E24-A

High Speed Rail (West Midlands - Crewe)

Environmental Statement

Volume 5: Technical appendices

Environmental Impact Assessment Scope and Methodology Report Addendum (CT-001-002) Part 1

July 2017

ES 3.5.0.1.2

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Department for Transport

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

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1 Introduction

1.1 Purpose of this Addendum

1.1.1 The HS2 Phase 2a Scope and Methodology Report (SMR)[1] was published in September 2016 and set out the proposed scope and methodology for the Environmental Impact Assessment (EIA) for Phase 2a (West Midlands - Crewe) of High Speed 2 (HS2).

1.1.2 This SMR Addendum outlines where the methodology presented within the SMR has been amended or developed as a result of:

- legislation or industry best practice guidance having changed;
- the methodology having undergone refinement in the course of preparation of the Environmental Statement (ES); and
- further feedback on the outlined methodology having been received from stakeholders including statutory bodies following the ongoing application of that methodology.

1.1.3 This addendum generally focuses on updates and refinement to:

- the establishment of the baseline and definition of the survey;
- the scope of the assessment; and
- the assessment methodology.

1.1.4 The scope and methodology is generally described to reflect the approach in the SMR (which, being a consultation document in advance of the preparation of the ES also used the future tense).

1.1.5 This addendum sets out minor changes to Part A and Part C of the SMR, in Sections 2 to 5. It should be noted that for ease of cross reference, the section numbers and title headings used in this addendum match those used in the SMR. For that reason, where there is no change made the section is marked as 'not used'. Where paragraphs/tables etc. from the SMR published in September 2016 have been amended, the original paragraph/table subject which has been subject to change is identified as follows - ***[bold italicised]***.

1.1.6 Part B of this addendum is arranged by topic in the same order as they are presented within the SMR. The section numbers in Part B match those used in the SMR. Thus, sections of this document where no change has been made are marked as 'not used'. Each section commences with a list of amendments to the SMR for the particular topic.

[1] Scope and Methodology Report, Volume 5: Appendix CT-001-001.

1.1.7 The detailed assessment methodology is collated and presented in one or more technical notes for the topics under assessment where required.

1.1.8 This SMR Addendum is divided into two parts as follows:

Part 1 (this document)

- SMR Addendum text;
- Annex A: Air quality;
- Annex B: Climate;
- Annex C: Community;
- Annex D: Cultural heritage;
- Annex E: Ecology;

Part 2

- Annex F: Electromagnetic interference;
- Annex G: Health;
- Annex H: Land quality;
- Annex I: Landscape and visual;
- Annex J: Major accidents and natural disasters;
- Annex K: Socio-economics;
- Annex L: Traffic and transport;
- Annex M: Waste and material Resources; and
- Annex N: Water and flood risk.

1.2 Structure of this SMR (not used)

1.3 Introduction to Hs2

List of amendments to the SMR for this section.

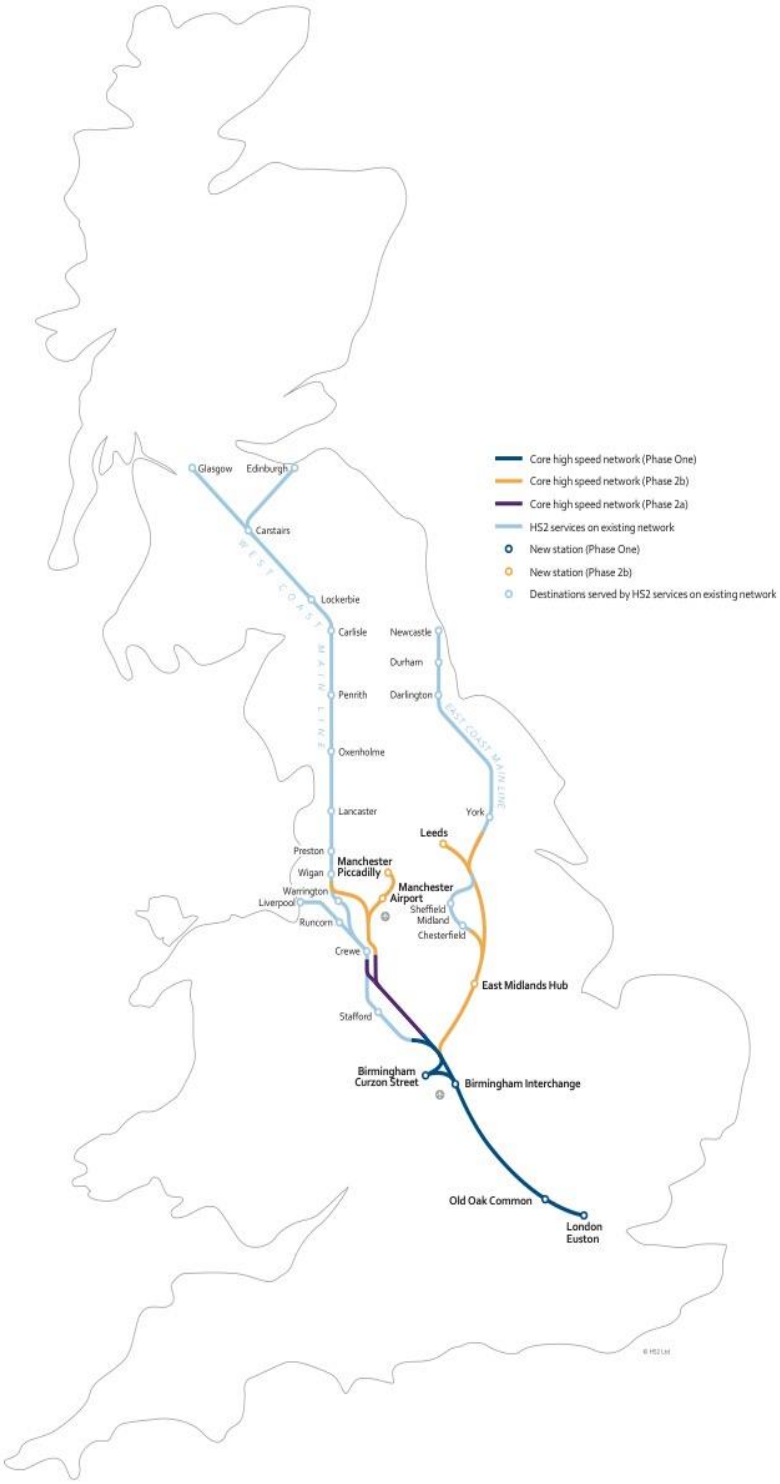
SMR paragraph reference/table number	Note
1.3.14	Paragraph text deleted and replacement text provided.
Figure 1	Updated Figure provided.

1.3.1 ***[paragraph 1.3.14 text deleted and replaced with]*** The Government set out the majority of its preferred route[2] from Crewe to Manchester and from the West

[2] 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

Midlands to Leeds, referred to as Phase 2b, on 15 November 2016. The powers for Phase 2b will be sought through a separate hybrid Bill that is expected to be laid before Parliament in 2019. Construction of Phase 2b is anticipated to commence in approximately 2023, with operation planned to start around 2033.

Figure 1 - The HS2 Core Network



1.4 Description of the HS2 Phase 2a route (not used)

1.5 Phase 2a interfaces (not used)

1.6 Previous environmental assessment work on the Proposed Scheme (not used)

1.7 Monitoring of performance against sustainability and environmental goals

List of amendments to the SMR for this section.

SMR paragraph reference/table number	Note
1.7.2	Paragraph text replaced
1.7.8	Paragraph text updated

1.7.1 ***[paragraph 1.7.2 text replaced]*** HS2 Ltd.'s Sustainability Policy (2017)[3] sets out its priority for sustainable design, which will help to reduce adverse environmental effects. The Sustainability Policy sets out its principles for sustainability in the following five themes:

- 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.

1.7.2 Each of the Sustainability Policy principles is further described in the HS2 Sustainability Approach Document[4].

1.7.3 Supporting the Sustainability Policy, the Environmental Policy[5] 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; climate change combined effects; air quality; water resources; historic environment; soils and agriculture; and sustainable materials and waste.

1.7.4 ***[paragraph 1.7.8 text updated]*** The revised EIA Directive 2014/52/EU (transposed into United Kingdom legislation as the Town and Country Planning (Environmental Impact

[3] HS2 Ltd (2017) *Sustainability Policy*. Available online at https://www.gov.uk/government/publications/hs2-sustainability-policy
[4] HS2 Ltd (2017) *Sustainability Approach*. Available online at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/610225/Sustainability_Approach.pdf
[5] HS2 Ltd (2017) *Environmental Policy*. Available online at: https://www.gov.uk/government/publications/hs2-environmental-policy

Assessment) Regulations 2017 (SI 2017/571) (the 'EIA Regulations'), 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.

2 Changes between Phase One and Phase 2a approach to EIA

List of amendments to the SMR for this section

SMR paragraph reference/table number	Note
2.2.3	Paragraph text deleted and replacement text provided.
2.2.7	Paragraph text amended

2.1 Changes to the EIA Directive

2.1.1 ***[paragraph 2.2.3 text deleted and replaced with]*** The EIA Directive 2014/52/EU[6] on environmental impact assessment was transposed into United Kingdom legislation as the Town and Country Planning (Environmental Impact Assessment) Regulations 2017 (SI 2017/571 (the 'EIA Regulations'). These regulations reflect European Union (EU) Directive requirements for assessment of the effects of certain public and private projects on the environment.

2.1.2 ***[paragraph 2.2.7 text deleted and replaced with]*** The EIA Directive 2014/52/EU uses the term 'Environmental Impact Assessment Report' (rather than 'Environmental Statement') to describe the documentation that presents the findings of an EIA. At the time of writing the working draft EIA Report, HS2 Ltd used the term 'EIA Report' for consistency with this EU Directive. Since the publication of the working draft EIA Report this Directive has been transposed through the Town and Country Planning (Environmental Impact Assessment) Regulations 2017 (SI 2017/571 (the 'EIA Regulations'). The updated Regulations have maintained the use of 'ES' rather than 'EIA Report' and therefore ES has been adopted for this suite of documents. The term ES is used in this SMR Addendum, where text has been updated or amended or included for context.

[6] 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.

3 Stakeholder engagement (not used)

4 EIA methodology

4.1 Introduction (not used)

4.2 Scope of the assessment (not used)

4.3 Approach to mitigation

List of amendments to the SMR for this Section

SMR paragraph reference/table number	Note
4.4.5	Paragraph text updated
4.4.6	Paragraph text updated

4.4 Cumulative Effects

4.4.1 **[*paragraph 4.4.5 text updated*]** The Command paper High Speed Two: East and West (November 2015) can be taken as national policy support for the development of a Crewe Hub. It set out, in paragraphs 6.14 and 6.15, the emerging options for a Crewe Hub station, noting that options work being undertaken by Network Rail and HS2 Ltd, with Cheshire East Council was focused on two locations (the existing Crewe station and Basford sidings). Network Rail has since considered those options, the outcome of which is that if the Crewe Hub scheme is to be taken forward, it should be located at the site of the existing station. In a further Command paper (High Speed Two: From Crewe to Manchester, the West Midlands to Leeds and beyond (November 2016)), the Government, in paragraphs 23 and 24, endorsed this conclusion and confirmed that it 'continues to support the vision for a Crewe Hub'. These emerging proposals are not part of HS2 Phase 2a and it will be confirmed, in due course, how any necessary development consent is to be secured.

