant noise or vibration effects may be:
- *adverse* from an increase in sound levels or *beneficial* from a decrease in sound levels caused by the Proposed Scheme;
 - *temporary* from construction or *permanent* from the operation of the Proposed Scheme;
 - *direct*, resulting from the construction or operation of the Proposed Scheme, and/or *indirect* e.g. resulting from changes in traffic patterns on existing roads or railways that result from the construction or operation of the Proposed Scheme; and
 - *off-route*, i.e. caused by the Proposed Scheme outside of the study area around the new railway and associated infrastructure.
- 8.9.5 The assessment is reported in the Volume 2: CFA reports with more detailed information available in the relevant appendices in Volume 5. The assessment of significant off-route noise or vibration effects is reported in Volume 4.
- 8.9.6 HS2 Ltd has engaged with the Environmental Health Practitioners acting for the local and county authorities along the line of route. There have been two forms of engagement. The first is with the Planning Forum Sub-Group (Acoustics) on route-wide matters and has included the review of the assessment methodology, baseline methodology and route-wide noise control measures. The second form of engagement is directly with each relevant local authority on local matters such as assessment locations, baseline monitoring locations, local conditions, location of quiet areas (as described in the SMR) and baseline monitoring results.
- 8.9.7 HS2 Ltd established an independent Acoustics Review Group (ARG) that has reviewed the detailed scope and methodology that forms the basis of the sound, noise and vibration

¹³⁹ 'Shared community open areas' are those that the emerging National Planning Practice Guidance identifies may partially offset a noise effect experienced by residents at their dwellings and are either a) relatively quiet nearby external amenity spaces for sole use by a limited group of residents as part of the amenity of their dwellings or b) a relatively quiet external publicly accessible amenity space (e.g. park to local green space) that is nearby.

¹⁴⁰ Quiet areas are defined in the Scope and Methodology Report as either Quiet Areas as identified under the Environmental Noise Regulations or are resources which are prized for providing tranquillity.

assessment reported in this Environmental Statement. The reporting structure and generic content of various volumes of ES, including maps, was also reviewed. The records of the ARG meetings have been published.

Baseline

- 8.9.8 Information on the existing airborne sound environment has been obtained from desktop research and extensive field surveys. Sound level monitoring has also been undertaken at locations suggested by local communities¹⁴¹. The aim has been to obtain objective data that describe the ambient sound environment, which is supported by a subjective assessment of the soundscape at each location.
- 8.9.9 Future changes in the airborne sound baseline have been considered where significant effects of HS2 might occur and where the future baseline is predictable with reasonable certainty, for example, due to growth in traffic flows or the introduction of committed developments.
- 8.9.10 It is likely that the majority of receptors adjacent to the route are not currently subject to ground-borne noise or vibration. Major existing railways are the only likely sources. Baseline vibration surveys have not been undertaken. The assumption that there is no baseline vibration provides a reasonable worst-case basis for the assessment of likely significant effects. Further information is provided in Volume 5: Appendix SV-001-00.

Methodology

- 8.9.11 The assessment identifies likely significant noise and vibration effects (both beneficial and adverse) and describes the measures envisaged to avoid or reduce these significant effects.
- 8.9.12 The method for identifying significant noise or vibration effects from the construction and operation of the Proposed Scheme draws on best practice from other major infrastructure projects, and is consistent with current Government noise policy¹⁴², and emerging guidance¹⁴³.
- 8.9.13 The emerging guidance is based on the premise that once sound becomes perceptible, the effect on people and other receptors used by people (for example schools, hospitals etc.) increases as the total level of sound increases. The Government policy defines, in increasing severity, four levels of effect: effect; adverse or beneficial effect; significant adverse or beneficial effect and unacceptable adverse effect. It also notes that noise level triggers should be set to define the onset of adverse effects and significant adverse effects and that these triggers should reflect the nature of the noise source, the sensitivity of the receptor and the local context.
- 8.9.14 Therefore for HS2 Phase One, trigger values for the onset of both 'adverse' and 'significant adverse' effects have been defined for noise and vibration. These are based on best practice and previous projects.

¹⁴¹ Where the monitoring provided further information relevant to the assessment.

¹⁴² Defra (2010), *Noise Policy Statement for England (NPSE)* and Department for Communities and Local Government (2012), *National Planning Policy Framework*.

¹⁴³ National Planning Practice Guidance – Noise <http://planningguidance.planningportal.gov.uk>; Accessed: October 2013.

Residential receptors: direct effects – individual dwellings

8.9.15 Where the forecast total noise or vibration (including noise from the Proposed Scheme and taking account of the noise reduction measures), exceeds the trigger value for onset of a significant adverse effect, then a significant noise or vibration effect has been identified on that individual receptor. In these situations, the significant adverse effect would be on residents inside buildings.

Residential receptors: direct effects – communities

8.9.16 Where the forecast total level of noise or vibration (including noise from the Proposed Scheme and taking account of the noise reduction measures), is between the trigger values for the onset of adverse effect and significant adverse effect, people's perception of the level of effect is generally indicated by the increase in noise or vibration from what it would be without the Proposed Scheme. People living in a local community when such a change in noise occurs, may consider it an adverse effect on the acoustic character of the area and hence may perceive it as a change in the quality of life.

8.9.17 People who do not experience the acoustic character of an area before a change occurs will consider noise based on the absolute, i.e. total level, not the change in level and therefore their perception of the magnitude of any effect is likely to be lower than those who experience the change.

8.9.18 Consistent with best practice and DMRB guidance, the magnitude of the level of adverse or beneficial effect on individuals due to noise change is identified as negligible, minor¹⁴⁴, moderate¹⁴⁵ or major¹⁴⁶.

8.9.19 When considered collectively on a community basis and taking into account the local context, changes in sound levels in areas containing a number of dwellings may be deemed to be significant. In considering whether the level of effect is significant on a community basis the following criteria have been taken into account:

- the number and grouping of adversely or beneficially affected dwellings and shared community facilities;
- the change in noise levels;
- the overall total level of noise exposure once the scheme is in operation;
- the level and character of the existing sound environment;
- any unique features of the source or receiving environment in the local area;
- combined exposure to noise and vibration;
- the duration of the adverse or beneficial effect (for construction); and
- the effectiveness of mitigation measures that are provided.

¹⁴⁴ 3 to 5dB long-term change – a noticeable change.

¹⁴⁵ 6 to 10dB long-term change.

¹⁴⁶ Greater than 10dB long-term change - a 10dB change is equivalent to a doubling or halving of perceived loudness.

- 8.9.20 The assessment is evidence-based. As examples, the assessment methodology could consider the following cases to be significant on a community basis:
- a large number of dwellings subject to minor adverse or beneficial effect due to noise change in a quiet existing environment and that are grouped together forming a residential community area;
 - a medium number of dwellings subject to moderate adverse or beneficial effect due to noise change in an existing environment with 'average' existing sound levels and that are grouped together forming a residential community area; or
 - a small number of dwellings subject to major adverse or beneficial effect due to noise change in an existing environment that is currently either quiet or averagely noisy and that are grouped closely together forming residential community area.
- 8.9.21 For the purposes of this assessment, 'considered significant on a community basis' refers to a group of residential dwellings situated close to each other, including any shared open space. Such residential community areas will usually be part of a named city, town, village or hamlet, in which case the name of the village is used to help denote the significant adverse or beneficial effect. Each significant effect has been given a unique identification, for example OSV12-Co2. As an example this identification refers to operational sound and vibration (OSV) in Volume 2: Waddesdon and Quainton (CFA 12) and this is the second significant effect identified on a community basis (Co2)¹⁴⁷. These identifications are provided to navigate the reader between the text in Volume 2: CFA reports and Volume 5 tables and maps.
- Non-residential receptors: direct effects*
- 8.9.22 Hotels, hospitals and other buildings where people may sleep temporarily (but which are not 'permanent' residential dwellings), along with buildings having specific noise and vibration sensitive resources, are called non-residential receptors.
- 8.9.23 The level of effect of noise or vibration on a non-residential receptor is dependent on:
- the overall sound level and the change in sound level (from the baseline) due to the Proposed Scheme;
 - the receptor's generic sensitivity to noise or vibration (this is dependent on the use of the receptor - for example, a school is considered more sensitive than a hotel); and
 - the receptor's specific sensitivity to noise or vibration (for example, the location, construction and layout of a school)¹⁴⁸.
- 8.9.24 The assessment has considered the noise and vibration exposure at each receptor and the receptor's generic sensitivity. On a worst-case basis¹⁴⁹, it assumes that the receptor is the

¹⁴⁷ Further information on identifications is provided in Volume 5: Appendix SV-001-000.

¹⁴⁸ Including matters such as whether the most sensitive parts of the school are closest to and face the Proposed Scheme or are located further from the route and are on the opposite side of a building; and the sound insulation performance of the building and hence whether sensitive indoor activities are insulated from change in outdoor noise.

¹⁴⁹ Note that the overall assessment of non-residential receptors is considered to be on a reasonable worst-case basis.

most sensitive it can be (for example, assuming that for a school the teaching spaces are at the closest point to the Proposed Scheme, facing the route with windows open).

Indirect effects

- 8.9.25 The assessment has considered likely noise or vibration effects from temporary or permanent changes in traffic on existing roads and railways caused by the Proposed Scheme. The assessment is based on evaluating the likely change in noise or vibration levels at receptors alongside each road or railway based on the anticipated change in traffic type and numbers. In determining whether effects are significant, the assessment has considered the magnitude of the change, the number of residential dwellings that would be affected by the change and the sensitivity of any non-residential receptor.

Airborne sound

- 8.9.26 Airborne sound arising from operating trains has been calculated using the method developed for HS1, taking account of aerodynamic sound generated by the operation of trains at speeds in excess of 300kph. The results have been plotted as a series of sound contour and noise effect maps using NoiseMap and GIS software.
- 8.9.27 Each map shows contours of equivalent continuous sound level over day and night, the primary measure of railway noise exposure ($L_{pAeq,T}$, 07:00-23:00, the daytime sound level, and $L_{pAeq,T}$, 23:00-07:00, the night-time sound level) and also indicates the magnitude of noise changes due to the Proposed Scheme.
- 8.9.28 Taking account of the envisaged mitigation, map Series SV-05 (Volume 2: Map Book) shows the long-term 40dB¹⁵⁰ night-time sound level contour from the operation of trains on the Proposed Scheme. The extent of the 40dB night-time sound level contour is equivalent to, or slightly larger than, the 50dB daytime contour¹⁵¹. These are adverse effect thresholds. In general, below these levels adverse effects are not expected.
- 8.9.29 Above 40dB during the night and 50dB during the day the magnitude of adverse or beneficial effect of noise is dependent on the baseline sound levels in that area and the change in sound level brought about by the Proposed Scheme. The airborne noise impacts and effects forecast for the operation of the scheme are indicated on the Maps by colouring affected dwellings according to the magnitude of the noise change effect (minor, moderate and major).
- 8.9.30 Railway noise from the Proposed Scheme is considered to cause a significant adverse effect on an individual receptor when it reaches a level of 65dB during the day or 55dB at night, irrespective of the change in sound level caused or where the relevant maximum sound level criterion¹⁵² is exceeded.
- 8.9.31 Levels of airborne sound arising during construction have been calculated in accordance with the relevant standard¹⁵³ and have been assessed on the basis of a series of

¹⁵⁰ Defined as the equivalent continuous sound level from 23:00 to 07:00 or $L_{pAeq,night}$

¹⁵¹ With the train flows described in the assumptions section of the Volume 2: CFA report, the daytime sound level (defined as the equivalent continuous sound level from 07:00 to 23:00 or $L_{pAeq,day}$) from the Proposed Scheme would be approximately 10dB higher than the night-time sound level. The 40dB contour therefore indicates the distance from the Proposed Scheme at which the daytime sound level would be 50dB.

¹⁵² During the night (23:00-07:00) a significant effect is also identified where the Proposed Scheme results in a maximum sound level at the façade of a building at or above: 85 dB L_{pAFmax} (where the number of train pass-bys exceeding this value is less than or equal to 20); or 80 dB L_{pAFmax} (where the number of train pass-bys exceeding this value is greater than 20).

¹⁵³ British Standards Institute (2009), *BS 5228-1:2009 Code of Practice for noise and vibration control on construction and open sites*.

assessment categories representing day-time, evening, night-time and weekend periods, that vary dependent on the existing baseline sound levels.

- 8.9.32 The Calculation of Road Traffic Noise (CRTN, 1988)¹⁵⁴ has been used to calculate the noise implications of any consequential changes in road traffic, with significance related to the magnitudes of noise change and baseline levels, as described earlier.
- 8.9.33 Noise from fixed sources such as ventilation shafts and lineside equipment has been assessed following the principles of the relevant standards¹⁵⁵ by comparing the sound levels from the Proposed Scheme with background levels¹⁵⁶.

Ground-borne sound and vibration

- 8.9.34 Levels of ground-borne sound and vibration have been calculated using the approach adopted for HS1, which is consistent with international standards¹⁵⁷ and guidance. The method has been further developed and verified to take account of the higher operational speeds for the Proposed Scheme. These levels have been compared to adverse effect thresholds for different types of receptor as used for comparable projects and as defined in relevant national and international standards and guidance. In the rare cases where the adverse effect thresholds are exceeded, the magnitude of the adverse effect has been evaluated (e.g. low, medium or high).
- 8.9.35 For non-residential receptors, vibration-sensitive equipment or processes (e.g. laboratories) have been considered on a case-by-case basis where information is available about the location and type of equipment or process is available.
- 8.9.36 Impact criteria that ensure that there is no risk of any damage to buildings, even cosmetic damage, resulting from ground-borne vibration have been adopted from the relevant standard¹⁵⁸.

Assumptions and limitations

Construction assumptions

- 8.9.37 The assessment considers noise and vibration on a month-by-month basis and assumes that the mitigation measures defined in the draft CoCP have been implemented. Noise levels will vary day-to-day, the highest daily levels may sometimes be around 5 dB higher than the monthly average levels but also could be substantially lower on other days.
- 8.9.38 It is anticipated that there may be some night-time working during works to cross or tie into existing roads and railways. In these situations, it is expected that the noise effects would be limited in duration and hence are unlikely to be significant. Any noise effects arising from these short-term construction activities will be controlled and reduced by the management processes set out in the draft CoCP.

¹⁵⁴ Department of Transport (Welsh Office) (1988), *Calculation of Road Traffic Noise*, Her Majesty's Stationary Office.

¹⁵⁵ International Organisation for Standardisation (1996), *ISO9613-2:1996 Attenuation of sound during propagation outdoors*.

¹⁵⁶ British Standards Institute (1997), *BS4142 Rating industry noise affecting mixed residential and industrial areas*.

¹⁵⁷ International Organisation for Standardisation (2005), *ISO 14837-1:2005, Mechanical vibration - ground borne noise and vibration arising from rail systems*.

¹⁵⁸ Refer to Volume 5: Appendix SV-001-000.

Operational assumptions

- 8.9.39 The effects of noise and vibration from the operation of the Proposed Scheme have been assessed based on the highest likely train flows, including the Phase Two services. The exception is the short section of the route between Manchester spur and Handsacre junction where the train flows will be greater during Phase One operation, and have been assessed on this basis.
- 8.9.40 The expected passenger service frequency for both Phase One, and Phase One with Phase Two services are described in Section 4.3. As a reasonable worst case, this assessment is based upon the service pattern for Monday to Saturday including Phase Two services.
- 8.9.41 At night there will be regular line inspections and planned maintenance work at some locations along the route. At any one location on the route maintenance is likely to be very occasional. Given the irregularity of the activity and short duration at any one location, maintenance work is considered unlikely to give rise to significant noise or vibration effects.
- 8.9.42 A small number of diesel-powered specialist engineering trains will travel on most nights from the IMD at Calvert to either inspect the line or to a location of planned maintenance. Planned train movements will leave the IMD as soon as possible after passenger services finish at 24:00 and are likely to return to the IMD shortly before passenger services start again at 05:00. It is assumed that the engineering trains will be specified and operated so that any adverse noise effects are no greater than those for the night-time passenger services.
- 8.9.43 Passenger services have been assumed to operate at up to 360kph (225mph) unless constrained by the design of the route as described the relevant Volume 2: CFA report. Where the maximum operational speed of 360kph applies, services will be timetabled based on a speed of 330kph (200mph). It is assumed that around 10% of services will operate at the full speed of 360kph.
- 8.9.44 Trains joining the Proposed Scheme from HS1 via the HS1-HS2 Link are assumed to be compliant with EU noise emission regulations¹⁵⁹, would be up to 400m in length and would operate on the route at speeds up to 330kph where the design permits.
- 8.9.45 In the years before Phase Two services commence, the operating speeds are assumed to be the same as those in Phase Two but there would be fewer trains per day over most of the Phase One route as described in Section 4.3. At the start of Phase One operation the airborne noise and vibration levels at receptors along the route would be around 2dB lower than those predicted with Phase Two services as reported in the Volume 2: CFA reports.

