HS2

October 2018

High Speed Rail (Crewe to Manchester and West Midlands to Leeds)

Working Draft Environmental Statement

Volume 1: Introduction and methodology

HS2

October 2018

High Speed Rail (Crewe to Manchester and West Midlands to Leeds)

Working Draft Environmental Statement

Volume 1: Introduction and methodology

Department for Transport

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

High Speed Two (HS2) Limited,
Two Snowhill
Snow Hill Queensway
Birmingham B4 6GA

Telephone: 08081 434 434

General email enquiries: HS2enquiries@hs2.org.uk

Website: www.hs2.org.uk

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

AECOM CAPITA lineco forward together

ARUP + ERM | FOSTER + PARTNERS | JACOBS RAMBOLL | TYPSA | COSTAIN

MWJV

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

recycle

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

Contents

List of figures

List of tables

Preface

The working draft Environmental Statement

This report is Volume 1 of the working draft Environmental Statement (ES) for Phase 2b of High Speed Two (HS2). The purpose of the working draft ES is to provide the public and other stakeholders with an opportunity to review and comment on preliminary environmental information for Phase 2b of HS2, which is based on a stage in the ongoing design development and environmental assessment process. Nothing included at this stage is intended to limit the form of the final scheme that will be presented in the hybrid Bill and formal ES in light of further scheme development and the ongoing discussions with stakeholders such as Transport for the North and Midlands Connect. Consultation on the working draft ES is being undertaken to help inform the ongoing design and environmental assessment in advance of producing a statutory formal ES. The formal ES will accompany the deposit of the hybrid Bill for Phase 2b of HS2.

Phase 2b comprises the section of the proposed HS2 rail network, from Crewe to Manchester (and a connection onto the West Coast Main Line (WCML)) (the western leg), and from the West Midlands to Leeds (and a connection onto, and part electrification of, the Midland Main Line (MML) and a connection onto the East Coast Main Line (ECML)) via the East Midlands and South Yorkshire (the eastern leg). Collectively, this is referred to in this working draft ES as the 'Proposed Scheme'. The working draft ES describes the Proposed Scheme and reports its likely significant environmental effects and the measures proposed to mitigate those effects, based on a stage in the ongoing design and environmental assessment.

The hybrid Bill for Phase One of the HS2 network, between London and the West Midlands, was the subject of an ES deposited in November 2013, followed by ESs deposited with Additional Provisions to that Bill in 2014 and 2015. The Phase One hybrid Bill received Royal Assent in February 2017 and pre-construction work on Phase One commenced in July 2017.

The hybrid Bill for Phase 2a of the HS2 network, between the West Midlands and Crewe, was the subject of an ES deposited in July 2017, followed by a subsequent ES deposited with an Additional Provision to that Bill in March 2018. The Phase 2a Bill is expected to receive Royal Assent in 2019.

Consultation on the working draft Environmental Statement

The public has an opportunity to comment on this working draft ES. The period of public consultation is taking place during October 2018 – December 2018; the first day of the consultation period being the date the Secretary of State for Transport formally announces the consultation and the publication of the working draft ES documents on www.gov.uk/hs2.

Structure of the HS2 Phase 2b working draft Environmental Statement

This report is Volume 1 of the working draft ES for Phase 2b of HS2. The working draft ES describes the design of the Proposed Scheme and reports the likely significant environmental effects of the construction and operation of the Proposed Scheme and proposed mitigation and monitoring measures, based on a stage in the ongoing design and environmental assessment process. The report will be updated for the formal ES to reflect further work on the design, assessment and mitigation and monitoring measures between now and when the hybrid Bill is deposited. The structure of the working draft ES is shown in Figure 1.

This working draft ES has been prepared by persons who have sufficient expertise to ensure the completeness and technical quality of the statement.

The working draft ES comprises the following documents:

Non-technical summary

This provides a summary in non-technical language of the following, identified at a stage in the ongoing design and environmental assessment:

- the Proposed Scheme and the reasonable alternatives studied;
- the likely significant beneficial and adverse effects of the Proposed Scheme;
- the means to avoid or reduce likely significant environmental effects; and
- an outline of the monitoring measures to manage the effects of construction and the effectiveness of mitigation post construction, as well as appropriate monitoring during operation.

Glossary of terms and list of abbreviations

This contains terms and abbreviations, including units of measurement, used throughout the working draft ES.

Volume 1: Introduction and methodology

This provides:

- a description of HS2, the environmental impact assessment (EIA) process and the approach to consultation and engagement;
- details of the permanent features of the Proposed Scheme and general construction techniques, based on a stage in the ongoing design;
- a summary of the scope and methodology for the environmental topics;
- an outline of the general approach to mitigation;
- an outline of the approach to monitoring, including measures to manage the effects of construction, the effectiveness of mitigation post construction, as well as the approach to monitoring during the operational phase, based on a stage in the ongoing design; and
- a summary of the reasonable alternatives studied (including local alternatives studied

prior to the Government's announcement of the preferred route in July 2017). Local alternatives studied post July 2017 are reported in the relevant Volume 2: Community area reports.

Volume 2: Community area reports and map books

These cover the following community areas:

- western leg: MA01 Hough to Walley's Green; MA02 Wimboldsley to Lostock Gralam; MA03 Pickmere to Agden and Hulseheath; MA04 Broomedge to Glazebrook; MA05 Risley to Bamfurlong; MA06 Hulseheath to Manchester Airport; MA07 Davenport Green to Ardwick; MA08 Manchester Piccadilly Station; and
- eastern leg: LA01 Lea Marston to Tamworth; LA02 Birchmoor to Austrey; LA03 Appleby Parva to Ashby-de-la-Zouch; LA04 Coleorton to Kegworth; LA05 Ratcliffe-on-Soar to Long Eaton; LA06 Stapleford to Nuthall; LA07 Hucknall to Selston; LA08 Pinxton to Newton and Huthwaite; LA09 Stonebroom to Clay Cross; LA10 Tibshelf to Shuttlewood; LA11 Staveley to Aston; LA12 Ulley to Bramley; LA13 Ravenfield to Clayton; LA14 South Kirkby to Sharlston Common; LA15 Warmfield to Swillington and Woodlesford; LA16 Garforth and Church Fenton; LA17 Stourton to Hunslet; and LA18 Leeds Station.

The reports provide the following information for each area, as identified at a stage in the ongoing design and environmental assessment:

- an overview of the area;
- a description of the construction and operation of the Proposed Scheme within the area;
- a summary of the local alternatives considered since the Government's announcement of the preferred route in July 2017;
- a description of the environmental baseline;
- a description of the likely significant beneficial and adverse effects of the Proposed Scheme;
- the proposed means of avoiding, reducing or managing the likely significant adverse effects; and
- where possible, the proposals for monitoring, including measures during and post construction, and during the operational phase.

The maps relevant to each community area are provided in a separate Volume 2: Community area map book. These maps include the location of the key environmental features (Map Series CT-10), key construction features (Map Series CT-05) and operation features (Map Series CT-06) of the Proposed Scheme. There are also specific maps showing proposed viewpoint and photomontage locations (Map Series LV-00, LV-02, LV-03, and LV-04, to be read in conjunction with Section 11, Landscape and visual of the Volume 2: Community area reports), operational sound contour maps (Map Series SV-01, to be read in conjunction with Section 13, Sound, noise and vibration of the Volume 2: Community area reports) and maps showing key surface water and groundwater features (Map Series WR-01 and WR-02, to be read in conjunction with Section 15, Water resources and flood risk of the Volume 2: Community area reports).

In addition to the community areas detailed above, reports are provided for community areas within which electrification of a section of the MML is proposed: MML01 Danesmoor to Brierley Bridge and MML02 Unstone Green to Sheffield Station. These reports are provided at an earlier stage of the design and environmental assessment process, following the amendment of the route of the Proposed Scheme to include the electrification of a section of the MML between Clay Cross and Sheffield Midland Station. This would enable high speed trains to connect to Chesterfield and Sheffield as part of the Proposed Scheme. They include for each area:

- an overview of the area;
- a description of the proposed works within the area, based on a stage in the ongoing design;
- an outline of potential effects; and
- an overview of stakeholder engagement and consultation to be carried out as part of the EIA process.

Mitigation measures have not been identified at this stage of the design and environmental assessment process in relation to the likely effects arising from construction and operation of the Proposed Scheme for the MML01 Danesmoor to Brierley Bridge and MML02 Unstone Green to Sheffield Station areas. Any required mitigation measures will be reported in the formal ES. In addition, any required environmental monitoring during operation of the Proposed Scheme will be reported in the formal ES.

Volume 3: Route-wide effects

This describes the effects that are likely to occur at a geographical scale greater than the community areas described in the Volume 2: Community area reports, based on a stage in the ongoing design and environmental assessment.

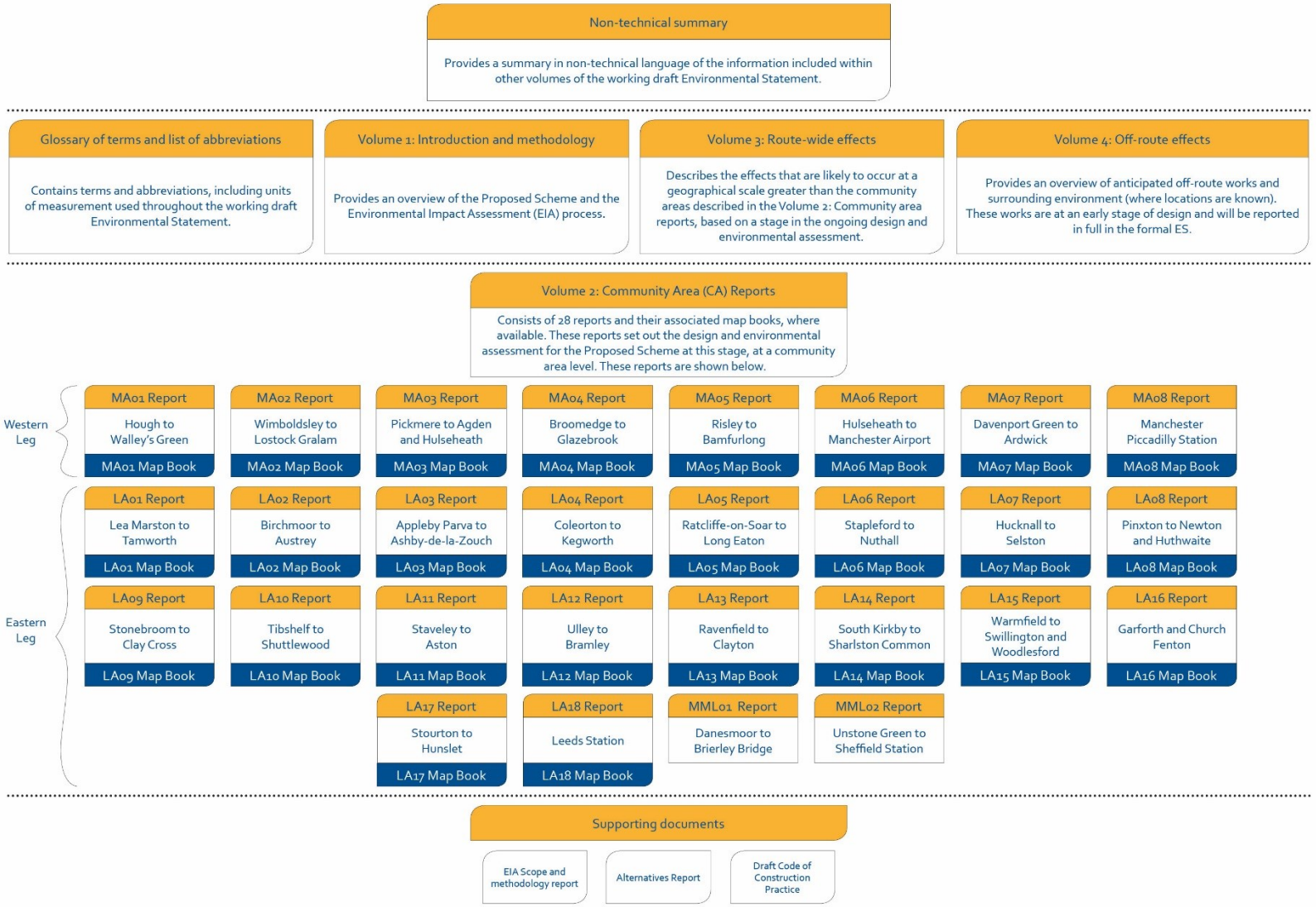
Volume 4: Off-route effects

This provides an overview of anticipated off-route works and surrounding environment (where locations are known) together with indicative lists of environmental topics expected to be included in the formal ES in due course. These works are at an early stage of design and will be reported in full in the formal ES.

Supporting documents

- EIA Scope and Methodology Report: this outlines the scope and methodology adopted for the EIA. HS2 Ltd consulted on a draft of the EIA Scope and Methodology Report (SMR) between July and September 2017. This updated version takes into consideration comments received, where appropriate, in addition to changes required as a result of updates to legislation or industry best practice guidance.
- Alternatives report: this describes the evolution of the Proposed Scheme and the reasonable alternatives considered at this stage of the design, at the strategic, route-wide, route corridor and local levels.
- Draft Code of Construction Practice (CoCP): this sets out measures and standards to provide effective planning, management and control of potential impacts on individuals, communities and the environment during construction.

Figure 1: Structure of the working draft Environmental Statement



Structure of this report

Volume 1, this report, comprises the following sections:

- Section 1: Introduction - introduces the Proposed Scheme, the hybrid Bill procedure and the EIA process;
- Section 2: Background to HS2 - explains how the Government's case for the Proposed Scheme has evolved;
- Section 3: Stakeholder engagement and consultation - describes the approach to consultation and engagement for the working draft ES and the process going forward;
- Section 4: The Proposed Scheme - provides a summary of the Proposed Scheme, the service pattern and other operational characteristics;
- Section 5: Permanent features of the Proposed Scheme - describes the main features of the Proposed Scheme;
- Section 6: Construction of the Proposed Scheme - describes the general construction methods likely to be used;
- Section 7: Environmental impact assessment - explains how the EIA is being carried out and the scope of the assessment;
- Section 8: Scope and methodology for environmental topics - provides an outline of the approach adopted for each environmental topic;
- Section 9: Approach to mitigation and monitoring - describes the proposed mitigation approach for each environmental topic and the approach to monitoring, including measures to manage the effects of construction, the effectiveness of mitigation post construction, as well as the approach to monitoring during the operational phase;
- Section 10: Strategic, route-wide and route corridor alternatives - provides a summary of the various reasonable alternatives that have been studied at a strategic, route-wide and route corridor level; and
- Section 11: Local alternatives - explains the reasonable local alternatives studied prior to the announcement of the Phase 2b preferred route in July 2017. Reasonable local alternatives studied after July 2017 are reported in the Volume 2: Community area reports.

1 Introduction

1.1 Overview of High Speed Two

1.1.1 High Speed Two (HS2) is a new high speed railway proposed by the Government to connect major cities in Britain. New stations in London, Birmingham, Leeds, Manchester and East Midlands would be served by high speed trains running at speeds of up to 360 kilometres per hour (kph) (225 miles per hour (mph)). HS2 trains would also run on the existing network to serve destinations including Crewe, Preston, Liverpool, Sheffield, Newcastle, York, Glasgow and Edinburgh.

1.1.2 In January 2012, following a consultation exercise, the Government announced its intention to develop a Y-shaped high speed rail network, which would be brought forward in two phases. The 2012 decision confirmed the Government's preferred route for a high speed line between London and the West Midlands, called Phase One. In November 2013, HS2 Ltd deposited a hybrid Bill in Parliament to seek powers for the construction and operation of Phase One. The High Speed Rail (London – West Midlands) Act received Royal Assent in February 2017 and pre-construction work on Phase One commenced in July 2017.

1.1.3 In January 2013, the Government announced its initial preferred route for Phase Two between the West Midlands, Leeds and Manchester. Following some minor amendments, the proposed route was subject to a seven-month public consultation from July 2013 until January 2014.

1.1.4 In two reports, HS2 Plus[1] and Rebalancing Britain[2], Sir David Higgins recommended accelerating the section of the Phase Two route between the West Midlands and Crewe to deliver some of the benefits that HS2 would bring to the region and the North sooner. In the November 2015 Command Paper High Speed Two: East and West: The next steps to Crewe and beyond[3], the Government announced its intention to bring forward the route between the West Midlands and Crewe, and set out the preferred line of route for what is known as Phase 2a. Phase 2a involves the construction of the first approximately 58km of the western leg of Phase Two from the end of the Phase One route to Crewe, with a connection to the West Coast Main Line (WCML) at Crewe. In July 2017, HS2 Ltd deposited a hybrid Bill to Parliament to seek powers for the construction and operation of Phase 2a. A subsequent ES deposited with an Additional Provision to that Bill followed in March 2018. The High Speed Rail (West Midlands - Crewe) Act is expected to receive Royal Assent in 2019.

[1] HS2 Ltd (2014). *HS2 Plus – A report by David Higgins*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/374695/HS2_Plus_-_A_report_by_David_Higgins.pdf
[2] HS2 Ltd (2014). *Rebalancing Britain – From HS2 towards a national transport strategy*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/374709/Rebalancing_Britain_-_From_HS2_towards_a_national_transport_strategy.pdf
[3] Department for Transport (2015). *High Speed Two: East and West: The next steps to Crewe and beyond November 2015*. Cm 9157. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/480712/hs2-east-and-west.pdf

1.1.5 On 15 November 2016 the Government set out the majority of its preferred route[4] between Crewe and Manchester and between the West Midlands and Leeds, referred to as Phase 2b and completing what is known as the 'Y network'. Alongside the preferred route of Phase 2b, the Government also announced a consultation on seven route refinement areas.

1.1.6 On 17 July 2017, the Government announced a decision on these refinements and confirmed the remainder of the preferred route for Phase 2b.

1.1.7 Phase 2b, referred to as 'the Proposed Scheme', is the subject of this working draft Environmental Statement (ES). The working draft ES is an interim report presenting preliminary environmental information for consultation. The design and assessment of the Proposed Scheme are at an early stage of development and are presented here to enable the public and stakeholders to provide comments, which will be taken into account, as appropriate. The environmental impact assessment (EIA) and design of the Proposed Scheme will continue to be refined during and following this consultation and reported in the formal ES. Therefore, nothing included at this stage is intended to limit the form of the final scheme that will be presented in the hybrid Bill and formal ES.

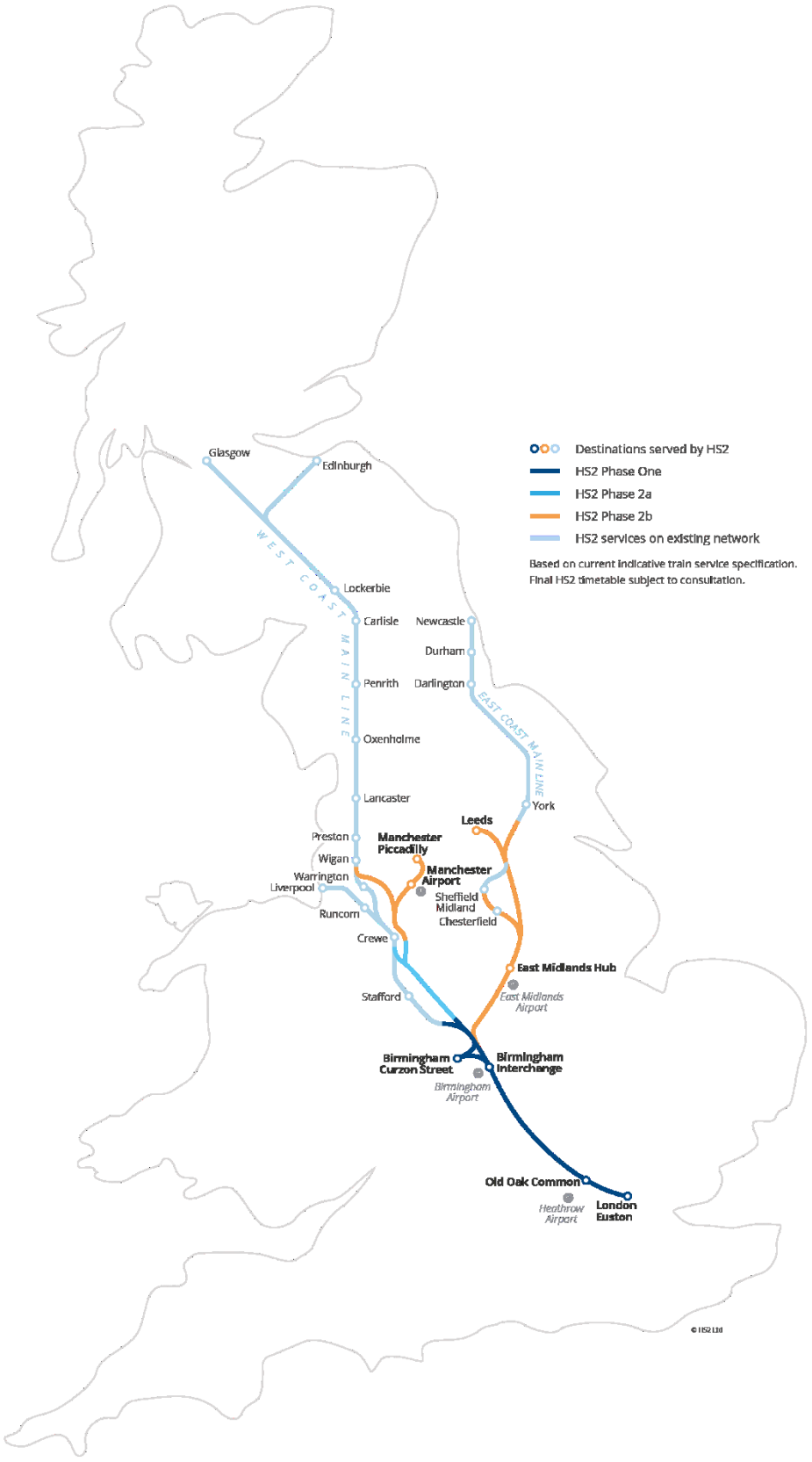
1.1.8 The Proposed Scheme comprises the route from Crewe to Manchester with a connection onto the WCML (referred to as the 'western leg'), and from the West Midlands to Leeds via the East Midlands and South Yorkshire with a connection onto, and part electrification of, the Midland Main Line (MML) and a connection onto the East Coast Main Line (ECML) (referred to as 'the eastern leg'). Since the Government announced the preferred route for Phase 2b in July 2017, the Proposed Scheme was amended to include the electrification of a section of the MML between Clay Cross and Sheffield Midland Station[5]. This would enable high speed trains to connect to Chesterfield and Sheffield as part of the Proposed Scheme. The design of the proposed electrification of this section of the MML is at an earlier stage of development (as reported in the MML01 and MML02 Volume 2: Community area reports) and the outcome of the environmental assessment of the likely significant effects of the electrification works will be reported in the formal ES.

1.1.9 The powers for Phase 2b will be sought through a hybrid Bill ('the Bill') that is expected to be deposited in Parliament in 2020. Construction of Phase 2b is anticipated to commence in approximately 2023, with operation planned to start around 2033.

[4] Department for Transport (2016). High Speed Two: From Crewe to Manchester, the West Midlands to Leeds and beyond. Cm 9355, November 2016. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/568208/high-speed-two-crewe-manchester-west-midlands-leeds-web-version.pdf

[5] HS2 Ltd (2018). Press release: HS2 Ltd to undertake development works for electrification of the Midland Main Line. Available online at: https://www.gov.uk/government/news/hs2-ltd-to-undertake-development-works-for-electrification-of-the-midland-main-line

Figure 2: The HS2 network

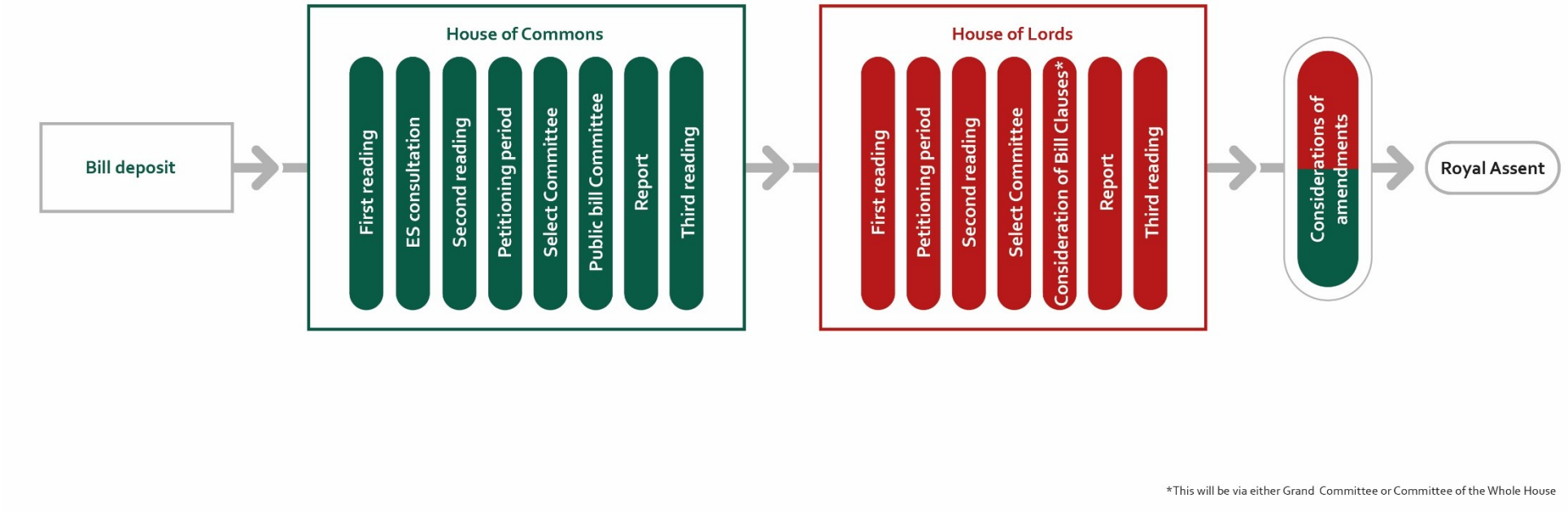


1.2 Hybrid Bill procedure

1.2.1 The Government occasionally uses hybrid Bills to promote major infrastructure projects of national importance. They have been used most recently for Phase 2a[6] and Phase One of HS2[7] and for other rail schemes, such as the Channel Tunnel Rail Link Act 1996[8] (known as HS1) and the Crossrail Act 2008[9]. Use of primary legislation rather than promoting a development consent order under the Planning Act 2008[10] allows the Government to seek the full range of statutory powers and authorisations that a project of this size and complexity requires. This may include revisions to the rail regulatory regime and the planning regime, as well as provisions to enable the making of subsequent orders and regulations by way of statutory instrument. The hybrid Bill process is shown in Figure 3 and described in the following section.

[6] *The High Speed Rail (West Midlands – Crewe) Bill* as introduced to the House of Commons Select Committee, March 2016. Available online at: https://publications.parliament.uk/pa/bills/cbill/2017-2019/0006/cbill_2017-20190006_en_1.htm
[7] *The High Speed Rail (London – West Midlands) Bill* as amended in the House of Commons Select Committee, March 2016. Available online at: http://www.publications.parliament.uk/pa/bills/cbill/2015-2016/0137/cbill_2015-20160137_en_1.htm
[8] *Channel Tunnel Rail Link Act 1996*. Her Majesty's Stationery Office, London.
[9] *Crossrail Act 2008*. Her Majesty's Stationery Office, London.
[10] *Planning Act 2008*. Her Majesty's Stationery Office, London.

Figure 3: Hybrid Bill procedure



1.2.2 A hybrid Bill is draft legislation that affects public and private interests, and the procedures followed in Parliament in considering such a Bill incorporate aspects of both public and private Bill procedures before it can be enacted.

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 an ES describing the likely significant effects of the Proposed Scheme on people and the environment together with a report on the reasonable alternatives studied (which is included within the ES).

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 undertaken by the Secretary of State for Transport and held over a period of at least 70 days (10 weeks). A summary of issues raised in responses to this consultation will be provided by Parliament's independent assessor to inform Members of Parliament (MPs) ahead of the Second Reading debate on the Bill.

1.2.5 At Second Reading, the principle of the Bill is debated, including the need for the Proposed Scheme. If the Bill is given a Second Reading, a Select Committee is then appointed[11] to hear petitions against the Bill.

1.2.6 Second Reading is followed by a petitioning period during which those whose property or interests that are specially and directly affected by the Bill can petition[12]. A petition is a summary of objections to particular aspects of the Bill. It is a request to the House of Commons for the petitioner to be allowed to argue their case before the Select Committee. Petitions have to be deposited within a stipulated time in the Private Bill Office and must conform to the rules for petitions against private Bills. Guidance on petitioning against hybrid Bills is published by the Private Bill Office of the House of Commons[13]. These petitions are then considered by the Select Committee, which can require the Government to change its plans, either by amendments to the Bill or changes to the commitments made by HS2 Ltd.

1.2.7 A Public Bill Committee of MPs then reviews the Public aspects of the Bill, and may make amendments to it. The Bill then progresses to Report and Third Reading stages in the House of Commons, during which further amendments may be made.

1.2.8 The Bill is then sent to the House of Lords where it follows a similar process as in the House of Commons, including a further opportunity for objectors to petition and to appear before a Select Committee. The petitioning period in the House of Lords follows First Reading and petitions must conform to the rules for petitions against private bills.

1.2.9 The Bill returns to the Commons for consideration of any amendments made in the House of Lords, after which it can then receive Royal Assent, becoming an Act of

[11] In the House of Commons, Select Committee members are Members of Parliament who have no constituency interest in the Bill.
[12] The petitioning period will be determined during the Second Reading.
[13] More information on who may petition against the Bill, and how to do so, is available on Parliament's website (http://www.parliament.uk).

Parliament[14]. Upon enactment, the Act of Parliament would grant deemed outline planning permission for the scheduled works as defined within the Act.

1.2.10 The powers within the hybrid Bill for the Proposed Scheme are likely to include:

- authority to nominate an undertaker to build, operate and maintain the railway line;
- authority to construct, operate and maintain the railway and associated major works as described in the Act (and its accompanying plans and sections) and other ancillary works;
- powers of compulsory acquisition or temporary possession of land and properties required for the Proposed Scheme;
- powers to divert or protect gas, water, telecommunications and electricity infrastructure, which might be affected by the Proposed Scheme; and
- powers over rights of way;
- powers to carry out works to listed buildings and buildings in conservation areas; and
- powers to carry out protective works to buildings and third party infrastructure.

1.2.11 The Parliamentary Plans and Sections accompanying the Bill will show, amongst other things, the land required, both permanently and temporarily, the 'limits of deviation' and 'limits of land to be acquired or used'[15] for the construction of the Proposed Scheme, as described in Section 1.3 of this report.

1.3 The need for EIA and the role of an ES

1.3.1 The European Union (EU) EIA Directive (2014/52/EU)[16] provides for the assessment of the environmental impacts of public and private projects. The objective of the EU 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 Under the relevant Standing Orders of Parliament, an ES must be deposited at the same time as the Bill is introduced. The EIA must fulfil the requirements of the Town and Country Planning (Environmental Impact Assessment) Regulations 2017 (SI

[14] Parliamentary procedure is determined by Parliament and so is liable to change.
[15] The Parliamentary Plans and Sections show the centreline of works, the Limits of Deviation (LOD) and the Limits of Land to be Acquired or Used (LLAU). The LOD are used to show the limits of the scheduled works, as listed in Schedule 1 of the Bill. These limits show the extent of the scheduled works based on the design developed to the stage necessary for the preparation of the Bill. The LOD provide allowances for contingencies, working spaces and similar factors. The LLAU are used to show additional limits for other works (i.e. ancillary works such as the provision of environmental mitigation).
[16] Official Journal of the European Union, *Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment.*

2017/571)[17] (the 'EIA Regulations') which reflect the EU Directive requirements for assessment of the effects of certain public and private projects on the environment.

1.3.3 In March 2017, the United Kingdom (UK) notified the EU, under Article 50 of the EU Treaty, that the UK would leave the EU. Until exit negotiations are concluded, the UK remains a full member of the EU and all of the rights and obligations of EU membership apply. Environmental assessment has been and will continue to be integral to the development of the Proposed Scheme.

1.3.4 Standing Order 27A[18] requires that the ES (i.e. the formal ES) should include:

- information set out in regulation 18 of the EIA Regulations;
- any additional information specified in Schedule 4 to the EIA Regulations which is relevant to the specific characteristics of the works authorised by the hybrid Bill and to the environmental features likely to be significantly affected; and
- a report which identifies, describes and evaluates reasonable alternatives to the works authorised by the hybrid Bill, taking into account the objectives and geographical scope of the hybrid Bill.

1.3.5 The information required by regulation 18 comprises:

- a description of the proposed development comprising information on the site, design, size and other relevant features of the development;
- a description of the likely significant effects of the proposed development on the environment;
- a description of any features of the proposed development, or measures proposed in order to avoid, prevent or reduce the likely significant adverse effects on the environment;
- a description of the reasonable alternatives studied by the developer, which are relevant to the proposed development and its specific characteristics, and an indication of the main reasons for the option chosen, taking into account the effects of the development on the environment; and
- a non-technical summary of the information above.

1.3.6 The 2017 EIA Regulations reflect the broader scope of assessment that is required under the 2014 EIA Directive, including: sustainability, biodiversity protection, climate change, health and the risks of major accidents and natural disasters. The formal ES will be compiled in accordance with that broader scope.

1.3.7 The environmental assessment reported in this working draft ES is based on the following:

- the permanent scheme as shown in Map Series CT-06, including the mitigation

[17] Town and Country Planning (Environmental Impact Assessment) Regulations, (2017). SI 2017 No. 571. London, Her Majesty's Stationery Office.
[18] House of Commons (2017). *Standing Order 27A relating to private business (environmental assessment),* House of Commons.

measures shown therein, based on a stage in the ongoing design and as described in Volume 2: Community area reports (Section 2);

- the construction arrangements, including land requirements, based on a stage in the ongoing design, shown on Map Series CT-05 and described in Volume 2: Community area reports (Section 2);
- the approach to mitigation and monitoring described in Section 9 of this report;
- the indicative construction programme shown in Volume 2: Community area reports (Section 2) and the construction durations described in the text therein; and
- the operational characteristics described in Volume 2: Community area reports (Section 2) and in Section 4 of this report.

1.3.8 In cases where information is not available at this time, the assessment is either based on a precautionary approach using reasonable worst-case assumptions and is reported in the working draft ES or is ongoing and will be reported in the formal ES.

1.3.9 The Parliamentary Plans and Sections that will accompany the Bill will show the vertical and horizontal alignment of the Proposed Scheme and the scheduled works required to construct it. The powers that would be acquired through the Bill process include the power to deviate within 'limits of deviation' from the alignments shown on the Parliamentary Plans and Sections. These limits allow those who are appointed to implement the powers (known as the nominated undertaker) to deviate when constructing or maintaining the Proposed Scheme, in the following directions:

- laterally to any extent within the limits of deviation for that work, as identified 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.

1.3.10 The formal ES will include a description of any differences to the likely significant effects that would arise and any further mitigation that would be provided were the Proposed Scheme to be built along a different alignment within these limits. Changes that are considered unlikely or impossible will not be assessed.

1.3.11 Detailed technical information supporting the assessment will be published as part of, or alongside, the formal ES. This will follow the assessment and reporting approach used for the HS2 Phase 2a ES and will include certain reports and maps containing background information and data (BID), which will not form part of the formal ES but will be available online at www.gov.uk/hs2.

1.4 Meeting environmental commitments after consent

1.4.1 The Secretary of State for Transport will establish a set of controls known as Environmental Minimum Requirements (EMRs). The nominated undertaker and its contractors would be contractually bound to comply with the EMRs and other controls contained within the Bill and other existing legislation.

1.4.2 During the passage of the Bill, the Secretary of State for Transport will confirm to Parliament the scope of, and the documents forming, the EMRs; 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 EMRs, together with the controls in the Bill, would ensure that the impacts identified in the formal ES would not be exceeded, unless:

- this results from a change in circumstances that was not foreseeable at the time the formal ES was prepared;
- any such changes would be unlikely to have significant adverse environmental effects;
- the relevant works would be subject to a separate consent process and further EIA; or
- any such change results from a change or extension to the project, where that change or extension does not itself require an EIA.

1.4.4 The EMRs would also impose requirements on the nominated undertaker to use reasonable endeavours to adopt measures to reduce the adverse environmental effects reported in the formal ES, provided that this does not add unreasonable cost or delay to the construction or operation of the Proposed Scheme. The 2014 EIA Directive makes provision for post-EIA monitoring of significant adverse effects on the environment in appropriate cases. HS2 Ltd will work with the relevant responsible authorities to develop the necessary monitoring in appropriate cases.

1.4.5 The EMRs will also detail any specific requirements on the nominated undertaker to monitor the impacts of construction; and the post-construction performance of mitigation measures implemented.

1.4.6 The EMRs will be set out in the formal ES and are expected to include:

- a Code of Construction Practice (CoCP), which will set out measures to provide effective planning, management and control during construction;
- an Environmental Memorandum, which provides 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 the Proposed Scheme is carried out with due regard for environmental considerations;
- a Planning Memorandum, which will set out the agreements between the Department for Transport, the nominated undertaker 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, depots, bridges, viaducts, 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 would 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 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 Assembly[19] defined sustainable development as meeting the needs of the present without compromising the ability of future generations to meet their own needs.

1.5.2 The Government's commitment to sustainable development builds on the Department for Environment, Food and Rural Affairs (Defra) strategy set out in Securing the Future[20], which identify 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.

1.5.3 The National Planning Policy Framework (NPPF)[21] sets out the Government's strategic guidance on development planning in England and Wales[22]. 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

[19] UN General Assembly (1989). *Implementation of General Assembly resolutions 42/186 and 42/187: resolution/adopted by the General Assembly*. A/RES/44/227.
[20] Defra (2005). *Securing the future – delivering UK sustainable development strategy* (PB10589). Available online at: https://sustainabledevelopment.un.org/content/documents/1408uk.pdf
[21] Department for Communities and Local Government (2012). *National Planning Policy Framework*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/728643/Revised_NPPF_2018.pdf
[22] In July 2018, the NPPF was revised and has been updated with reforms to be implemented. The assessment will be updated and reported in the formal ES.

- 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).

1.5.4 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.

1.5.5 HS2 Ltd's Sustainability Policy (2017)[23] sets out its priority for sustainable design, which will help to reduce adverse environmental effects. The Sustainability Policy sets out the following principles for sustainability in:

- spreading the benefits: Economic growth and community regeneration;
- opportunities for all: Skills, employment and education;
- safe at heart: Health, safety and wellbeing;
- respecting our surroundings: Environmental protection and management; and
- standing the test of time: Design that is future-proof.

1.5.6 Each of the Sustainability Policy principles is further described in the HS2 Sustainability Approach Document[24].

1.5.7 Supporting the Sustainability Policy, an Environmental Policy[25] states HS2 Ltd's commitment to "developing an exemplar project, and to limiting negative impacts through design, mitigation and by challenging industry standards whilst seeking environmental enhancements and benefits". The policy also sets out HS2 Ltd's principles for environmental sustainability, covering the following environmental topics: biodiversity; landscape; noise and vibration; carbon; combined effects of the project and climate change; air quality; water resources; historic environment; soils and agriculture; and sustainable materials and waste.

1.5.8 These principles of the NPPF and HS2 Ltd's Sustainability Policy and Environmental Policy have been, and continue to be, an important influence on the development of the Proposed Scheme[26]. An appraisal of sustainability (AoS) has been used to appraise and report on the sustainability performance of the Phase Two (Phase 2a and 2b) proposals throughout their development.

[23] HS2 Ltd (2017). *Sustainability Policy*. Available online at: https://www.gov.uk/government/publications/hs2-sustainability-policy
[24] HS2 Ltd (2018). *HS2 Supplier Guide*. Available online at: https://www.gov.uk/government/publications/hs2-supplier-guide
[25] HS2 Ltd (2017). *Environmental Policy*. Available online at: https://www.gov.uk/government/publications/hs2-environmental-policy
[26] The NPPF is not applicable to the Proposed Scheme as consent is being sought through a hybrid Bill. However, for best practice and to achieve a sustainable scheme, the principles within the NPPF have been followed.

1.5.9 In July 2013, the Government published the *HS2 Phase Two Sustainability Statement*[27] as part of a public consultation on Phase Two and to inform the Government's decision on the preferred route for Phase Two. The Sustainability Statement described the extent to which the Government's proposed route for Phase Two (including Phase 2b) supported objectives for sustainable development, following the AoS. Four sustainable development priorities were used for the appraisal:

- reducing greenhouse gas emissions and combating climate change;
- protecting natural and cultural resources and providing environmental enhancement;
- creating sustainable communities; and
- sustainable consumption and production.

1.5.10 The Phase Two Sustainability Statement 2013 provided a systematic review of the scheme proposals using 18 sustainability topics, each under one of the four headings described above. This informed both the Proposed Scheme designs and the selection of alternative options for Phase Two as a whole, taking into account wider transport and economic objectives, operational requirements, cost and practicality. This was incorporated into decision-making on the development of the route, which helped refine the number of options down to a single preferred route.

1.5.11 Consultation on the route of HS2 Phase Two took place between July 2013 and January 2014. Question 7 of the consultation asked for feedback on the AoS of the Phase Two route, including the alternatives. HS2 Ltd produced the *Response to HS2 Phase Two Consultation: Appraisal of Sustainability (Question 7) Report for Government* to respond to the issues raised. The report was published by Government in November 2016 alongside a wider response to the consultation[28].

1.5.12 An updated *Sustainability Statement*[29] for Phase 2b was published in November 2016. As well as outlining the majority of the preferred scheme and the associated sustainability impacts, it also summarised the key changes from the 2013 consultation route. A further consultation was also launched on several changes to the route. This consultation took place between November 2016 and March 2017, with a decision on the Government's preferred route in July 2017.

1.5.13 The potential significant effects identified in the Sustainability Statement will be reviewed during the EIA and assessed in the context of the Proposed Scheme.

---

[27] Temple-ERM (2013). *Sustainability Statement - Volume 1: main report of the Appraisal of Sustainability*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/401154/pc205_vol_1_sustainability_statement_180713.pdf

[28] *HS2 Ltd (2016). High Speed Two Phase 2b Crewe to Manchester, West Midlands to Leeds Response to HS2 Phase Two Consultation: Appraisal of Sustainability (Question 7)*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/569783/Response_to_HS2_Phase_Two_Consultation_Question_7_report.pdf

[29] Temple-RSK (2016). *Sustainability Statement – Sustainability Statement including Post Consultation Update*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/568547/D25_WEB_C331_Sustainability_Statement_Including_Post_Consultation_Update_Volume_1_Main_Report_WEB_VERSION.pdf

1.6 The acquisition and use of land

1.6.1 The Bill for Phase 2b will include powers for the compulsory acquisition of land or rights in land for the Proposed Scheme. Payment of compensation for land compulsorily acquired will be in accordance with the general statutory framework set out under the Compensation Code[30]. Compensation for land used temporarily for construction will be paid in accordance with the provisions of the relevant schedule to the Bill.

1.6.2 The Parliamentary Plans and Book of Reference will show the extent of land that 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 and occupiers of such land.

1.6.3 The limits of deviation enable the Proposed Scheme to deviate slightly from the centre line of the works, or of footpaths, shown on the Parliamentary Plans and Sections as may be required following detailed design, but the scheme must remain within the land shown on the Parliamentary Plans and Sections. The nominated undertaker would 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.

[30] The compensation code is not a single document but a collective term used for the principles set out in Acts of Parliament, principally the Land Compensation Act 1961, the Compulsory Purchase Act 1965, the Land Compensation Act 1973, the Planning & Compulsory Purchase Act 1991 and the Planning & Compulsory Purchase Act 2004.This is supplemented by case law, relating to compensation for compulsory acquisition.

2 Background to High Speed Two

2.1 The need for high speed rail

2.1.1 The case for a high speed rail network has already been accepted in the High Speed Rail (London - West Midlands) Act 2017. A summary of the Government's rationale for pursuing a high speed rail network is set out in Section 10 of this report.

2.2 Evolution of High Speed Two Phase 2b

2.2.1 A summary of the development of the strategic case for a high speed rail network and for the HS2 Phase One and Phase 2a routes is contained within Volume 1 of the Phase One ES[31] and Phase 2a ES[32]. The main milestones informing the development of Phase 2b are summarised in Table 1.

Table 1: Main milestones in the development of Phase 2b

Date	Activity
January 2012	The Secretary of State for Transport 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 network. The network was to be brought forward in two phases, with powers sought initially for a London-West Midlands high speed line.
January 2013	Publication of *High speed rail: investing in Britain's future, Phase Two: The route to Leeds, Manchester and beyond*[33]. The Secretary of State for Transport announced the Government's intention to proceed with the planning and design of Phase Two, and published the initial preferred route to Leeds and Manchester. Published alongside this was a Sustainability Summary and initial preferred route plan and profile maps. Also published was HS2 Ltd's March 2012 advice to Government that helped inform the selection of the initial preferred route, including[34]: • options for Phase Two of the High Speed Network; • options for Phase Two of the High Speed Network AoS; • record of stakeholder engagement for Phase Two of the high speed rail network; • HS2 cost and risk model report; • options for Phase Two of the high speed rail network approach to design; • three Phase Two engineering options reports (West Midlands to Manchester, West Midlands to Leeds and Heathrow); and

[31] HS2 Ltd (2013). HS2 Phase One *Environmental St*atement. Available online at: https://www.gov.uk/government/collections/hs2-phase-one-environmental-statement-documents
[32] HS2 Ltd (2017). *West Midlands - Crewe Environmental Statement*, July 2017. Available online at: https://www.gov.uk/government/collections/hs2-phase-2a-environmental-statement
[33] Department for Transport (2013). *High speed rail: investing in Britain's future Phase Two: The route to Leeds, Manchester and beyond*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69738/hs2-phase-two-command-paper.pdf
[34] Department for Transport (2013). *HS2 Phase Two initial preferences*. Available online at: https://www.gov.uk/guidance/hs2-phase-two-initial-preferred-route-plan-and-profile-maps

Date	Activity
	• selecting an initial preferred scheme for HS2 Phase Two refinement work since March 2012.
July 2013	Launch of public consultation on the proposed route for Phase Two from the West Midlands to Manchester, Leeds and beyond. Consultation documents included supporting technical information (including maps) the Sustainability Statement and quick reference factsheets[35].
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 conventional rail network[36].
October 2013	Publication of the Economic Case for HS2 and Strategic Case for HS2.
November 2013	The Secretary of State for Transport announced that Sir David Higgins had been tasked with reporting on how to reduce the cost of HS2; how its benefits could be delivered earlier; and, how to ensure that HS2 delivers benefits like jobs and growth[37].
March 2014	Publication of *HS2 Plus – a report by David Higgins*, which recommended the accelerated delivery of the Phase 2a route to Crewe[38].
October 2014	Publication of *Rebalancing Britain: From HS2 towards a national transport strategy, a second report by the Chairman of HS2 Ltd Sir David Higgins*. This highlighted the need for greater consideration of transport connectivity across the north of England. It described HS2 as a new spine for the national rail network, and as an important catalyst for a national transport strategy.
July 2016	Publication of the *Sheffield and South Yorkshire Report* which reported on the analysis of options for HS2 services in South Yorkshire, and made recommendations about how HS2 can best serve the area.
November 2016	The Secretary of State for Transport confirmed part of the Phase 2b route. A Sustainability Statement was published. As well as outlining the preferred scheme and the associated sustainability impacts, it also summarised the key changes from the July 2013 consultation route. Launch of consultation on seven route refinement areas (see Section 11 of this report). Publication of the *Response to HS2 Phase Two Consultation: Appraisal of Sustainability (Question 7)*. This report provided an HS2 Ltd response to feedback from question 7 of the July 2013 Phase Two consultation, regarding the AoS. Publication of the High Speed Two Phase 2b strategic outline business case, including the Strategic Case[39] and Economic Case[40]. The Strategic Case set out the Government's strategic case for Phase 2b and the Economic Case set out the economic case for completing the Y network. As well as the Strategic Case and Economic Case, the following remaining documents of the outline business case were also published: the commercial case, financial case, and the management case. Launch of the High Speed Rail Phase 2b Property Consultation.

[35] HS2 Ltd (2013). Phase Two Route Consultation, http://webarchive.nationalarchives.gov.uk/20141027142236/http://www.hs2.org.uk/phase-two/route-consultation/document-library
[36] Hs2 Ltd (2013). *HS2 Regional Economic Impacts.* Available online at: http://assets.hs2.org.uk/sites/default/files/inserts/HS2%20Regional%20Economic%20Impacts.pdf
[37] Department for Transport (2013). News story. Available online at: https://www.gov.uk/government/news/sir-david-higgins-to-drive-down-cost-of-hs2
[38] HS2 Ltd (2014). HS2 Plus – A report by David Higgins. Available online at: https://www.gov.uk/government/publications/hs2-plus-a-report-by-david-higgins
[39] Department for Transport (2016). *High Speed Two Phase 2b Strategic Outline Business Case: Strategic Case*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/570068/hs2-phase-2b-sobc-strategic-case.pdf
[40] Department for Transport (2016). *High Speed Two Phase 2b Strategic Outline Business Case: Economic Case*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/570845/hs2-phase-2b-sobc-economic-case.pdf

Date	Activity
July 2017	The Secretary of State for Transport announces the 2017 Phase 2b preferred route to Manchester and Leeds. Publication of the updated HS2 Business Case (including the Phase Two commercial case, economic case, financial case, management case, strategic case, and economic case advice for the Department for Transport (DfT)), route refinement advice, Crewe to Manchester 2017 route engineering report, West Midlands to Leeds 2017 route engineering report, and plan and profile maps for the western and eastern legs[41]. Publication of the HS2 Phase 2b Draft EIA Scope and Methodology Report (SMR) for consultation[42].
July 2018	The Government confirmed that the Proposed Scheme includes the electrification of a section of the MML between Clay Cross and Sheffield Midland Station.

2.3 Enhancing capacity and connectivity

2.3.1 As noted in Section 2.1 of this report, the Government's case for a new high speed rail network has already been accepted in the High Speed Rail (London-West Midlands) Act 2017. The purpose of the high speed network is primarily to ensure that the intercity rail network supports the economic development of the country by providing improved capacity and connectivity between urban centres. The need for additional capacity will become increasingly pressing on Britain's key north-south inter-urban rail routes from the mid-2020s and the Government has concluded that HS2 is the solution to enhancing connectivity and relieving pressure. More detailed information on the purpose of HS2 can be found in Volume 1 of the Phase One ES.

2.3.2 Phase One of HS2 will link London, Birmingham and the West Midlands and, through the connection to the WCML at Handsacre, serve destinations in the North West and up to Glasgow greatly improving capacity and connectivity and reducing journey times. The interchange at Old Oak Common will also offer the opportunity to link to Crossrail and the Great Western Main Line.

2.3.3 Phase Two of HS2 would extend the high speed railway between the West Midlands and Manchester and between the West Midlands and Leeds, with connections onto the WCML to the south of Wigan, to the MML at Clay Cross and to the ECML south of York.

2.3.4 Once completed, Phase 2b would unlock the full benefits of HS2. It would offer journey time reductions within the Midlands and the North, as well as to London, and would deliver a step change in capacity on the WCML and ECML. It would relieve pressure on the existing conventional rail network, thereby improving reliability and performance.

2.3.5 To illustrate how released capacity on the existing conventional rail network could be utilised once Phase 2b of HS2 is operational, the DfT commissioned consultants to

[41] Updated information on proposals for the HS2 route from Crewe to Manchester and West Midlands to Leeds that supported the announcement of the 2017 Preferred Route to Manchester and Leeds (2b) is available online at: https://www.gov.uk/government/collections/hs2-phase-2b-crewe-to-manchester-and-the-west-midlands-to-leeds

[42] HS2 Ltd (2017). HS2 Phase 2b d*raft Environmental Impact Assessment Scope and Methodology* Report. Available online at: https://www.gov.uk/government/consultations/hs2-phase-2b-draft-environmental-impact-assessment-scope-and-methodology-report

undertake a preliminary assessment of the following future rail transport scenarios[43]. The released capacity on the existing conventional rail network could allow for:

- a higher frequency service on the WCML and ECML between intermediate stations and the end points of HS2 (e.g. from Rugby to Manchester, from Retford to Leeds, and from Peterborough to London);
- improved connectivity between London and destinations that are either not currently served or served irregularly by the existing conventional rail network (e.g. Huddersfield, Sunderland, Bolton, and North Wales);
- new cross country inter-regional services, increasing frequency and reducing journey times between non-London destinations (e.g. Manchester to Northampton, and Leeds to Cambridge);
- enhancing commuter services into London on the ECML, in a similar manner to the benefits from Phase One of HS2 on the WCML. This could involve a higher frequency of services to destinations such as Stevenage, Hitchin, Letchworth, Royston, and Cambridge;
- improved city-to-city connectivity in line with the future rail aspirations of sub-national transport bodies, such as Transport for the North (TfN) and Midlands Connect (e.g. Leeds to Sheffield via Doncaster, and Northampton to Wolverhampton via Birmingham New Street); and
- increased capacity for freight services to serve a number of important and growing markets, including an increasing demand for intermodal freight driven by global trade and from growth in rail freight transportation within Britain.

2.3.6 HS2 Ltd is working with TfN and Midlands Connect to consider how HS2 can help further improve connectivity and the Government is currently considering whether additional connections should be included in the Proposed Scheme.

2.3.7 Northern Powerhouse Rail (NPR) is a major strategic rail programme, designed to transform connectivity between the key economic centres of the North. Government is considering the NPR programme alongside HS2 with the aim of offering faster, more frequent and reliable rail links across the North and opening up new opportunities for communities and businesses.

2.3.8 It is expected that the Government, alongside TfN, will identify how NPR would utilise and interact with the Proposed Scheme. TfNs vision for the NPR network is outlined in the TfN's *Strategic Transport Plan Draft for Consultation*[44]. HS2 Ltd are working with TfN, DfT and Network Rail to identify feasible engineering concepts that would either deliver or move towards substantially meeting the Conditional Outputs for the NPR programme (as set out in the *One North Report* and *Northern Transport Strategy*[45]).

[43] HS2 Ltd (2017). *HS2 Phase Two Strategic Case.* Available online at: https://www.gov.uk/government/publications/hs2-phase-two-strategic-case
[44] Transport for the North (2018). *Strategic Transport Plan Draft for Consultation*. Available online at: https://transportforthenorth.com/wp-content/uploads/TfN-Strategic-Plan_draft_lr.pdf
[45] Department for Transport/Transport for the North (2015). *The Northern Powerhouse: One Agenda, One Economy, One North.* Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/427339/the-northern-powerhouse-tagged.pdf

Once the Government has decided how this work should be taken forward, this will be reported in the formal ES.

2.3.9 Midlands Connect is a partnership of 23 local transport authorities and local business representatives working with DfT, HS2 Ltd, Network Rail and other key stakeholders. Midlands Connect are working with Government and national bodies to ensure that the infrastructure needed for the Midlands economy to grow is delivered. Midlands Connect have outlined their strategic plans in *Midlands Connect Strategy: Powering the Midlands Engine*[46] and more recently in their latest publication *Midlands Connect – Our Routes to Growth*[47].

2.3.10 Midlands Connect is making the case for direct, conventional compatible services linking Leicester and Leeds via the proposed East Midlands Hub station at Toton. HS2 Ltd are working with Midlands Connect, DfT and Network Rail to identify a feasible engineering concept for a conventional compatible link. Once the Government has decided how this work should be taken forward, this will be reported in the formal ES.

2.4 Generating growth

2.4.1 Investment in infrastructure is a key part of the Government's industrial strategy. Not only can improved transport infrastructure reduce delays, but it can also raise productivity through the agglomeration (or collecting together) of towns and cities. Better connected towns and cities have larger labour markets, greater competition and greater economies of scale, leading to higher growth and living standards.

2.4.2 Increased connectivity can, therefore, support the rebalancing of our economy. As set out in the July 2017 Phase Two Strategic Case, the economy of the south-east of England has pulled ahead of much of the rest of the country. Figures show that London is much more productive than city regions in the north of England and the Midlands, which are found to be 10 to 17 per cent below the average productivity for the UK. This divergence can, in part, be attributed to weaknesses in infrastructure and connectivity.

2.4.3 Phase Two of HS2 can deliver the transformation in connectivity that is required to meet the objective of supporting economic growth in the Midlands and the North. HS2 would drive growth by acting as a catalyst for major regeneration and development schemes delivering better connectivity and providing opportunities for the UK's businesses and workforce. It would generate economic opportunities and development beyond the direct impacts of building a new railway, including in key industry sectors such as tourism, technology and digital, professional business and financial services, and advanced manufacturing.

2.4.4 HS2 would also have a direct impact on growth through job creation; it would be the biggest infrastructure project in Europe and would create jobs, both directly and through its supply chain, particularly in engineering and construction. The new high

[46] Midlands Connect (2017). Our routes to growth. Available online at: https://www.midlandsconnect.uk/media/1176/midlands-connect-ar-v18_final_web.pdf
[47] Midlands Connect (2018). Midlands Connect Strategy: Powering the Midlands Engine. Available online at: https://www.midlandsconnect.uk/media/1100/midlands-connect-strategy-march-2017.pdf

speed rail stations would 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. In addition, a National College for High Speed Rail has been established with campuses set up in Birmingham and Doncaster to provide training and work experience related to the construction, operation and maintenance of high speed rail projects.

2.5 Climate change

2.5.1 The Proposed Scheme has been developed against a background of concern and strengthening policy regarding climate change. This includes consideration of both the need to mitigate climate change through reductions in greenhouse gas emissions, and the need for critical infrastructure and environments to be resilient to climate change impacts and risks.

2.5.2 The Kyoto Protocol of 1997 took the lead in converting this concern into action at an international level. Negotiations in December 2015 on the future of international cooperation on climate change at the 21st Conference of the Parties (CoP21) of the United Nations Framework Convention on Climate Change (UNFCCC) in Paris[48] resulted in a legally binding treaty on climate action. The central aims of the agreement is to strengthen the global response to climate change by keeping global temperature rise this century below 2 degrees Celsius above pre-industrial levels, and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius. Limiting global warming to below 1.5 degrees Celsius essentially sets a target for net zero global emissions for the second half of this century. The Paris Agreement was ratified by the UK along with other parties to the convention in October 2016, and entered into force a month later in November.

2.5.3 At a UK level the Climate Change Act 2008[49] established a framework for the UK to achieve its long-term goals of reducing GHG emissions by at least 80% from 1990 levels by 2050. The Climate Change Act 2008 includes an interim target of at least a 34% reduction from 1990 levels by 2020. To ensure that regular progress is made towards the target, the Climate Change Act 2008 also established a system of carbon budgets. The first five carbon budgets have been set in law. The fifth carbon budget (2028-32) target would reduce UK GHG emissions in 2030 by 57% relative to 1990 levels[50].

2.5.4 In April 2018, the UK Government announced that they would instruct the Committee on Climate Change (CCC) to provide new advice regarding how the Paris Agreement is expected to impact the UK's long-term greenhouse gas reduction targets. The request is likely to be made after the UN Intergovernmental Panel on Climate Change (IPCC) publishes a special report assessing 'the impacts of 1.5°C of global warming above pre-industrial levels and related emissions pathways'.