4.4.2 **[*paragraph 4.4.6 text updated*]** At this time, the Crewe Hub proposal is at an early stage of development and there is insufficient information on which to base a robust assessment of in-combination construction effects. Nevertheless, the construction assessment for the Proposed Scheme considers the potential combined construction impacts of the Proposed Scheme and the Crewe Hub proposal, in the event that the latter proceeds at the same time as the Proposed Scheme.

5 Reporting of alternatives (not used)

6 Agriculture, forestry and soils

List of amendments to the SMR for this topic

SMR paragraph reference/table number	Note
6.6.47 and 6.6.48	Paragraphs amended

6.1 Introduction (not used)

6.2 Establishment of baseline and definition of survey (not used)

6.3 Consultation and engagement (not used)

6.4 Key aspects of the Proposed Scheme for the topic (not used)

6.5 Scope of assessment (not used)

6.6 Assessment methodology

Operational effects

6.6.1 ***[paragraphs 6.6.47 and 6.6.48 text updated]*** The following screening criteria for the predicted operational airborne sound levels will be used to identify potential adverse effects upon agricultural livestock:

- Daytime 70 dB $L_{pAeq, 16hour}$;
- Night-time 60 dB $L_{pAeq, 8hour}$; and
- During a train pass-by 90 dB L_{pAFmax}[7].

6.6.2 Since grazing livestock is able to move freely away from the sound source, the assessment will concentrate on identifying fixed livestock buildings or other enclosures. Once identified, the sound, noise and vibration specialists will advise on the operational sound level at the identified receptor locations given the likely train speeds and known scheme design (including cuttings and other features that would attenuate sound). The significance of effect will be determined in liaison with the sound, noise and vibration specialists.

6.7 Assumptions (not used)

[7] Where the animal is habituated to the source then this screening criterion is not applicable.

7 Air quality

List of amendments to the SMR for this topic

SMR paragraph reference/table number	Note
7.5.2	Supplementary paragraph provided
7.6.2	Paragraph amended
7.6.5	Supplementary paragraph provided

7.1 Introduction (not used)

7.2 Establishment of baseline and definition of survey (not used)

7.3 Consultation and engagement (not used)

7.4 Key aspects of the Proposed Scheme for the topic (not used)

7.5 Scope of assessment

Spatial scope

7.5.1 ***[supplementary text provided as new paragraph after 7.5.2]*** The assessment of dust emissions associated with mineral extraction during construction undertaken as part of the Proposed Scheme will be carried out in accordance with the IAQM mineral dust guidance[8].

7.6 Assessment methodology

Guidance

7.6.1 ***[paragraph 7.6.2 amended to]*** The assessment will take into account the following guidance:

- LAQM Technical Guidance (2016)[9];
- DMRB Volume 11 Environmental Assessment, Section 3 Environmental Assessment Techniques, Part 1 Air Quality, HA207/07;
- IAQM and Environmental Protection UK (EPUK) guidance on land-use planning and development control[10];
- IAQM guidance on the assessment of dust from demolition and construction; and

[8] IAQM, 2016, Guidance on the assessment of mineral dust impacts for planning.
[9] Department for Environment, Food and Rural Affairs, 2016, Local Air Quality Management Technical Guidance.
[10] Moorcroft and Barrowcliffe et al., 2017, Land-Use Planning & Development Control: Planning for Air Quality, Institute of Air Quality Management, London.

- IAQM guidance on the assessment of mineral dust impacts.

Construction effects

Dust emissions

7.6.2 ***[supplementary text provided as new paragraph after 7.6.5]*** An assessment of dust emissions associated with mineral extraction activities will be carried out using the risk-based approach from the IAQM mineral dust guidance.

7.7 Assumptions (not used)

8 Climate change

List of amendments to the SMR for this topic

SMR paragraph reference/table number	Note
8.3.1	Paragraph amended
8.3.2	Paragraph deleted
8.3.4	Paragraph amended
8.3.8	Paragraph amended (second to last bullet point)
Table 12	Supplementary or new text (in *italics*) added
8.4.30	Paragraph amended
8.4.37	Paragraph amended
8.4.37	Supplementary paragraph provided
8.4.38	Paragraph amended
8.4.39	Paragraph amended
8.4.39	Supplementary paragraph provided
8.5.14	Paragraph amended
8.5.19	Paragraph amended

8.2 Consultation and engagement (not used)

8.3 Greenhouse gases

Introduction

8.3.1 *[paragraph 8.3.1* ***amended to]*** The Proposed Scheme will be assessed within the context of the UK's evolving carbon agenda. The Climate Change Act 2008[11] committed the UK to its first statutory carbon-reduction target to reduce GHG emissions by at least 80% from 1990 levels by 2050. To ensure that regular progress is made towards the target the Climate Change Act also established a systems of carbon budgets. The first five carbon budgets, leading to 2032, have been set in law. Meeting the fourth (2023-27) and fifth (2028-2032) carbon budgets will require that carbon emissions are reduced by 50% (by 2025) and 57% (by 2030) respectively relative to 1990 levels. It is expected that the Government will publish a plan for meeting the legislated carbon budgets in the second half of 2017.

8.3.2 ***[paragraph 8.3.2 deleted]***

8.3.3 ***[paragraph 8.3.4 amended to]*** The GHG assessment will quantify and report the GHG emissions associated with the construction and operation of the Proposed Scheme in

[11] Her Majesty's Stationery Office (2008) Climate Change Act 2008, London. Available online at: http://www.legislation.gov.uk/ukpga/2008/27/contents

the form of the 'carbon footprint'. The carbon footprint will be reported in tonnes of carbon dioxide equivalent (tCO_2e). The Proposed Scheme's carbon footprint will be compared to UK national and transport sector GHG emissions in order to provide context for the scale of the carbon footprint.

Establishment of baseline and definition of survey (not used)

Key aspects of the Proposed Scheme for the topic

8.3.4 ***[paragraph 8.3.8 (second last bullet point) amended to]*** Key aspects of the Proposed Scheme for this topic include:

- energy supply - the construction and operational assessment will take account of grid decarbonisation projections and will be based on evidence from sources such as the UK's Low Carbon Transition Plan[12], the CCC reports[13] [14], and the Department for Business, Energy & Industry Strategy; and

Scope of the GHG assessment

[Table 12 amended – supplementary text in italics]

Table 12 – Scope of the GHG assessment broken down by life cycle stages, consistent with the principles set out in BS EN 15978:2011 and PAS 2080:2016.

Life cycle assessment boundary stages	**Description**
Pre-construction stage (module A0)	*Represents preliminary desk-based studies and works such as:* *strategy and brief development;* *architecture;* *design efforts;* *EIA; and* *cost planning.* *Includes emissions associated with office energy use and consultants' travel.*
Product stage (modules A1 – A3)	Represents the embedded GHG emissions associated with the extraction, processing and manufacturing of the Proposed Scheme's construction material for permanent assets. This includes all energy and GHG emissions from manufacturing plants, primary and secondary manufacturing stages as well as any transport emission between these stages. For example, concrete manufacturing includes energy and GHG emissions linked to all key stages: quarrying, aggregate crushing, transport of aggregates to ready-mix concrete plants and asphalt plants. This final stage includes emissions associated with the adding of water and cement mixes.
Construction process - transport stage (module A4)	Represents transport related GHG emissions associated with the delivery of construction material, such as concrete and steel, and construction equipment to construction sites along the Proposed Scheme from the point of production (or point of storage in the case of plant and machinery).

[12] Department of Energy and Climate Change, *The UK Low Carbon Transition Plan: national strategy for climate and energy*, 2009. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/228752/9780108508394.pdf
[13] Committee on Climate Change (2008) *Building a low-carbon economy – the UK's response to tackling climate change*. CCC, London.
[14] Committee on Climate Change (2009) *Meeting Carbon Budgets – the need for a step change*. CCC, London.

Life cycle assessment boundary stages	**Description**
Construction process – on-site stage (module A5)	Represents GHG emissions from construction site works activities including: 1. temporary works, ground works, and landscaping*;* 2. materials storage and any energy or otherwise need to maintain necessary environmental conditions**;** 3. transport of materials and equipment on site*;* 4. installation of materials and products into the infrastructure asset*;* 5. emissions associated with site water demand*;* 6. waste management activities (transport, processing, final disposal) associated with waste arising from the construction site*; and* 7. production, transportation, and waste management of materials/products lost during works. *Includes carbon emissions from land use change.*
Use stage – installed products and materials (module B1)	Represents the GHG emitted directly from the fabric of products and materials once they have been installed, *as well as the sequestration of emissions from trees planted as part of the Proposed Scheme*.
Use stage (modules B2 – B5)	Represents the GHG emissions resulting from activities of works and new materials for the maintenance, repair, replacement and refurbishment of the Proposed Scheme during the use stage/operation.
Use stage - operational energy (modules B6)	*Represents the carbon emissions resulting from the energy used by the Proposed Scheme to operate infrastructure-integrated systems necessary for the technical and functional performance of the Proposed Scheme (e.g. lighting, ventilation, drainage, heating and cooling) minus any electricity generated through on site low carbon energy sources not exported to the grid.*
Use stage - operational water (modules B7)	*Represents water required by the Proposed Scheme to enable it to operate and deliver its service. It will include all water used and its treatment (pre- and post-use) during the normal operation of the Proposed Scheme.*
Use stage - other operational processes (module B8)	Represents other process GHG emissions arising from the Proposed Scheme to enable it to operate and deliver its service including management of operational waste.
Use stage – users utilisation (module B9)	*Represents the carbon emissions associated with the operation of the rolling stock and un-regulated energy consumption not required for the technical and functional performance of the infrastructure (e.g. plug-in appliances, such as computers, refrigerators, audio, TV and production or process-related energy use).*
End of life stage (module C1)	Represents the GHG emissions resulting from activities of deconstructing, demolishing and decommissioning the Proposed Scheme. Essentially these are on-site GHG emissions from plant equipment.
End of life stage (modules C2 – C4)	Represents the activities associated with transport, waste management and final disposal of materials associated with the site and materials of the Proposed Scheme.
Benefits and loads beyond the infrastructure life cycle (module D)	Includes: 1. avoided GHG emission impacts associated with the Proposed Scheme including potential for re-use, recovery and recycling of materials and/or energy beyond the system boundary. 2. savings in GHG emissions from modal shift of passenger and freight journeys associated with the Proposed Scheme; *and* 3. *electricity and fuel use for surface access journeys to depots.*

8.4 In-combination climate change impacts

Assessment methodology

8.4.1 ***[paragraph 8.4.30 amended to]*** Potential climate change impacts relevant to the Proposed Scheme will be considered at a route-wide level for all environmental topics. This will form the basis for an initial in-combination climate change impacts assessment to be led by the climate change topic specialists with input from all environmental topic specialists. This will be informed by climate change projections for the Phase 2a route, recent and relevant science, policy and guidance for each topic, and the initial assessment results from all topics' community area (Volume 2) and route wide (Volume 3) assessments. The initial in-combination climate change impacts assessment will identify environmental topics to remain scoped in for a more detailed assessment. See Figure 10 for an illustration of this approach.