8.10 Traffic and transport

Scope

- 8.10.1 The traffic and transport assessment covers all relevant modes of transport, including cars, goods vehicles, HGV, public transport (road and rail), equestrians, walking and cycling,

¹⁵⁹ Technical Specification for Interoperability - 2008/232/CE: Commission Decision of 21 February 2008 concerning a technical specification for interoperability relating to the 'rolling stock' sub-system of the trans-European high-speed rail system (notified under document C(2008) 648).

waterways and air. The assessment has included consideration of effects resulting from physical changes to transport networks (e.g. road or bus route diversions) and from the additional trips generated by the Proposed Scheme both during construction (e.g. HGV) and after opening (e.g. trips made by new/reassigned passengers and by employees), causing congestion or other effects on existing road users.

- 8.10.2 The spatial scope includes direct changes to the road network, together with the extent of the relevant networks likely to be significantly affected. This extent has varied according to the magnitude and nature of the impacts, and the characteristics of the network, in each case.

Baseline

- 8.10.3 The assessment has taken 2012 baseline conditions and adjusted these for future assessment scenarios in 2021¹⁶⁰ (for construction) and 2026 and 2041 (for operation). This adjustment has taken account of background growth and changes in transport flows from known improvements to networks and planned and committed developments.
- 8.10.4 Current transport conditions have been derived from a combination of surveys, modelling and site visits. Where appropriate, modelling has been used to predict future baseline scenarios and to identify projected passengers using HS2 and their source, i.e. whether the trips are new journeys or reassignment from other rail networks/transport modes. The modelling has allowed the mode of travel of passengers to/from their origin/destination stations on HS2 to be identified and the consequential changes in flows on the transport networks to be calculated.
- 8.10.5 A mix of DfT strategic transport models and 'local' models 'owned' by others (e.g. Transport for London (TfL)) has been used. HS2 station passenger demand forecasts have been developed using the PLANET Framework Model. TfL's Railplan model and West London Highway Assignment Model (WeLHAM) and Central London Highway Assignment Model (CLoHAM) have also been used to assess public transport and highways in London. The West Midlands regional transport model, PRISM (Policy Responsive Integrated Strategy Model) and Birmingham City Council's Birmingham City Centre Highway Assignment Model have also been used as a data source in the West Midlands. The DfT traffic forecasting tool, Trip End Model Presentation Program (TEMPRO) has also been used to inform future traffic forecasts.

Methodology

- 8.10.6 The assessment has taken account of best practice guidance published by DfT and TfL. The effects of traffic congestion and delay, road safety, parking and loading, public transport, cyclists, pedestrians, equestrians, mobility-impaired people and navigable waterways and have been considered against future assessment years. The evaluation of significance has taken account of guidance such as DMRB Volume 11, WebTAG and Institute of Environmental Management and Assessment guidelines. Key assessment criteria have included:
- delays in public transport;

¹⁶⁰ Transport impacts have been assessed against a 2021 forecast year baseline for consistency across the route, although actual construction activities may take place earlier/later than this. This is not expected to affect the conclusions of the assessment.

- congestion at stations/interchanges;
- delays, diversions or volumetric changes in traffic flows;
- changes to parking provision or demand;
- changes in journey time, amenity or ambience for vulnerable road and PRow users (pedestrians, cyclists, equestrians);
- accident and safety risks;
- severance impacts on non-motorised modes; and
- obstruction of navigable waterways.

8.10.7 Cumulative effects are addressed by comparing the future baseline¹⁶¹ with the additional traffic generated by the Proposed Scheme.

Assumptions and limitations

8.10.8 The modelling for the transport assessment and future year assessments has required a number of assumptions to be made, including:

- committed developments and transport schemes;
- socio-economic forecasts (e.g. population, employment, economic conditions);
- demand forecasts; and
- travel characteristics, including:
 - modal share of trips;
 - traffic flows;
 - public transport passenger flows;
 - traffic speeds and congestion; and
 - journey times.

8.10.9 Where existing traffic flow information has not been available, surveys or modelled flows have been used or flows have been estimated on the basis of surrounding flows. Where there are no data for pedestrians and cyclists, flow levels which trigger the most sensitive criteria have been assumed so that a robust assessment has been made.

8.10.10 In general, the assessment of construction traffic has been based on the assumption that there will be one inward and one outward route to and from each worksite (and that these routes are often the same route).

8.10.11 Utilities works (including diversions) are assessed in detail where they involve major works and where there would be potentially significant traffic and transport impacts and effects

¹⁶¹ The future baseline includes the traffic from general baseline growth and from committed and planned developments in the area.

from the works separately, or in combination with other works. In this context 'major works' has been assumed to include;

- large pipes and sewers;
- high pressure gas pipeline diversions;
- extra high voltage underground cable diversions; and
- overhead pylon diversions.

8.10.12 More minor utilities works are expected to result in only localised traffic and pedestrian diversions that will be of short duration.

8.11 Waste and material resources

Scope

- 8.11.1 The assessment establishes the likely significant environmental effects from the off-site disposal to landfill of solid waste that will be generated by the construction and operation of the Proposed Scheme. The quantity of waste requiring off-site disposal to landfill has been calculated and compared to the amount of landfill capacity projected to be available during construction and operation.
- 8.11.2 The scope includes wastes generated during both construction (i.e. from earthworks, construction and demolition activities and from worker accommodation sites) and operation (i.e. wastes from railway stations and passenger trains, rolling stock maintenance facilities, track maintenance and ancillary infrastructure). It does not consider material inputs to construction (e.g. aggregates), or surplus excavated material that will be disposed of via sustainable placement within the Proposed Scheme.
- 8.11.3 Liquid waste is addressed in the water resources and flood risk assessment (Volume 2: CFA reports, Section 13).
- 8.11.4 The direct and indirect effects of waste-related transport have been addressed within Volume 2: CFA Reports, Section 13 (traffic and transport), Section 4 (air quality) and Section 12 (sound, noise and vibration).
- 8.11.5 Issues relating to mineral resources are addressed in the land quality assessment contained within Volume 2: CFA reports, Section 8 (land quality).
- 8.11.6 The scope includes any contaminated material identified within the land quality assessment that cannot be remediated and is suitable only for off-site disposal to landfill.
- 8.11.7 The spatial scope (and study area) for the assessment has been defined as the counties (local area) and former regional planning jurisdictions (regional area) through which the route of the Proposed Scheme will pass. This represents the administrative areas for which waste arisings and waste infrastructure data are available and within which the various waste streams are likely to be managed.

Baseline

- 8.11.8 The baseline describes environmental conditions with respect to the types, quantities and management of waste generated and the availability (types and capacity) of waste infrastructure within the study area.
- 8.11.9 Baseline conditions have been obtained from the latest available published data from the Environment Agency, Defra and waste planning authorities. Future baseline data is based on the extrapolation of this data for the construction and operation phase and other published forecasts.

Methodology

- 8.11.10 The types of waste that will generated during construction and operation of the Proposed Scheme have been forecast according to the methodology set out in the waste forecast and assessment methodology technical note, which can be found in the SMR Addendum.
- 8.11.11 Forecasts of the quantities of waste that will require off-site disposal to landfill have been based on the integrated earthworks design approach for the Proposed Scheme (for surplus excavated material) and evidence-based landfill diversion rates (i.e. for reuse, recycling and recovery) applicable to waste from construction, demolition, worker accommodation sites and operational activities.
- 8.11.12 The quantities of surplus excavated material and other wastes requiring off-site disposal to landfill have been compared to the projected landfill capacity that will be available during construction and operation.
- 8.11.13 Assessment and mitigation have been considered with respect to relevant legislation, policy and guidance applicable to the generation and management of waste in England.

Assumptions and limitations

- 8.11.14 Consideration of material resources in the assessment is limited to the beneficial reuse of excavated material arising from construction of the Proposed Scheme. Only if excavated material is not required or is unsuitable for construction of the Proposed Scheme will it be considered waste.

8.12 Water resources and flood risk

Scope

- 8.12.1 The assessment considers surface water features (both natural and artificial), groundwater resources, flood risk and drainage networks (storm water and combined sewers). The spatial scope of the assessment was based upon the identification of surface water and groundwater features within 1km of the centre line of the route, except where there is clearly no hydraulic connectivity. For surface water features in urban areas, the extent was reduced to 500m. Outside of these distances it is unlikely that direct impacts upon the water environment will be attributable to the Proposed Scheme. Where works extend more than 200m from the centre line, for example at stations and depots, professional judgement has been used in selecting the appropriate limit to the extension in spatial scope required. For the purposes of this assessment this spatial scope is defined as the study area.

- 8.12.2 In addition to surface water, the assessment addresses potential hydrological and qualitative effects on groundwater within Source Protection Zones, due to, for example, dewatering for tunnelling and major sub-surface construction works. Groundwater within 1km (0.6 miles) of the centre line of the Proposed Scheme is considered where it falls within 10m of the lowest possible depth of construction or dewatering.
- 8.12.3 Impacts to groundwater quality from existing land contamination are presented in Section 8.6 and Volume 2: CFA reports, Section 8.

Baseline

- 8.12.4 Baseline information has included the following:
- surface and groundwater hydrology, quality, designations and licensed abstractions;
 - floodplain extent and characteristics for the following annual probability events: 1 in 20 (5%), 1 in 100 (1%), 1 in 100 including an allowance for climate change (1% CC) and 1 in 1,000 (0.1%) where available; and
 - drainage network extent and capacity.
- 8.12.5 Current projections to the 2080s indicate that climate change may affect the future baseline against which the impacts of the Proposed Scheme on surface water and groundwater resources have been assessed. There may be changes in the flow and water quality characteristics of surface water and groundwater bodies as a result of changes in climate. However, except for flood flows described below, these changes are not considered to result in significant changes to the reported effects from the Proposed Scheme.
- 8.12.6 Current projections indicate that there will be more frequent, higher intensity rainfall events in the future. The probability and severity of surface water flooding could therefore increase as surface water drainage systems fail to cope with more frequent, higher intensity storms. Peak river flows during flood events are expected to increase, potentially causing greater depths and extents of flooding.
- 8.12.7 When considering the influence that climate change may have on the future baseline, against which the impacts from the Proposed Scheme on flood risk during have been evaluated, the assessment has used the recommended precautionary sensitivity ranges of key parameters, as given in Table 5 in the technical guidance to the NPPF. The sensitivity testing undertaken allows for variations in climate change factors included in other national guidance.
- 8.12.8 Further information on the potential additional impacts of climate change for water resources and flood risk is provided in Sections 7 and Table 13 of Volume 5: Appendix CT-009-000.
- 8.12.9 Information has been obtained primarily from secondary/published sources such as the Environment Agency, Lead Local Flood Authorities, British Geological Survey, Internal Drainage Boards and water companies, supplemented where necessary by targeted hydraulic modelling and sampling of surface waters. Hydrogeological information was obtained from geological maps and borehole logs where available. Information on

baseline groundwater levels, flows or quality has been obtained from the reporting of groundwater strikes or rest water levels associated with geotechnical drilling. In some areas springs and spring fed streams also give an indication of groundwater levels. Consultation has taken place with relevant organisations, both to obtain information and to identify potential concerns (e.g. the Canal and River Trust in relation to water supply for navigation).

- 8.12.10 Water Framework Directive (WFD) classification data in Volume 2 and Volume 5: Appendix WR-002 is taken from the Environment Agency River Basin Management Plan annexes. These classifications are the formal baseline against which the Environment Agency will assess compliance with the no deterioration objective in 2015. The WFD assessment in Volume 5: Appendix WR-001-000 and data shown on the WR-03 series drawings in Volume 5: Map Book use the Environment Agency status reported in February 2013 and therefore provided the current best estimate of status in 2015.
- 8.12.11 Flood flows could be altered through higher intensity rainfall events in the future. The probability and severity of surface water flooding could therefore increase, as surface water drainage systems fail to cope with more frequent, higher intensity storms. Peak river flows during flood events are expected to increase, potentially causing greater depths and extents of flooding.
- 8.12.12 When considering the influence that climate change may have on the future baseline, against which flood risk impacts have been evaluated, the assessment has used the recommended precautionary sensitivity ranges of key parameters, as given in Table 5 in the Technical Guidance to the NPPF. The sensitivity testing allows for variations in climate change factors included in other national guidance. Further information on the potential additional impacts of climate change for water resources and flood risk is provided in Volume 2: CFA reports and Volume 5: CT-000-009.

Methodology

- 8.12.13 The assessment has taken account of relevant policy and guidance as set out in the SMR. Effects have been derived from the interaction between the magnitude of impact and the value of the receiving water body, flood zone or aquifer. Impact magnitude has been based on quantitative criteria wherever possible, e.g. area of land required for construction and/or operation within a floodplain or percentage of an aquifer potentially affected by dewatering. Receptor value reflects its degree of vulnerability or importance, e.g. level of flood risk, water quality or functions such as water supply, biodiversity or recreation.

Assumptions and limitations

- 8.12.14 The assessment assumes that railway track drainage will wherever possible be kept separate from existing land drainage that crosses the route.
- 8.12.15 A worst- case assessment has been undertaken assuming that existing ground or groundwater contamination is present where desk study research suggests that there is a potential source of contamination in the area.
- 8.12.16 There are limited borehole records available from which to understand the local geological and hydrogeological conditions likely to be encountered for areas of below ground

construction. It is assumed that topography has some control over groundwater flow directions with groundwater level contours roughly parallel to topographic contours.

- 8.12.17 The estimated zone of influence, and therefore the assessment of the potential impact of dewatering on receptors, is therefore based on a worst-case assessment using available literature, values of hydraulic parameters and geological cross sections. Hydraulic conductivity values, obtained from available literature values, were used in conjunction with professional judgment to estimate the maximum extent of the zone of influence that is likely to be produced when dewatering of a cutting occurs. The hydraulic conductivity values used are generally in the high range of literature values to provide a realistic factor of safety to the estimated zone of influence.
- 8.12.18 For watercourses without existing hydraulic models, the channel and floodplain geometry was extracted from the LiDAR data in some cases. The limitation of this method is that the channel geometry is not well defined, resulting in a probable overestimation of the floodplain inundation.

9 Approach to mitigation

9.1 Overview

9.1.1 The EIA regulations require an ES to include “a description of the measures envisaged in order to avoid, reduce and, if possible, remedy significant adverse effects”. Such measures are described generically in this ES as mitigation measures. The approach to mitigation adopted for the Proposed Scheme has a hierarchy, whereby priority has been given to avoiding or preventing effects; and then (if this was not possible), to reducing or abating them; and then, if necessary, to offsetting them through repair (restoration or reinstatement) or compensation. The hierarchy is illustrated in Figure 43.

Figure 43: Mitigation hierarchy

Avoid	Designing the Proposed Scheme so that a feature causing effects is avoided (e.g. through changes in alignment)
Reduce	Designing the Proposed Scheme so that a feature causing effects is reduced (e.g. design changes to reduce visual effects)
Abate	Abating, either at the railway (e.g. noise barrier) or at receptor (e.g. screening at property)
Repair	Restoring or reinstating a feature after effects have occurred (e.g. to address temporary construction effects)
Compensate	Compensation for loss or damage (e.g. planting new woodland elsewhere, or compensation for loss of amenity)

9.1.2 This approach is driven by the HS2 Sustainability Policy (see Section 1.5) which states that “We will strive to limit the negative impacts through design, mitigation and by challenging industry standards and we will look for environmental enhancements and benefits”. Furthermore, the Environmental Minimum Requirements (EMR) (see Section 1.4) will impose a general requirement on the nominated undertake to use reasonable endeavours to adopt measures to reduce the adverse environmental effects reported in the ES, provided that this does not add unreasonable cost or delay to the construction and operation of the Proposed Scheme. The draft CoCP has been produced in conjunction with the ES so that the ES can take account of the measures that will be imposed during construction to avoid or limit the occurrence of environmental impacts and effects.

9.1.3 Mitigation opportunities have been identified throughout the development of the Proposed Scheme and the assessment of its environmental effects. Potentially significant adverse effects have been fed back into the design process to verify whether they can be avoided at source, reduced or otherwise mitigated in accordance with the hierarchy above. This process has been driven by collaborative working between the engineering, design and environmental teams and has been informed by the consultation and engagement process.