[48] UNFCCC (2015). *Conference of the Parties, Adoption of the Paris Agreement*; http://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf
[49] Climate Change Act 2008. Her Majesty's Stationery Office, London
[50] Committee on Climate Change (2015). *The Fifth Carbon Budget - The next step towards a low-carbon economy*. Available online at: https://www.theccc.org.uk/wp-content/uploads/2015/11/Committee-on-Climate-Change-Fifth-Carbon-Budget-Report.pdf

2.5.5 The CCC, in its annual progress report to Parliament in June 2018[51], highlighted that the UK's greenhouse gas emissions have reduced by 43% when compared to the 1990 levels, in a period where the economy has grown by over 70%. However, in the last five years, 75% of emissions reductions have come from the power sector whilst very little progress has been made within the transport, industry, building and agricultural sectors. As a result emissions reductions have stalled with only a 3% fall in emissions in 2017. Accordingly, the report suggests that the fourth and fifth carbon budgets are likely to be missed. In order to put emissions reduction back on track, the CCC suggests that the Government should: support the simple, low-cost options (e.g. onshore wind and solar and improving energy efficiency in buildings); implement consistent policy to help drive investment and cut bills; commit to effective regulation and strict enforcement; and act now to keep long-term options open (e.g. by investing in carbon capture and storage and floating offshore wind).

2.5.6 The UK Government published its *Clean Growth Strategy*[52] in 2017, setting out a detailed set of policies and proposals that aim to accelerate economic growth and decrease carbon emissions in line with the fourth and fifth carbon budgets (2023-2027 and 2028-2032).

2.5.7 Britain's *Industrial Strategy*[53], also published in 2017, sets out a vision for transforming and ensuring the future productivity of Britain. The strategy identifies infrastructure as one of the five foundations where investment is needed in order to ensure Britain remains a competitive and attractive business destination. HS2 is identified as a 'transformational' infrastructure project enabling new investment and economic activity by connecting cities and communities across Britain.

2.5.8 The construction of a new high speed railway would result in substantial greenhouse gas emissions. However, in terms of enhancing inter-urban connectivity, high speed rail is one of the most carbon efficient means of transporting large numbers of people, measured in terms of emissions per passenger kilometre. High speed rail is considered to draw an optimum balance between carbon reduction and economic benefits. Furthermore, the carbon emissions of high speed rail are likely to reduce in future as the energy supply is decarbonised, i.e. as Britain moves away from using gas, oil and coal-fired power stations and towards renewable and low carbon sources of energy. There will be a large carbon benefit associated with the operation of Phase One of HS2. There would be further carbon benefits associated with the operation of Phase Two.

2.5.9 Encouraging a shift to lower-carbon modes 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.

---

[51] Committee on Climate Change (2017). *2017 Report to Parliament – Meeting Carbon Budgets: Closing the policy gap*. Available online at: https://www.theccc.org.uk/wp-content/uploads/2017/06/2017-Report-to-Parliament-Meeting-Carbon-Budgets-Closing-the-policy-gap.pdf

[52] Department for Business, Energy and Industrial Strategy (2017). *The Clean Growth Strategy – Leading the way to a low carbon future*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/700496/clean-growth-strategy-correction-april-2018.pdf

[53] Department for Business, Energy and Industrial Strategy (2017). *Industrial Strategy: building a Britain fit for the future*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/664563/industrial-strategy-white-paper-web-ready-version.pdf

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)[54], following the publication of the first Climate Change Risk Assessment (CCRA) in 2012[55], to help build this resilience. The NAP and the CCRA must be reviewed every five years - the second CCRA was published in January 2017[56] and the next NAP is due to be published in 2018[57]. Together they 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 for major infrastructure projects 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 Cabinet Office guidance *Keeping the country running*[58] is a key document used in the development of HS2's approach to climate change resilience. There is a resilience objective within the HS2 Sustainability Policy and Environment Agency guidance on climate change allowances to be used in flood risk assessments as set out in the NPPF[59] and has informed the assessment.

2.5.13 Further information is provided in Section 8.4 and Section 9.4 of this report and in Volume 3: Route-wide effects, Section 4.

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 and effects. However, in developing the Phase 2b route, impacts have been reduced insofar as reasonably practicable. Environmental appraisal and assessment has been integral to route development and design, initially by way of the AoS process (as reported in the Sustainability

[54] Defra (2013). *The National Adaptation Programme, Making the country resilient to a changing climate*, Her Majesty's Stationery Office. Available online at: https://www.gov.uk/government/publications/adapting-to-climate-change-national-adaptation-programme
[55] Defra (2012). UK Climate Change Risk Assessment: Government Report. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69487/pb13698-climate-risk-assessment.pdf
[56] Committee on Climate Change (2017). UK Climate Change Risk Assessment 2017. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/584281/uk-climate-change-risk-assess-2017.pdf
[57] Defra (2016). *Government policy paper on climate change adaptation 2010-2015*; Available online at: https://www.gov.uk/government/publications/2010-to-2015-government-policy-climate-change-adaptation/2010-to-2015-government-policy-climate-change-adaptation
[58] Cabinet Office (2011). *Keeping the country running: natural hazards and infrastructure.* Available online at: https://www.gov.uk/government/publications/keeping-the-country-running-natural-hazards-and-infrastructure
[59] Environment Agency (2017). *Flood risk assessments: climate change allowances.* Available online at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

Statement) and subsequently through the EIA process (as reported in this working draft ES).

2.6.2 Options for mitigating adverse effects will continue to be identified during development of the Proposed Scheme prior to deposit of the Bill. Mitigation measures that are considered to be effective, reasonably practicable and affordable will continue to be incorporated into the design and management of the Proposed Scheme. A structured approach has been adopted towards mitigation, whereby priority is given to avoiding significant adverse effects. Where that is not achievable, such effects will be reduced insofar as reasonably practicable or compensatory environmental measures provided. The approach to mitigation is described further in Section 9 of this report.

2.6.3 Local impacts are also being identified through the engagement and consultation process. Options for addressing these issues are being considered as the alignment and design of the Proposed Scheme evolves. Further details of the engagement and consultation process are set out in Section 3 of this report.

3 Stakeholder engagement and consultation

3.1 Background

3.1.1 Stakeholder engagement has been an integral and ongoing part of the process of designing and assessing the Proposed Scheme from its inception. It is enabling the general public, businesses, local authorities, statutory bodies, and expert, technical and specialist stakeholders to respond to, and inform:

- the development of the design;
- the scope and methodology of the assessment;
- the collection of relevant baseline environmental information and data;
- the assessment of the significant environmental effects arising from construction and operation of the Proposed Scheme;
- the enhancement of the beneficial effects of the Proposed Scheme;
- the measures identified to avoid or mitigate significant adverse effects; and
- monitoring arrangements.

3.1.2 This section sets out:

- the range of stakeholders involved;
- how and when engagement and consultation has been undertaken to date; and
- future opportunities for stakeholder engagement and consultation.

3.1.3 A brief summary of how stakeholder feedback has been considered in the development of the design and assessment of the Proposed Scheme is set out in the Volume 2: Community area reports, Section 3.

3.2 Stakeholders

Communities

3.2.1 Communities are being engaged and formally consulted during the design and assessment process to ensure they have the opportunity to input to and influence the development of the Proposed Scheme.

3.2.2 Communities that may be directly affected by the Proposed Scheme have been identified and are a key focus of engagement and formal consultation. Engagement is taking place directly with communities, with key community representatives and with a broad range of interest groups within the respective areas.

3.2.3 Engagement has been, and will continue to be, undertaken with schools and educational establishments, in particular, with those in proximity to the Proposed Scheme and those with specialist interests or catering to the needs of vulnerable

people within the community. This has informed the assessment of community and health in this working draft ES as well as the separate working draft Equality Impact Assessment Report (EQIA).

3.2.4 As part of the consultation process for this working draft ES and the separate working draft EQIA, information events are being held in communities across the route of the Proposed Scheme.

Local authorities

3.2.5 Engagement with metropolitan, county, borough, district and parish councils has been ongoing throughout the design and assessment of the Proposed Scheme. The aim is to maximise the opportunity for local authorities and parish councils to engage positively in the development of the Proposed Scheme both in the context of technical input to the assessment and providing local knowledge and issues.

3.2.6 The local authorities and parish councils provide valuable technical information to aid the design development and environmental assessment process and influence local area mitigation proposals. They also provide information on communities and other stakeholders within their area, to help identify and understand local issues and concerns, provide access to wider stakeholders and communities and provide a mechanism for ongoing dialogue and discussion on the assessment and design development.

Expert, technical and specialist groups

3.2.7 This group comprises stakeholders with specific technical knowledge or particular interest in the Proposed Scheme, many of whom will have a high level of influence on the design and assessment process, particularly in relation to technical feasibility and likely environmental impacts. This stakeholder group includes national representatives of environmental statutory authorities and government departments, as well as non-statutory technical/specialist organisations. These stakeholders are helping to influence project-wide mitigation strategies and principles.

3.2.8 Designated statutory consultees (such as the Environment Agency and Natural England) for the process of undertaking an EIA have been, and will continue to be, engaged with throughout the assessment. Specific, dedicated engagement on health will also be undertaken, including with health and joint wellbeing boards, Directors of Public Health and Public Health England.

Directly affected individuals, major asset owners and businesses

3.2.9 This group includes those with property potentially affected by the Proposed Scheme. The engagement and consultation has a strong focus on directly affected individuals, major asset owners and businesses. This group comprises farmers, growers and those whose property would be directly affected by the Proposed Scheme whether permanently or temporarily. It also includes major asset owners and businesses who may also be impacted directly, or indirectly, by the Proposed Scheme.

3.2.10 A wider range of property owners have also been engaged, including residential owners. This engagement remains ongoing.

Utility companies

3.2.11 Engagement is ongoing with utility companies and statutory stakeholders, such as Network Rail, National Grid and the Oil and Pipelines Agency, to establish how the Proposed Scheme may affect utility company infrastructure.

3.3 Key stages and mechanisms for engaging with stakeholders

Introduction

3.3.1 The process of direct engagement with stakeholders for Phase Two of HS2 began in 2009. A variety of mechanisms are being used to ensure an open and inclusive approach to engagement and consultation, reflecting the differing requirements and expectations of stakeholders.

3.3.2 Key engagement undertaken to date is summarised in Table 2. This includes consultation on the Phase 2b draft EIA and EQIA SMRs, property consultation and a series of meetings with national and local environmental stakeholders, local authorities, parish councils, individual landowners and organisations.

Table 2: Engagement, consultation and decision points to date for HS2 Phase 2b

Date	Engagement, consultation and decision points
2009 – 2012	Initial consultation on High Speed Rail and the subsequent announcement to pursue the Y network in two phases. Development of the Phase Two route and consideration of route-wide alternatives input, including: • engagement with a limited number of key expert, specialist and technical stakeholders to help inform development of the route, including the consideration of alternative route alignment, station and depot locations; and • engagement on methodological approach and information generated by desk-based studies, including environmental information.
2012 – to date (ongoing)	HS2 National Environment Forum and HS2 Ministerial Environmental Roundtable: • attended by members of key statutory and non-governmental organisations to represent the interests of local people and the wider society in respect to specific environmental issues; • managed at national representative level and supplemented with bilateral meetings on specific issues on a case by case basis; and • regular engagement with organisations including Natural England and the Environment Agency.
2012	Informal engagement by the Secretary of State for Transport with potential station cities to help inform initial preferences for Phase Two, including consideration of relevant environmental information.
January 2013	Announcement of the Phase Two initial preferred scheme which allowed an early opportunity to engage with key stakeholders on potential key issues and concerns about the route and its impacts ahead of consultation.
July 2013 – January 2014	Following minor amendments to the January 2013 initial preferred scheme, public consultation was carried out on the Phase Two scheme: • consultation of the proposed route, stations and depots; • supported by various documentation, including a Sustainability Statement describing the sustainability performance of the scheme; and • sought comments on the approach to the sustainability appraisal carried out by

Date	Engagement, consultation and decision points
	independent consultants on behalf of HS2 Ltd.
July – August 2016	Information events held to engage with local communities and members of the public following publication of the recommended M18/Eastern route alignment along the Leeds leg of the Phase 2b route.
November 2016	Announcement of the majority of the Phase 2b preferred route to Manchester and Leeds.
November 2016 – March 2017	Consultation on the seven proposed refinements to the Phase 2b route. Information events were held in local communities along the route. Consultation with property owners along the route. Phase 2b property information events took place in January and February 2017. The purpose of the consultation was to give stakeholders the opportunity to speak to HS2 Ltd about the Government's proposals for compensation and assistance for property owners, and to inform the Government's decision on whether the compensation and assistance schemes in place for Phase One and Phase 2a needed to be amended for Phase 2b. The outcome of this consultation is summarised in *High Speed Two Phase 2b: Crewe to Manchester, West Midlands to Leeds and Beyond – Property Consultation Response*[60].
July 2017	Announcement of the Phase 2b preferred route following consultation on the seven route refinement areas (referred to as the '2017 preferred route to Manchester and Leeds'. Engagement with local communities and stakeholders to inform the EIA and EQIA commenced in July 2017 and is ongoing.
July – September 2017	Consultation on the draft EIA and EQIA SMRs to inform the EIA and EQIA (see following paragraphs for further details on the consultation on the draft EIA SMR).
September 2017	Information events held with local communities following confirmation of the 2017 Phase 2b preferred route.
June – July 2018	Information events held across the route with local communities to share emerging design information.
October – December 2018	Consultation on the working draft ES and working draft EQIA (see following paragraphs for further details on the consultation on the working draft ES).

Consultation on the draft EIA Scope and Methodology Report

3.3.3 The draft EIA SMR was subject to consultation, alongside the draft EQIA SMR, from 17 July to 29 September 2017. It was issued, as part of the consultation process, to statutory bodies, local authorities (including parish councils) and expert, technical and specialist groups. It was available on the Government's website, allowing comment by local interest groups and the public.

3.3.4 The draft EIA SMR was amended in response to the consultation and the EIA SMR is published as a supporting document to this working draft ES. The scope and methodology of the assessment reported in the working draft ES is set out in the EIA SMR (unless otherwise stated).

Consultation on the working draft ES

3.3.5 Consultation on the working draft ES is taking place during October to December 2018[61]. Copies of the working draft ES have been made available in public locations

[60] DfT (2017). *High Speed Two Phase 2b: Crewe ro Manchester, West Midlands to Leeds and beyond – Property Consultation Response.* Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/629394/high-speed-two-phase-2b-crewe-to-manchester-west-midlands-to-leeds-and-beyond-property-consultation-response-web-version.pdf

and online at www.gov.uk/hs2. Information events are being held in communities across the Proposed Scheme as part of the consultation.

3.3.6 Feedback from consultation will be considered in the further development of the Proposed Scheme and taken into account in preparation of the formal ES that will accompany the Bill for Phase 2b. A summary of these changes will be provided in a Consultation Summary Report, which will be published when the Bill is deposited. The Bill is due to be deposited in Parliament in 2020.

3.4 Future engagement and consultation

Introduction

3.4.1 HS2 Ltd will continue to engage with the public and other stakeholders following the consultation on the working draft ES and separate working draft EQIA. Feedback from ongoing engagement will continue to be considered during the design and assessment of the Proposed Scheme.

Planning forum

3.4.2 The planning forum will be the main mechanism for discussion on planning matters between HS2 Ltd and the local planning authorities affected by the Proposed Scheme. It will focus on matters of route-wide interest.

3.4.3 It is anticipated that the Phase 2b planning forum and its sub-groups will commence prior to hybrid Bill submission and will focus on matters associated with powers contained in the Bill. Specific technical disciplines have been meeting with local authorities to discuss technical matters.

Parliamentary consultation and petitioning

3.4.4 In accordance with Standing Orders, Parliament will be undertaking public consultation on the formal ES. Consultees will have at least 70 days (10 weeks) to respond to the consultation following the deposit of the Bill documents in Parliament and the first publication of the necessary newspaper notices. Parliamentary officials will appoint an independent assessor who will summarise responses and provide a report to Parliament before Second Reading of the Bill.

3.4.5 There will also be a petitioning period. This petitioning period will provide an opportunity for individuals or organisations specially and directly affected by the Proposed Scheme to petition against the Bill. More information on who may petition against the Bill, and how to do so, is available on Parliament's website (http://www.parliament.co.uk).

[61] The first day of the consultation period being the date of the first newspaper notices that follow publication of the working draft ES documents on www.gov.uk/hs2.

4 The Proposed Scheme

4.1 Introduction

4.1.1 This section provides a summary description of the Proposed Scheme, which is shown in Figure 4. Detailed route descriptions at a local level are contained in the Volume 2: Community area reports, Section 2. The route of the Proposed Scheme has been divided into the community areas shown in Figure 4 for environmental assessment and community engagement.

4.1.2 This section also provides a description of:

- the interfaces between Phase 2b and Phase One and Phase 2a;
- the interfaces with the conventional rail network and other transport services; and
- the anticipated services, operating characteristics and maintenance requirements of the Proposed Scheme.

4.1.3 Please refer to Section 5 for more information on the main permanent features of the Proposed Scheme.

4.2 Additional scheme features for consideration in the formal ES

4.2.1 Since the Government announced the 2017 preferred route for Phase 2b in July 2017, the Proposed Scheme was amended in July 2018 to include the electrification of a section of the MML between Clay Cross and Sheffield Midland Station.

4.2.2 Electrification of this section of the MML would require works to approximately 29km (18 miles) of existing conventional railway from the proposed spur off the HS2 main line at Clay Cross to Sheffield Midland Station, via Chesterfield Station. In addition, works would be required to a further 1km of existing conventional railway beyond the Clay Cross, Tapton and Dore junctions to facilitate the operation of HS2 train services.

4.2.3 The works associated with electrification of this section of the MML are likely to include:

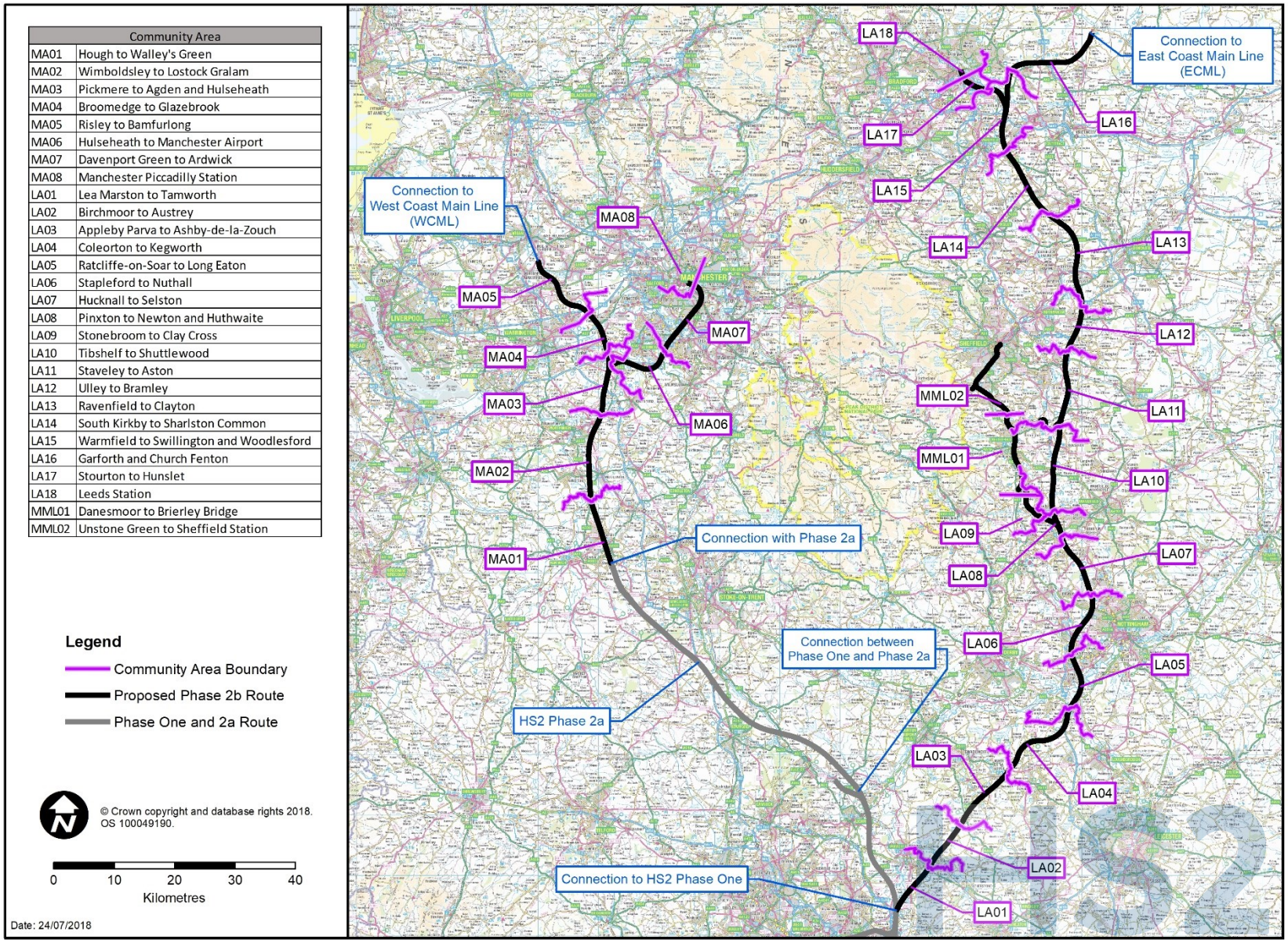
- installation of necessary power supply infrastructure for operation of HS2 trains (e.g. overhead line equipment, electricity cables, cable ducting, auto-transformer stations and power supply points from the National Grid;
- appropriate vertical and widening clearance provision at stations, tunnels, bridges, third party power lines, existing signalling infrastructure and other crossing structures, by raising existing structures, lowering existing track levels, or realigning existing track as locally appropriate;
- additional track and widening requirements at a number of locations along the route of the Proposed Scheme;
- realignments of roads, public rights of way (PRoW) and access routes, drainage features and any temporary and permanent utility diversions;
- signalling and telecommunications infrastructure;

- necessary arrangements to accommodate HS2 trains at Chesterfield and Sheffield Midland stations; and
- provision of maintenance arrangements, such as access points.

4.2.4 Development of the design and the associated environmental assessment process for the electrification works for this section of the MML is at an earlier stage and will be reported in the formal ES. The environmental assessment of any likely significant effects of the electrification works in the section of the MML between Clay Cross and Sheffield Midland Station will be reported in Volume 2: community area reports for the MML01 Danesmoor to Brierley Bridge and MML02 Unstone Green to Sheffield Station areas. Any works that may be required to the existing conventional railway between the northern boundary of MML02 (north of Sheffield Midland Station) and Clayton Junction would be defined as off-route works for the purposes of the environmental assessment of the Proposed Scheme and this assessment would be reported in Volume 4: Off-route effects of the formal ES.

Figure 4: Community areas

Community Area	
MA01	Hough to Walley's Green
MA02	Wimboldsley to Lostock Gralam
MA03	Pickmere to Agden and Hulseheath
MA04	Broomedge to Glazebrook
MA05	Risley to Bamfurlong
MA06	Hulseheath to Manchester Airport
MA07	Davenport Green to Ardwick
MA08	Manchester Piccadilly Station
LA01	Lea Marston to Tamworth
LA02	Birchmoor to Austrey
LA03	Appleby Parva to Ashby-de-la-Zouch
LA04	Coleorton to Kegworth
LA05	Ratcliffe-on-Soar to Long Eaton
LA06	Stapleford to Nuthall
LA07	Hucknall to Selston
LA08	Pinxton to Newton and Huthwaite
LA09	Stonebroom to Clay Cross
LA10	Tibshelf to Shuttlewood
LA11	Staveley to Aston
LA12	Ulley to Bramley
LA13	Ravenfield to Clayton
LA14	South Kirkby to Sharlston Common
LA15	Warmfield to Swillington and Woodlesford
LA16	Garforth and Church Fenton
LA17	Stourton to Hunslet
LA18	Leeds Station
MML01	Danesmoor to Brierley Bridge
MML02	Unstone Green to Sheffield Station



4.3 Description of the Proposed Scheme

Overview

4.3.1 The Proposed Scheme comprises a 'western leg' and an 'eastern leg'. The western leg would comprise the route from Crewe to Manchester with a connection to the WCML, and the eastern leg would comprise the route from the West Midlands to Leeds via the East Midlands and South Yorkshire with connections to the MML and the ECML.

4.3.2 The route of the Proposed Scheme on the western and eastern legs is summarised in the text and figures that follow. Each of the distances provided in this section is approximate.

Western leg

4.3.3 As shown in Figure 5, the route of the Proposed Scheme from Crewe to Manchester forms the northern 85km (53 miles) section of the western leg of Phase Two. This section would commence to the south of the existing Crewe Station, to the south of the A500, where it would join the Phase 2a route.

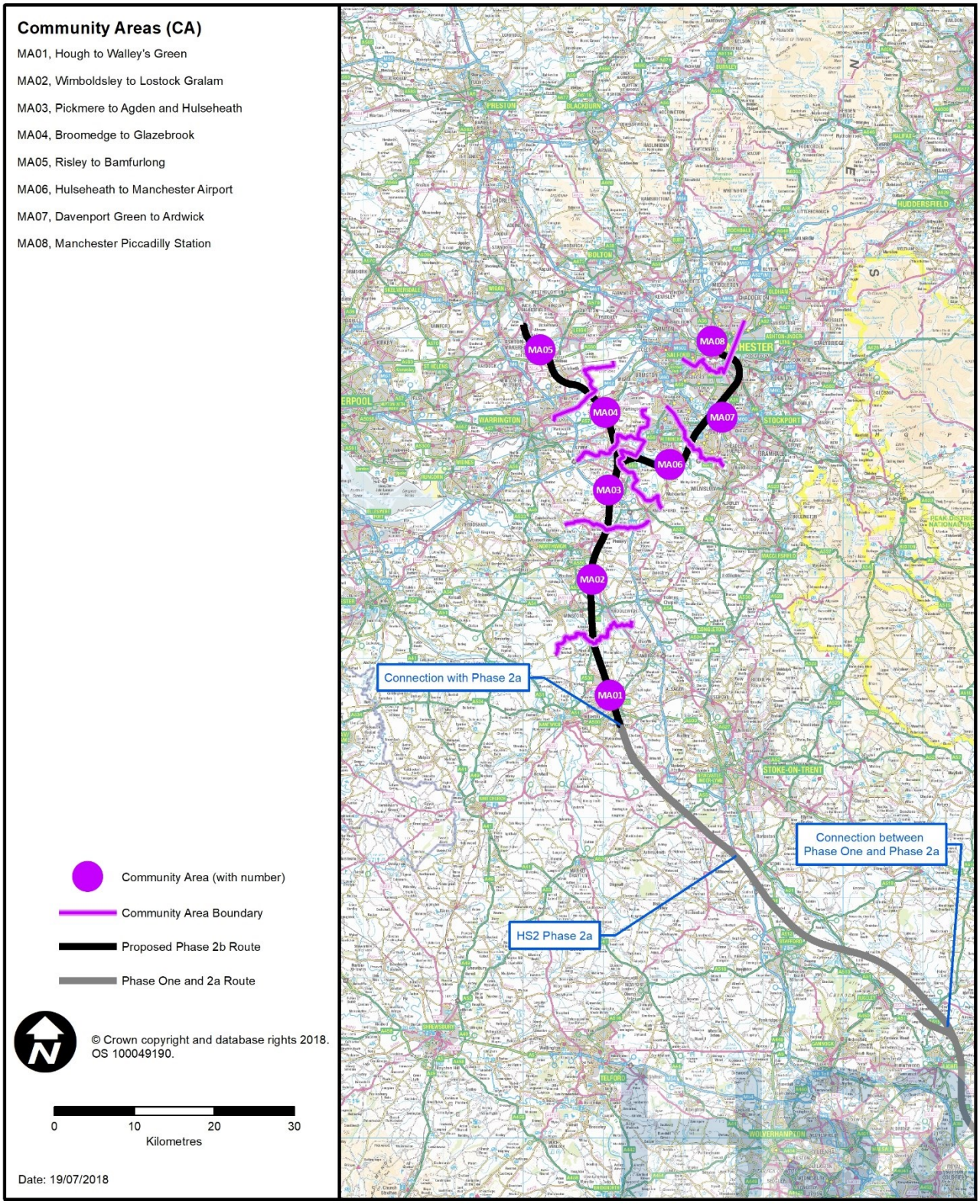
4.3.4 The route of the Proposed Scheme would continue beneath Crewe in tunnel before emerging to the north of the town near the B5076 Bradfield Road. The route would then run parallel to the east of the WCML corridor before bearing north, away from the WCML. Where the route of the Proposed Scheme diverges from the WCML, a rolling stock depot (RSD) would be provided on land between the HS2 main line and the existing WCML.

4.3.5 The route of the Proposed Scheme would continue north passing between the towns of Winsford and Middlewich on a series of embankments and viaducts to the west of Lostock Green and east of Rudheath, Lostock Gralam and Higher Wincham. The route would then cross the M6 before diverging at Hoo Green where the HS2 main line would continue north towards Golborne and the Manchester Spur would continue east towards Manchester.

4.3.6 The Manchester spur would be located to the north of Rostherne Mere, running broadly parallel to the M56 before turning north to pass beneath the M56 at Warburton Green and through to Manchester Airport High Speed station to the north-west of Manchester Airport. The Manchester spur would then enter into tunnels near Davenport Green, passing beneath south Manchester and re-emerging in the Ardwick area where it would continue on viaduct approach before terminating at Manchester Piccadilly High Speed station.

4.3.7 The HS2 main line would continue north from the Manchester spur to pass beneath the M56 and then cross the Manchester Ship Canal to the east of Hollins Green on viaduct. The HS2 main line would then continue north to cross the M62 and pass to the west of Culcheth, before continuing through Lowton and connecting with the WCML at Bamfurlong, south of Wigan.

Figure 5: Western leg of the Proposed Scheme



Eastern leg

4.3.8 As shown in Figure 6, the eastern leg of the route of the Proposed Scheme would run from the West Midlands to Leeds with a total route length of 198km (123 miles).

4.3.9 It would provide a connection to the MML via the Erewash Valley Line, to the south-east of Chesterfield, and would also connect to the conventional network at Church Fenton, south-west of York, before joining the ECML.

4.3.10 The eastern leg would begin to the north-east of Birmingham where it would connect to Phase One of HS2 near Marston. The route of the Proposed Scheme would connect with the Phase One route, and follow the M42 and A42 corridor to Kegworth, near the East Midlands Airport. After Kegworth the route would curve on viaduct in a northerly direction, passing over the flood plain of the River Soar and River Trent. Following this, the route would pass through Long Eaton to the new East Midlands Hub station at Toton. The route would then follow the M1 corridor, to the east of the motorway.

4.3.11 Prior to Tibshelf, there would be a spur to provide a connection to the existing conventional rail network near Clay Cross. The spur would be located near the A38 and Hilcote and would pass under the M1 south of Newton, before joining the existing Erewash Valley Line east of Stonebroom. The spur would enable HS2 services to connect to the MML to serve the existing Chesterfield Station and Sheffield Midland Station. This section of the MML would be electrified as part of the Proposed Scheme.

4.3.12 From Tibshelf, the HS2 main line would pass Hardwick Hall on a short section of embankment and travel north via Stainsby and Heath, mainly following the M1 alignment in cutting. In the Bolsover area, the route would be on embankment and in cutting as it passes Sutton Scarsdale, Staveley and Shuttlewood.

4.3.13 A spur would diverge from the HS2 main line near Barlborough. The spur would be on a combination of cuttings and embankments and would follow an existing disused railway to the proposed Staveley Infrastructure Maintenance Depot (IMD). The IMD would be located on the former Staveley Chemical Works site. The spur would then connect to the existing conventional Chesterfield to Beighton Railway.

4.3.14 North of the spur at Staveley, the HS2 main line would be on embankment and in cutting, following a narrow corridor alongside the M1 and passing close to several communities including Barlborough, Wales, and Aston.

4.3.15 At Thurcroft, the route of the Proposed Scheme would cross over a delta junction of the M1 and the M18 on two viaducts. It would then run in cutting and on embankment between Bramley and Mexborough. The route would then pass to the east of Barnburgh on embankment and Hickleton in deep cutting, before heading north-west to pass north of Thurnscoe and Clayton on a viaduct over the existing railway.

4.3.16 To the north of Clayton, a spur would allow trains travelling north from Sheffield Midland Station on the MML to continue on the HS2 main line. The route would then travel north-west towards Hemsworth and Crofton, passing through rolling countryside on a series of cuttings and embankments.

4.3.17 North of the village of Crofton the route of the Proposed Scheme would travel between Wakefield and Normanton and would pass over a viaduct (the first of two) east of Methley Junction. At this location, the route would divide with the HS2 main

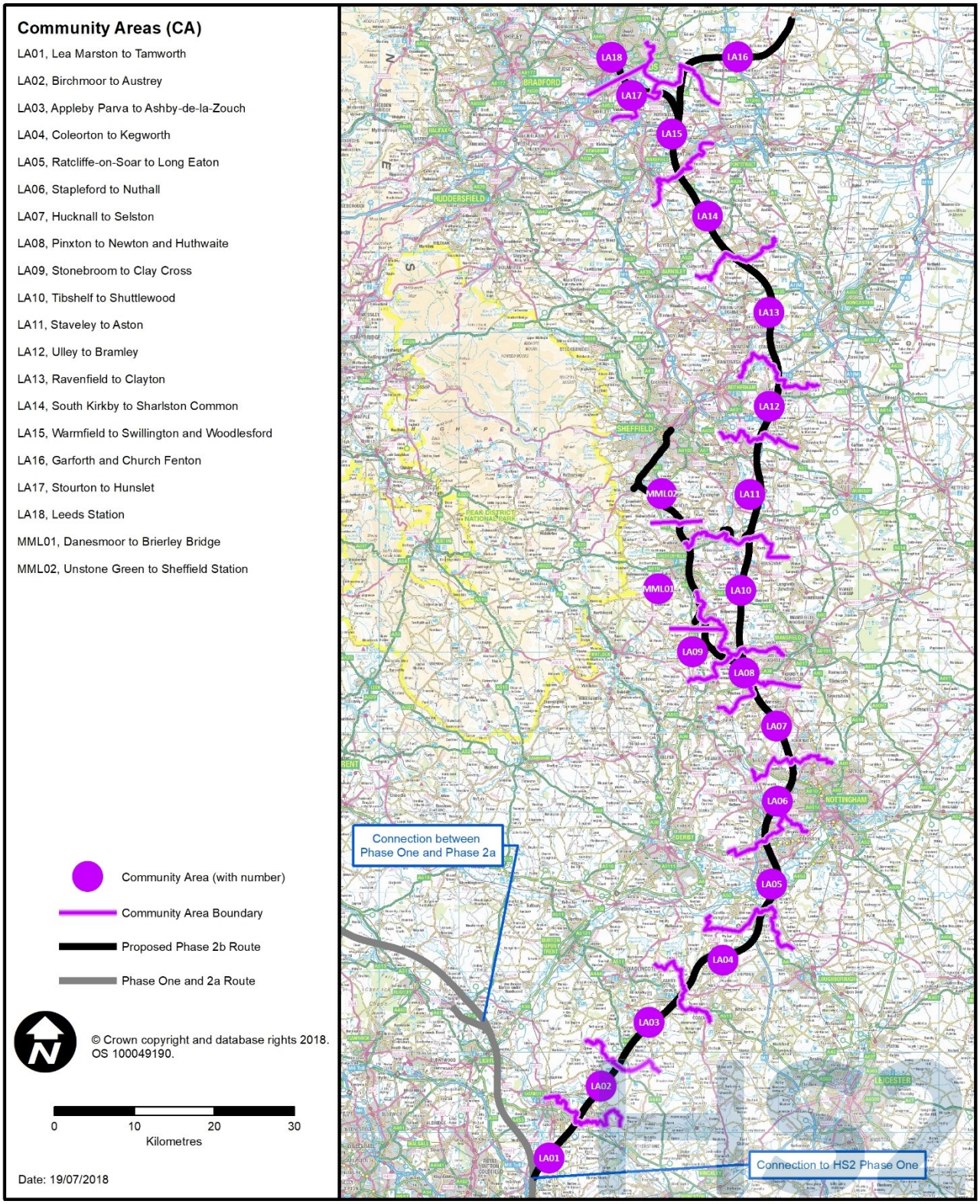
line travelling north to Swillington and with a spur moving north-west towards the existing Leeds Station.

4.3.18 The HS2 main line would cross a long viaduct (the second of two) and would proceed northwards to the west of Swillington and then east towards Church Fenton, where it would join the existing York to Church Fenton Line prior to joining the ECML. The approach to the existing conventional network would be on a long viaduct.

4.3.19 The spur towards the existing Leeds Station would start at Methley and would proceed towards Woodlesford where it would pass through a tunnel under the village. The route of the spur would exit the tunnel before travelling west within the existing conventional rail corridor on a series of cuttings and embankments.

4.3.20 The route of the Proposed Scheme would pass through the southern outskirts of Leeds prior to approaching the new high speed station adjacent to the River Aire. A common concourse would connect the new high speed station with the existing Network Rail station. To the east of Leeds city centre, near the M1 junction 45, there would be a new RSD.

Figure 6: Eastern leg of the Proposed Scheme



Interfaces between Phase 2b and other phases of HS2

4.3.21 The eastern leg of Phase 2b would continue from the Phase One route near Marston. The Phase One route terminates in cutting on a short spur off the Phase One main line and the Phase 2b route would continue in a north-easterly direction from the end of this cutting.

4.3.22 The Phase 2a main line would terminate at a portal headwall[62], which would form the southern end of the tunnel that would continue underneath Crewe towards Manchester as part of the Proposed Scheme. Provision has been made in the design for the Proposed Scheme for this purpose. Phase 2a would also run on spurs from the main line connecting to the WCML and into Crewe Station.

Interfaces between Phase 2b and the conventional rail network

4.3.23 The western leg of Phase 2b would connect to the existing WCML at Lily Lane, to the south of Wigan in the Risley and Bamfurlong area (MA05), and at the Crewe North RSD, in the Wimboldsley to Lostock Gralam area (MA02).

4.3.24 The eastern leg of Phase 2b would connect to the York to Church Fenton Line at Ulleskelf in the Garforth and Church Fenton area (LA16). The eastern leg would also include spurs off the HS2 main line at the following locations:

- near Clay Cross (LA09), to enable HS2 services to connect to the MML via the Sheffield Southern spur to serve existing stations at Chesterfield and Sheffield city centre (MML01 and MML02);
- to the north of Thurnscoe and Clayton (LA13) where trains travelling north of Sheffield Midland Station on the existing MML would connect to the Dearne Valley Line to then join the HS2 main line via the Sheffield Northern spur to continue north; and
- near Barlborough (LA11), to connect to the Staveley IMD. The Staveley spur would continue through the proposed IMD following an existing link along a disused railway and then connect to the existing Chesterfield to Beighton Railway.

Interfaces with other transport services

4.3.25 The Proposed Scheme would interface with other public transport modes at many locations. The main points of direct operational interface are summarised in Table 3. All stations are assumed to offer interchange opportunities with buses, taxis, cycling and walking.

[62] A supporting, protecting or retaining wall built at the front or top of a structure or area.

Table 3: Operational interfaces with other rail services at HS2 stations

Location	Relation to other transport services
Manchester Airport High Speed station	The Proposed Scheme includes provision for Metrolink passengers to interchange onto high speed rail services.
Manchester Piccadilly High Speed station	The Proposed Scheme would allow for interchange onto conventional rail services and Metrolink.
East Midlands Hub station	The Proposed Scheme would allow for interchange onto conventional rail services on the Erewash Valley Line.
Leeds High Speed station	The proposed high speed station would be connected to the existing Leeds Station via a common concourse, providing direct interchange onto the existing Leeds Station platforms.

4.4 Services and operating characteristics

Overview

4.4.1 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 would operate. However, a provisional service pattern has been identified in order to test the Business Case and to provide assumptions for an operational specification for the assessment of the Proposed Scheme.

4.4.2 It is envisaged that passenger services would operate from 05:00 up to midnight from Monday to Saturday and from 08:00 up to midnight on a Sunday. Maintenance and engineering works would occur outside these hours, unless the works can be safely undertaken with trains operating at the same time. Passenger services would start at or after 05:00 from the terminal stations and would progressively increase to the number of trains per hour in each direction on the main lines as shown in Figure 7 and as detailed within the Volume 2: Community area reports. It is assumed that this number of services would operate every hour from 07:00 to 21:00. The number of services would progressively decrease after approximately 21:00 and the last service is expected to arrive at terminal stations by midnight.

Journey times

4.4.3 The expected fastest typical journey times are set out in Table 4. Note that for journeys to destinations that are not on the core HS2 network, a change on to the conventional rail network would be required.

Table 4: Fastest typical journey times between key destinations 'without' and 'with' HS2 in operation

Leg of Phase 2b	Train origin/ destination	Train destination/ origin	Current fastest journey time by conventional rail (hours:minutes)	Fastest journey time with the Proposed Scheme (including Phase One and Phase 2a) (hours:minutes)
Western leg	London	Crewe	1:30	0:55 (requires Phase One and Phase 2a only)
		Manchester Airport	2:24 (to existing	1:03 (to high speed station)

Leg of Phase 2b	Train origin/ destination	Train destination/ origin	Current fastest journey time by conventional rail (hours:minutes)	Fastest journey time with the Proposed Scheme (including Phase One and Phase 2a) (hours:minutes)
			conventional rail station)	
		Manchester Piccadilly	2:07	1:07
		Preston	2:08	1:18
		Liverpool Lime Street	2:14	1:34
		Glasgow	4:30	3:40
		Edinburgh (Haymarket)	4:22	3:40
	Birmingham	Liverpool	1:34	1:09
		Manchester	1:28	0:40
		Glasgow	4:02	3:20
		Edinburgh (Haymarket)	4:07	3:11
Eastern leg	London	East Midlands Hub	N/A (new station as part of the Proposed Scheme)	0:52
		Derby	1:25	1:12
		Nottingham	1:40	1:09 (to East Midlands Hub)
		Sheffield	2:01	1:27
		Leeds	2:11	1:21
		York	1:51	1:24
		Newcastle	2:50	2:17
	Birmingham	Nottingham	1:09	0:20 (to East Midlands Hub)
		Sheffield Midland	1:03	0:49
		Leeds	1:58	0:49 (if served via the HS2 main line, not via Sheffield)*
	Nottingham	Sheffield Midland	0:50	0:27 (from East Midlands Hub)

* Note: If electrification and capacity improvements were provided between Sheffield Midland Station and Clayton Junction, a Birmingham to Leeds service via Sheffield is estimated to take 1 hour and 18 minutes. On this basis, a Sheffield to Leeds journey time is estimated to take 27 minutes.

Form of trains

4.4.4 Following completion of the Proposed Scheme in 2033, the high speed railway could be used by two types of service:

- services running on high speed and existing rail infrastructure would use specially designed high speed trains that are also capable of running on the existing UK rail network (referred to as 'conventional compatible' trains); and
- services operating on high speed infrastructure only could use standard

European-sized high speed trains (referred to as 'captive' trains), or conventional compatible trains.

4.4.5 To enable conventional compatible trains to operate on the conventional network, they would be equipped with suitable train control and power systems and would be of a reduced width and height.

4.4.6 It is anticipated that conventional compatible and captive high speed trains would be 200m-long and that, when required, could be coupled together to form 400m-long trains. A greater number of HS2 trains are expected to be 400m long during peak hours, with a mix of 200m and 400m-long trains at other times. Up to approximately 550 passengers would be accommodated on each 200m-long high speed train, and therefore, up to approximately 1,100 passengers for each 400m-long train.

Train flows and speeds

4.4.7 Figure 7 shows the peak hour train flow in each direction across the Proposed Scheme that has been assumed in the working draft ES, with the exception of the sound, noise and vibration assessment as discussed in the text that follows. Figure 7 shows the peak hour one-way train flow by route section with both Phase One and Phase Two of HS2 operating. These flows on both the western and eastern legs of the Proposed Scheme account for an element of growth from the year of opening.

4.4.8 Figure 8 shows the peak hour train flow in each direction across the Proposed Scheme that has been assumed for the purpose of the sound, noise and vibration assessment reported in the working draft ES. These assumed train flows provide a reasonably foreseeable worst case basis for this specific topic assessment over the first 15 years of operation in the following ways:

- the number of trains shown for the Phase One and Phase 2a[63] sections, and hence at the southern end of the western and eastern legs of Phase 2b, has been assumed to be the same as those that underpinned the relevant sound, noise and vibration assumptions reported in the Phase One and Phase 2a ESs; and
- the number of trains shown either side of each junction does not necessarily total the number in the subsequent section of the route of the Proposed Scheme; this is because the values shown for each section provides flexibility for delivery and future operation. This relates to junctions where future flexibility is required as to whether a train service would stay on the HS2 main line or transfer to a spur. To provide future flexibility, the sound, noise and vibration assessment assumes that such services would operate on both the HS2 main line and the spur. This is consistent with the approach adopted for Phase One and Phase 2a.

[63] The assumption of seven trains per hour in each direction on the spur connecting Phase One to the WCML at Handsacre is for the first year of operation before Phase 2a is proposed to come into operation. The assumption of six trains per hour in each direction on the spur connecting Phase 2a to the WCML at Crewe is for the six years of operation before Phase 2b is proposed to come into operation.

4.4.9 HS2 conventional compatible trains would transfer between the Proposed Scheme and the conventional rail network via the WCML on the western leg, at Lily Lane to the south of Wigan, and via the ECML on the eastern leg, to the south of York. This would provide HS2 conventional compatible services to destinations such as Preston, York, Newcastle, Glasgow and Edinburgh as well as a number of other intermediate stations. The number of HS2 trains transferring between the Proposed Scheme and the conventional rail network is shown in Figure 7. Work is ongoing to confirm the resulting change in rail services on the conventional rail network and any associated likely significant environmental effects will be reported in the formal ES.

Figure 7: Phase One, Phase 2a and the Proposed Scheme (with growth) – peak hour one-way train flow

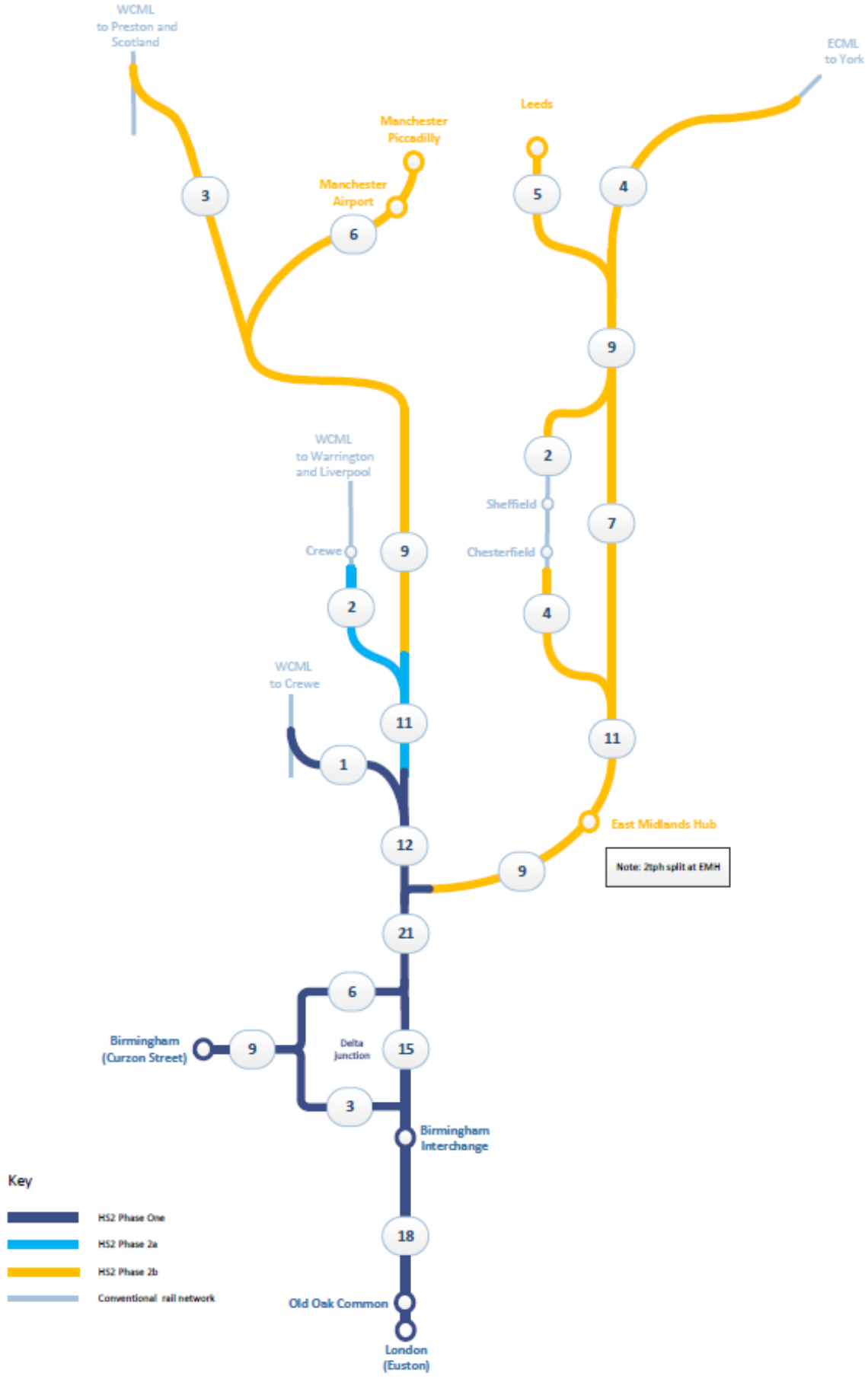
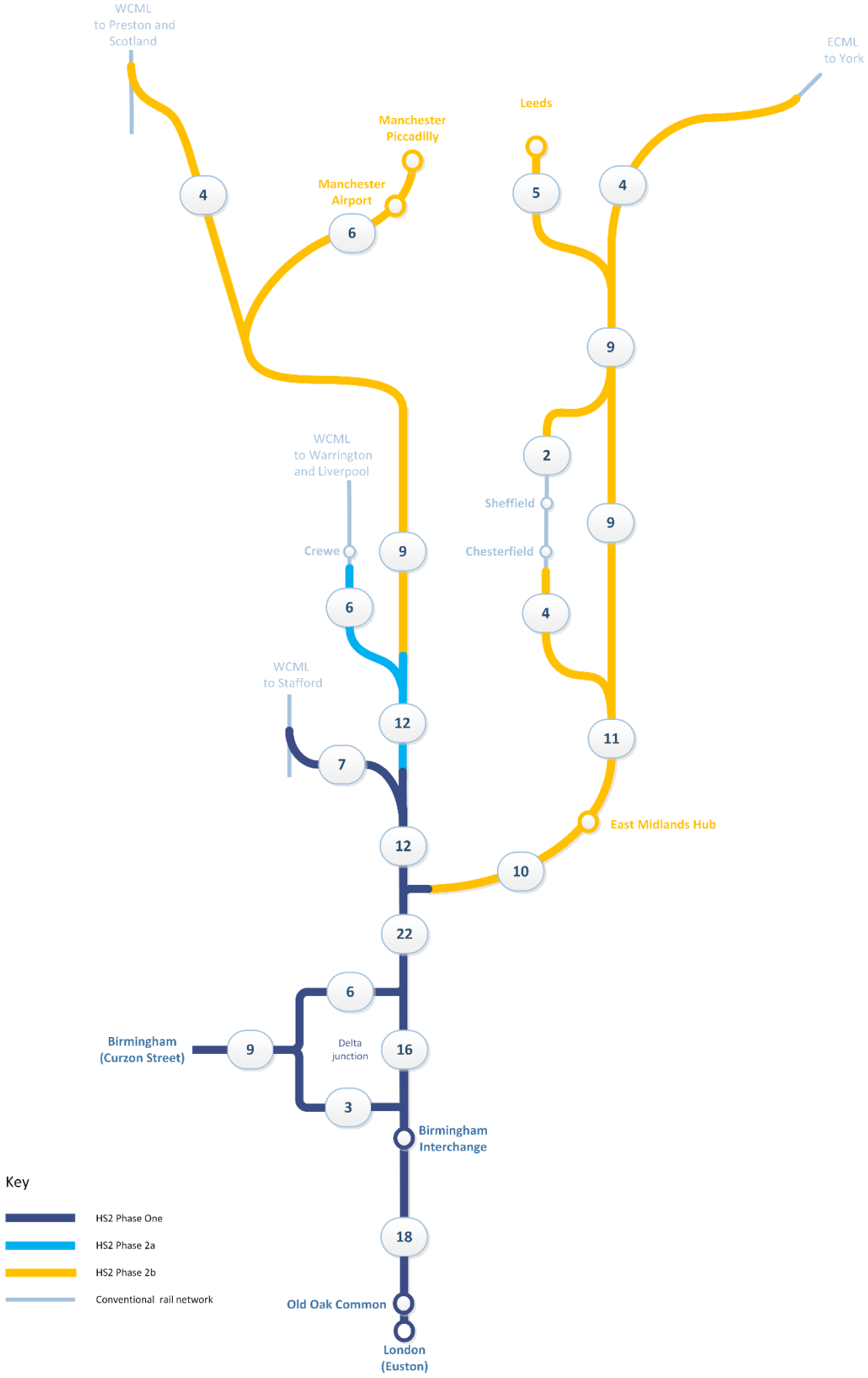


Figure 8: Phase One, Phase 2a and the Proposed Scheme (with growth) – peak hour one-way train flow for the assessment of sound, noise and vibration effects



4.4.10 High speed trains would generally operate at up to 360kph (225mph), where the alignment allows. However, where possible, the route of the Proposed Scheme has been designed to allow for train speeds of up to 400kph (248mph) in the future where there is a commercial justification for doing so. Operation at up to 400kph would require demonstration that improved train design enables services to operate at that higher speed without giving rise to new or different likely significant environmental effects.

4.4.11 Sections of the route are designed to maximum operational speeds as follows:

- up to 360kph (225mph) on the western leg between the interface with Phase 2a and the connection to the WCML near Golborne;
- up to 230kph (142mph) on the Manchester Spur;
- up to 360kph (225mph) on the eastern leg between the interface with Phase One and the connection to the conventional railway network and the ECML near Ulleskelf;
- up to 200kph (125mph) on the Sheffield Southern spur and 120kph (75mph) on the connection to the MML; and
- up to 230kph (140mph) on the eastern leg spur into Leeds.

4.4.12 The technical and operational specification for the Proposed Scheme is derived from the EU's Technical Specifications for Interoperability (TSI)[64], which defines the requirements for all new high speed railways and their connections to conventional rail networks.

4.4.13 It is anticipated that conventional compatible trains would operate over the conventional rail network at speeds no greater than existing services and would use the existing traction power electrification.

4.4.14 A number of modifications to the conventional rail network are required as part of the Proposed Scheme. These are outlined within Volume 4: Off-route effects of this working draft ES. There may be further works required to the conventional 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 would require assessment at that stage.

Maintenance of HS2 operational infrastructure

4.4.15 The maintenance regime would include inspection and monitoring to predict and prevent changes to the condition and performance of HS2 infrastructure that might affect operation of the Proposed Scheme. This would be achieved through:

- remote condition monitoring of assets;

[64] European Railway Agency. Multiple Technical Specifications for Interoperability (TSI). Available online at: http://www.era.europa.eu/Core-Activities/Interoperability/Pages/TechnicalSpecifications.aspx

- measurement systems fitted to passenger rolling stock that monitor physical interaction between train and rail system assets;
- the frequent operation of infrastructure measurement trains which record the condition of infrastructure assets; and
- inspection staff.

4.4.16 Viaducts and tunnels would be examined using a combination of vehicles equipped with appropriate lifts and access platforms, hi-definition video and laser scan, and drone/unmanned aerial vehicle technologies. Civil engineering assets would be monitored using asset condition monitoring sensors.

4.4.17 Other elements of the maintenance regime would include:

- inspection and maintenance of electrical and mechanical equipment including lineside locations such as auto-transformers;
- preventative maintenance of the track systems would include the use of dedicated works trains for infrastructure maintenance, rail re-profiling and other heavy-duty operations;
- preventative maintenance for other equipment may include 'maintenance by replacement' whereby components are exchanged, to be serviced offline in a depot or factory;
- planned periodic refurbishment and replacement of assets;
- during the life of the railway, elements of the railway system would need to be replaced on the basis of condition criteria, although civil infrastructure such as tunnels and viaducts would be maintained during their operational life through servicing and repair of structural elements to avoid the need for replacement; and
- update or replacement of control and telecommunication systems and other software-based elements, depending on technological developments and obsolescence.

4.4.18 The assumptions underpinning the HS2 maintenance regime include:

- maintenance within the operational rail corridor would take place between the hours of midnight and 04:59 on Monday to Saturday and midnight to 07:59 on Sunday, outside passenger train operating hours;
- design, system and process would separate maintenance activity and staff from operating passenger trains;
- safe working areas would be established by isolating traction power supply from the control centre, with coordination between power and traffic control to allow quick and efficient access;
- where reasonably practicable, mechanical and electrical equipment would be located to allow servicing from a safe and secure location and without affecting operations;

- maintenance affecting services would be largely mechanised and undertaken from rail-based vehicles, including the use of mobile factory trains[65]; and
- maintenance trains would be of a hybrid type.

4.4.19 Other maintenance and repair activities for systems such as traction power distribution or train control would largely be carried out away from the operational railway.

Maintenance depots

4.4.20 Infrastructure maintenance operations, including routine line checks and replacement of track and overhead line equipment, would be managed and resourced from the proposed IMDs (see Section 5.14 of this report). The principal infrastructure maintenance activities on the eastern leg would be managed and resourced from the IMD at Staveley. The IMD at Stone, which is included in the Phase 2a Bill, would also serve the western leg of the Proposed Scheme.

4.4.21 Maintenance planning and rolling stock maintenance would be conducted from the Crewe North RSD and Leeds East RSD (see Section 5.15 of this report).

4.4.22 Overnight train stabling and service preparation would likely be required to take place at off-route locations in order to reduce the number of empty train movements at the beginning and end of service. An overview of possible depot locations is provided within the Volume 4: Off-route effects report.

[65] 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 HGVs.

5 Permanent features of the Proposed Scheme

5.1 Design

5.1.1 The design of Phase 2b has been developed over a period of time and in line with the principles of the *HS2 Design Vision*[66]. The Design Vision sets out nine principles grouped around the following three themes:

- people – design for everyone to benefit and enjoy;
- place – design for a sense of place; and
- time – design to stand the test of time.

5.1.2 Building on the Design Vision, HS2 Ltd has produced the *Landscape Design Approach*[67] to guide the appointed designers to achieve a high quality landscape design which is functional, works well and responds sensitively in terms of scale to the local context along the route of the Proposed Scheme. It is also intended that the landscape design delivers a strong identity for the Proposed Scheme, including the creation of new landscapes and transformational public spaces and places.