8.4.2 ***[paragraph 8.4.37 amended to]*** Following the initial assessment, topics will then be categorised into one of the following four categories based on the number and consequence of potential in-combination impacts as part of the initial assessment:

- many potential climate change impacts with high consequences (to remain scoped in for more detailed assessment);
- few potential climate change impacts with high consequences (to remain scoped in for more detailed assessment);
- few potential climate change impacts with low consequences (to be scoped out); and
- no potential climate change impacts (to be scoped out).

The scoping decision will be reviewed by the environmental topic specialists in collaboration with the climate change topic specialists.

8.4.3 ***[supplementary text provided as new paragraph after 8.4.37]*** A more detailed assessment will then be undertaken for those topics which remained scoped in which will include an assessment of each topic's respective significant effects and a determination of whether they could potentially be exacerbated or ameliorated by climate change impacts. This will determine whether there are any significant in-combination climate change effects to report.

8.4.4 ***[paragraph 8.4.38 amended to]*** The potential significance of in-combination climate change impacts identified will then be assessed qualitatively, based upon the professional judgement of relevant environmental topic specialists working closely with the climate change topic specialists.

8.4.5 ***[paragraph 8.4.39 amended to]*** An exception to the approach outlined above is the assessment of water resources, flood risk and drainage design which will be

quantitative and take into account current Environment Agency climate change allowances for increases in peak river flow and rainfall intensity[15].

8.4.6 ***[supplementary text provided as new paragraph after 8.4.39]*** If existing mitigation measures[16] are considered to not address adverse effects of climate change on the ability of resources and receptors to adapt, then additional mitigation measures will be developed by the climate change topic specialists in collaboration with the environmental topic specialists. Allowances for future measures and monitoring to ensure the continued resilience of receptors and resources will also be identified.

8.5 Climate change resilience

Assessment methodology

8.5.1 ***[paragraph 8.5.14 amended to]*** The climate change resilience assessment will initially be considered at a route-wide level and will include all infrastructure and assets associated with the Proposed Scheme. The assessment will comprise an assessment of climate hazards which may affect the Proposed Scheme as a result of climate change, and an assessment of the likelihood of each hazard occurring (taking into account resilience measures already incorporated into the design of the Proposed Scheme) and the consequence of the potential impact on the Proposed Scheme during the construction and operation phases. The assessment will identify infrastructure and assets which may require a more detailed assessment.

8.5.2 ***[paragraph 8.5.19 amended to]*** The initial route-wide climate change resilience assessment will be informed by descriptions of changes in climate averages and extreme weather events provided in UKCP09 and the professional expertise of the climate change topic specialists and the engineering and design experts to qualitatively assess the impacts of climate change on the Proposed Scheme. It will take into account current weather events and climatic conditions, and consider how these might worsen or improve due to projected climate change during construction and the operational life of the infrastructure and assets associated with the Proposed Scheme. A more detailed and quantitative assessment may then be carried out during future design stages.

[15] Environment Agency, Flood risk assessments: climate change allowances (updated 3 February 2017) Available online at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

[16] Existing mitigation measures refers to embedded design mitigation measures and environmental mitigation measures identified by topics as part of their assessments.

9 Community (not used)

10 Cultural heritage

List of amendments to the SMR for this topic

SMR paragraph reference/table number	Note
Table 19	Supplementary text (in *italics*) added to 'Asset categories' column.

10.1 Introduction (not used)

10.2 Establishment of baseline (not used)

10.3 Consultation and engagement (not used)

10.4 Key aspects of the Proposed Scheme for the topic (not used)

10.5 Scope of the assessment (not used)

10.6 Assessment methodology

Significance criteria

[Table 19 amended – supplementary text in italics]

Table 19 - Factors for assessing the significance/value of heritage assets

Significance (value)	Asset categories
High	World Heritage Sites Grade I and Grade II* Listed Buildings Grade I and Grade II* Registered Parks and Gardens Scheduled Monuments Registered battlefields Conservation Areas (as appropriate) Non-designated heritage assets (archaeological sites, buildings, monuments, parks, gardens or landscapes) that can be shown to have high significance (value) Burial Grounds and Cemeteries *Well preserved historic landscape character areas, exhibiting considerable coherence, time-depth or other critical factor(s)*
Moderate	Grade II listed Buildings Conservation Areas (as appropriate) Grade II Registered Parks and Gardens Locally listed buildings as recorded on a local authority list Non-designated heritage assets (archaeological sites, buildings, monuments, parks, gardens or landscapes) that can be shown to have moderate significance (value) Historic Townscape with historic integrity in that the assets that constitute their make-up are clearly legible *Averagely well-preserved historic landscape character areas with reasonable coherence, time-depth or other critical factor(s)*

Significance (value)	Asset categories
Low	Non-designated heritage assets (archaeological sites, buildings, monuments, parks, gardens or landscapes) that can be shown to have low significance (value) Assets whose values are compromised by poor preservation or survival or of contextual associations to justify inclusion into a higher grade *Historic landscape character areas whose value is limited by poor preservation and/or poor survival of contextual associations*
Not significant	Assets identified as being of no historic, evidential, aesthetic or communal interest Assets whose values are compromised by poor preservation or survival or of contextual associations to justify inclusion into a higher grade *Landscape with no or little significant historical interest*

10.7 Assumptions (not used)

11 Ecology and biodiversity

List of amendments to the SMR for this topic

SMR paragraph reference/table number	Note
11.5.5	Paragraph format amended (1st bullet split into two separate bullet points)

11.1 Introduction (not used)

11.2 Establishment of baseline and definition of survey (not used)

11.3 Consultation and engagement (not used)

11.4 Key aspects of the Proposed Scheme for the topic (not used)

11.5 Scope of the assessment

Spatial scope

11.5.1 ***[paragraph 11.5.5 amended to]*** Due to the large scale of the Proposed Scheme and the large volumes of information to be collected in support of the assessment, the ES will report on only those resources/receptors identified as potentially relevant to the assessment. For Natura 2000 sites this is identified through Habitats Regulations Assessment to determine the potential for likely significant effects. For other receptors, it has been defined as follows:

- all statutory designated sites within Natural England's SSSI Impact Risk Zones, and any others considered potentially subject to significant effects;
- Non-statutory designated sites (and ancient woodlands) located within a 500m radius of the land required for the construction of the Proposed Scheme, and any others considered potentially subject to significant effects; and
- protected and/or notable habitats and species[17] within or adjacent to land required for the construction of the Proposed Scheme, and any others considered potentially subject to significant effects.

11.6 Scope of the assessment (not used)

11.7 Assumptions (not used)

[17] HM Government, 2006, Natural Environment and Rural Communities Act 2006, The Stationery Office.

12 Electromagnetic interference (not used)

13 Health (not used)

14 Land quality (not used)

15 Landscape and visual

List of amendments to the SMR for this topic

SMR paragraph reference/table number	Note
Figures 13 and 14	Figures updated to refer to 'landscape character' rather than LCAs; wording amended to provide clarity in relation to visual receptors and removal of arrow between value and magnitude to improve clarity.
15.2.2	Clarification of wording around landscape value and amendment of wording in 6th bullet point to better reflect GLVIA3.
15.2.3	Paragraph re-ordered to appear under section title 'Establishment of baseline and definition of survey' in paragraph 15.2.1.
15.2.4	Wording amended to refer to 'landscape character' rather than 'landscape character area'.
15.5.5	Updated reference to ZTV production to refer to Phase 2a Technical Note.
15.6.2 - 15.6.8	Clarification around wording on landscape value and susceptibility in relation to landscape character.
15.6.2	Cross reference to landscape value added.
15.6.8	Clarification added re: value and susceptibility (added to introductory text at paragraph 15.6.8 rather than changing the content of Table 26).
15.6.10	Reference to 'character area' replaced with 'landscape character'.
Table 26	Substitution of words 'substantial proportion' with 'substantially alter'.