9.1.4 The ES describes the adopted mitigation and identifies the significant residual effects (i.e. those remaining after mitigation). Not all such effects will be adverse, and beneficial effects are reported where it is reasonable to do so.

9.1.5 The mitigation measures and policies considered in the assessment can be divided into three types:

- mitigation that is provided through the planning and design of the Proposed Scheme. This is not shown explicitly as such on the scheme drawings;
- mitigation that requires additional physical features, which are shown on the drawings; and
- mitigation to be delivered through further measures in accordance with HS2 Ltd policies. These may include:
 - committed mitigation – measures for which agreement(s) are in place with the affected party and/or local authority; or
 - other mitigation – measures for which there is a commitment to reach an agreement with the affected parties and/or local authority.

9.1.6 Examples of the first two measures are described in Section 9.2. The approach to mitigation including the "further measures and policies" for each topic is described in Sections 9.3 onwards.

9.1.7 In addition to mitigation through design and policy, construction impacts will be mitigated through the application of the CoCP.

9.1.8 Opportunities for mitigation beyond that described in the ES will be considered as part of the detailed design process in accordance with the EMR.

9.2 Incorporated mitigation

9.2.1 Mitigation that has been incorporated into the route alignment and design of the Proposed Scheme has included:

- selection of the Proposed Scheme from a range of alternatives taking account of environmental issues;
- alignment of the Proposed Scheme where reasonably practicable to avoid impacts at source, especially on residential properties, community facilities, public open space, business premises, farm buildings, sites of ecological importance and important heritage features;
- design of the vertical alignment of the Proposed Scheme (i.e. height below/above existing ground level) to achieve, where reasonably practicable:
 - an excavated material management strategy based on detailed consideration of materials arising from excavations and material required to build embankments or for land profiling in order to reduce the need to import material or to dispose of surplus excavated material;
 - noise mitigation at sensitive locations by placing the route within cutting; and
 - visual screening using natural landforms.
- provision of bridges or underpasses to avoid the severance of PRow and private accesses;
- provision of green tunnels;

- creation of new habitats and other features of ecological value to compensate for losses;
- avoidance or reduction of impacts on floodplains and flood storage areas;
- provision of retained cuttings (i.e. with vertical or near-vertical retaining walls), in order to reduce the amount of land required;
- provision of noise fence barriers and earth bunds close to sensitive properties;
- provision of planting to screen views to assimilate the Proposed Scheme into the local landscape. There is a commitment to plant two million trees as part of Phase One; and
- provision of balancing ponds, in order to control the volume of surface water run-off from the Proposed Scheme in rural areas.

9.3 Restitution of open space and community facilities

9.3.1 Where there will be a temporary but significant effect on a community resulting from the temporary loss of public open space or a community facility, mitigation is likely to take one of the following forms:

- improvements or alterations to the remaining portion of the public open space (in instances where the public open space is partially occupied) or community facilities, e.g. reconfiguring pitch layouts or relocating play areas;
- improvements to other public open spaces or community facilities in the area;
- improving accessibility to other existing public open space or community facilities;
- identifying land owned by the relevant local authority that could be brought into use as public open space or used to accommodate community facilities with its agreement; and/or
- where land used as open space or as a community facility is temporarily occupied by the Proposed Scheme, there will be a statutory requirement for the land to be restored in agreement with the relevant local authority.

9.3.2 Where there is a permanent and significant community effect resulting from the permanent loss of public open space or a community facility, mitigation is likely to take one of the following forms:

- improvements or alterations to the remaining portion of the public open space (in instances where the public open space is partially occupied) or community facility, e.g. reconfiguring pitch layouts or relocating play areas;
- provision of compensatory open space or community facilities as part of the design of the permanent works within the hybrid Bill limits;
- improvements to other public open spaces or community facilities in the area; and
- improving accessibility to other existing public open space or community facilities;
- identifying land owned by the relevant local authority that could be brought into use as public open space or used to accommodate community facilities with its

agreement.

9.3.3 The CoCP includes provisions to mitigate community effects during construction, including:

- appointment of community relations personnel;
- a community helpline to handle enquiries from the public;
- sensitive layout of construction sites to reduce nuisance; and
- maintenance of public roads, cycleways and PRow around construction sites, where reasonably practicable, to avoid their deterioration due to construction traffic.

9.3.4 The specific measures within the CoCP for the mitigation of individual noise, air quality, visual and construction traffic effects will also serve to reduce amenity impacts¹⁶² on nearby open spaces and community facilities.

9.4 Agriculture, forestry and soils

9.4.1 Impacts on agricultural holdings will vary according to the size of the holding and the nature of its use and business. Work with farmers and landowners will be undertaken to assist in mitigating the effects of the Proposed Scheme on their businesses where reasonably practicable.

9.4.2 To enable agricultural land to be restored and reused after the completion of construction, topsoil (and subsoil where appropriate) will be stripped prior to construction and stored appropriately.

9.4.3 Land restoration will be followed by an aftercare period during which the land will be managed to achieve the appropriate level of agricultural productivity.

9.4.4 Where land drainage schemes and water supplies used for livestock and irrigation will be severed or otherwise affected by the Proposed Scheme, these will be re-instated or made good as early as reasonably practicable to enable their continued functioning during the construction period.

9.4.5 The Proposed Scheme will inevitably sever some accesses within agricultural holdings and create new field layouts that will require new accesses. The scheme drawings included in the ES show the new accesses under or over the railway that are proposed to mitigate this impact. Where necessary, these accesses will be built as early as reasonably practicable, so that they can be used during construction. In addition, the contractor will be required to consult with the affected farmers to agree the phasing of the works so as to reduce severance. Where appropriate access arrangements cannot be provided during construction, the severed land will be acquired, subject to agreement between the appropriate parties.

¹⁶² Significant amenity effects are the result of cumulative residual effects associated with noise and vibration, air quality, landscape and visual and HGV construction traffic impacts on residential and community resources. The in-combination effect of two or more residual significant effects arising from these other topic assessments results in a significant amenity effect.

9.4.6 Further details of the approach to compensation for land compulsorily acquired is discussed within Section 1.6.

9.5 Air quality

9.5.1 There are no proposed air quality mitigation measures beyond those contained in the draft CoCP (e.g. in relation to dust emission) or described in the transport assessment in relation to road traffic.

9.6 Climate

9.6.1 The HS2 Sustainability Policy describes the Proposed Scheme's approach to climate as being to "minimise the carbon footprint [of the Proposed Scheme] as far as practicable and deliver low carbon long distance journeys that are supported by low carbon energy". The approach to carbon minimisation is further described in Section 2.5.

Climate change adaptation and resilience

9.6.2 The HS2 Sustainability Policy defines that the approach is to "build a network which is resilient for the long-term and seek to minimise the combined effect of the project and climate change on the environment".

9.6.3 To address this objective, the EIA has considered how climate change, in combination with the impacts of the Proposed Scheme, may affect communities, business and the natural, historic and built environment.

9.6.4 Where possible, each topic area has identified appropriate mitigation based on the potential impacts of the Proposed Scheme in combination with a changing climate. This includes:

- a green infrastructure approach to address the landscape and visual assessment effects associated with the Proposed Scheme. This approach will result in a multi-functional landscape that will contribute to reduced vulnerability and increased resilience to climate change;
- the creation of 'stepping stones', buffer areas and transitional habitats around existing habitat to increase landscape connectivity and to provide wildlife with the opportunity for autonomous adaptation (e.g. allowing for changes in species distribution as average temperatures increase); and
- measures to ensure that there will be no increased risk of flooding and embankment/cutting erosion by creating suitable landforms/gradients, designing drainage and creating replacement storage areas for the one in 100 year annual rainfall probability event, with an allowance for climate change.

9.7 Cultural heritage

9.7.1 The design of the Proposed Scheme has sought to avoid direct impacts on all heritage assets. Where this has not been possible, a range of measures will be implemented to mitigate the impact on such assets.

9.7.2 A Heritage Memorandum will be prepared to explain the nominated undertaker's management regime for designated and non-designated heritage assets. The memorandum will form part of the EMR (as described in Section 1.4) that represent the

overarching commitment by the Secretary of State to afford appropriate management and protection of people, the natural, cultural and built environment.

- 9.7.3 The nominated undertaker will prepare a route-wide generic Written Scheme of Investigation to set route-wide standards of recording for designated and non-designated archaeology and built heritage, before works commence and during construction. Such measures will reflect national planning policy and industry standards and practice, and will be set out as requirements in construction procurement documentation. The process will be carried out and overseen by suitably qualified archaeological and heritage specialists.
- 9.7.4 The nominated undertaker will record, analyse, report and publish the results of all archaeological and built heritage investigations, and will archive the resulting records, artefacts and materials in suitable repositories.
- 9.7.5 The hybrid Bill will dis-apply the various legislative provisions currently in place for affected nationally designated heritage assets: scheduled monuments, listed buildings and buildings within conservation areas. The hybrid Bill will identify the affected assets and will provide a new mechanism for the delivery of mitigation, including Heritage Agreements.
- 9.7.6 The nominated undertaker will enter into heritage agreements with local authorities for listed buildings and with English Heritage for scheduled monuments. As part of each agreement, a method statement for specified works in relation to these named heritage assets will be submitted to them for agreement within specified timescales.
- 9.7.7 Where construction of the Proposed Scheme will directly affect human remains and monuments, notably burial grounds, the hybrid Bill will dis-apply the various legislative provisions, and a project-specific regime will be put in place to ensure that all human remains and burial grounds are afforded all due dignity, care and respect. A Human Remains and Monuments Procedure will be implemented to implement these requirements. Where burial has occurred over 100 years ago, consideration will be given to the need for and extent of archaeological investigation works.
- 9.7.8 Mitigation measures have been developed in consultation with other disciplines, notably landscape, to ensure that heritage assets have been incorporated into mitigation works such as sympathetic design to the local landscape or townscape. Further discussion with other disciplines will be undertaken during detailed design to identify any further measures that can be incorporated to avoid or reduce impacts on cultural heritage assets.
- 9.7.9 Where there may be an effect on the viability of an asset, potentially leading to dereliction or changes in managements affecting heritage assets, mitigation will be addressed on a case by case basis with the community and any other relevant stakeholders. Mitigation measures will take account of the range of effects that have been identified in the ES.

9.8 Ecology

- 9.8.1 The design of the Proposed Scheme has sought to avoid or reduce impacts on habitats, species and other features of ecological value where reasonably practicable.
- 9.8.2 Where avoidance has not been possible or practicable, then efforts have been made to reduce the duration, scale and extent of the anticipated effects. Where effects are still

anticipated following mitigation, appropriate compensation or enhancements have been incorporated to offset these effects.

- 9.8.3 Where mitigation and/or compensation is required, then these areas are included within the identified extent of the Proposed Scheme. This includes provision of areas to act as receptor sites for habitats and species which will be translocated prior to construction and thus require land that will not be subject to any construction works, and of areas where habitats of ecological value will be created following the completion of construction.
- 9.8.4 Where SSSI will be affected mitigation and compensation provision for these sites is provided following discussion with Natural England. Prior to second reading HS2 Ltd will seek to obtain confirmation from Natural England that all effects on SSSIs have been adequately mitigated or compensated.
- 9.8.5 Mitigation and/or compensation requirements for non-statutory sites and other notable habitats have been developed and are described within the ES.
- 9.8.6 The Proposed Scheme will seek to achieve a no net loss in biodiversity at a route-wide level as far as reasonably practicable. Habitat losses and gains will be measured using a modified version of the Defra biodiversity offsetting metric, which has been developed in consultation with Defra and Natural England.
- 9.8.7 The proposed methodology to be used for the offsetting calculation is included as part of the SMR Addendum. Relevant parties will be provided with additional documentation to show the conclusions of the calculation. The calculation offers a framework to ensure that compensatory provision is suitably adjusted if any changes to design occur. The methodology considers changes in the type, extent and condition of habitats. In addition it considers the value of both existing and created habitats in relation to ecological networks. In doing so it has sought to promote mitigation provision that adheres to the Lawton report¹⁶³ principles of 'bigger, better, more joined up' and that will increase robustness to the effects of climate change through promoting movement of species through the landscape.
- 9.8.8 The Environmental Memorandum includes a commitment to provide long-term management of habitat creation to ensure that the target value of these habitats is achieved. This may be achieved through a variety of potential mechanisms, including the following:
- retention and management of the land by the nominated undertaker;
 - returning the land to the original landowner, with an agreement to manage it within the required parameters;
 - transferring the land for management by a third party such as a Wildlife Trust; or
 - developing a bespoke management arrangement on a case-by-case basis.
- 9.8.9 Mitigation and compensation to address effects on legally protected species will, where appropriate, include translocation or relocation of species, the provision of replacement

¹⁶³ Lawton (2010), *Making space for nature: A review of England's wildlife sites and ecological network*, Defra, London.

habitat and provision of special measures such as underpasses, green tunnels and green bridges to facilitate the movement of species across the route.

- 9.8.10 Mitigation and/or compensation may be required as a result of impacts on protected species that may occur within areas where there has been no or limited access available for field surveys. Since a reasonable worst-case approach has been adopted in the assessment it is considered that any necessary mitigation and/or compensation can be provided within the ecological compensation areas that are shown in the Volume 2: Map Books CT-06. Mitigation provision within these areas would be undertaken in accordance with the principles of ecological mitigation set out in the SMR Addendum.
- 9.8.11 As the scheme is yet to undergo detailed design, and there remains uncertainty over some elements of the baseline, mitigation and compensation provision for protected species within the ecological compensation areas will be secured through commitment to providing mitigation and compensation in accordance with the principles of ecological mitigation included as part of the SMR Addendum. This document describes the generalised approach to mitigation and compensation that will be implemented
- 9.8.12 Formal applications for derogation licences for protected species will be made after Royal Assent and are likely to be accompanied by updated baseline surveys to be conducted when powers of access become available under the hybrid Bill.

9.9 Land quality

- 9.9.1 Mitigation of the effects of pre-existing contaminated soils or groundwater will mainly take the form of various established methodologies for soil and groundwater remediation, such as:
- soil washing;
 - soil stabilisation;
 - bio-engineering; and
 - in-situ or ex-situ groundwater treatment.
- 9.9.2 In the small number of cases where soils are not responsive to treatment, they will be excavated and removed off-site and deposited within a suitably licensed landfill.
- 9.9.3 Appropriate construction methods will be used to prevent contamination migration, such as vertical and horizontal barriers (for ground gases and leachates within old landfills), and soil cover systems. Where piling through contaminated materials needs to take place, preventative measures will be adopted to reduce groundwater migration down pile bores.
- 9.9.4 Methods to mitigate effects during the actual process of remediation, within the construction period, are described in the draft CoCP.
- 9.9.5 Mitigation measures for mining/mineral resources may include prior extraction of the resources for use within the Proposed Scheme. Where this is reasonably practicable, a plan will be discussed and agreed in advance with relevant landowners, mineral planning authorities and other stakeholders to assist in achieving an effective management of affected minerals.

- 9.9.6 There are few instances along the Proposed Scheme where geo-conservation resources are affected. In one location, where a local geological site is located just outside the construction area, provision will be made to ensure its protection during the construction period.

9.10 Landscape and visual

- 9.10.1 The landscape objective for mitigating impacts forms part of an integrated design approach that considers both engineering requirements and environmental considerations alongside best practice design. The landscape proposals will integrate mitigation measures for landscape, noise, ecology, agriculture, cultural heritage and open space.
- 9.10.2 Mitigation measures have been developed to:
- avoid or reduce effects on the character and setting of the landscape, including valued, designated and historic landscape features ;
 - seek to enhance such resources where appropriate; and
 - avoid or reduce effects on the visual amenity of residential communities, receptors and users of the landscape due to potential intrusion into, obstruction of, or loss of existing views.
- 9.10.3 Landscape mitigation measures have also been designed to provide visual screening for built heritage, whilst landscape earthworks can help to attenuate noise, and woodland and grassland habitats can create areas of ecological benefit.
- 9.10.4 The mitigation has been considered firstly at a strategic scale with consideration given to the route alignment and the horizontal and vertical levels required to reduce landscape and visual effects. In addition, careful consideration has been given to the design (and/or to the design approach) of the many individual elements of the Proposed Scheme, to ensure that they are sympathetic to the local landscape or townscape. Specific measures include one or more of the following:
- design of earthworks to achieve visual screening and integration of the route into the local landscape, and to facilitate the restoration of agricultural land;
 - provision of new planting and protection of important areas of existing vegetation;
 - design and setting of new structures such as bridges, viaducts and buildings. The design or external appearance of these structures will be subject to the approval of the relevant local authority;
 - design of areas of public realm associated with new stations and associated infrastructure;
 - design and setting of new operational infrastructure;
 - landscape design associated with new, diverted or realigned roads and PRoW; design of noise mitigation, including earthworks and noise fence barriers (in association with the noise consultants) to ensure good fit with the local landscape and townscape;
 - design and appearance of fencing, including boundary and security fencing; and
 - design of diverted watercourses and balancing ponds to ensure integration with

the local landscape.