5.1.3 Good design requires a collaborative approach, where all the design elements of the project can be successfully brought together whilst also respecting the operational and maintenance requirements of a high speed railway. Landscape design can help to merge and consolidate the work of other design areas, including civil engineering and railway systems, the architecture of high speed stations and structures and the related environmental topics, such as agriculture, forestry and soils, community, ecology and biodiversity, historic environment, sound, noise and vibration and traffic and transport.

5.1.4 The scope of landscape design is wide. Along with new landscapes and public places, it would deliver environmental requirements such as visual screening and appropriate settings for engineering design and architectural elements. The landscape design would also provide the opportunity to restore agricultural land, build-in noise mitigation, create new ecological habitats, improve water quality, provide opportunities for green infrastructure, build in resilience to the effects of climate change, provide settings for heritage features and historic landscapes and promote the integration of footpath, bridleways and cycle paths.

5.1.5 In addition to the HS2 Design Vision and Landscape Design Approach documents, the Secretary of State for Transport has established an independent Design Panel. The Design Panel has its own terms of reference and governance structure, to ensure that designs of high speed stations, structures and other related aspects of the new railway

[66] HS2 Ltd (2017). HS2 Design Vision, April 2017. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/607020/HS2_Design_Vision_Booklet.pdf
[67] HS2 Ltd (2017). HS2 Landscape Design Approach. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/550791/HS2_Landscape_Design_Approach_July_2016.pdf

would complement local aspirations and contribute to the natural and built environment. The Design Panel provides professional expertise and independent advice to help HS2 Ltd achieve a high standard of design that is also cost-effective and sustainable.

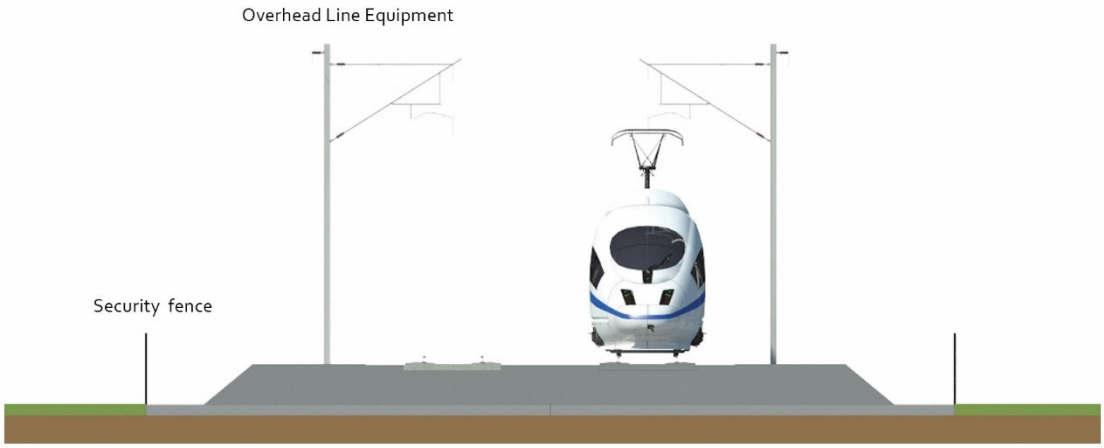
5.2 Rail corridor

5.2.1 In most locations the Proposed Scheme would comprise two railway tracks, one for northbound and one for southbound services. The width of the rail corridor would vary along its length to accommodate the topography and cuttings and embankments. The rail corridor would, in general, encompass the two tracks, associated overhead line equipment, track drainage, electricity cables, cable ducting, line-side walkways and noise fence barriers, where required. Power supply (see Section 5.19 of this document) and train control and telecommunications (see Section 0 of this document) infrastructure would be required at certain locations along the route of the Proposed Scheme.

5.2.2 The rail corridor would be continuously fenced. An integrated approach would be taken when designing fencing layouts since a successful design is dependent on full consideration of numerous design disciplines and physical interfaces.

5.2.3 An indicative cross section through a two-track rail corridor at ground level is shown in Figure 9.

Figure 9: Indicative two-track rail corridor



5.2.4 In some locations the rail corridor would be wider to accommodate more than two tracks. This would be necessary:

- where the rail corridor approaches a station;
- where trains need to slow down and access a station, without impeding through trains;
- for sections of the route of the Proposed Scheme where different lines converge; and
- on the approach to the IMD or a RSD, where additional track work would be provided for trains to enter/exit the depot facilities.

5.3 Cuttings and embankments

5.3.1 Cuttings would be formed by excavation in areas where the local topography is at a higher level than the desired route alignment. Embankments would be formed by placing fill material where the local topography is lower than the desired route alignment. Embankments would also be used where the route would cross valleys and is not otherwise on bridges or viaducts.

5.3.2 Embankments and cuttings have been named in this working draft ES according to their predominant physical characteristics i.e. whether it is engineered predominantly above or below ground level.

5.3.3 An illustration of a cutting is shown in Figure 10 and an illustration of an embankment is shown in Figure 11.

Figure 10: Illustration of a generic cutting and cross-section of cutting

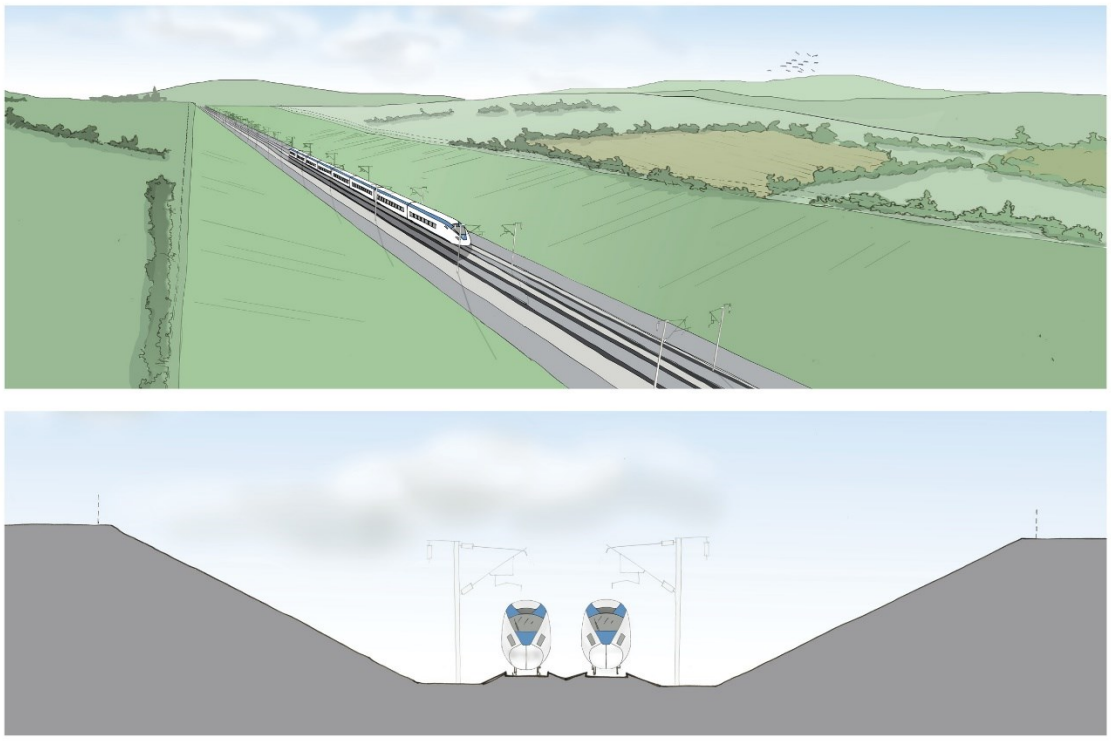
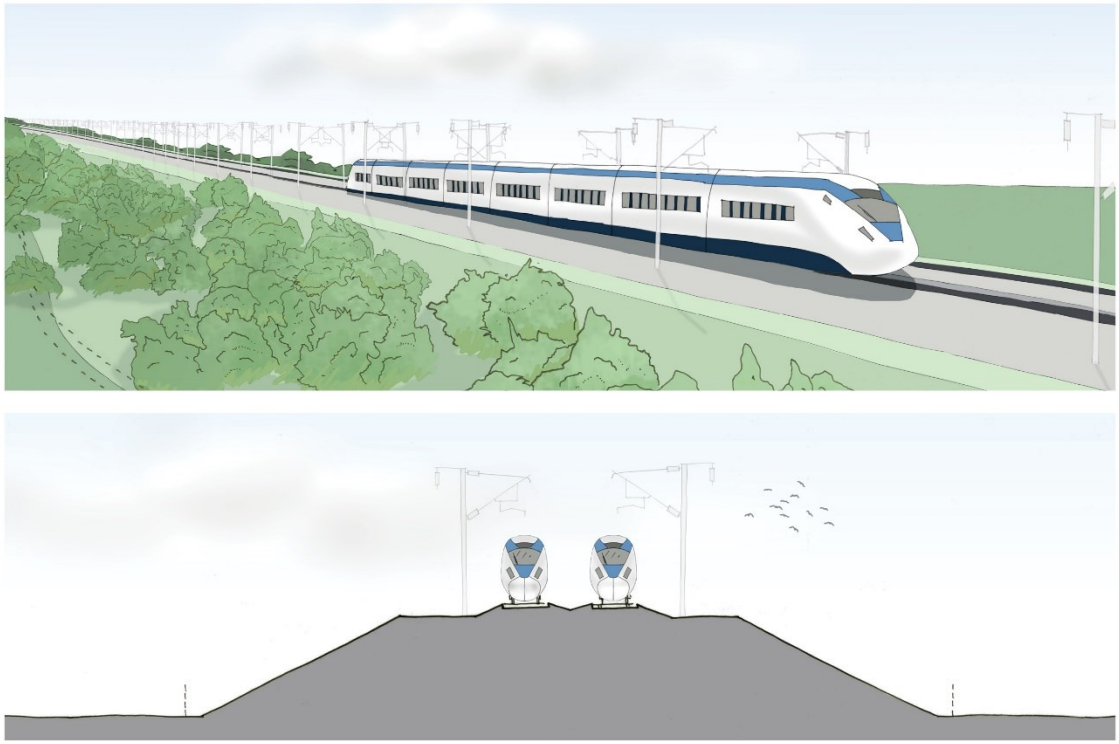
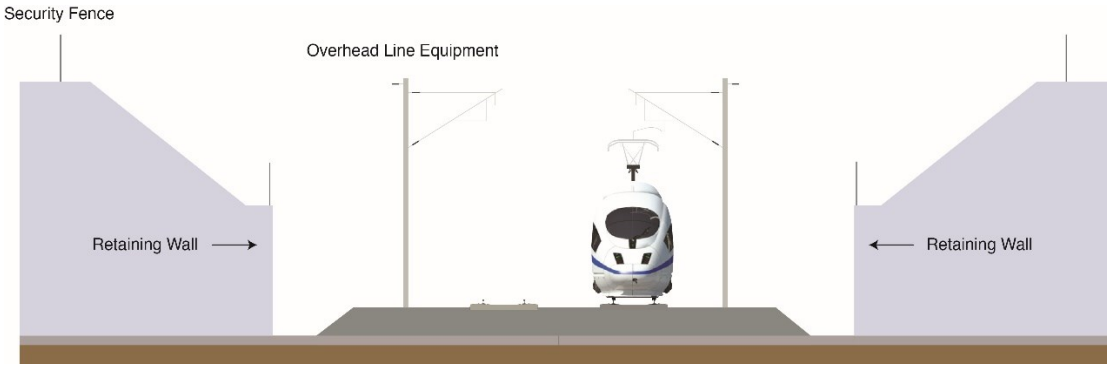


Figure 11: Illustration of a generic embankment and environmental mitigation earthworks and cross-section of embankment



5.3.4 The angle of side slopes for cuttings and embankments, and therefore, the overall width of the works, would depend on local ground conditions and topography, and on the quality of excavated material. In general, embankment slopes would be 1:2.5, that is for each metre of depth or height, the width of each slope would be 2.5 times larger. Slopes may be steepened or retaining walls may be used where space is limited; for example, where the area of land required needs to be reduced. An illustration of retaining walls is shown in Figure 12.

Figure 12: Illustration of generic retaining walls



5.3.5 Slopes would generally be top-soiled and seeded. In unfavourable geological conditions, stabilising elements and/or drainage may be incorporated within slopes. Where mitigation earthworks are proposed to be returned to agricultural use, arable slopes would be re-graded to no steeper than 1:8, although steeper grades may be adopted for pastoral use.

5.3.6 Priority would be given to reusing material excavated from the Proposed Scheme in the engineering earthworks to form embankments and environmental mitigation earthworks along the route of the Proposed Scheme. This would help to reduce the need to move surplus excavated material[68] off-site, which has associated environmental effects. This approach would also reduce the impact of the Proposed Scheme by making best use of the excavated material to significantly reduce the need to import material. A number of options are being considered for where additional acceptable engineering material is needed for rail embankments (see Section 6.10 of this report).

5.4 Drainage and watercourse realignments

Railway drainage

5.4.1 Drainage parallel to the railway would generally comprise filter drains feeding balancing ponds at intervals along the route of the Proposed Scheme. These ponds would be of three types: attenuation ponds, infiltration ponds and hybrid ponds. Attenuation ponds would attenuate peak flows so that runoff generated from the railway track discharges at an agreed rate to a nearby watercourse, thereby reducing the risk of localised flooding. Infiltration ponds would allow runoff to be absorbed into the ground where conditions are suitable. Many of the ponds would be a hybrid combining features of both types.

5.4.2 Balancing ponds would typically be unlined and may have banks with a varying profile. Their size would depend on drainage requirements. The balancing ponds would not be designed to hold water permanently, but would be dry most of the time, except following intense rainfall events. They would be designed to accommodate a one in 100 year annual rainfall probability event, with an allowance for climate change.

5.4.3 Surface water runoff within built-up areas may need to be discharged to the urban drainage system, for example, a piped combined sewer, at a controlled rate.

Buildings and facilities drainage

5.4.4 Sewage from the IMD, RSDs and other manned facilities would be discharged into adjacent sewers, where available with appropriate capacity. On-site treatment or collection of foul effluent may be necessary in specific cases.

5.4.5 Surface water runoff from stations, buildings and areas of hardstanding (e.g. accesses and parking) would be infiltrated to ground or would be attenuated and discharged, at a rate agreed with the relevant authority, to a nearby watercourse or a sewer. The

[68] 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.

design will employ sustainable drainage systems to manage surface water runoff and improve discharge water quality. The drainage system would also incorporate pollution control devices such as oil and silt traps where necessary.

Land drainage

5.4.6 In some locations, structural and landscape earthworks would affect existing drainage systems of agricultural and other land adjacent to the new railway. Elsewhere, they would alter the existing overland flow routes helping to drain surface water runoff from fields and areas of woodland, or change the slope of the land. The design will therefore include land drainage measures to address these changes in an appropriate way.

Floodplain storage areas

5.4.7 The Proposed Scheme avoids an increase in the risk of flooding from all sources, taking into account the projected impact of climate change. Where required, the Proposed Scheme would mitigate loss of floodplain by creating replacement floodplain storage areas.

Watercourse crossings

5.4.8 New structures would be required to carry the railway over existing watercourses, ranging from box culverts[69] to underbridges[70]. The length of culverts would be kept to a practicable minimum. Culverts will be designed for a one in 100 year annual rainfall probability event, including an allowance for climate change. Bridge soffits[71] would be raised above the one in 100 year annual rainfall probability event, including allowances for climate change and freeboard[72].

Watercourse realignment

5.4.9 Watercourses would need to be realigned in some cases. Channel flows would be designed and maintained in consultation with the relevant drainage authority. The methods to divert watercourses are described in more detail in Section 0 of this report.

5.4.10 Rivers and streams would be reinstated, where reasonably practicable, with a natural-looking appearance, having consideration for the requirements of the Water Framework Directive (WFD). Appropriate access would be provided to watercourses to allow for maintenance.

5.5 Highways (roads) and public rights of way

5.5.1 New, diverted or realigned roads and public rights of way (PRoW, i.e. footpaths, bridleways and byways), would be constructed to the appropriate standard for each location. Alterations to major roads would be designed using the UK's national

[69] A tunnel (pipe or box shaped) that carries a stream or open drain under a road or railway.
[70] A bridge carrying the Proposed Scheme over other features.
[71] The underside of a bridge.
[72] 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.

standards given in the Design Manual for Roads and Bridges (DMRB)[73]. However, country lanes are very different to the main road network, and it is important to retain the existing character of minor rural routes where reasonably practicable. Since most published standards do not cater adequately for this type of road, HS2 Ltd has developed a set of design criteria which is based on experience from HS1 and industry good practice. These would be applied where new, realigned or diverted routes are required, helping them to retain a similar 'feel' as other roads in the locality. Local authority design standards would also be used, where appropriate, together with national guidance including the *Manual for Streets*[74]. The shortest practicable route for realignment consistent with design and safety requirements would normally be used. PRoW realignment and replacement would be designed into their surroundings as far as possible, and to retain the existing character of the route.

5.5.2 New or enhanced vehicular access would be required at various points to allow access to the Proposed Scheme. Facilities such as the stations and the IMD would require access at all times. Emergency access would be required to tunnel portals and vent shafts, whilst occasional access would be required for maintenance purposes to features such as balancing ponds, structures, landscaped areas and line-side equipment.

5.6 Tunnels

Introduction

5.6.1 Tunnels would be constructed at a number of locations along the route of the Proposed Scheme, as described in the Volume 2: Community area reports, Section 2. Three methods of construction would be used:

- bored and mined, which leaves 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.

5.6.2 All tunnels would have portals (i.e. exit/entrance structures) whilst longer tunnels would require cross passages and vent shafts. The different tunnel types and features are described in the following sections.

Bored tunnels

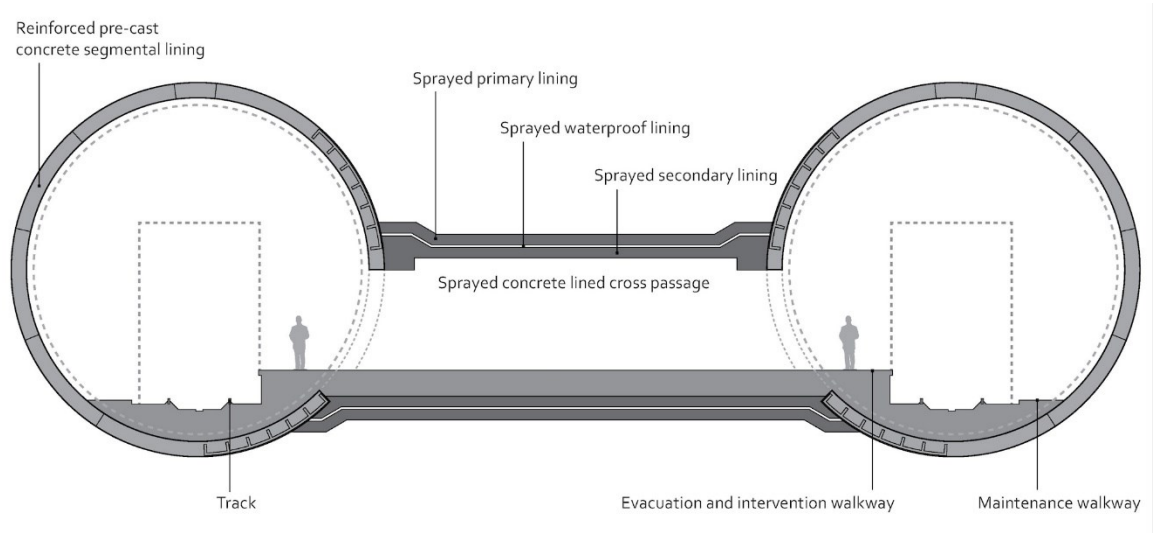
5.6.3 Bored tunnels would generally be constructed where the depth between the railway and existing ground is such that open excavation is not practicable, and where the tunnel length is sufficient to make the use of tunnel boring machine (TBM) equipment viable (further detail about the nature and operation of TBMs is provided in Section 6.16 of this report). Bored tunnels are proposed underneath Crewe (MA01), under south Manchester (LA06 and LA07) and under Woodlesford (LA15) (which would be part bored tunnel and part cut-and-cover tunnel, see following section).

[73] Department for Transport (2012). Design Manual for Roads and Bridges. Available online at: http://www.standardsforhighways.co.uk/ha/standards/dmrb/index.htm
[74] Department for Transport (2007). *Manual for Streets*. Thomas Telford publishing, London.

5.6.4 Tunnel bores would usually have an external diameter of between approximately 10m and 11m and an internal lined diameter of between approximately 7m and 9m. Twin-bore tunnels would comprise two parallel bores, each containing a single rail track. They would be approximately one tunnel diameter apart, except where they approach the portals, and would be connected by cross passages at intervals.

5.6.5 A cross-section of a typical twin-bore tunnel is shown in Figure 13.

Figure 13: Cross-section of typical twin-bore tunnel



Mined tunnels/sprayed concrete lined tunnels

5.6.6 Mined tunnelling/sprayed concrete lined (SCL) techniques would be used on shorter sections of tunnels and cross passages and/or where the tunnel geometry is complex. Mined/SCL tunnels would 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.

5.6.7 A section of the Strelley tunnel (LA06) would be mined.

Cut-and-cover tunnels

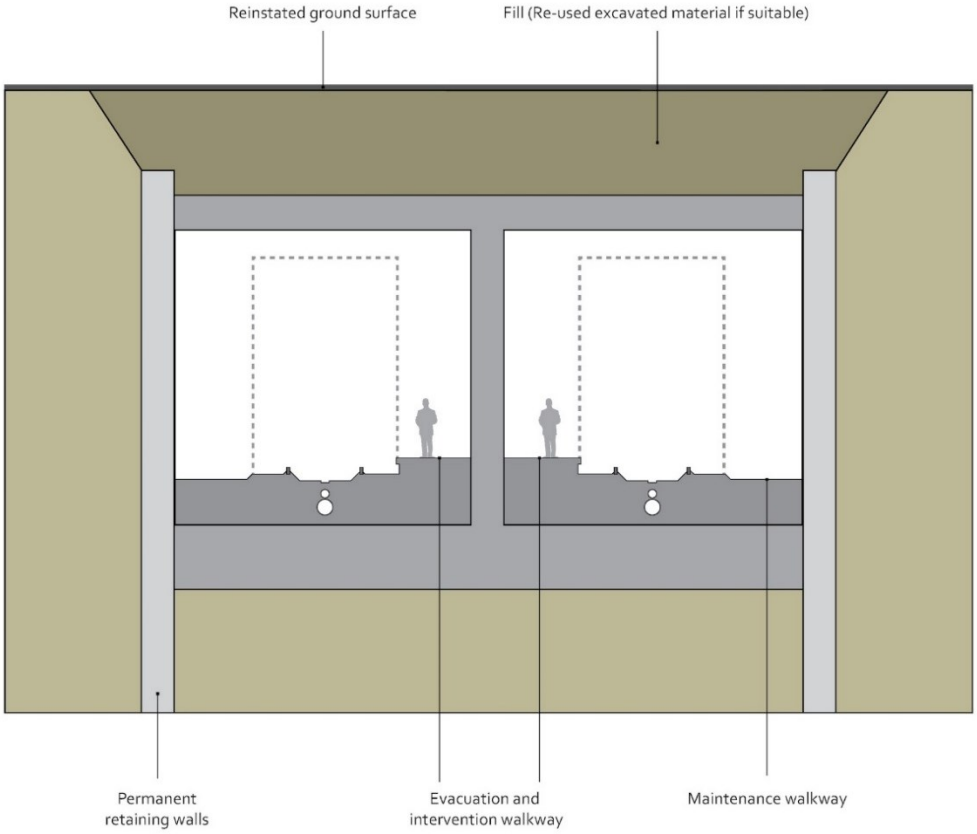
5.6.8 Cut-and-cover tunnels are built by excavating the ground, building a tunnel structure, and then restoring the land over the top. Soil would be spread on top to help integrate it with the landscape, thus reducing visual impacts and making the presence of a railway less noticeable. PRoW and access tracks can be replaced over the completed tunnel, vegetation can be replanted and the land returned to its former use.

5.6.9 Cut-and-cover tunnelling would be used for the M42 junction 10 tunnel (LA01), M42 Tamworth tunnel (LA02), Tibshelf tunnel (LA10) and part of the Woodlesford tunnel (LA15).

5.6.10 Redhill tunnel (LA05) would be a green tunnel. The Redhill green tunnel is a cut-and-cover tunnel with an area of woodland and grassland habitat creations located above the tunnel to provide replacement habitat.

5.6.11 Figure 14 shows a cross section of a typical cut-and-cover tunnel.

Figure 14: Cross-section of a typical cut-and-cover tunnel



5.7 Portals

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

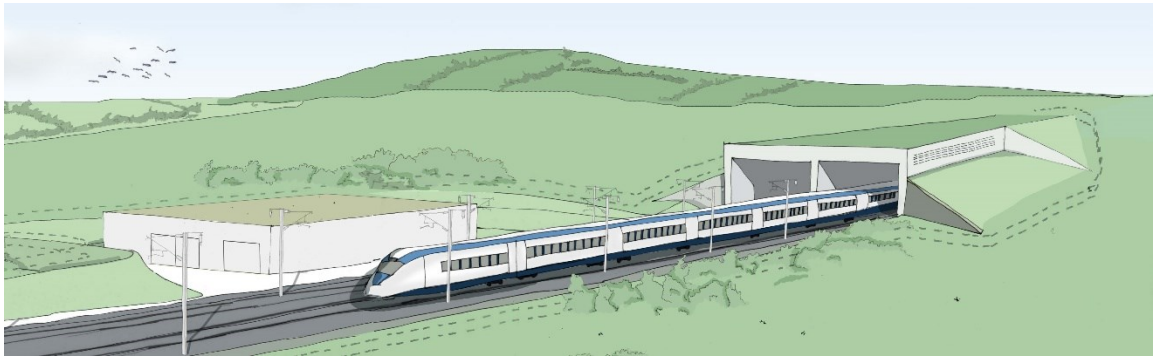
5.7.2 Tunnel portals may incorporate some or all of the following features:

- porous portal (i.e. tapered, perforated, reinforced concrete structures)[75];
- mechanical ventilation[76];
- 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; and
- a 550m² area for parking and hardstanding for service vehicles (which would also be used by passengers in the event of an emergency).

[75] Perforated structures at tunnel portals (entrances), usually formed of concrete, designed to allow the passage of air from the tunnel. These reduce both air pressure changes and the noise generated when a high speed train enters or leaves a tunnel.
[76] Ventilation 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.

5.7.3 An illustrative example of a cut-and-cover tunnel portal in a rural location is shown in Figure 15.

Figure 15: Illustration of a generic cut-and-cover tunnel portal



5.8 Ventilation and intervention (vent) shafts

5.8.1 Vent shafts to the surface would be spaced every 2km-3km (1.2-1.9 miles). The vent shafts would provide access for maintenance, pressure relief from the rail tunnels and emergency intervention, and would require mechanical ventilation for smoke control purposes in the event of a train fire in the tunnel. They would incorporate both lifts and stairs, terminating at ground level in headhouses, which would accommodate ventilation fans, lift winding gear and other plant, together with emergency access doors. The design and external appearance of headhouses would be approved by relevant local authorities in order to fit into the local surroundings.

5.8.2 An illustration of a typical vent shaft and headhouse in an urban location is shown in Figure 16.

5.8.3 Possible examples of a headhouse in a rural location are shown in Figure 17.

Figure 16: Illustration of a generic ventilation shaft and headhouse in an urban location

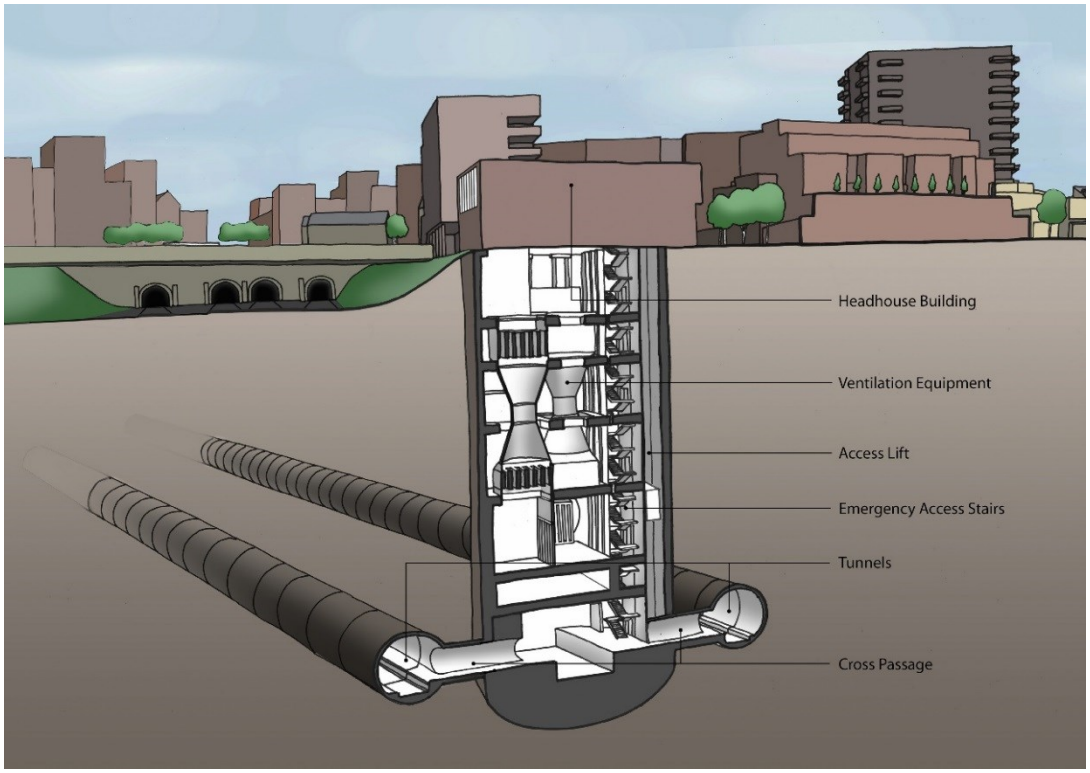
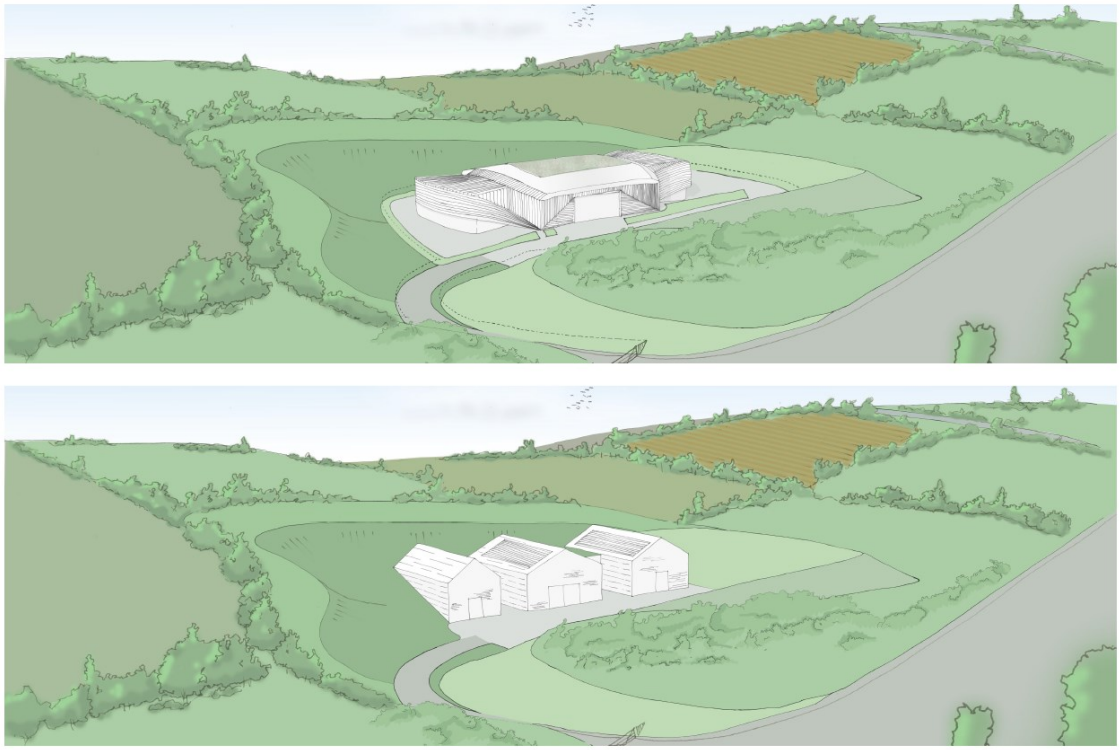


Figure 17: Illustration of a generic rural headhouse



5.8.4 Ventilation equipment and control cabinets would be required within some or all of the tunnels. For tunnels with shafts, axial fans[77] would normally be installed into the shafts. These would supply or extract air to/from the tunnels either via dampers[78] 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.

5.8.5 Under normal operating conditions, air would be pushed out of the vent shafts as each train approaches and would be drawn in after each train has passed. If a train stalls in the tunnel, the fans would 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 would be used in a similar way to eject smoke and supply fresh air.

5.8.6 For tunnels without shafts, and in some tunnels in addition to shafts, ventilation would be provided by jet fans[79] located within the tunnel, providing ventilation from one portal to the other. These fans would be switched off under normal conditions, but would be activated in the event of an emergency and for periodic testing.

[77] 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.
[78] A damper is a framed opening in a wall fitted with moveable horizontal slats for admitting air and or light.
[79] 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.

5.9 Cross passages

5.9.1 Tunnels would have cross passage evacuation escape routes, spaced every 350m, between individual twin-bore tunnels and access routes from the surface. These would be used for rescue, maintenance and evacuation purposes. The cross passages would be a minimum of 1.5m wide and 2.25m high. Additional cross passages for the sole use of emergency services would be provided at each vent shaft. These would be a minimum of 2.3m wide and 2.3m high. Cross passage doors would be provided every 350m in the central wall of cut-and-cover tunnels.

5.10 Bridges

5.10.1 Bridges are required where the route would pass over or under an existing feature such as a PRoW, road, river, floodplain or existing 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 Scheme) would typically be constructed of concrete or weathering steel. Typical height clearances would be 7.15m (i.e. from rail level to the underside of the bridge).

5.10.3 Intermediate piers are likely to be of reinforced concrete construction on pad or piled foundations[80], subject to ground conditions.

5.10.4 Generally, parapets[81] would be 1.8m in height where above the railway lines.

5.10.5 Underbridges (i.e. bridges carrying the Proposed Scheme over other features) are likely to be constructed of reinforced concrete and/or steel. Clearances would vary as required by the type of feature being crossed. For watercourses, underbridges would be designed for a one in 100 year annual rainfall probability event, including allowances for climate change and freeboard.

5.10.6 Figure 18 is an illustrative example of a single-span overbridge. Figure 19 is an illustrative example of a pedestrian underbridge.

[80] Pad foundation – 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.
[81] Low walls along the edges of the bridge, to protect people from falling.

Figure 18: Illustration of a generic single-span bridge

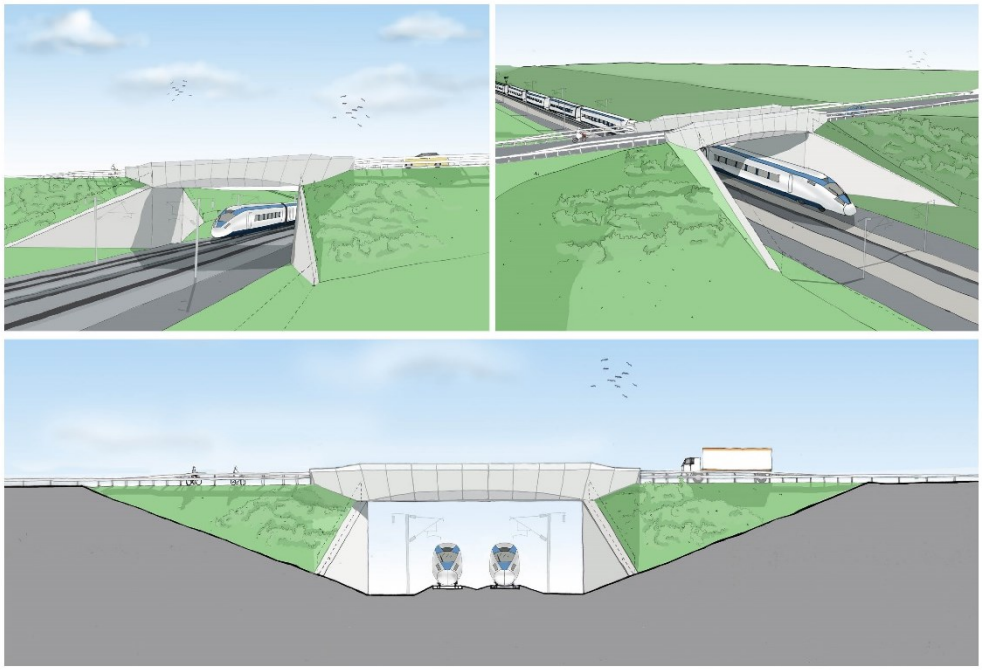
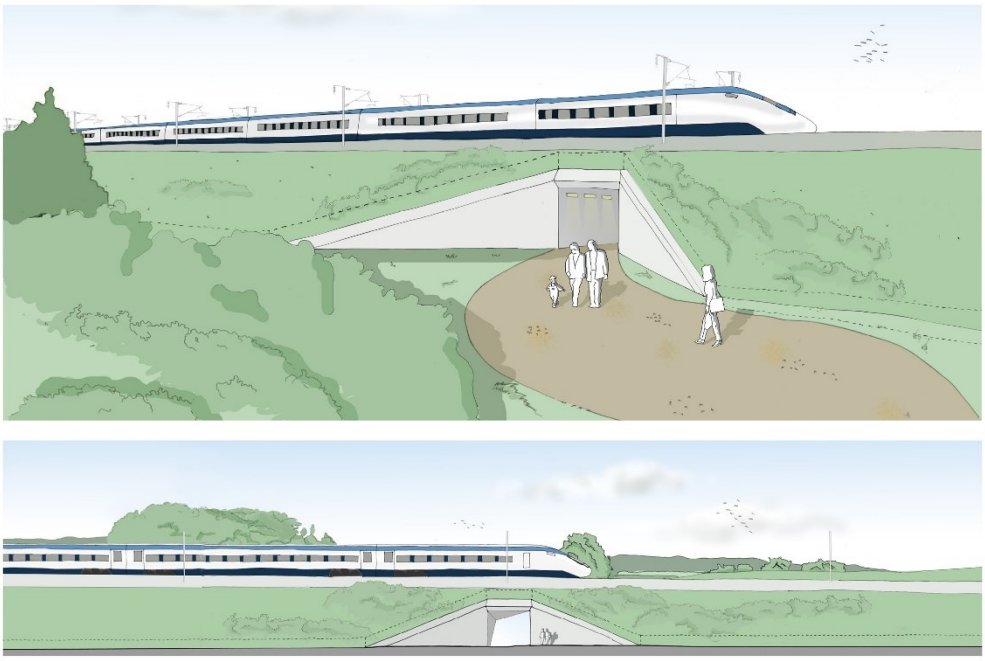


Figure 19: Illustration of a generic pedestrian underbridge



5.11 Green bridges

5.11.1 HS2 Ltd is considering the need for green bridges as part of the Proposed Scheme, based on the results of ongoing survey work. Should the need for any green bridges be identified these will be assessed and reported in the formal ES.

5.11.2 Green bridges are overbridges that have been designed in order to maintain habitat connectivity, and to enable the safe movement of animals (including bats) from one side of linear infrastructure to the other. Typically, these bridges are multi-functional and provide other types of access such as footpath, road or agriculture as their primary purpose. The main difference between a standard bridge and a green bridge is the increased width to allow vegetation, typically including one or two hedgerows comprising a range of local/native species, to be planted across the bridges.

5.11.3 In order to encourage species to use green bridges, planting on and around the entrance to the structures would link to existing vegetation in the local landscape. In some cases the design for planting may include the enhancement of existing vegetation nearby to allow a seamless transition between bridge and land. As well as providing safe passage and habitat links, the addition of vegetation would also help integrate the bridge into the surrounding landscape.

5.11.4 Typically green bridges would be unlit to ensure that light sensitive species, such as bats, are not discouraged from using them. Where lighting is considered essential for safety purposes, levels and light spill would be carefully controlled. In addition, some underbridges would provide ecological connectivity through their design and planting approach.

5.12 Viaducts

5.12.1 Viaducts are constructed where embankments would not be a practicable or effective solution, such as crossing a river or floodplain. Viaducts would generally be built where a multi-span structure is needed to provide a continuous elevated route across undulating terrain, existing roads or floodplains.

5.12.2 The height of the viaducts would depend on local topography and on the clearances required over existing features. Intermediate piers are likely to be of reinforced concrete construction on pad or piled foundations, subject to ground conditions or the construction methodology. Abutments would be constructed of reinforced concrete on pad or piled foundations. Viaducts over waterways would be designed for a one in 100 year annual rainfall probability event, including allowances for climate change and freeboard.

5.12.3 The standard viaduct design is proposed to have a solid wall on the viaduct edge (the parapet) of height approximately 1m (above track level). This would provide edge protection and a degree of incorporated noise mitigation. Where further noise mitigation is required, additional noise barrier elements would be mounted on top of this parapet wall. In addition, train derailment protection would also be provided on viaducts.

5.12.4 Figure 20 and Figure 21 are illustrative examples of high and low-level viaducts.

Figure 20: Illustration of a generic high viaduct

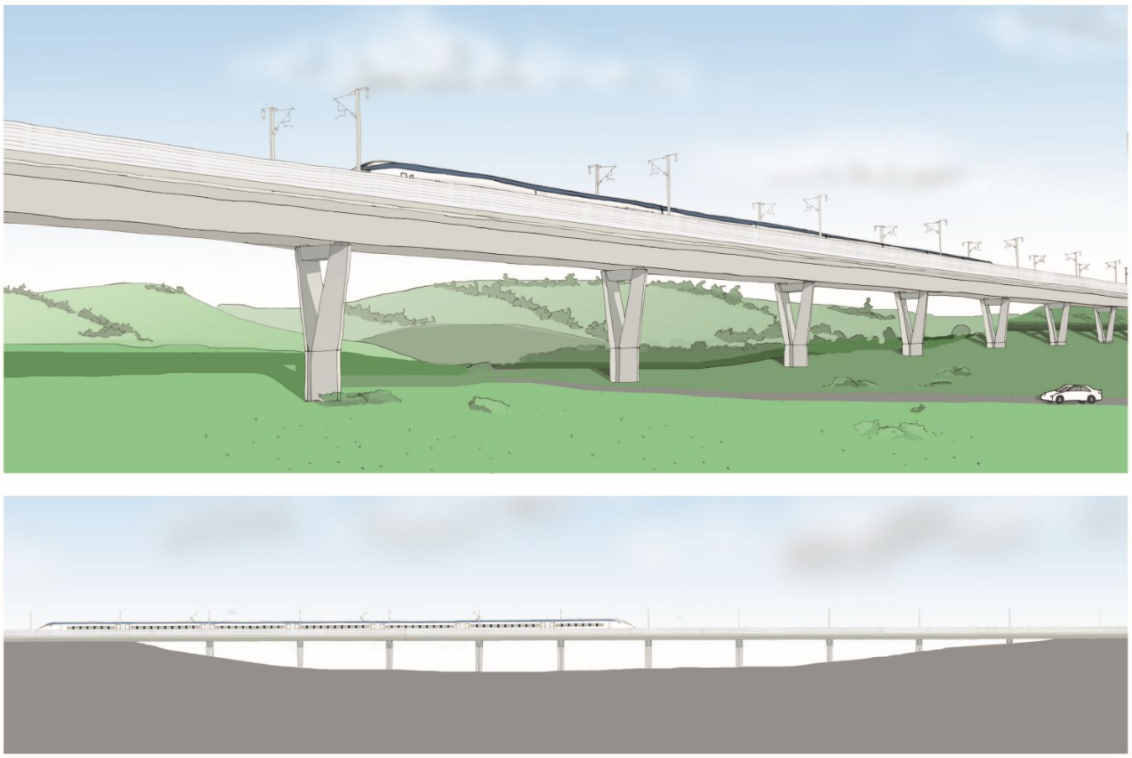
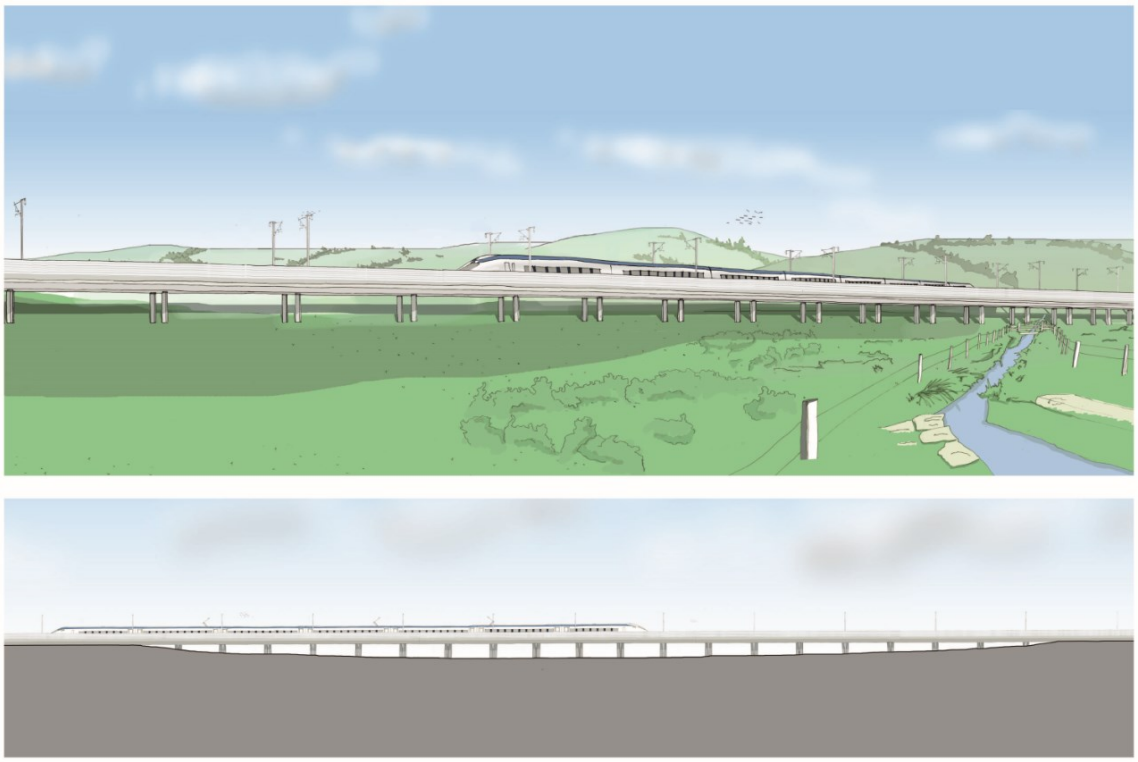


Figure 21: Illustration of a generic low viaduct



5.13 Stations

5.13.1 The Manchester terminus of the Proposed Scheme (the proposed Manchester Piccadilly High Speed station) would be located adjacent to the existing Network Rail Manchester Piccadilly Station. The Leeds terminus (the proposed Leeds high speed station) would be located adjacent to the River Aire. There would be two intermediate stations; Manchester Airport High Speed station and East Midlands Hub station.

5.13.2 The four proposed stations have individual design requirements. However, they share a number of functional characteristics. Their typical layout would 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. Connections would be provided to other transport modes as necessary via escalators, lifts and walkways.

5.13.3 Further information on the emerging station designs and layout is provided in Volume 2: Community area reports Hulseheath to Manchester Airport (MA06), Manchester Piccadilly Station (MA08), Long Eaton and Toton (LA05) and Leeds Station (LA18).

5.13.4 The design of these stations would offer opportunities to help integrate with local development plans and strategies. More detail regarding future potential for over-site development is contained in Section 7.5 of this report.

5.14 Infrastructure Maintenance Depots

5.14.1 IMDs would be required at locations across the Proposed Scheme in order to provide:

- stabling, i.e. the parking of the infrastructure maintenance trains whilst out of service;
- servicing and replenishing of the infrastructure maintenance trains, including refuelling, cleaning, refilling water tanks and emptying of controlled emission toilets;
- light maintenance of the infrastructure maintenance trains; and
- storage areas for materials, spare parts and plant.

5.14.2 The IMDs would be operational 24 hours a day, seven days a week.

5.14.3 The principal infrastructure maintenance activities on the eastern leg would be managed and resourced from an IMD at Staveley (LA11). Further information is provided in the relevant Volume 2: Community area report. The depot at Stone, which is included in the Phase 2a Bill, would also serve the western leg of the Proposed Scheme. At this stage, there is an ongoing process of identifying the maintenance needs for the high speed railway. Any requirements for further IMDs would be confirmed in the formal ES. Stakeholders associated with potential IMD locations and operational characteristics would be engaged during the design development process.

5.15 Rolling stock depots

5.15.1 RSDs would be required for both the western and eastern legs of the Proposed Scheme. Crewe North RSD would be located to the to the north of Crewe in the Wimboldsley to Lostock Gralam area (MA02), occupying land between the existing

WCML and the route of the Proposed Scheme south of Winsford. Leeds East RSD would be located to the south-west of junction 45 of the M1 in the Stourton to Hunslet area (LA17), occupying an area of land with the A63 to the north, M1 to the east, Yorkshire Water Treatment works to the west and River Aire to the south. Further information is contained in the relevant Volume 2: Community area reports.

5.15.2 HS2 trains serving the north of England and Scotland would need overnight stabling and some depot facilities where it is operationally impracticable for them to be returned to the proposed RSDs at Crewe North and Leeds East. At the current time it is expected that approximately three off-route stabling and depot facilities would be provided in the following locations; between Carlisle, Glasgow and Edinburgh near the WCML, in the York area, and in the Tyne and Wear area. An overview of these off-route locations is provided in the Volume 4: Off-route effects report of the working draft ES.

5.15.3 The RSDs would serve as operational and maintenance hubs for the Proposed Scheme's passenger rolling stock, with provision for some stabling of infrastructure maintenance trains. Activities undertaken at the RSD would include train servicing (interior and exterior cleaning, refilling water tanks and emptying of controlled emission toilets) and light and heavy maintenance. The RSDs would be operational 24 hours a day, seven days a week.

5.16 Noise barriers

5.16.1 The Proposed Scheme would include noise barriers where needed to avoid or reduce significant airborne noise effects. The barriers would generally take the form of landscape earthworks or noise fence barriers. The locations of noise barriers, based on a stage in the ongoing design and environmental assessment process, are shown in the Volume 2: Community area map books.

5.16.2 The extents and heights of noise barriers are designed to minimise noise effects taking into account considerations such as the benefit of the barrier, its cost; engineering practicability; and other potential impacts such as visual intrusion.

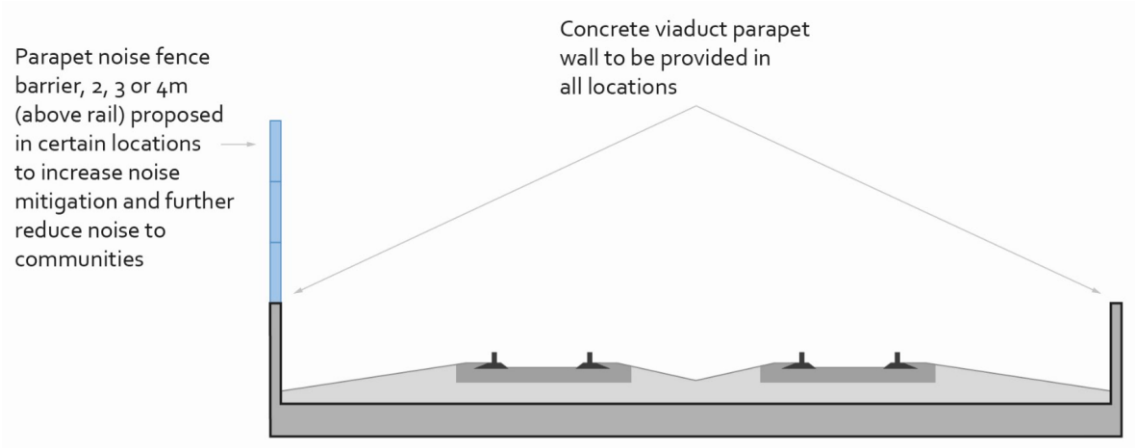
5.16.3 Noise effects would be reduced at many locations along the route of the Proposed Scheme by engineering structures, such as cuttings, and by landscape earthworks provided to avoid or reduce significant visual effects. Noise fence barriers would also be used at locations along the route of the Proposed Scheme to reduce noise effects. An example of a noise fence barrier is shown in Figure 22.

Figure 22: Photograph of a noise fence barrier

5.16.4 On viaducts, where further noise mitigation (in addition to the standard parapet wall described in Section 5.12.3) may be required to avoid or reduce significant noise effects, the parapet wall would be enhanced to provide an acoustically absorptive noise barrier of a total height of 2m, 3m or 4m above rail level in certain locations.

5.16.5 A cross section of a generic viaduct showing the provision of increasing heights of parapet noise fence barrier is shown in Figure 23.

Figure 23: Cross section of a generic viaduct including parapet noise fence barrier



5.17 Site restoration and landscape treatment

5.17.1 All temporary plant, materials, equipment, buildings, access roads and vehicles would be removed from the site when construction is complete.

5.17.2 Land used only for construction purposes would be restored as agreed with the owner of the land and the relevant planning authority once the construction works in that area are complete.

5.17.3 Mitigation design would be developed to respond to the appropriate landscape strategies and design objectives set out in HS2 Ltd's Landscape Design Approach[82] (e.g. to conserve, enhance, restore or transform landscapes in response to landscape character and context). The following may be provided (among others) within restored areas, to compensate for, or replace, resources adversely affected during construction:

- habitat for wildlife species; and
- compensatory planting and restoration of landscape features and elements, to enhance connectivity and integration.

5.17.4 Any areas of replacement habitat would be established and appropriately monitored to maintain the long-term conservation status of the species/habitat.

5.17.5 Landscaped design solutions, as set out in the Landscape Design Approach, can provide multiple benefits, including visual screening, noise mitigation, habitat creation, and the protection and enhancement of heritage assets, as indicated in Figure 24. The provision of woodland, for example, can provide:

- screening and visual integration of the Proposed Scheme; and
- an interconnected and multi-functional green infrastructure network (providing enhanced resilience and biodiversity connectivity).

[82] The Landscape Design Approach was produced to guide and direct professionals in the development of all landscape areas with the aim to achieve an integrated and contextually driven landscape design.

Figure 24: Landscape design solutions

5.17.6 Landscape design can facilitate biodiversity enhancement by linking existing features such as ponds, streams or waterways with woodlands, copses or hedgerows.

5.17.7 Trees and shrubs planted within restored areas would be of local provenance. Section 9 of this report provides further information on the approach to mitigation and monitoring.

5.18 Track

5.18.1 The track for the Proposed Scheme would either be laid on crushed stone (i.e. ballasted track) or on concrete slabs supported on a continuous structural layer (i.e. slab track). A final decision on the track form would be made during the detailed design of the Proposed Scheme.

5.18.2 The EIA has been undertaken on the assumption of a worst case scenario for each relevant environmental topic assessment. The assessments that include construction vehicle movements (e.g. traffic and transport and related topics such as air quality) have included the number of HGV movements associated with ballasted track. The sound, noise and vibration operational assessment is being undertaken on the assumption that slab track would be used for the Proposed Scheme. The track and track-bed would be designed to avoid or reduce significant ground-borne noise or vibration effects from tunnels and surface sections of the route of the Proposed Scheme.

5.19 Power supply

5.19.1 Figure 25 shows the HS2 system for providing power to high speed trains. Power supply infrastructure would be provided within the high speed rail corridor.

5.19.2 Power would be provided from National Grid 400kV or 275kV grid supply points (GSP) to auto-transformer feeder stations (ATFS) located adjacent to the route of the Proposed Scheme.

5.19.3 In cases where the National Grid GSP is remote from the route of the Proposed Scheme, underground or overhead power line connections would be required from the National Grid GSP to the corresponding ATFS. Each connection would consist of either 132kV or 50kV transmission lines. Where the power supply transitions from overhead power lines to underground power lines, or vice versa, compounds of approximately 0.5ha that are accessible by road would be required.

5.19.4 National Grid GSPs would contain switchgear, power transformers and ancillary equipment to step down the electrical power from 400kV or 275kV.

5.19.5 The ATFSs would contain 25kV switchgear, traction transformers, and ancillary equipment. In some cases they would also include termination of 132kV overhead power lines, 132kV switchgear, and provision for electrical phase balancing equipment. ATFSs would be located adjacent to the route of the Proposed Scheme, generally occupying an area of approximately 2.75ha and would require road access.

5.19.6 Traction power auto-transformer stations (ATS) would be provided along the route of the Proposed Scheme at approximately 5km intervals. They would require road access and each would occupy an area of approximately 0.2ha.

5.19.7 Mid-point auto-transformer stations (MPATS) would allow the overhead line to be sectioned at the boundary between two supply areas. An MPATS would require an area of approximately 0.2ha and would require road access.

5.19.8 Express feeder auto-transformer stations (EFATS) manage the distribution of large electrical loads and transfer them to an adjacent ATFS. An EFATS would require approximately 0.4ha of land and would require road access.