15.1 Introduction (not used)

15.1.1 ***[Figures 13 and 14 updated]:***

Figure 13 - Assessment process for the landscape assessment

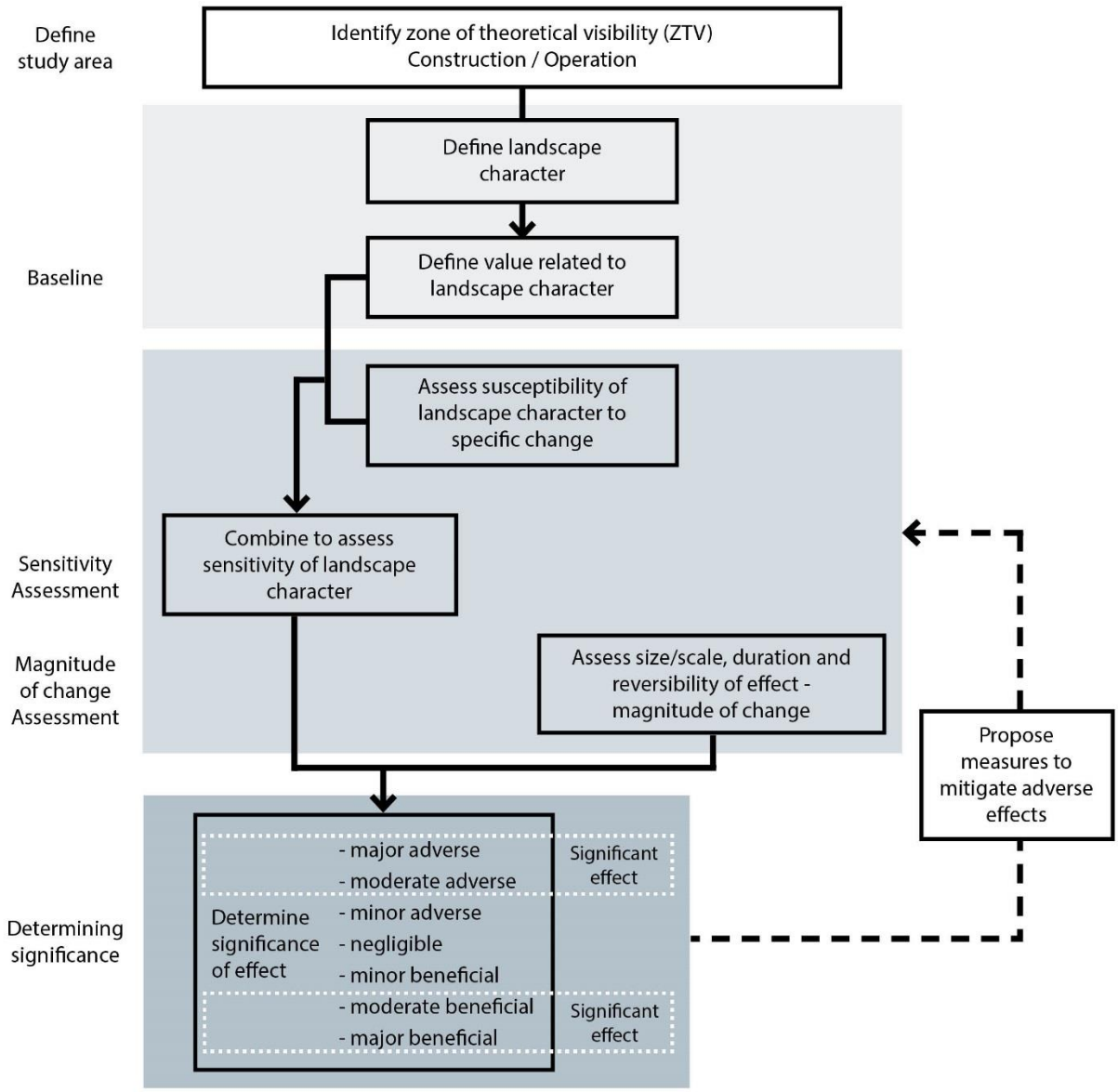
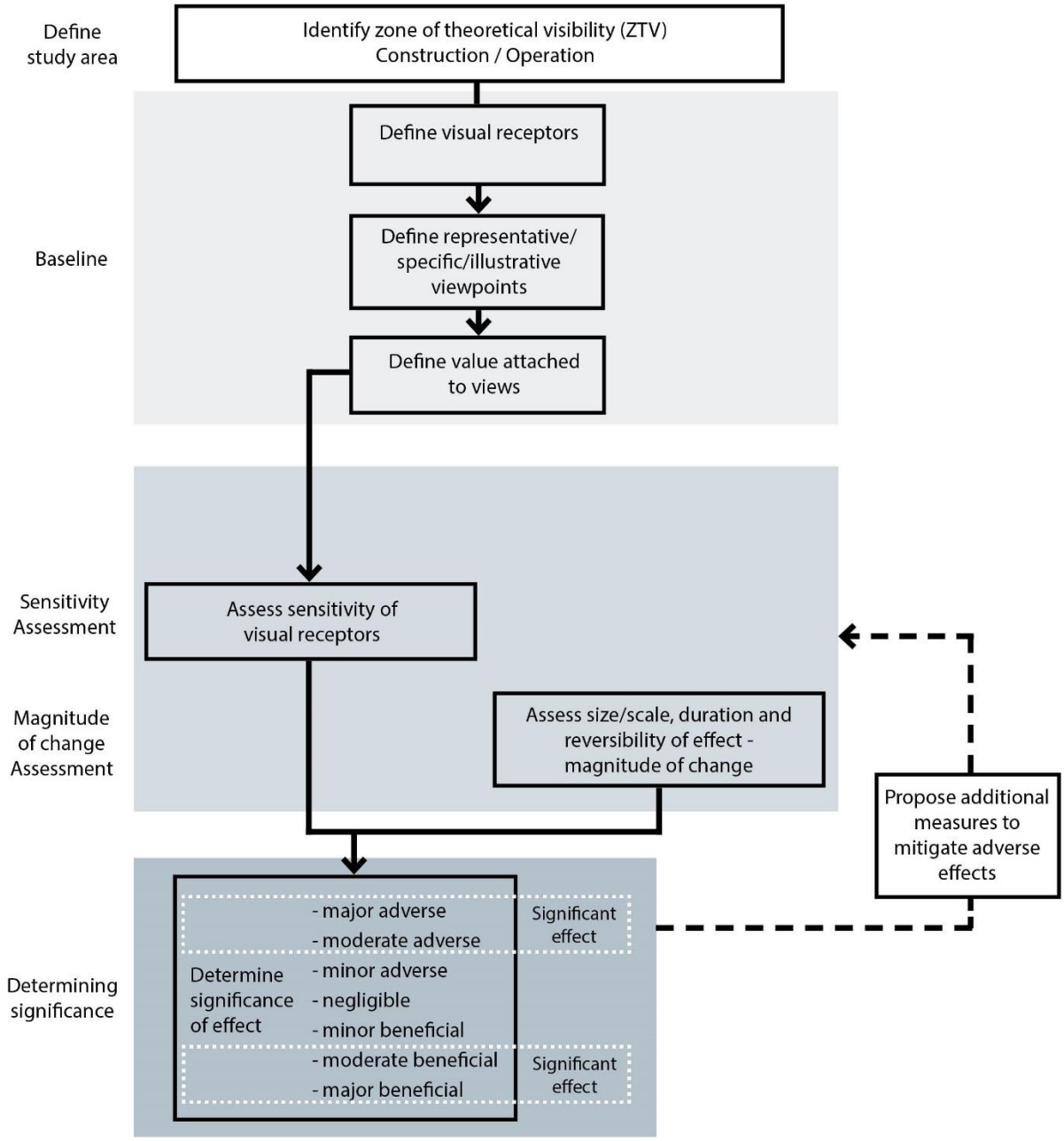


Figure 14 - Assessment process for the visual assessment



15.2 Establishment of baseline and definition of survey

15.2.1 ***[paragraph 15.2.3 and 15.2.4updated and amended as below]*** The landscape and visual surveys will be carried out by Chartered Landscape Architects experienced in EIA. Assessments made will be verified by at least two other Chartered Landscape Architects experienced in EIA. Survey work will be carried out in both winter and summer, in order for seasonal change to be considered in the assessment. The survey work will be undertaken in a methodical order as follows:

- verification of the zone of theoretical visibility (ZTV) to inform the study area (see Section 15.5 Scope of assessment - Spatial Scope);

- definition and verification of the landscape character (in consultation with relevant disciplines such as heritage and ecology and reviewing and adapting information in existing landscape character assessments);
- determination of the value of the landscape;
- assessment of the susceptibility of the landscape character to change;
- assessment of the sensitivity of the landscape character based on value and susceptibility;
- definition of groups of visual receptors (people who may be affected by the Proposed Scheme) and definition of representative, specific and illustrative viewpoints within the ZTV;
- definition of the type and nature of the view from each viewpoint;
- determination of the value of each of the viewpoints;
- assessment of the susceptibility to change of each of the viewpoints; and
- consideration of size/scale, duration and reversibility to determine the magnitude of change for landscape character and viewpoints.

15.2.2 ***[paragraph 15.2.4 amended to]*** The field study will include a comprehensive photographic record carried out in both the summer and winter, to illustrate the landscape character and viewpoints.

Spatial scope

15.2.3 ***[paragraph 15.5.5 amended to]*** The ZTVs will be based on the most recently available topographic data. A datum of 1.6m above ground level will be used to represent the eye level view of an average height person. The validity of the route wide ZTV will be checked on site, using professional judgement, to ensure the output is a fair representation of the theoretical visibility of the Proposed Scheme, in line with guidance provided by the Landscape Institute. The detailed methodology for producing the ZTV is described in the Phase 2a ZTV production methodology technical note (as included in Annex I).

15.3 Consultation and engagement (not used)

15.4 Engagement as part of the EIA process (not used)

15.5 Scope of the assessment (not used)

15.6 Assessment methodology

15.6.1 ***[paragraph 15.6.2 amended to]*** Landscape character sensitivity is derived from judgements about the susceptibility of landscape character to the type of change arising from the Proposed Scheme; and the value attached to the landscape in the baseline (refer to paragraphs 15.2.7 to 15.2.10).

15.6.2 ***[paragraphs 15.6.3-15.6.7 copied for context below]*** The susceptibility of the landscape will be assessed against the following five criteria:

- landform;
- land cover and land use;
- scale;
- prominent landmarks; and
- perceptual aspects and tranquillity.

15.6.3 For each criterion, the susceptibility will be assessed on a scale from low to high using professional judgement with reference to site visits and existing documentation, including local authority character assessments, historic landscape character assessments and conservation area character appraisals where available.

15.6.4 An overall level of susceptibility for each landscape character area will be assessed by comparing the judgements made for each category described above.

15.6.5 Further detail on the attributes that influence the susceptibility judgements for each criteria are described in the Phase 2a Technical Note – Approach to Landscape Sensitivity, which will be included in Volume 5 of the ES (SMR Addendum, Annex I).

15.6.6 With reference to the overall value and susceptibility of the landscape, the sensitivity of the landscape will be assessed. The assessment of sensitivity requires the application of professional judgement, in line with guidance provided by the Landscape Institute. The presence of any combination of attributes within the criteria described may be considered when assessing the sensitivity of a character area. This allows professional judgement to be used when determining the relative importance of different attributes.

15.6.7 ***[paragraph 15.6.8 amended to]*** The attributes that influence the sensitivity of the landscape character area described in Table 26 and in the technical note on landscape sensitivity Volume 5 of the ES (SMR Addendum, Annex I).

Determining magnitude of change

15.6.8 ***[paragraph 15.6.10 amended as below]*** Factors that would be considered in assessing the magnitude of change to landscape character are summarised in Table 27. These criteria are based on guidance provided by the Landscape Institute.

15.6.9 ***[Table 27 amended]***

Table 27 - Landscape magnitude of change

Impact magnitude	Definition
High	Total loss or substantial alteration to key characteristics of the character and/or setting of the character area. Addition of new uncharacteristic features or components that substantially alter character and/or a large part of the setting of the character area. Introduction of irreversible change over a substantial area of an LCA or its setting. Introduction of long term or permanent change uncharacteristic of the area.
Medium	Noticeable change or alteration to one or more key characteristics of the character and/or setting of the character area.

Impact magnitude	Definition
	Addition of new features or components that form prominent elements of the character and/or setting of the character area, but are largely characteristic of the existing setting. Uncharacteristic changes across only a proportion of the character area or its setting. Introduction of some irreversible changes in parts of a character area or its setting. Introduction of medium to long term uncharacteristic changes and/or permanent changes largely characteristic of the existing setting.
Low	Slight loss or alteration to one or more characteristics of the character and/or setting of the character area. Addition of new features or components that form largely inconspicuous elements of the existing character and/or setting. Introduction of short to medium term uncharacteristic changes and/or long term / permanent changes in a small proportion of a character area or its setting.
Negligible	No change to, or barely perceptible loss or alteration of inconspicuous characteristics of the character and/or setting of the character area. Addition of new features or components that do not influence the overall character and/or setting of the character area, or are entirely characteristic of the existing setting. Introduction of short term uncharacteristic changes in parts of the area and/or longer term changes in a small part of the wider setting.

15.7 Assumptions (not used)

16 Major accidents and natural disasters (not used)

17 Socio-economics (not used)

18 Sound, noise and vibration (not used)

19 Traffic and transport

List of amendments to the SMR for this topic

SMR paragraph reference/table number	Note
19.6.12	Paragraph text deleted and replacement text provided.
19.6.40	Paragraph text deleted and replacement text provided.