- 9.10.5 Mitigation will also seek to reduce the effects of construction; for example, through advance planting, temporary screening or earthworks. Where appropriate, temporary or permanent mitigation will be installed at the earliest opportunity. Planting away from the route will also be established to reduce adverse landscape and visual effects.
- 9.10.6 The nominated undertaker will maintain landscaped areas within the rail corridor to an appropriate horticultural standard, and will ensure that the maintenance of other landscaped areas is secured through agreement. The aim is to ensure that the planting scheme successfully establishes and develops, so that it achieves its mitigation objective and remains effective thereafter in perpetuity.
- 9.10.7 Areas of mitigation provided outside the rail corridor will, where reasonably practicable, be transferred to third parties, subject to agreements to ensure that the necessary management objectives are met.
- 9.10.8 Landscape maintenance will incorporate a risk assessment for vegetation in landscape areas. Visual inspections of mitigation planting (and/or existing planting in the vicinity of the Proposed Scheme) will be carried out on a regular basis to determine whether it poses a risk to the safe operation of the railway. Maintenance operations will ensure that trees within all operational land (and adjoining land if applicable) cannot fall onto the track, overhead lines or other line-side equipment.

9.11 Socio-economics

- 9.11.1 Businesses displaced by the Proposed Scheme will be compensated within the provisions of the National Compensation Code. This recognises that businesses displaced from their existing premises by compulsory purchase will usually seek to relocate to another site. The code normally provides for the cost of such relocation to be taken into account under the heading of disturbance compensation.
- 9.11.2 The National Compensation Code is considered a fair basis for compensation in respect of such costs. HS2 Ltd recognises the importance of displaced businesses being able to relocate to new premises and will therefore provide additional support over and above statutory requirements to facilitate this process.
- 9.11.3 All reasonably practicable steps will be undertaken to limit the impact of the Proposed Scheme on existing businesses, thereby keeping to a minimum the need to incur liability for disturbance compensation to such businesses.
- 9.11.4 The construction of the Proposed Scheme offers considerable opportunities to businesses and residents along the line of the route in terms of supplying goods and services and obtaining employment. There is a commitment to work with suppliers to build a skilled workforce that fuels further economic growth across the UK.
- 9.11.5 No further mitigation of significant temporary amenity effects is proposed at this stage. However, the measures set out in the CoCP will, where reasonably practicable, provide further mitigation for individual significant effects (noise, air quality, visual, construction traffic) on a case-by-case basis.

9.12 Sound, noise and vibration

- 9.12.1 The development of a new high speed railway requires that provision be made for mitigation measures to protect the environment from intrusive noise and vibration. By avoiding many noise-sensitive locations and by keeping the proposed alignment as low in the ground as possible, the Proposed Scheme has been able to reduce its overall noise impact.
- 9.12.2 The Proposed Scheme seeks to manage and control the impact of railway noise and vibration, in so far as is reasonably practicable:
- by avoiding or reducing significant noise effects; and
 - where there are opportunities to do so, by reducing existing exposure to noise or vibration through the provision of mitigation.
- 9.12.3 Mitigation of likely significant adverse noise or vibration effects has, where practicable, been incorporated into the Proposed Scheme in the following order:
- at source: the project has the opportunity to design and specify a complete railway system including quieter trains, track and their maintenance to reduce noise emission;
 - by noise barriers: delivered, for example, as fence barriers or constructed cuttings using landscape earthworks or as a combination of both, and lastly; and
 - by reducing noise entering property.
- 9.12.4 Mitigation has been prioritised at source and by noise barriers wherever practicable as this will minimise the effects on the overall environment and amenity as well as inside property.
- 9.12.5 Preference has been given to the most sustainable means of providing the necessary noise mitigation. For example providing mitigation on the train is, where practicable, preferred to providing mitigation by way of noise barriers or noise insulation. As a second example, providing a noise barrier in a rural location by a landscape earthwork is, where practicable, preferred to a fence noise barrier. This is because the landscape earthwork can be shaped to follow the grain of the landscape, it can be used to return as much land as possible to agricultural or community use, and it reduces the need to move surplus excavated material from the project off-site and along local roads.

Construction

- 9.12.6 Construction noise and vibration will be controlled and managed in accordance with the draft CoCP as described in Section 6.3.

Operation

- 9.12.7 The development of the Proposed Scheme has, as far as reasonably practicable, kept the alignment away from main communities and low in the ground. These avoidance measures have protected many communities from likely significant noise or vibration effects.

Airborne noise

- 9.12.8 HS2 trains will be quieter than the relevant current European Union specifications. This will include reduction of aerodynamic noise from the pantograph that otherwise would occur above 300kph (186mph) with current pantograph designs, drawing on proven technology in use in East Asia. The track will be specified to reduce noise, as will the maintenance regime. Overall these measures would reduce noise emissions by approximately 3dB at 360kph compared to a current European high speed train operating on the new track. Further information is provided in Volume 5: Appendix SV-001-000.
- 9.12.9 To avoid or reduce significant airborne noise effects, the Proposed Scheme incorporates noise barriers in the form of landscape earthworks, noise fence barriers and/or 'low-level' barriers on viaducts. Noise barrier locations are shown on Volume 2: Map Book - Sound, noise and vibration map series SV-05.
- 9.12.10 Generally, the assessment has been based on noise barriers having a noise reduction performance equivalent to a noise fence barrier with a top level 3m above the top of the rail, which is acoustically absorbent on the railway side, and which is located 5m to the side of the outer rail. In practice, barriers may differ from this description, but will provide the same acoustic performance. For example, where noise barriers are in the form of landscape earthworks they will need to be higher above rail level to achieve similar noise attenuation to a 3m barrier because the crest of the earthwork will be further than 5m from the outer rail.
- 9.12.11 The Proposed Scheme incorporates low-level noise barriers into the design of viaducts. Where needed to avoid or reduce significant airborne noise effects, these barriers are designed to provide noise reduction that is equivalent to a 2m high absorptive noise barrier located on the parapet of the viaduct. Locating these low-level barriers close to the rail also reduces visual impact and limits the mass of the viaduct itself.
- 9.12.12 Noise effects are reduced in other locations along the line by landscape earthworks provided to avoid or reduce significant visual effects and engineering structures such as cuttings and safety fences on viaducts (where noise barriers are not required). The location of these barriers is shown on Volume 5: Map Book - Sound, noise and vibration, map series SV-05.
- 9.12.13 The Proposed Scheme includes taller barriers in some locations to avoid or further reduce significant adverse noise effects. Such mitigation was determined taking account of:
- its benefit compared to cost;
 - engineering practicability;
 - other environmental effects caused by the further noise mitigation; and
 - response from consultation and stakeholder engagement.
- 9.12.14 Tunnel portals will be designed to avoid any significant airborne noise effects caused by the trains entering the tunnel.
- 9.12.15 Significant noise effects from the operational static sources such as line-side equipment will be avoided through their design and the specification of noise emission requirements. Further information is provided in Volume 5: Appendix SV-001-000).

- 9.12.16 Noise insulation measures will be offered for qualifying buildings as defined in the Noise Insulation (Railways and Other Guided Transport Systems) Regulations 1996¹⁶⁴ (the Regulations). The assessment reported in this section provides an estimate of the buildings that are likely to qualify under the Regulations. Qualification for noise insulation under the Regulations will be identified and noise insulation offered at the time that the Proposed Scheme becomes operational.
- 9.12.17 Where required, as well as improvements to the noise insulation of windows facing the railway, ventilation will be provided so that windows can be kept closed to protect internal sound levels.
- 9.12.18 Following Government's emerging National Planning Practice guidance, where the noise from the use of new or additional railways authorised by the Bill measured outside a dwelling exceeds the Interim Target defined by the WHO Night Noise Guidelines for Europe¹⁶⁵, residents are considered to be significantly affected by the resulting noise inside their dwelling. The effect on people at night due to the maximum sound level as each train passes has also been assessed¹⁶⁶. The Interim Target is a lower level of noise exposure than the Regulations trigger threshold for night noise. In these particular circumstances, following the methodology set out in the Regulations (i.e. pertaining to new or additional railways) where night-time noise levels are predicted to exceed 55dB¹⁶⁷, or the maximum noise level (dependent on the number of train passes) as a train passes exceeds the criterion, noise insulation will be offered for these additional buildings.

Ground-borne noise and vibration

- 9.12.19 Significant ground-borne noise or vibration effects will be avoided or reduced through the design and maintenance of the track and track-bed.

9.13 Traffic and transport

Construction

- 9.13.1 The CoCP sets out various mitigation measures to reduce the impact of construction traffic. These include:
- traffic management measures and plans, which will be prepared in consultation with the highway and traffic authorities and emergency services;
 - an approach to reduce the impacts of temporary road closures or disruption to railways or navigable waterways;
 - use of internal haul routes for construction vehicles within the construction sites to reduce the need to use public roads;
 - workplace travel plans to reduce employee movements to/from construction sites and compounds; and
 - various management procedures intended to reduce the impact of construction

¹⁶⁴ Her Majesty's Stationery Office (1996), *The Noise Insulation (Railways and Other Guided Transport Systems) Regulations*, London.

¹⁶⁵ World Health Organization (2010), *Night Noise Guidelines for Europe*.

¹⁶⁶ During the night (2300-0700) a significant effect is also identified where the Proposed Scheme results in a maximum sound level at the façade of a building at or above: 85 dB L_{pAFmax} (where the number of train pass-bys exceeding this value is less than or equal to 20); or 80 dB L_{pAFmax} (where the number of train pass-bys exceeding this value is greater than 20).

¹⁶⁷ Equivalent continuous level, $L_{pAeq,23:00-07:00}$ measured without reflection from the front of buildings.

traffic; agreed routes for construction (HGV) vehicles, keeping to the main road network (e.g. motorways and all-purpose trunk roads and other 'A' roads).

- 9.13.2 Traffic management mitigation to be used during construction and utility works may include temporary lane closures, junction signal retiming, temporary traffic signals, tidal flow workings, reduced lane widths and overnight/weekend (instead of daytime/weekday) road closures. Where temporary road closures are required, traffic diversions will be provided.
- 9.13.3 Where new highway crossings of the Proposed Scheme are required, these will generally be built offline so that they can be completed prior to closure of the existing road, thereby avoiding or substantially reducing the degree of disruption to road users. Where a bus route is affected by temporary road closures, a diversionary route and temporary bus stops (where necessary) will be identified.
- 9.13.4 Where PRow may be temporarily closed, they will usually be substituted or diverted/realigned (with appropriate signing) to the nearest available PRow (or road, if suitable for non-motorised users) prior to closure, until either the original route is re-established (usually via an underpass or overbridge) or a permanent diversion/realignment is available. Where several PRow are affected along the same part of the railway, a phased closure programme will be implemented, where reasonably practicable, so as to maintain access.
- 9.13.5 Some construction workers are likely to live on-site during the week, arriving on Sunday evening/Monday morning and departing on Friday evening/Saturday morning. This will reduce the level of construction employee traffic travelling to and from compounds during the week and will encourage off-peak travel.

Framework travel plan

- 9.13.6 An over-arching framework travel plan will be produced that will require travel plans to be used along with a range of potential measures to mitigate the impact of transport and movement associated with construction, maintenance and operation of the Proposed Scheme. The scope of this will include:
- a construction workforce travel plan – the framework aim will be to inform site specific plans which the lead contractors will be required to produce and in particular to reduce workforce commuting by private car, especially sole occupancy car travel. Where practical, this will encourage the use of sustainable modes of transport;
 - consideration of the travel movements arising from operation of the new depots and stations (Euston, Old Oak Common, Calvert, Birmingham Interchange, Washwood Heath, Curzon Street). The framework will provide guidance on the expected contents of a station or depot specific travel plan which will be the responsibility of the station or depot operators;
 - details of the approach to promoting the use of sustainable travel for Euston; and
 - consideration of how operational, delivery and servicing and car parking management plans will be included in travel plans.

9.13.7 Where adverse impacts are predicted to occur at some distance from the Proposed Scheme, the need for off-site mitigation has been considered.

9.14 Waste and material resources

9.14.1 Construction of the Proposed Scheme will source and make efficient use of sustainable materials, and will seek to will minimise waste and maximise the proportion of material diverted from landfill.

9.14.2 The principles of the waste hierarchy will be followed, with priority given to the prevention of waste generation, followed (where this is not possible) by reuse, recycling and recovery of waste respectively, with disposal to landfill adopted only as a last resort.

9.14.3 The majority of excavated material that will be generated across the Proposed Scheme will be reused as engineering fill material or in the environmental mitigation earthworks of the Proposed Scheme, either with or without treatment.

9.14.4 For the surplus excavated material which cannot be beneficially reused for the earthworks of the Proposed Scheme the nominated undertaker will seek to provide surplus excavated material for:

- use in other local construction projects where opportunities arise at the time of construction; and/or
- use for restoration of mineral sites,

where the transportation of that material does not result in significant environmental effects.

9.14.5 Where the transportation of that material would result in significant environmental effects sustainable placement will be used.

9.14.6 Sustainable placement is the on-site placement for disposal of surplus excavated material to avoid causing environmental effects (e.g. transport) that would otherwise be associated with the off-site disposal of that material.

9.14.7 Sites for sustainable placement have been selected on the basis of their suitability for the disposal of surplus excavated material.

9.14.8 During detailed design, further opportunities will be investigated for the prevention, management and treatment of waste during the operation phase of the Proposed Scheme.

9.15 Water resources and flood risk

9.15.1 The design of the Proposed Scheme includes sustainable drainage systems to control the rate, volume and quality of run-off from the rail corridor and other infrastructure, taking projected climate change impacts into account. These systems will encourage storm water to soak into the ground or, where that is not reasonably practicable, will discharge it into watercourses or surface water/combined sewers at a rate matching existing run-off rates, or at an otherwise agreed rate at each location, taking account of any low flow problems with watercourses. Where possible, these drainage systems will also help to maintain the quality of receiving waters.

- 9.15.2 Where the Proposed Scheme has the potential to increase flood risk, its design will reflect the approach required by the NPPF and the supporting Technical Guidance (e.g. incorporation of flood resilience and resistance). The aim is for there to be no increased risk of flooding for vulnerable receptors during the lifetime of the development, taking projected climate change impacts into account. If required, the design will mitigate any loss of floodplain by creating replacement storage areas for the one in 100 year annual rainfall probability event, with an allowance for climate change.
- 9.15.3 Impacts on groundwater flows and quality will be analysed, and where the assessment predicts that a likely significant adverse effect may occur, a strategy to manage the risk will be agreed with the Environment Agency.
- 9.15.4 The design of the Proposed Scheme will seek to ensure that controlled waters are protected from pollution and that appropriate water quality standards are met. A compliance assessment of the WFD and a draft operation and maintenance plan for water resources and flood risk is contained within Volume 5: Appendix WR-001-000.
- 9.15.5 Engagement has been, and will continue to be, undertaken with the Environment Agency, Lead Local Flood Authorities, Internal Drainage Boards and the Canal and River Trust, to ensure that likely residual significant adverse effects are managed and mitigated appropriately.

10 Strategic and route-wide alternatives

10.1 Introduction

10.1.1 This section sets out the background to the consideration of alternatives by HS2 Ltd and DfT during development of the Proposed Scheme, and describes the strategic and route-wide alternatives. A more detailed account of these alternatives, how they were considered and the reasons for the choices made can be found in Volume 5: CT-002-000. Local alternatives considered prior to January 2012 are addressed in Section 11. Local alternatives considered since January 2012 are addressed in the Volume 2: CFA reports.

Regulatory requirements

10.1.2 Parliamentary SO27A requires the hybrid Bill to be accompanied by an ES containing the information referred to in Part II of Schedule 4 of the EIA Regulations as described in Section 1.3. The information includes:

“An outline of the main alternatives studied by the applicant or appellant and an indication of the main reasons for his choice, taking into account the environmental effects.”