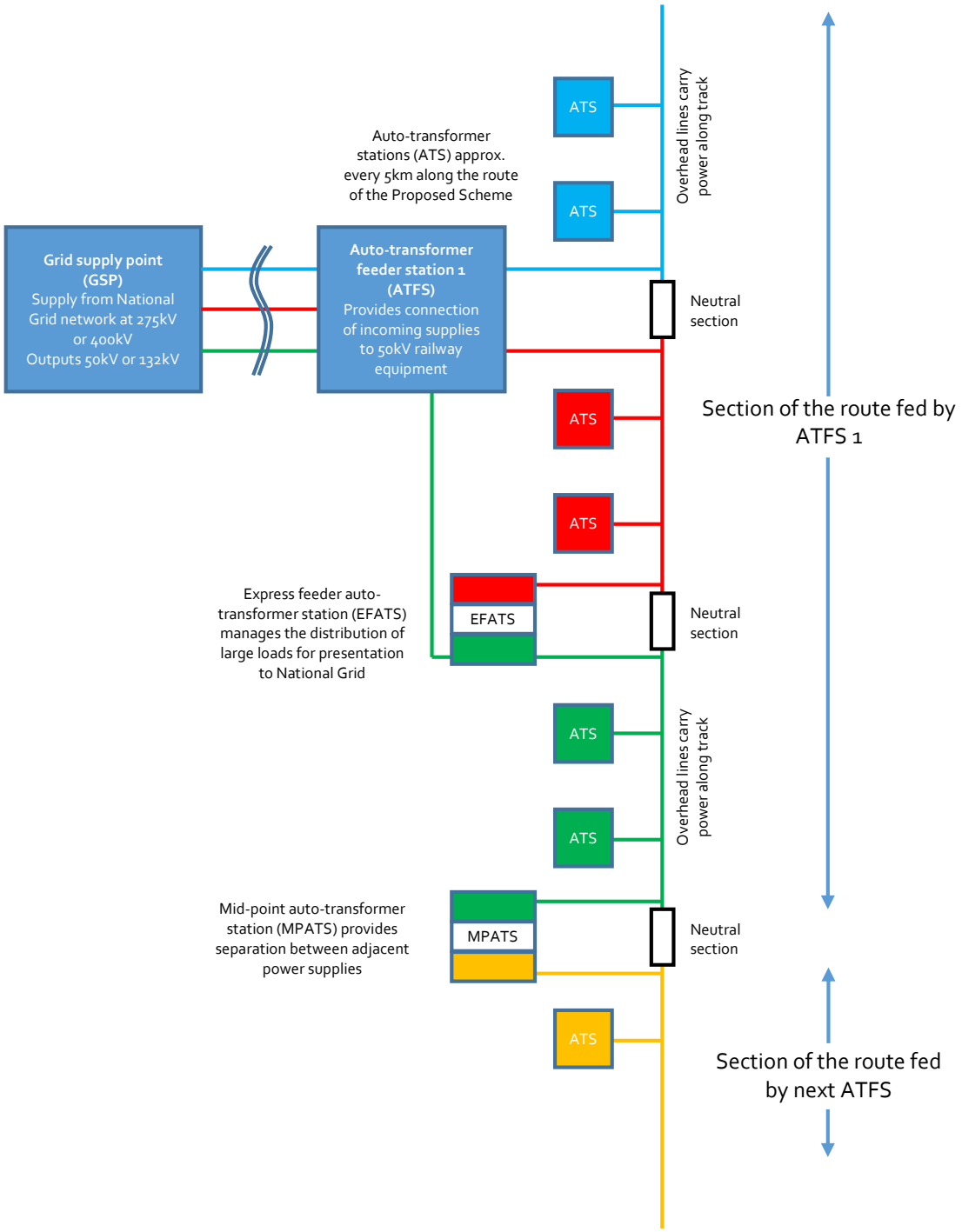
5.19.9 In many cases traction power sites (ATFS, EFATS, MPATS, ATS) would also accommodate non-traction power switchgear, transformers, and communications and control equipment rooms and/or cabinets. Some sites may also contain radio transmission masts up to 25m in height to carry train safety-critical communications. The final height of the radio transmission masts at individual sites would depend of a number of factors, including the difference in height between track level and the radio transmission mast, and distance between adjacent radio transmission masts.

5.19.10 Electrical power would be required for other purposes in addition to the traction power supply, including points heating, junction lighting, for rail systems (e.g. train control and telecommunications equipment), lighting and the operation of equipment in tunnels. Arrangements would be made with the local Distribution Network Operator for auxiliary power supplies at each location where they are required.

5.19.11 Power would be transmitted to the trains through overhead line equipment. The overhead line equipment would comprise steel masts and cantilever supports, portal frames where appropriate, contact support wires to transmit the current to the train pantographs, catenary wires , auto-transformer feeder wires and earth wires. The masts and frames would be approximately 8.5m high and would typically be spaced at approximately 45-65m intervals along the track.

5.19.12 The overhead line equipment would be divided into major electrical sections which would be fed by separate supplies from the National Grid. Each major section is shown as a different colour in Figure 25. Neutral sections provide separation of the major sections.

Figure 25: Diagram showing the indicative process of supplying power to the trains



5.20 Train control and telecommunications

5.20.1 The train control system would be a computer-based interlocking system, controlled from a route-wide network control centre at the Washwood Heath depot in Birmingham (as described in Volume 1 of the Phase One ES).

5.20.2 The Proposed Scheme would not require traditional trackside signals for its operation on the HS2 main line. However, a number of conventional railway signals and associated equipment would be required on HS2 infrastructure where HS2 trains transition onto the conventional railway.

5.20.3 The associated line-side equipment on the route of the Proposed Scheme would include cable troughs, axle counter equipment, switches and crossings control equipment, marker boards and boards and cabinets, generally no more than 1-3m high.

5.20.4 HS2 would use radio communications as part of its railway operations and train control systems. This would require radio antennae to be installed at fixed locations approximately every 2-3km along the route of the Proposed Scheme. The antennae would typically be at a height of 15-20m from track level but, in limited circumstances, depending on what is required to achieve reliable and adequate radio coverage, may extend up to 30m above track level. The associated radio transmission equipment would be mounted at the base of the antennae masts. A communications backbone would be provided by a network of optical fibre cables. These cables would be laid in troughs beside the track, and would connect all line-side equipment, including the extended communications equipment within the footprints of the traction power sites (ATFS/ATS), to the control centre.

5.20.5 To facilitate the transition from HS2 to the conventional railway and vice versa, it may be necessary to install HS2 radio system equipment for several kilometres alongside the conventional railway. Similarly, Network Rail equipment, such as Global System for Mobile Communications- Railways (GSM-R) apparatus, may be necessary alongside the HS2 track.

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 used during construction of the Proposed Scheme which would commence in 2023, with operation planned to start in 2033. An indicative construction programme for each community area is included within the Volume 2: Community area reports.

6.2 Construction land requirements

6.2.1 Land would be required temporarily during the construction period for uses including the following:

- construction compounds, batching plants, land for temporary storage of excavated material/temporary material stockpiles and their access/egress;
- the diversion, realignment and widening of roads and junctions, and/or the provision of temporary alternative routes;
- the diversion and realignment of PRoW and private accesses, and/or the provision of temporary alternative routes;
- the diversion and realignment of sections of existing railways, watercourses and utilities; and
- transfer nodes[83] and railheads would be used for the movement of excavated material and delivery of construction materials and plant.

6.2.2 Land for the temporary storage of excavated material would 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 would be required at certain sections of the route to limit the distances over which such materials need to be transported. Land used only for construction purposes would be restored as agreed with the owner of the land and the relevant planning authority once the construction works in that area are complete.

6.2.3 Based upon a reasonable worst-case approach, the design and assessment at this stage generally assumes that all property falling within the land required for the Proposed Scheme would be demolished to enable construction and operation. However, as the design develops, it is likely that not all the properties reported within the assessment would need to be demolished, for example where not all of the land is required for permanent works.

[83] A transfer node is a location where bulk deliveries or excavated materials leave or enter the construction worksites from public roads.

6.3 Environmental controls during construction

Overview

6.3.1 The nominated undertaker and all construction contractors would be subject to existing applicable legislation and the protective legislative provisions set out in the hybrid Bill. As described in Section 0 of this report, environmental controls and processes contained in the EMRs would provide the mechanisms for meeting environmental commitments once Royal Assent has been received. The nominated undertaker and all construction contractors would be required to comply with the CoCP and a series of local environmental management plans (LEMPs).

6.3.2 Site-specific control measures at a local level would be included within the LEMPs, which would be developed during the Parliamentary process and detailed design stage in consultation with the relevant stakeholders. The Proposed Scheme extends across 36 local authorities, necessitating engagement with a wide range of stakeholders. The CoCP is, therefore, intended to provide a framework to ensure a consistent approach.

6.3.3 The draft CoCP[84] is presented as a supporting document to this working draft ES. 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 would 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 upon people, businesses and the natural and historic environment. This also includes arrangements for monitoring, where appropriate; 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 would comply as a minimum with applicable environmental legislation at the time of construction, together with any additional environmental controls imposed by the Bill. For this reason the applicable statutory requirements are not repeated within the draft CoCP. Further guidance on specific areas, such as soil handling and dust management, would be considered from industry best practice guidance documents as set out in the draft CoCP.

Environmental management system

6.3.6 As part of its implementation of Phase One of HS2, HS2 Ltd (as nominated undertaker) has developed and implemented an environmental management system

[84] The CoCP will be in draft form until it is finalised when the Bill receives Royal Assent.

(EMS) in accordance with BS EN ISO 14001[85]. The scope of the EMS would cover all phases of HS2 during construction.

6.3.7 The EMS for Phase 2b would provide 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 throughout the construction phase. The EMS would set out:

- the procedures to be implemented to plan and monitor compliance with environmental legislation and other relevant requirements;
- the key environmental aspects of the work and how they would 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 Bill; and
- the procedure to monitor compliance and the effectiveness of the measures included within the draft CoCP.

Lead contractors' environmental management systems

6.3.8 The nominated undertaker would require each of its lead contractors[86] to have an EMS certified to BS EN ISO 14001. Their EMSs would 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 contractor is a joint venture, their EMS would be certified to cover the activities of the joint venture.

6.3.9 Lead contractors would be required, as part of their EMSs, to plan their works in advance to ensure that, as far as is reasonably practicable, measures to reduce environmental effects are integrated into the construction methods and that commitments from the ES and Bill are complied with. The works would 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.

6.3.10 The lead contractors' EMSs would cover the activities of all their contractors. The lead contractors would also be required to coordinate with other contractors and relevant parties relevant to their works. This would be documented in their EMSs, as appropriate.

6.3.11 The lead contractors' EMSs would include procedures to monitor and report on compliance with the project's environmental requirements, together with provisions

[85] British Standard (2004). *BS EN ISO 14001:2004 Environmental management systems*.
[86] A lead contractor is a construction company that is directly contracted for the works by the nominated undertaker.

for any corrective actions required. The detailed provisions of the lead contractors' EMSs would be subject to review and acceptance as being suitable by the nominated undertaker.

Enforcement and local environmental management plans

6.3.12 The requirements set out in the CoCP would be applicable to the whole of the Proposed Scheme. They would apply to each construction contract let by the nominated undertaker. These requirements would be supplemented by a LEMP for each relevant local authority area.

6.3.13 The LEMPs would set out how the Proposed Scheme would adapt and deliver the required environmental and community protection measures within each local authority area, through a series of topic-specific measures (including, for example, air quality and noise monitoring reports) that reflect the general requirements of the CoCP.

Monitoring

6.3.14 The lead contractors would 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 EMSs. Aspects to be monitored would include the impact of the works and the effectiveness of mitigation measures. Any actions that may be necessary for compliance would be identified.

Considerate Constructors Scheme

6.3.15 Lead contractors would be required to sign up and adhere to the Considerate Constructors Scheme[87]. The Considerate Constructors Scheme is a UK-wide initiative that promotes good practice on construction sites through its codes of considerate practice. These commit the users of registered sites to be considerate and good neighbours, as well as being respectful, environmentally conscious, responsible and accountable.

Community relations

6.3.16 HS2 Ltd has produced a Community Engagement Framework[88] which sets out how HS2 Ltd and its contractors, as well as their sub-contractors, would undertake community engagement during the construction of the HS2 project. The framework is being implemented on Phase One of HS2 and is applicable to all phases of HS2.

6.3.17 The objectives of the framework include:

- to set out how HS2 Ltd and its contractors would undertake community engagement during the construction of the project;
- to provide clarity and reassurance to HS2 Ltd's stakeholders about how community engagement activity would be managed; and

[87] Considerate Constructors Scheme. Available online at: www.ccscheme.org.uk .
[88] HS2 Ltd (2017). Community Engagement Framework. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/625971/hs2_community_engagement_framework.pdf

- to help HS2 Ltd be a good neighbour to local communities, including by providing accurate and timely information about construction works and offering opportunities to influence them, where appropriate.

6.3.18 The nominated undertaker and its contractors would provide appropriately experienced community relations personnel to implement the Community Engagement Framework. The role of the personnel would be to provide appropriate information and to be the first point of contact to resolve community issues. The nominated undertaker would take reasonable steps to engage with the community, particularly focusing on:

- those who may be affected by construction impacts, including local residents, businesses, landowners and community resources; and
- the specific needs of protected groups (as defined in the Equality Act 2010)[89].

6.3.19 Regular meetings would be held 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.

Advance notice of works

6.3.20 The nominated undertaker and its contractors would ensure that local residents, occupiers, businesses, local authorities and parish councils affected by the proposed construction works, as outlined in the formal ES, would be informed in advance of work taking place using the methods identified in the Community Engagement Framework. The notifications would detail the estimated duration of the works, the working hours and the nature of the works. In the case of works required in response to an emergency, the local authority, parish council, local residents, businesses and community resources would be advised as soon as reasonably practicable. All notifications would include the community helpline number. In addition, information on the works would also be available on the HS2 website and at appropriate locations along the route.

Core working hours

6.3.21 The contractors would apply for consents for the proposed works from the relevant local authority under Section 61 of the Control of Pollution Act 1974[90]. Applications would include details on proposed working hours.

6.3.22 The draft CoCP outlines the anticipated working hours. Core working hours would be from 08:00-18:00 on weekdays (excluding bank holidays) and from 08:00-13:00 on Saturdays. The nominated undertaker would require its contractors to adhere to these core working hours for each site insofar as reasonably practicable, unless otherwise permitted by the relevant local authority under Section 61 of the Control of Pollution Act.

[89] *Equality Act 2010*. Her Majesty's Stationery Office, London.
[90] *Control of Pollution Act 1974*. Her Majesty's Stationery Office, London.

6.3.23 Guidance on site-specific variations to core hours and/or additional hours likely to be required would be included within the LEMPs following consultation with the relevant local authority.

6.3.24 The Section 61 process would also be used to agree, in advance, any work required to be undertaken outside core hours, except in the case of emergency and not including repairs or maintenance.

Start up and close down periods

6.3.25 The nominated undertaker's contractors would require start-up and closedown periods to help maximise productivity during the core hours. A period of up to one hour before and up to one hour after core working hours would be required. Activities within these periods would include (but not be limited to) deliveries, movement to place of work, unloading, maintenance and general preparation works. Activities within these periods would not include operation of plant or machinery likely to cause a disturbance to local residents or businesses. These periods would not be considered an extension of core working hours.

Additional working hours

6.3.26 Tunnelling and activities directly associated with it (such as removal of excavated material, supply of materials and maintenance of tunnelling equipment) would be carried out on a 24 hour a day, seven days a week basis. Where reasonably practicable, material would be stockpiled within the compound boundary for removal during normal working hours.

6.3.27 Works within existing stations, railheads, track laying activities and work requiring possession of major transport infrastructure may be undertaken during night-time, Saturday afternoons, Sundays and/or bank holidays, for reasons of safety or operational necessity. Such activities would often involve consecutive nights of work over weekend possessions, and on occasion involve longer durations. Activities outside core working hours that could give rise to disturbance would be kept to a reasonably practicable minimum.

6.3.28 Certain operations such as earthworks are season- and weather-dependent. In these instances the nominated undertaker's contractors would 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.

6.3.29 Certain other specific construction activities would 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, such as for wildlife or engineering purposes, may also need to be carried out outside core working hours.

6.3.30 The relevant local authority would be informed as soon as reasonably practicable of the reasons for, and likely duration of, any works required in response to an emergency or which, if not completed, would be unsafe or harmful to the works, staff, the public or the local environment. This information would also be made available via the HS2 Ltd helpline. Examples of the type of work envisaged include: 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

6.3.31 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

6.3.32 Vehicles accessing the construction compounds 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 (LGV): pickups and small tipper trucks, vans and 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.

6.3.33 Construction vehicles carrying materials, plant, other equipment or workforce, or that are empty, would travel on public roads and via the rail network, as well as within the construction area between compounds. Wherever reasonably practicable, the rail network would be used in preference to public roads. The construction compounds would provide the interface between construction areas and the public roads or rail network. Movements between the construction compounds and the working areas would be on designated site haul routes within the construction area, often along the line of the new railway or parallel to it.

6.3.34 The transport assessment assesses the impact of construction traffic on the transport network at a local and regional level. Its findings would inform the traffic management plans that would 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 compounds;
- the delivery mechanisms for temporary and permanent closures, diversions or realignments of highways (i.e. roads and PRoW); and
- the proposed traffic management and logistics strategies.

6.3.35 Lead contractors would be required to ensure that impacts on the local community from construction traffic are reduced to a reasonably practicable minimum and that public access is maintained where reasonably practicable. Traffic impacts would be reduced by identifying clear controls on vehicle types and hours of operation, and agreed routes for HGV. Highway works required to accommodate construction traffic would be identified. The number of private car trips to and from each site (both workforce and visitors) would be reduced by encouraging alternative sustainable modes of transport or vehicle sharing.

6.3.36 The measures in the draft CoCP 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 would 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. General and site-specific traffic management measures would be implemented on relevant roads, PRoW and other points of access as necessary.

Handling of construction material and surplus excavated material

6.3.37 Construction of the Proposed Scheme would generate significant quantities of excavated material. HS2 Ltd has developed an integrated approach to earthworks design in order to reduce the quantity of excavated material generated. The nominated undertaker would use excavated material in the construction of the Proposed Scheme wherever feasible (as described in Section 5.3 of this report), thereby reducing the need for imported materials and the off-site disposal of surplus excavated material.

6.3.38 The majority of excavated material that would be generated across the Proposed Scheme would be reused as engineering fill material or in the environmental mitigation earthworks of the Proposed Scheme.

6.3.39 The nominated undertaker would seek to provide any surplus excavated material that arises and which cannot be beneficially reused for the earthworks of the Proposed Scheme 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.

6.3.40 Only if excavated material is not required or is unsuitable for the construction of the Proposed Scheme would it be considered waste. Surplus excavated material that displays hazardous properties would be unsuitable for use within the design of the Proposed Scheme and would be disposed to landfill as hazardous waste.

6.3.41 Further information regarding excavated material is given in the draft CoCP.

Waste management

6.3.42 The main waste streams likely to arise during the construction phases would 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 would 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 would be undertaken only as a last resort[91].

6.3.44 HS2 Ltd has adopted circular economy principles for the specification, design, procurement, construction and operation and maintenance and end of life phases of the project[92]. The circular economy is an alternative approach to the typical 'linear' way of using resources. By finding opportunities of remanufacturing, reusing or recycling materials and keeping them in use for longer, both resource use and waste generation can be reduced. HS2 Ltd's circular economy principles are to keep resources in use for as long as possible, recover and regenerate resources at the end of each use and keep resources at their highest quality and value at all times.

6.3.45 HS2 Ltd's approach to the circular economy is complemented by its overarching principles 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 for materials efficiency' principles would be applied to reduce the quantity of waste generated. An integrated earthworks design approach has been developed in order to minimise the quantity of excavated material generated and use that which is generated to satisfy the necessary engineering and environmental mitigation requirements for the Proposed Scheme.

6.3.46 A site waste management plan would 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.

6.3.47 Further information regarding waste management is given in the draft CoCP.

Noise and vibration strategy

6.3.48 Construction noise and vibration would be controlled and managed in accordance with the CoCP. The principles of these control and management processes are as follows:

- Best Practicable Means (BPM), as defined by the Control of Pollution Act and Environmental Protection Act 1990[93], would be applied during construction activities to minimise noise (including vibration) at neighbouring residential properties;
- mitigation measures would be applied, as part of BPM, 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

[91] Unacceptable material Class U2 material will be disposed of directly to hazardous landfill. Class U2 'hazardous waste', is described in the Specification for Highway Works, Series 601 Classification, Definitions and Uses of Earthworks Materials sub-Clause 3(i); http://www.standardsforhighways.co.uk/ha/standards/mchw/vol1/

[92] HS2 Ltd (2017). HS2 Circular Economy Principles. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/657833/hs2_circular_economy_principles.pdf

[93] *Environmental Protection Act* (1990). London, Her Majesty's Stationery Office.

- 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 rehousing would be offered;

- lead contractors would 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 would 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 would undertake and report such monitoring as is necessary to assure and demonstrate compliance with all noise and vibration commitments. Monitoring data would be provided regularly to, and be reviewed by, the nominated undertaker and would be made available to the local authorities; and
- contractors would be required to comply with the terms of the CoCP and appropriate action would be taken by the nominated undertaker as required to ensure compliance.

6.3.49 Taller screening would also be used if required to avoid or further reduce significant effects along the edge of the construction site boundary. This is described in the draft CoCP[94].

6.3.50 Noise insulation or ultimately temporary rehousing would enable residents to avoid being significantly affected[95] by levels of construction noise inside their dwellings.

6.3.51 Buildings qualifying for noise insulation or residents qualifying for temporary rehousing would 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.

Ground settlement

6.3.52 Excavation for the tunnels and other below ground structures would potentially lead to small ground movements at the surface and below ground. The amount of ground movement would 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 would have no material 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, HS1 and the Elizabeth Line (formerly Crossrail). Appropriate techniques would be implemented to control and limit, insofar as reasonably practicable, the effects of settlement.

6.3.53 The nominated undertaker would assess potential settlement along the route of the Proposed Scheme and include the risk of damage to all buildings within the zone affected by settlement. Depending on the level of risk, either no action would be required, buildings would be monitored during construction, or special measures would be implemented where required to protect the buildings.

6.3.54 Measures to reduce settlement would form part of the EMRs, as would survey and monitoring requirements.

[94] 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.
[95] Information is provided in Planning Practice Guidance– Noise. Available online at: https://www.gov.uk/guidance/noise--2 (for example, the table summarising the noise exposure hierarchy).

Extreme weather events

6.3.55 The nominated undertaker's contractors would pay due consideration to the impacts of extreme weather events and related conditions during construction. The contractors would use a short- to medium-range weather forecasting service from the Met Office or other approved provider of meteorological data and weather forecast provider to inform short- to medium-term programme management, environmental control and impact mitigation measures. The contractors would register with the Environment Agency's Flood Warnings Direct service in areas of flood risk.

6.3.56 The lead contractors would ensure that appropriate measures within the CoCP are implemented, and as appropriate, additional measures to ensure the resilience of the proposed mitigation of impacts during extreme weather events.

6.3.57 The lead contractors' EMSs 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

Introduction

6.4.1 Works required in advance of the main construction programme would generally include:

- advance site access works;
- further detailed site investigations and surveys;
- further detailed environmental surveys; and
- advanced mitigation works including, where appropriate, the remediation of contamination, the translocation of species and/or habitats, creation of habitats, visual screening planting, and surveys and investigation of archaeology and built heritage.

Further detailed site investigations and surveys

6.4.2 Additional detailed investigations and surveys would be required before construction to gather further information about the land required for construction. This would include the location of construction compounds in order to plan their layout and access and egress arrangements. Investigations and surveys are likely to include:

- ground investigations, such as drilling boreholes, performing in-situ tests, and taking samples for testing to establish geotechnical and geo-environmental parameters; and
- topographical surveys to map ground contours and existing surface features.

Further detailed environmental surveys

6.4.3 Further detailed, site-specific environmental surveys would also be undertaken. These would include:

- ecological surveys to confirm the baseline in areas where no access had been possible to date, and to inform licence applications and proposed works to translocate habitat/species;
- historic building, geophysical and/or trial trenching surveys to confirm the character of archaeological and built heritage assets and to inform the design of detailed mitigation strategies;
- hydrological and hydrogeological surveys to confirm flooding potential, surface water hydromorphological, quality and groundwater conditions; and
- 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, to confirm any possible contamination sources and pathways, and support the design of any remediation works that may be required.

Advance mitigation works

Remediation of contamination

6.4.4 The following further works may be required where surveys identify that soil contamination is present:

- monitoring of groundwater;
- monitoring and sampling of ground gas;
- remediation works, including:
  - excavation;
  - soil treatment using methods such as soil-washing;
  - groundwater treatment;
  - monitoring natural attenuation (MNA);
  - bioremediation, in situ chemical treatment and stabilisation;
  - provision of capping layers or ground barriers to prevent the migration of contaminants or ground gases;
  - installation of venting systems for ground gases; and
- off-site disposal of unsuitable soils.

Creation of habitat and translocation of species/habitat

6.4.5 Most of the areas that will be identified for the provision of ecological compensation would be outside the extent of the construction works. Some areas identified for the translocation of protected or notable species would 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, hibernacula[96] or basking features[97]; and
- the construction of artificial badger setts.

6.4.7 It may take up to two years to translocate or relocate protected species, where this is required. Translocation/relocation would occur before the start of construction in that area.

6.4.8 In some locations, notably where ancient woodlands are unavoidably affected, the woodland soils that would otherwise be lost would be translocated to identified receptor sites.

Archaeological and built heritage works

6.4.9 A programme of investigation works would be developed as set out in Section 8 of the draft CoCP. Investigation and recording may include historic building recording, archaeological excavation, palaeo-environmental boreholes and the in-situ preservation of assets.

Planting and other landscape measures

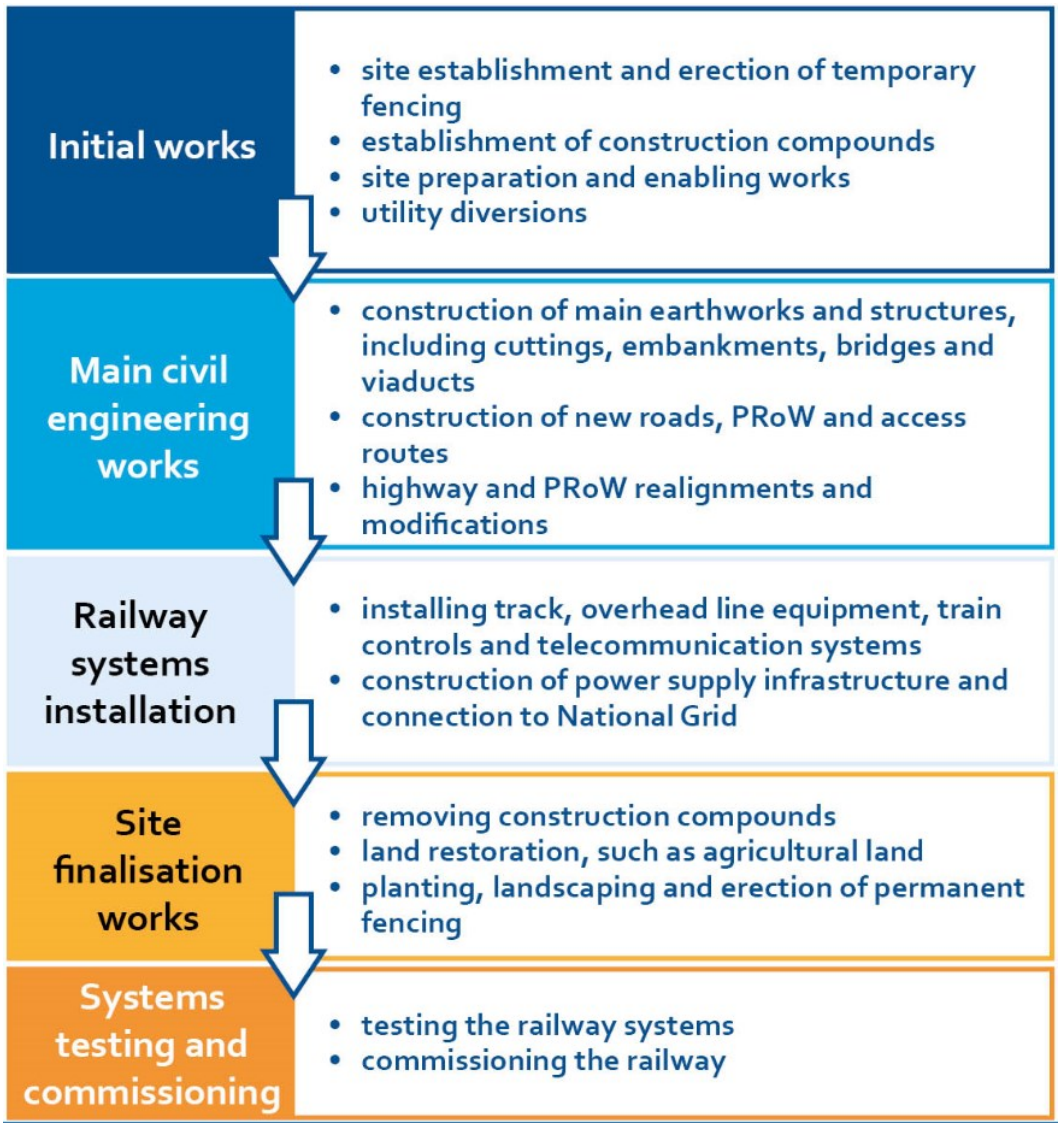
6.4.10 Planting and other landscape measures would be implemented as early as is reasonably practicable where there is no conflict with construction activities or other requirements of the Proposed Scheme. The nominated undertaker would require its contractors to consider where measures can be implemented early and programme the landscape works accordingly, as set out in Section 12 of the draft CoCP.

6.5 Overview of the main construction works

6.5.1 Following the advance construction works, the main construction works along and adjoining the route of the Proposed Scheme would generally be of two broad types; civil engineering and railway systems installation. Figure 26 shows these works, alongside the initial works, site finalisation works and systems testing and commissioning (see Section 6.32 of this report).

[96] A hibernaculum is the winter den of a hibernating animal or insect.
[97] Many species habitually seek out external sources of heat or shelter from heat. For example, many reptiles regulate their body temperature by basking in the sun, or seeking shade when necessary.

Figure 26: Stages of main construction activities



6.5.2 There are also locations where sections of the existing conventional railway network would need to be modified, which could involve a combination of civil engineering and/or railway installation works. An overview of possible locations for these works is included in the Volume 4: Off-route effects report of the working draft ES.

6.6 Site establishment and temporary fencing/hoardings

6.6.1 Temporary security fencing or hoardings (as appropriate) would be erected on land required for construction, including at construction compounds (see Section 0 of this report). Fencing could also be used to protect trees and to temporarily delineate field boundaries. Further information relating to site establishment is provided in Section 6.8 of this report.

6.7 Construction compounds

6.7.1 Construction compounds would be required in various locations along the route of the Proposed Scheme, and would generally be sited alongside or adjacent to the relevant works. Each Volume 2: Community area report identifies the location and use of the compounds for construction works and railway installation activities within its area.

6.7.2 There would be two types of construction compounds: main and satellite construction compounds. Main construction compounds would act as strategic hubs for core project management activities (i.e. engineering, planning and construction delivery) and for office-based construction personnel. They would include offices, storage for materials (such as aggregates, structural steel, and 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. Main compounds would typically require approximately 3ha of land (although this may vary depending on site conditions) and would typically support up to 400 construction personnel at peak times.

6.7.3 Satellite construction compounds would generally be smaller, providing office accommodation for construction personnel. Depending on the nature and extent of works to be managed from these compounds they may include local storage for plant and materials, welfare facilities, and car parking for construction personnel. Satellite construction compounds would typically require between approximately 0.5 and 3ha of land and would typically support up to 150 construction personnel at peak times.

6.7.4 A number of main and satellite construction compounds would continue to be used as compounds for railway systems works following the completion of civil engineering works at these locations. The railway systems compounds would facilitate installation, testing and commissioning of the railway systems, including track, overhead line equipment, communication and signalling equipment and traction power supply.

6.7.5 Construction satellite compounds and railway systems satellite and main compounds would be managed from an associated main construction compound.

6.7.6 Some construction compounds may act as points of entry to the worksites from the public highway. Some would also act as an interface with the existing rail network for receipt and/or disposal of materials by rail.

6.7.7 Construction compounds would also be used for stockpiling of materials such as topsoil, for transfer nodes or railheads and to facilitate transfer of materials to and from the site. Compounds may also include construction works, including pre-cast yards to manufacture and store concrete elements such as viaduct beams. In these situations the Volume 2: Community area reports describe the use of the compound and associated area, and where sufficient environmental information is available, any resulting impacts and significant environmental effects.

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

6.7.9 The total number of compounds per community area and the total number of construction personnel supported at each is provided within the Volume 2: Community area reports, Section 2.

6.7.10 Overnight accommodation for construction staff would be provided at a limited number of compounds (as indicated in the relevant Volume 2: Community area reports). This accommodation would help to reduce daily travel for those not normally based locally.

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

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

6.7.12 Construction compounds would be connected to existing local utility services (i.e. electricity, water, data, foul sewers and surface water drainage), where reasonably practicable. This would reduce the need for generators, storage tanks and associated traffic movements.

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

6.7.14 Some of the construction compounds would be used to manage demobilisation, testing and commissioning of the railway.

6.8 Site clearance, enabling works and site mobilisation

6.8.1 Areas of land required permanently and temporarily for the works would be cleared, where appropriate (e.g. under new or diverted overhead power lines).

6.8.2 Vegetation would be removed and structures demolished, as necessary, before any excavation works or embankment construction. Any resulting waste material would be removed from site for reuse, recycling, recovery or disposal. Topsoil and subsoil would be stripped down to the top of the subsoil layer and formation respectively, and stored in accordance with best practice. The surfaces of stockpiled material would be formed to prevent degradation of the material and would be managed to control weed growth. Stockpiles would be kept away from sensitive features (including natural and historic features), watercourses and surface drains, insofar as reasonably practicable. Elsewhere, stockpiles may be located near the site boundary, where they can help to provide temporary screening.

6.8.3 Where reasonably practicable, trees and hedgerows would not be removed during the bird nesting season, with site clearance for non-critical design elements phased accordingly. European protected species would be translocated where appropriate, following best practice.

6.8.4 Conventional methods would be used for demolitions (e.g. boom-mounted hydraulic breakers[98] and cutters). The best practicable means would be used to recover materials for reuse and recycling. Asbestos and any other hazardous materials identified during surveys would be removed by a specialist contractor prior to demolition, as described in the draft CoCP. A condition survey of building foundations/third party assets would also be undertaken before and after the relevant works where it is agreed with the local authority that there is no best practicable means to reduce predicted or measured vibration.

6.8.5 Activities described as 'advance works' may also be undertaken during this stage of construction.

6.9 Utility diversions

6.9.1 A number of utility diversions would be required before construction commences. Utilities that would need to be diverted include water, gas mains, sewers, telecommunications equipment, electricity, and fuel pipelines.

6.9.2 Feasibility studies are being undertaken by the statutory undertakers/utility companies to determine whether the relevant asset requires diversion, protection, strengthening or assurance i.e. can it be left in situ.

6.9.3 A methodology or approach would be agreed with the relevant statutory undertaker (i.e. the utility company) where excavation or piling is required within the vicinity of high pressure mains, high voltage cables or fuel mains. The approach would include

[98] Demolition hammers or shears fitted to hydraulic excavator plant. The hammers/shears are often on long-reach booms to increase the demolition reach.

appropriate protective measures in accordance with the protective provisions included in the Bill.

6.9.4 Ground-penetrating radar surveys would be undertaken and trial holes excavated to identify if underground utilities are in their expected locations (subject to the agreement of the statutory undertaker and local authorities).

6.9.5 Some utility works would require PRoW or highways to be temporarily realigned. This would be managed using a traffic management plan, as detailed in Section 6.3 of this report.

6.9.6 The height and/or location of pylon towers for overhead line electricity cables would need to be changed in some locations. This would require the erection of temporary towers to carry the cables whilst the new or amended towers are being built. It would also require new power cables to be installed and tensioned, and these cabling works would require works at a number of towers either side of those to be amended. The cabling works are unlikely to necessitate works at ground level in between towers, although access would be required. There may also be some restrictions to non-residential access at ground level between towers where re-cabling is being undertaken, as a precaution.

6.9.7 Discussions with utility providers are underway at this stage in the ongoing design and environmental assessment process. Therefore, utility diversions have not been assessed for the working draft ES. The likely significant effects of these works will be identified in the formal ES.

6.10 Borrow pits

6.10.1 For construction of the Proposed Scheme, there is anticipated to be a shortfall of acceptable engineering material (typically sands and gravels) from the excavation of cuttings and other works (for example, tunnels or balancing ponds) to construct the HS2 railway embankments[99]. As part of the ongoing development of the Proposed Scheme design, three options are being considered to overcome this shortfall:

- using materials extracted during the construction of the Proposed Scheme, which are unlikely to be acceptable on their own, and stabilise with cement or lime;
- using suitable granular material imported from commercial quarries; and
- excavating acceptable engineering material from borrow pits.

6.10.2 Stabilising materials extracted during construction of the Proposed Scheme with cement or lime could cause unacceptable levels of heave[100]. This would result in the material being unacceptable for use in Proposed Scheme embankments within the constraints of the construction programme.

[99] The sands and gravels extracted from the borrow pits would be intended for constructing the Proposed Scheme railway embankments. However, if the properties of the materials extracted were found to be suitable, it could also be used to make concrete or other cement bound materials for construction of the Proposed Scheme.
[100] The expansion of the material, causing the upward movement of the ground.

6.10.3 Obtaining material from commercial quarries would require the transport of the material by HGV, potentially at some distance from the Proposed Scheme, which would result in impacts on the local road network and communities. Under this option, surplus materials of unacceptable quality extracted during construction of the Proposed Scheme would be transported off-site, increasing HGV movements and again leading to impacts on the local road network and communities.

6.10.4 Excavating borrow pits would provide an option for acceptable aggregate to be extracted and processed more locally to the Proposed Scheme, with the potential for material to be transported primarily on site haul routes within the construction area of the Proposed Scheme, depending on their proximity. This option would generate fewer traffic movements on the public highway network than importing the material from commercial quarries located at a distance from the Proposed Scheme, potentially reducing impacts on the local road network and communities.

6.10.5 Any borrow pits created would be restored in line with a scheme approved by the local planning authority in accordance with the Phase 2b Bill. It is expected that borrow pits created during excavation would, subject to the approval of the local planning authority, be backfilled with materials generated from the construction of the Proposed Scheme, which do not have acceptable characteristics for use as railway embankment fill. This would present a more sustainable option, reducing the need to move this material off-site to locations which may be some distance from the Proposed Scheme. Borrow pit excavation, backfilling, restoration and aftercare would be undertaken adhering to the measures outlined within the draft CoCP.

6.10.6 Potential borrow pit locations will be identified as part of the ongoing design development and assessment process. HS2 Ltd would undertake detailed ground investigations to help confirm the depth of granular deposits suitable for construction material, which would inform the extent and depth of extraction required within the borrow pit area. Stakeholders associated with potential borrow pit locations, operational characteristics and restoration (e.g. minerals planning authorities, land owners and occupiers, mineral owners and local communities) would be engaged during the design development process. Where borrow pits are identified for inclusion in the design of the Proposed Scheme, the environmental assessment will be reported in the formal ES.

6.11 Cuttings and embankments

Cuttings

6.11.1 Cuttings would be excavated using excavators, graders and scrapers.

6.11.2 Material excavated from cuttings would be used, where reasonably practicable, to construct embankments, noise bunds and landscape earthworks including false cuttings[101]. The construction of cuttings and embankments would therefore be interdependent, in most cases.

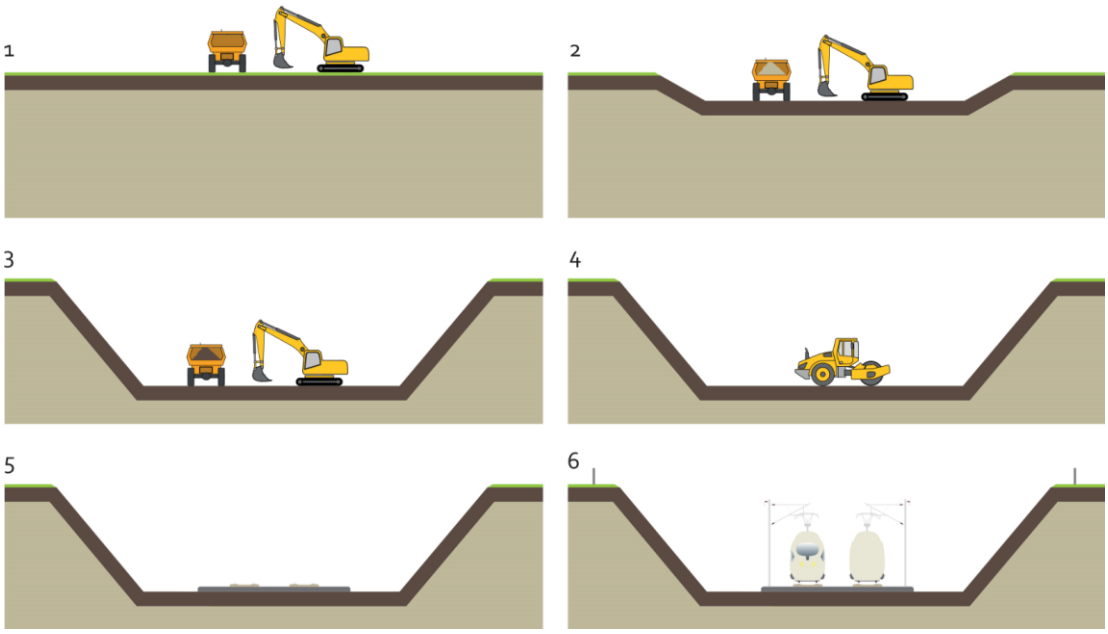
[101] A means of screening a linear feature (e.g. a railway) by forming embankments on both sides of the feature.

6.11.3 Cuttings would generally be constructed in the following sequence:

- vegetation would be removed, and drainage installed where required;
- topsoil and subsoil would be stripped, with temporary material stockpiles being appropriately located and sloped to enable surface water runoff and subsequent re-soiling work;
- the cutting would be excavated sequentially, in layers;
- excavated material would be transported to embankment compound(s), where practicable, or to temporary stockpiles, with the material processed, where necessary, to improve its suitability for 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 would 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.

6.11.4 Figure 27 shows a generic construction sequence for a cutting.

Figure 27: Illustration of a generic construction sequence for a cutting



6.11.5 Temporary stockpiling of excavated material may be required where it cannot be placed directly into its permanent location. Granular materials such as gravels produced from excavations 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

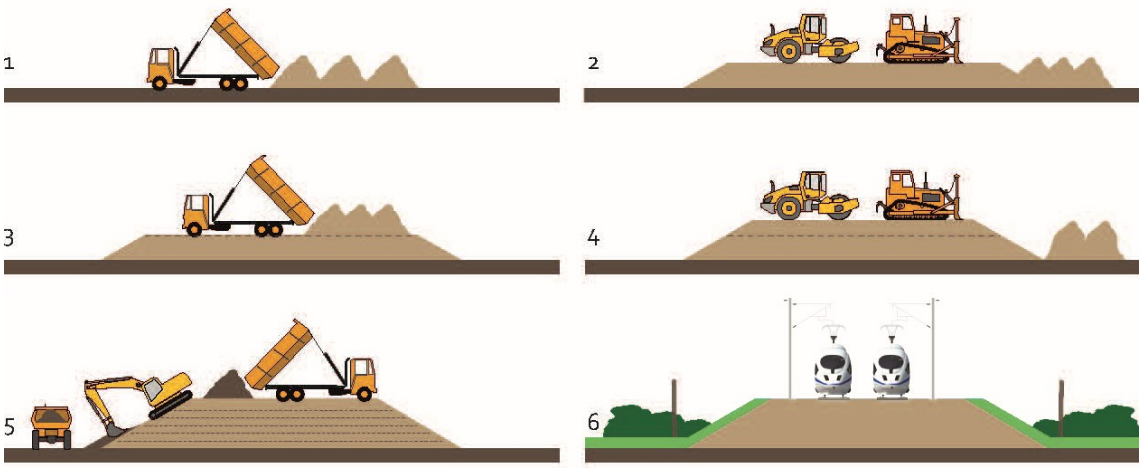
6.11.6 Earthworks would include the bulk excavation of material and placing of that material to create the route of the Proposed Scheme. Embankments may be built in stages, commencing early in the construction programme, to allow settlement to occur.

6.11.7 Embankments would typically be constructed in the following sequence:

- vegetation would be removed, and surface water drainage installed where required;
- topsoil and subsoil would be stripped, with temporary material stockpiles being appropriately located and sloped to enable surface water runoff and subsequent re-soiling work;
- excavation to the required formation level meeting design requirements and installation of required granular starter layer, providing a suitable platform for construction;
- spreading, levelling and compacting of excavated material in layers over the area required;
- installation of slope drainage, where necessary, to manage surface water runoff and prevent siltation of waterways or water-bodies;
- trimming and re-soiling of slopes to the required profile; and
- the placing of subsoil and topsoil to the required depth, which would be determined by the proposed use (e.g. as grassland, planted with trees and shrubs or returned to agriculture).

6.11.8 Figure 28 shows a generic construction sequence for an embankment.

Figure 28: Illustration of a generic construction sequence for an embankment



6.12 Drainage and watercourse realignment

6.12.1 Construction would require both temporary and permanent drainage works, including track drainage, culverts, balancing ponds and watercourse realignments. These would involve standard earthmoving techniques and equipment (e.g. backhoe excavators), and may use materials such as pre-cast concrete units, plastic pipes and filter drains.

6.12.2 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 then 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.

6.12.3 Where watercourse realignments are required, soft engineering techniques (such as the use of pre-seeded geotextile mats and vegetation rolls) would be used, where reasonably practicable.

6.12.4 Watercourses would generally be realigned to avoid impacts from the Proposed Scheme. A single realigned channel could represent a more sustainable solution where the route would otherwise need to cross a watercourse several times. Minor realignment would be required in many cases to reduce the length of watercourses that need to be culverted or bridged.

6.12.5 Watercourses that require horizontal realignment would generally be constructed by:

- temporarily fencing around the route of the realignment;
- excavating the realigned channel to the required level, leaving existing ground at each end (a 'plug'), or installing sheet pile walling[102], sufficient to prevent inflow from the existing watercourse;
- stabilising the side slopes and channel;
- lining the channel invert, if required;
- sealing with clay or constructing a concrete base and walls, if required;
- removing 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.

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

6.12.6 A crossing and a horizontal realignment of the flow path may be required where areas of surface water are affected by the Proposed Scheme. Vertical and horizontal realignment below existing bed level may be undertaken using drop inlet culverts[103] and inverted siphons[104]. Pumping may also be necessary in some situations. The choice of method would reflect the sensitivity and size of the flood risk, the availability of land and other physical or environmental constraints.

6.12.7 Site activities and working methods would be managed so as to protect the quality of surface water and groundwater from adverse effects. The quality, rate and volume of surface water runoff would be controlled. Monitoring systems would be used during the construction works. Emergency procedures would be implemented in the case of any pollution incidents.

6.13 Highways (roads) and public rights of way

6.13.1 Existing roads or PRoW that are crossed by the route of the Proposed Scheme, or land required for construction, would either be closed and the traffic diverted onto other existing highways, or new crossings would be built. New crossings, utilising under or overbridges, would either be built:

- on the line of the existing road or PRoW (termed 'online'), thereby requiring its closure or temporary realignment during construction; or
- along or nearby existing routes which would remain open during construction (termed 'offline'), allowing the road to remain open for the majority of construction.

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

6.13.3 Online crossings would usually be constructed by:

- constructing the temporary layout of the crossing, if needed;
- temporarily realigning traffic and utilities (if they cannot be retained in their original location) and closing the existing route;
- constructing the new road or PRoW (and associated underbridge or overbridge, where applicable) and installing associated utilities;
- re-directing traffic back onto the existing alignment.

[103] 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. Drop inlet culverts will be constructed using either an open cascade (a series of steps down the side of a cutting between an adjacent watercourse) or an enclosed chamber on the upstream side only.
[104] A form of culvert used on level ground where the water level has to be lowered to pass under the Proposed Scheme, other railways or a road access. Inverted siphons will be constructed using enclosed chambers on both sides of the route.

6.13.4 Offline diversions would generally be constructed by:

- constructing the new permanent road or PRoW (and associated underbridge or overbridge, where applicable);
- diverting utilities onto the new alignment; and
- switching traffic onto the new alignment and closure of the existing route.

6.13.5 Works to existing roads, including temporary diversions, would be carried out in consultation with the relevant highway authority.

6.13.6 Highway works would involve standard drainage and earthworks techniques, the laying of capping and sub-base materials and paving. Generally, plant would include excavators, dump trucks, bulldozers, rollers, graders and paving machines.

6.13.7 Smaller-scale works to existing PRoW would also be carried out in consultation with the relevant highway authority.

6.14 Site haul routes

6.14.1 Where reasonably practicable, movement of construction material, construction machinery and/or construction workers between the construction compounds and work sites would be on designated temporary roads within the area of land required for construction (known as site haul routes), along the line of the route of the Proposed Scheme, or running parallel to it. Using site haul routes would reduce the need for construction vehicles to use the existing public highway network, thereby reducing traffic related impacts on the road network and local communities.

6.14.2 Site haul routes would generally be no wider than 10m (including land for any associated infrastructure, such as signalling). Where a site haul route crosses a public highway or PRoW, the crossing points would be safely managed by either temporary traffic signals or roundabouts, or manned control points.

6.14.3 Site haul routes would be surfaced at the connection point between a site haul route and public highway. This would help to maintain the cleanliness of the public highway.

6.14.4 Following construction, site haul routes would be appropriately restored (see Section 6.27 of this report).

6.15 Piling

6.15.1 Deep foundations would be required where ground conditions are not suitable for the necessary loading or settlement requirements. They are usually required for:

- the piers and abutments of viaducts and bridges;
- retaining walls; and
- other large structures, such as the IMD buildings.

6.15.2 Piles and diaphragm walls[105] are the most common form of deep foundation.

6.15.3 A designed piling platform of suitable material would be used as a working platform to ensure the stability of the heavy plant used for piling and diaphragm walling. A piling platform typically consists of compacted crushed or granular material laid on a geotextile membrane[106]. The existing ground surface would be levelled and the material placed in layers of suitable thickness before being compacted.

6.15.4 A number of techniques would be used to form deep foundations. The choice of pile type and installation method would be based upon a piling risk assessment and would generally be dictated by factors such as design loads, ground conditions, proximity of sensitive receptors and speed of installation. Precautions would be taken to prevent soil contamination migrating downwards into aquifers where piling takes place, in accordance with guidance from the National Groundwater and Contaminated Land Centre[107].

6.15.5 Diaphragm walling involves the construction of reinforced concrete walls within the ground using bentonite slurry as a temporary support medium.

6.15.6 Vibratory or silent piling systems would be preferred where displacement piles are used (i.e. steel sheet piling driven into the ground).

6.15.7 Continuous flight auger piles are constructed using a hollow stemmed piling auger. The auger is rotated into the ground to the required depth, then concrete is pumped down the hollow stem as the auger is extracted. The required steel reinforcement cage is then craned into the bore using a vibrating tool, if required. The use of continuous flight auger piles can be restricted by factors such as diameter, depth or by the design of the steel cage.

6.15.8 Bored piles 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. The material lower down the pile 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.

6.15.9 Figure 29 shows an example piling rig.

[105] 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.
[106] Synthetic (generally) fabric used in conjunction with earthworks. Can be used to provide filter or reinforcement properties.
[107] National Groundwater & Contaminated Land Centre (2001). *Piling and penetrative ground improvement methods on land affected by contamination – guidance on pollution prevention NGCLC Report NC/99/73.* Available online at: http://webarchive.nationalarchives.gov.uk/20140329082415/http://cdn.environment-agency.gov.uk/schoo501bitt-e-e.pdf

Figure 29: Photograph of an example of a piling rig

6.16 Tunnels

Tunnel boring machines

6.16.1 Tunnels are generally excavated using a TBM. Figure 30 shows a typical TBM.

Figure 30: Photograph of a typical tunnel boring machine

6.16.2 A 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. Three main types of TBM can be used in soft ground:

- earth pressure balance machine (EPBM);
- slurry shield; or
- open face.

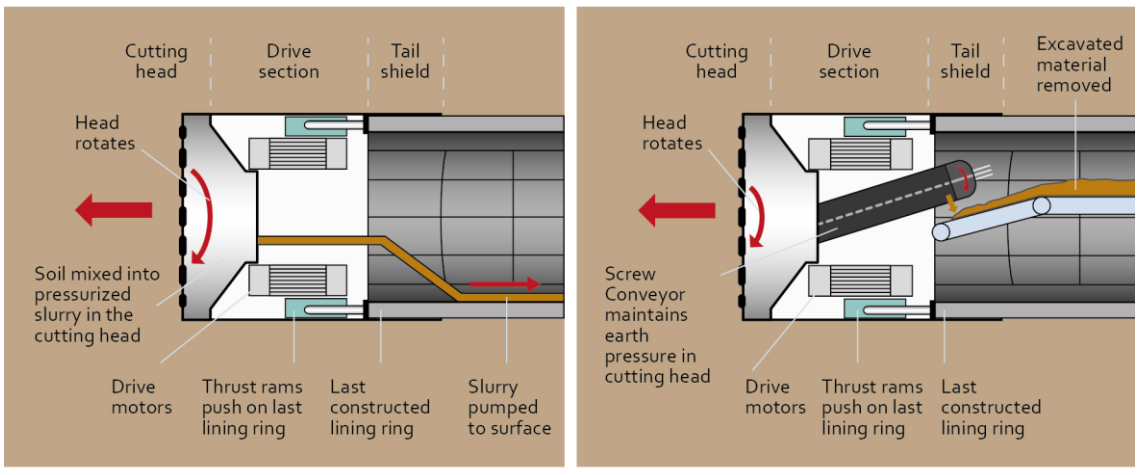
6.16.3 A slurry shield TBM is used where the groundwater table and pressure are higher and there is very wet ground. An EPBM can be used in a wider range of ground types. Both systems use mixing and backfilling systems to maintain optimal pressure and to ensure a stable face in soft ground. Open face TBM are used when the ground is more stable and self-supporting.

6.16.4 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.

6.16.5 The tunnel lining is erected and back grouted as the TBM is moved forward. 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 would generally be twin-tracked to enable two-way traffic and servicing of cross passage construction.

6.16.6 Figure 31 shows a cross-section of a slurry shield and EPBM TBM.

Figure 31: Cross-section of a slurry shield and earth pressure balance machine



Slurry shield Tunnel Boring Machine (TBM) Earth Pressure Balance Machine (EPBM)

Bored tunnels

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

6.16.8 Possible construction methods for particular tunnel features, such as junctions with cross passages, 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.

6.16.9 The sequence of a twin-bored tunnel constructed using a single TBM, including the construction of tunnel portals, would be as follows:

- site clearance, enabling works and compound establishment;
- excavation of drive shaft (providing an opening for the lowering of the TBM) or portal, commencing with stripping of topsoil, followed by removal of any hardstanding;
- one portal would act as the drive portal at the start of the tunnel, from where the TBM would be launched, whilst the other portal would act as a reception portal from where the TBM would be recovered once boring is complete;
- the TBM and associated support plant and equipment, such as conveyors and grout plant, would be delivered and erected on-site;
- a concrete batching plant and pre-cast concrete facility may also be installed at the drive portal or at a supporting construction compound;
- the TBM would be moved into position, once it is assembled, and the portal headwall would be broken out;
- tunnelling would be continuous, with excavated material removed by conveyor (or by slurry pipes) to a local stockpile, and the pre-cast concrete tunnel segments delivered as the TBM advances;
- 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 railway[108];
- the portal headwall would be broken out, as the TBM approaches the reception portal, 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 would be dismantled, lifted out of the reception portal, loaded onto trucks, taken via the road network to the drive portal and then reassembled to commence the second drive;

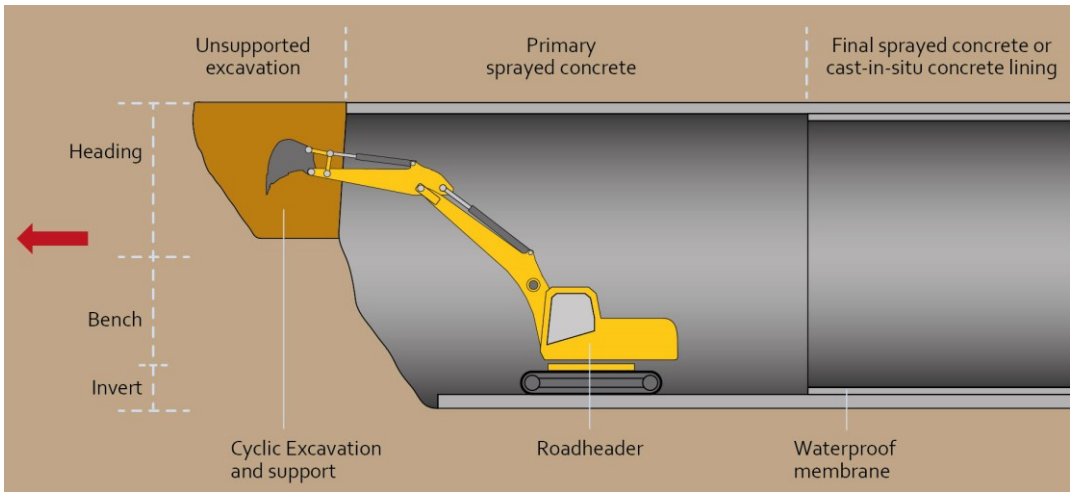
[108] Ground-borne noise and vibration will be controlled by the design and maintenance.

- the process detailed above would be repeated for the second drive;
- as the second bore progresses, cross passages between the bores would be constructed;
- once the second tunnel drive is completed, the TBM, tunnelling train and other associated plant would 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, would be constructed, and the headhouse building would be erected and fitted out.

Mined tunnels

6.16.10 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 32 shows how conventional mined excavation may be undertaken.

Figure 32: Mined excavation by conventional methods



Cut-and-cover tunnels

6.16.11 Construction of cut-and-cover tunnels would involve excavation, construction of a box structure and backfilling with fill material and soil. The land surface above would be graded to match the natural terrain and landscaped or restored to the original or an alternative use, in agreement with the landowner and the local planning authority.

6.16.12 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. Reinstatement would be carried out, where possible, using stored material from the cut or excavation stage.

6.16.13 Option one would be constructed by:

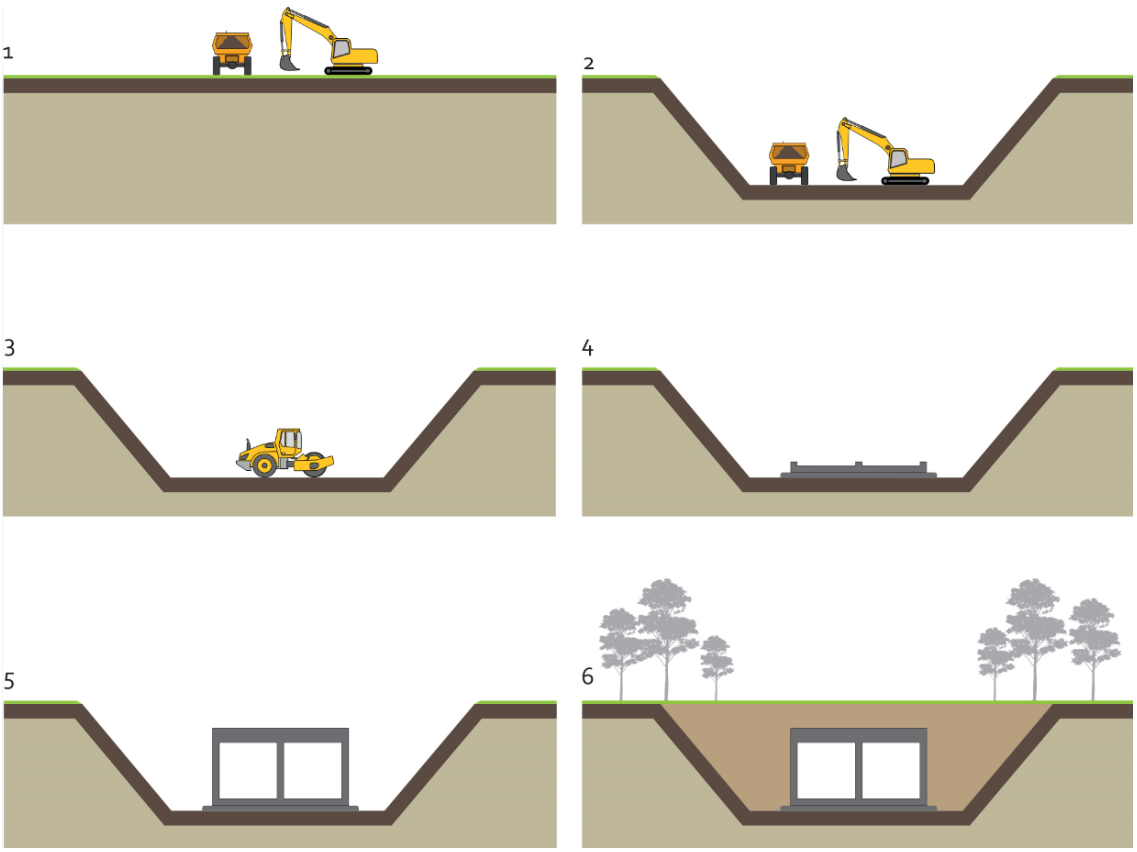
- site clearance, enabling works and compound establishment;
- excavating to the required depth;
- constructing a 'box' structure from reinforced concrete;
- backfilling around the sides and across the top of the structure, to suit the intended land use, and completing the landscaping works;
- diverting and installing utilities and laying road surfaces, as required; and
- removing temporary works, including any diversion/realignment of roads and PRoW.