19.1 Introduction (not used)

19.2 Establishment of baseline and definition of survey (not used)

19.3 Consultation and engagement (not used)

19.4 Key aspects of the Proposed Scheme for the topic (not used)

19.5 Scope of the assessment (not used)

19.6 Assessment methodology

Significance criteria for construction assessment traffic flows and delays to vehicle occupants

19.6.1 ***[paragraph 19.6.12 text deleted and replaced with]*** A change in traffic levels can result in changes to traffic-related severance for non-motorised road users, particularly pedestrians using or seeking to cross a road. A significant change is defined as a 30% increase in traffic flows (either HGVs or all vehicles), where the increase is greater than 40 vehicles per day in urban areas or 10 vehicles per day in rural areas.

19.6.2 Where HGV traffic, including HS2 related traffic, is less than 10% of total traffic, the significance level of any adverse effect would be reduced such that, for example, what would otherwise be assessed as a moderate significant effect would be considered to be a minor significant effect.

Significance criteria for operational assessment

Traffic flows and delays to vehicle occupants

19.6.3 ***[paragraph 19.6.40 text deleted and replaced with]*** A change in traffic levels can result in changes to traffic-related severance for non-motorised road users, particularly pedestrians using or seeking to cross a road. A significant change is defined as:

- a 10% increase change in peak hour two-way traffic flows where the increase is greater than 40 vehicles per day in urban areas or 10 vehicles per day in rural areas; and
- a 30% increase in the average off-peak hour two-way traffic flows where the increase is greater than 40 vehicles per day in urban areas or 10 vehicles per day in rural areas.

19.6.4 Where HGV traffic, including HS2 related traffic, is less than 10% of total traffic, the significance level of any adverse effect would be reduced such that, for example, what would otherwise be assessed as a moderate significant effect would be considered to be a minor significant effect.

19.7 Assumptions (not used)

20 Waste and material resources (not used)

21 Water resources and flood risk

List of amendments to the SMR for this topic

SMR paragraph reference/table number	Note
Table 51	Criteria text amended for 'moderate adverse' impacts
Table 52	Criteria text amended

21.1 Introduction (not used)

21.2 Establishment of baseline and definition of survey (not used)

21.3 Consultation and engagement (not used)

21.4 Key aspects of the Proposed Scheme for the topic (not used)

21.5 Scope of assessment (not used)

21.6 Assessment methodology

Significance criteria

[Table 51 amended as below - amended text in italics]

Table 51 – Magnitude of possible impacts

Magnitude	Criteria	Examples
Major	Adverse: Loss of an attribute and / or quality and integrity of an attribute Beneficial: Creation of new attribute or major improvement in quality of an attribute	Adverse: Increase in peak flood level* (> 100mm); loss of a fishery; *deterioration* in surface water ecological or chemical WFD element status or groundwater qualitative or quantitative WFD element status. Beneficial: Creation of additional flood storage and decrease in peak flood level* (> 100mm); increase in productivity or size of fishery; *improvement* in surface water ecological or chemical WFD element status; *improvement* in groundwater qualitative or quantitative WFD element status.
Moderate	Adverse: Loss of part of an attribute or decrease in integrity of an attribute Beneficial: Moderate improvement in quality of an attribute	Adverse: Increase in peak flood level* (> 50mm); partial loss of fishery; measurable decrease in surface water ecological or chemical quality or flow *with potential for deterioration in WFD element status*. Reversible change in the yield or quality of an aquifer, such that existing users are affected, *with potential for deterioration in WFD element status.* Beneficial: Creation of flood storage and decrease in peak flood level* (> 50mm); *measurable increase in surface water ecological or chemical quality or flow with potential for WFD element status to be improved. Measureable increase in the yield or quality of an aquifer, benefiting existing users, with potential for WFD element status to be improved.*
Minor	Adverse: Measurable change to the integrity of an attribute	Adverse: Increase in peak flood level*(> 10mm); measurable decrease in surface water ecological or chemical quality or flow; decrease in yield or quality

	Beneficial: Measurable increase, or reduced risk of negative effect to an attribute	of aquifer, not affecting existing users or changing any WFD element status. Beneficial: Creation of flood storage and decrease in peak flood level* (> 10mm); measurable increase in surface water ecological or chemical quality; increase in yield or quality of aquifer not affecting existing users or changing any WFD element status.
Negligible	No change to integrity of attribute	Negligible change to peak flood level* (< +/- 10mm); discharges to watercourse or changes to an aquifer which lead to no change in the attribute's integrity.

* Peak flood level for floods up to and including a 1% annual probability event, including climate change. Where access or egress routes are affected, the magnitude of the impact will be defined by the change in the Flood Hazard Rating as defined in Defra/Environment Agency report FD2320

21.6.1 ***[paragraph 21.6.5 text amended]*** Table 52 provides an indication of the value of receiving water body or receptor. The examples, and in particular the specified Q95 flow thresholds, are not exhaustive and are intended as a guide.

[Table 52 amended as below]

Table 52 – Examples of the value of possible waterbodies or receptors

Value	**Criteria**	**Examples**
Very high	Nationally significant attribute of high value	Watercourse with a Q95 299 flow ≥ 1.0 m3/s*, SPZ 1 within a Principal aquifer, essential infrastructure or highly vulnerable development**
High	Locally significant attribute of high value	Watercourse with a Q95 flow > 0.01 m3/s*, Principal aquifer, more vulnerable development**
Moderate	Of moderate quality and rarity	Watercourses with a Q95 flow > 0.002 m3/s to ≤0.01m3/s*, Secondary aquifer, less vulnerable development**
Low	Lower quality	Watercourses with a Q95 flow ≤0.002m3/s*, surface water sewer, minor pond or ditch, non-aquifer, water compatible development**

** based on watercourse Q95 flow estimate at location of Proposed Scheme.*

** as defined in Table 2 of the Flood Risk section of the Technical Guidance to the NPPF.

21.7 Assumptions (not used)

22 Structure of the formal EIA Report (not used)

Annex A: Air quality- technical note

The following technical note is contained in this Annex:

- Guidance on assessment methodology.

HS2 Phase 2a West Midlands to Crewe: Technical note – Air Quality: Guidance on the assessment methodology

Contents

List of tables

1 Introduction

1.1 Purpose of the note

1.1.1 This technical note provides further information on the assessment of air quality during construction and operation of the Proposed Scheme. The Environmental Impact Assessment (EIA) Scope and Methodology Report (SMR)[1] provided the general methodology to be followed. This note provides a more detailed framework for assessing air quality effects during the construction and operation of the Proposed Scheme.

2 General considerations

2.1 Guidance documents

2.1.1 The following guidance documents are relevant for the assessment of air quality:

- The Department for Environment, Food and Rural Affairs (Defra) Local Air Quality Management (LAQM) Technical Guidance (TG16) (April 2016) [referred to as 'Defra TG16 guidance']**[2]**;
- Defra LAQM Policy Guidance (PG16) (April 2016) [referred to as 'Defra PG16 guidance']**[3]**;
- Institute of Air Quality Management (IAQM) guidance on the assessment of dust from demolition and construction (February 2014) [referred to as 'IAQM construction dust guidance']**[4]**;
- IAQM guidance on the assessment of mineral dust impacts for planning (May 2016) [referred to as 'IAQM mineral dust guidance']**[5]**; and
- IAQM and Environmental Protection UK (EPUK) guidance on land-use planning and development control (January 2017) [referred to as 'IAQM/EPUK guidance']**[6]**.

2.2 Baseline data

2.2.1 Baseline monitoring data should be reported from the nearest available sites that represent the location under assessment. Where data capture is less than 90% in a year, commentary will be given on how these data may or may not reflect annual mean concentrations.

[1] Scope and methodology Report, Volume 5: Appendix CT-001-001.
[2] Defra (2016), Local Air Quality Management Technical Guidance.
[3] Defra (2016), Local Air Quality Management Policy Guidance.
[4] IAQM (2014), Guidance on the assessment of dust from demolition and construction.
[5] IAQM (2016), Guidance on the assessment of mineral dust impacts for planning.
[6] IAQM (2017), Land-use planning & development control: Planning for air quality.

2.3 Interfaces

2.3.1 Any results that relate to receptors within an adjacent community area (CA) will be included as part of the relevant Volume 2 of the Environmental Statement (ES).

2.4 Meteorological data

2.4.1 When dispersion modelling is undertaken, a sensitivity analysis will be performed using five years of hourly sequential meteorological data from a station as indicated below (depending on location). The results for the full assessment will then be presented based on 2016 meteorological data, unless the sensitivity analysis suggests that another year is likely to lead to results that would materially affect the conclusions of the assessment. The choice of any year other than 2016 will be justified.

2.4.2 The following meteorological stations (Table 1) will be used in the assessment, unless there are particular local features to suggest another site is more appropriate.

Table 1: Meteorological stations

No.	Meteorological station	Ordnance Survey (OS) coordinates	Local authority
1	Birmingham Elmdon	417223, 283590	Lichfield
2	Shawbury	355059, 322703	Stafford, Cheshire East, Newcastle under Lyme

2.5 Limitations

2.5.1 Non-scheme car park emissions will not be assessed unless professional judgement indicates that they may contribute significantly to the outcome and have not been included in the baseline.

2.5.2 Emissions from rail brake and track wear during operation are assumed to be negligible and will not be included in the assessment.

2.5.3 Trains and much of the Proposed Scheme infrastructure will be electrically operated. Emissions from power plants used to power the trains and infrastructure are outside the scope of a local air quality assessment and will not be included in the assessment.

3 Assessment of dust emissions

3.1 Type of assessment required

3.1.1 Emissions of dust and particulates during construction will be assessed following the relevant IAQM guidance[4]. This section provides an interpretation of the guidance for application to the assessment of the Proposed Scheme.

3.1.2 Within the IAQM guidance, an 'impact' is described as a change in pollutant concentrations or dust deposition and an 'effect' is described as the consequence of an impact. The main impacts that may arise during construction are:

- dust deposition, resulting in soiling of surfaces;
- visible dust plumes; and
- elevated PM10 concentrations.

3.1.3 The IAQM guidance considers the potential for dust emissions from dust-generating activities, such as demolition of existing structures, earthworks, construction of new structures and trackout. Earthworks refer to the processes of soil stripping, ground levelling, excavation and land capping, while trackout is the transport of dust and dirt from the site onto the public road network where it may be deposited and then re-suspended by vehicles using the network. This arises when vehicles leave the site with dusty materials, which may then spill onto the road, or when they travel over muddy ground on site and then transfer dust and dirt onto the road network.

3.1.4 For each of these dust-generating activities, the guidance considers three separate effects: annoyance due to dust soiling, harm to ecological receptors and the risk of health effects due to a significant increase in PM10 exposure. The receptors can be human or ecological and are chosen based on their sensitivity to dust soiling and PM10 exposure.

3.1.5 The methodology takes into account the scale to which the above effects are likely to be generated (classed as small, medium or large), along with the levels of background PM10 concentrations and the distance to the closest receptor, in order to determine the sensitivity of the area. This is then taken into consideration when deriving the overall risk for the site. Suitable mitigation measures are also proposed to reduce the risk of dust emissions from the site.

3.2 Types of receptors

3.2.1 The IAQM guidance details two types of relevant receptors that will be taken into account in the assessment – human and ecological receptors.