Definition of alternatives

10.1.3 The alternatives reported here are grouped into four categories:

- **doing nothing** represents the future scenario that would arise in the event that no further investment in relevant transport capacity were to take place beyond those improvements already planned or committed;
- **strategic alternatives** comprise non-high speed rail (i.e. classic rail and other modal) responses to the objectives for both the Proposed Scheme and the future Y network. These alternatives were considered primarily by DfT, although a number were also raised by other parties;
- **route-wide alternatives** comprise different configurations or specifications for a high speed line between London and the West Midlands, including route corridors, operational criteria (speed), connections, stations and other key infrastructure (stabling and maintenance depots). These alternatives were considered by HS2 Ltd in developing the Proposed Scheme; and
- **local alternatives** comprise different design, construction and mitigation responses to engineering or environmental requirements at specific locations within the preferred route corridor (e.g. station configurations, tunnel length, vent shaft locations and fine-tuning of the route).

Option generation, sifting and selection

10.1.4 HS2 Ltd has been preparing and refining proposals for a new high speed line from London to the West Midlands and the north since the beginning of 2009, at the same time as the Government has been considering and comparing the emerging HS2 scheme with the strategic alternatives. In both strands of work a wide range of options were considered, and these were assessed against selection criteria derived from three sources:

- the Government’s transport and economic objectives to provide for long-term demand;
- The Treasury Green Book requirements to ensure that public funds are spent on activities that provide the greatest benefits to society, and that they are spent in the most efficient way¹⁶⁸; and
- national sustainability objectives and environmental policies and requirements.

10.1.5 For the more specific selection of options for the Proposed Scheme, the appraisal criteria were grouped under eleven headings:

- strategic fit;
- construction feasibility;
- operational feasibility – trains (HS2 and Network Rail);
- operational feasibility – operations (stations, depots etc.);
- operational feasibility – passengers;
- demand;
- costs;
- environment (using EIA topic areas);
- safety;
- commitments; and
- development opportunities.

10.2 Doing nothing

10.2.1 The ‘do nothing’ scenario implies carrying out no further investment in transport infrastructure to meet the demand met by the Proposed Scheme, beyond the projects that are already committed. This would effectively allow crowding conditions to worsen to such an extent that individuals would be deterred from travelling, thereby restricting demand to the available capacity. However, successive governments have concluded that such an approach is not an acceptable way of meeting the future travel needs of the country or of ensuring that the economic benefits of improved accessibility are realised.

10.2.2 In 2008 the then Government reiterated its commitment to provide sufficient capacity to serve forecast demand in the long term: “The Government remains committed to investment and to tackling the problems of congestion and crowding.”

10.2.3 In 2012 the current Government, having considered the responses to the Hs2 consultation concluded:

“The Government’s view is that continuing investment in steps to meet rising demand for intercity travel is necessary, given the importance of these journeys to the success of the

¹⁶⁸ HM Treasury (2003), *The Green Book. Appraisal and Evaluation in Central Government*, Her Majesty’s Stationery Office, London.

UK economy. Measures to address intensifying and more extensive crowding, growing rail congestion and the consequent increasing challenge of running a reliable railway for passengers are vital if the transport system is to continue to support economic growth¹⁶⁹.”

- 10.2.4 The option of failing to provide for growing demand would not be consistent with the Government’s objectives for economic growth nor with the 2011 National Infrastructure Plan aim “to improve connectivity and capacity between main urban areas and between them and international gateways, to deal with longer term capacity constraints¹⁷⁰”.
- 10.2.5 The Government does not believe it is tenable to do nothing. In addition to the negative economic effects, there would be severe individual impacts either crowding people off the networks, or allowing the experience to become so unpleasant that people choose not to travel.

10.3 Strategic and route-wide alternatives

- 10.3.1 In parallel with HS2 Ltd’s work on developing a high speed rail proposal, DfT explored the strategic options for serving the long-term demand for city-centre to city-centre travel between London, the West Midlands and eventually the northern conurbations. Successive Governments have discounted domestic aviation or new motorways as viable options. The options considered included upgrading existing road and railways.

Other modes

Domestic aviation

- 10.3.2 The main reasons why domestic air services are not a realistic or acceptable alternative to high speed rail for serving future growth in intercity travel are as follows:
- for shorter journeys aviation cannot offer door-to-door journey times comparable to road or rail, due to the time taken for travel to the airport, check in, security etc.;
 - the capacity of London’s airports is limited and providing for future growth in international travel will be a significant challenge without also serving additional demand from domestic air services; and
 - the carbon emissions per passenger kilometre from air travel are significantly greater than those from high speed rail. Whilst reductions in the carbon intensity of air travel per flight up to 2050 are expected, these are likely to be offset in part by the expected growth in passenger miles and hence the number of flights.

Roads

- 10.3.3 New motorways could provide extra capacity between cities and could address other transport issues, since cars are an extremely flexible means of providing door to door transport. However, new roads are rarely a realistic option for increasing commuter capacity into city centres without entailing unacceptable property destruction and community severance. Nor can cars offer anything like the centre-to-centre journey times or the reliability of high speed rail, especially at times when traffic is most congested. For

¹⁶⁹ Department for Transport (2012), *High Speed Rail: Investing in Britain’s Future – Decisions and Next Steps*. Her Majesty’s Stationery Office, London. P18, para 13.

¹⁷⁰ National Infrastructure Plan (HMT) (2011), <https://www.gov.uk/government/publications/national-infrastructure-plan-november-2011>, Accessed: October 2013.

all these reasons the Government decided not to give further consideration to new motorways as an alternative to HS2. However, it did not discount the possibility that decarbonisation of road transport might alter the case for road infrastructure in the very long-term, though not for city-centre markets¹⁷¹.

10.3.4 In 2009 the Government nevertheless commissioned Atkins to explore the potential for a package of road capacity enhancements to accommodate increasing travel between London and the West Midlands¹⁷². Atkins examined four packages of enhancements to the M1/M6, M40, M25 and M42, with each representing an increment improvement on the previous package.

10.3.5 Together the four packages represent an approximation to the realistic maximum potential for increasing capacity on the motorways between London and the West Midlands. They would provide only a fraction of the additional intercity capacity of a new rail line, and little or none of its capacity into city centres. Whilst they could increase the capacity of all the relevant motorways by approximately 20%, this should be compared with the Government's central forecast of growth in strategic road traffic of 46% by 2040¹⁷³. Where schemes can be justified, the Government intends to implement capacity enhancements on the strategic road network. In June 2013 it announced the biggest programme of road investment since the 1970s, including hundreds of miles of extra lanes on the busiest motorways through the use of managed motorways technology¹⁷⁴.

Strategic high speed route options

10.3.6 Though the Proposed Scheme is a discrete project that can be justified on its own merits, it has been conceived as part of a long-term strategy for a network of high speed lines connecting the major conurbations. In 2009 Hs2 Ltd was asked to consider the potential for extension of the core London-West Midlands route specifically to connect Britain's four largest conurbations – London, Birmingham, Manchester and Leeds.

10.3.7 The strategic choices are determined by the locations of the major cities, which suggest a network based on a western route to Liverpool/Manchester, and an eastern route via some or most of the cities in the East Midlands, and South and West Yorkshire. North of Leeds, Teesside and Tyneside lie on the eastern route, but there are no conurbations in the North-West to the north of Manchester. In Scotland, there are a number of permutations for serving Edinburgh and Glasgow, but in order to create a like-for-like comparison of the routes through England, all options considered by HS2 Ltd assumed the same configuration in Scotland.

10.3.8 With this geographic context in mind, three families of option were prepared in outline, analysed and compared:

Inverse 'A'	Bifurcate the line north of Birmingham with an eastern branch to the East Midlands, Sheffield, Leeds and Newcastle; and a western branch to Manchester and Scotland, with a link between Manchester and Leeds and a spur to Liverpool.
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¹⁷¹ Department for Transport (2012), *High Speed Rail: Investing in Britain's Future – Decisions and Next Steps*. Her Majesty's Stationery Office, London, P45.

¹⁷² Atkins (2010), *High Speed Two Alternative Study Strategic Outline Case*.

¹⁷³ Department for Transport and Highways Agency (2013), *Action for Roads*, P17 para 1.22

¹⁷⁴ HM Treasury (2013), *Investing in Britain's Future* P13 and P17 para. 2.11-13

Reverse 'S'	A single line to Newcastle and Scotland via Manchester and Leeds, with a spur to Liverpool.
Reverse 'E'	A single line to Newcastle and Scotland via East Midlands, Sheffield and Leeds, with trans-Pennine branches from Sheffield and Leeds to Manchester and Liverpool.

10.3.9 In 2009/10 a high level sustainability appraisal was undertaken. At that stage there was no line of route for any of the options north of Birmingham, so the aim was to ensure that the options were appraised on a consistent basis to identify whether there were any distinguishing environmental considerations that should be taken into account before any decision on the strategic route. Although there are numerous environmental features and issues that could influence detailed route choice, no environmental or sustainability issues were identified that would affect the strategic decision on whether HS2 should be extended on both sides of the Pennines or only on the east or west side.

10.3.10 In February 2010 HS2 Ltd submitted a report to Government¹⁷⁵ on the demand and business case analysis of the proposals. The analysis concluded that the Inverse 'A' had a benefit-cost-ratio (BCR) of 2.3:1, compared to 1.9:1 and 1.8:1 for the Reverse 'E' and Reverse 'S' respectively reflecting the following characteristics of the options.

- the Inverse 'A' option would be the most expensive because the total length of route is so much greater. However, it would provide much better value for money because it connects London and Birmingham directly to both sides of northern England. It would be more comprehensive, would offer better overall journey times, particularly to Scotland, and the benefits would be consequently much greater. The link between Leeds and Manchester would need to be justified on trans-Pennine passenger flows because north-south passengers would use the new lines either side of the Pennines;
- the Reverse 'E' option could not offer better journey times from London or Birmingham to Manchester/Liverpool than HS2 trains continuing to the north-west from Lichfield via the WCML; and
- the Reverse 'S', would be the least expensive of the three families of option, but offered the lowest value for money because it could not serve the East Midlands or Sheffield and the time savings to Leeds, the North-East and Scotland would be much less than the other two options.

10.3.11 After considering the consultation responses, in January 2012 the Government confirmed its intention to promote hybrid Bills for the Y network¹⁷⁶ (i.e. the Inverse 'A' but no further north than Manchester and Leeds and without the trans-Pennine link between these cities):

“The construction of a national high speed rail network from London to Birmingham, Manchester and Leeds, (the Y network), is the best means for enhancing rail capacity and performance on Britain’s key north-south corridors. The Y network should incorporate links to the WCML and ECML to enable through-running services to additional

¹⁷⁵ HS2 Ltd (2010), *High Speed Rail, London to the West Midlands and Beyond*.

¹⁷⁶ Department for Transport (2012), *High Speed Rail: Investing in Britain’s Future – Decisions and Next Steps*. Her Majesty’s Stationery Office, London, P37.

destinations, as well as intermediate stations in the East Midlands and South Yorkshire. Such a network will also provide a foundation for potential future expansion.”

Higher or lower design speeds

Higher design speed

- 10.3.12 The Proposed Scheme has been designed for a maximum speed of 360kph, but with a capability to allow the operating speeds to increase to 400kph as high speed technology develops. Maximum speeds are lower where this is impractical, such as in tunnels and at junctions. As a desk exercise, HS2 Ltd explored the options of a higher design speed. It concluded that a higher speed would save little time because of the distance taken to accelerate between stations and the effect of features that permanently restrict speed. It concluded that 400kph represents a reasonable maximum design speed, given likely technology development over the coming decades¹⁷⁷.

Conventional speed

- 10.3.13 Scheme development in 2009-10 included a high-level consideration of building a conventional speed version of the proposed London-West Midlands route. There was no scheme design for a classic speed railway to compare with the high speed proposal. However, it was assumed to comply with the same specification as HS2 in all respects except speed, and that it would follow the same route and provide the same connections, stations and level of service.
- 10.3.14 In January 2012 the Government concluded that any environmental advantage of a conventional speed line would be relatively marginal and that “the additional benefits generated by designing a new line to accommodate high speed services, compared to the only real long-term alternative of a new conventional speed line, would outweigh the additional costs by a factor of more than four to one¹⁷⁸”.

Reducing design speed locally to mitigate adverse environmental effects

- 10.3.15 After the public consultation in 2011, HS2 Ltd considered whether environmental impacts could be reduced by reducing speed. Trains could reach the maximum design speed on only around half of the 400kph route – the section between Amersham and Birmingham Interchange station. Six areas on this section of the route were identified where environmental concerns had been expressed and where there was potential to alter the route alignment. In other areas a reduced design speed would not affect the alignment.
- 10.3.16 For three of the six areas, it was considered that any environmental benefits could more advantageously be achieved by realigning and mitigating the high speed route without the need to reduce design speed, and for the remaining three areas it was considered that this effect could be achieved through mitigation only. HS2 Ltd therefore concluded:
- “The only environmental improvements delivered by a lower maximum design speed would be a marginal reduction in noise impacts, which would be outweighed by a substantial reduction in economic benefits. We consider that mitigation of the consultation route, the approach we have taken, is a more appropriate way of reducing

¹⁷⁷ Department for Transport and HS2 Ltd (2012), *Review of HS2 London to West Midlands route selection and speed*, Section 4.2.

¹⁷⁸ Department for Transport (2012), *High Speed Rail: Investing in Britain's Future – Decisions and Next Steps*. Her Majesty's Stationery Office, London, P72, para 3.96.

environmental impacts, particularly noise. This would also be the case for a line designed at a conventional speed¹⁷⁹.”

- 10.3.17 Having reviewed all this work the Government concluded that the new line should be high speed¹⁸⁰, not classic speed, that 400kph is the appropriate maximum design speed for the line¹⁸¹, and that the route should not be realigned to a lower design speed¹⁸².

Options for upgrading existing main lines

- 10.3.18 In March 2010 Atkins were instructed to review the potential for upgrades to the WCML and the CML, focusing on the London-West Midlands corridor. A number of upgrade packages were developed to serve anticipated demand after 2021, assuming that there would be no reductions to existing services and that additional trains would not be permitted to compromise their reliability.

- 10.3.19 The packages were as follows:

Rail Package 1 (RP1)	Longer long distance trains on the WCML (14-car and 17-car options);
Rail Package 2 (RP2)	Increasing the long distance services into Euston to 16tph (compared with the current 13-14tph peak services) by effectively providing four tracks throughout and grade separation as far north as Crewe ¹⁸³ ;
Rail Package 3 (RP3)	Package 2 plus additional capacity on the Chiltern route to allow four fast WCML London - Birmingham trains to be diverted to the CML, releasing capacity on the WCML for other services;
Rail Package 4 (RP4)	Package 3 plus further upgrades to the CML to reduce London to Birmingham journey times; and
Rail Package 5 (RP5)	Package 4 plus additional capacity between Birmingham and Stafford to enable two WCML trains per hour between London and the North West to be diverted to the Chiltern route, releasing capacity on the WCML for other services.

- 10.3.20 It was concluded that:

- RP1 was unlikely to be significantly less expensive or disruptive than providing the infrastructure for more train services. This option was not considered to be economically viable, and was therefore not appraised any further;
- RP2 would provide a moderate increase in rail capacity on the WCML. Overall, the

¹⁷⁹ Department for Transport and HS2 Ltd (2012), *Review of HS2 London to West Midlands route selection and speed*. Executive Summary, Para 8.

¹⁸⁰ Department for Transport (2012), *High Speed Rail: Investing in Britain's Future – Decisions and Next Steps*. Her Majesty's Stationery Office, London, P23, para 38.

¹⁸¹ Department for Transport (2012), *High Speed Rail: Investing in Britain's Future – Decisions and Next Steps*. Her Majesty's Stationery Office, London, P86, para 5.14.

¹⁸² Department for Transport (2012), *High Speed Rail: Investing in Britain's Future – Decisions and Next Steps*. Her Majesty's Stationery Office, London, P86, para 5.19.

¹⁸³ Atkins (2010), *HS2 Strategic Alternatives Study Rail Interventions Report*, P15.

appraisal concluded that Package 2 would reduce journey times (by 12 minutes to Birmingham and 6.5 minutes to Manchester). It would have only moderate environmental impacts, but implementation would be disruptive to existing services; and

- RP 3-5 would offer relatively small crowding relief on the WCML in relation to their very substantial cost.