6.16.14 Side slopes may be strengthened during excavation 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. Scaffolding, falsework[109], formwork[110], steel reinforcement and other materials would be placed using cranes before the reinforced box structure is constructed. Concrete delivered by mixer trucks would be placed either directly within the excavation or by concrete pumps located at ground level.

6.16.15 An illustration of this construction sequence is shown in Figure 33.

[109] Temporary structures such as scaffolding used to support the permanent works.
[110] Temporary or permanent moulds into which concrete or similar materials are poured.

Figure 33: Cut-and-cover construction method – option one



6.16.16 For the second option, the walls would be constructed first using diaphragm walling[111] 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.

6.16.17 This method is likely to be adopted where space limitations restrict the width of an open excavation with side slopes.

6.16.18 Option two would be constructed by:

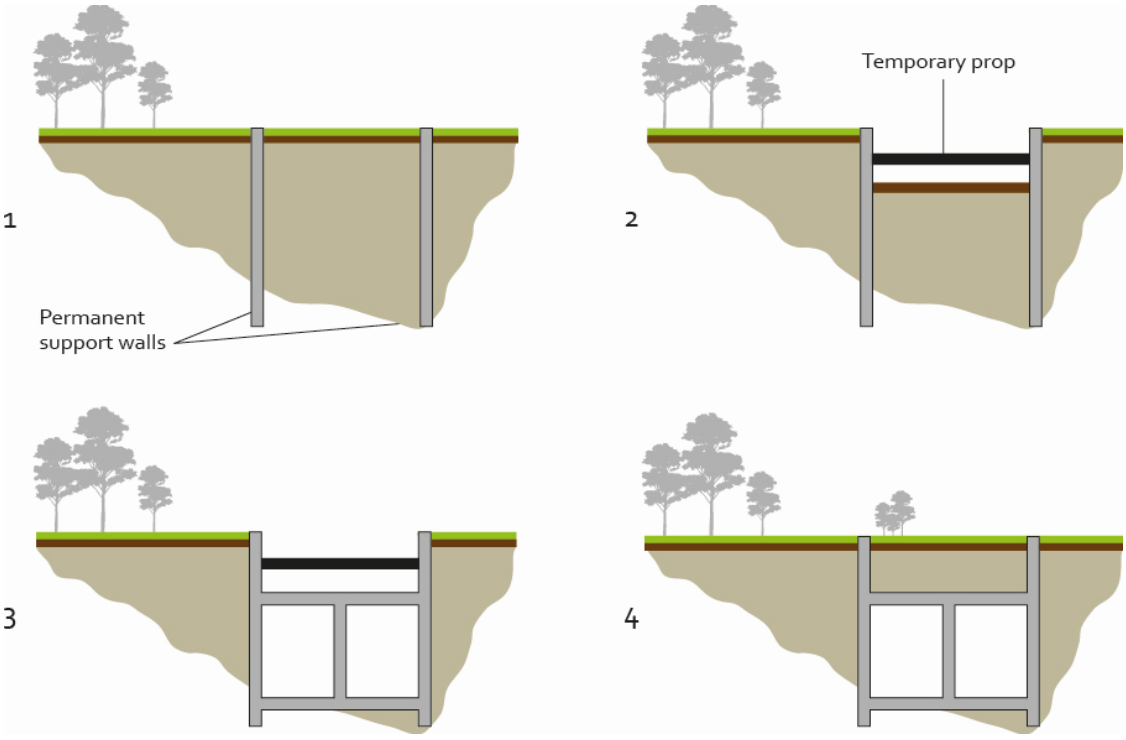
- constructing the walls, with vertical retaining panels (i.e. piles or diaphragm walls) installed along the perimeter of the intended excavation from the surface downwards;
- excavating down to the level of the roof slab of the intended structure, which may require the propping of retaining walls, if installed;
- constructing 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;
- excavating and constructing the floors below roof level;

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

- excavating beneath the roof slab by means of a ramp formed at the portal end;
- casting the permanent base slab;
- removing any temporary props;
- diverting and installing utilities and laying road surfaces as required; and
- removing temporary works, including any diversion/realignments of roads and PRoW.

6.16.19 The excavation beneath the roof slab would be executed in stages if temporary props are required, with these being installed progressively. An illustration of this construction sequence is shown in Figure 34.

Figure 34: Cut-and-cover construction method – option two



6.17 Portals

6.17.1 In rural locations, portals would typically be constructed by open excavation, with soil and rock slopes benched (i.e. cut in steps) and reinforced as necessary. Reinforced concrete headwalls and wing walls[112] would be formed around the tunnel entrances. In urban locations, and where space is restricted, portals would utilise embedded retaining wall structures.

6.17.2 Portals would be constructed by open cut where the excavation is relatively shallow. Diaphragm wall or contiguous bored pile[113] techniques would be used for deeper

[112] A smaller wall attached or next to a larger wall or structure.
[113] Closely spaced, bored piles used to form an underground wall, for the construction of a deep basement or cut-and-cover tunnel.

excavations, requiring support by propping beams or a cover slab for the deepest excavations. A slab up to 120m long would also be required where portals are required to accommodate a TBM, to allow the back-up equipment for the TBM to be established.

6.18 Ventilation and intervention (vent) shafts

6.18.1 Vent shaft construction would be undertaken during tunnelling. The methods for constructing vent shafts would depend on local ground and groundwater conditions, the depth of shaft and whether there is any need to access the TBM during construction.

6.18.2 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).

6.18.3 Vent shafts would 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 would 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 would be landscaped.

6.19 Cross passages

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

6.19.2 Cross passages would 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.

6.20 Viaducts

6.20.1 The following methods of constructing viaduct decks are likely to be used:

- 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.

6.20.2 The deck in beam and deck construction 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.

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

6.20.4 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).

6.20.5 In-situ construction is more economic for low, bespoke, shorter span structures with high degrees of geometric complexity. The beam and deck solution is convenient for bridging over obstructions, for example railways or rivers, especially where construction headroom is restricted.

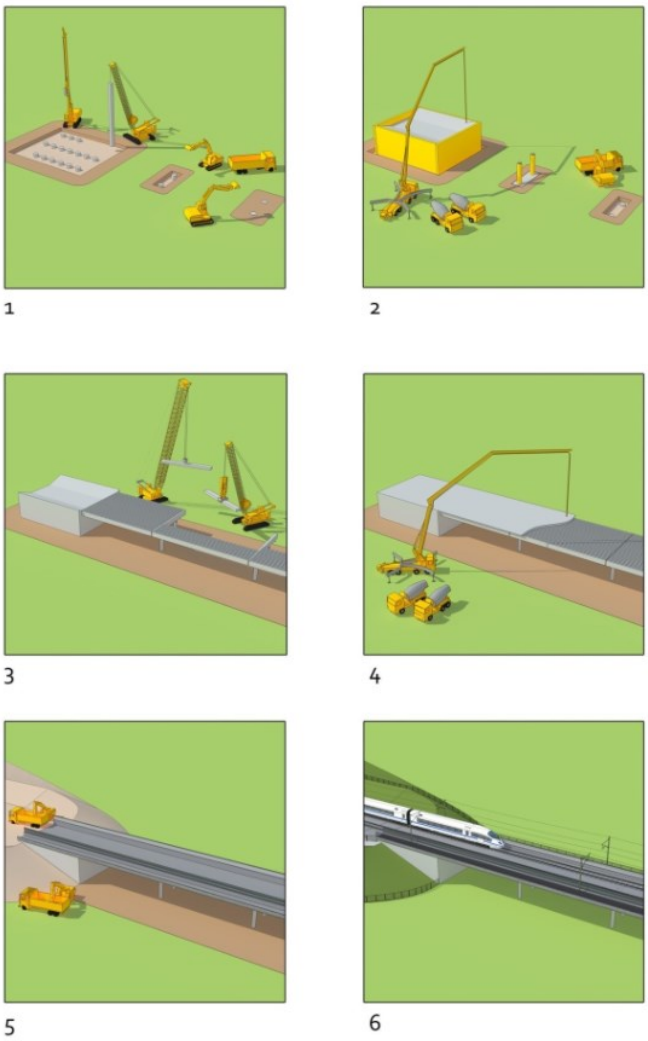
6.20.6 Viaducts would generally be constructed by:

- installing the construction access and working platform;
- constructing foundations and piers from the platform, installing concrete piles, excavating pile caps and constructing pile caps and support piers, followed by backfilling of excavations;

- constructing abutments, including excavating and constructing the pile mat, installing piles, constructing the abutment base and wall, and backfilling; and
- constructing the deck using either launched, in-situ construction or beam and deck solution.

6.20.7 An illustration of this construction sequence is shown in Figure 35.

Figure 35: Generic sequence for constructing a beam and deck viaduct



6.20.8 The following sequence would be repeated, for in-situ construction, until the viaduct deck is completed:

- installing falsework and formwork, reinforcement and stressing tendons[114];
- casting the concrete deck;
- post-tensioning the structure; and
- removing formwork and falsework.

[114] 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.

6.20.9 The launch formwork for launched construction would be manufactured off-site and delivered to site in 10-30m components. The following sequence would then be repeated until the viaduct deck is completed:

- installing a temporary intermediate pier in some instances (e.g. where the permanent spans exceed 40m);
- establishing a concrete casting yard behind the abutment wall at each end of the viaduct;
- setting up the formwork in the casting yard;
- assembling the launching nose for the deck section;
- installing the superstructure formwork with an antifriction layer on supports;
- fixing the sliding equipment on the pier heads;
- fixing the section of deck reinforcement, placing the tendons, pouring the concrete, and attaching the launching nose to the front of the deck section; and
- forward launching of the deck section using hydraulic jacks.

6.20.10 Final post-tensioning would be installed to the deck on completion of deck launching, and the temporary supports removed.

6.20.11 The following sequence would be repeated, for the beam and deck solution, until the viaduct deck is completed:

- placing the precast/steel beams using cranes;
- placing the precast permanent soffit slabs, reinforcement and tendons;
- concreting the top slab; and
- post-tensioning connections between beams.

6.21 Bridges

6.21.1 Bridges to carry the route of the Proposed Scheme over rivers or other features (underbridges), or to carry those features over the route of the Proposed Scheme (overbridges), would generally be constructed in advance of the main earthworks.

6.21.2 The construction sequence for overbridges and underbridges is generally the same. It consists of the following steps:

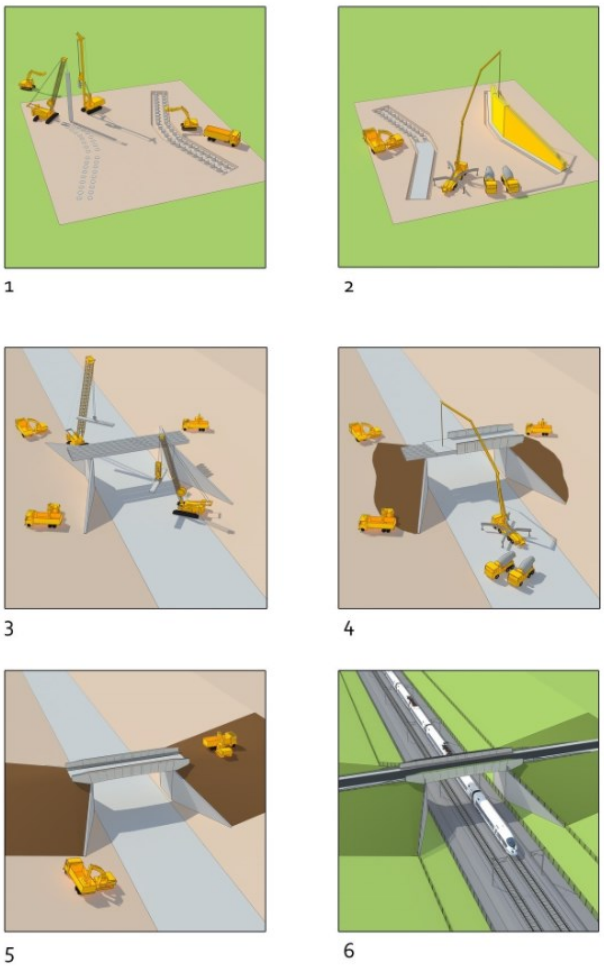
- excavating and installing foundations;
- constructing piers, abutments and wing walls;
- backfilling of abutments and wing walls;
- installing bearings and deck beams;

- casting of the deck slab; and
- installing parapets, expansion joints and finishes.

6.21.3 The backfilling operation for integral bridges[115] would generally take place after the deck is constructed.

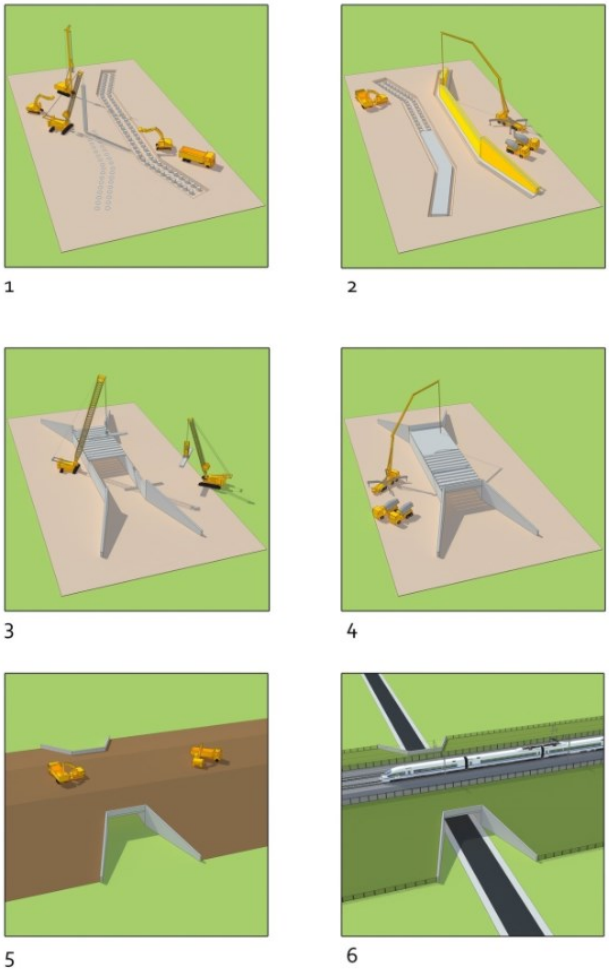
6.21.4 Figure 36 shows a generic sequence for construction an overbridge. Figure 37 shows a generic sequence for construction an underbridge.

Figure 36: Generic sequence for constructing an overbridge



[115] A bridge that does not need bearings and movement joints and is designed as one whole structure produced of reinforced concrete or reinforced concrete and steel deck beams. The normal stresses and strains are accommodated in the structure without allowing free movement. This is beneficial as these bridges do not include bearings and joints, which usually only last 20-25 years.

Figure 37: Generic sequence for constructing an underbridge



6.22 Stations

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

- Manchester Airport High Speed station: Hulseheath to Manchester Airport (MA06);
- Manchester Piccadilly High Speed station: Manchester Piccadilly Station (MA08);
- East Midlands Hub station: Long Eaton and Toton (LA05); and
- Leeds High Speed station: Leeds Station (LA18).

6.23 Railheads

6.23.1 Railheads would be required for construction of the Proposed Scheme. The railheads would be used as the delivery location for bulk rail-borne materials such as fill material, concrete elements, ballast, pre-cast slab track, rails, sleepers and switches and crossings units. They could also be used for the removal of excavated material. Facilities at the railheads would include offices, welfare facilities, storage areas,

workshops, a rail marshalling yard and pre-assembly area, car parking areas and rail reception loops. The railheads would operate 24 hours a day, seven days a week during the construction period.

6.23.2 The railheads would be located in proximity to the existing conventional railway and strategic road network to facilitate the movement of material. At this stage in the design, the requirement for a railhead has been identified at the site of the proposed Staveley IMD (see Volume 2: Community area report LA11). In addition, sites for potential railheads are currently being considered in the Ashby-de-la-Zouch area (see Volume 2: Community area report LA03) and within the Hulseheath to Manchester Airport area (see Volume 2: Community area report MA06). The potential need for, and location of, additional railheads for construction of the Proposed Scheme would be confirmed in the formal ES. Stakeholders associated with potential railhead locations and operational characteristics would be engaged during the design development process.

6.24 Infrastructure Maintenance Depot

6.24.1 Construction details for the Staveley IMD are described in the Volume 2: Community area report for the Staveley to Aston area (LA11).

6.25 Rolling stock depots

6.25.1 Construction details for the Crewe North and Leeds East RSDs are described in Volume 2: Community area reports for the Wimboldsley Gralam area (MA02) and the Stourton to Hunslet area (LA17).

6.26 Noise barriers and bunds

6.26.1 Earth bunds used for noise mitigation would be constructed in the same way as embankments, as described in Section 6.11 of this report. Bunds would be designed with a flat top for the construction of environmental barriers, where required. On completion of the bund, top soiling and landscaping would be undertaken.

6.26.2 Noise fence barriers would be installed in-situ or as pre-fabricated panels. On completion of the barrier, top soiling and landscaping would be undertaken at these sites.

6.27 Site restoration and landscape treatment

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

6.27.2 Land used only for construction purposes would be appropriately restored once the construction works in that area are complete. Land would be returned to its pre-construction use, wherever appropriate, or to a condition as agreed with the owner of the land and the relevant planning authority. This would involve the removal of temporary structures, plant, materials and equipment. Any required infilling would be completed, followed by landscaping. The engineered embankments and/or cuttings

would be reshaped, where appropriate, to help integrate the Proposed Scheme sympathetically into the character of the surrounding landscape.

6.27.3 The remainder of the permanent fencing would be erected as part of the landscaping works. Additional information regarding the approach to mitigation and monitoring is contained within Section 9 of this report.

6.28 Track

6.28.1 The track for the Proposed Scheme would either be ballasted track or slab track (see Section 5.18). A final decision on the track form would be made during the detailed design of the Proposed Scheme.

6.28.2 Ballasted track would 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 regulars intervals on top of the ballast;
- installation of rails on top of the sleepers;
- stressing the rails and welding of the joints between rails; and
- tamping (a process to pack the ballast beneath the rails and sleepers to make the track more durable) and alignment of the track to its final position.

6.28.3 Slab track construction would use either pre-cast or cast-in-situ concrete elements to support the track, instead of ballast. Slab track would usually be constructed by:

- constructing the hydraulically bound layer[116];
- placing the track slab on top of the hydraulically bound layer;
- installing the rails;
- adjusting the track to final position, and grouting into place; and
- stressing the rails and welding the joints between the rails.

6.28.4 For both types of track, it is expected that the completed sections of line would be used for delivery of materials, such as ballast, long welded rails, sleepers, catenary wire, cables and granular fill, to the point of installation.

6.29 Power supply

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

[116] Aggregate mixture incorporating cement, lime based or other binders, which harden in-situ by a chemical/hydraulic reaction.

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

6.29.3 Road access would 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 cranes to use.

6.29.4 Secondary fit-out for traction power and associated switch rooms would then take place.

6.29.5 Switch rooms and external transformers would be off-loaded by crane or slid from large vehicles.

6.29.6 The overhead line equipment would be installed by specialised machines, where construction phasing allows. The masts supporting the overhead line equipment would require foundations, such as concrete pads or monopiles[117], pre-cast piles[118] or steel screw piles[119] with reinforced concrete pile caps[120]. The masts would be lifted into place and bolted to the foundations from specialised equipment, followed by installation of the overhead line equipment.

6.29.7 Installation of the power supply system would be co-ordinated and timed to achieve phased 'powering on' milestones for each section of the Proposed Scheme.

6.30 Train control and telecommunications

6.30.1 Train control and telecommunication equipment would generally be installed after the track is laid and the overhead line equipment system installed. This would involve the laying of cabling into the trough system throughout the route of the Proposed Scheme, and the installation of line-side cabinets and signage.

6.30.2 The line-side telecommunications equipment would be constructed from within the rail corridor and access points along the route of the Proposed Scheme.

6.30.3 The radio masts and antennae would be installed from within the rail corridor where suitable for construction. The equipment would be delivered to site and lifted into place onto the foundations and cranes may be required for lifting of telecommunications masts.

6.30.4 The workforce would access the equipment from the permanent points of maintenance access for the rail corridor, where further fit-out is required.

6.30.5 Final installation of telecommunications systems would occur during the testing and commissioning phase.

[117] A single large diameter pile with significant vertical and lateral load carrying capacity. It is used as an alternative to a pile group.
[118] A driven pile produced from pre-cast concrete.
[119] A displacement pile screwed into the ground in order to transfer vertical load into the ground.
[120] A concrete structure used to link a number of discrete pile elements into a single arrangement to support significant loads that the pile elements are not capable of supporting individually.

6.31 Interfaces with the conventional rail network during construction

6.31.1 The construction of the Proposed Scheme would involve physical and operational interfaces with the conventional rail network. The main points of interface are identified in Table 5.

Table 5: Construction interfaces with the existing conventional rail network

Location	Summary of work
North of Crewe: WCML	Heading north from the Crewe tunnel, the route of the Proposed Scheme would run parallel to the WCML until the Crewe North RSD where the HS2 main line and WCML diverge. Where the route of the Proposed Scheme diverges from the WCML, a rolling stock depot (RSD) would be provided on land between the HS2 main line and the existing WCML.
Whatcroft: Sandbach to Northwich Line	Construction of an underbridge where the route of the Proposed Scheme would pass over the existing Sandbach to Northwich Line.
Glazebrook: Liverpool to Manchester Line (via Warrington Central)	Construction of an underbridge where the route of the Proposed Scheme would pass over the existing Liverpool to Manchester Line (via Warrington Central).
Culcheth: Liverpool to Manchester Line (Chat Moss)	Construction of an underbridge where the route of the Proposed Scheme would pass over the existing Liverpool to Manchester Line (Chat Moss).
Lily Lane: WCML	Realignment of, and modifications to, the existing WCML to connect with the Proposed Scheme. Construction of an underbridge for the northbound and southbound lines of the Proposed Scheme to cross over the existing WCML.
Ashley: Mid-Cheshire Line	Construction of an underbridge where the route of the Proposed Scheme (Manchester spur) would pass over the existing Mid-Cheshire Line.
Manchester Piccadilly	Reconstruction and extension of the existing Manchester Piccadilly station concourse, replacement of a service basement and loading bay underneath the existing station, and alternations to accesses for the Metrolink tram services.
Kingsbury: Birmingham to Derby Railway	Construction of a viaduct to carry the route of the Proposed Scheme over the existing Birmingham to Derby Railway and the M42.
Polesworth: WCML	Construction of a viaduct to carry the route of the Proposed Scheme over the Coventry Canal, Pooley Country Park, the existing WCML, the River Anker and Linden Lane.
Ashby-de-la-Zouch: Leicester to Burton upon Trent Line	Construction of an overbridge where the route of the Proposed Scheme would pass under the existing Leicester to Burton upon Trent Line.
Ratcliffe-on-Soar: MML	Construction of a viaduct to carry the route of the Proposed Scheme over the existing MML.
Long Eaton: Long Eaton Line and Nottingham to Trent Junction Line	Construction of a viaduct to carry the route of the Proposed Scheme over the existing Long Eaton Line and Nottingham to Trent Junction Line .
East Midlands Hub station	Construction of the East Midlands Hub station, with interchange to conventional rail services on the Erewash Valley Line.
Stapleford: Erewash Valley Line	Construction of a viaduct to carry the route of the Proposed Scheme over the existing Erewash Valley Line.
Trowell: Radford and Trowell Railway	Construction of a viaduct to carry the route of the Proposed Scheme over the existing Radford and Trowell Railway.
Selston: Sutton Junction	**Construction of a viaduct to carry the route of the Proposed Scheme over the existing**

Location	Summary of work
to Pye Bridge Railway	**Sutton Junction to Pye Bridge Railway.**
Clay Cross: Erewash Valley Line and MML	The route of the Proposed Scheme (Sheffield Southern spur) would meet the Erewash Valley Line at Stonebroom and run in parallel before connecting to it south-east of Clay Cross. From the Erewash Valley Line a connection would be made to the MML.
Staveley: Chesterfield to Beighton Railway	The Proposed Scheme would connect to the Chesterfield to Beighton Railway at the north-west corner of the Staveley IMD.
Wales: Sheffield to Worksop Railway	Construction of a viaduct to carry the route of the Proposed Scheme over the existing Sheffield to Worksop Railway.
Mexborough: Sheffield to Doncaster Railway	Construction of a viaduct to carry the route of the Proposed Scheme over Denaby Lane, the Sheffield to Doncaster Railway, the River Don, the Sheffield and South Yorkshire Navigation, the A6023 Doncaster Road and Pastures Road.
Thurnscoe: Dearne Valley Line	Modifications to the existing Dearne Valley Line to facilitate the connection of the route of the Proposed Scheme (Sheffield Northern spur) to the existing Dearne Valley Line.
Wintersett: Doncaster to Wakefield Line	Construction of a viaduct to carry the route of the Proposed Scheme over the existing Doncaster to Wakefield Line.
Crofton: Pontefract to Wakefield Line	Construction of an underbridge where the route of the Proposed Scheme would pass over the existing Pontefract to Wakefield Line.
Warmfield: Hallam Line	Construction of a viaduct to carry the route of the Proposed Scheme over the existing Hallam Line.
Woodlesford: Hallam Line	Upon emerging from the Woodlesford tunnel that passes under the existing Hallam Line, the route of the Proposed Scheme (Leeds spur) would run parallel to the existing Hallam Line before the two diverage on the approach to the existing Leeds Station.
Leeds Station	Construction of the high speed rail station, with the northern concourse forming part of a common concourse with the existing Leeds Station.
Garforth: Leeds to Selby Line	Construction of an underbridge where the route of the Proposed Scheme would pass over the existing Leeds to Selby Line.
Church Fenton: York to Church Fenton Line	Realignment of, and modifications to, the existing York to Church Fenton Line to connect with the Proposed Scheme.

6.32 System testing and commissioning

6.32.1 The railway would be fully tested to ensure it can operate safely and reliably. Testing and commissioning of the Proposed Scheme would 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 approximately three years, commencing by 2030 and completing in 2033.

6.32.2 Testing and commissioning would start on the section of route of the Proposed Scheme closest to the connection with Phase 2a on the western leg and the connection with Phase One on the eastern leg.

6.32.3 The programme of testing and commissioning would be divided into a number of phases:

- phase 1: off-site testing – factory acceptance tests;
- phase 2: on-site testing – static tests;
- phase 3: on-site testing – site acceptance testing;
- phase 4: on-site testing – dynamic testing; and
- phase 5: trial running.

6.32.4 A certificate would be issued at the end of each phase of testing to confirm that the tests have been successfully completed and that the next phase can start.

6.32.5 Each of the systems to be tested would be broken down into commissioning lots. Each commissioning lot would be subjected to each test phase in sequence and is the smallest element that would be subjected to formal inspection. When breaking down the systems, due regard would be taken of the interfaces and dependencies between the systems and between the commissioning lots within each system. This would allow for the test sequence logic and test programme to be developed.

6.32.6 Rolling stock acceptance tests would take place once a sufficient length of route has been commissioned, and would be followed by performance tests involving multiple trains to confirm operability. The conventional compatible trains would be tested and commissioned on conventional infrastructure at the same time. Final installation of telecommunications systems would also occur during the testing and commissioning phase.

6.32.7 Trial operations would allow operational procedures to be tested and refined at the same time as staff are trained.

7 Environmental impact assessment

7.1 Overview

Introduction

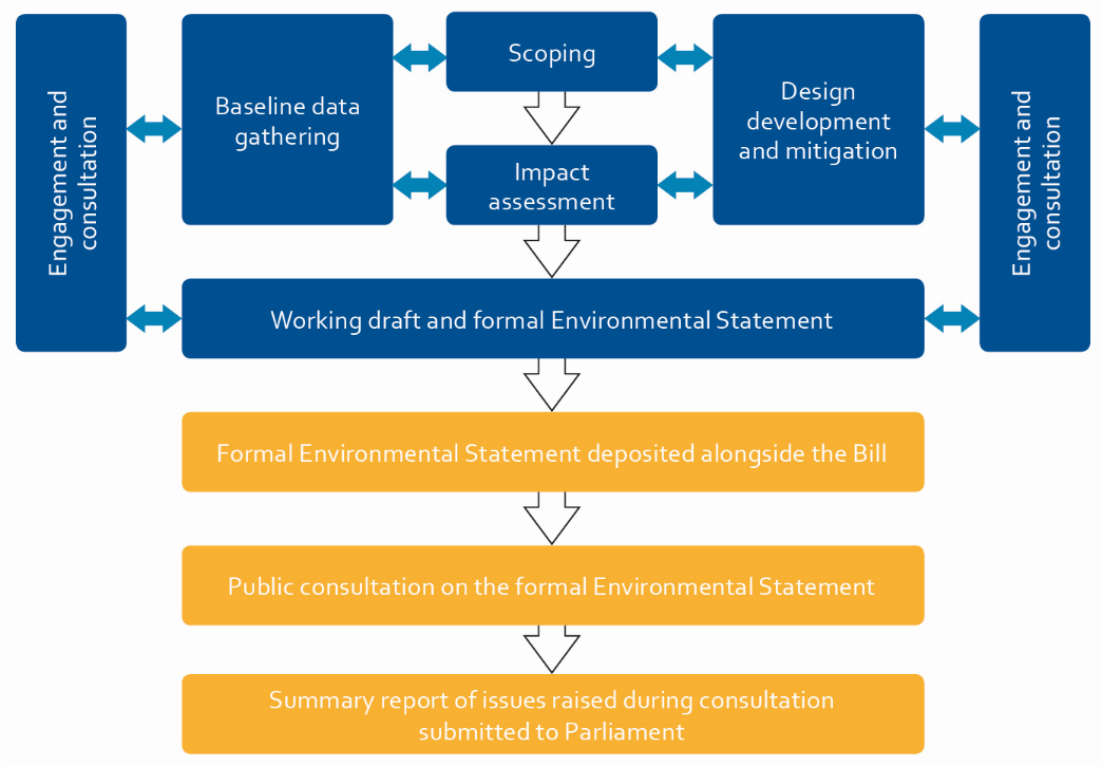
7.1.1 The purpose of EIA is to identify the likely significant effects of a proposed development on people and the environment. In simple terms, it does this by identifying the current (baseline) conditions, anticipating how these may change in the future, and predicting the potential impacts of the development across a range of environmental 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 environmental topic is summarised in Section 8 of this report.

7.1.2 The working draft ES is an interim report presenting preliminary environmental information for consultation. The design and assessment of the Proposed Scheme are at an early stage of development and are presented here to enable the public and stakeholders to provide comments, which will be taken into account, as appropriate. The design and environmental assessment of the Proposed Scheme will continue to be refined during and following this consultation and reported in the formal ES.

Preparation of the Environmental Statement and deposit to Parliament

7.1.3 The main steps in the EIA process, preparation of the formal ES and deposit to Parliament are shown in Figure 38 and detailed in the following section.

Figure 38: Environmental impact assessment process for Phase 2b



Scoping

7.1.4 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 EIA SMR (a supporting document to this working draft ES), which was finalised through engagement and consultation with local authorities, a wide range of environmental organisations and the general public. The EIA SMR is published as a supporting document to the working draft ES.

Collection and presentation of baseline data

7.1.5 Baseline studies are ongoing to establish the environmental conditions that exist in the vicinity of the Proposed Scheme for each environmental topic study area. These studies comprise desk-top research to gather and evaluate previous environmental work and publicly available information, together with new environmental surveys and feedback from consultation. Relevant policies, guidelines and legislation, together with industry-accepted practice, are also being identified as part of this stage.

7.1.6 The current baseline will be extrapolated, where appropriate, into the future to take account of predicted or anticipated variations due to factors such as changing climatic conditions, 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 are consented or will be under construction at the time of construction of the Proposed Scheme, with the potential to result in significant impacts and resultant effects.

7.1.7 As this is a working draft ES, where information is not currently available professional judgement and reasonable assumptions have been used to provide an indication of likely impact to inform consultation and engagement on the Proposed Scheme.

7.1.8 Future developments will be identified in the formal ES where they may introduce new environmental receptors[121] that could be significantly affected by, and/or interact with and create cumulative impacts with, the Proposed Scheme.

Impact assessment

7.1.9 Assessment of the impacts and effects of the Proposed Scheme is being undertaken in accordance with the methodology outlined for each environmental topic in the EIA SMR. This is also summarised within Section 8 of this report. The assessment will identify the likely significant effects, the measures proposed to mitigate adverse effects, and the likely significant residual effects (i.e. effects remaining following mitigation), for the construction and operation phase.

[121] 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. Residents of a new housing development close to the route are an example of a new receptor.

7.1.10 The working draft ES presents preliminary environmental information in the form of:

- baseline data gathered to date;
- the emerging likely significant beneficial and adverse effects of the Proposed Scheme identified to date; and
- the emerging mitigation measures that have been identified to address the likely significant adverse effects, where known at this stage.

7.1.11 The working draft ES has taken account of relevant policies, guidelines, legislation and industry accepted practice in assessing impacts for each environmental topic, as well as the experience and professional judgement of specialists.

Mitigation and monitoring

7.1.12 Mitigation measures and procedures for monitoring (including measures to manage the effects of construction, the effectiveness of mitigation post construction, and monitoring during the operational phase) are being identified throughout the development and assessment of the Proposed Scheme. More information on the approach to mitigation and monitoring is set out in Section 9 of this report. Any mitigation proposed can be amended at a later date, in the event that the anticipated development does not take place, to reflect the change from the future baseline position.

Consultation and engagement

7.1.13 Stakeholder engagement has taken place throughout the design process and preparation of the working draft ES, as described in Section 3 of this report. Public consultation on the working draft ES is taking place during October to December 2018.

Consideration of reasonable alternatives

7.1.14 A number of reasonable alternatives to the Proposed Scheme have been studied in the development of the Proposed Scheme. The strategic, route-wide and route corridor alternatives are described in Section 10 of this report. Local alternatives studied prior to July 2017 are outlined in Section 11 of this report. A more detailed account of the reasonable alternatives studied, how they were studied and the reasons for the choices made can be found in the working draft ES Alternatives report. Local alternatives studied since July 2017 are addressed in the relevant Volume 2: Community area reports.

Preparation of the formal ES

7.1.15 The design and environmental assessment of the Proposed Scheme will continue to be refined during and following the consultation on the working draft ES. The formal ES to be submitted to Parliament with the hybrid Bill will consider the consultation responses, and reflect ongoing engineering design development and construction arrangements, further environmental baseline surveys and proposed further mitigation.

7.1.16 It is envisaged that the formal ES will include Volume 5 as an additional volume. This will include technical appendices and map books, providing supporting environmental information. The detailed technical appendices supporting the assessment will be published as part of the formal ES.

Deposit to Parliament and subsequent steps

7.1.17 Once the formal ES has been prepared, in accordance with House of Commons Standing Order 27A, it will be deposited in Parliament and will include the information set out in Section 1.3 of this report. Copies of the ES (containing the non-technical summary) deposited will be made available for inspection, and for sale at a reasonable price, in accordance with the standing order.

7.1.18 Also, in accordance with Standing Order 224A, public participation on the ES allows for a period of at least 70 days (10 weeks) within which members of the public and other stakeholders may comment on the ES. An independent assessor will then prepare a report summarising the issues raised during that period. This report will then be submitted in Parliament ahead of Second Reading by the Examiner.

7.2 Scope of the assessment

Introduction

7.2.1 The scope determines what is included within the assessment of the Proposed Scheme, in terms of:

- years and time periods – 'the temporal scope';
- areas – 'the geographic scope'; and
- environmental topics – 'the technical scope'.

Temporal scope

7.2.2 The main construction works are expected to take place between 2023 and 2033 (including a period of testing and commissioning), although the duration, intensity and scale of construction along the route would vary over this period. The Proposed Scheme is expected to become operational in 2033. The environmental topics have generally assessed the period of maximum intensity over the construction period and compared it to a defined baseline year.

7.2.3 The EIA compares the future patterns of movement of transport and passengers resulting from the Proposed Scheme with the predicted transport and passenger movements without HS2, otherwise known as the 'do minimum case'. The do minimum case refers to the future that would exist if the Proposed Scheme were not developed.

Geographic scope

7.2.4 The geographic (or spatial) scope is the area over which 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 likely to be propagated. It takes account of both the land required permanently for rail infrastructure and the additional land required temporarily for construction.

7.2.5 Each of the environmental topics identifies the area within which impacts and effects have been assessed. This is summarised in Section 8 of this report and further explained within the EIA SMR.

7.2.6 The reporting of likely significant effects of the Proposed Scheme identified to date is presented in the Volume 2: Community area reports. Volume 2 is split into community area reports, each of which is based on a distinct geographical area.

7.2.7 The assessment of environmental impacts and effects identified to date that cover a wider geographical area is reported in Volume 3: Route-wide effects. The effects reported in Volume 3 are those considered to be appropriately assessed at a geographical scale greater than that presented within the Volume 2: Community area reports.

7.2.8 The assessment of environmental impacts and effects identified to date that may occur beyond the route corridor is reported in Volume 4: Off-route effects.

7.2.9 The design of the proposed electrification of the section of the Erewash Valley Line and the MML between Clay Cross and Sheffield Midland Station is at an earlier stage of development and an overview of the proposals is presented in the MML01 and MML02 Volume 2: Community area reports. The environmental assessment of the likely significant effects of those works will be reported in the formal ES.

7.2.10 Transboundary effects are significant environmental effects caused in other countries (i.e. other than the UK). There are no direct connections between HS2 and other countries. Therefore, it is considered unlikely that the Proposed Scheme will result in any significant effects on the environment of another country and thus transboundary effects will not be considered further unless individual environmental topic areas identify any such significant effects.

Technical scope

7.2.11 The technical scope refers to the environmental topics that have been addressed in the assessment. The working draft ES describes the likely impacts, and where possible the potential significant effects, of the Proposed Scheme identified to date for the following environmental topics:

- agriculture, forestry and soils;
- air quality;
- climate change;
- community;
- ecology and biodiversity;
- electromagnetic interference;
- health;
- historic environment;
- land quality;

- landscape and visual;
- major accidents and disasters;
- socio-economics;
- sound, noise and vibration;
- traffic and transport;
- waste and material resources; and
- water resources and flood risk.

7.2.12 These environmental topics have been evaluated during the scoping process to determine the extent to which they require inclusion/consideration within the working draft ES, having regard to whether they are likely to give rise to significant effects. It was determined as part of this process that all environmental topics, with the exception of electromagnetic interference, could potentially give rise to significant effects.

Electromagnetic interference

7.2.13 High voltage electrical equipment creates electromagnetic fields (EMF), which can potentially have implications for human health and may cause electromagnetic interference (EMI) to other electrical/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.

7.2.14 The main potential source of EMI associated with the Proposed Scheme would be the traction power system, comprising the overhead line equipment along the route and supporting infrastructure such as feeder stations. The railway communications system would, in addition, generate radio signals that are in licensed areas of the radio spectrum and that would be controlled both in frequency and radiated power.

7.2.15 The railway's own operating systems would need to be immune to EMI and radio interference, whilst levels of exposure for passengers and staff must be acceptable. This would be achieved by ensuring that all electrical equipment complies with the relevant standards for electromagnetic compatibility (EMC) and personal protection, for example BS EN 50121-5-2017[122] and BS EN 50122-1- 2011[123] and EU Directive 2013/35/EU[124] Electromagnetic Fields (EMF) limits, which is closely based on ICNIRP (International Commission on Non-Ionising Radiation Protection) guidance[125].

7.2.16 EMF extend over relatively short distances. Any residual risk to nearby receptors (e.g. residential properties, businesses or communications infrastructure) would not be

[122] British Standards Institute (2017). *BS EN 50121-5-2017 Railway Applications, Electromagnetic Compatibility*.
[123] 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*.
[124] Official Journal of the European Union. *Directive 2013/35/EU on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields).*
[125] International Commission on non-ionizing radiation protection (2010). *ICNIRP Guidelines*.

significant, on the assumption that acceptable levels are achieved on the railway itself.

7.2.17 Equipment used during construction of the Proposed Scheme would 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.

7.2.18 Tower cranes would be used in some locations during the construction phase. If complaints about interference are received (e.g. in relation to TV reception), appropriate remedial action would 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.

7.2.19 The scope and methodology for electromagnetic interference is contained within the EIA SMR (a supporting document to this working draft ES).

7.3 Impacts and effects

7.3.1 The working draft ES identifies both beneficial and adverse impacts on environmental and community resources or receptors. The likelihood that an impact would 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 and community. The formal ES will identify the likely significant effects of the Proposed Scheme. It will also identify the level of impact that gives rise to the significant effects and explain how adverse impacts would be mitigated.

7.3.2 The predicted impacts have generally been classified according to whether they are considered to be major, moderate or minor; and beneficial or adverse. Whilst the definition of each category varies by topic, as shown in the EIA SMR, 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;
- minor: slight, very short-term and/or highly localised impact;
- moderate: limited impact (by extent, duration and/or magnitude); and
- major: 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 has been defined as either temporary or permanent. Impacts can occur either directly or indirectly. Direct impacts are those that would 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 on conventional rail services).

7.3.4 Impacts have been assessed qualitatively, based on professional judgement, in instances where quantification was not possible. Section 8 of this report indicates where uncertainty exists, and the route-wide assumptions that have been made. The Volume 2: Community area reports indicate where local assumptions have been made.

7.3.5 Effects deemed to be significant will be evaluated against recognised standards and accepted criteria for each environmental topic, where these are available. Professional judgement will be used in instances where no recognised standards or criteria exist, 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.

7.3.6 Where effects are considered to be significant, the working draft and formal ES will show the geographic (or spatial) level at which they are viewed as significant (for example, at a community level or a regional or national level).

7.3.7 The EIA is being undertaken by independent qualified and competent experts from a number of consultancies with sufficient expertise to ensure the completeness and quality of the assessment. The leads for each environmental topic, from the appointed consultancies, meet regularly to discuss the methodology being applied, the issues, impacts and effects arising, and the solutions available. National representatives of environmental statutory authorities and government departments are also involved in these discussions. This approach enables experienced EIA practitioners to apply expert professional judgement where appropriate on a consistent basis.

7.4 Cumulative effects

Introduction

7.4.1 Consideration will be given to potential cumulative effects of the Proposed Scheme and other committed developments and will be reported in the formal ES.

7.4.2 Cumulative effects are broadly defined as incremental effects that result from the accumulation of a number of individual effects. They may result either from:

- a combination of effects arising from the Proposed Scheme (intra-project effects). For example, intra-project effects may arise during construction in cases where the occupiers of a group of neighbouring residential properties experience noise, visual and traffic effects, resulting from construction activities and the passage of construction vehicles on the local road network; or
- from an interaction between the effects of the Proposed Scheme with the effects of other developments that are likely to be under construction or to have been completed during construction or operation of the Proposed Scheme (inter-project effects). For example, construction of the Proposed Scheme and Phase One or Phase 2a may give rise to inter-project effects at the interfaces between the schemes.

7.4.3 Cumulative effects can be either temporary or permanent and can broadly arise from:

- the combined effects on a single receptor of a number of individual environmental impacts, for example noise, dust and traffic;
- the effects of existing and/or approved projects in the vicinity of the Proposed Scheme which are under construction or have been consented or are subject to site allocation in a statutory development plan, including HS2 Phase One, which when combined with the effects of the Proposed Scheme may have an incremental significant effect; and
- the cumulation of individual effects on a receptor, which when summed (including in a regional context or over the length of the Proposed Scheme), result in an effect of greater significance than the sum of the individual effects (i.e. synergistic effects).

7.4.4 Developments expected to be completed between 2023 and 2033 (i.e. before the Proposed Scheme is operational), may give rise to cumulative effects. However, smaller projects are unlikely to give rise to significant cumulative effects, as the scale of their construction impact, in combination with the Proposed Scheme, would not generate any noticeable increases in effects.

7.4.5 People living in developments to be completed before 2023 will be included as receptors of construction of the Proposed Scheme and those in developments to be completed before 2033 are included as receptors of the operational effects of the Proposed Scheme.

7.4.6 Developments that may be completed after 2033 will 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 that 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. However, the progress of these proposals will continue to be monitored by HS2 Ltd. The formal ES will 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, Phase 2a and Phase 2b

7.4.8 Construction of the Phase One route commenced in July 2017 and it is scheduled to be operational in 2026. The Phase 2a scheme is due to commence construction in 2020 and open a year later than Phase One, in 2027. Phase 2b is due to commence construction in 2023 and become operational in 2033. There would, therefore, be some overlap between the construction (and commissioning) phases for Phase One, Phase 2a, and 2b. A summary of the combined impacts of Phase One, Phase 2a and Phase 2b of HS2 identified to date is presented in Volume 3: Route-wide effects of the working draft ES.

7.5 Over-site development

7.5.1 Over-site development (OSD) is development that can be built over and around the permanent operational structures of the Proposed Scheme. The assumption is that any such development would be applied for and determined through the normal planning process if it is brought forward, rather than through the hybrid Bill.

7.5.2 This working draft ES only assesses the environmental effects of the works that will be authorised by the Bill; it does not assess the effects of any future OSD. However, any works that would be required to facilitate future potential OSD that are included within the scope of the Bill will be assessed and reported in the formal ES.

7.5.3 The 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 Bill, or (b) is not so listed, but its replacement is likely to have significant effects on the environment.

7.5.4 Consequently, where a planning application is made for a replacement building (i.e. the OSD) in the circumstances cited above, an ES would be required to accompany the relevant planning application, even if it would not otherwise be required under the EIA Regulations. Such an ES would include a cumulative assessment of the OSD with the Proposed Scheme in place.

7.6 Assumptions and limitations

7.6.1 A precautionary approach is used in the EIA of the Proposed Scheme in identifying impacts and effects in instances where there is uncertainty or limited information. Any assumptions and limitations that affect the assessment of significant environmental effects of the Proposed Scheme are described in the relevant environmental topic

sections within this Volume of the working draft ES and the Volume 2: Community area reports of the working draft ES.

7.6.2 The EIA and design of the Proposed Scheme will continue to be refined during and following the consultation on the working draft ES, as explained in the Preface. It is, therefore, a provisional document in several respects, and should be read as such.

8 Scope and methodology summary for environmental topics

8.1 Introduction

8.1.1 This section provides a summary, by environmental topic, of:

- assessment scope and methodology;
- the key assumptions and limitations underpinning the assessment methodology; and
- further work, including surveys and modelling, to be undertaken for each topic prior to completion of the formal ES.

8.1.2 The full scope and methodology is contained within the EIA SMR (a supporting document to this working draft ES).

8.2 Agriculture, forestry and soils

Scope

8.2.1 The assessment covers the environmental topic areas of agriculture, forestry and soils, which includes assessments on agricultural land quality, soil resources, local rural businesses and on farm enterprises and agri-environment schemes. The impacts on these resources and receptors result directly from land required (both temporarily and permanently) for the construction and operation of the Proposed Scheme, from severance, and from construction activities on adjacent agricultural land.

8.2.2 Effects are identified for all agricultural and forestry land that would be required for the construction and operation of the Proposed Scheme, and for all holdings that include such land.

8.2.3 Most effects on agriculture, forestry and soils would arise during the construction phase and would be either temporary or permanent. Temporary effects include land that would be used during construction and available for restoration to agricultural use using conserved soil resources on completion of construction (in agreement with the landowner). Where agricultural uses are to be resumed on land disturbed during the construction of the Proposed Scheme, the design objective is to avoid any reduction in long term capability, which would downgrade the quality of the disturbed land, through the adoption of good practice techniques in handling, storing and reinstating soils on that land. Other temporary effects include the severance of land during construction, and the potential effects of construction noise and dust on adjacent agricultural activities. Permanent effects would 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 relate primarily to the effects of operational noise on agricultural and related enterprises and the ongoing management of operational railway land.

Baseline

8.2.4 Information on current agricultural land quality is derived from an interpretation of geological, topographical, soil, agro-climatic and existing detailed and predictive Agricultural Land Classification (ALC) information. This ALC information will be augmented by field surveys to provide further detailed ALC information and to validate the findings of the predictive desk exercise, where required and where access is available. Desktop research is also being used to identify relevant agri-environmental schemes and forestry. Details of land used for commercial forestry and farming practices are being obtained primarily from interviews with landowners and farmers.

Methodology

8.2.5 The level of significance of effects will be based on the magnitude of change due to the Proposed Scheme, the sensitivity of the affected receptor/receiving environment to change, and the relative scarcity or abundance of resource in the locality, as well as in the wider context.

8.2.6 The nature of impacts on agricultural land will be assessed according to the proportion of best and most versatile agricultural (BMV) land required by the Proposed Scheme. The main issue in the assessment is the amount of BMV agricultural quality land temporarily or permanently required by the construction of the Proposed Scheme.

8.2.7 Forestry will be considered as a commercial land use feature providing resources such as timber or fuel. The permanent impact on commercial forestry due to the construction of the Proposed Scheme will be determined within the context of the abundance of forestry land in the locality, as measured within a 4km-wide corridor.

8.2.8 The primary functions provided by soils, other than for food and biomass production, such as flood water attenuation, carbon storage or the support of ecological habitats, are identified in this topic and the ability of soils to fulfil their primary functions after construction will be assessed.

8.2.9 The main issue for farm holdings is disruption by the Proposed Scheme of the physical structure of agricultural holdings and the operations taking place upon them, during both construction and operational phases.

8.2.10 The areas of land required to construct and operate the Proposed Scheme are calculated on the basis of the maximum extent of the permanent infrastructure and temporary works (including soil storage areas).

Assumptions and limitations

8.2.11 It is assumed, as part of the assessment, that:

- there would be no reduction in long-term capability or agricultural quality of land used temporarily for construction of the Proposed Scheme, by adopting good practice techniques in handling, storing and reinstating soils on the land;
- agricultural land required temporarily for construction would be restored as agreed with the landowner and the relevant local planning authority;
- all agricultural soil resources generated by the Proposed Scheme would be

used appropriately and on-site to fulfil one or more of the recognised functions of soil;

- displaced ancient woodland soils would be translocated as appropriate to form the basis of new woodland planting and that all other woodland soils would be reused as appropriate, including as the basis for new woodland planting;
- land required for environmental mitigation measures would no longer be available for agricultural use, which is a worst-case assumption, although some land such as grasslands may be managed on a low input basis by agricultural interests;
- in the majority of cases, the details of land use have been obtained from face-to-face interviews. Where this has not been possible, holding data have been obtained from publicly available sources;
- capital items demolished would not be replaced as replacement assets are not included in the Proposed Scheme and would ultimately be at the discretion of the landowner; and
- severed land would continue to be used by the holding where access is available to that land. Where access it not available, new field accesses to severed parcels of land would be created from public highways.

8.3 Air quality

Scope

8.3.1 The air quality assessment includes consideration of the potential effects of construction and operation. Construction effects would occur as a result of the construction activities, associated traffic movements and highway interventions. Operational effects on air quality would occur as a result of changes to road layouts and traffic flows.

8.3.2 The key pollutants considered are: dust, oxides of nitrogen (NOx), including nitrogen dioxide (NO_2), and particulate matter (PM_{10} and $PM_{2.5}$). Traffic effects are assessed for the peak years during the construction period and for the year of opening for operational effects.

8.3.3 The spatial scope of the assessment reflects 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. Criteria from the DMRB are used to determine the relevant extent of the highway network to be assessed for traffic emissions.

Baseline

8.3.4 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 Defra Air Information Resource website; and
- the UK Air Pollution Information System.

Methodology

8.3.5 The effects from dust emissions during construction are assessed using an approach developed from the guidance produced by the Institute of Air Quality Management (IAQM)[126]. 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).

8.3.6 The assessment assumes that dust control measures would be applied to the construction activities, through the CoCP, so that dust levels at sensitive receptors are kept as low as reasonably practicable. For ecological 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 designation of the receptor.

8.3.7 An assessment of traffic related effects on receptors will be undertaken for the formal ES. Changes to traffic flows and road alignments will be screened using the DMRB criteria. Where the changes exceed the thresholds, traffic related effects on sensitive receptors (e.g. residential properties, educational or healthcare facilities) will be predicted using dispersion modelling. The level of effects from traffic emissions on individual receptors will be identified on the basis of air quality standards (EU/UK air quality limit values and objectives), in accordance with the descriptors used in the IAQM/Environmental Protection UK (EPUK) *Land-Use Planning & Development Control: Planning for Air Quality*[127]. The likelihood of nitrogen deposition on ecologically sensitive sites (e.g. protected habitats) will also be assessed in accordance with the DMRB guidance. Dispersion modelling of point sources (e.g. combustion emissions from energy centres) will also be undertaken where appropriate.

Assumptions and limitations

8.3.8 Assumptions necessary to undertake the air quality assessment are set out in the EIA SMR. The air quality assessment assumes that HS2 Ltd's policies on vehicles emissions, i.e. the use of Euro VI HGVs and Euro 4/6 petrol/diesel cars and LGVs, would be applied during construction of the Proposed Scheme.

8.4 Climate change

Introduction

8.4.1 Climate change is being assessed in three ways as part of the EIA:

- a greenhouse gas (GHG) assessment;

[126] Institute of Air Quality Management (2014). Guidance on the assessment of dust from demolition and construction, IAQM, London
[127] Moorcroft and Barrowcliffe (2017). Land-Use Planning & Development Control: Planning for Air Quality, IAQM, London

- an in-combination climate change assessment; and
- a climate change resilience assessment.

GHG assessment

Scope

8.4.2 The scope of the GHG assessment includes the following stages: before use (also referred to as construction emissions), use (also referred to as operational emissions), end-of-life, and carbon benefits (e.g. from modal shift (such as shifting from cars to trains) and loads (such as journeys by car to a station served by HS2) beyond the Proposed Scheme's boundary.

Baseline

8.4.3 The existing and future environmental baselines for the Proposed Scheme are based on a 'without the Proposed Scheme' scenario (i.e. the Proposed Scheme is not built) and there are no associated carbon emissions.

Methodology

8.4.4 The GHG assessment takes a life cycle assessment (LCA) approach consistent with the principles set out in BS EN 15978[128] , BS EN 15804[129], PAS 2080[130], IEMA[131] and RICS[132] standards, which is detailed in the EIA SMR. The GHG emissions associated with the construction and operation of the Proposed Scheme will be reported in the formal ES in the form of the 'carbon footprint' - reported in tonnes of carbon dioxide equivalent (tCO_2e).

Assumptions and limitations

8.4.5 Assumptions and limitations to the in-combination climate change impacts assessment will be presented in the formal ES.

In-combination climate change impacts assessment

Scope

8.4.6 The in-combination climate change impacts assessment covers all environmental topics assessed as part of the EIA.

8.4.7 The spatial scope of the in-combination climate change impacts assessment covers the entire Phase 2b route, comprising the 28 community areas along the route of the Proposed Scheme and the distances either side of the Proposed Scheme within which other topics are undertaking their own assessments of effects.

[128] British Standard (2011). Sustainability of Construction Works – Assessment of environmental performance of buildings – Calculation method, BSI Limited, London, UK.
[129] British Standard (2012). Sustainability of Construction Works – Environmental Products Declarations. Core Rules for the product category of construction products, BSI Limited, London, UK
[130] Construction Leadership Council & the Green Construction Board (2016). PAS 2080: 2016: Carbon Management in Infrastructure, BSI Limited, London, UK.
[131] IEMA (2017). *Assessing Greenhouse Gas Emissions and Evaluating their Significance*. Available online at: https://www.iema.net/assets/uploads/Webinar%20presentations/20170517%20KS.pdf
[132] RICS (2017). *Whole life carbon assessment for the built environment*. Available online at: http://www.rics.org/Global/Whole_life_carbon_assessment_for_the_BE_PGguidance_2017.pdf

8.4.8 The temporal scope of the in-combination climate change impacts assessment includes effects for the '2020s' (construction including commissioning) and the '2080s'[133] (operation), based on available climate projections for the UK.

Baseline

8.4.9 The in-combination climate change impacts assessment will be informed by UKCP18, due for publication in November 2018. The format of the current and future climate baselines used for the assessment reported in the formal ES will be determined by the structure of the UKCP18 outputs. In case of any unforeseen delay in the publication of UKCP18 outputs, the assessment will be undertaken based on current and future climate baselines informed by UKCP09[134], which is the most recent set of climate projections for the UK at the time of writing.

Methodology

8.4.10 The approach to the in-combination climate change impacts assessment is informed by good practice and guidance including that from the European Commission, the Institute of Environmental Management and Assessment (IEMA)[135], and topic specific guidance published by the Food and Agriculture Organisation[136,137], Woodland Trust[138], the Forestry Commission[139], the Landscape Institute[140], the Health Protection Agency (now known as Public Health England)[141] and Defra[142].

8.4.11 Potential climate change impacts and effects are considered at the route-wide level for all topics and community areas. This initial in-combination climate change impact assessment then identifies EIA topics to be included for a more detailed assessment. This more detailed assessment determines whether there are any significant in-combination effects to report. The conclusions of this assessment will be reported in the formal ES.

Assumptions and limitations

8.4.12 Assumptions and limitations to the in-combination climate change impacts assessment will be presented in the formal ES.

---

[133] The '2020s' refers to the period between 2010 and 2039. The '2080s' refer to the period between 2070 and 2099.
[134] UKCP09 (2009). UKCP09 Climate Change Projections Report. Available online at: http://ukclimateprojections.metoffice.gov.uk/media.jsp?mediaid=87894&filetype=pdf
[135] IEMA (2015). IEMA guide to climate change resilience and adaptation. Available online at: https://www.iema.net/assets/templates/documents/iema_guidance_documents_eia_climate_change_resilience_and_adaptation%20(1).pdf
[136] Food and Agriculture Organization of the United Nations (2013). *Climate-smart agriculture sourcebook*. Available online at: http://www.fao.org/docrep/018/i3325e/i3325e.pdf
[137] Food and Agriculture Organization of the United Nations (2013). *Climate change guidelines for forest managers*. Available online at: http://www.fao.org/docrep/018/i3383e/i3383e.pdf
[138] Woodland Trust (2015). *Climate change - the Woodland Trust's position*. Available online at: https://www.woodlandtrust.org.uk/publications/2015/06/climate-change
[139] Forestry Commission (2016). *Forests and climate change*. Available online at: https://www.forestry.gov.uk/climatechangeengland
[140] Landscape Institute (2008). Landscape architecture and the challenge of climate change. Available online at: http://www.landscapeinstitute.org/PDF/Contribute/LIClimateChangePositionStatement.pdf
[141] Health Protection Agency (2012). *Health Effects of Climate Change in the UK*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/371103/Health_Effects_of_Climate_Change_in_the_UK_2012_V13_with_cover_accessible.pdf
[142] Defra (2011). Biodiveristy 2020: A Strategy for England's wildlife and ecosystem services. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69446/pb13583-biodiversity-strategy-2020-111111.pdf

Climate change resilience assessment

Scope

8.4.13 The technical scope of the climate change resilience assessment covers risks for infrastructure and assets that are part of the Proposed Scheme, associated with a range of climate parameters, including high rainfall, low rainfall, high temperature, low temperature, wind, fog, lightning and humidity.