3.2.2 A human receptor is defined as any location where a person may experience the annoyance effects of airborne dust or dust soiling, or exposure to PM10 over a time period relevant to the air quality standards. For the purposes of the assessment of the Proposed Scheme this is mainly residential dwellings. The IAQM guidance also directs that some commercial premises may have a particular sensitivity to dust, however, the assessment must take into account the actual situation at premises of this type as they may already have protected their operations against increased dust levels. Some horticultural operations are also considered to be dust sensitive.

3.2.3 An ecological receptor is any habitat that may be sensitive to dust soiling from direct impacts (e.g., excessive dust deposition) or indirect impacts on fauna (foraging habitats).

3.3 Spatial scope of assessment

3.3.1 The IAQM guidance suggests that an assessment is required where there are sensitive receptors within 350m of the boundary of the site (or 50m for ecological receptors), within 50m of the route used by construction vehicles on the public highway and up to 500m from the site entrance. It is acknowledged in the guidance that these values are conservative and hence there is scope for specific criteria to be applied at certain locations if required.

3.4 Temporal considerations

3.4.1 The assessment of impacts will consider the construction activities throughout the construction period. However, a separate assessment will not be undertaken for every year throughout construction at every site. However, the assessment will capture the periods where the risk of adverse impacts are at their highest.

3.4.2 The assessment of each major construction activity will therefore draw upon the construction programme to identify the duration and location of activities that would give rise to air quality impacts. As the IAQM guidance provides a three scale level of risk for various activities that depends on their scale and distances to sensitive receptors, it is likely that the overall risk will change at different times during the construction period.

3.4.3 The assessment will therefore identify any changes in the risk of adverse effects through the construction period and set out an appropriate level of mitigation to reduce those risks. The level of mitigation proposed will be consistent with that proposed in the IAQM guidance document and detailed within the draft Code of Construction Practice (CoCP)[7].

3.5 Mitigation measures

3.5.1 When undertaking the construction impact assessment the mitigation measures detailed within the draft CoCP will be applied. The assessment will also take into consideration any policies and commitments made by HS2 Ltd.

3.5.2 The IAQM guidance notes that with the application of sufficient mitigation measures, no significant effects would be anticipated from construction activities.

3.5.3 Should further mitigation measures be necessary at certain locations, these will be formulated taking into consideration the measures detailed in the IAQM guidance and best practice.

[7] Draft Code of Construction Practice, Volume 5: Appendix CT-003-000.

4 Assessment of mineral dust emissions

4.1 Type of assessment required

4.1.1 Emissions of dust and particulates from mineral extraction operations during construction will be assessed following the relevant IAQM mineral dust guidance[8]. This section provides an interpretation of the guidance for application to the assessment of the Proposed Scheme.

4.1.2 Dust arising from mineral extraction operations can be distinguished between coarser particles that can reduce amenity in the local community due to visible dust plumes and dust soiling ('disamenity dust') and smaller particles that can increase local pollutant concentrations (PM10 and PM2.5) which is associated with a range of health effects.

4.1.3 Within the IAQM mineral dust guidance, an 'impact' is described as a change in suspended particulate matter concentration or dust deposition and an 'effect' is described as the consequence of an impact to human health or disamenity. The main impacts that may arise during mineral activities are:

- dust accumulation, resulting in soiling of surfaces and disamenity;
- visible dust plumes; and
- elevated concentrations of particulate matter.

4.1.4 The IAQM mineral dust guidance considers the potential for emissions from dust-generating activities, such as preparation of the land, extraction, processing, handling and transportation of extracted material.

4.1.5 The assessment will be undertaken using the Source-Pathway-Receptor approach described in the IAQM mineral dust guidance. This is a concept whereby a hypothetical relationship is applied between the source of the pollutant, the pathway by which exposure may occur and the receptor that could be adversely affected.

4.1.6 The methodology takes into account the effectiveness of the pathway and the scale of the source to derive the risk of dust impacts at individual receptors. This is then combined with the sensitivity of each receptor to derive the likely magnitude of the effect that will be experienced. A consideration is then given to the overall effects from dust deposition from each mineral extraction site.

4.1.7 For the assessment of suspended particulate matter, consideration needs to be given to the existing background PM10 concentrations in the area. The process contribution from the mineral extraction activities is then estimated at each receptor and an overall PM10 impact for the area is derived.

[8] IAQM, 2016, Guidance on the assessment of mineral dust impacts for planning. Institute of Air Quality Management, London.

4.2 Types of receptors

4.2.1 The IAQM guidance details two types of relevant receptors that will be taken into account in the assessment – human and ecological receptors. A human receptor is defined as any location where a person may experience the disamenity effects of dust or the health effects from exposure to PM10 over a time period relevant to the air quality standards. For the purposes of the assessment of the Proposed Scheme this is mainly residential dwellings. An ecological receptor is any habitat that may be sensitive to dust deposition from direct impacts on vegetation or aquatic ecosystem or indirect impacts on fauna.

4.3 Spatial and temporal scope of assessment

4.3.1 The IAQM guidance suggests where there are sensitive receptors within 1km of dust generating activities, an assessment of PM10 concentrations will be required. Where there are sensitive receptors within 250m (soft rock) or 400m (hard rock) of extraction activities, an assessment of disamenity dust will be required.

4.3.2 The assessment of impacts will consider the mineral extraction operations throughout the construction period. It will identify the risk of adverse effects during the construction period and set out an appropriate level of mitigation to reduce those risks. The level of mitigation proposed will be consistent with that proposed in the IAQM mineral dust guidance and has been detailed within the draft CoCP.

4.4 Mitigation measures

4.4.1 When undertaking the assessment of mineral dust impacts the mitigation measures detailed within the draft CoCP will be applied. The assessment will also take into consideration any policies and commitments made by HS2 Ltd. Should further mitigation measures be necessary at certain locations, these will be formulated taking into consideration the measures detailed in the IAQM mineral dust guidance and best practice.

5 Assessment of vehicle emissions

5.1 Type of assessment required

5.1.1 Traffic data will be screened using the Design Manual for Roads and Bridges (DMRB) criteria[9], to identify where assessment is required. These criteria are the following:

- change in road alignment by 5m or more;
- change in daily traffic flows by 1,000 vehicles or more as annual average daily traffic (AADT);
- change in daily flows of Heavy Duty Vehicles (HDVs) by 200 AADT or more;
- change in daily average speed by 10kph or more; or

[9] Highways Agency, 2007, Design Manual for Roads and Bridges Volume 11 Section 3 Part 1 Air Quality HA 207/07.

- change in peak hour speed by 20kph or more.

5.1.2 The screened in roads will then be included in an atmospheric dispersion model for detailed assessment.

5.1.3 Consideration will also be given as to whether other roads that would be screened out using the above criteria are to be included in the assessment. An example of this is roundabout links and slip roads along dual carriageway road links that have been screened in.

5.2 Types of receptors

5.2.1 Human receptors to be included in the air quality assessment of vehicle emissions will be taken from the Ordnance Survey (OS) Address Layer 2 database. These will be screened for sensitivity to air quality following the Defra TG16 guidance.

5.2.2 Ecological receptors to be included in the air quality assessment will be those national or international designated sites with habitats sensitive to NOx deposition. These could include Sites of Special Scientific Interest (SSSI), Special Areas of Conservation (SAC), National Nature Reserves (NNR), Special Protection Areas (SPA) or Ramsar sites.

5.2.3 Receptors will be chosen so the worst affected relevant sensitive exposure (residential properties, schools, hospitals, nursing homes) on each road and at each junction on the assessed road network is represented. If several receptors are present at a junction and it is unclear which of them would be the worst affected receptor, all of the potential worst affected receptors will be modelled. Where there is no sensitive exposure at junctions, receptors will be chosen alongside the screened in roads so that all possible worst case effect locations are represented.

5.2.4 For assessment of car parks, receptors will be chosen near the perimeter of the car park where worst case effects are likely, considering contributions from other modelled sources (car parks and roads). Additionally, receptors included in any combustion plant assessment will be included in the model runs to account for cumulative effects.

5.2.5 All sensitive receptors will be modelled at a height of 1.5m. For ecological receptors, transects will be used from the edge of the road towards the ecological site, with modelled points every 20m or 50m and up to 200m from the road.

5.3 Spatial scope of assessment

5.3.1 Any quantitative air quality assessment will cover the roads which meet the DMRB criteria and roads which adjoin them to enable the effects at junctions to be assessed.

5.4 Scenario nomenclature

5.4.1 The following scenarios will be assessed:

- 2016 current baseline (for model verification if required);

- selected year(s) within the construction period for the assessment of the effects of construction. The year(s) of assessment will be selected based on the construction programme and on when significant effects might be expected.
- an operational scenario will be assessed for the first full operational year after construction is completed.

5.4.2 For each assessment year, the scenario without the Proposed Scheme in place and the scenario with the Proposed Scheme in place will both be assessed.

5.5 Modelled pollutants, model version and emission factors

5.5.1 Only annual mean NO2 and PM10 concentrations are required to be modelled (and NOx for ecological receptors). Where the predicted PM10 concentrations are greater than 25µg/m^3, then PM2.5 concentrations will also be required to be modelled. The treatment of short-term statistics is explained in the following paragraphs.

5.5.2 NOx output from the models for both on road sources and car parks will be combined with the background NOx and NO2 concentrations in the Defra NOx to NO2 conversion spreadsheet[10] to obtain total roadside and background annual mean NO2 concentrations. Modelled combustion plant NO2 contributions will be added to these values to yield a total annual mean NO2 concentration.

5.5.3 The predicted number of exceedances of the 1-hour NO2 objective will not be reported since it is only likely to be breached if the annual mean NO2 concentrations are over 60µg/m^3. Therefore, this less onerous statistic will not be reported, unless there is a very short term activity being examined where high peaks in NO2 concentrations are expected.

5.5.4 To calculate the annual mean PM10 (or PM2.5) concentrations, the background PM10 (or PM2.5) concentrations will be added to the roadside concentration output (and any modelled combustion plant output) from the model.

5.5.5 The number of exceedances of the 24-hour PM10 objective will be calculated using the formula in the Defra TG16 guidance, that is: No. 24-hour mean exceedances = -18.5 + 0.00145 × annual mean^3 + (206/annual mean).

5.5.6 The most recent versions of ADMS-Roads and ADMS will be used for any dispersion modelling assessment. Emissions suitable for use in the ADMS-Roads model will be generated using the most recent Emission Factors Toolkit (EFT)[11] available at the start of the assessment.

5.5.7 The assessment will also incorporate HS2 Ltd's policy on the type of heavy goods vehicles (HGVs) to be used on a route-wide basis, which is detailed in in HS2 Phase 2a Information Paper E14 'Air Quality'.

[10] Defra, NOx to NO2 calculator, http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html#NOxNO2calc
[11] Defra, Emissions Factor Toolkit, https://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html

5.6 ADMS model parameters

5.6.1 ADMS-Roads meteorological setting will remain as default, except for the surface roughness and minimum Monin-Obukhov length[12] – advice on the relevant values to be used will be taken from the ADMS-Roads manual[13] based on the characteristics of the study area as shown in Table 2.

5.6.2 For the meteorological site, the surface roughness will be selected as representative of the meteorological station location (e.g., 0.02 for airports) and no minimum Monin-Obukhov length will be selected.