- 10.3.21 Reviewing the analysis of these options, the Government in 2010 decided to continue to prepare proposals for a new high speed line. This was because the upgrade packages would together cost more than a new line, but would offer only marginal reductions in journey times and at best only half the capacity benefit, as well as being very disruptive to implement (the cost of which was not included in the appraisal)¹⁸⁴.
- 10.3.22 Whilst the five rail packages focused on the London-West Midlands corridor, the Y network to Manchester and Leeds provides capacity and time saving directly to the North West, the East Midlands and Yorkshire. It was therefore considered necessary to evaluate and consult on more comprehensive packages before the decision was taken to promote a hybrid Bill for the Proposed Scheme. Three new scenarios were therefore developed that also included enhancement to the Midland (MML) and East Coast (ECML) main lines:
- scenario A, which explored the effects of lengthening trains on all three main lines;
 - scenario B, which examined the provision of more long distance trains, based on RP2 for the WCML and additional trains on the MML and ECML; and
 - scenario C, which was based on RP3 and further increases in East Coast long distance trains.
- 10.3.23 Meanwhile, the 51m group of local authorities put forward an 'optimised' variant of Rail Package 2 the 'Optimised Alternative' (OA) designed to maximise the capacity potential of the existing lines. The OA is based on the RP2 option, but with additional capacity and reduced infrastructure. The 51m proposal did not include additional platforms at Euston or four-tracking between Beechwood and Stechford, but did include works to increase line speed at Northampton. Compared with RP2, there would be more capacity enhancement on outer suburban services and less on long distance services.
- 10.3.24 The proposed service changes comprised a 15tph service on the fast lines:
- lengthening long distance trains to twelve cars (except Liverpool Lime St. trains);
 - reconfiguring one first class carriage to standard class;
 - running additional peak long distance services; and
 - running four fast line services to outer suburban destinations.
- 10.3.25 The capacity benefits from the OA are additionally constrained by the fact that it only generates a limited number of additional train paths – just three per hour in the peak, two

¹⁸⁴ Department for Transport (2010), *High Speed Rail – Command Paper*. Her Majesty's Stationery Office, London., P46 para. 2.22 and P50, para 2.40-6.

of which are allocated to semi-fast services to Northampton. Therefore, the distribution of any additional capacity would necessarily be uneven between destinations¹⁸⁵.

10.3.26 When it reviewed the evidence on the upgrade options in January 2012, the Government noted that the appraisals showed strong BCR and significantly lower capital costs, whilst taking account of Network Rail's reservations on capacity and crowding, operational issues, unquantified additional costs and disruption to services over a long period during construction. It also accepted that upgrades would tend to have lower environmental and sustainability effects on landscape, townscape and noise than a new-build line. On carbon emissions it weighed the advantage of lower emissions against the opportunities for a new high speed line to attract passengers from domestic aviation. However, the key consideration was that an extensive package of upgrades would not address demand, capacity and crowding in the long-term. It concluded:

"The Government's view is that any sustainability and cost advantages are outweighed by the substantial disbenefits of enhancing existing lines. Furthermore, even if some options may offer good value for money, they fail to offer an effective long-term solution to crowding issues and therefore cannot be considered a viable alternative to new lines. There is a significant risk that an approach of this kind would simply create years of delay and disruption for passengers and freight services, and even after that only give rise to a railway that it is still overcrowded, delaying but not avoiding the need for new lines. For these reasons, the Government does not favour this strategic approach to addressing the long-term rail capacity constraints¹⁸⁶."

10.4 Route-wide alternatives

10.4.1 The original elements of the Proposed Scheme are set out in HS2 Ltd's report High Speed Rail London to the West Midlands and Beyond. This included operational and technical specifications and geographic requirements comprising a London terminus, an interchange with the GWML, Crossrail and Heathrow, the feasibility of a connection to HS1 and the potential for an intermediate parkway station. HS2 Ltd's remit also included potential for HS2 to extend to the conurbations of Greater Manchester, West Yorkshire, the North East and Scotland. Since 2009 the project's brief has developed and to some extent changed as work on the Proposed Scheme has progressed.

10.4.2 In 2009 HS2 Ltd approached the task of identifying and selecting options by dividing the scheme into four components:

- London stations;
- Heathrow/Crossrail interchanges;
- lines of route; and
- West Midlands stations and routes.

10.4.3 For each component a long list of options was prepared, then sifted to determine a short list of the more feasible options, from which the best option was then selected. The four

¹⁸⁵ Department for Transport (2012), *Review of the Government's Strategy for a National High Speed Rail Network*, P44-45, para 5.3.13-18.

¹⁸⁶ Department for Transport (2012), *High Speed Rail: Investing in Britain's Future – Decisions and Next Steps*. Her Majesty's Stationery Office, London, P72. para 3.92.

components were subsequently reconciled and amalgamated to form the preferred scheme. An amended version of the proposed route and scheme elements was published by the Secretary of State in March 2010. Since then the Scheme has been augmented, refined and reviewed, both before and after the public consultation in 2011. The main route and scheme component options considered during this process are described below.

London terminus

- 10.4.4 The Government's remit to HS2 Ltd in January 2009 included consideration of options for access to central London. A terminus station would need to be large enough to accommodate up to 18 tph. With this in mind a long list of 27 potential locations was prepared¹⁸⁷. The consideration included not only a surface station, but also cut and cover or deep underground solutions:
- nine station locations (eight in central London and Canary Wharf) were eliminated because there was little or no existing capacity and so an entirely new station would need to be built alongside, requiring unacceptable land required in densely built up areas;
 - thirteen locations outside central London and Canary Wharf (mostly in inner London but as far away as Heathrow and Watford) were eliminated because the journey time penalties for passengers with central London destinations would severely reduce the benefits of HS2;
 - options for a station under a Royal Park were not pursued because the parks are London landmarks safeguarded for public enjoyment;
 - St. Pancras: Two variants - either above the MML platforms or on the west side north of the British Library - were also eliminated, the former because it would require complete closure of the station during construction and the latter because it would entail extensive demolition;
 - options for a station under the Thames were eliminated because of the technical difficulties and deep tunnelled cavern options for Paddington and Kings Cross were discounted because of cost, ground conditions and settlement risk; and
 - a cut-and-cover station on Kings Cross railway lands was eliminated because the site is heavily constrained below ground by the Thameslink station and tunnels and the Camden sewer, and above ground by the Regents Canal and numerous railway lines. In addition an HS2 station would have severely affected the extensive regeneration plans for the area.
- 10.4.5 This left Euston as the only viable option. Various alternatives for Euston were considered, including all the platforms at the same level and double deck options. Having reviewed the considerably greater cost and engineering problems associated with double deck schemes, HS2 Ltd recommended that the London terminus should be approximately at ground level on the west side, partly on the existing station and railway and partly on land east of Cobourg St.

¹⁸⁷ HS2 Ltd (2010), *High Speed Rail, London to the West Midlands and Beyond*, P53-68.

10.4.6 However, before finally selecting this option, HS2 Ltd considered whether the overall cost and extensive impact could be reduced by having two smaller stations. Three options were reviewed:

- a combination of a through station and a terminus station – rejected both because of cost and time penalties;
- a through station with facilities allowing trains to be turned round and cleaned; and
- two independent stations.

10.4.7 All were rejected on cost grounds and to varying degrees because they would not significantly reduce demolition and because suitable sites were lacking.

10.4.8 Successive Secretaries of State concurred with HS2 Ltd's recommendation for a new station at Euston with all the platforms at the same level, and this option was included in the post-consultation scheme. However, further work during 2012 on construction planning and railway systems design revealed that the preferred solution at Euston would take more than twelve years to build and would be considerably more expensive than had been previously estimated.

10.4.9 A revised scheme was therefore prepared. Instead of rebuilding the whole station, it was proposed to retain thirteen existing platforms with only minor modification and build eleven new HS2 platforms to the west on a footprint slightly smaller than the post-consultation proposal. The two parts of the station would be integrated with a continuous concourse serving all platforms.

Great Western Main Line and Heathrow connections

10.4.10 HS2 Ltd's original remit included consideration of "options for a Heathrow International interchange station on the GWML with an interchange also with Crossrail¹⁸⁸". Direct access to Heathrow and the wider question of an interchange with the GWML and Crossrail are linked because the GWML/Crossrail interchange station would provide access to Heathrow via Crossrail and Heathrow Express, whilst offering HS2 passengers rail connections to and from areas west of London and a faster alternative to Euston for passengers to the West End, the City, Canary Wharf and destinations in East London and Essex.

10.4.11 Eleven station options were considered in 2009, including three airport locations and most of the stations between Old Oak Common and Iver. In late 2009, Arup submitted their 'Heathrow Hub' proposal for a multi-modal interchange. This comprised an off-airport terminal located on the GWML to the east of the M25 between West Drayton and Iver that would be connected to the other airport terminals via a mass transit people mover and baggage system. This concept was incorporated into the Iver station option considered by HS2 Ltd.

Interchange station options

10.4.12 The conclusions of the initial review were as follows:

¹⁸⁸ Department for Transport (2009), *Britain's Transport Infrastructure*, P24.para 63.

- North Pole and Willesden should be merged and optimised to become the (preferred) Old Oak Common proposal. This would be the best option for GWML and Crossrail connectivity. It would be connected to all five Heathrow terminals via the 4tph Heathrow Express or the slower 4tph Crossrail service¹⁸⁹;
- Acton was eliminated because it would require relocation of a major freight terminal for which there was no suitable alternative site;
- Hayes was inferior to nearby Southall due to construction and heritage problems;
- at Ealing Broadway there was insufficient land available;
- at Southall there was a largely unused site, but there would be limited scope for onward connectivity and an HS2 station would adversely affect planned redevelopment;
- Hanwell was a site at Osterley Park approximately between the WCML and the M4, but it was not pursued due to its very poor onward connectivity and adverse environmental impact;
- Iver could be connected to Heathrow by a people mover and could be a parkway station, but there would be major adverse environmental impacts on the flood plain and riparian habitats¹⁹⁰.

10.4.13 For various reasons Old Oak Common or Iver would be much better locations for an HS2 interchange than any of the intermediate stations. Whilst Iver would offer better journey times to Heathrow, it would be considerably more expensive because it would require a people mover, and it would be much less attractive as an alternative to Euston for HS2 passengers bound for central or east London. More passengers would therefore use an interchange at Old Oak Common.

10.4.14 The analysis of interchange options established that a station at Old Oak Common would be justified irrespective of any of the options for serving Heathrow, because it offers a faster route than Euston to Central London and beyond for a large proportion of HS2 passengers¹⁹¹. This would be true even if there were a hub station at Iver, though the case would be weaker than with the other Heathrow station options.

10.4.15 In 2012 the Government therefore decided to include Old Oak Common in the Proposed Scheme. The Old Oak Common interchange would also offer much better access than currently exists from the Midlands to Heathrow, but is not necessarily an alternative to direct HS2 services to Heathrow.

Direct access to Heathrow

10.4.16 Whilst HS2 Ltd's remit in 2009 sought only options for a Heathrow International interchange station on the GWML¹⁹², this was expended in June 2010 to "develop options

¹⁸⁹ HS2 Ltd (2010), *High Speed Rail, London to the West Midlands and Beyond*, P81, para 3.36-37.

¹⁹⁰ HS2 Ltd (2010), *High Speed Rail, London to the West Midlands and Beyond*, P79 and P80.

¹⁹¹ It would take 15-30 minutes longer to travel from the Midlands to central London via Iver compared with Old Oak Common (depending on what GWML and Crossrail service patterns were introduced to serve the interchange).

¹⁹² HS2 Ltd (2010), *High Speed Rail, London to the West Midlands and Beyond*, P13, para 1.1.10.

for a direct high speed link to Heathrow, to include options for a loop and a spur from your recommended alignment, and for a through route via Heathrow¹⁹³”.

- 10.4.17 Passenger destinations at Heathrow are concentrated at the five terminals, which are approximately 1.5-2km apart. In 2009 three location options for a station within the airport were considered:
- under the Central Terminal Area (CTA);
 - to the west of Terminal 5;
 - a 'Terminal 6' (T6) station for a third runway that was favoured by Government at the time; and
 - the Heathrow station could be an off-airport hub in the vicinity of Iver such as the Arup Heathrow Hub proposal.
- 10.4.18 In 2010 the third runway proposal was abandoned, and with it the T6 option, but a further location on the northern perimeter of the existing airport was considered, known as 'Heathrow North'.
- 10.4.19 Options for a direct route were considered both as an alternative to a GWML/Crossrail interchange and in addition to Old Oak Common. The Heathrow options included not only station locations but also whether the station should be located directly on the HS2 main line, or on a loop or spur. In 2009 nine alignment options for serving Heathrow were considered:
- three route options for the HS2 main line to run through a new station at Heathrow;
 - three options for a loop from the HS2 main line through the airport; and
 - three options for a spur off the HS2 main line to the airport.
- 10.4.20 A Terminal 5 station served directly by the HS2 main line was discounted because the station would have to be oriented north-west/south-east to avoid existing rail and underground infrastructure, which would require an expensive and circuitous route affecting all train services. Otherwise any of the route options could serve any of the airport station options.
- 10.4.21 All the options for direct HS2 main line access to Heathrow would entail substantial additional cost. A main line through the airport or a loop would be considerably more expensive than a spur. The through route would entail a time penalty to the vast majority of passengers not going to Heathrow of 10 minutes for non-stop trains or 14-15 minutes for trains stopping at Heathrow. Additionally, up to one tph into central London could be lost as a result of stopping trains re-joining the main line.
- 10.4.22 Whilst a loop option would incur no time penalty for most passengers, London-bound passengers on via-Heathrow trains would lose nine to 14 minutes, depending on which Heathrow station option is chosen.

¹⁹³ HS2 Ltd (2010), *Secretary of State's letter to Chairman*.

- 10.4.23 The spur options would have no impact on journey time for the majority of passengers, who would be travelling to and from central London, and would provide direct access to whichever terminal is chosen for the station. It is therefore the quickest and cheapest option. Its disadvantage is that, with very low demand – at least initially – there would be insufficient passengers to justify the Heathrow service, and that the Heathrow terminating trains using the spur would take up a train path that could otherwise be used to carry passengers to central London.
- 10.4.24 The current position is that the Government has allowed for the future provision of spur junctions in the Proposed Scheme, but has suspended work on the Heathrow spur until 2015 pending the Airports Commission's report. No decisions will be taken until the public has been consulted on the proposals.

Routes from London to the West Midlands

- 10.4.25 In 2009 HS2 Ltd prepared a long list of options and sub-options for the London and West Midlands route, which were then subject to sifting, selection and refinement. Where possible the routes followed the main transport corridors whilst avoiding urban areas and environmentally sensitive locations.
- 10.4.26 As a result of this process, six main corridors (and one hybrid) were considered for the route to the north of Old Oak Common. Other options were eliminated where adjacent routes would be better on environmental and/or cost criteria. Consideration of the effects on the Chilterns AONB was particularly important in this process. The options were:
- **Route 1 – M40 corridor** – This was the most expensive option and had the longest journey times. In addition, it involved almost 15km (9miles) of surface route through the AONB, and would have given rise to significant impacts on biodiversity as it affects several nationally designated sites and would require demolition and severance. There was thus no compelling environmental case to justify the additional cost;
 - **Route 2 – CML corridor** – via High Wycombe, to re-join Route 1 near Bicester. The southern part of this route offered advantages such as a relatively short surface section through the Chilterns. Further work was therefore done to test whether cost reductions and improved journey times could be achieved, as a result of which a new Route 2.5 was developed. This comprised the southern section of Route 2 and the northern section of the preferred Route 3;
 - **Route 3 – A413 Valley and Great Central route** – This route was broadly aligned to existing transport corridors (A413, Marylebone to Aylesbury line) before joining the route of the former Great Central Line between Aylesbury and Brackley. It would then run relatively straight, passing to the east of Warwick and between Kenilworth and Coventry, towards the NEC;
 - **Route 2.5 – via Princes Risborough** – This route passed through three tunnels under the Chilterns, then largely on the surface before re-joining Route 3 near Bicester. It was marginally longer than Route 3 and consequently marginally slower and more expensive. It would have resulted in fewer adverse impacts relating to landscape across the Chilterns and noise, but would require a visually intrusive viaduct across the Hughenden Valley and entail more demolition and a greater

impact on townscape;

- **Route 4 – WCML corridor** – This route ran in tunnel to Kings Langley, and then broadly parallel with the M1 corridor to pass to the west of Milton Keynes and between Kenilworth and Coventry. It would provide the shortest section through the Chilterns, but its alignment would have potentially greater impacts in relation to biodiversity, vibration and community integrity than Route 3. It would be slightly shorter than Route 2.5 and slightly longer than Route 3, with commensurate implications for journey times. Providing a direct connection from Route 4 to Heathrow would be a major undertaking, including crossing the Chilterns AONB along a new corridor in a mix of cutting and viaduct and at significant cost. It would require twice as much tunnelling as Route 3 (as then proposed) and would be almost 40% more expensive; the reduced impact on the AONB was considered to be insufficient to outweigh the tunnelling costs. It would have resulted in fewer adverse impacts for landscape and townscape, cultural heritage, water resources, flooding, construction and operational noise, but greater impacts relating to biodiversity and community severance;
- **Route 5 – M1 corridor** – This route continued from Old Oak Common in tunnel, emerging between St. Albans and Hemel Hempstead, passing Luton, Milton Keynes and Northampton, before cutting across to the south of Coventry. It would have no effect on the Chilterns AONB, but would be significantly more expensive than Route 3 and require substantial tunnelling or property demolition in order to traverse residential areas. Importantly, there would be no feasible way of connecting it to Heathrow and even a connection via Old Oak Common would be difficult. It would also be five minutes slower than Route 3; and
- **Route 6 – MML corridor** – This would also avoid the AONB, running in tunnel from Old Oak Common, to re-emerge near St. Albans. It would pass around Luton, Bedford and to the east of Northampton, before cutting across to pass between Kenilworth and Coventry. For most of its length Route 6 would be either in tunnel or close to residential areas. It would have the same shortcomings as Route 5 in relation to cost, Heathrow and Old Oak Common, and would be nine minutes slower than Route 3.