8.4.14 The spatial scope of the climate change resilience assessment covers the entire Proposed Scheme.

8.4.15 The temporal scope of the climate change resilience includes the '2020s' (construction including commissioning) and the '2080s'[143] (operation), based on available climate projections for the UK.

Baseline

8.4.16 The baseline for the climate change resilience assessment is the same as that for the in-combination climate change impacts assessment.

Methodology

8.4.17 The approach to the climate change resilience assessment is informed by good practice and guidance including that from the European Commission[144] and IEMA. Additionally, the assessment will take into consideration relevant literature, including relevant reports submitted under the UK Adaptation Reporting Power in the first and second rounds of reporting[145], as well as reports by RSSB[146] and the Cabinet Office, amongst others.

8.4.18 The climate change resilience assessment is considered at a route-wide level and includes relevant assets associated with the Proposed Scheme. It is based on a high level climate change risk assessment, which uses projections of changes in climate averages and extreme weather events to qualitatively assess the impacts of climate change on the Proposed Scheme using professional expertise and judgement. The conclusions of this assessment will be reported in the formal ES.

Assumptions and limitations

8.4.19 Assumptions and limitations to the climate change resilience assessment will be presented in the formal ES.

8.5 Community

Scope

8.5.1 The community assessment addresses the likely effects on residential properties (and their occupants), community facilities, including recreational facilities, open space and

[143] The '2020s' refers to the period between 2010 and 2039. The '2080s' refer to the period between 2070 and 2099.
[144] European Commission (2013). Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment. Available online at: http://ec.europa.eu/environment/eia/pdf/EIA%20Guidance.pdf
[145] Defra (2017). *Climate change adaptation reporting: second round reports.* Available at: https://www.gov.uk/government/collections/climate-change-adaptation-reporting-second-round-reports
[146] RSSB (2016). *Tomorrow's Railway and Climate Change Adaptation*. Available online at: https://www.rssb.co.uk/Library/research-development-and-innovation/2016-05-t1009-exec-report.pdf

promoted PRoW (and their users) and communities as a whole. Effects may result from:

- a loss or gain as a result of the land required for the construction or operation of the Proposed Scheme;
- displacement from re-location of receptors and resources;
- isolation as a consequence of barriers (physical, psychological and social) that communities would face resulting from construction or operation of the Proposed Scheme;
- in-combination effects relating to a change in the amenity value of community resources, as a consequence of a combination of factors (noise and vibration, HGV traffic, air quality and visual effects); and
- the temporary presence of construction workers and their demands on community facilities.

8.5.2 All significant community effects identified at this stage of the design and assessment are reported. Non-significant effects that are considered to be of importance in the study area are also reported in Volume 2: Community area reports.

Baseline

8.5.3 Information is being collected on the current location and use of community resources. Sources of information include:

- data collected during preparation of the 2016 Sustainability Statement, supplemented and updated as appropriate;
- published sources such as Census data and Office for National Statistics – Neighbourhood Statistics;
- existing local studies and information on community resources such as public open space;
- analysis and data from other relevant assessment topics; and
- new field surveys where appropriate, for example, relating to the condition of publicly accessible open spaces and recreational routes.

8.5.4 Community resources are described 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 described.

Methodology

8.5.5 There are no industry-wide accepted methods for assessing community effects. The method that has been developed for predicting and assessing effects draws on existing guidance, analysis and methods established for other large infrastructure projects, including Phase One and Phase 2a of HS2.

8.5.6 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 value).

8.5.7 The community assessment is largely based on qualitative information. However, relevant quantitative inputs have been used wherever possible (e.g. numbers of properties affected or percentage of open space displaced by land required for construction and/or operation). Opportunities to mitigate community effects are being identified during the course of the Proposed Scheme development and consultation. Where replacement open space or other land would be provided as part of the Proposed Scheme, this would be assessed and reported in the formal ES.

8.5.8 The assessment reported in the formal ES will draw on other topics for the assessment of in-combination effects. This will take into account the significant residual effects reported by other topics (e.g. sound, noise and vibration, air quality, landscape and visual and traffic and transport) and professional judgement about the sensitivity of the resource and receptors.

8.5.9 The spatial scope of the assessment varies, depending on the nature of the receptors and the impacts being considered. The effects of construction on the land used for construction and/or operation are confined to the immediate vicinity of the route. Effects resulting from a combination of effects or relating to the overall functionality of a community will typically apply to wider areas such as neighbourhoods or whole settlements.

Assumptions and limitations

8.5.10 Key assumptions underlying the assessment include the following:

- the baseline characteristics established during the EIA process would remain largely unchanged;
- the different assessments within the community section (e.g. isolation and in combination effects) are not directly comparable in terms of determining significance of effect. Assessments will be considered in aggregate as part of the community-wide analysis that is reported in the formal ES;
- the assessments consider the function of land rather than its ownership as the key parameter for assessing impacts associated with the Proposed Scheme;
- where practicable, land required solely during the construction period would be returned to its previous use after construction unless that use cannot continue or resume within a reduced area. Where the use cannot resume, the effect is treated as permanent;
- effects relating to the severance of PRoW and highway and pedestrian diversions, are assessed as part of the traffic and transport topic. However, where PRoW and other routes are 'promoted' destinations 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 condition surveys, where it has been possible to undertake such surveys;

- where reasonably practicable, public footpaths and routes would be reinstated or convenient alternatives provided. HS2 Ltd would seek to provide a temporary or permanent alternative route in advance of a closure of a road or PRoW. No significant effects on these routes are likely once the mitigation measures have been implemented. Alternative temporary routes have not been defined in all cases at the current stage in the design of the Proposed Scheme. Where this is the case they will be assessed and reported in the formal ES;
- for the working draft ES, the full details of construction traffic routes and geographical scope of likely in-combination (amenity) effects are not yet known. In the formal ES, the study area and associated baseline of community resources will be updated to take account of these;
- at this stage it has not been possible to complete surveys of public open spaces in this area. For the working draft ES an assumption has been made about the level of sensitivity on a case by case basis. This will be adjusted, as appropriate, on the basis of survey results to inform the formal ES; and
- open space that is privately owned and not available for use by the general public (e.g. woodlands on farmland) has been excluded from the assessment. However, land that is privately owned but open for public use (e.g. parks or gardens surrounding country houses) has been included in the assessment.

8.5.11 For the assessment of in-combination operational effects, the assessment will be based on the first year of operation (2033) with the exception of noise, which will be based upon the service frequency associated with all of Phase Two (Phase 2a and Phase 2b) operating.

8.6 Ecology and biodiversity

8.6.1 The ecological impact assessment considers all ecological receptors that 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 and fragmentation, severance of ecological corridors and networks, noise and visual disturbance (including disturbance from lighting), barrier effects to movement of fauna, changes in water quality and quantity, air pollution, and wildlife mortality due to passing trains.

8.6.2 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 working draft ES.

8.6.3 The spatial scope of the assessment depends on the ecological receptor under consideration and the magnitude and nature of the potential impacts. It 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 EIA SMR.

Baseline

8.6.4 Existing biological data for the Proposed Scheme is being obtained from relevant Local Biological Records Centres and from national and local specialist data sources, such as barn owl groups. National and local biodiversity action plans and ancient woodland inventories are also being consulted. The geographic extents of search areas varies, based on the likely value and mobility of the receptor involved.

8.6.5 A wide range of field surveys are being conducted to inform the working draft and formal ES. The survey methodologies used have been based on recognised best practice.

Methodology

8.6.6 The ecological impact assessment has taken account of the guidance published by the Chartered Institute of Ecology and Environmental Management (CIEEM)[147].

8.6.7 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: Community area reports in relation to nationally and internationally designated sites and European protected species. Potential cumulative and in-combination effects of multiple local/parish level effects are addressed in Volume 3: Route-wide effects.

8.6.8 In line with the CIEEM guidance, the evaluation of species receptors has been based on the distribution and status of the species concerned, rather than being based solely on the legal protection afforded to that species.

Assumptions and limitations

8.6.9 A precautionary approach to valuation has been used for instances where baseline information is incomplete, to ensure that all likely significant effects of the Proposed Scheme have been identified. Precautionary valuations have been based on all available information. These valuations are based on a consideration of available desk study data (including aerial photography and information from stakeholders), 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.

8.6.10 The ecological assessment of off-route effects will be based largely on information available from existing sources, recognising the constraints of such an approach. These effects will be reported in the Volume 4: Off-route effects report of the formal ES.

[147] Chartered Institute of Ecology and Environmental Management (2016). *Guidelines for Ecological Impact Assessment in the UK and Ireland – Terrestrial, Freshwater and Coastal*. Available online at: https://www.cieem.net/data/files/Publications/EcIA_Guidelines_Terrestrial_Freshwater_and_Coastal_Jan_2016.pdf

8.6.11 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 would be lost except for areas included only for the purpose of ecological enhancement[148];
- all construction activity would occur concurrently across the entire length of the Proposed Scheme and would start at the beginning of the construction period – a worst-case scenario;
- by the time the Proposed Scheme is operational, otter would be present in all watercourses suitable for the species;
- the nominated undertaker would ensure that ongoing management of all mitigation and compensatory habitat is provided, either directly or through suitable legal and financial agreements with third parties; and
- the nominated undertaker would commit to monitoring habitats and species to ensure that predictions of effects are accurate and that mitigation/compensation is successful.

8.7 Health

Scope

8.7.1 The assessment of the impact of the Proposed Scheme on health is introduced as a result of Directive 2014/52/EU and the 2017 EIA Regulations. The definition of health used in the assessment follows that of the World Health Organization, which describes health as 'a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity'. Potential health effects have been identified based on information that is available at this stage of the assessment. A full assessment of health effects, applying the assessment criteria set out in the SMR, will be provided in the formal ES.

8.7.2 The health status of a population is governed, in part, by a wide range of environmental, social and economic determinants. The Proposed Scheme would have the potential to impact on a number of health determinants, which in turn would affect health and wellbeing. Health effects are assessed at local (community area) or route-wide level, depending on the nature of the health determinant, as described in the following paragraphs.

8.7.3 The health effects resulting from impacts on the following determinants are assessed at local (community area) level, and are reported in Volume 2: Community area reports:

- impacts on neighbourhood quality (impacts on the physical environment in

[148] The re-instatement and landscaping of these areas on completion of construction are considered as part of the proposed 'other mitigation measures, described in the Volume 2: Community area reports. 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.

neighbourhoods along the route such as noise and visual impacts);

- impacts on access to services, health and social care, resulting from direct loss of services and facilities, impacts on the amenity of facilities, and changes to accessibility due to traffic and transport impacts;
- access to green space, recreation and physical activity, resulting from direct (loss) or indirect (amenity, access) impacts on green space, sport and leisure facilities, and impacts on non-motorised road users;
- direct (loss) or indirect (amenity, access) impacts on places of education; and
- impacts on social capital resulting from community severance, direct impacts on community spaces, and the presence of the construction workforce.

8.7.4 The health effects resulting from impacts on the following determinants are assessed at a route-wide level, because of their diffuse geographical nature or, in some cases, because it is only meaningful to report the health effects for a large population. These effects which are considered in Volume 3: Route-wide effects are:

- employment and income;
- housing;
- transport (traveller stress and road safety);
- planning blight and stress; and
- sound, noise and vibration (railway noise).

8.7.5 Health assessment is a multi-disciplinary activity that cuts across the boundaries of health, public health, social sciences and environmental sciences. Many of the potential impacts on health determinants are described elsewhere in the working draft ES and the assessment of health effects has drawn on this analysis in an integrated process.

8.7.6 The study area for the assessment of health and wellbeing effects is aligned with the study areas for related environmental topics, where relevant.

Baseline

8.7.7 Baseline data are being collected from a variety of publically available online sources including Office for National Statistics (ONS) and English Indices of Deprivation (2015). The data are being used to construct a community health profile, which provides an overview of the prevailing socio-economic and health status of the population. The analysis of data includes the identification of vulnerable sub-groups that may be particularly sensitive to health and wellbeing effects.

Methodology

8.7.8 Impacts on health determinants have been assessed using a set of criteria to describe the nature of an impact, its intensity, and the size of the population exposed. This approach has been informed by available guidance and precedent from other large scale health assessments. The assessment criteria and methodology were reviewed during the process of engagement with stakeholders in the health sector.

8.7.9 The assessment of health effects is based on a review of scientific evidence linking impacts on determinants with health outcomes. Most health effects cannot be quantified, since either there are currently no robust or scientifically widely agreed upon methods for doing so, or because the types of data required cannot realistically be obtained. Therefore, the assessment is largely qualitative in its description of health effects.

Assumptions and limitations

8.7.10 Over the timescale of the Proposed Scheme's delivery, the profile of affected communities will change, influenced by wider social, economic and health policy and demographic trends. The likely future community profile will be considered in the formal ES in instances where data and forecasts are available. It will be necessary, for assessment purposes, to assume that the baseline characteristics established during the health assessment process will remain largely unchanged where such data and forecasts were unavailable.

8.7.11 The community profiles are informed by publicly available data and consultation and stakeholder engagement.

8.7.12 Potential health effects have been identified based on information that is available at this stage of the assessment. A full assessment of health effects, applying the assessment criteria set out in the EIA SMR, will be provided in the formal ES.

8.7.13 The assessment is supported by a review of published research relating to each of the identified health determinants, using the most up to date and credible sources. The evidence for health effects ranges from strong, where this is well supported by research evidence, to weak, where evidence is sparse or conflicting. Consequently, professional judgement is necessary to assess the likely health effects.

8.8 Historic environment

Scope

8.8.1 Impacts on the following types of heritage asset are being assessed as part of the EIA:

- archaeological and palaeo-environmental remains[149] including geological deposits that may contain evidence of the human past;
- historic landscapes; and
- historic buildings and the historic built environment.

8.8.2 Designated and non-designated heritage assets are being assessed. Effects arising from both construction and operation of the Proposed Scheme are being considered (e.g. effects arising from the requirement for land during construction or from effects arising from development within the setting of heritage assets).

8.8.3 The study area for the assessment of heritage assets consists of the land required for construction (both temporary and permanent), plus 500m on either side in rural areas

[149] The organic remains of plants, animals and sediments which are studied in order to examine past environments and human interaction with past environments.

and 250m in urban areas. The study area for data gathering to identify impacts upon designated heritage assets, and to understand the historic landscape, is 2km either side of the land required in rural areas and urban areas.

8.8.4 The study area for designated and non-designated assets in the vicinity of bored and mined tunnels is 100m either side of the extent of tunnelling to allow for an assessment of the potential effects of ground movement (settlement) on heritage assets.

8.8.5 The 2km study area has taken account of the zone of theoretical visibility (ZTV), as described in Section 8.10. Professional judgement has been used to determine the extent to which assets within the 2km study area require detailed assessment of effects.

Baseline

8.8.6 Information about heritage assets is being obtained from a range of sources, including:

- the National Heritage List for England held by Historic England (the register of designated heritage assets);
- historic environment records;
- historic landscape characterisation;
- conservation area appraisals; and
- historic maps and aerial photography.

8.8.7 Information is also being gathered from specific surveys and research such as:

- LiDAR surveys;
- site visits; and
- non-intrusive surveys (surface artefact collection and geophysical surveys).

8.8.8 Survey work is being discussed with Historic England and local authority archaeologists on a case-by-case basis.

8.8.9 Surveys to confirm or update the historic environment baseline from that presented in the working draft ES would be required prior to construction. It is assumed that access would be available for these surveys and that the programme of investigation and recording would apply to these works.

Methodology

8.8.10 There is no national guidance on the methodology for assessment of impacts on the historic environment and heritage assets. However, DMRB Volume 11 (Environmental Assessment) provides an approach to highway schemes and is of some relevance to the historic environment assessment of the Proposed Scheme. Also pertinent is the guidance on heritage impact assessments for Cultural World Heritage Properties

(International Council on Monuments and Sites)[150], and a range of guidance notes from Historic England. These existing methodologies and guides have been considered during the development of the assessment methodology for the historic environment topic.

8.8.11 The NPPF requires that impacts on heritage assets are assessed in relation to the significance of the asset. Heritage significance is defined in the glossary to the NPPF as 'the value of a heritage asset to this and future generations because of its heritage interest; that interest may be archaeological, architectural, artistic or historic.' Significance (value) derives not only from a heritage asset's physical presence, but also from its setting.

8.8.12 The assessment of the significance of effects is determined by cross referencing the significance (value) of the asset and the type and magnitude of impact, such as whether construction and/or operation of the Proposed Scheme would entail the removal of the heritage asset or change to its setting. Appropriate mitigation measures have been identified and taken into account.

Assumptions and limitations

8.8.13 Heritage assets within the land required to construct the Proposed Scheme are assumed to require complete removal and the assessment has been undertaken on that basis, unless otherwise stated.

8.8.14 No site-specific intrusive site investigations have been undertaken as part of the baseline data collection. Intrusive investigations would be undertaken at the pre-construction stage or later.

8.8.15 The assessment of impacts takes account of mitigation measures such as noise fence barriers, landscaping and planting. During the construction phase it is assumed mitigation measures would be in accordance with the draft CoCP.

8.8.16 Other assumptions and limitations of the historic environment impact assessment include:

- heritage data from local lists held and maintained by the local planning authorities has only been obtained where data is publicly accessible for the working draft ES. It is anticipated that comprehensive data will be available for the formal ES;
- field surveys are ongoing, and are subject to land access and site conditions. The result of field surveys will be included as part of the formal ES;
- desk-based assessment is ongoing and data on non-designated heritage assets will be described more fully in the formal ES;
- intra-project topic assessments are ongoing and will be considered as part of the assessment of historic environment effects as part of the formal ES;

[150] International Council on Monuments and Sites (ICOMOS) (2011). *Guidance on Heritage Impact Assessments for Cultural World Heritage Properties.* Available online at: https://www.icomos.org/world_heritage/HIA_20110201.pdf

- with respect to overhead power line diversions/realignments, it is likely that the majority of the heritage assets can be retained, as the land is only required to allow for raising or lowering of pylons and/or re-stringing of cables, or to provide an access route to the works;
- common features of the historic landscape such as marl pits, field boundaries and former areas of ridge and furrow are not individually considered but have been included in the baseline, as part of the historic landscape character and will be considered as part of the overall assessment of impacts on historic landscape reported in the formal ES; and
- planting as a means of softening setting effects on heritage assets would not be fully effective until maturity.

8.9 Land quality

Scope

8.9.1 The main potential for impacts would occur during the construction phase, from disturbance of pre-existing contamination. Operational sources are also being considered (e.g. leaks or spillages within the Staveley IMD from line-side equipment or from trains). The assessment also includes consideration of any areas of geological significance, such as geological site of special scientific interest (SSSI), local geological sites (LGS) and mineral resources.

8.9.2 Potentially contaminated sites have been identified within the footprint of the Proposed Scheme and within 250m of the boundary of the land required for the construction of the Proposed Scheme. The 250m zone has been widened where evidence suggests that it is required; for example where a potentially contaminated site lies just beyond, or straddles, the boundary. The assessment of groundwater abstractions as receptors extends to 1km from the boundary of the land required for the construction of the Proposed Scheme.

8.9.3 Consideration has also been given to the possibility of disturbance to contamination, resulting in impacts at greater distances from the route (e.g. via pathways such as watercourses or aquifers), where appropriate.

8.9.4 Land contamination issues are closely linked with those involving waste and water resources. Issues regarding waste are addressed in Section 8.15 (Waste and material resources) of this document and Volume 3: Route-wide effects, Section 15 (Waste and material resources). Issues regarding groundwater resources that are not related to land contamination are addressed in Section 8.16 (Water resources and flood risk) of this document.

8.9.5 The route of the Proposed Scheme would intercept mining and mineral resources, including both deep and opencast coal mining, sand and gravel extraction, building stone and aggregate production from quarries, and the exploitation of other identified geological materials (e.g. salt, brine, hydrocarbons and coal bed methane). Where these resources would be impacted by the Proposed Scheme, they are dealt with in the context of their value as an asset.

Baseline

8.9.6 Baseline information has been obtained from desktop sources, site visits and where available, previous ground investigations. Desktop sources include published geological/hydrogeological mapping, information from the Environment Agency, the Coal Authority and other organisations (particularly for existing and historical landfill and mining sites), historical mapping, and local authority data. Site visits have been targeted at locations where a greater potential for current or historical contamination has been identified, where geological sites have been identified or where significant mineral resources are present and where mining and hydrocarbon extraction activities are concentrated.

Methodology

8.9.7 For the contaminated land assessment, a conceptual site model (CSM) and risk assessment approach has been used, in line with the Environment Agency guidance document CLR 11[151]. The CSM model provides an initial understanding of the types of contaminants that may be present, the receptors (i.e. people, buildings and the wider environment) that may be affected and the likely pathways by which contaminants can impact receptors.

8.9.8 This contaminant/pathway/receptor model is being used to assess the potential for pre-existing contamination to cause a risk of impact on defined receptors at each location, for the period prior to, during and following construction (once remediation has been carried out). The significance of effects is derived from the change in level of risk, taking account of the sensitivity of the receptor.

8.9.9 The remediation of existing contamination, as part of the construction works, would usually be regarded as beneficial.

8.9.10 The methods for assessment of the significance of effects arising from the Proposed Scheme on geological sites and mining/mineral resources are set out in the EIA SMR. The mineral assessments will take into account the degree of impact that the construction activities may have on such sites, their sensitivity and importance.

Assumptions and limitations

8.9.11 No site-specific intrusive site investigations are being undertaken as part of the baseline data collection. Intrusive investigations would be undertaken during the detailed design process to provide contamination data for risk assessments, and where necessary, for detailed remediation design.

8.9.12 The minerals assessment is based upon the mineral resources identified on published minerals plans, and existing planning or licensed areas. Any inference of minerals provided by geological maps/reports is excluded (except where these are covered by the relevant minerals plans).

8.9.13 The geo-conservation assessment is based upon publicly available local authority and publicly available local geological trust records.

---

[151] Environment Agency (2004). *Model Procedures for the Management of Land Contamination CLR 11.* Available online at: http://webarchive.nationalarchives.gov.uk/20140328160926/http://cdn.environment-agency.gov.uk/scho0804bibr-e-e.pdf

8.9.14 The majority of new and diverted utilities would be laid in the boundaries of existing highways within normal road construction layers and natural soils below. These have been considered in the context of the CSM approach, and the lack of contact with nearby potentially contaminated sites, and the absence of sensitive receptors within the roadways reduces the risk of an impact occurring to very low levels. The impact of laying these new and diverted utilities has therefore been scoped out of the assessment as they are unlikely to cause any significant land quality effects.

8.10 Landscape and visual

Scope

8.10.1 The assessment includes consideration of the effects on landscape and on visual receptors within the study area. The landscape and visual assessment is being undertaken for the following years:

- construction – an assessment of landscape effects;
- construction – an assessment of visual effects in winter during the peak period[152] of the construction phase;
- operation – an assessment of visual effects in winter and summer[153] during operation year 1;
- operation – an assessment of visual effects in summer during operation year 15, once any vegetation planted as part of the Proposed Scheme has matured further or has achieved its design intention; and
- operation – an assessment of landscape effects at both year 1 and year 15.

8.10.2 The landscape assessment does not consider seasonal variations e.g. winter/summer, since these do not affect character.

8.10.3 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, including effects on the setting of heritage assets. The ZTV have been produced in line with the methodology described in the EIA SMR and are an indication of the extent of theoretical visibility of the Proposed Scheme. In some locations, extensive vegetation cover would mean the actual extent of visibility is substantially less than that shown in the ZTV, and professional judgement will be used to further refine the study area to focus on likely significant effects.

8.10.4 The Guidelines for Landscape and Visual Impact Assessment (GLVIA) third edition states that ZTV mapping should 'assume that the observer eye height is some 1.5 to 1.7 metres about ground level, based on the midpoint of average heights for men and

[152] The period during which the main construction works will take place, including the establishment of compounds, main earthworks and structure works.
[153] It should be noted that seasonal distinctions are only drawn for the visual component of the assessment and not for the assessment in relation to landscape character

women'. As set out in the EIA SMR, a datum of 1.6m above ground level has been used for the ZTV mapping to represent the eye level view of an average height person. The ZTV takes account of the following factors:

- the existing topography;
- existing buildings, excluding any that would be demolished as part of the construction of the Proposed Scheme; and
- existing tree cover, excluding any trees that would be removed as part of the construction of the Proposed Scheme.

8.10.5 Thin bands of trees narrower than 10m are excluded as, during winter, these would provide only minimal screening.

8.10.6 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 of the Proposed Scheme, in compounds, at tunnel portals, cut-and-cover tunnels, road diversions and any other known works;
- temporary fencing and hoarding;
- temporary stockpiling of materials;
- welfare facilities and storage;
- structures being demolished; and
- new permanent structures under construction.

8.10.7 Very tall construction plant (e.g. cranes) is excluded from the ZTV, since they rarely give rise to significant effects if they are the only elements visible.

8.10.8 The ZTV for the operation phase shows the visibility of the permanent structures, including:

- stations and depots;
- road/pedestrian diversions;
- bridges and viaducts; and
- fencing and noise fence barriers.

8.10.9 The overhead line equipment is excluded from the model on the basis that this rarely gives rise to significant effects if it is the only element visible.

8.10.10 The ZTV for year 15 of operation (2048) will illustrate how planting proposed along the route would reduce visibility of the Proposed Scheme.

8.10.11 Landscape and visual receptors within 1.5km of the route of the Proposed Scheme have been considered. However, this study area varies 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 or from elevated locations).

Baseline

8.10.12 Baseline information is being obtained from a combination of desktop research and fieldwork. Desktop sources include published landscape character assessments (national, county and local authority level landscape character assessments), and a wide range of supporting GIS data, aerial photography and Ordnance Survey mapping, plus desk study and fieldwork.

8.10.13 Published LCAs have been adapted for this assessment, as appropriate, to provide LCAs of an appropriate and consistent scale. The LCAs have been determined as part of an integrated process of environmental characterisation, informed by a review of historic landscape mapping and the outcome from other topics including ecological assessments. These LCAs will be refined upon review of historic landscape characterisation data and will be reviewed in consultation with LPAs.

8.10.14 Fieldwork is also being used to identify and verify visual receptors. Fieldwork is being undertaken in both summer and winter to capture best and worst case visibility.

Methodology

8.10.15 The assessment methodology has been designed to ensure an integrated and iterative process of assessment and design, to directly inform landscape design outcomes for the Proposed Scheme, in line with the objectives of the HS2 Design Vision and the Landscape Design Approach. The methodology has taken account of relevant guidance such as the Landscape Institute's Guidelines for Landscape and Visual Impact Assessment (3rd edition)[154] . The value of each LCA and its susceptibility to change resulting from the Proposed Scheme has been assessed, from which an evaluation of overall landscape sensitivity has been made. The significance of landscape effects are derived from the interaction between the magnitude of change (e.g. duration, geographic extent and reversibility or otherwise of effect, considering among other factors the extent of the land required for construction and/or operation or loss of features within a character area, plus introduction of new features) and the sensitivity of the landscape.

8.10.16 Engagement with the competent authorities is being undertaken and will continue as the design of the Proposed Scheme progresses. The purpose of this engagement is to discuss the assessment methodology, the extent of the landscape and visual study area, and the locations of visual assessment and verifiable photomontage viewpoints.

8.10.17 The significance of visual effects are derived from the interaction between the magnitude of change to these views and the susceptibility and sensitivity of receptors to the visual change. View value is also captured to inform the assessment. Impacts on selected views will be illustrated by preparing verified photomontages from locations agreed with the competent authorities for the formal ES. The focus for photomontage selection has been on complex aspects of the design where a photomontage would aid the assessment, or where level of effect is borderline between significant and non-significant.

[154] Landscape Institute and Institute of Environmental Management and Assessment, Guidelines for Landscape and Visual Impact Assessment, 2013, 3rd Edition

Assumptions and limitations

8.10.18 Assumptions necessary to undertake the landscape and visual assessment are set out in the EIA SMR and in individual sections of the Volume 2: Community area reports. They are summarised in the following paragraphs.

8.10.19 The landscape and visual assessments have been based on professional judgement and take into account both the adverse and beneficial contribution that new development can have upon the existing landscape character and on the visual amenity of receptors.

8.10.20 All baseline surveys are being carried out on publicly accessible land and in line with industry accepted guidance. In instances where site access is not available from publicly accessible land, professional judgement is used to approximate and record the likely views and visual effects from these locations.

8.10.21 The extent of the study area has been informed by the construction and operational phase ZTV. The ZTV have been produced in line with the methodology described in the EIA SMR, and are an indication of the theoretical visibility of the Proposed Scheme. In some locations, extensive vegetation cover means the actual extent of visibility is substantially less than that shown in the ZTV, and professional judgement will be used to further refine the study area to focus on likely significant effects.

8.10.22 Landscape and visual receptors within approximately 1.5km of route of the Proposed Scheme have been assessed as part of the study area. Long distance views of up to 2km have also been considered at settlement edges in certain areas.

8.10.23 Tall construction plant (for example cranes and piling rigs) is excluded from the ZTV for the construction phase, as there is a great degree of variability in the extent and timeframes of visibility of construction activity and plant. Overhead line equipment rarely gives rise to significant effects if it is the only element visible and has, therefore been excluded from the ZTV to give a better indication of the possible spread of significant effects to aid the assessment.

8.10.24 Summer surveys for the landscape and visual assessment were undertaken from July to September 2017 and winter surveys were undertaken from November 2017 to March 2018. Further surveys will be undertaken to inform the assessment and will be reported in the formal ES. At this stage it has not been possible to complete surveys of all publicly accessible land along the route of the Proposed Scheme; therefore, for the working draft ES assumptions have been made about the level of sensitivity and magnitude of change on a case by case basis. These will be adjusted, as appropriate, on the basis of survey results to inform the formal ES.

8.10.25 This assessment is based on preliminary design information and makes reasonable worst case assumptions on the nature of potentially significant effects where these can be substantiated. It is based on information known at present.

8.11 Major accidents and disasters

Scope

8.11.1 The assessment of the vulnerability of the Proposed Scheme to major accidents and disasters is introduced as a result of Directive 2014/52/EU and the Town and Country

Planning (EIA) Regulations 2017. The EIA Regulations require an EIA to include an assessment of 'the expected significant adverse effects of the development on the environment deriving from the vulnerability of the development to risks of major accidents and/or disasters which are relevant to the project concerned'.

8.11.2 For the purposes of this assessment, vulnerability is defined as the 'exposure and resilience' of the Proposed Scheme to the risk of a major accident and/or disaster. A risk is defined as the likelihood of an impact occurring, combined with effect or consequence(s) of the impact on a receptor if it does occur.

8.11.3 Major accidents, in the context of the Proposed Scheme, are events that threaten immediate or delayed serious damage to human health, welfare and/or the environment, and requires the use of resources beyond those of HS2 Ltd or its contractors. Serious damage includes the loss of life or permanent injury and/or permanent or long-lasting damage to an environmental receptor that cannot be restored through minor clean-up and restoration efforts.

8.11.4 A disaster, in the context of the Proposed Scheme, is a naturally occurring phenomenon such as an extreme weather event (e.g. storm, flood, temperature) or ground-related hazard events (e.g. subsidence, landslide, earthquake) with the potential to cause an event that meets the definition of a major accident.

8.11.5 The assessment of 'significant adverse effects' includes consideration of all factors identified in the EIA Regulations (i.e. population and human health, biodiversity, land, soil, water, air, climate, material assets, cultural heritage and landscape).

8.11.6 The scope of this assessment follows that set out in the EIA SMR and addresses those unplanned events that have been determined as being relevant to the Proposed Scheme, and are low likelihood but potentially high consequence with the potential to result in a significant adverse environmental effect. For the Proposed Scheme, a significant adverse effect is considered to mean the loss of life or permanent injury, and/or permanent or long-lasting damage to an environmental receptor.

Baseline

8.11.7 The baseline relevant to this topic comprises:

- features external to the Proposed Scheme that contribute a potential source of hazard to the Proposed Scheme;
- sensitive environmental receptors at risk of significant effect; and
- a review of existing risk assessments.

Methodology

8.11.8 The assessment requires interaction with other assessment topics, in particular climate change, community, ecology and biodiversity, health, socio-economics, traffic and transport, and water resources and flood risk.

8.11.9 The assessment is being undertaken with reference to the regulatory requirements, legislation and design standards in place for the construction and operation of the Proposed Scheme.

8.11.10 The baseline for the assessment considers the regulatory requirements in place and does not reproduce for example the safety risk assessment that must be in place for the licence to use and operate the railway under the Common Safety Method for Risk Evaluation and Assessment (CSM-RA)[155].

8.11.11 The framework for the environmental risk assessment follows a standard source pathway-receptor approach, where sources (accidents and disasters) are based on existing risk assessments, and receptors include:

- members of the public and local communities;
- infrastructure and the built environment;
- the natural environment, including ecosystems, land and soil quality, air quality, surface and groundwater resources and landscape; and
- the historic environment, including archaeology and built heritage.

Assumptions and limitations

8.11.12 Key assumptions for the major accidents and disasters assessment are:

- the Proposed Scheme would not carry freight;
- there would be no level crossings included as part of the Proposed Scheme design; and
- only those hazardous events with a feasible source-pathway-receptor model are considered.

8.12 Socio-economics

Scope

8.12.1 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 community area within Volume 2. Wider economic benefits are reported within Volume 3: Route-wide effects.

8.12.2 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 included consideration of effects arising during the construction and operation phases.

8.12.3 The route-wide assessment considers effects resulting from land required for construction and/or operation, in-combination effects (e.g. as a consequence of the combination of significant residual effects from air quality, noise and vibration, visual impacts or construction traffic) and isolation effects on existing businesses and

[155] European Commission (2013). *EU Regulation 402/2013 (as amended) on the common safety method for risk evaluation and assessment and repealing Regulation* (EC) No 352/2009.

organisations, together with potential opportunities for construction and operational employment. The in-combination effects assessment will be reported in the formal ES.

Baseline

8.12.4 Baseline information is being obtained for a series of areas representative of the local economy where data is readily available. These relate to the areas across which economic functions and data can be readily understood. Data are being collected within these areas across a range of socio-economic indicators, including business demography, employment, labour supply characteristics, skills, property market and, where applicable, local economic policy. Sources include official national data sets, local government, individual businesses, commercial property data sets and stakeholder views.

Methodology

8.12.5 The assessment has drawn on guidance such as the Treasury Green Book[156], DfT WebTAG guidance[157] Homes and Communities Agency (HCA) Employment Density Guide[158] and the HCA Additionality Guide[159].

8.12.6 The significance of effects is being assessed based on 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.

Assumptions and limitations

8.12.7 Changes to the environmental conditions can affect a business operationally. Certain types of business are more likely to be sensitive to changes in their environmental condition than others e.g. those dependent upon attracting recreational visitors. Changes in turnover resulting from a loss of trade may have an effect on employment (assuming that there is a positive relationship between growth/contraction in a business's turnover and growth/contraction in employment at that business).

8.12.8 It is assumed that the employment within businesses affected by land required for the Proposed Scheme would either be relocated or lost. The employment implications are less clear for resources affected by isolation and/or changes in the combined effects of significant noise, air quality, visual and HGV congestion on trading conditions. Any employment implications are assessed at route-wide level, whilst impacts are assessed and reported at an individual resource level.

[156] HM Treasury (2003). *The Green Book: Appraisal and Evaluation in Central Government*. Available online at: https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-governent
[157] Department for Transport (2017). *Transport analysis guidance: WebTAG*. Available online at: https://www.gov.uk/guidance/transport-analysis-guidance-webtag
[158] Homes and Communities Agency (2015). Employment Density Guide. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/484133/employment_density_guide_3rd_edition.pdf
[159] Homes and Communities Agency (2014). Additionality Guide. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/378177/additionality_guide_2014_full.pdf

8.12.9 It is assumed that 88% of businesses directly affected by the Proposed Scheme would successfully relocate to alternative locations and no employment at these relocated businesses would 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 lost[160].

8.12.10 For the assessment that will be reported in the formal ES, it is assumed that a business experiencing an adverse effect on trade due to isolation or changes in the combined effects of significant noise, vibration, air quality, visual and HGV congestion can adopt a number of strategies before reducing employment. These strategies include cancelling/postponing investment in premises and stock; reducing staff working hours; cancelling/postponing plans to expand business; temporarily laying-off staff; renegotiating loans or mortgage; and increasing marketing or advertising activity. Any reduction in employment will be calculated by:

- estimating the total employment of the business(es) affected; and
- applying a percentage, based on the type of business activity/sector, to represent the likely proportion of employment that could be significantly affected by changes in the combined effects of significant noise, vibration, air quality, visual and HGV congestion or isolation on trading conditions.

8.12.11 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.

8.12.12 Operational employment on the conventional network is assumed to remain the same as present as released capacity is utilised by new services.

8.13 Sound, noise and vibration

Scope

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

- 'residential receptors'; people, primarily where they live, in terms of individual dwellings and on a wider community basis including any shared community open areas[161]; and
- 'non-residential receptors'[162] such as:
  - community facilities including schools, hospitals, places of worship and 'quiet areas'[163]; and

[160] 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.
[161] 'Shared community open areas' are those that the 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 or local green space) that is nearby.
[162] Non-residential receptors with multiple uses would be assessed either based on the most noise sensitive use or would be subject to multiple assessments as appropriate.

- commercial properties such as offices and hotels.

8.13.2 Potential noise and/or vibration effects on animals, the historic environment and tranquillity will be reported in the respective ecology and biodiversity, historic environment and landscape and visual sections of the formal ES, as appropriate.

8.13.3 In this assessment, significant noise or vibration effects may be:

- adverse from an increase in sound or vibration levels, or beneficial from a decrease in sound or vibration levels caused by the Proposed Scheme where the noise or vibration from the Proposed Scheme would exceed the relevant Lowest Observed Adverse Level in line with Government noise policy[164] and the EIA SMR;
- 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, 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, caused by the Proposed Scheme outside of the study area around the new railway and associated infrastructure.

8.13.4 HS2 Ltd is engaging with the environmental health practitioners acting for the local and county authorities along route of the Proposed Scheme. The purpose of this engagement is twofold. Firstly, engagement undertaken on a route-wide basis covering matters including process, scope, methodology and the approach to baseline and mitigation strategy. Secondly, local engagement to obtain relevant information regarding residential and non-residential receptors and existing baseline sound levels, and to discuss the development of the mitigation to be included in the Proposed Scheme. Officers from local and county authorities are invited to attend and witness baseline sound measurements. Engagement with local and county authorities will continue as part of the development of the Proposed Scheme.

8.13.5 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.

[163] 'quiet areas' are defined as either Quiet Areas as identified under the Environmental Noise Regulations 2007 (as amended) or are resources which are prized for providing tranquillity as noted in the NPPF and are therefore designated as such under the relevant local plan or are designated under local plans or neighbourhood development plans as local green spaces.
[164] Defra (2010). Noise Policy Statement for England (NPSE) and Department for Communities and Local Government (2012), National Planning Policy Framework. Available online at: Available online at:
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69533/pb13750-noise-policy.pdf

Baseline

8.13.6 Information on the existing airborne sound environment is being obtained from desktop research and extensive field surveys. Sound level monitoring is also being undertaken at locations suggested by local communities, where the monitoring provides further information relevant to the assessment. The aim is to obtain empirical data that describe the existing sound environment that is supported by an assessment of the existing acoustic character at each location.

8.13.7 Future changes in the airborne sound baseline will be considered where significant effects of the Proposed Scheme 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 and/or noise reduction provided in Important Areas identified in Defra's Noise Action Plans for Agglomerations[165], Roads[166] or Railways[167]. HS2 Ltd will engage with the competent authorities responsible for the relevant Important Areas. This will be reported in the formal ES.

8.13.8 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. The assumption that there is no baseline vibration provides a reasonable worst-case basis for the assessment of likely significant effects.

Methodology

8.13.9 The assessment identifies noise and vibration likely significant effects (both beneficial and adverse) and describes the measures proposed to avoid or reduce these significant effects.

8.13.10 The methodology for the assessment of likely significant noise and vibration effects was developed in alignment with Government noise policy[168], planning policy and planning practice guidance on noise (PPGN)[169] and relevant project precedent. HS2 Phase One was the first major infrastructure project to set out the interaction between Government noise policy and the EIA Regulations. During the parliamentary examination of the Phase One hybrid Bill, HS2 Ltd's interpretation of noise policy, planning guidance and EIA regulations was formalised in a number of Information Papers; these papers were adopted on Phase 2a and have been reflected in the Phase 2b EIA SMR.

[165] Defra (2014). *Noise Action Plan: Agglomerations (large urban areas).* Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/276228/noise-action-plan-agglomerations-201401.pdf
[166] Defra (2014). *Noise Action Plan: Roads (including major roads).* Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/276237/noise-action-plan-roads-201401.pdf
[167] Defra (2014). *Noise Action Plan: Railways (including major railways).* Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/276238/noise-action-plan-railways-201401.pdf
[168] Defra (2010). Noise Policy Statement for England (NPSE) and Department for Communities and Local Government (2012), National Planning Policy Framework. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69533/pb13750-noise-policy.pdf
[169] Department for Communities and Local Government, (2016), National Planning Practice Guidance – Noise. Available online at: http://planningguidance.planningportal.gov.uk

8.13.11 The assessment will inform the Environmental Minimum Requirements[170] that would ensure that as the design of the Proposed Scheme progresses, the requirements of the current Government noise policy and guidance will continue to be met. The assessment takes health outcomes into account within the context of Government policy on sustainable development, which seeks to:

- avoid significant adverse impacts on health and quality of life;
- mitigate and minimise adverse impacts on health and quality of life; and
- where possible, contribute to the improvement of health and quality of life.

8.13.12 Government planning guidance on noise is based on the premise that once the level of noise is above a specific threshold, the effect on people in their homes increases as the level of sound increases. The guidance defines two levels of effect: Lowest Observed Adverse Effect Level; and Significant Observed Adverse Effect Level. The explanatory note to Government noise policy considers it likely that these effect thresholds will be different for different sources, different receptors and at different times.

8.13.13 Therefore, for the Proposed Scheme, effect thresholds for the onset of both 'adverse' and 'significant adverse' effects on health and quality of life have been defined for noise and vibration, as described in the EIA SMR. These thresholds are based on national and international regulations, standards and guidance.

8.13.14 'Significant adverse' effects of health and quality of life are reported in the assessment as 'likely significant effects'. 'Adverse' effects on health and quality of life on a larger community group may also be identified as an effect likely to be considered significant on a community basis. The criteria for identifying 'likely significant effects' are set out in the EIA SMR.

Assumptions and limitations

Construction assumptions

8.13.15 The assessment includes consideration of noise and vibration on a month-by-month basis, assuming that the mitigation measures defined in the draft CoCP have been implemented. Noise levels would vary day-to-day. The highest daily levels may sometimes be around 5dB higher than the monthly average levels but could also be substantially lower on other days.

8.13.16 The assessment takes account of people's perception of noise during the day, evening and night. More stringent criteria are applied during evening and night-time periods, when people are more sensitive to noise, compared to the busier and more active daytime period.

8.13.17 In line with, and as would be controlled by, the draft CoCP the assessment assumes that the following construction activities would require extended (evening) working hours for periods of greater than one month at some stage, or stages, of the overall construction programme:

[170] For example please refer to HS2 Phase One and Phase 2a Information Papers: https://www.gov.uk/government/publications/hs2-information-papers-environment and https://www.gov.uk/government/publications/environment-hs2-phase-2a-information-papers .

- embankments, cuttings and landscape earthworks (during summer months to make best use of suitable weather); and
- bridges, viaducts, retaining walls, tunnel vent shafts and station buildings (associated with, for example, piling and large concrete pours).

8.13.18 It is anticipated that there may be some night-time working during 'possessions' 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 would be controlled and reduced by the management processes set out in the draft CoCP. Where night-time work would be required over extended periods, for example at tunnel portals, it is assessed against night-time noise criteria.

8.13.19 During certain construction processes, there may be the need to operate fixed construction plant such as generators[171] and water pumps for reasons of safety or engineering practicability on a continuous basis. Noise would be controlled and reduced by the management processes set out in the draft CoCP and this equipment would be sited, or locally screened, to control noise at neighbouring residential premises to avoid likely significant effects.

8.13.20 Likely significant effects from ground-borne noise and/or vibration generated from temporary construction traffic (road vehicles) within the construction sites would be avoided through the commitment given in the draft CoCP that the surface of temporary and permanent access roads and temporary site haul routes for the Proposed Scheme would be maintained through the construction of the Proposed Scheme.

8.13.21 Taking into account the control and management processes set out in the draft CoCP, including the provision of advanced notification, the short relative duration of the works (often less than one month) and/or the rises and falls in level as the works pass by a given receptor mean that the following activities are unlikely to cause a noise or vibration significant effect during construction:

- the use of vibratory rollers for minor works, such as road surfacing and reinstatement, etc.;
- the use of pneumatic breakers to break up existing concrete structures during demolition;
- standard utilities work; and
- track laying, power system and signalling installation works along the route of the Proposed Scheme.

8.13.22 Certain types of piling and vibratory compaction would likely result in short-term appreciable ground-borne vibration at a small number of dwellings, situated very close to these activities. These receptors would also be exposed to appreciable noise

[171] As required by the CoCP, the use of diesel or petrol-powered generators will be reduced by using mains electricity or battery-powered equipment where reasonably practicable.

from the construction of the Proposed Scheme. The significance of the identified vibration effects will be assessed in combination with the airborne noise effects also identified at these receptors and reported in the formal ES.

Operational assumptions

8.13.23 The effects of noise and vibration from the operation of the Proposed Scheme are assessed based on the likely train flows.

8.13.24 The assessment is based on the expected passenger service frequency when the full Phase One and Phase Two service is operational, as identified in Section 0 of this report.

8.13.25 There would be regular line inspections and planned maintenance work at night 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.

8.13.26 On most nights, a small number of diesel-powered specialist engineering trains would travel from the IMDs to remote locations on the route of the Proposed Scheme to either inspect the line or undertake planned maintenance. These trains would leave the IMD as soon as possible after passenger services finish at midnight and are likely to return to the IMD shortly before passenger services start again at 05:00. It is assumed that the engineering trains would be specified and operated so that any adverse noise effects are no greater than those for the night-time passenger services. The operation of these maintenance and inspection trains is considered as part of the assessment of the Proposed Scheme's operation as reported in the Volume 2: Community area reports.

8.13.27 Through the procurement process for the trains and the track, the use of proven international technology would enable the high speed railway to be quieter than implied by current minimum European standards. Details of operational train noise will be provided in the formal ES. This will include reduction of aerodynamic noise from the pantograph that would otherwise occur above 300kph (186mph) with current pantograph designs, drawing on proven technology in use in East Asia where reasonably practicable. Overall it is assumed that proven international technology would reduce noise emissions by approximately 3dB at 360kph (225mph) compared to the current minimum European standards[172].

8.13.28 The assessment has been undertaken on the precautionary assumption that slab track would be installed along the length of the Proposed Scheme.

8.13.29 Passenger services have been assumed to operate at up to 225mph (360kph) where the alignment would permit. Services would be timetabled based on a speed of 200mph (330kph) where the maximum operational speed of 225mph (360kph) applies. It is assumed that around 10% of services would operate at the full speed of 225mph (360kph). Where the alignment would constrain train speed, the noise and vibration

[172] Technical Specification for Interoperability (TSI) Noise – EU Commission Regulation No 1304/2014

assessment has assumed the speed profile prepared as part of the journey time analysis.

Noise and vibration effects considered unlikely to be significant

8.13.30 Taking account of the avoidance and mitigation measures included in the Proposed Scheme and the transient/irregular use of the following receptors, it is unlikely that significant effects would result from construction and/or operation of the Proposed Scheme at:

- facilities that permit short term occupation, typically up to two weeks, such as static moorings, camp sites or caravan parks, but which do not permit permanent residential use;
- PRoW; and
- public open spaces and outdoor sports/recreation community facilities (e.g. football pitches, golf courses).

8.13.31 PRoW are, by their nature, transitory in their use, with users not staying in any one location for any length of time. Levels of noise from the construction and operation of the Proposed Scheme would vary as the PRoW moves closer to and further from the Proposed Scheme. During construction, noise would be controlled and managed in accordance with the draft CoCP as described in Section 6.3 of this report. During operation, noise levels on PRoW would be reduced by engineering cuttings, landscape earthworks provided to reduce the visual impact of the Proposed Scheme and noise mitigation provided to protect adjacent residential and non-residential receptors. Train noise from the Proposed Scheme would be intermittent. Significant noise effects are, therefore, considered unlikely on PRoW during either construction or operation although increases in noise due to the Proposed Scheme may adversely affect the acoustic character of the area around PRoW.

8.13.32 Public open spaces and outdoor sports/recreation community facilities (e.g. football pitches, golf courses, etc.) are, by their nature, transitory in their use. Outdoor sport activities are unlikely to be significantly affected by noise at the levels associated with operation of the Proposed Scheme. Increases in noise due to operation of the Proposed Scheme may adversely affect the acoustic character of the area around such open spaces and facilities. However, as users will not be exposed to any increased noise for long periods and hence use of the open spaces and facilities would not be disrupted, the adverse noise effects on users are not considered significant.

8.13.33 Quantitative assessments will be undertaken for any outdoor community facility formally identified or designated as a quiet area under Government regulations or policy and reported in the formal ES.

8.14 Traffic and transport

Scope

8.14.1 The traffic and transport assessment covers the impact on all relevant modes of transport, including pedestrians, cyclists, equestrians, mobility impaired people, highways, public transport and waterways. The assessment includes consideration of effects resulting from physical changes to transport networks (including road, rail, bus

routes and PRoW diversions) and from the additional trips generated by the Proposed Scheme both during construction (including HGV movements and workforce trips) and, where appropriate, during the operational period of the Proposed Scheme (including HS2 demand, changes to demand and levels of crowding on the conventional rail network, and trips associated with employees at stations and depots).

8.14.2 The spatial scope of the traffic and transport assessment is different for the construction and operational impacts being assessed. For construction, the assessment focusses on traffic and transport issues resulting from land required for the Proposed Scheme, land required for worksites, the presence of construction traffic on the local road network, and effects on routes crossing the construction areas (PRoW and highways). The extent of the assessment includes the highway network, public transport network, transport interchange arrangements, pedestrian, cyclist and equestrian routes in the vicinity of the Proposed Scheme and railways used to transport materials and excavated materials; and navigable waterways.

8.14.3 For operation, the spatial scope includes the transport routes where there is a substantial change in the usage either through people accessing the Proposed Scheme, or from changes to travel demand on other routes or modes. It also includes roads and other rights of way that are permanently diverted or closed. The extent of the assessment for the operational phase includes the highway network, the public transport system (and transport networks used to access the public transport system), the pedestrian, cyclist and equestrian routes in the vicinity of the Proposed Scheme and navigable waterways.

8.14.4 The scope also includes consideration of the impacts at a route-wide and off-route level, presented in Volumes 3 and 4 respectively. The route-wide effects will be reported in the formal ES and will be mainly focussed on the construction impacts on rail passengers and rail freight during rail possessions and, during operation, the potential of the Proposed Scheme to provide improved journey times on HS2 services building on the benefits of Phase One and Phase 2a and the impacts on travel patterns, including released capacity on the conventional rail network.

Baseline

8.14.5 Current transport conditions have been derived from a combination of surveys, transport modelling and site visits. Future baseline conditions will be derived by taking into account both changes in the demand for travel (by using transport modelling or applying growth factors to the baseline traffic and incorporating, where relevant, committed and planned developments) and change to the transport supply network (by considering committed and planned transport improvement schemes). Transport modelling will be used, where appropriate, to inform the future baseline conditions.

Methodology

8.14.6 The assessment takes account of best practice guidance published by the DfT and local guidance where relevant and appropriate. Consideration is given to the effects on traffic congestion and delay, road safety, parking and loading, public transport, non-motorised users (including cyclists, pedestrians and equestrians) and navigable waterways. The evaluation of significance takes account of guidance such as:

- DMRB Volume 11: Environmental Assessment (1993 and updates);
- DfT WebTAG;
- Guidelines for the Environmental Assessment of Road Traffic[173];
- Guidelines for Traffic Impact Assessment[174]; and
- assessment criteria used for assessing the Elizabeth Line (formerly Crossrail)[175] and other major infrastructure schemes including HS2 Phase One and Phase 2a.

8.14.7 The assessment criteria for both construction and operation comprise:

- the increase in rail capacity from the introduction of HS2 services;
- significantly improved journey times between major cities in the north, Midlands and south of the UK;
- released capacity on the existing conventional rail network, easing pressure and reducing crowding on other passenger rail services, creating significant major beneficial effects to both local commuters and freeing up space for freight;
- delays to public transport;
- stations/interchange impacts;
- traffic flows and delays to vehicle occupants;
- effects on vulnerable road users;
- traffic related severance impacts on non-motorised road users;
- non-traffic related severance;
- changes to amenity or ambience for vulnerable road users;
- accident and safety risk;
- changes to parking and loading provision or demand; and
- impact of works affecting the navigation or amenity of waterways.

Assumptions and limitations

8.14.8 The potential effects on traffic and transport have been assessed qualitatively for the working draft ES, based on the current Proposed Scheme design, proposed construction routes, initial estimates of construction traffic and professional

[173] Institute of Environmental Assessment (IEA) (1993). Guidelines for the Environmental Assessment of Road Traffic, IEA
[174] Institution of Highways and Transportation (1994). Guidelines for Traffic Impact Assessment, Institution of Highways and Transportation
[175] Crossrail (2005). Environmental Statement Volume 8a Appendices Transport assessment: methodology and principal findings (Section 5 Assessment Criteria). Available online at: http://74f85f59f39b887b696f-ab65625904 8fb93837eccoecbcf0c557.r23.cf3.rackcdn.com/assets/library/document/v/original/volume_08a.pdf

judgement. No quantitative assessment has been undertaken at this stage. A quantitative assessment will be presented in the formal ES.

8.14.9 The following assumptions are relevant to the traffic and transport assessment:

- operational patterns and capacities of the Proposed Scheme;
- change in operational patterns and stations served by other operators;
- changes to both temporary and permanent highways and PRoW; and
- construction related volumes (HGV and other) and workforce trips.

8.14.10 The approach to the transport assessment for future year assessments requires a number of assumptions to be made relating to:

- 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.

8.14.11 Future baseline flows will be sourced from strategic transport models where relevant and appropriate or from factoring observed data to the relevant future baseline year using traffic growth from TEMPRO. PRoW surveys, undertaken in 2017, have been used as the basis for pedestrian and cyclist flows.

8.14.12 The assessment of the construction impacts of the Proposed Scheme for the formal ES will include the identification of the number of construction vehicles (including HGVs) and workers/person trips travelling on a daily basis and also for the identified assessment periods.

8.14.13 The assessment of construction traffic is based on construction vehicle (HGVs) routeing to the strategic and/or primary network and with the use of the local road network limited insofar as reasonably practicable. There would generally be one primary inbound and one outbound route to and from each compound (and these would often use the same route).

8.14.14 The effects of works to existing utilities will be included in the formal ES. In general, the key impacts of utilities works are expected to be associated with road closures and/or significant diversions.

8.15 Waste and material resources

Scope

8.15.1 The assessment identifies 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 will be forecast and compared to the amount of landfill capacity projected to be available during construction and operation.

8.15.2 The scope includes wastes generated during construction (i.e. from earthworks, construction and demolition activities and from worker accommodation sites) and operation (i.e. from passengers and track and ancillary infrastructure maintenance).

8.15.3 The consideration of material resources in this assessment is limited to the beneficial reuse of excavated materials arising from the construction of the Proposed Scheme. It does not include material inputs to construction (e.g. aggregates).

8.15.4 Liquid waste (e.g. wastewater from construction site dewatering) is addressed in the water resources and flood risk assessment (Volume 2: Community area reports, Section 15). Other liquid wastes[176], such as waste oil, are not considered as they would be limited in quantity, compared to solid wastes and have, therefore, been scoped out.

8.15.5 The direct and indirect effects of waste-related transport are addressed within Volume 2: Community area reports, Section 5 (Air quality), Section 13 (Sound, noise and vibration) and Section 14 (Traffic and transport).

8.15.6 Issues relating to mineral resources and contaminated land are addressed within Volume 2: Community area reports, Section 10 (Land quality).

8.15.7 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.

8.15.8 The spatial scope (and study area) for the assessment has been defined as the counties and districts (local area) and former regional planning jurisdictions (regional area) through which the route of the Proposed Scheme would 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

8.15.9 The baseline describes environmental conditions with respect to the types, quantities and management of waste generated and the availability (capacity) of waste infrastructure within the study area.

8.15.10 Baseline conditions have been obtained from the latest available published data from the Environment Agency, Defra and waste planning authorities. Future baseline data are based on the extrapolation of this data for the construction and operation phase, and other published forecasts.

Methodology

8.15.11 Forecasts of the quantities of waste that would require off-site disposal to landfill are based on an 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.

[176] Official Journal of the European Union, Directive 1999/31/EC of 26 April 1999 on the landfill of waste (Article 6).

8.15.12 The quantities of surplus excavated material and other wastes requiring off-site disposal to landfill are compared to the projected landfill capacity that would be available during construction and operation.

8.15.13 Forecasts of the quantities of waste that would require off-site treatment and recovery at appropriate facilities are based on reasonable assumptions for the amount of waste likely to be generated and evidence-based recycling rates applicable to waste from construction, demolition and operational activities.

8.15.14 The quantities of wastes requiring off-site treatment are compared with the treatment and recovery capacity that would be available during construction and operation.

8.15.15 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

8.15.16 Assumptions have been made on the proportion of solid construction, demolition and operational waste that would be diverted from landfill via reuse, recycling and recovery. This has been informed by information gathered at the time of the assessment as to any waste management measures proposed to divert waste from landfill. Alternatively, landfill diversion performance for other similar rail-related projects, such as Crossrail, have been considered.

8.15.17 Consideration of material resources in the assessment is limited to the beneficial reuse of material arising from construction of the Proposed Scheme. Excavated material is only considered to be waste if it would not be required or would be unsuitable for construction of the Proposed Scheme.

8.16 Water resources and flood risk

Scope

8.16.1 This assessment includes consideration of all surface water and groundwater bodies, including their associated water resources, water quality, hydromorphology, hydrology and flood risk.