5.6.3 Terrain will not be included in dispersion modelling unless justified using professional judgement.

Table 2: Surface roughness values for ADMS

Study area	Surface roughness (m)
Large urban areas	1.5
Cities / woodlands	1.0
Parkland, open suburbia	0.5
Agricultural areas (max)	0.3
Agricultural areas (min)	0.2
Root crops	0.1
Open grassland	0.02
Short grass	0.005

5.7 Car parks, stationary idling vehicles

5.7.1 Any new car parks will be assessed using ADMS-Roads. Emissions from movements within the car park will be estimated using the EFT spreadsheet. The travel speed will be set at 5kph and the travel distance within the car park will be set to the car park perimeter for surface car parks with half the perimeter distance added for each floor above ground level for multi-storey car parks.

5.7.2 Consideration will be given to the inclusion of places where vehicles may stand with engines idling e.g., taxi stands (use design length of taxi ranks, number of vehicles, duration of stay etc.) and a separate calculation made for these emissions with EFT.

[12] The minimum Monin-Obukhov length is a parameter describing the stability of the atmosphere.
[13] Cambridge Environmental Research Consultants, 2014, *ADMS Roads User Guide v3.4*.

5.7.3 The EXEMPT model, available on the Defra website[14], will be used to estimate cold start emissions from car parks. Cold start emissions should be applied to vehicles which stay over two hours. If this information is not available, all vehicles should be assigned cold start emissions (using a length of stay of 600 min and an assumed ambient temperature of 10°C) as a worst case assessment. The "excess emissions" from the model will be calculated using half the driving distance within the car park (as estimated using the method in the previous paragraph) since cold start emissions will only be applicable to vehicles exiting the car park.

5.7.4 Car parks will be modelled as area sources at ground level for surface cars parks, as volume sources using the height of the car park for multi-storey car parks, or as point sources at ventilation points for mechanically ventilated underground car parks (or at the entrance or openings of the car park if not mechanically ventilated), using emissions calculated for cold start and internal movement emissions uniformly distributed throughout the sources.

5.8 Background concentrations

5.8.1 Data for background concentrations will be taken from the maps available on the Defra website[15] and from local monitoring information available in the area. Professional judgment will be used to determine which data is most appropriate to be used for the assessment of each area.

5.8.2 If local monitoring data is not available for the base year of 2016, it will be adjusted using the same factors for the area as those used in the Defra background maps. Local background monitoring data will also be adjusted, if used, for the required assessment years.

5.9 Speeds

5.9.1 Where data exist on actual speeds these will be used. In the absence of actual or modelling traffic speed data, the following speeds will be used (unless justified otherwise):

- 50% of the speed limit on central urban and or congested roads;
- 75% for urban but not congested roads;
- roads within 50m and on junctions (including roundabouts) should have their speeds adjusted as advised by the Defra TG16 guidance;
- signalled junctions = 10kph;
- small roundabouts (total roundabout length < 150m) = 20kph;
- large roundabouts (total roundabout length > 150m) = 30kph; and
- roads within 50m of roundabouts with traffic lights = 15kph.

[14] Defra, EXEMPT Model, http://laqm.defra.gov.uk/review-and-assessment/tools/emissions.html
[15] Defra, Background maps, https://uk-air.defra.gov.uk/data/laqm-background-home

5.10 Model verification

5.10.1 An existing baseline year of traffic data will be used for the study area (i.e. 2016 current baseline scenario). A full assessment of the entire study area will not be required, however, this information will be used to test model performance and undertake model verification.

5.10.2 The model will be verified at selected suitable continuous and/or diffusion tube NO2 monitoring sites in accordance with the Defra TG16 guidance. Kerbside sites will not be included in the model verification exercise. Adjustment to the model using the procedure detailed in the Defra TG16 guidance will be made if the average difference between modelled and monitored NO2 concentrations exceeds 25% of monitored concentrations or if there is a consistent under or over prediction.

5.10.3 Predicted PM10 concentrations will not be adjusted.

6 Combustion plant assessment

6.1 Type of assessment required

6.1.1 Emissions from any buildings will be considered in the assessment. Professional judgement will be used to determine the most appropriate method for assessment which will be qualitative or quantitative, including dispersion modelling.

6.1.2 The assessment of stationary combustion plant will comply with the provisions of the Clean Air Act 1993[16]. In summary:

- plant burning less than 45.4kg/hr of solid fuel or thermal input of liquid of gaseous fuel of less than 366.4kW (or combined plant sharing flues) will be screened out of the assessment; and
- plant falling within the provisions of the Clean Air Act will have their stack/flue sited at a location and height acceptable under the terms of the Act. This will initially be estimated using the D1 method[17].

6.1.3 Where relevant, professional judgement and/or dispersion modelling will be used to suggest design modifications including height and location of flues/stacks, particularly in relation to any adjacent or neighbouring buildings or structures.

6.1.4 Professional judgement will be exercised to ensure that the criteria given above are appropriate, e.g. if there are many small boilers that may each fall under the criteria set out above but cumulatively their effect on air quality may be non-negligible, modelling may be deemed appropriate.

6.1.5 Professional judgement will be used as to whether modelling of plant that is not used throughout the year is appropriate (e.g. back-up generators run only for testing other than in the event of power failure).

[16] Clean Air Act 1993, London: Her Majesty's Stationery Office.
[17] Her Majesty's Inspectorate of Pollution, 1993, *Technical Guidance Note (Dispersion) D1: Guidelines on Discharge Stack Heights for Polluting Emissions*. London, Her Majesty's Stationery Office.

6.1.6 Dispersion modelling will be undertaken with the atmospheric dispersion model ADMS and/or ADMS-Roads, using the most up to date version as of the date of receipt of the model input data.

6.1.7 Dispersion modelling of point source emissions will be undertaken if one or more of the following conditions are met:

- the height of stack from the D1 determination is not acceptable for some reason (e.g., it is unacceptable to the designers, physical limitations relating to use/access); or
- the combustion plant has the potential to affect air quality where the existing or estimated future annual mean baseline NO2 concentrations are over 36µg/m^3 or PM10 concentrations are over 30µg/m^3 (if the source is non-gas fired) and where impacts are likely to be significant.

6.1.8 For natural gas fired equipment modelling will only be for NO2. For other fuel types (e.g., biomass) consideration will be given to the inclusion of PM10, PM2.5 and/or SO2.

6.1.9 Where existing or future air quality is likely to exceed the relevant assessment criteria consideration will be given to the modelling of sources that would be excluded using the above criteria.

6.2 Pollutants emissions and model inputs

6.2.1 The D1 and modelling assessments will consider annual mean NOx emissions for gas fired plant and both NOx and PM10 emissions for other fired plant. If a specific combustion plant has not been selected by the energy consultant/mechanical engineer, standard emissions data will be used. Background concentrations for use with the D1 method will be taken from Table 2 of the D1 Technical Guidance[17] using the 'type of district' at the location of the assessed boiler. This information is repeated in Table 3, however, this data will be checked for consistency with available local background concentration information and where good quality local information is available this will be used in preference. To convert locally measured annual mean NO2 concentrations to the 98th percentile values used in D1, a factor of 2.5 will be used.

Table 3: D1 – Typical background levels of common pollutants

Type of district	Background concentrations (mg/m^3)	
	NO2*	PM10
Major city centre/heavy industrial area	0.17	0.15
Highly developed large urban area	0.12	0.10
Urban area of limited size with parkland or largely rural surroundings	0.09	0.07
Partially developed area	0.07	0.05

Type of district	Background concentrations (mg/m^3)	
	NO2*	PM10
Rural area with little development	0.05	0.03

* 98th percentile of hourly means

6.2.2 Emission characteristics from Table 4 will be used in any boiler dispersion modelling. Boilers of intermediate size will have their characteristics linearly interpolated using a most similar smaller and most similar larger boiler from the table.

Table 4: Combustion plant model inputs for natural gas CHPs (MW thermal input)

Property	0.5MW	1MW	2MW	5MW	10MW
Stack height (m)	As per D1 or building height +1m				
Total flow (actual m^3/s)	0.22	0.44	0.87	2.98	5.69
Stack/Flue diameter (m)	0.17	0.24	0.33	0.62	0.85
Exit velocity (m/s)	10				
Discharge temperature (°C)	72	69	69	179	162
NO2 emissions rate g/s *	0.011	0.022	0.044	0.111	0.222

Based on the Hoval Ultragas (0.5, 1 and 2MW) and Royalist range of boilers (5 and 10MW). Assumed density of flue gas is the same as nitrogen (1.25g/l at normal conditions).
* NB this is based on an emission factor of 80mg/kWh; there may be other local authority advice for the particular study area.

6.2.3 For boilers of intermediate size, emissions will be interpolated, using sizes rounded to the nearest 100kW before interpolation takes place.

6.2.4 Assumptions on NOx to NO2 conversion ratios for point source plant NOx emissions will be based on the likely oxidation rates to the point of maximum impact. Where no other data exist, Table 5 will be used to determine the NOx to NO2 oxidation rate for specific distances. It is assumed that the minimum conversion is 10% based on the likely NO2 percentage in the emissions. Linear interpolation will be undertaken between the distances provided to the nearest 10m.

Table 5: Oxidation rates (derived from Janssen)[18]

Distance from source (m)	Estimated annual mean ozone concentration (ppb)			
	< 20	20 – 40	40 – 60	> 60
10	10%	10%	10%	10%
25	10%	10%	10%	10%
50	10%	10%	10%	10%

[18] Janssen et al., 1987, *A Classification of NO Oxidation Rates in Power Plant Plumes Based on Atmospheric Conditions.*

Distance from source (m)	Estimated annual mean ozone concentration (ppb)			
	< 20	20 – 40	40 – 60	> 60
75	10%	10%	10%	10%
100	10%	10%	10%	10%
200	10%	10%	10%	10%
300	10%	10%	10%	10%
500	10%	10%	10%	14%
750	10%	10%	14%	20%
1,000	10%	10%	18%	26%
1,500	10%	15%	25%	36%
2,000	10%	19%	32%	44%
3,000	14%	27%	43%	57%

Note: Assuming that wind speed is in the range 5-15m/s and conversion rates are the highest they would be for the range of ozone given. In reality, conversion rates to NO_2 would be lower than stated.

6.2.5 All combustion plant sharing a common flue or stack will be combined in a manner that preserves an exit velocity of 15m/s (the minimum recommended stack emission velocity).

6.2.6 Only annual mean concentrations will require modelling. The handling of short term statistics is explained in Section 5.5.

6.3 Types of receptors

6.3.1 Receptors will be selected based on either their proximity to the source or as the likely most affected receptors. Receptors will include all locations where people might reasonably be (including residential, hotels, nurseries, hospitals, schools, nursing home buildings) and/or ecological receptors if considered sensitive to the pollutant being considered and present on a nationally designated site.

6.3.2 If receptors are present in several directions from the stack, the closest receptor in each direction will be selected. The height above ground of the receptors will be set to the height of opening windows and/or air intakes most similar in height to the stack height. Nearby receptors included in any quantitative road and car park assessment will be included in the model runs to account for cumulative effects.