10.4.27 A further option – **Route 1.5** – was a variant of Route 1, providing for main line services through Heathrow (or Iver), running midway between Routes 2 and 3 at the southern end before re-joining Route 3 east of Bicester. It would be longer, slower and more expensive than Routes 2.5 or 3, and would only be considered for a station at Heathrow or Iver served by a through route.

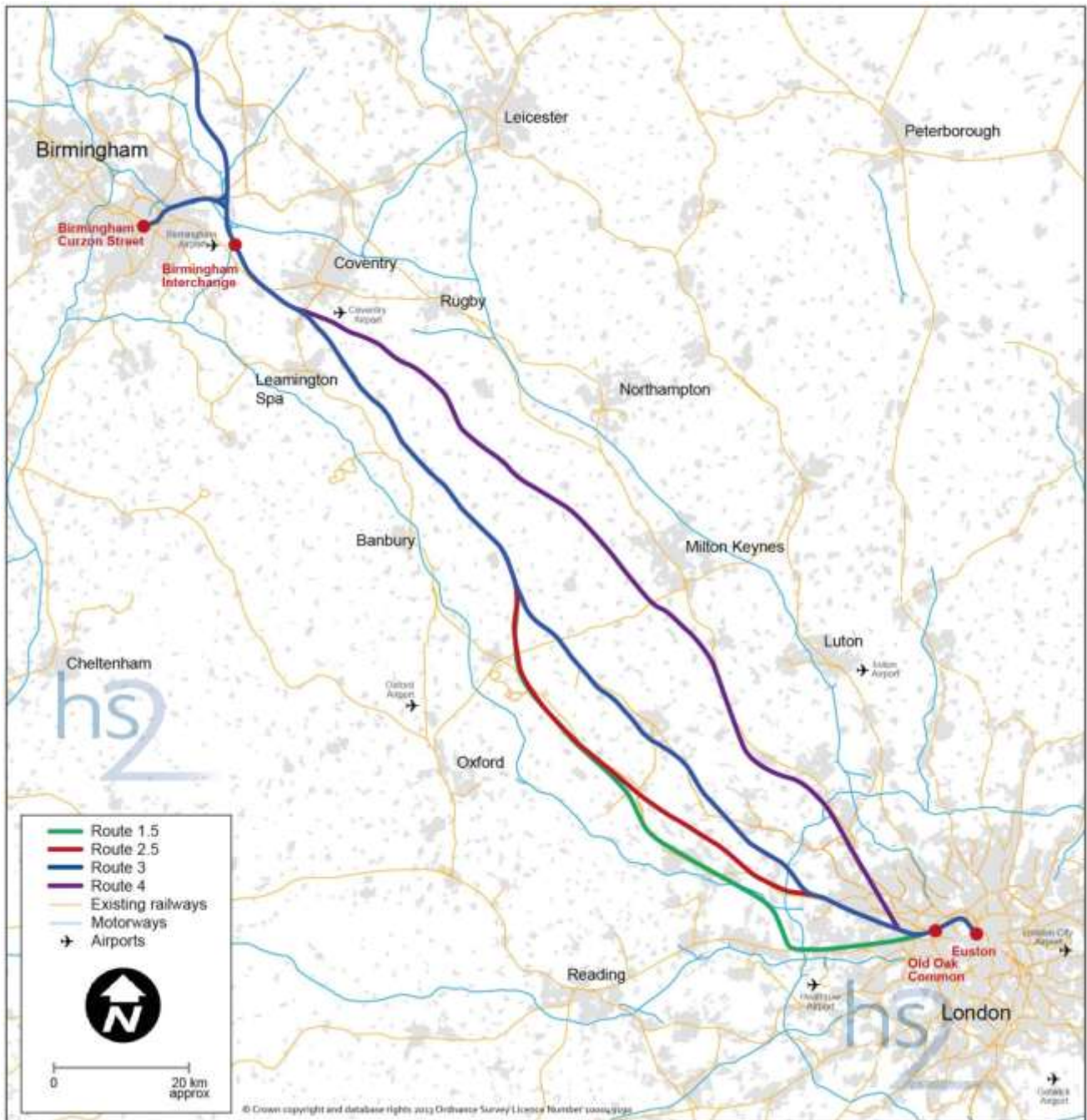
10.4.28 Route 1 was the most expensive, for no great advantage. Route 2.5 was a better option than Route 2 and was substituted for it. The most easterly routes (Routes 5 and 6) were considered because they would avoid the Chilterns AONB, but would require substantial tunnelling or property demolition through built up areas, particularly in Luton, and would add around ten minutes to journey times¹⁹⁴.

¹⁹⁴ HS2 Ltd (2010), *High Speed Rail, London to the West Midlands and Beyond*, P94, para 3.5.6.

- 10.4.29 Having stated its preference for Route 3 in 2010, because it offers significant advantages over the other options in terms of cost and journey time, and is no worse on sustainability grounds, the Government shortlisted Routes 2.5, 3 (a refined version) and 4, together with Route 1.5, with Route 3 being its preferred option. Figure 44 illustrates these options.
- 10.4.30 The Government supported HS2 Ltd's view that Route 3, subject to the refinements that have been made since May 2010, would be the best option. The main reasons were stated as follows:
- the Government considers that there is a compelling strategic case for being able to link the high speed network to Heathrow. HS2 Ltd's Route 4, following the WCML Corridor more closely through the Chilterns, would make this unfeasibly expensive and impractical;
 - the alternative route through the Chilterns, Route 2.5, would create a new transport corridor through the AONB and would be very intrusive in the Hughenden Valley. It would also cost more and mean longer journey times, and therefore lower benefits; and
 - the alternative route via Heathrow would be substantially more expensive and the longer journey times would reduce the benefits. Although it would have less direct impact on the Chilterns, it would adversely affect other sensitive areas¹⁹⁵.

¹⁹⁵ Department for Transport (2011), *High Speed Rail – Investing in Britain's Future Consultation*. Her Majesty's Stationery Office, London. P86, para 5.9.

Figure 44: Alternative corridors for the London and West Midlands route



10.4.31 After considering the responses to the public consultation, in January 2012 the Government concluded:

- “The proposed route corridor, including the approach for mitigating its impacts, is the best option for a new high speed line between London and the West Midlands. Many people expressed a view on the line of route in their local area. HS2 Ltd looked again at the route in light of the consultation responses and, subject to the alterations noted below, we believe this route remains the best option in terms of its overall benefits and costs, including impacts on sustainability; and
- A package of alterations to the proposed route should be made to further reduce its impacts on the local environment and communities. These include additional

tunnelling in the Chilterns AONB and in the Northolt area of West London¹⁹⁶.”

West Midlands stations and routes

Birmingham station

- 10.4.32 In 2009 HS2 Ltd began considering where the principal station for the West Midlands should be located. The issue was somewhat different from London in that both a through station or a terminus could be practicable. Initially the key consideration was to establish which location would be most convenient for the majority of passengers. Locations at Wolverhampton, Walsall, Birmingham International and Heartlands were assessed, but the demand analysis clearly showed that the station needs to be in Birmingham city centre in order to capture significant passenger share¹⁹⁷.
- 10.4.33 The second step was to prepare a long list of options for through and terminus stations in the city centre. In Birmingham this is a matter of construction feasibility as well as business case and environmental criteria.
- 10.4.34 The long list of locations was reviewed to eliminate those that would be impractical or obviously inferior to better options in the same location:
- New Street and Snow Hill were eliminated on operational, engineering and cost grounds;
 - Moor Street (Terminal) West, Curzon Street¹⁹⁸ (Terminus) and Proof House were eliminated because they were inferior to other options; and
 - a wholly new subsurface station was eliminated because it would be prohibitively expensive in comparison with the viable surface options.
- 10.4.35 As a result of this process, two through and three terminus station options remained for further consideration when the route into or through Birmingham had been determined.

West Midlands routes

- 10.4.36 In developing the route through the West Midlands, three generic families were considered:
- routes around the east side of Birmingham with a spur into the centre;
 - routes around the west side with a spur; and
 - direct routes through the centre.
- 10.4.37 Routes around the west side were not pursued because they would be longer and more circuitous, and because they presented significant environmental and technical difficulties. To varying degrees this also applied to the routes through Birmingham on the western side.

¹⁹⁶ Department for Transport (2012), *High Speed Rail: Investing in Britain's Future – Decisions and Next Steps*. Her Majesty's Stationery Office, London, P38.

¹⁹⁷ HS2 Ltd (2010), *High Speed Rail, London to the West Midlands and Beyond*, P105, para 3.6.2.

¹⁹⁸ This station option was to the east of the preferred option which at this stage was labelled 'Fazeley St.', and was subsequently renamed 'Curzon Street'.

- 10.4.38 Several routes through the centre were considered for a surface station, but were discarded because of the land required and townscape implications of three large open boxes in the centre of Birmingham. An all-tunnel option would be unjustifiably expensive when compared with the viable surface options. This sifting process also eliminated the remaining through station options – Moor Street and Curzon Street.
- 10.4.39 Three route options for a spur off an HS2 main line east of Birmingham were identified: the Solihull corridor; the Coventry corridor; and the Water Orton corridor. Though less expensive, a spur along the Solihull corridor would entail greater social and environmental impact and, crucially, would seriously undermine the case for a Phase Two extension of HS2, since trains from Birmingham to Leeds or Manchester would suffer a long detour to the south east before joining the main line¹⁹⁹.
- 10.4.40 A spur along the Coventry corridor would entail similar, though less severe journey time disadvantages to Leeds and Manchester, as the main line junction would be south of the NEC. In order to create a sufficiently wide angle for the northbound chord of this junction, the main line would have to be routed in a wide arc to the east of Coleshill. As a result, there would be no obvious location for an interchange station near Birmingham International station and the airport. It would also entail greater disruption during construction, severance, noise and water resource effects.
- 10.4.41 The preferred option was a spur from a junction at Water Orton via the M6 corridor to Bromford and the city centre. This route could serve a city centre terminus at either Warwick Wharf or Fazeley Street (Curzon Street). Either would deliver broadly the same passenger benefits, but Warwick Wharf would bisect the Warwick Bar Conservation Area and the local street pattern, would affect a number of listed buildings and would create much greater local severance. It would also be marginally more expensive to build. Fazeley Street was therefore selected in 2010 as the preferred option for consultation. The station was subsequently renamed Curzon Street.

Birmingham Interchange station

- 10.4.42 Ten potential locations were identified with good links to the strategic road network and close to possible HS2 alignments. Consideration of interchange options took place in parallel with route and terminus station options. All options except a location close to Birmingham International and the NEC were eliminated for the following reasons:
- four locations to the north east and north west of Birmingham (Walsall/Bescot, Wolverhampton, East Sutton Coldfield, and Shenstone south of Lichfield) offered relatively poor demand potential. Some had also been superseded by the choice of alignment;
 - Earlswood and Solihull, south of Birmingham, were superseded by the choice of route;
 - Heartlands was too close to Curzon Street to add significantly to the catchment and would add traffic to a constrained road network; and
 - A location at Water Orton was eliminated because it was constrained by existing

¹⁹⁹ HS2 Ltd (2010), *High Speed Rail, London to the West Midlands and Beyond*, P115-116, para 3.6.27.

motorways and would be very difficult and therefore expensive to build.

- 10.4.43 Locations for an interchange station near Birmingham International and the NEC were identified for both of the route options under consideration. Once the preferred route to Lichfield had been determined, only one NEC/Birmingham International option remained. Its location 2km from the existing Birmingham International station and the airport, and 1km from the NEC, offers opportunities unique in the West Midlands to serve both interchange and destination demand. Following consultation, this option was selected for inclusion in the Proposed Scheme.

Intermediate stations

- 10.4.44 The case for intermediate stations was investigated in 2009²⁰⁰ and was re-examined following consultation in 2011. Intermediate stations bring a range of potential benefits to the communities they serve, in terms of improved connectivity and congestion relief, especially on commuter services into London. However, these benefits would come at the cost of slower journey times for through passengers and reduced train path capacity. The reduced capacity effect would be particularly significant for the Phase Two proposals to Leeds and Manchester, and for services to the north, as demand pressures would be much greater when both phases are implemented.
- 10.4.45 In 2009 HS2 Ltd analysed existing rail trips from twelve of the largest population centres in the London-West Midlands corridor and identified existing rail demand for a potential long list of intermediate stations. Three locations including Aylesbury, Milton Keynes and Bicester (serving Oxford) were selected for further assessment. This analysis was undertaken prior to consideration of the choice of route between London and the West Midlands because, if an intermediate station were included in the proposals, it could have implications for route selection.
- 10.4.46 The potential demand at an intermediate station would largely comprise commuting trips into London, particularly in the case of smaller towns such as Bicester. Against these benefits to the passengers using an intermediate station, there would be very substantial costs to other passengers²⁰¹. More significantly, the trains would be full of long distance passengers at peak times and any additional intermediate station passengers would therefore (notionally) displace those already on the trains. This would result in a net disbenefit because the time savings for longer distance passengers would be greater than for medium distance passengers. Fare revenues would also be lower. In addition, a three per hour service to an intermediate station would result in the loss of three train paths per hour, leading to an overall 20% reduction in the maximum capacity of the route (unless there were extensive delays in the station).
- 10.4.47 In January 2012, having considered the responses to the 2011 consultation, the Government concluded that an additional intermediate station would not be appropriate for the London-West Midlands phase²⁰².

²⁰⁰ HS2 Ltd (2010), *High Speed Rail, London to the West Midlands and Beyond*, P89-92.

²⁰¹ HS2 Ltd (2010), *High Speed Rail London to the West Midlands and Beyond HS2, Demand Model Analysis*, P64, para 6.2.8.

²⁰² Department for Transport (2012), *High Speed Rail: Investing in Britain's Future – Decisions and Next Steps*. Her Majesty's Stationery Office, London, P90, para 5.35.

10.4.48 As well as having a very poor business case, there would be adverse environmental effects. Typically, a parkway location would entail roads, car parks, visual intrusion and other environmental effects, while a town centre location would require property demolition and disturbance to adjacent occupiers.

10.4.49 Due to the weakness of the business case, the Government remains of the view that the Proposed Scheme should not include an intermediate station. From a strategic point of view, if the primary function of an intermediate station is to serve the commuter market to London, capacity and/or journey time enhancements to existing main lines are a more cost effective solution than filling long distance trains with commuter distance passengers. In addition, by releasing long distance train paths, HS2 will enable additional medium distance services to be run on the WCML.

Hs1-Hs2 link

10.4.50 In 2009 HS2 Ltd undertook its analysis of potential links between HS1 and HS2 in relation of three groups of options:

- a new high speed connection between the two lines, which would require tunnels from Old Oak Common to Barking – this would be prohibitively expensive and would give rise to risks in relation to vibration, reradiated noise and ground settlement for the shallower sections of tunnel;
- a conventional speed link, either one or two tunnels from Old Oak Common to Primrose Hill and thence to HS1 via the NLL; and
- an improved interchange between Euston and St. Pancras – Whilst this would be far less convenient than direct link options, this would be partly offset by the greater frequency of trains. A people mover could improve the interchange and would generate greater benefits at a much lower cost.

10.4.51 HS2 Ltd initially recommended that if a link were built it should be a dual-track conventional speed line running in tunnel from Old Oak Common to Primrose Hill, and then via the North London Line to HS1.