8.16.2 Descriptions of the current baseline for water resources and flood risk, the likely impacts, and significant effects of the route of the Proposed Scheme's construction and operation on surface water and groundwater bodies and their associated water resources are assessed in the Volume 2: Community area reports. The likely impacts and significant effects of the Proposed Scheme on flood risk and land drainage are also considered.

8.16.3 Volume 3: Route-wide effects covers the following at a route-wide level:

- the risk to water resources associated with accidents or spillages from trains during operation of the Proposed Scheme;
- a summary of how the Proposed Scheme complies with the statutory requirements of the WFD; and

- route-wide flood risk issues related to application of the Sequential Test and Exception Test in the NPPF.

8.16.4 The spatial scope of the assessment (the study area) is generally 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. In urban areas the distance is 500m. Outside of these distances it is unlikely that direct impacts upon the water environment will be attributable to the Proposed Scheme. However, in some community areas, the study area has been extended, for example where works extend more than 200m from the centre-line, or where very high value receptors are in proximity, but outside of the 1km zone. These extensions to the study area are defined within the assumptions and limitations section of each Volume 2: Community area report.

8.16.5 Impacts to groundwater quality from existing land contamination are presented in Section 8.9 of this report and in the Volume 2: Community area reports, Section 10. Impacts on biological receptors and ecology are presented in Section 8.6 of this report and in the Volume 2: Community area reports, Section 7.

Baseline

8.16.6 Baseline information includes:

- surface water and groundwater hydrology, quality, designations, licensed abstractions, private water supplies; and
- areas at risk of flooding from rivers, surface water, groundwater and reservoir failure inundation.

8.16.7 Information is being obtained primarily from secondary/published sources such as the Environment Agency, Lead Local Flood Authorities, British Geological Survey and water companies, supplemented where necessary by targeted survey of surface waters, as well as hydraulic analysis. Hydrogeological information is being obtained from geological maps and borehole logs where available.

8.16.8 Current projections indicate that climate change may affect the future baseline against which the impacts of the Proposed Scheme are being assessed. The projected impacts of climate change on peak river flows and peak rainfall intensities are being considered in the assessment based on the recommended allowances contained in Environment Agency guidance issued in February 2017; *Flood risk assessments: climate change allowances*. Whilst other changes may occur in the water baseline due to climate change, these are unlikely to change the significance of the effects of the Proposed Scheme reported in the Volume 2: Community area reports.

8.16.9 WFD classification data are taken from the Environment Agency Cycle 2 River Basin Management Plan annexes. These classifications are the formal baseline against which the Environment Agency will assess compliance with the no deterioration objectives. This information will be supplemented by specialist surveys.

Methodology

8.16.10 The assessment has taken account of relevant policy and guidance, as set out in the EIA SMR. Effects are derived from the interaction between the magnitude of impact and the value of the receiving water body or flood receptor. Impact magnitude has been based on quantitative criteria wherever possible. Receptor value reflects its degree of vulnerability or importance, for example vulnerability to flooding, or relative importance for water supply, biodiversity or recreation.

8.16.11 There is no established methodology for assessing compliance with WFD legislation. The WFD Assessment will be based largely on internal Environment Agency guidance[177], the prior experience of HS2 Ltd on Phase One and Phase 2a and professional judgement. The approach applied is also in general accordance with recently published advisory note provided by the Planning Inspectorate[178].

Assumptions and limitations

8.16.12 The following assumptions have been made for the working draft ES:

- the Environment Agency's Flood Maps provide an indication of areas potentially at risk of flooding from rivers, surface water, groundwater and reservoirs (although this information is being supplemented by hydraulic analysis in areas where the potential for impacts to occur has been identified);
- hydraulic analysis has made best use of existing river models, topographic and LiDAR data available. Conservative assumptions have been made about the capacity of the hydraulic structures for which detailed measurements are not yet available. Similarly, conservative assumptions have been made about the potential for new proposed structures, such as viaduct piers, to impact on flood levels. This is to help ensure that locations where there is potential for flood risk impacts to occur have been identified and to inform the additional mitigation required at the detailed design stage;
- all ground and surface water abstractions are assumed to be active and sensitive to disruption, unless site surveys have confirmed otherwise;
- all watercourses, other than minor drainage ditches, are assumed to be of high or very high value, unless surveys have been completed that confirm otherwise;
- springs, spreads, issues or seepages shown on Ordnance Survey maps are conservatively assumed to be surface expressions of groundwater bodies (aquifers), unless surveys have been completed that confirm otherwise;
- in the absence of site specific data, it is assumed that permeable alluvium deposits that underlie watercourses are likely to be in hydraulic connection with them and provide an element of baseflow, particularly during drier periods;

[177] Environment Agency (2010). Assessing new modifications for compliance with WFD: detailed supplementary guidance.
[178] The Planning Inspectorate (2017). Advice note eighteen: The Water Framework Directive. Available online at: https://infrastructure.planninginspectorate.gov.uk/wp-content/uploads/2017/06/advice_note_18.pdf

- railway track drainage would, where reasonably practicable, be kept separate from existing land drainage that crosses the route of the Proposed Scheme; and
- where there are limited borehole records available from which to understand the local geological and hydrogeological conditions, it is assumed that topography has some control over groundwater flow directions with groundwater level contours roughly parallel to topographic contours.

8.16.13 The estimated zone of influence, and therefore, the assessment of the potential impact of dewatering on receptors, is based on a reasonable worst-case assessment using available literature, values of hydraulic parameters and geological cross sections. Hydraulic conductivity values, obtained from available literature, are being 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.

9 Approach to mitigation and monitoring

9.1 Overview

Mitigation

9.1.1 The EIA Regulations require an ES to include a description of the measures proposed in order to avoid, prevent or reduce the likely significant adverse effects on the environment. Such measures are described generally in this working draft ES as mitigation measures. Priority has been given to avoiding or preventing effects; and then (if this is not possible), to reducing or abating them, through restoration and compensation.

9.1.2 This approach is driven by the HS2 Sustainability Policy (see Section 1.5 of this report) and the HS2 Environmental Policy, with the latter stating HS2 Ltd's commitment to "developing an exemplar project, and to limiting negative impacts through design, mitigation and by challenging industry standards whilst seeking environmental enhancements and benefits". Furthermore, the Environmental Minimum Requirements (see Section 0 of this report) would impose a general requirement on the nominated undertake to use reasonable endeavours to adopt measures to reduce the adverse environmental effects reported in the formal ES, provided that this does not add unreasonable cost or delay to the construction and operation of the Proposed Scheme. The draft CoCP is being produced in conjunction with the working draft ES and later with the formal ES so that the EIA can take account of the measures that would be imposed during construction to avoid or limit the occurrence of environmental impacts and effects.

9.1.3 Mitigation opportunities will continue to be identified during development of the Proposed Scheme prior to the submission of the Bill. The EIA process is iterative, which is likely to enable further refinement of the Proposed Scheme, with the objective of avoiding or reducing significant adverse environmental effects. Mitigation measures will be identified by regularly reviewing the likely significant adverse environmental effects identified during the ongoing assessment process and considering these at design workshops within the HS2 Ltd project teams. Design modifications will be considered to avoid or reduce significant adverse effects.

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

9.1.5 Some mitigation is currently under development, since the design development and environmental assessment are ongoing. Measures may be added or amended as a result of consultation on the working draft ES. Furthermore, some mitigation will be defined in principle in the working draft ES, but the actual measures or mechanisms to be used, or the land to be involved, will not be defined until the formal ES.

9.1.6 Mitigation measures will, therefore, continue to emerge during the course of the assessment. This section provides a preliminary description of the range of measures and policies that have either already been adopted or will be considered as the assessment proceeds. These measures are principally of three types:

- mitigation that is provided through the planning and design of the Proposed Scheme, which is not shown explicitly as such on the scheme drawings;
- mitigation that requires additional physical features, which is shown on the scheme drawings; and
- mitigation to be delivered through further measures in accordance with HS2 Ltd policies.

9.1.7 Construction impacts would be mitigated through the application of the measures set out in the CoCP in addition to mitigation through design and policy.

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

9.1.9 Mitigation that is being incorporated into the route alignment and design of the Proposed Scheme includes:

- selection of the Proposed Scheme from a range of alternatives taking account of environmental issues;
- horizontal 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 environmental and 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:
  - noise mitigation at sensitive locations by placing the route of the Proposed Scheme within cutting; and
  - visual screening using natural landforms;
- provision of bridges or underpasses to avoid the severance of roads, PRoW and private accesses, where reasonably practicable;
- creation of new habitats and other features of ecological value to compensate for losses;
- avoidance or reduction of impacts on floodplains and the provision of replacement 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 for noise mitigation;
- provision of planting to screen views to assimilate the Proposed Scheme into the local landscape; and
- provision of balancing ponds, in order to control the volume of surface water runoff from the Proposed Scheme in rural areas.

Monitoring

9.1.10 The EIA Regulations require a description, where appropriate of any proposed monitoring arrangements of significant adverse effects on the environment. This monitoring is for significant adverse effects associated with both the construction and operational phases of a scheme.

Monitoring during construction

9.1.11 The draft CoCP includes commitments to monitoring significant effects during construction. Further information on this can be found within Section 6.3 of this report. Monitoring measures during construction for each environmental topic are presented in Section 9 of this report.

Monitoring during operation

9.1.12 HS2 Ltd would carry out appropriate post-construction monitoring during the operational phase for both:

- 'general' monitoring, for example, monitoring of: mitigation provided for protected species; the progress of habitat creation works; the condition of restored agricultural land; and the establishment of landscape planting; and
- 'specific' monitoring agreed for particular significant adverse effects where appropriate e.g. monitoring of a public water supply borehole.

Operational monitoring measures for each environmental topic are presented in Section 9 of this report. Operational monitoring specific to significant effects reported in a community area is presented within the Volume 2: Community area reports on a topic basis, where relevant and known at this stage. Further details will be provided in the formal ES, as required.

9.2 Agriculture, forestry and soils

Mitigation

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

9.2.2 Topsoil and subsoil would be stripped prior to construction and stored appropriately to enable agricultural land to be restored. The design objective is to avoid any reduction in long term capability, which would downgrade the quality of the disturbed land, through the adoption of good practice techniques in soil handling.

9.2.3 Land drainage schemes and water supplies used for livestock and irrigation may be severed or otherwise affected by the Proposed Scheme. These effects would be accommodated by suitable works in order to maintain continuity of land drainage and supply of water so far as reasonably practicable during the period of construction of the Proposed Scheme. Where it is not possible to maintain continuity of land drainage or supply of water, the facilities would be reinstated or made good as soon as reasonably practicable.

9.2.4 The Proposed Scheme would inevitably sever some accesses within agricultural holdings and create new field layouts that would require new accesses. Map Series CT-06 in the Volume 2: Community area map books included in the working draft ES show the new accesses under or over the railway that are currently proposed to accommodate this severance and so reduce this impact. New accesses would be provided so that they are available as soon as is reasonably practicable in order to reduce the effects of severance. In addition, the contractor would 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 consideration would be given to the acquisition of severed land. The ongoing design of the Proposed Scheme will continue to assess further requirement for agricultural access to severed land parcels, which will be reported in the formal ES.

9.2.5 Further details of the approach to compensation for land compulsorily acquired can be found within Section 1.6 of this report.

Monitoring

Construction

9.2.6 Appropriately qualified environmental management staff would be appointed to facilitate compliance with Section 6 of the draft CoCP in relation to soils. Their responsibilities would include the monitoring of topsoil and subsoil stripping, handling, storage and replacement, as appropriate.

9.2.7 During construction on-site inspections of works would be carried out by the nominated undertaker, to monitor progress and standards of restoration. Completed works would be inspected by a suitably qualified and experienced soil scientist or practitioner to certify that the land has been restored to the specifications as set out in the construction area-wide Soil Resource Plans (and as specified in the individual plans for affected farms). Contractors would also provide an audit of soil resources following a soil survey within six months of completion of the restoration. The nominated undertaker would put in place agricultural liaison officers who would be available by telephone 24 hours a day, seven days per week, during the construction of Proposed Scheme works on agricultural land. More information would be available on this once Royal Assent has been received.

9.2.8 On completion of construction, soils restored to agricultural, forestry or landscape uses would be monitored to identify any unsatisfactory growing conditions during the five-year aftercare period.

Operation

9.2.9 Where noise mitigation measures are agreed in respect of effects on housed livestock, some monitoring of noise levels may form part of an agreement with owners and occupiers. No other significant agriculture, forestry and soils effects are anticipated during operation of the Proposed Scheme. Therefore no further operational monitoring has been identified at this stage.

9.3 Air quality

Mitigation

9.3.1 The proposed mitigation measures to control and manage the construction effects of the Proposed Scheme in relation to air quality are stated in the draft CoCP and in the transport assessment in relation to road traffic emissions.

9.3.2 These include the following general measures:

- contractors being required to manage dust, air pollution, odour and exhaust emissions during construction works;
- inspection and visual monitoring, undertaken in consultation with the local authorities, to assess the effectiveness of the measures taken to control dust and air pollutant emissions;
- cleaning (including watering) of vehicle routes and designated vehicle waiting areas to suppress dust;
- the use of water spray systems on demolition sites to dampen down fugitive dust;
- keeping soil stockpiles away from sensitive receptors where reasonably practicable, also taking into account the prevailing wind direction relative to sensitive receptors;
- the use of enclosures to contain dust emitted from construction activities; and
- soil spreading, seeding and planting of completed earthworks as soon as reasonably practicable following completion of earthworks.

9.3.3 The draft CoCP includes the requirement for site-specific traffic management measures, such as the use of site haul routes for construction vehicles to minimise the need to use public roads.

9.3.4 Best practice engine emission standards have been set for on and off road construction vehicles.

9.3.5 The high speed railway would operate efficient, non-polluting electrically powered passenger trains.

Monitoring

Construction

9.3.6 The nominated undertaker would require its contractors to implement inspection and monitoring procedures to assess the effectiveness of measures to prevent dust and air pollutant emissions. Relevant local authorities would be consulted on the monitoring procedures to be implemented.

9.3.7 Reports of the monitoring would be provided to local authorities. These would include, where appropriate, the interpretation of any continuous automatic monitoring data, any site action level alarms, investigations and remedial actions.

9.3.8 Monitoring of dust and particulate matter during construction of the project would be undertaken following the current best practice guidance (currently IAQM 2012).

9.3.9 Monitoring of significant air quality effects adjacent to highways would be undertaken following current best practice guidance (currently Defra's Local Air Quality Management Technical Guidance[179]).

9.3.10 Further information on general air quality monitoring during construction is set out in Section 7.3 of the draft CoCP.

Operation

9.3.11 No operational monitoring in relation to air quality is currently proposed. This will be confirmed in the formal ES.

9.4 Climate change

Greenhouse gases emissions

Mitigation

9.4.1 Environmental Protection and Management is one of five key themes established in HS2's Sustainability Policy, which is further expanded within HS2's Environmental Policy. The Environmental Policy describes the Proposed Scheme's approach to climate change as being to 'minimise the carbon footprint (of the Proposed Scheme) and deliver low-carbon, long-distance journeys that are supported by low-carbon energy'. HS2 Ltd has also endorsed[180] the Government's Infrastructure Carbon Review[181], reinforcing its commitment to pursing lower carbon solutions that cost less and also release the value of lower carbon through leadership, innovation and procurement.

9.4.2 Publicly Available Specification (PAS) 2080 has been adopted as a best practice framework for managing and minimising HS2's whole lifecycle carbon emissions, the approach will continue to be developed and applied to the Proposed Scheme.

Monitoring

9.4.3 There currently is no specific guidance or GHG emissions threshold which if exceeded is considered significant. Nevertheless carbon emissions from relevant construction and operation activities will be monitored as outlined below.

Construction

9.4.4 The draft CoCP requires the nominated undertakers lead contractors to produce carbon management plans detailing 'the approach to energy and carbon dioxide (CO_2) monitoring and reporting from relevant site activities'.

[179] Defra (2018). *Local Air Quality Management Technical Guidance (TG16)*. Available online at: https://laqm.defra.gov.uk/documents/LAQM-TG16-February-18-v1.pdf
[180] The Green Construction Board. *Statement of Endorsement*. Available online at: http://www.greenconstructionboard.org/index.php/resources/infrastructure/statement-of-endorsement
[181] HM Treasury (2013). *Infrastructure Carbon Review*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/260710/infrastructure_carbon_review_251113.pdf

Operation

9.4.5 Carbon dioxide emissions would be calculated and monitored during operation.

In-combination climate change impacts

Mitigation

9.4.6 The HS2 Environmental Policy sets out the Proposed Scheme's principles in relation to climate change as seeking to 'minimise the combined effect of the project and climate change on the environment'.

9.4.7 To address this policy principle the in-combination climate change impacts assessment considers how climate change, in combination with the impacts of the Proposed Scheme, may affect the receiving environment.

9.4.8 The mitigation of potential in-combination climate change effects during construction would be provided by the draft CoCP and existing topic specific mitigation measures. The mitigation of potential in-combination climate change effects during operation would be mitigated by embedded topic specific mitigation measures. Any significant in-combination climate change effects identified during construction or operation would be mitigated by additional mitigation measures address adverse effects on the ability of resources and receptors to adapt to climate change.

9.4.9 The approach to the mitigation of in-combination climate change impacts and effects is further described in the EIA SMR and in Volume 3: Route-wide effects.

Monitoring

Construction

9.4.10 The draft CoCP includes a requirement for the nominated undertaker's lead contractor to monitor extreme weather events during construction.

9.4.11 Monitoring of any significant adverse in-combination climate change effects arising from construction would form part of the aftercare and monitoring strategies for the relevant topics.

Operation

9.4.12 Monitoring of any significant adverse in-combination climate change effects during operation would form part of the operational monitoring strategies for the relevant topics.

Climate change resilience

Mitigation

9.4.13 The HS2 Sustainability Policy defines the Proposed Scheme's approach to climate change as 'building a network which is resilient to climate change in the long-term and adaptable to future trends and demands…'.

9.4.14 To address this policy theme the climate change resilience assessment considers how climate change impacts may affect the resilience of infrastructure and assets associated with the Proposed Scheme.

9.4.15 The mitigation of climate change related risks to HS2 assets and infrastructure during construction would be provided by the draft CoCP and adherence to relevant health

and safety standards. The mitigation of climate change related risks during operation is provided through one or more of the following categories of embedded measures:

- existing resilience measures embedded within the design of the Proposed Scheme;
- measures which would be included in the development of maintenance and monitoring measures for the Proposed Scheme; and/or
- measures which would be considered and developed during appropriate further design stages as not being considered as part of the Proposed Scheme for the formal ES.

9.4.16 The approach to ensuring the resilience of the Proposed Scheme is further described in the EIA SMR and Volume 3: Route-wide effects.

Monitoring

Construction

9.4.17 The CoCP would include a requirement for the nominated undertaker's lead contractor to monitor extreme weather events during construction.

Operation

9.4.18 Requirements for weather and climate change resilience monitoring would be integrated into processes for developing asset management and procurement strategies for the Proposed Scheme.

9.5 Community

Mitigation

9.5.1 The Government has developed a package of property compensation measures over and above statutory requirements.

9.5.2 Significant effects on a community resulting from the loss of public open space or of a community facility can be mitigated in a number of ways, including:

- improvements or alterations to the remaining portion of the public open space (in instances where the public open space is partially occupied);
- improvements to other public open spaces or community facilities in the area;
- improving accessibility to other existing public open space or community facilities; and/or
- 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.

9.5.3 For land used as open space or a community facility is temporarily required for the Proposed Scheme it would be restored to its former use, in agreement with the original owners or users of the land and the local planning authority. For permanent effects mitigation may include provision of compensatory open space or community facilities as part of the design of the Proposed Scheme.

9.5.4 The draft 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.

9.5.5 The specific measures within the draft CoCP for the mitigation of individual noise, air quality, visual and construction traffic effects would also serve to reduce in-combination effects[182] and isolation effects on community facilities, residential properties and open space.

9.5.6 Where there are community effects that cannot currently be mitigated, HS2 Ltd would continue to engage with owners and operators of these facilities to identify reasonably practicable measures to help mitigate the residual significant effects identified in the assessment.

Monitoring

9.5.7 Any construction and operational monitoring requirements in relation to in-combination effects arising from noise, air quality, visual and construction traffic effects have been described in the relevant Sound, noise and vibration, Air quality, Landscape and visual, and Traffic and transport topic sections of this report.

9.6 Ecology and biodiversity

Mitigation

9.6.1 The Proposed Scheme is being designed to avoid or reduce impacts on habitats, species and other features of ecological value where reasonably practicable.

9.6.2 Efforts have been made to reduce the duration, scale and extent of the anticipated effects in instances where avoidance has not been practicable. Appropriate compensation or enhancements will be identified for effects that are still anticipated following mitigation.

9.6.3 Areas are included within the identified extent of the Proposed Scheme where mitigation and/or compensation is required. These areas include:

- receptor sites for habitats and species that would be translocated prior to construction and thus require land that would not be subject to any construction works; and

[182] Significant in-combination 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 in-combination effect.

- areas where habitats of ecological value would be created following the completion of construction.

9.6.4 In accordance with the Ecological Principles of Mitigation set out in the EIA SMR, a route-wide, integrated strategic approach has been developed to compensate for loss of widely distributed habitats, especially woodland and grassland. The habitat creation is required to fulfil the objective of no net loss in biodiversity insofar as reasonably practicable in the local area, as well as to ensure that the populations of protected and priority species are maintained. With these objectives in mind, where reasonably practicable, the locations of habitat creation areas have been selected so as to increase the size of existing higher quality habitat and to increase connectivity.

9.6.5 The Environmental Memorandum (which forms part of the EMRs) will include 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.

9.6.6 Mitigation and compensation to address effects on legally protected species will, where appropriate, include translocation or relocation of species, the provision of replacement habitat and provision of special measures such as underpasses and green bridges to facilitate the movement of species across the route.

9.6.7 Formal applications for derogation licences for protected species would be made once Royal Assent has been received.

Monitoring

Construction

9.6.8 The nominated undertaker would define a programme for undertaking ecological surveys prior to and during construction. The surveys would be used to verify the baseline ecological conditions described in the formal ES, to refine the mitigation and control measures required during construction as appropriate, and to provide appropriate monitoring during construction.

9.6.9 The nominated undertaker would require its contractors to undertake appropriate monitoring of the consequences of construction works on ecological resources and of the effectiveness of the management measures designed to control ecological effects, associated with works that may affect protected or notable species, statutory designated or non-statutory sites of ecological interest. Monitoring would be put in place throughout the habitat establishment period to measure its success. This may need to continue beyond the establishment period.

9.6.10 HS2 Ltd is committed to monitoring the effectiveness of ecological mitigation and compensation measures for a sufficient period to ensure the objectives of the proposals for nature conservation are achieved, as set out in the Environmental Memorandum. An Ecology Review Group would review the outputs of monitoring for habitat creation sites and make recommendations for remedial action where appropriate.

Operation

9.6.11 The nominated undertaker would be required to monitor the effective management and performance of ecological mitigation and compensation measures.

9.7 Health

Mitigation

9.7.1 Design-based interventions to reduce health effects are incorporated through the scheme design and wider EIA process – for example, route design to avoid (where reasonably practicable) residential properties and other sensitive receptors, vertical alignment, incorporation of bunds and other measures to reduce noise and visual effects. The assessment of the incorporated mitigation will be reported in the formal ES. Other, non-design related mitigation measures may be made with regard to the construction process and ongoing management and delivery of the Proposed Scheme. These will be incorporated into the draft CoCP and other HS2 strategies and policies as appropriate.

Monitoring

9.7.2 Any construction and operational monitoring requirements in relation to impacts generated from air quality, noise and vibration, traffic and visual effects that have the potential to influence health have been described in the relevant environmental topic sections in Volume 2: Community area reports and Volume 3: Route-wide effects.

9.8 Historic environment

Mitigation

9.8.1 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 would be implemented to mitigate the impact on such assets.

9.8.2 A Heritage Memorandum would be prepared setting out the commitments of the Secretary of State for Transport to the historic environment and heritage assets. The memorandum provides a framework for the nominated undertaker, Historic England, local authorities and other stakeholders to work together to ensure that the Proposed Scheme is designed and constructed with proper regard to the historic environment. The memorandum would form part of the EMRs (as described in Section 0 of this report).

9.8.3 Route-wide research approaches have been developed by the nominated undertaker in consultation with Historic England and local authorities for Phase One and Phase 2a. A route-wide general written scheme of investigation: historic environment research and delivery strategy (GWSI:HERDS) has also been prepared setting out the research framework and general principles for design, evaluation, investigation,

recording, analysis, reporting and archive deposition to be adopted for the design development and construction of the Proposed Scheme. The document would be revised in consultation with Historic England and the Heritage Subgroup for Phase 2b to reflect the different geographical research objectives. The GWSI:HERDS is supported by strategies, technical standards and procedures that would provide the detailed mechanisms for the delivery of the works. These would be set out as requirements in construction procurement documentation. The process would be carried out and overseen by suitably qualified archaeological and heritage specialists.

9.8.4 The nominated undertaker would record, analyse, report and publish the results of all historic environment investigations, and would archive the resulting records, artefacts and materials in suitable repositories.

9.8.5 The Bill would dis-apply various legislative provisions currently in place for affected designated heritage assets. The Bill would identify the affected assets and will provide an alternative planning mechanism. The nominated undertaker would enter into heritage agreements with local authorities for listed buildings and with Historic England for scheduled monuments. As part of each agreement, a method statement for specified works in relation to these named heritage assets would be submitted to the local authorities and Historic England for agreement within specified timescales.

9.8.6 The Bill would dis-apply the various legislative provisions in instances where construction of the Proposed Scheme would directly affect burial grounds, human remains and monuments. A project-specific regime would be put in place to ensure that all human remains and burial grounds are afforded all due dignity, care and respect. A Burial Grounds, Human Remains and Monuments Procedure would be used to implement these requirements.

9.8.7 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 historic landscape or townscape. Further discussion with other disciplines would be undertaken during detailed design to identify any further measures that can be incorporated to avoid or reduce impacts on heritage assets.

9.8.8 The assessment does not currently predict that any heritage asset is likely to be rendered unviable as a result of the construction and operation of the Proposed Scheme. In the event that such an effect were to occur, potentially leading to dereliction or changes in management affecting heritage significance, mitigation will be addressed on a case by case basis with relevant stakeholders. Mitigation measures will take account of the range of effects that have been identified.

Monitoring

Construction

9.8.9 The nominated undertaker would require its lead contractors to implement appropriate monitoring of the consequences of construction work, as required, on all heritage assets (designated and non-designated) to ensure the effectiveness of management measures and compliance with agreed approaches to construction activities and heritage assets.

9.8.10 Risk assessments identifying appropriate surveys, for example, structural or condition surveys, and settlement and vibration monitoring would be undertaken at locations of archaeological or built heritage interest adjacent to the construction site prior to, during and following construction works. The risk assessments will include, but not be limited to, specific buildings identified in the hybrid Bill and the working draft ES.

Operation

9.8.11 There are no specific monitoring requirements during operation of the Proposed Scheme, although monitoring specified during the construction phase may continue during the operational phase. It is assumed that all heritage assets within the land required for construction will be removed unless expressly excluded as a result of the mitigation process. Noise effects can contribute to setting effects on heritage assets (for example where a quiet rural setting contributes to the significance of the asset). The heritage assessment has drawn on noise modelling to identify where this may be relevant. It is not however at present proposed to monitor noise at any heritage assets specifically in relation to the predicted effects on the asset's heritage value, either during operation or construction.

9.9 Land quality

Mitigation

9.9.1 Mitigation of the effects of pre-existing contaminated soils or groundwater would mainly take place as close to the point of excavation/deposition as possible and take the form of various established methodologies for soil and groundwater remediation, such as:

- soil washing;
- soil stabilisation;
- reed beds;
- bio-remediation; and
- in-situ or ex-situ groundwater treatment.

9.9.2 Soils that are not responsive to in-situ or ex-situ treatment would be deposited within a suitably licensed landfill, in the expected small number of cases where this occurs.

9.9.3 Appropriate remediation methods would be used to minimise contamination mobilisation, such as vertical and horizontal barriers (for ground gases and leachates within old landfills), and soil cover systems. Where piling through contaminated soils is required, appropriate piling techniques and preventative measures would be adopted to mitigate the potential for contaminant migration.

9.9.4 Methods to mitigate temporary effects during the process of remediation, within the construction period, are described in the draft CoCP.

9.9.5 Mitigation measures for sand, gravel, clay and building stone mineral resources may include prior extraction of the resource for use within the Proposed Scheme or elsewhere. A plan would be discussed and agreed in advance with relevant

mineral/landowners, mineral planning authorities and other stakeholders to help manage affected minerals, where this is reasonably practicable.

9.9.6 Mitigation measures for hydrocarbon mineral resources would require discussion with relevant stakeholders. A plan would be discussed and agreed in advance with relevant Petroleum Extraction and Exploration Licence (PEDL) holders, mineral planning authorities and other stakeholders to help manage affected areas, where this is reasonably practicable.

9.9.7 Mitigation measures for areas of brine extraction and deep and shallow coal mining are likely to include a programme of grouting. This in turn may lead to potentially contaminative impacts, such as mobilisation of acidic mine water (acid mine drainage) and/or mine gases which would need to be taken into account.

Monitoring

Construction

9.9.8 The nominated undertaker would require gas, groundwater and/or leachate monitoring procedures to be implemented, as appropriate, in contaminated land, which may comprise landfill, made ground, former and existing industry sites, quarries and naturally occurring gassing strata.

9.9.9 Groundwater and surface water monitoring plans would be prepared, as appropriate, by the lead contractors as part of their EMS, in the vicinity of contamination remediation works, or where a piling risk assessment has indicated a potential effect on below ground contamination.

9.9.10 Monitoring of any works that have the potential to impact identified geological resources would be carried out. Such procedures would be agreed in consultation with stakeholders for any works which may affect geological SSSI or LGS, including inspections, the appropriate recording of geological information, and mapping of soil and rock exposures.

9.9.11 Monitoring of any works that have the potential to impact identified mineral resources would be carried out. Such procedures would be agreed in consultation with the relevant licence holders and stakeholders.

9.9.12 Appropriate health, safety and environmental monitoring would be set out to support adherence to the procedures relating to working on or adjacent to land affected by contamination.

Operation

9.9.13 During the operational phase, monitoring works (such as for groundwater and landfill gas) would continue, where required, in order to demonstrate the effectiveness of any remedial works, or as part of a strategy of any agreed Monitored Natural Attenuation (MNA) programme.

9.10 Landscape and visual

Mitigation

9.10.1 Measures to mitigate landscape and visual impacts are part of an integrated design approach that includes consideration of engineering requirements, environmental

considerations and best practice design. The landscape design proposals for the Proposed Scheme incorporate mitigation measures for landscape, noise, ecology, agriculture, cultural heritage and open space.

9.10.2 Mitigation measures are being developed to:

- avoid or reduce effects on the character of the landscape, including valued, designated and historic landscape features and their settings;
- seek to enhance such resources where appropriate and to secure wider landscape, green infrastructure and ecological connectivity; 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 design and mitigation is being considered at a strategic scale to help integrate the Proposed Scheme into the surroundings. Specific measures include:

- design of earthworks to achieve visual screening, integration of the route of the Proposed Scheme by reflecting the character of local topography, and to facilitate the restoration of agricultural land where appropriate;
- provision of new planting to connect with existing woodland and vegetation, reinstatement of lost historic planting where possible, reconnecting to locally fragmented woodland or vegetation/habitats, as well as to provide habitat creation and contribute to HS2 Ltd's policy aspiration for the Green Corridor;
- design of earthworks and large-scale planting to help integrate new structures, such as bridges, viaducts, depots and ancillary structures such as ATFS, into the landscape;
- provision of compensatory greenspace where this is affected by the Proposed Scheme, and to contribute to wider green infrastructure connectivity and the aspirations of the Green Corridor, wherever possible;
- design of new, diverted or realigned roads and PRoW to reconnect lost routes, integrate into wider access networks and promote walking and cycling initiatives;
- design of noise mitigation earthworks to ensure good fit with the local landscape;
- design of diverted watercourses, balancing ponds and ecological ponds to ensure integration with the local landscape and the promotion of multi-functional green infrastructure; and
- provision of public realm, including tree planting and green space in urban areas, to help integrate new railway stations and associated operational requirements into their local context, and to contribute to urban green infrastructure networks and city resilience.

9.10.4 The design or external appearance of new structures would be subject to the approval of the relevant local authority.

9.10.5 Mitigation would also reduce the effects of construction through, for example, advance planting, temporary screening or earthworks. Temporary or permanent mitigation would be installed at the earliest opportunity, where appropriate and reasonably practicable. Planting away from the route would also be established to reduce adverse landscape and visual effects, where this is appropriate to landscape character and context.

9.10.6 The nominated undertaker would maintain landscape areas within the rail corridor to an appropriate standard. The aim is to ensure that planting successfully establishes and develops, so that it achieves and maintains its mitigation objective. The new areas of woodland, grassland and wetland planting created along the route of the Proposed Scheme would be maintained.

9.10.7 Areas of mitigation provided outside the rail corridor would, 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 would 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) would be carried out on a regular basis to determine whether it poses a risk to the safe operation of the railway. Maintenance operations would ensure that trees within all operational land (and adjoining land if applicable) cannot fall onto the track, overhead lines or other line-side equipment.

Monitoring

Construction

9.10.9 The nominated undertaker would require its contractors to implement appropriate monitoring of any new advanced permanent or temporary planting to ensure they become established and are properly maintained throughout the construction period.

9.10.10 The nominated undertaker would supply its contractors with information prior to construction to verify the landscape planting design and requirements as set out in the ES, on drawings and in the specification. This would allow the contractor(s) to fully understand the required landscape mitigation measures.

9.10.11 Further information on inspection, monitoring and maintenance requirements of planting and seeding works throughout the construction period can be found in Section 12.4 of the draft CoCP.

Operation

9.10.12 The nominated undertaker would monitor all new landscape areas to ensure that all planting (woodlands, grasslands, wetlands and hedgerows) successfully establishes and develops, so that it achieves its wide range of functions and remains effective thereafter.

9.10.13 Any third parties undertaking the maintenance of landscape areas outside the rail corridor would also be required to undertake monitoring to ensure that the necessary management objectives are met.

9.10.14 Further detail on the successful establishment and maintenance of all planting (advanced permanent or temporary and planting in operation) is described in the HS2

Landscape Design Approach, (which guides and directs the development of integrated and multifunctional landscape design solutions along the route of the Proposed Scheme).

9.11 Major accidents and disasters

Mitigation

9.11.1 Management and mitigation of safety risks is a fundamental concept of the Proposed Scheme, embedded in HS2 Ltd's legal and contractual obligations as well as its management frameworks. The guiding principle is to manage all risks to be as low as reasonably practicable. A number of UK legislative requirements and EU regulations must be complied with, to demonstrate the management of safety risks throughout the design, management, operation and maintenance of the Proposed Scheme.

9.11.2 Measures to mitigate health, safety and environmental risks related to the potential for major accidents and disasters during construction and operation of the Proposed Scheme would be embedded through technical standards and specifications for the Proposed Scheme.

Monitoring

Construction

9.11.3 The draft CoCP includes a requirement to monitor weather events and make due consideration of the potential impacts of extreme weather events and related conditions.

9.11.4 Specific monitoring solutions, for example during tunnelling activities would be developed as part of detailed design.

Operation

9.11.5 A rigorous safety management system (SMS) would be established and adhered to as part of the Proposed Scheme. This is a requirement of the Railways and Other Guided Transport Systems (Safety) Regulations 2006[183]. The SMS would record adverse incidents and monitor these in order to take appropriate action where appropriate.

9.12 Socio-economics

Mitigation

9.12.1 Businesses displaced by the Proposed Scheme would be compensated within the provisions of the Compensation Code. This recognises that businesses displaced from their existing premises by compulsory purchase would usually seek to relocate to another site. The code provides for the cost of such relocation to be taken into account under the heading of disturbance compensation.

9.12.2 The 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

[183] Railways and Other Guided Transport Systems (Safety) Regulations 2006 (ROGS) 2006. Her Majesty's Stationery Office, London.

relocate to new premises and would offer appropriate support to facilitate this process, as it has done on Phase One and Phase 2a.

9.12.3 All reasonably practicable steps are and will be undertaken to limit the impact of the Proposed Scheme on existing businesses.

9.12.4 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 accessing employment opportunities. HS2 Ltd at this stage assumes that it would, therefore, adopt a policy to work with its suppliers to build a skilled workforce that promotes further economic growth across the UK as it has done on Phase One and Phase 2a.

9.12.5 No further mitigation of significant temporary in-combination effects has been identified at this stage. However, the measures set out in the draft CoCP would provide further mitigation for individual significant effects (noise, vibration, air quality, visual, construction HGV traffic) on a case-by-case basis.

Monitoring

9.12.6 Where there are likely residual significant effects at existing businesses, the specific operational monitoring requirements in relation to noise, vibration, construction HGV traffic, air quality and visual effects are described in the relevant Air quality, Sound, noise and vibration, Landscape and visual, and Traffic and transport topic sections in Volume 2: Community area reports and Volume 3: Route-wide effects.

9.13 Sound, noise and vibration

Mitigation

Introduction

9.13.1 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.

9.13.2 The Proposed Scheme is being designed to manage and control the impact of railway noise and vibration and so far as is reasonably practicable:

- avoid significant adverse effects on health and quality of life due to noise or vibration;
- mitigate and minimise adverse effects on health and quality of life due to noise or vibration and hence avoid or reduce likely significant effects identified on a community due to noise change arising from the Proposed Scheme; and
- contribute to improvements to health and quality of life by reducing, where possible[184], existing exposure to noise or vibration through the provision of mitigation.

[184] HS2 Ltd will engage with the Competent Authorities responsible for the Important Areas identified in Defra's Noise Action Plans for: Agglomerations (large urban areas) (2014) Department for Environment, Food & Rural Affairs (Defra); Roads (including major roads) (2014) Department for Environment, Food & Rural Affairs (Defra); or Railways (including major railways) (2014) Department for Environment, Food & Rural Affairs (Defra).

9.13.3 Mitigation of likely significant adverse noise or vibration effects is, where practicable, being incorporated into the Proposed Scheme in the following order since they would reduce effects on the environment as a whole, and on amenity, as well as inside properties:

- through alignment design: that is, keeping the railway as far from as many sensitive receptors as possible (whilst taking into account other environmental impacts and engineering considerations);
- 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
- then by reducing noise entering property.

9.13.4 Preference has been given to the most sustainable means of providing the necessary noise mitigation. For example, providing a noise barrier in a rural location by a landscape earthwork is, where reasonably practicable, preferred to a noise fence 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.

Construction

9.13.5 Construction noise and vibration would be controlled and managed in accordance with the draft CoCP as described in Section 6.3 of this report.

Operation

9.13.6 The development of the Proposed Scheme has sought to keep the route alignment as low as reasonably practicable and away from main communities. These avoidance measures would protect many communities from likely significant noise or vibration effects.

Airborne noise

9.13.7 Through the procurement process for the trains and the track, the use of proven international technology would enable the railway to be quieter than implied by current minimum European standards. Details of operational train noise will be provided in the formal ES. 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 where reasonably practicable. Overall it is assumed that proven international technology would reduce noise emissions by approximately 3dB at 360kph (225mph) compared to the current minimum European standards[185].

[185] Technical Specification for Interoperability (TSI) Noise – EU Commission Regulation No 1304/2014

9.13.8 Noise effects would be reduced in other locations along the line by landscape earthworks provided to avoid or reduce significant visual effects and engineering structures such as cuttings.

9.13.9 Tunnel portals are designed to avoid significant airborne noise effects caused by the trains entering the tunnel.

9.13.10 Significant noise effects from the operational static sources such as line-side equipment, station ventilation equipment and public address systems would be avoided through their design and the specification of noise emission requirements.

9.13.11 The Proposed Scheme would include noise barriers in the form of landscape earthworks, noise fence barriers and/or parapet barriers on viaducts to avoid or reduce significant airborne noise effects. Such mitigation will be identified taking account of:

- environmental and health benefit;
- cost;
- engineering practicability;
- other environmental effects caused by the further noise mitigation; and
- responses from consultation and stakeholder engagement (such as a stated preference for a noise barrier in the form of landscape earthworks rather than a fence).

9.13.12 Noise insulation measures would be offered for qualifying buildings as defined in the Noise Insulation (Railways and Other Guided Transport Systems) Regulations 1996[186]. The assessment reported in the formal ES will provide an estimate of the buildings that are likely to qualify under the Noise Insulation Regulations. Qualification for noise insulation under the Noise Insulation Regulations is identified and noise insulation offered in time to enable it to be installed when the Proposed Scheme becomes operational.

9.13.13 Where required, as well as improvements to the noise insulation of windows facing the railway, ventilation would be provided so that windows can be kept closed to protect internal sound levels.

9.13.14 Following Government's 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 World Health Organisation (WHO) Night Noise Guidelines for Europe[187], 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 assessed[188]. The WHO Interim Target is set at a lower level of noise exposure than the Noise Insulation

[186] The Noise Insulation (Railways and Other Guided Transport Systems) Regulations 1996. Her Majesty's Stationery Office, London.
[187] World Health Organization (2010). Night Noise Guidelines for Europe. Available online at: Available online at: http://www.euro.who.int/__data/assets/pdf_file/0017/43316/E92845.pdf
[188] 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 LpAFmax (where the number of train pass-bys exceeding this value is less than or equal to 20); or 80 dB LpAFmax (where the number of train pass-bys exceeding this value is greater than 20).

Regulations trigger threshold for night noise. In these particular circumstances, following the methodology set out in the Noise Insulation Regulations (i.e. pertaining to new or additional railways) where night-time noise levels are predicted to exceed 55dB[189], or the maximum noise level (dependent on the number of train passes) as a train passes exceeds this criterion (in line with the EIA SMR), noise insulation would be offered for these additional buildings.

Ground-borne noise and vibration

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

9.13.16 Operation of modern high speed railways has demonstrated that it is unlikely that vibration from the operation of the Proposed Scheme would present any risk of building damage.

9.13.17 The occurrence of high levels of vibration from ' Rayleigh or bow waves' (analogous to the bow waves caused by a ship on the surface of the water) is a rare situation which can occur where trains are travelling at a speed, known as the critical speed, over a railway situated on very soft ground. The critical speed is dependent on the ground conditions below and is not confined to high speed railways. This phenomenon is well understood is mitigated by appropriate design and construction techniques (e.g. HS1 across Wennington Marshes). Where this could occur, measures such as soil strengthening or bridging over soft ground to ensure bow waves do not adversely affect train operations, or damage the infrastructure, would be incorporated. Experience from the design and environment assessment of HS2 Phase One indicates that any effects are unlikely to be significant.

Monitoring

Construction

9.13.18 The nominated undertaker would require its contractors to undertake and report monitoring, including real-time noise and vibration monitoring, as is necessary to ensure and demonstrate compliance with all noise and vibration commitments and the requirements of the CoCP. The monitoring and compliance assurance process would be set out in each of the lead contractors' noise and vibration management plans. Proposals for monitoring locations would be set out in each LEMP. The Section 61 applications under the Control of Pollution Act 1974 would include a detailed description of the monitoring and monitoring locations proposed for the particular works covered by the consent application. Monitoring data would be provided regularly to and reviewed by the nominated undertaker and would be made available to the local authorities.

Operation

9.13.19 Noise and vibration monitoring would be carried out at different times during the lifetime of the Proposed Scheme at a combination of appropriate monitoring locations including: adjacent or attached to moving vehicles, at fixed positions or in

[189] Equivalent continuous level, LpAeq,23:00-07:00 measured without reflection from the front of buildings

the vicinity of individual assets; and locations within the surrounding areas and communities alongside the rail corridor. These data, together with noise and vibration measurements would be used to monitor the operational noise and vibration performance of the Proposed Scheme.

9.13.20 Where noise and vibration performance deviates from expected conditions, either this information would be used to inform possible improvements (where measurements indicate better-than-expected performance), or investigations would be undertaken to inform reasonable remedial measures (where measurements indicate worse-than expected performance).

9.13.21 The expected noise and vibration performance of the Proposed Scheme, operational noise and vibration measurement data, associated asset information, description of corrective actions, results of measured performance compared to expected conditions, and monitoring reports would be shared with the relevant local authorities at appropriate intervals.

9.14 Traffic and transport

Mitigation

Construction

9.14.1 The draft CoCP sets out various mitigation measures to reduce the impact of construction traffic. These include:

- traffic management measures and plans, which would be prepared in consultation with the highway and transport authorities and emergency services;
- an approach to reduce the impacts of temporary road and PRoW closures or disruption to railways or navigable waterways;
- use of site haul routes for construction vehicles within the construction sites to reduce the need to use public roads;
- management procedures to reduce the impact of construction traffic such as: agreed routes for construction (HGV) vehicles; and use of the main road network (e.g. motorways and strategic trunk roads and other primary 'A' roads) where reasonably practicable; and
- workplace travel plans to reduce employee movements to/from construction sites and compounds.

9.14.2 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. Traffic diversions would be provided where temporary road closures are required.

9.14.3 New highway crossings of the Proposed Scheme would be built offline, where reasonably practicable, so that they can be completed prior to closure of the existing road. This would avoid or substantially reduce disruption to road users. A diversionary

route and temporary bus stops (where necessary) would be identified for bus routes affected by temporary road closures.

9.14.4 During the construction phase, PRoW routes would be maintained operational where reasonably practicable. Where routes would cross the Proposed Scheme and would be required to be diverted, generally the alternative PRoW crossing of the Proposed Scheme would be constructed prior to any closure of existing routes. Where routes would cross the Proposed Scheme in proximity to the existing route, a temporary alternative alignment may be required before the new crossing on the existing alignment is available. In some instances, PRoW routes may need to pass through construction compounds and interface with the site haul route. Where this is necessary, the movement through the compounds and across site haul routes would be managed to minimise any conflict with construction vehicles and to provide safe routes for users.

9.14.5 It would be necessary to close, realign or divert certain local roads and PRoW along the Proposed Scheme, both during construction and, in some cases, permanently. In these cases, alternative routes would be available either through the use of temporary alternative routes or the existing wider network.

9.14.6 Temporary highway measures including junction improvements, passing places and carriageway widening to manage the safe passing of construction vehicles would be provided to avoid impacts that could otherwise occur. Further information is provided in the Volume 2: Community area reports and, where these are off-route and known at this stage, in the Volume 4: Off-route effects report.

9.14.7 Construction vehicles would be routed along the strategic and/or primary road network and, insofar as reasonably practicable, the use of the local road network would be limited to use for site set-up, access for surveys and on-going servicing (including refuse collection and general deliveries to compounds) during construction. The use of roads as main construction routes would be subject to approval processes through local planning authorities.

9.14.8 Temporary workers' accommodation provided at construction compounds would reduce the level of construction employee traffic travelling to and from the compounds during the week and would encourage off-peak travel.

9.14.9 Where reasonably practicable, movement of construction material, machinery and/or construction workers between the construction compounds and work sites would be via site haul routes. These site haul routes would reduce the need for construction vehicles to use the public road network, therefore helping to reduce traffic related impacts.

9.14.10 The need for mitigation will be considered for adverse impacts that could occur at some distance from the Proposed Scheme. Where appropriate, these will be reported in the Volume 4: Off-route effects report of the formal ES.

Framework travel plan

9.14.11 An over-arching framework travel plan will be developed. This will be based on the framework travel plan for HS2 Phase One and Phase 2a and amended where relevant for the Proposed Scheme. It will require travel plans to be produced that would

include a range of potential measures to mitigate the impacts of traffic and movements associated with construction, maintenance and operation of the Proposed Scheme. The scope of this will include:

- a construction workforce travel plan – the framework will:
  - inform site-specific plans that the lead contractors will be required to produce;
  - aim to reduce workforce commuting by private car, especially sole occupancy; and
  - encourage the use of sustainable modes of transport, where practicable.

Operation

9.14.12 The following measures have been included as part of the design of the Proposed Scheme and would avoid or reduce impacts on transport users:

- HS2 stations would include provision for access by sustainable mode, including public transport, walking and cycling to promote non-car access;
- Improvements to the highway and public transport network to accommodate users of the HS2 services;
- reinstatement of roads on or close to their existing alignments, where reasonably practicable; and
- replacement, diversion or realignment of PRoW if relevant.

9.14.13 Specific station travel plans for each high speed station would include measures that aim to reduce the impacts and effects of traffic and transport movements.

9.14.14 Specific depot travel plans for each high speed depot would include measures that aim to reduce the impacts and effects of traffic and transport movements.

Monitoring

Construction

9.14.15 The nominated undertaker would require its contractors to undertake the necessary monitoring to ensure compliance with the requirements of the CoCP, associated Local Traffic Management Plans (LTMPs) and construction travel plans. Details of any monitoring programme, the approach to regular consultation with relevant highway authorities and emergency services and the control processes would be set out in any LTMPs and construction travel plans by the lead contractors' EMSs.

Operation

9.14.16 Station travel plans or depot travel plans for the HS2 stations or depots would detail monitoring of travel associated with operation of the relevant HS2 station or depot.

9.14.17 There are no other area-specific monitoring requirements currently identified for traffic and transport.

9.15 Waste and material resources

Mitigation

9.15.1 Sustainable materials would be sourced and made efficient use of for construction of the Proposed Scheme. The aim is to minimise waste and maximise the proportion of material diverted from landfill.

9.15.2 The principles of the waste hierarchy would 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.

9.15.3 The principles of the circular economy would be proactively considered throughout specification, design, procurement, construction and operation of the Proposed Scheme, in accordance with the HS2 Circular Economy Principles. The circular economy is an alternative approach to the typical 'linear' way of using resources. By finding opportunities of remanufacturing, reusing or recycling materials and keeping them in use for longer, both resource use and waste generation can be reduced.

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

9.15.5 The nominated undertaker would seek to provide any surplus excavated material that arises and which is not required for reuse within the Proposed Scheme:

- for use in other construction projects, where opportunities arise at the time of construction; and/or
- for use for restoration of mineral sites, where the transportation of that material does not result in significant environmental effects.

9.15.6 Further opportunities would be investigated during detailed design for the prevention, management and treatment of waste during the operational phase of the Proposed Scheme.

Monitoring

Construction

9.15.7 Monitoring of waste management activities would be undertaken by lead contractors in accordance with Section 15.3 of the draft CoCP.

9.15.8 An effective and robust programme for recording appropriate waste metrics would be established and undertaken by contractors. Recording and reporting enhanced resource and waste data would improve awareness, and focus the management of waste.

Operation

9.15.9 Monitoring of waste management activities would be undertaken by train operating companies and other users of the Proposed Scheme in accordance with statutory requirements.

9.16 Water resources and flood risk

Mitigation

9.16.1 The principal strategy adopted to limit the temporary and permanent effects associated with the Proposed Scheme is through avoidance of sensitive surface water and groundwater resources and flood risk receptors wherever reasonably practicable. Where receptors could not be avoided, mitigation measures would be incorporated, where necessary, to limit the potential effects. The draft CoCP includes a range of mitigation measures that are suitable to reduce construction impacts as far as is reasonably practicable. The measures that are particularly relevant to each community area are described within the Volume 2: Community area reports.

9.16.2 Where the Proposed Scheme has the potential to increase flood risk, its design will reflect the approach required by the NPPF and the supporting practice guidance. The aim is for there to be no increased risk of flooding for vulnerable receptors during the lifetime of the Proposed Scheme, taking projected climate change impacts into account. If required, the design will mitigate any loss of floodplain by creating replacement flood storage areas for the one in 100 (1%) annual probability flood, with an allowance for climate change.

9.16.3 The design of the Proposed Scheme will seek to ensure that controlled waters - rivers, streams, canals, lakes, ponds, ditches and groundwater - are protected from pollution and that appropriate water quality standards are met.

9.16.4 Sustainable drainage systems would be used to control the rate, volume and quality of runoff from the rail corridor and other infrastructure, taking projected climate change impacts into account. These systems would encourage storm water to soak into the ground or, where that is not reasonably practicable, discharge it into the wider water environment at a rate that matches existing runoff rates.

9.16.5 The detailed design of watercourse diversions, watercourse realignments and of culverts will be developed in general accordance with CIRIA and Environment Agency guidance and in consultation with the relevant consenting authority.

9.16.6 Engagement has been, and will continue to be, undertaken with the Environment Agency, Lead Local Flood Authorities, water companies and the Canal & River Trust, to ensure that likely residual significant adverse effects are managed and mitigated appropriately.

Monitoring

Construction

9.16.7 The nominated undertaker would require its lead contractors to implement appropriate surface water and groundwater inspection and monitoring procedures as part of their EMS. This would include, but not be limited to, procedures to monitor the effectiveness of the mitigation measures associated with potentially significant effects outlined in the Volume 2: Community area reports, Section 15.

9.16.8 Requirements would cover monitoring of potentially adverse impacts on WFD water bodies identified in the latest version of the WFD compliance assessment, including:

- quantitative or chemical impacts on groundwater bodies;
- water quality (physico-chemical) and quantitative (flow/level) impacts on surface water bodies; and
- hydromorphological impacts on surface water bodies.

9.16.9 The nominated undertaker would require its contractors to consult the Environment Agency regarding water quality, flow and level monitoring to be undertaken for watercourses and groundwater that would be affected by construction works or discharge of surface water runoff, which would include the following, as appropriate:

- pre-construction monitoring to establish baseline water quality conditions for watercourses and groundwater;
- monitoring during construction works to enable the effectiveness of mitigation measures to limit pollution risk to be monitored and any pollution incidents to be identified; and
- monitoring of watercourses or groundwater receiving surface water runoff during construction to enable the effectiveness of treatment and other sustainable drainage systems measures to be determined and to ensure that an unacceptable rise in groundwater levels does not occur.

9.16.10 The nominated undertaker would require its contractors to undertake monitoring to identify:

- pollution risks that are unacceptably high;
- spillages and leakages;
- non-compliance with the CoCP; and
- suspected pollution incidences.

9.16.11 Appropriate actions would be taken where pollution risks are unacceptably high, where there is non-compliance with the CoCP, where spillages and leakages are unacceptable or where there are any suspected pollution incidents.

9.16.12 Groundwater monitoring would be undertaken at any groundwater sensitive areas, as required, to inform the detailed design of the Proposed Scheme and the development of construction methods to mitigate potential impacts.

9.16.13 The contractors would also consult with the relevant regulatory body regarding the pollution incident control plan which would set out the measures to be implemented to address any adverse findings from the monitoring procedures during and following completion of construction works.

Operation

9.16.14 The nominated undertaker would be responsible for ensuring that monitoring is undertaken for agreed periods to confirm the efficacy of implemented mitigation.

This would include monitoring of potentially adverse impacts on WFD water bodies identified in the latest version of the WFD compliance assessment, including:

- quantitative or chemical impacts on groundwater bodies;
- water quality (physico-chemical) and quantitative (flow/level) impacts on surface water bodies; and
- hydromorphological impacts on surface water bodies.

9.16.15 The duration of this monitoring would be agreed with the Environment Agency and would depend on the nature of the potential impact concerned.

9.16.16 Provided the construction phase mitigation proves effective, as demonstrated through post-construction monitoring, the remaining measures comprise procedures for inspection, operation and maintenance of the Proposed Scheme.

10 Strategic, route-wide and route corridor alternatives

10.1 Introduction

Background

10.1.1 This section of the report sets out the background to the alternatives studied by HS2 Ltd and DfT during development of the Proposed Scheme, and describes the strategic, route-wide and route corridor alternatives. A more detailed account of these alternatives, how they were studied and the reasons for the choices made can be found in the Alternatives report (a supporting document to this working draft ES).

10.1.2 This working draft ES does not set out the alternatives to the proposed Y network, as they were presented in Volume 1 and the Alternatives report for the Phase One ES published in November 2013. A summary of the strategic alternatives to the proposed Y network is set out in Section 10.2 of this report.

10.1.3 Local alternatives studied prior to the Government's announcement of the 2017 preferred route for Phase 2b in July 2017 are addressed in Section 11 of this report. Local alternatives studied since July 2017 are addressed in the Volume 2: Community area reports. Further details on local alternatives studied both prior to and since July 2017 can also be found in the Alternatives report.

Regulatory requirements

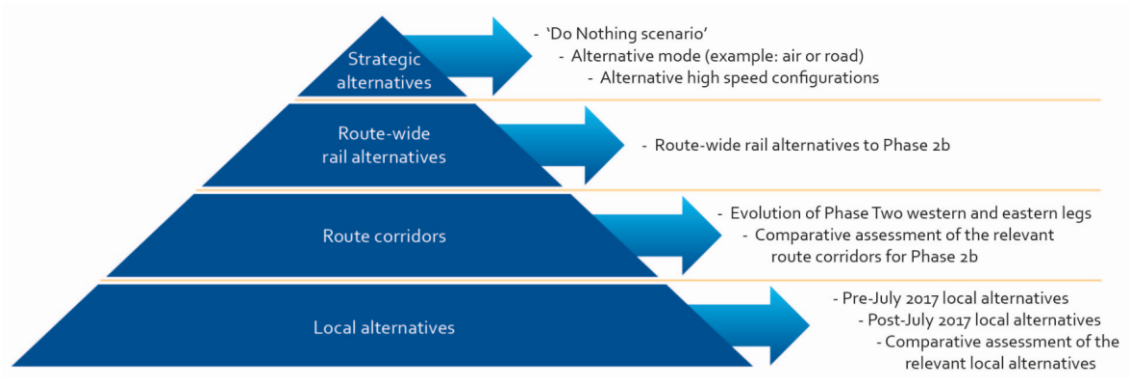
10.1.4 The EIA Regulations require an ES to include:

"A description of the reasonable alternatives studied by the developer, which are relevant to the proposed development and its specific characteristics, and an indication of the main reasons for selecting the option chosen, taking into account the effects of the development on the environment."

Definition of alternatives

10.1.5 The alternatives reported here are grouped into categories, as shown in Figure 39.

Figure 39: Hierarchy of alternatives considered



10.2 Strategic alternatives to the Y network previously studied

10.2.1 As set out in the HS2 Phase One ES published in November 2013, the Government has concluded that action is needed to meet the future travel needs of Britain and 'doing nothing' is not an option.

10.2.2 Before deciding to proceed with HS2, a wide range of options to address Britain's inter-urban transport challenges were reviewed. These included domestic aviation, new motorways, a new conventional speed railway as well as upgrades to existing roads and railways.

10.2.3 The potential for capacity upgrades to the existing conventional rail network has been explored. The Government rejected this option as further upgrades will not provide the scale of capacity increase and connectivity benefits needed to fulfil the Government's objectives. This would also fail to meet Government objectives for future performance of the conventional rail network and would cause considerable disruption to existing train services during construction.

10.2.4 Carbon emissions from air travel are significantly greater than from high speed rail. The capacity of London's airports is limited and providing for future growth in international travel will be a significant challenge without also serving additional demand from domestic air services. The Government's policy therefore is to enable and encourage more people to take the train instead of air for domestic and short-haul journeys, to achieve environmental benefits and to release capacity at airports for longer journeys.

10.2.5 The Government also decided not to give further consideration to major new motorways as an alternative to HS2, as high speed rail is preferable in terms of both capacity and journey times and has lower carbon emissions and environmental effects.

10.2.6 The cost of a new conventional speed railway would be almost as high as those of high speed rail without delivering the reduced journey times and would have only marginal environmental benefits. For these reasons, a new conventional rail line option was rejected. Prior to the introduction of the Phase One Bill into Parliament in November 2013, the Government considered and reported on alternative configurations of its proposed high speed rail Y network. The Government's conclusions and its reasons for promoting the Y network were reported both in the Command Paper *High Speed Rail: Investing in Britain's Future* and in the ES deposited in Parliament alongside the Phase One Bill in accordance with standing orders. The Phase One Bill was enacted in February 2017.

10.3 Strategic alternatives to the Proposed Scheme

Do nothing

10.3.1 Consideration of 'doing nothing' for the whole of the Y network is provided by the HS2 Phase One ES Alternatives Report[190].

10.3.2 For Phase 2b, the 'do nothing' scenario implies not delivering the Proposed Scheme between Crewe and Manchester and between the West Midlands and Leeds, nor connections to the WCML, ECML or MML. However, the Government has concluded that action is required to meet the rising demand for inter-city rail travel, and reduce crowding and congestion on the existing conventional rail network, to support economic growth. 'Doing nothing' is therefore not considered an option[191].

Alternative modes – air or road

10.3.3 Consideration of alternative modes of transport to high speed rail is provided by the HS2 Phase One ES Alternatives Report.

10.3.4 The Government considers that a continuing increase in demand will create a need over the next 20 to 30 years for additional capacity to cater for inter-city journeys between London and the major conurbations in the Midlands and the North. It does not, however, believe transferring rail demand to road or domestic aviation to be an appropriate solution. Rather, the Government considers that it is the rail network which needs to be in a position to play the lead role in delivering new capacity and that a clear case exists for this new capacity to be a new high speed rail network.

10.4 Route-wide rail alternatives

Background

10.4.1 The DfT commissioned a study to assess the route-wide rail alternatives to Phase 2b of HS2 in November 2016[192]. Building on previous work undertaken in 2013[193], five options, that all tried to varying degrees to overcome capacity and journey time limitations on the WCML, ECML, and MML, were developed and considered against the Proposed Scheme and a 'do minimum' (with Phase 2a) scenario.

10.4.2 The options considered (Option 1, Option 2S, Option 2L, Option 3 and Option 4) required a range of different combinations of infrastructure upgrades and sections of new track to deliver improved journey times and similar train frequencies to the Proposed Scheme. For the eastern leg to Leeds, the five options reflected the different ways of reaching Edinburgh, Leeds and Nottingham, whereas for the western leg to Manchester, one single infrastructure option was considered based on infrastructure upgrades to the WCML north of Crewe, with slight train service

[190] HS2 Ltd (2013), *HS2 Phase one environmental statement volume 5: alternatives report.* Available online at: https://www.gov.uk/government/publications/hs2-phase-one-environmental-statement-volume-5-alternatives-report
[191] Department for Transport (DfT), (2012), *High Speed Rail: Investing in Britain's Future – Decisions and Next Steps*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/3648/hs2-decisions-and-next-steps.pdf
[192] Atkins (2016). *Strategic Alternatives to HS2 Phase 2b. A report for the Department for Transport*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/568309/strategic-alternatives-to-hs2-phase-2b-atkins-report.pdf
[193] Atkins (2013). *HS2 Strategic Alternatives: Final Report*. Available online: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/253456/hs2-strategic-alternatives.pdf

specification variations to take into account the options considered for the eastern leg to Leeds.

10.4.3 Alternatives to the western leg assumed that Phase 2a would have been built and that it would be necessary to utilise Manchester Victoria Station, rather than Manchester Piccadilly Station, to delivery sufficient capacity. On the eastern leg to Leeds, all of the route-wide rail alternatives would require a new electrified and upgraded link from HS2 Phase One to the existing conventional Birmingham to Derby Railway. All alternatives on the eastern leg would serve the East Midlands via Derby and Nottingham (not via East Midlands Hub station) in order to match the proposed Phase 2b train service specification as far as possible. All the alternatives examined would serve Sheffield Midland Station via upgrading the existing conventional Derby to Sheffield Line.

Option 1

10.4.4 Option 1 would require upgrades to the WCML north of Crewe and would provide (as would Option 4) one additional service to Manchester relative to Options 2S, 2L and 3.

10.4.5 Upgrades to the ECML would be required in order to reach Leeds, York and Newcastle. Option 1 would require the most investment and upgrades along the ECML compared to the other route-wide rail alternatives considered. The line speed along the ECML would be increased from a current maximum speed of 201kph (125mph) to 225kph (140mph) for this option to broadly match journey times along the eastern leg of the Proposed Scheme. City centre stations at Nottingham and Sheffield would be reached via an improved MML route from Trent Junction, which would connect to Phase One via an upgrade of the existing conventional railway via Burton and would involve mainly four tracking and a new connection to Phase One near Birmingham.

10.4.6 The key elements of this option are summarised as follows:

- western leg to Manchester:
  - partial four tracking of the Crewe (Wilmslow) – Weaver Junction on the WCML and provision of an alternative freight route via Sandbach;
  - substantial grade separated junction between Crewe and Preston on the WCML and some platform lengthening so trains can split and join at both stations; and
  - a chord from Phase One that would allow two trains per hour to connect with the WCML Stoke branch via Stone to Manchester Piccadilly Station.
- eastern leg to Leeds:
  - four tracking of the existing two track ECML through Welwyn North and modifications to local signalling;
  - replacement of the existing flat crossing at Newark with a grade separated junction to allow movement of trains to, and from, Nottingham;
  - provision of a grade separation junction in the Doncaster area to allow for the east-west running of trains and the north-south running of freight services;

- upgrades, to the eastern side of the HS2 main line at Darlington, including the provision of loops, to provide extra capacity for the running of trains along the ECML;
- grade separation of the Trent and Stenson junctions on the MML;
- upgrades to the MML to improve capacity and speed between Derby and Sheffield; and
- upgrades to the MML between Trent Junction and Nottingham, and connection to Phase One via mainly four tracking of the existing conventional railway via Burton.

Option 2S and 2L

10.4.7 Like Option 1, both Options 2S and 2L western leg train services would run along the WCML, although the Stoke via Stone chord would not be required as only one conventional train per hour would operate via Stoke between Manchester and London Euston Station. The WCML services would broadly match those designed for the Proposed Scheme, albeit at a lower speed and sometimes with less capacity per train.

10.4.8 Like Option 1, both Options 2S and 2L eastern leg train services would run along the ECML to York, Newcastle and Edinburgh, but Leeds would be served via a spur from Phase One, an upgraded section of the existing conventional railway, the MML (assumed to be electrified) and a section of new track that would broadly follow the M18 route of the Proposed Scheme between Leeds and the MML near Sheffield. This new section of track would allow high speed trains to Leeds to operate from London Euston Station and would remove the need for extra capacity on the ECML and in particular in the Welwyn area.

10.4.9 For Option 2S, this section of new track would be approximately 42km long and would be constructed between Leeds and just south of Mexborough, where the HS2 main line would then divert away to connect to the existing conventional railway between Sheffield and Leeds (via Moorthorpe) near Rawmarsh. For Option 2L, the section of new HS2 main line would be approximately 63km long and would be built as far south as Killamarsh before diverting to connect to the same existing conventional railway further south between Sheffield and Leeds. Options 2S and 2L were considered in order to compare whether a shorter or longer section of new HS2 main line at this location would perform better.

Option 3

10.4.10 Option 3 would require the least upgrades to the existing conventional railway lines when compared to the other route-wide rail alternatives. It would be the same as Option 2S except that Edinburgh, like Glasgow, would be reached via a joint service from London Euston, as per the Proposed Scheme, except the WCML would be joined at Crewe. Since the ECML would not be required to serve Leeds or Edinburgh, upgrades to increase line speeds would not be required. The flyover and associated grade separation works at Newark would therefore not be required to allow for faster trains running on the ECML. As a result, a slightly different running pattern for Cross Country train services would be required that would revert back to using Doncaster as their main ECML route.

Option 4

10.4.11 Option 4 was the same as Option 2S except that Nottingham would be served via the MML. The MML would be upgraded north of Kettering while upgrades in the Trent area would not be required.

Appraisal of alternatives

10.4.12 The appraisal of alternatives found that:

- **journey times**: the Proposed Scheme would offer the fastest journey times between London and Leeds, Manchester, Newcastle, the East Midlands and Sheffield;
- **additional network capacity**: both the Proposed Scheme and the route-wide rail alternatives would create extra capacity on the existing conventional rail network for other services, when compared to the do minimum' (with Phase 2a) scenario. However, only the Proposed Scheme would create extra capacity for potential additional high speed services north of Birmingham and therefore meet the Government's strategic objectives for HS2;
- **train seating capacity**: the route-wide rail alternatives would change the service offered and the frequency of destinations served and therefore could either approximately meet or slightly exceed the train frequencies of the Proposed Scheme. The Proposed Scheme would, however, operate significantly longer trains (400m in length) than the route-wide rail alternatives to the destinations of Manchester, Leeds and the East Midlands, and therefore, would provide more seating overall to these destinations;
- **reliability and punctuality**: the resilience of the rail network would be improved with the introduction of the Proposed Scheme due to a new high speed line coming into operation. No punctuality and reliability benefits were identified for the existing conventional rail network from the introduction of the route-wide rail alternatives or the Proposed Scheme (however, the route-wide rail alternatives would typically be less punctual and less reliable than the Proposed Scheme as they would add additional trains on to the conventional rail network from Phase One and Phase 2a);
- **disruption**: an assessment of the likely disruption caused by constructing the route-wide rail alternatives found that each would require: between approximately 1,500 and 2,000 weeknight possessions; approximately 360 'equivalent Sunday'[194] possessions; and approximately 100 full or extended weekend possessions; and
- **environmental impact**: the high level environmental appraisal found that the route-wide rail alternatives would have a reduced environmental impact than the Proposed Scheme, largely because they could be delivered through upgrades and alterations to sections of the existing conventional rail network within or adjacent to existing railway land.

[194] The closure of a service for a day in order for maintenance/improvement work on the railway.

Conclusions

10.4.13 The DfT commissioned study identified that there is no alternative that could deliver the same level of resilience, capacity, connectivity and service that the Proposed Scheme would in pursuit of the HS2 strategic objectives. As these route-wide rail alternatives did not meet the Government's strategic objectives for HS2 they were not taken forward.

10.4.14 The Midlands Connect and Transport for the North sub-national transport bodies propose to use additional capacity created by the Proposed Scheme as a first step in transforming and connecting the economies of the Midlands and the North. This would rely, in particular, on some sections of the Proposed Scheme that would not be built as part of the proposed route-wide rail alternatives. It follows, therefore, that the aspirations of Midlands Connect and Transport for the North would be more expensive, disruptive or difficult to achieve utilising the alternatives.

10.5 Route corridor alternatives

10.5.1 The Proposed Scheme has evolved through a refinement process referred to as sifting. The sifting process consisted of a sequentially more detailed appraisal of route options whereby sustainability performance was considered alongside cost, operational and engineering considerations. Preferred options were identified to progress to the next level of sift for a more detailed appraisal. The following environmental factors were considered as part of the consideration of sustainability performance: climatic factors and adaptability; greenhouse gases; landscape; townscape and cultural heritage; biodiversity and geodiversity; water resources; flood risk; air quality; noise and vibration; community integrity; accessibility; health and well-being; security and safety; economic prosperity; economic welfare; soil and land resources; waste generation; and resource use.

10.5.2 The sequence of subsequent sifts were aimed at reducing the number of options under consideration (e.g. by avoiding centres of population and/or key environmental features). In the later sifts, the predicted impacts of the remaining options were further mitigated by refining the vertical and/or horizontal alignments and by introducing certain structures such as viaducts or cuttings with retained walls, where appropriate. In this way, the route development process has ensured that mitigation is inherent within the design from the outset.

10.5.3 Route options appraisal between 2010 and 2012 focused on establishing a preferred route from the West Midlands to Manchester and Leeds and many thousands of kilometres of route options had been appraised. As described in the *Options for Phase Two – appraisal of sustainability report* (2012)[195], 42 separate route sections for the western leg to Manchester and 32 for the eastern leg to Leeds were considered. This equates to up to 144 and 112 possible route combinations respectively. The 74 route sections presented in the report had been sifted down from several hundred through the earlier route options appraisal process described previously.

[195] Temple – ERM (2012). *Options for Phase 2 of the high speed network – Appraisal of Sustainability*. Available online at: https://www.gov.uk/government/publications/options-for-phase-two-of-the-high-speed-rail-network-appraisal-of-sustainability

10.5.4 Work undertaken on the route options appraisal for the western leg considered three sections of reasonable alternative corridors that would bypass Crewe to the east and provide alternative approaches into Manchester. All three route corridors would commence at Swynnerton and, from there would take different horizontal alignments north across the Cheshire plains. As the different corridors would approach south Manchester, alternative approaches into both Manchester Piccadilly Station and Manchester Salford Station were considered as well as onward connectivity to the WCML at Golborne.

10.5.5 Following the route options appraisal, the western leg of the route that was presented in the 2013 proposed scheme for consultation approached Manchester via a new high speed station near Manchester Airport. It included a new station in Manchester city centre adjacent to the existing Manchester Piccadilly Station and a connection to the WCML at Golborne. Two depots were proposed at sites near Basford south of Crewe for the IMD, and near to the WCML connection at Golborne for the RSD.

10.5.6 Work undertaken on the eastern leg to Leeds prior to 2013 considered alternative corridors in four sections; Derby and Nottingham, South Yorkshire, ECML connection, and Leeds city centre. The first and southernmost section considered a corridor to the east to serve a station in Derby city centre and a corridor to the west to serve a station at Toton to the south-west of Nottingham. The second section considered corridors to serve station options for South Yorkshire in and around Sheffield. The third section considered corridors for the ECML connection whilst the fourth section considered options, broadly within the corridor between Wakefield and Leeds city, for approaches to Leeds city centre station from the west, east and south.

10.5.7 Following the route options appraisal, the eastern leg of the route that was presented in the 2013 proposed scheme for consultation included high speed stations at Toton to the south-west of Nottingham (known as East Midlands Hub), Meadowhall in South Yorkshire, and in Leeds city centre accessed from the south-east of the city. A connection to the ECML at Church Fenton and two depots (an IMD near Staveley and an RSD south of New Crofton) were proposed.

11 Local alternatives

11.1 Introduction

11.1.1 This section of the report describes the main local alternatives that were studied and sifted during development of the Proposed Scheme following publication of the 2013 proposed scheme for consultation and prior to the Government's announcement of the preferred route for Phase 2b in July 2017. Alternatives were addressed in three stages; following public consultation between July 2013 and January 2014, in 2015 in order to try and achieve further efficiency, and following public consultation between November 2016 and March 2017.

11.1.2 The main local alternatives considered comprised those raised during the course of consultations, those resulting from the implementation of revised engineering standards, and general improvements in relation to cost and ease of construction. Most of the alternatives studied took the form of different alignments and were assessed in terms of constructability, cost, sustainability, journey time and demand/business case.

11.1.3 In some locations it was concluded that the alternatives proposed did not offer any net benefit and were therefore not taken forward. In others the route was amended. The revised scheme formed the basis of the route that was the subject of the Government's announcement of the preferred route for Phase 2b in July 2017.

11.1.4 The local route alternatives considered during this process are set out in Table 6, Table 7 and Table 8 for the relevant locations. In each case, the issue considered is given and the design response (i.e. to amend the scheme or not) is explained.

11.1.5 Local alternatives studied since the Government's announcement of the preferred route in July 2017 are reported in the Volume 2: Community area reports. Details on local alternatives studied both prior to and since July 2017 can be found in the Alternatives report (a supporting document to this working draft ES).

11.2 Route development – refinement of the 2013 proposed scheme for consultation

11.2.1 The 2013 proposed scheme for consultation was subject to a series of refinements (termed local alternatives) as a consequence of post-consultation feedback, improved baseline data, design development and lessons learnt from Phase One.

11.2.2 Following this, and building on an earlier recommendation from Sir David Higgins in 2014, the Government announced its intention to bring forward the construction of the route from Lichfield to Crewe as Phase 2a of HS2 in November 2015. This split the western leg of the 2013 proposed scheme for consultation in two and included a connection with Phase One to the north of Lichfield, a connection with the WCML near the A500 south of Crewe, and an IMD at Basford.

11.2.3 In July 2016, HS2 Ltd published the *HS2 Phase 2b Sheffield and South Yorkshire Report*[196]. The report reviewed locations for the high speed station in South Yorkshire and recommended that HS2 should utilise the existing Sheffield Midland Station by running conventional compatible trains into Sheffield city centre via a dedicated spur off the HS2 main line onto the conventional rail network. The report also recommended that the HS2 main line be moved further east, to run parallel to a section of the M18 corridor. This alignment would avoid the complexities and risks associated with the previous route and would provide journey time savings for services to Leeds, York and Newcastle.

11.2.4 In November 2016, the Government announced the '2016 preferred route to Manchester and Leeds' as described in the Phase 2b Sustainability Statement and Post Consultation Update (November 2016)[197]. This was based on refinements made to the route as a result of earlier consultation, updated design standards and the recommendations of the Sheffield and South Yorkshire Report published in July 2016. In some locations, substantial changes had been made to the 2013 proposed scheme for consultation.

11.2.5 As a result of these changes, a further period of public consultation was launched alongside the announcement of the 2016 preferred route to Manchester and Leeds. The consultation ran from November 2016 to March 2017 and focused on seven sections of the route, across both the eastern leg to Leeds and western leg to Manchester (see Section 11.5 of this report).

11.2.6 Additional route refinements sought to address specific consultee concerns raised during the consultation period and, in July 2017, the Government announced the '2017 preferred route to Manchester and Leeds' with decisions made to proceed with six of the seven proposed changes that were consulted on. The exception was the consulted change at Measham; following the consideration of responses to the consultation the Government confirmed a modified version of the 2013 proposed scheme for consultation to the west of Measham (which would be slightly further east than the 2013 proposed scheme for consultation) that would include a longer viaduct to mitigate commercial property impacts.

11.2.7 The July 2017 announcment also launched a separate consultation on a proposal to relocate the eastern leg RSD from New Crofton to a site within the Aire Valley, east of Leeds, adjacent to the M1. This consultation was held between July 2017 and October 2017 and the Government confirmed the location of the eastern leg RSD at the Leeds East site in July 2018.

[196] HS2 Ltd (2016). *HS2 Phase 2b: Sheffield and South Yorkshire Report 2016.* Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/535307/CS550A_South_Yorkshire_Report_WEB.pdf

[197] HS2 Ltd (2016). *HS2 Phase 2b: Sustainability statement 2016.* Available online at: https://www.gov.uk/government/publications/hs2-phase-2b-sustainability-statement-2016

11.3 Local alternatives considered post 2013/2014 consultation

11.3.1 HS2 Ltd published the *High Speed Rail: Consultation on the route from the West Midlands to Manchester, Leeds and beyond - Sustainability Statement* in July 2013 to assist with public consultation from July 2013 to January 2014. Following that consultation, HS2 Ltd investigated a number of local alternatives to the scheme (referred to as the 2013 proposed scheme for consultation) as detailed in Table 6.

Table 6: Main reasonable local alternatives considered post 2013/2014 consultation prior to July 2017 preferred route announcement

Location	Concern or proposal considered	Project response
Western leg		
Crewe surface	The route through/around Crewe and possible integration with Network Rail proposals for a Crewe Hub station.	The 2013 proposed scheme for consultation was retained as the preferred option, which approaches Crewe in a cutting alongside the existing WCML before entering an approximately 3.8km bored tunnel under the existing Crewe Station. The alternative options would have run on surface in a cutting through the centre of Crewe alongside the WCML. The preferred option of a tunnel would have substantially fewer sustainability impacts than the alternative options, as well as reduced engineering and interface complexity. The surface options would also have major implications for the existing road network through Crewe.
Middlewich to Pickmere (routes through salt mining areas)	The proximity of the railway to Lostock Green, Lostock Gralam and Pickmere Telescope. Risks associated with crossing the large expanse of salt fields, salt mining and gas storage operations north of Crewe, in addition to potential long term operational liability. Further review of alternative route corridors from Crewe north-east towards Manchester Airport via Mobberley.	An option was adopted that runs at a minimum elevation of approximately 1m above the ground (rather than in cutting) to reduce the risk associated with salt dissolution, gas storage and drainage issues compared to the 2013 proposed scheme for consultation. North of Crewe the route would initially follow a similar horizontal profile to the 2013 proposed scheme for consultation, but would cross the River Dane on a 26m high viaduct, as opposed to a 10m high viaduct, and then cross the Trent and Mersey Canal on three occasions. The route would head north-east alongside the existing A556 and to the west of Lostock Green, before continuing north to the east of Lostock Gralam and Pickmere Telescope.
WCML connections north of Crewe	Opportunity for a WCML connection to the north of Crewe.	The 2013 proposed scheme for consultation was retained as there was no requirement to provide a connection to the WCML on the north side of Crewe at this stage of the project. The alternatives considered would require additional land and have increased landscape and visual impacts from the introduction of a grade separated junction.
Delta junction zone 1	Clearance and navigational visibility when crossing the Bridgewater Canal and Agden Brook; and local concerns regarding visual impact.	An option was adopted that would follow a similar horizontal alignment to the 2013 proposed scheme for consultation under the M56, but at a shallower depth. Further north, the railway would be on raised crossing over the Bridgewater Canal. This would avoid the substantial cost and engineering complexities associated with a section of cut-and-cover tunnel in a floodplain environment under the Bridgewater Canal.
Delta junction zone 2	Configuration of the delta junction between the HS2 main line and the Manchester spur.	An option was adopted that would follow a similar horizontal alignment to the 2013 proposed scheme for consultation, but the section of the spur from Manchester would pass under, rather than over, the HS2 main line. This would reduce the overall height of the junction and reduce visual impacts.
Manchester Ship Canal	Landscape, visual and noise impacts as the route crosses the Manchester Ship Canal.	An option was adopted that would follow a similar horizontal and vertical alignment to the 2013 proposed scheme for consultation with a reduction in line speed to 300kph (186mph) on the canal crossing. The

Location	Concern or proposal considered	Project response
		reduction in line speed on the canal crossing would allow for lower embankments either side of the canal, and a slightly lower vertical alignment of the viaduct, with an associated reduction in noise impacts.
East and west of Culcheth	The location of the route past Culcheth, particularly in relation to Taylor Business Park and Culcheth Linear Park.	An option was adopted that would follow a similar alignment to the 2013 proposed scheme for consultation over the Manchester Ship Canal and past Holcroft Moss, but then take a more westerly route approaching Culcheth. This alignment would avoid direct impacts on the Taylor Business Park, Culcheth Linear Park and Leigh Golf Club, as well as avoiding the demolition of the Grade II Listed Newchurch Old Refectory.
Lowton gap	Alignment of the route through Lowton gap (the section of route between Lowton and Lowton Common) and impacts on the community of Lowton.	The 2013 proposed scheme for consultation was retained due to engineering complexity and substantial cost of the alternative option, a fully retained cut. There would be similar noise impacts from both alternatives, whilst the rejected alternative would require two fewer residential demolitions when compared to the preferred option.
Alternative western leg RSD locations	RSD location and layout and ensure compatibility with wider network operational strategies.	An option to locate the RSD to the north of Crewe, located east of Wimboldsley, between the HS2 main line and the WCML, was adopted. At a central location on the western leg, and in proximity to the WCML, the Crewe North depot would reduce sustainability impacts at Golborne, including avoiding a direct impact on the Grade II* listed Lightshaw Hall.
Golborne (without depot)	Connectivity of the HS2 main line with the WCML at Bamfurlong without provision for an RSD at Golborne.	An option was adopted which would run to the south of Byrom Hall and would allow for the inclusion of maintenance loops should they be required at a later date. The option would be approximately 500m closer to Golborne than the 2013 proposed scheme for consultation, but further south from the Grade II* Listed Lightshaw Hall, Abram Flashes SSSI and the Leeds & Liverpool Canal. It also increases the distance to Slag Lane abstraction borehole.
Maintenance loops at Golborne	Provision of maintenance loops in the vicinity of Golborne (without provision for an RSD).	An option was adopted which, after passing to the south of both Byrom Hall and Grade II* Listed Lightshaw Hall, would be on a straighter alignment than that adopted for the Golborne (without RSD) alternative on the basis of including provision for maintenance loops. This would take the route further south and closer to Golborne than that adopted for the Golborne (without RSD) alternative but further still from the Grade II* Listed Lightshaw Hall, Abram Flashes SSSI, Leeds & Liverpool Canal, and Slag Lane abstraction borehole.
Manchester Airport vicinity	Horizontal and vertical alignment of the route. Impacts on the local environment in proximity to Tatton Park, Ashley, Rostherne Mere and Manchester Airport.	The 2013 proposed scheme for consultation was maintained as the preferred option on the basis that the alternatives would have similar or increased impacts on the local environment, would incur substantial cost increase, and increase the engineering complexities.
Manchester Piccadilly Station and approaches	Refinement of the proposed high speed station and approach with the aim of improving engineering and operational arrangements. Review of the demolitions of a block of 47 residential properties on Chapeltown Street.	An option was adopted whereby the tunnel portal would be located approximately 500m further north, within the existing Ardwick Depot site, when compared to the 2013 proposed scheme for consultation. It would therefore be further away from West Gorton and the associated Corn Brook flood plain and West Gorton Major Development Site. This option would also provide an improved arrangement and operational performance of the proposed high speed station.

Location	Concern or proposal considered	Project response
Eastern leg		
Whateley	The location and height of the railway in the Kingsbury area.	An option was adopted that lowers the route past Kingsbury and Kingsbury Water Park, reducing impacts on the surrounding landscape.
Measham	The location and height of the railway past Austrey and Measham. Also to identify whether it would be feasible to avoid the Plastic Omnium business property and/or the Measham Wharf development site.	The 2013 proposed scheme for consultation was retained. Whilst it would impact on the Plastic Omnium site (a major local employer) and the Measham Wharf Major Development Site, the alternative options would either have additional sustainability impacts (including on surrounding listed buildings and the River Mease Special Area of Conservation (SAC)), would result in a less favourable crossing of the River Mease or result in substantial additional cost.
Tonge	Route alignment past Tonge, Breedon-on-the-Hill, the Grade II* Listed Langley Priory, the G.Park industrial and distribution centre, and the East Midlands Gateway Strategic Rail Freight Interchange (SRFI).	The 2013 proposed scheme for consultation was retained. Whilst the alternatives considered would have avoided Tonge and Breedon-on-the-Hill, they would result in additional demolitions and severance of scattered communities in the area to the south and east of Coleorton Hall Registered Park and Gardens.
East Midlands Hub (Toton)	Footprint and functionality of the proposed high speed station. Impacts to the River Erewash, highways and the communities of Long Eaton, Toton and Stapleford.	An option was adopted that was very similar to the 2013 proposed scheme for consultation, along one of the existing Network Rail rail corridors through Long Eaton. Each of the options considered would have impacts on the Roman Site on Red Hill Scheduled Monument, Attenborough Gravel Pits SSSI and would require two major diversions of the River Erewash. The preferred option would have a reduced impact on the surrounding landscape as it would not require a long viaduct over the River Trent and River Erewash.
Strelley	Vertical alignment through the Nottingham Business Park and Strelley conservation area and listed buildings.	The 2013 proposed scheme for consultation was retained, passing Strelley village in a cut-and-cover tunnel and Nottingham Business Park in a deep cutting. The alternatives considered would be substantially more costly and potentially have an increased impact on the surrounding environment during construction.
Bogs Farm Quarry SSSI	The location and vertical alignment of the railway past Bogs Farm Quarry SSSI, Bentinck Colliery (a high-risk spoil heap), and Langton Hall.	An option was adopted that would be located closer to the M1 corridor. This would reduce impacts on the Bogs Farm Quarry SSSI, avoid the need for demolitions at Langton Hall, and avoid the colliery lagoons and spoil heap, removing the risks and substantial cost associated with crossing these.
Tibshelf	The location and vertical alignment of the railway to reduce impacts on Sawpit Industrial Estate and Hardwick Hall.	The 2013 proposed scheme for consultation was retained, crossing under the M1 between Tibshelf and Hardwick Hall and through Sawpit Industrial Estate in cutting. The alternatives considered would either cost substantially more than the preferred option or have a greater environmental impact (notably on views from Hardwick Hall due to the viaduct crossing of the M1).
Hardwick Hall	Vertical alignment of the railway and visual impacts on Hardwick Hall (a Grade I Listed Building and RPG).	The 2013 proposed scheme for consultation was retained, rather than including a tunnel past Hardwick Hall. The alternatives considered would be more complex and susbstantially more costly and would result in increased environmental impacts, including on heritage, landscape and surrounding views.
Church Fenton	The location of the railway past Church Fenton.	The 2013 proposed scheme for consultation was retained as the alternatives were not considered to offer sufficient environmental benefit (they either did not demonstrate a significant reduction in impact, moved impacts from one community to another, or resulted in

Location	Concern or proposal considered	Project response
		additional environmental impacts), or they resulted in substantial additional costs that were not justified by a substantial enough reduction in environmental impact.
Woodlesford	Proximity of the railway, height of the viaducts, and risks from crossing the River Aire at Woodlesford.	An option was adopted whereby the route would pass beneath Woodlesford in tunnel rather than on viaduct around the north-eastern edge of Woodlesford. This would avoid the need for diversions of the River Aire and would reduce landscape and visual impacts at Woodlesford and for recreational users of the Aire and Calder Navigation Canal.
Leeds Station	Footprint and operational layout of the station to respond to the recommendations set in the report 'Rebalancing Britain'.	An option was adopted that would comprise a north-south orientated high speed station with five terminal platforms immediately adjacent to the existing east-west orientated Network Rail station. The preferred option would offer the greatest benefit to the wider region through the enhanced rail to rail connectivity and the opportunity to create a shared concourse with the existing station.
Staveley depot	Increased footprint for the IMD based on experience of the HS2 Phase One Calvert IMD.	An option was adopted which would comprise an increased footprint for the IMD, allowing for additional storage and stabling area requirements. The increased footprint would result in a greater impact on the surrounding environment but would allow for an improved connection to the Barrow Hill freight lines and provide greater operation flexibility.

11.4 Local alternatives considered in 2015/2016

11.4.1 HS2 Ltd considered a number of further refinements in 2015/6 in response to a series of updated design principles which sought to improve the technical performance of the scheme design. These alternatives were considered against the scheme as amended following public consultation from July 2013 to January 2014 (which is referred to as the base case in this section). These alternatives are detailed in Table 7.

Table 7: Main reasonable local alternatives considered in 2015/2016 prior to the July 2017 preferred route announcement

Location	Concern or proposal considered	Project response
Western leg		
Crewe tunnel northern portal (further refinement)	Review the length of the tunnel under Crewe following changes in design requirements and improve the crossing of the Fowle Brook watercourse.	An option was adopted which would move the northern tunnel portal approximately 265m further south, resulting in a shorter tunnel under Crewe. Whilst this option would slightly increase the noise and landscape and visual impacts, it would reduce the hydrological fluvial risk associated with the Fowle Brook due to the tunnel surfacing in a different location and offer a substantial cost saving.
Crewe North RSD (further refinement)	Sufficiency of the RSD footprint at Crewe North; junction layout, operational footprint and alignment of the HS2 main line.	An option was adopted that provided capability to stable an increased number of trains and moved the RSD junction further north to address operational issues, without bringing the HS2 main line and RSD closer to Wimboldsley. The alternative considered would have a considerable impact on the local environment, including the surrounding landscape and views, and recreational users of the Shropshire Union Canal.
Manchester Airport	Operational requirements and layout of Manchester	An option was adopted whereby the high speed station footprint extends to the south of the M56. Whilst the option would have a direct impact on the

Location	Concern or proposal considered	Project response
station (further refinement)	Airport station	Grade II Listed Buckhall (Marriot Hotel), it would allow for better highways connectivity with the M56 and A538 Hales Road.
Manchester Junction (further refinement)	Watercourse clearance at the delta junction between the HS2 main line and the Manchester spur.	An option was adopted whereby the Manchester spur alignment would pass over, rather than under, the HS2 main line and Millington Clough. This would allow Millington Clough to be culverted under the spur rather than diverted, reducing the risk of flooding.
Northern Chord (further refinement)	Requirement for the Northern chord of the Manchester delta junction, based on the decision to relocate the RSD from Golborne to Crewe North. N.B. The Northern Chord was proposed in order to facilitate the movement of rolling stock from Manchester Piccadilly to the previously proposed Golborne RSD.	The base case was retained. As the RSD was no longer to be located at Golborne, the Northern Chord and grade separated junctions were not required. The alternative considered would have resulted in landscape and visual impacts from the grade separated junctions, impacts on users of the Bridgewater Canal and the setting of the Grade II Chapel House, require an increased area of land through Hancock's Bank Ancient Woodland and result in five additional demolitions from construction of the chord.
M56 crossing	Depth of the railway under the M56 and approaching the high speed station.	The base case was retained, but a recommendation was made to review the construction options and potential for lowering the route during the design development. The alternative considered would also require the demolition of the Grade II Buckhall (Marriot Hotel) but would have greater impacts on the surrounding landscape.
Manchester Ship Canal (further refinement)	Viaduct span and height over the Manchester Ship Canal.	The base case was retained, but with the recommendation of reviewing the construction options and potential for lowering the route during the design development. The alternatives considered would have increased visual impacts due to the increased height of the viaduct.
Manchester Piccadilly station (further refinement)	Operational requirements and layout of the station.	An option with a similar operational layout to the base case was adopted, but with a revised footprint that extends across the Mancunian Way and Fairfield Street to take into consideration works for the reconfiguration of existing highways. The chosen option would require an increase of three commercial demolitions when compared to the alternative option.
Eastern leg		
Measham (2016)	Impacts on, and height of the railway past, the Plastic Omnium site and the Measham Wharf Development Site.	An option was adopted that would pass to the east of Measham, requiring an 11m high viaduct over the River Mease floodplain and an active landfill site, but avoiding any direct impacts to the Plastic Omnium and Measham Wharf sites. The preferred option would have a reduced impact on the River Mease SAC.
East Midlands Airport tunnel avoiding	Location of the route past Tonge, Breedon-on-the-Hill, East Midlands Airport and the East Midlands SRFI.	An option was adopted that would follow the A42, rather than passing close to Tonge and Breedon-on-the-Hill before entering a tunnel under East Midlands Airport and through the middle of the East Midlands SRFI partly in tunnel. This would avoid the substantial cost and engineering challenges of tunnelling underneath the airport, and would result in reduced noise and visual impacts on the Tonge Conservation area and Worthington. Impacts on the East Midlands SRFI would be limited to a proposed access road.
East Midlands	Location and height of the railway through Toton and	An option was adopted that included almost 5km of viaduct from the River Trent to Toton sidings. Whilst this would have increased landscape and visual

Location	Concern or proposal considered	Project response
Hub (Toton) (2016)	Long Eaton, reconsidering flood risk, highways impacts and severance.	and noise impacts, there would be a reduced risk of fluvial flooding from the River Erewash and fewer demolitions would be required. This was also deemed the more cost-effective solution.
Church Fenton	The vertical alignment of the railway at Church Fenton, regarding road clearance, drainage and visual impact.	Following the consideration of updated HS2 design standards, an option was adopted which included a high embankment and viaduct past Church Fenton and thereby increased the clearance over Common Lane.

11.5 Local alternatives considered post 2016/2017 consultation

11.5.1 Following the period of public consultation between November 2016 and March 2017 on the *Sustainability Statement including Post-Consultation Update Phase 2b* and a set of seven areas of the route where substantial changes had been made from the 2013 proposed scheme for consultation, HS2 Ltd conducted a further set of refinements which sought to address specific consultee concerns raised during the consultation period. In some instances this included a re-consideration of the previous decision to refine the route, taking into account the additional information received during the consultation, and in some instances this involved sifting new route refinements against the preferred scheme that was consulted on. These alternatives are detailed in Table 8.

Table 8: Main reasonable local alternatives considered post 2016/2017 public consultation

Location	Concern or proposal considered	Project response
Western leg		
Crewe North rolling stock depot	Revisiting the previously considered option at Golborne alongside the opportunity to use brownfield sites along the line of route that would have met the RSD requirements.	The RSD would remain at Crewe North as it is centrally located on the Phase Two western leg and the site would meet the requirements of an RSD, including providing connectivity to the WCML. A review of previously considered options confirmed that there were no brownfield sites that met the requirements of the RSD on the current line of route. Again, a review of the previously considered options confirmed that locating the RSD at Crewe North would avoid impacts near Golborne, including those on the Grade II* Listed Lightshaw Hall, the Grade II Listed Byrom Hall and Abram Flashes SSSI. The Northern Chord (for movement of rolling stock from Manchester Piccadilly station to the Golborne RSD) would not be required, resulting in reduced land required for construction and substantially reduced costs.
Middlewich to Pickmere (routes through salt mining areas)	Strategic review of all previous route options in this area in light of alternatives suggested during consultation.	The route between Middlewich and Pickmere was recommended to remain as set out in the 2016 preferred route to Manchester and Leeds. This alignment would avoid direct interfaces with existing brining and gas storage infrastructure, would be raised to allow for management of drainage and geological risk, and provides more flexibility with regards to ground stability mitigation options. This would reduce construction and operational risk, and addresses specific concerns over the long-term liability to HS2 Ltd. The alternatives proposed during consultation (a route closer to the M6 corridor, a tunnel under Sandbach, an alignment east of Middlewich, and options to reduce line speed) were not recommended on the basis of a substantial increase in cost and environmental and/or engineering and

Location	Concern or proposal considered	Project response
		operational considerations.
Manchester Piccadilly Station approach	Review of previously considered refinements for the approach to Manchester Piccadilly station and an alternative tunnel alignment.	The approach into Manchester Piccadilly station was recommended to remain as set out in the 2016 preferred route to Manchester and Leeds. This remains the optimal approach based on engineering, environmental and operational considerations; it would reduce the risk of flooding at Corn Book floodplain, avoid a number of residential demolitions, a development site and community impacts at a primary school at West Gorton, and reduce the impact on existing structures at Manchester Piccadilly Station. The alternative tunnel alignment was not progressed as it would result in an increased journey time.
Eastern leg		
Measham	Reconsideration of the horizontal and vertical alignment of the route past Measham.	An option was adopted that moved the alignment slightly to the south-east from the 2013 proposed scheme for consultation, in order to avoid the majority of the Plastic Omnium site. The adopted option would remove the issue of 'islanding' the communities of Appleby Parva, Appleby Magna and Measham between the HS2 main line and the A42 that had been a major impact resulting from the 2016 preferred route to Manchester and Leeds.
East Midlands Airport tunnel avoiding	Re-consideration of decision to remove the tunnel beneath East Midlands Airport and instead follow the M42/M1.	The 2016 preferred route that follows the A42 and M1 transport corridor on its eastern side was retained as it avoids the tunnel under the airport and engineering complexities associated with the East Midlands Gateway Strategic Rail Freight Interchange and the M1/A50 crossing. The retained option would also avoid heritage impacts on the Langley Priory Grade II* listed building and reduce impacts on the communities at Tonge and Breedon-on-the-Hill, as well as on the Tonge Conservation Area.
East Midlands Hub approach	Consideration of two options presented during consultation - a retained embankment or viaduct solution for the approach to East Midlands Hub.	It was determined that, of the two options consulted on, the solution to be taken forward should be the viaduct option, over the retained embankment option. The viaduct would reduce disruptive work on the existing conventional rail network in this location, help address concerns on interaction between HS2 and the floodplain in the area (requiring fewer flood defences) and maintain east–west permeability through Long Eaton.
Derbyshire to West Yorkshire (M18/Eastern route) – routes to the east of the M18	Impact of the railway between Barlborough and South Kirby past Wales, Aston, Bramley Mexborough and Barnburgh.	The 2016 preferred route to Manchester and Leeds was retained in this area as, although the other options generally reduced impacts at Wales, Aston, Bramley and, in some cases, Mexborough, they introduced/transferred potential impacts onto different communities and environmental receptors whilst increasing engineering complexity and without delivering any improvement in the overall performance of the route.
Derbyshire to West Yorkshire (M18/Eastern route) – Aston	Vertical alignment of the railway past Aston.	The 2016 preferred route to Manchester and Leeds was retained past Aston as the alternatives considered (a bored tunnel or cut-and-cover tunnel) would introduce increased construction impacts, additional engineering complexity and operational challenges.
Derbyshire to West Yorkshire (M18/Eastern route) –	The location and vertical alignment of the railway to avoid impacts at Mexborough, Barnburgh and	The 2016 preferred route to Manchester and Leeds was retained past Mexborough with a recommendation to keep this assessment under review during hybrid Bill development. It was recommended that further work should be done during hybrid Bill development to assess an option to the east of Conisbrough. Other options were not progressed based on

Location	Concern or proposal considered	Project response
Mexborough	Hickleton.	additional potential environmental impact or due to a combination of the substantial cost and engineering complexity. The preferred option would have a direct impact on the residential housing at Shimmer (that was a development site at the time of the appraisal).
Derbyshire to West Yorkshire (M18/Eastern route) – Sheffield spur	Consideration of an alternative location for the spur from the HS2 main line to the conventional rail network to facilitate services to Sheffield Midland station.	The location of the Sheffield spur to remain as set out in the 2016 preferred route to Manchester and Leeds. This was retained on the basis of both operational performance (faster journey times) and the substantial costs of the alternatives (increased length of electrification of the Erewash Valley Line). Whilst the preferred option would have impacts on communities at Newton, Blackwell and Hilcote, views from the surrounding area, the setting of the listed Erewash Canal bridge and a conservation area, and direct impacts on two landfill sites, the alternatives considered would have greater environmental impacts on the surrounding landscape and views and the listed Erewash Canal bridge, as well as on the Erewash floodplain.
Eastern leg rolling stock depot	Alternative locations for the New Crofton RSD.	An option was proposed which would see the eastern leg RSD relocated from a site at New Crofton to a site to the east of Leeds. The relocation of the RSD from New Crofton would offer major operational improvements and relieve many of the community concerns, including noise and visual impacts from construction and operation. In July 2017, the Government was minded to agree with this recommendation and launched a public consultation on the proposed relocation. The consultation ran from July to October 2017.
Eastern leg rolling stock depot (post July to October 2017 consultation)	Relocation and orientation of the RSD.	Following the public consultation on the proposed relocation of the RSD between July and October 2017, the recommendation to move the RSD to the Leeds East site was reconsidered in light of information received in response to the consultation. It was decided that the Leeds East site should be confirmed based on the operational improvements and reduction in impacts on communities. It was concluded unfeasible to reorient the depot, without impacting directly on the A63 and, in some instances, the operational Yorkshire Water treatment site.

12 References

Atkins (2013). *HS2 Strategic Alternatives: Final Report*. Available online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/253456/hs2-strategic-alternatives.pdf

Atkins (2016). *Strategic Alternatives to HS2 Phase 2b*. A report for the Department for Transport. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/568309/strategic-alternatives-to-hs2-phase-2b-atkins-report.pdf

British Standard (2004). *BS EN ISO 14001:2004 Environmental management systems*.

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

British Standard (2011). *Sustainability of Construction Works – Assessment of environmental performance of buildings – Calculation method*, BSI Limited, London, UK.

British Standard (2012). *Sustainability of Construction Works – Environmental Products Declarations. Core Rules for the product category of construction products*, BSI Limited, London, UK

British Standard (2017). *BS EN 50121-5-2017 Railway Applications, Electromagnetic Compatibility*.

Cabinet Office (2011). *Keeping the country running: natural hazards and infrastructure.* Available online at: https://www.gov.uk/government/publications/keeping-the-country-running-natural-hazards-and-infrastructure

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

Chartered Institute of Ecology and Environmental Management (2016). *Guidelines for Ecological Impact Assessment in the UK and Ireland – Terrestrial, Freshwater and Coastal*. Available online at: https://www.cieem.net/data/files/Publications/EcIA_Guidelines_Terrestrial_Freshwater_and_Coastal_Jan_2016.pdf

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

Committee on Climate Change (2015). *The Fifth Carbon Budget - The next step towards a low-carbon economy*. Available online at: https://www.theccc.org.uk/wp-content/uploads/2015/11/Committee-on-Climate-Change-Fifth-Carbon-Budget-Report.pdf

Committee on Climate Change (2017). *UK Climate Change Risk Assessment 2017.* Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/584281/uk-climate-change-risk-assess-2017.pdf

Committee on Climate Change (2017). *Meeting Carbon Budgets: Closing the policy gap. 2017 Report to Parliament*. Available online at: https://www.theccc.org.uk/wp-content/uploads/2017/06/2017-Report-to-Parliament-Meeting-Carbon-Budgets-Closing-the-policy-gap.pdf

Considerate Constructors Scheme. Available online at: www.ccscheme.org.uk

Construction Leadership Council & the Green Construction Board (2016). *PAS 2080: 2016: Carbon Management in Infrastructure*. BSI Limited, London, UK.

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

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

Crossrail (2005). *Environmental Statement Volume 8a Appendices Transport assessment: methodology and principal findings (Section 5 Assessment Criteria).* Available online at: http://74f85f59f39b887b696f-ab65625904 8fb93837eccoecbcfoc557.r23.cf3.rackcdn.com/assets/library/document/v/original/volume_08a.pdf

Defra (2005). *Securing the future – delivering UK sustainable development strategy* (PB10589). Available online at: https://sustainabledevelopment.un.org/content/documents/1408uk.pdf

Defra (2010). *Noise Policy Statement for England (NPSE) and Department for Communities and Local Government (2012)*, National Planning Policy Framework. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69533/pb13750-noise-policy.pdf

Defra (2011). *Biodiveristy 2020: A Strategy for England's wildlife and ecosystem services.* Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69446/pb13583-biodiversity-strategy-2020-111111.pdf

Defra (2012). UK *Climate Change Risk Assessment: Government Report*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69487/pb13698-climate-risk-assessment.pdf

Defra (2013). *The National Adaptation Programme, Making the country resilient to a changing climate*, Her Majesty's Stationery Office. Available online at: https://www.gov.uk/government/publications/adapting-to-climate-change-national-adaptation-programme

Defra (2014). *Noise Action Plan: Agglomerations*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/276228/noise-action-plan-agglomerations-201401.pdf

Defra (2014). *Noise Action Plan: Roads (including major roads)*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/276237/noise-action-plan-roads-201401.pdf

Defra (2014). *Noise Action Plan: Railways (including major railways)*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/276238/noise-action-plan-railways-201401.pdf

Defra (2016). *Government policy paper on climate change adaptation 2010-2015.* Available online at: https://www.gov.uk/government/publications/2010-to-2015-government-policy-climate-change-adaptation/2010-to-2015-government-policy-climate-change-adaptation

Defra (2017). *Climate change adaptation reporting: second round reports.* Available at: https://www.gov.uk/government/collections/climate-change-adaptation-reporting-second-round-reports

Defra (2018). *Local Air Quality Management Technical Guidance (TG16)*. Available online at: https://laqm.defra.gov.uk/documents/LAQM-TG16-February-18-v1.pdf

Department for Business, Energy and Industrial Strategy (2017). *The Clean Growth Strategy – Leading the way to a low carbon future*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/700496/clean-growth-strategy-correction-april-2018.pdf

Department for Business, Energy and Industrial Strategy (2017). *Industrial Strategy: building a Britain fit for the future*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/664563/industrial-strategy-white-paper-web-ready-version.pdf

Department for Communities and Local Government (2012). *National Planning Policy Framework*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/728643/Revised_NPPF_2018.pdf

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

Department for Transport (2012). Design Manual for Roads and Bridges. Available online at: http://www.standardsforhighways.co.uk/ha/standards/dmrb/index.htm

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

Department for Transport (2013). *High speed rail: investing in Britain's future phase two - the route to Leeds, Manchester and beyond*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69738/hs2-phase-two-command-paper.pdf

Department for Transport (2013). *HS2 Phase Two initial preferences*. Available online at: https://www.gov.uk/guidance/hs2-phase-two-initial-preferred-route-plan-and-profile-maps

Department for Transport (2013). News Story. Available online at: https://www.gov.uk/government/news/sir-david-higgins-to-drive-down-cost-of-hs2

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

Department for Transport (2016). *High Speed Two: From Crewe to Manchester, the West Midlands to Leeds and beyond*. Cm 9355, November 2016. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/568208/high-speed-two-crewe-manchester-west-midlands-leeds-web-version.pdf

Department for Transport (2016). *High Speed Two Phase 2b Strategic Outline Business Case: Strategic Case*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/570068/hs2-phase-2b-sobc-strategic-case.pdf

Department for Transport (DfT) (2016). *High Speed Two Phase 2b Strategic Outline Business Case: Economic Case*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/570845/hs2-phase-2b-sobc-economic-case.pdf

Department for Transport (2017). Transport analysis guidance: WebTAG. Available online at: https://www.gov.uk/guidance/transport-analysis-guidance-webtag

Department for Transport (2017). *High Speed Two Phase 2b: Crewe ro Manchester, West Midlands to Leeds and beyond – Property Consultation Response.* Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/629394/high-speed-two-phase-2b-crewe-to-manchester-west-midlands-to-leeds-and-beyond-property-consultation-response-web-version.pdf

Department for Transport/Transport for the North (2015). *The Northern Powerhouse: One Agenda, One Economy, One North*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/427339/the-northern-powerhouse-tagged.pdf

Environment Agency (2004). *Model Procedures for the Management of Land Contamination CLR 11.* Available online at: http://webarchive.nationalarchives.gov.uk/20140328160926/http://cdn.environment-agency.gov.uk/scho0804bibr-e-e.pdf

Environment Agency (2010). *Assessing new modifications for compliance with WFD: detailed supplementary guidance*.

Environment Agency (2017). *Flood risk assessments: climate change allowances.* Available online at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

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

Equality Act 2010. Her Majesty's Stationery Office, London.

European Commission (2013). *EU Regulation 402/2013 (as amended) on the common safety method for risk evaluation and assessment and repealing Regulation* (EC) No 352/2009.

European Commission (2013). *Guidance on integrating Climate Change and Biodiversity into Environmental Impact Assessment*. Available online at: http://ec.europa.eu/environment/eia/pdf/EIA%20Guidance.pdf

European Railway Agency. *Multiple Technical Specifications for Interoperability (TSI).* Available online at: http://www.era.europa.eu/Core-Activities/Interoperability/Pages/TechnicalSpecifications.aspx

Food and Agriculture Organization of the United Nations (2013). *Climate change guidelines for forest managers*. Available online at: http://www.fao.org/docrep/018/i3383e/i3383e.pdf

Forestry Commission (2016). *Forests and climate change*. Available online at: https://www.forestry.gov.uk/climatechangeengland

Health Protection Agency (2012). *Health Effects of Climate Change in the UK*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/371103/Health_Effects_of_Climate_Change_in_the_UK_2012_V13_with_cover_accessible.pdf

HM Treasury (2003). *The Green Book: Appraisal and Evaluation in Central Government*. Available online at: https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-governent

HM Treasury (2013). *Infrastructure Carbon Review*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/260710/infrastructure_carbon_review_251113.pdf

Homes and Communities Agency (HCA) (2014). *Additionality Guide*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/378177/additionality_guide_2014_full.pdf

Homes and Communities Agency (HCA) (2015). *Employment Density Guide*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/484133/employment_density_guide_3rd_edition.pdf

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

HS2 Ltd (2013). *HS2 Phase One environmental statement volume 5: alternatives report.* Available online at: https://www.gov.uk/government/publications/hs2-phase-one-environmental-statement-volume-5-alternatives-report

HS2 Ltd (2013). *HS2 Regional Economic Impacts.* Available online at: http://assets.hs2.org.uk/sites/default/files/inserts/HS2%20Regional%20Economic%20Impacts.pdf

HS2 Ltd (2013). *HS2 Phase One Environmental Statement*. Available online at: https://www.gov.uk/government/collections/hs2-phase-one-environmental-statement-documents

HS2 Ltd (2013). *Phase Two Route Consultation*. Available online at: http://webarchive.nationalarchives.gov.uk/20141027142236/http://www.hs2.org.uk/phase-two/route-consultation/document-library

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

HS2 Ltd (2014). *Rebalancing Britain – From HS2 towards a national transport strategy*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/374709/Rebalancing_Britain_-_From_HS2_towards_a_national_transport_strategy.pdf

HS2 Ltd (*2016). High Speed Two Phase 2b Crewe to Manchester, West Midlands to Leeds Response to HS2 Phase Two Consultation: Appraisal of Sustainability (Question 7)*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/569783/Response_to_HS2_Phase_Two_Consultation_Question_7_report.pdf

HS2 Ltd (2016). *HS2 Landscape Design Approach*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/550791/HS2_Landscape_Design_Approach_July_2016.pdf.

HS2 Ltd (2016). *HS2 Phase 2b: Sheffield and South Yorkshire Report 2016.* Available online at: https://www.gov.uk/government/publications/hs2-sheffield-and-south-yorkshire-report-2016

HS2 Ltd (2016). *HS2 Phase 2b: Sustainability Statement 2016.* Available online at: https://www.gov.uk/government/publications/hs2-phase-2b-sustainability-statement-2016

HS2 Ltd (2017). *HS2 Phase 2b draft Environmental Impact Assessment Scope and Methodology* Report. Available online at: https://www.gov.uk/government/consultations/hs2-phase-2b-draft-environmental-impact-assessment-scope-and-methodology-report

HS2 Ltd (2017). *Environmental Policy*. Available online at: https://www.gov.uk/government/publications/hs2-environmental-policy

HS2 Ltd. (2017). *HS2 Design Vision, April 2017*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/607020/HS2_Design_Vision_Booklet.pdf

HS2 Ltd (2017). *Sustainability Policy*. Available online at: https://www.gov.uk/government/publications/hs2-sustainability-policy

HS2 Ltd (2017). *HS2 Phase Two Strategic Case.* Available online at: https://www.gov.uk/government/publications/hs2-phase-two-strategic-case

HS2 Ltd (2017). *Community Engagement Framework*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/625971/hs2_community_engagement_framework.pdf

HS2 Ltd (2017). *HS2 Circular Economy Principles*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/657833/hs2_circular_economy_principles.pdf

HS2 Ltd (2018). *HS2 Supplier Guide*. Available online at: https://www.gov.uk/government/publications/hs2-supplier-guide

HS2 Ltd (2018). *Press release: HS2 Ltd to undertake development works for electrification of the Midland Main Line*, https://www.gov.uk/government/news/hs2-ltd-to-undertake-development-works-for-electrification-of-the-midland-main-line

IEMA (2015). *IEMA guide to climate change resilience and adaptation*. Available online at: https://www.iema.net/assets/templates/documents/iema_guidance_documents_eia_climate_change_resilience_and_adaptation%20(1).pdf

IEMA (2017). *Assessing Greenhouse Gas Emissions and Evaluating their Significance*. Available online at: https://www.iema.net/assets/uploads/Webinar%20presentations/20170517%20KS.pdf

Institute of Air Quality Management (2016). Guidance on the assessment of mineral dust impacts for planning, IAQM, London.

International Commission on non-ionizing radiation protection (2010). *ICNIRP Guidelines*.

International Council on Monuments and Sites (ICOMOS) (2011). *Guidance on Heritage Impact Assessments for Cultural World Heritage Properties.* Available online at: https://www.icomos.org/world_heritage/HIA_20110201.pdf

Landscape Institute (2008). *Landscape architecture and the challenge of climate change*. Available online at: http://www.landscapeinstitute.org/PDF/Contribute/LIClimateChangePositionStatement.pdf

Midlands Connect (2017). *Our routes to growth*. Available online at: https://www.midlandsconnect.uk/media/1176/midlands-connect-ar-v18_final_web.pdf

Midlands Connect (2018). *Midlands Connect Strategy: Powering the Midlands Engine*. Available online at: https://www.midlandsconnect.uk/media/1100/midlands-connect-strategy-march-2017.pdf

Moorcroft and Barrowcliffe (2017). L*and-Use Planning & Development Control: Planning for Air Quality*, IAQM, London

National Groundwater & Contaminated Land Centre (2001). *Piling and penetrative ground improvement methods on land affected by contamination – guidance on pollution prevention NGCLC Report NC/99/73.* Available online at: http://webarchive.nationalarchives.gov.uk/20140329082415/http://cdn.environment-agency.gov.uk/scho0501bitt-e-e.pdf

Official Journal of the European Union, Directive 1999/31/EC of 26 April 1999 on the landfill of waste (Article 6).

Official Journal of the European Union, *Directive 2013/35/EU on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields).*

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

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

Planning Inspectorate (2017). *Advice note eighteen: The Water Framework Directive.* Available online at: https://infrastructure.planninginspectorate.gov.uk/wp-content/uploads/2017/06/advice_note_18.pdf

Railways and Other Guided Transport Systems (Safety) Regulations 2006 (ROGS) 2006. Her Majesty's Stationery Office, London.

RICS (2017). *Whole life carbon assessment for the built environment*. Available online at: http://www.rics.org/Global/Whole_life_carbon_assessment_for_the_BE_PGguidance_2017.pdf

RSSB (2016). *Tomorrow's Railway and Climate Change Adaptation*. Available online at: https://www.rssb.co.uk/Library/research-development-and-innovation/2016-05-t1009-exec-report.pdf

Temple-RSK (2016). *Sustainability Statement – Sustainability Statement including Post Consultation Update*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/568547/D25_WEB_C331_Sustainability_Statement_Including_Post_Consultation_Update_Volume_1_Main_Report_WEB_VERSION.pdf

Temple-ERM (2013). *Sustainability Statement - Volume 1: main report of the Appraisal of Sustainability.* Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/401154/pc205_vol_1_sustainability_statement_180713.pdf

The Green Construction Board. *Statement of Endorsement*. Available online at: http://www.greenconstructionboard.org/index.php/resources/infrastructure/statement-of-endorsement

The High Speed Rail (London – West Midlands) Bill as amended in the House of Commons Select Committee, March 2016. Available online at: http://www.publications.parliament.uk/pa/bills/cbill/2015-2016/0137/cbill_2015-20160137_en_1.htm

The High Speed Rail (West Midlands – Crewe) Bill as introduced to the House of Commons Select Committee, March 2016. Available online at: https://publications.parliament.uk/pa/bills/cbill/2017-2019/0006/cbill_2017-20190006_en_1.htm

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

Town and Country Planning (Environmental Impact Assessment) Regulations, (2017). SI 2017 No. 571. London, Her Majesty's Stationery Office.

Transport for the North (2018). *Strategic Transport Plan Draft for Consultation*. Available online at: https://transportforthenorth.com/wp-content/uploads/TfN-Strategic-Plan_draft_lr.pdf

UKCP09 (2009), *UKCP09 Climate Change Projections Report*. Available online at: http://ukclimateprojections.metoffice.gov.uk/media.jsp?mediaid=87894&filetype=pdf

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

UNFCCC (2015). *Conference of the Parties, Adoption of the Paris Agreement*; http://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf

Woodland Trust (2015). *Climate change - the Woodland Trust's position*. Available online at: https://www.woodlandtrust.org.uk/publications/2015/06/climate-change

World Health Organization (2010). *Night Noise Guidelines for Europe.* Available online at: http://www.euro.who.int/__data/assets/pdf_file/0017/43316/E92845.pdf

HS2

www.hs2.org.uk

High Speed Two (HS2) Limited
Two Snowhill,
Snow Hill Queensway,
Birmingham B4 6GA
Freephone: 08081 434 434
Minicom: 08081 456 472
Email: HS2enquiries@hs2.org.uk