10.4.52 In March 2010 the Government asked HS2 Ltd to develop options for a direct link via the NLL and for improved passenger connection between Euston and St. Pancras²⁰³. The Proposed Scheme includes a rail link with a capacity of up to three trains an hour, which can be used either for through trains to the continent, or to extend Eurostar services to an interchange with HS2 at Old Oak Common, or for Kent trains to interchange with Heathrow Express or Crossrail.

10.4.53 In the February 2011 Consultation Document, the Government summarised the strategic case for a link between HS1 and HS2 as follows:

- “International rail connectivity has also grown significantly across mainland Europe. The networks of high speed rail lines being developed by France, Germany Spain, the Netherlands, Belgium and Italy have all been designed to enable international travel. Connecting any UK high speed line to this rapidly growing

²⁰³ Department for Transport (2010), *High Speed Rail*, P125-6. Para 7.20-28.

network will be vital if the UK is not to become isolated from what is already a key mode of travel between major European cities;”

- “However, at present, services on HS1 and the Channel Tunnel are relatively inaccessible for those outside London and the South East. By providing direct access to the wider European network for services from Manchester, Birmingham and other cities, a link between a national high speed rail network and the current HS1 line could address this;” and
- “The Government’s view is that the strategic case for a direct link between the proposed high speed rail network and the HS1 line to the Channel Tunnel is strong²⁰⁴.”

Options for a direct link between HS1 and HS2

10.4.54 It was clear from the previous work that minimising cost would be a key factor in determining whether a business case could be made.

10.4.55 Two options to reduce the length of tunnelling were considered at this time²⁰⁵:

- A shorter single-track tunnel that would emerge at Queens Park rather than Primrose Hill, utilising the slow lines on the WCML. However, this option was not pursued because it would have been only slightly cheaper and entailed more train service disruption and compensation to train operators; and
- An underground junction entailing long caverns near Euston for each of the HS2 tracks. This option was not pursued because it would entail a significant settlement risk and would result in very little overall cost saving.

10.4.56 Constructability was also a major issue²⁰⁶. A two track link would be more complex to build, as it would require more significant works to the NLL, probably entailing total closure of the line for several months. A variant would be to provide a single track initially and then build a second track sometime after HS2 becomes operational if it were justified by demand. However, the disruption caused during construction of a second track would be the same as if the whole link were built later, with the added disadvantage that HS1-HS2 services would need to be suspended as well as NLL services. The environmental consequences of the two track option would be similar to a single track link, but the townscape effects of a wider NLL viaduct would be greater and several more listed buildings would be affected.

Improved Euston-St. Pancras interchange

10.4.57 A travelator connection between Euston and St. Pancras would not have sufficient capacity for peak demand and would not be significantly faster than walking. All remaining options to improve the interchange between Euston and St. Pancras were therefore based on an Automatic People Mover (APM) – a fixed-track train similar to those used between terminals at airports.

²⁰⁴ Department for Transport (2011), *High Speed Rail – Investing in Britain’s Future Consultation*. Her Majesty’s Stationery Office, London. pp.67-8 paras 3.25-6 and 3.29.

²⁰⁵ HS2 Ltd (2010), *High Speed Rail: London to the West Midlands and Beyond Supplementary Report*, P43.

²⁰⁶ HS2 Ltd (2010), *High Speed Rail: London to the West Midlands and Beyond Supplementary Report*, P44. para. 2.2.5-2.2.8.

- 10.4.58 A surface link was discounted as it would be too disruptive to road traffic, whilst a link at any level along Euston Road proved not to be feasible. The potential infrastructure options were thus either an elevated or a sub-surface link on two alignments – Euston Road/Polygon Road or Phoenix Road/Brill Place. The subsurface links would have severe effects on adjacent properties during construction and could not run east of Midland Road because of the Thameslink tunnels. The elevated options would also have permanent adverse effects on noise, townscape and visual intrusion.
- 10.4.59 After having considered the responses to the public consultation, in January 2012 the Government reiterated the potential importance of the wider strategic benefits of seamless connectivity between HS2 and HS1, and stated that a direct link is an important objective and its intention to implement such a link as part of Phase One²⁰⁷. Whilst the Government supported a direct link via a new tunnel and the existing NLL, it also commissioned HS2 Ltd to continue discussions with Network Rail and TfL to consider whether a 3tph service on the link would impede existing services on the NLL.

Alternative alignments

- 10.4.60 Three tunnel options following the surface alignment were considered, rising up on a shallow ramp to join the NLL viaduct to the north of St Pancras, bridging over the MML and then turning south onto the existing link to HS1. They would also involve permanent stopping up of between three and four roads, depending on the option (including St Pancras Way, Baynes Street, Camley Street and Randolph St).
- 10.4.61 A tunnelled option would have advantages in terms of providing full segregation of services from HS1 to HS2, whilst reducing the need for surface works along the NLL route (including viaduct widening, the upgrading of Camden Road station and the replacement of eight bridges), and imposing no constraint on future enhancements to NLL capacity. However, the construction risks associated with tunnelling in this area (which would in practice be likely to add substantially to the costs), the permanent stopping up of roads, and the substantially increased loss of domestic property for the northern tunnel option, tilted the decision in favour of a surface route.
- 10.4.62 Following consideration of the issues and options the Government remains convinced of the strategic importance of a link between HS2 and HS1 and is committed to providing it in the Phase One scheme. It has also concluded that the Proposed Scheme is preferable to the alternatives, because it would require demolition of fewer residential properties and no loss of public open space as well as other environmental advantages.

Depots and maintenance

- 10.4.63 In 2009 HS2 Ltd set out the requirements and the approach taken to identify the location of depots and other equipment sites, including a main IMD and a rolling stock maintenance depot (RSMD) for Phase One. The report noted that depot location decisions were best taken once a preferred line of route is confirmed. However, for the preliminary assessment and costing, a site on the intersection between HS2 and the Oxford to Bletchley Line was identified as a credible location for the IMD, whilst Washwood Heath

²⁰⁷ Department for Transport (2012), *High Speed Rail: Investing in Britain's Future – Decisions and Next Steps*. Her Majesty's Stationery Office, London, P81, para 4.41-3.

was identified for the RSMD²⁰⁸. The choice of location was taken no further at that stage, as HS2 Ltd recommended that consideration also be given to alternatives.

Infrastructure maintenance depot

- 10.4.64 The preferred location for the principal maintenance depot for the Proposed Scheme is somewhere midway between London and the West Midlands, with access to all parts of the line. This depot would provide a base for maintenance of the track, signalling equipment, power systems, cuttings and embankments, and other elements of the HS2 infrastructure.
- 10.4.65 In September 2010 a short list of six potential sites in the area around Calvert, and a seventh site around 10km further north near Mixbury, were identified²⁰⁹. The Mixbury site was not taken forward because it would have required a 10km single track line to provide a rail freight connection to the Oxford-Bletchley Line²¹⁰, whilst the site levels would have necessitated major alteration of the landscape in a rural setting²¹¹ and (on a very high level appraisal) it was assessed as worse than Calvert in terms of potential noise, visual intrusion and cost with no evident compensating advantage²¹².
- 10.4.66 Of the six sites at Calvert, the option in the north-east quadrant of the intersection of the two lines was identified as the most promising because it performed best against the selection criteria. The site is adjacent to both HS2 and the Bicester to Bletchley railway, affording excellent access to both, whilst the location also offers the least risk of adverse impacts on local communities.
- 10.4.67 Prior to the Secretary of State's selection of the preferred site in January 2012, a further six sites between Quainton and Fleet Marsden, north of Aylesbury were considered²¹³. These sites are not as well located as Calvert, because they are further towards the southern end of the route. They would entail higher train operating costs and either of the two best of these options would be more than twice as expensive as the Calvert site.

Maintenance loops

- 10.4.68 The frequency of the proposed train service limits the opportunity to undertake infrastructure maintenance during operating hours. Maintenance must therefore take place during the night closure period or in limited periods at the beginning and end of the day when the service is less frequent. To maximise the amount of work undertaken within this night shift, and to reduce the travel distance required, maintenance trains must arrive quickly at their worksites. This would be achieved by providing two loops, one on each half of the route, where maintenance trains would be parked. These loops also provide a safe stopping location for any passenger train that develops a fault, allowing the main line to remain in operation.
- 10.4.69 Four sites between Calvert and the West Midlands were considered for the northern loop and three sites between Calvert and London for the southern loop. A northern loop near Wormleighton and a southern loop near Stoke Mandeville were selected because in both

²⁰⁸ HS2 Ltd (2010), *High Speed Rail, London to the West Midlands and Beyond*, P151, para 3.11.1.

²⁰⁹ HS2 Ltd (2010), *High Speed Rail, London to the West Midlands and Beyond Supplementary Report*, P54-6.

²¹⁰ Arup (2011), *High Speed 2 Infrastructure Maintenance Depot (IMD)*, P19, para 5.6.2.

²¹¹ Arup (2011), *High Speed 2 Infrastructure Maintenance Depot (IMD)*, P21, para 7.1.7.

²¹² Arup (2011), *High Speed 2 Infrastructure Maintenance Depot (IMD)*, P20.

²¹³ Department for Transport and HS2 Ltd (2012), *Review of HS2 London to West Midlands Route*, Section 8.

cases they are the options that would be most operationally efficient and would have the least impact on the local environment.

Rolling stock maintenance depot

- 10.4.70 A depot is required to maintain the dedicated HS2 train fleet and the captive and conventional-compatible fleet. Whilst one maintenance depot is required to maintain all trains, other stabling facilities could be located elsewhere. The depot would be used for rolling stock inspection, repair, cleaning, light and heavy maintenance, re-watering and the replenishment of consumables.
- 10.4.71 A short list of five potential sites was prepared, but two were immediately eliminated – Elmdon was required for continued vehicle production and Berkswell in the Green Belt did not offer sufficient accessibility for people, materials and rail connections.
- 10.4.72 A high level appraisal of the three remaining sites - Washwood Heath, Coleshill and Middleton – concluded that Washwood Heath was most advantageous site on both technical and environmental criteria. It was therefore selected and following consultation in 2011 and was included in the 2012 post-consultation scheme.
- 10.4.73 Following confirmation of the preferred route in January 2012, the site options were re-assessed, including sites close to the whole of the Phase One route. There were 86 potential sites on the long list. Six of these sites met some of the selection criteria - Kings Bramley, Ufton, Ludgershall, Aylesbury Vale, Little Kimble and Birmingham Interchange – whilst four sites met most or all of the selection criteria: Newton Purcell, Westcott, Bishopstone and Washwood Heath.
- 10.4.74 The greenfield sites generally entailed long acceleration/deceleration lines, greater environmental impact, a shortage of skilled labour in the locality and higher operational cost.
- 10.4.75 The train service specification assumed that there would be train movements to and from the rolling stock depot in the middle, as well as at the start and end, of day to support the efficient use of rolling stock and operating costs. As a result, the sites along the main HS2 route would need grade separated junctions with acceleration and deceleration tracks to allow the trains quickly to join or leave the fastest sections of the main line.
- 10.4.76 The two strongest options were at Birmingham Interchange and Washwood Heath. Four options immediately adjacent to Birmingham Interchange station were prepared, one on the west side and three to the east, each with a different configuration of reversing sidings and access to HS2 main line. This study demonstrated that Birmingham Interchange would be viable, particularly if a direct connection were provided from the north. However, it would entail running empty trains to the depot on the main line and reversing moves would result in additional unit mileage and crew hours.
- 10.4.77 Taking account of the wide range of environmental factors, the setting of the depot at the Birmingham Interchange site is less environmentally favourable than Washwood Heath and would cost more. The additional costs are largely due to earthworks and structures to form grade separated junctions where the tracks cross the M6 and M42. HS2 Ltd concluded that the depot should be located at Washwood Heath as previously proposed.

11 Local alternatives

11.1 Introduction

- 11.1.1 This section describes the main local alternatives that were considered during development of the Proposed Scheme prior to January 2012.
- 11.1.2 The main local alternatives were addressed by HS2 Ltd in Autumn 2011, in response to feedback following publication of their preferred route for consultation purposes earlier that year (the consultation route). They comprised alternatives raised during the course of consultation, alternatives facilitated by lower speeds and alternative locations for the infrastructure maintenance depot. Local alternatives considered since January 2012 are reported in Volume 2: CFA reports.

11.2 Alternatives to the consultation route

- 11.2.1 Most of these alternatives took the form of different alignments, and were intended to address the environmental impacts of the Proposed Scheme at specific locations. The alternatives were assessed against factors such as their cost, engineering feasibility, impact on journey time and compliance with the AoS criteria.
- 11.2.2 In some locations it was concluded that the alternatives proposed did not offer any net benefit and the alignment used for the consultation scheme was retained. In others the route was amended. The revised scheme formed the basis of the route that was the subject of the Government's announcement in January 2012.
- 11.2.3 The local route alternatives considered during this process are set out in Table 8 for relevant locations. In each case, the issue raised by the consultation scheme is given and the design response (i.e. to amend the scheme or not) is explained. The technical reports supporting this process were issued by HS2 Ltd in January 2012²¹⁴ as part of the Government's announcement. Alternatives that have been the subject of detailed design work since that time are reported in Volume 2: CFA reports.

Table 8: Main local alternatives considered following consultation prior to January 2012

Location	Concern or proposal raised during consultation	Project response (January 2012)
Euston	Consider options for avoiding or reducing property demolitions, especially of listed buildings.	This was not adopted in January 2012 ²¹⁵ .
HS1 Link	Avoid or reduce disruption to NLL.	This was not adopted in January 2012.
London Tunnel	Re-align to run beneath WCML to avoid perceived risks.	This was not adopted in January 2012.
	Relocate vent shaft from Salusbury Road.	This was not adopted in January 2012.
Northolt Corridor	Consider tunnelling to reduce impacts relating to land required, noise and Northolt Junction.	Introduce a 4.4km (2.75 mile) bored tunnel along the Northolt corridor.

²¹⁴ Department of Transport (2012), *Review of possible refinements to the proposed HS2 London to West Midlands Route*.

²¹⁵ Since January 2012 the design now avoids demolition of the Grade II* listed building 1-9 Melton Street. This is described in Volume 2: Euston -Station and Approach (CFA 1).

Location	Concern or proposal raised during consultation	Project response (January 2012)
Colne Valley	Consider re-aligning viaduct to avoid impact on Hillingdon Outdoor Activity Centre.	This was not adopted in January 2012.
M25 to Amersham (Chiltern tunnel)	Consider re-aligning and extending tunnel to reduce impacts on aquifer, land required, visual amenity, landscape and the setting of cultural heritage assets.	Introduce a longer, continuous tunnel from Little Missenden to the M25 through the Chilterns AONB.
South Heath	Consider options for reducing visual, landscape and noise impacts.	Introduce an extension to the green tunnel at South Heath.
Wendover Dean	Lower alignment to eliminate need for a viaduct within AONB.	This was not adopted in January 2012.
Wendover	Consider options for reducing visual, landscape, noise, demolition and road closure impacts within AONB and close to residential area.	Introduce a longer green tunnel to reduce impacts around Wendover.
Stoke Mandeville and Aylesbury	Consider options for reducing visual and noise impacts on residential area and setting of Hartwell House.	Lower the alignment past Aylesbury and Stoke Mandeville.
Quainton	Consider options for minimising the diversion of Station Road.	This was not adopted in January 2012.
Twyford	Consider options for reducing impacts due to proximity to the village.	Move the route further away from Twyford.
Turweston and Greatworth	Consider options for reducing impact on the villages due to proximity and vertical alignment.	Lower the alignment and introduce a green tunnel past Greatworth and a short green tunnel at Turweston.
Edgcote	Consider options for avoiding or reducing impacts on a Scheduled Monument, Battlefield and the setting of Edgcote House and Park.	Curve the route to avoid a cluster of important heritage sites at Edgcote.
Chipping Warden and Aston le Walls	Consider options for reducing impact due to proximity to villages.	Introduce a longer green tunnel past Chipping Warden and Aston le Walls.
Ladbroke to Southam	Consider options for reducing impacts on Long Itchington Wood, employment site and polo ground.	Introduce a longer bored tunnel at Long Itchington Wood.
Stoneleigh and Kenilworth	Consider options for reducing impacts on South Cubbington Wood, listed Dalehouse Farm, Stoneleigh Conference and Exhibition Centre and Kenilworth Golf Club.	Move the route slightly further east to avoid Kenilworth Golf Club, lower it further into cutting through the National Agricultural Centre, and introduce a retained cutting through South Cubbington Wood.
Burton Green	Increase the length of green tunnel and consider options for reducing the impact on a local walking/cycling route.	A shallower cutting and longer green tunnel at n Burton Green.

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