6.3.3 In addition to modelling at selected discrete receptors, a grid of equally spaced receptors will be modelled incorporating at least 50 x 50 points with a maximum spacing of not more than 1.5 times the minimum stack/flue height being modelled. The grid will be centred on the stack(s) and ensure that the maximum off-site

concentration is included (this may require several iterations of the model to ensure the optimal spacing is selected). Several grids may also be used. All discrete receptors do not need to be within the area covered by the receptor grid. Maximum concentrations will be reported as well as those at discrete receptors.

6.3.4 Receptors (gridded and/or discrete) will all be set at local ground level and also at various heights above ground if relevant. Consideration will be given in urban areas where there are many receptors at heights more than two metres above ground to modelling a series of grids at various heights (in order to ensure that exposure of receptors at height are considered. Discrete receptors at height may also be used if an elevated grid is not justified.

7 Assessment of rail emissions

7.1 Type of assessment required

7.1.1 An assessment of emissions from diesel locomotives will be undertaken following the Defra TG16 guidance.

7.2 Pollutants emissions

7.2.1 The assessment will take into account both stationary and moving locomotives. The criteria detailed in the Defra TG16 guidance will be used; These are:

- locations where sensitive receptors are within 15m from sites that locomotives remain stationary for periods of 15 minutes or more, at least 3 times a day; and
- locations where sensitive receptors are within 30m of the railway track and background annual mean NO2 concentrations are above 25µg/m^3.

7.2.2 Where these criteria are met, it will be concluded that there is a risk of exceedance of the air quality standards and mitigation measures will be proposed.

8 Assessment of significance

8.1 Type of assessment required

8.1.1 The significance of effects resulting from the Proposed Scheme on local air quality from vehicle and/or combustion plant emissions will be assessed using the framework described in this section.

8.2 Describing the impacts

8.2.1 Predicted annual mean pollutant concentrations will be compared between the 'with' and 'without' Proposed Scheme assessment scenarios. The predicted change in concentrations will be used along with the predicted concentrations from the 'with the Proposed Scheme' scenario to assess local air quality impacts at individual receptors. The impact descriptors are shown in Table 6, taken from the IAQM/EPUK guidance. Changes in pollutant concentrations less than 0.5% of the air quality standard will be described as 'negligible'.

8.2.2 Where an increase in concentrations has been predicted with the Proposed Scheme, the resulting impact will be described as 'adverse'. Where a decrease in concentrations has been predicted with the Proposed Scheme, the resulting impact will be described as 'beneficial'.

Table 6: Impact descriptors for individual receptors (adapted from the IAQM/EPUK guidance)

Predicted annual mean concentration in relation to standard	**Percent change in concentrations as a result of the Proposed Scheme in relation to standard**			
	1%	**2 – 5%**	**6 – 10%**	**> 10%**
< 75%	Negligible	Negligible	Slight	Moderate
76 – 94%	Negligible	Slight	Moderate	Moderate
95 – 102%	Slight	Moderate	Moderate	Substantial
103 – 109%	Moderate	Moderate	Substantial	Substantial
> 110%	Moderate	Substantial	Substantial	Substantial

8.3 Significance of effects

8.3.1 The approach used to assess significance described in the EPUK/IAQM guidance is designed to be a measure of the significance of the changes in air quality in terms of compliance with air quality standards and is not intended to be an assessment of any potential health impacts. That is to say, a significant air quality impact determined on the basis of the IAQM/EPUK approach would not necessarily, or usually, denote a significant health impact. However, the assessment method is intended to provide information on changes in pollutant concentrations that can be used to assess health effects, by flagging up locations and impacts which may merit further consideration.

8.3.2 Receptors predicted to experience negligible or slight impacts will be described as having no significant air quality effects. Receptors predicted to experience moderate or substantial impacts will be described as having significant air quality effects.

Annex B: Climate - technical note

The following technical note is contained in this Annex:

- Greenhouse gas assessment methodology.

HS2 Phase 2a West Midlands – Crewe: Technical note – Greenhouse gases assessment methodology

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1 Introduction

1.1.1 This technical note presents the detailed methodology for the quantification, assessment, interpretation and reporting of the greenhouse gas (GHG) emissions associated with the construction and operation of the Proposed Scheme. GHG emissions are typically converted into tonnes of carbon dioxide equivalent (tCO_2e) which standardises the global warming potential of the main GHG[1] into one index based on the global warming potential of carbon dioxide (CO_2). Hereafter the term carbon is used to refer to the combined GHG emissions.

1.1.2 The GHG assessment will be undertaken in accordance with the principal steps (see Figure 1) identified in Publicly Available Specification 2080: Carbon Management in Infrastructure (PAS2080)[2].

Figure 1: Principal steps of GHG emissions quantification (adapted from PAS 2080)

1.2 General principles

1.2.1 Table 1 summarises fundamental principles underpinning the GHG assessment.

Table 1: General principles underpinning the GHG assessment (adapted from PAS2080)

Principles	Description
Relevance	Data collection and GHG assessment methods used will be relevant to the Proposed Scheme.
Completeness	All carbon emissions providing a material contribution to the Proposed Scheme's carbon footprint will be included.
Consistency	Consistent data and assessment methodologies will be used. Any changes in data, methodology or assumptions will be transparently documented.
Accuracy	Carbon emissions will be assessed and uncertainties reduced as far as reasonably practicable. The level of accuracy should be such that decision makers have a reasonable level of assurance as to the integrity of the carbon emissions reported.
Transparency	Information on the methodology, data sources used and relevant assumptions will be made available.

[1] Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFCs), hydroflurocarbons (HFCs), sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3).
[2] Construction Leadership Council & the Green Construction Board (2016), *PAS 2080: 2016: Carbon Management in Infrastructure*. BSI Limited, London, UK.

2 Goal and scope

2.1 Goal

2.1.1 The goal is to quantify and report – in the form of a 'carbon footprint' – the reasonable worst case scenario carbon emissions associated with the construction and operation of the Proposed Scheme. The GHG assessment will identify carbon hotspots associated with the Proposed Scheme and help focus mitigation efforts in areas with the most potential for carbon reduction. Results will be reported under the climate change chapter within the HS2 Phase 2a Environmental Statement (ES). This will ensure that decision makers and wider stakeholders understand the reasonable worst case carbon impact of the Proposed Scheme.

2.2 Scope

2.2.1 High Speed Two (HS2) is a proposed Y-shaped high speed railway linking stations in London, Birmingham, Leeds, Manchester, South Yorkshire and the East Midlands with a capacity to convey up to 18 trains per hour at speeds of up to 225 miles per hour (mph) (360 kilometres per hour). HS2 trains will be up to 400 metres (m) long with 1,100 seats during peak hours. Two types of trains will operate on HS2. Captive trains will only be able to run on newly built high speed lines. Compatible trains with conventional rail will be similar in performance to captive trains, but will be built to fit existing rail infrastructure.

2.2.2 Phase 2a (the 'Proposed Scheme') comprises the first section of the western leg of Phase Two from the West Midlands to Crewe. It includes a connection with Phase One near Fradley, and a connection to the West Coast Main Line (WCML) south of Crewe, to provide onward services beyond the HS2 network to the north-west of England and to Scotland. Construction would commence in 2020 and the section is planned to be operational in 2027.

3 Study boundaries

3.1 Study boundary

3.1.1 The GHG assessment will adopt a life cycle assessment (LCA) approach. Table 2 presents each of the life cycle stages (modules) and representative activities associated with the Proposed Scheme.

Table 2: The GHG assessment study boundary broken down by life cycle stages (modules), consistent with the principles set out in BS EN 15978: 2011 and PAS 2080: 2016.

Life cycle stage	Activities incorporated
Pre-construction stage (module A0)	Represents preliminary desk-based studies and works such as: - strategy and brief development; - architecture; - design efforts; - EIA; and - cost planning. Includes emissions associated with office energy use and consultants' travel.
Product stage (modules	Represents the embedded carbon emissions associated with the extraction, processing and

Life cycle stage	Activities incorporated
A1-A3)	manufacturing of the Proposed Scheme's construction material for permanent assets. This includes all energy and carbon emissions from manufacturing plants, primary and secondary manufacturing stages as well as any transport emission between these stages. For example, concrete manufacturing includes energy and carbon emissions linked to all key stages: quarrying, aggregate crushing, transport of aggregates to ready-mix concrete plants and asphalt plants. This final stage includes emissions associated with the adding of water and cement mixes.
Construction process stage – transport to site (module A4)	Represents transport related carbon emissions associated with the delivery of construction material, such as concrete and steel, and construction equipment to construction sites along the Proposed Scheme from the point of production (or point of storage in the case of plant and machinery).
Construction process stage – construction and installation (module A5)	Represents carbon emissions from construction site works activities including: - temporary work, ground works and landscaping; - materials storage and any energy or otherwise need to maintain necessary environmental conditions; - transport of materials and equipment on site; - installation of materials and products into the infrastructure asset; - emissions associated with site water demand; - waste management activities (transport, processing, final disposal) associated with waste arising from the construction site; and - production, transportation, and waste management of materials/products lost during works. Includes carbon emissions from land use change.
Use stage - Installed products and materials (module B1)	Represents the carbon emissions emitted directly from the fabric of products and materials once they have been installed, as well as the sequestration of emissions from trees planted as part of the Proposed Scheme.
Use stage – Maintenance (module B2)	The production, transportation (to and from the site) and end of life processing of all materials required. The electricity, fuel and water for regular preventative maintenance of the Proposed Scheme.
Use stage – Repair (module B3)	The production, transportation (to and from the site) and end of life processing of all materials required for responsive or reactive treatment to an acceptable condition. The electricity, fuel and water used for responsive or reactive treatment to an acceptable condition.
Use stage – Replacement (module B4)	The production, transportation (to and from the site) and end of life processing of all materials required to replace any assets or any components within assets that have a design life of less than 120 years e.g. the rolling stock.
Use stage – Refurbishment (module B5)	The production, transportation (to and from the site), and end of life processing of all materials required for any anticipated refurbishment of the Proposed Scheme. The electricity, fuel and water used for any refurbishment of the Proposed Scheme.
Use stage - operational energy (module B6)	Represents the carbon emissions resulting from the energy used by the Proposed Scheme to operate infrastructure-integrated systems necessary for the technical and functional performance of the Proposed Scheme (e.g. lighting, ventilation, drainage, heating and cooling) minus any electricity generated through on site low carbon energy sources not exported to the grid.
Use stage - operational water (module B7)	Represents water required by the Proposed Scheme to enable it to operate and deliver its service. It will include all water used and its treatment (pre- and post-use) during the normal operation of the Proposed Scheme.
Use stage - other operational processes (module B8)	Represents other process carbon emissions arising from the Proposed Scheme to enable it to operate and deliver its service including management of operational waste.

Life cycle stage	Activities incorporated
Use stage - users utilisation (module B9)	Represents the carbon emissions associated with the operation of the rolling stock and un-regulated energy consumption not required for the technical and functional performance of the infrastructure (e.g. plug-in appliances, such as computers, refrigerators, audio, TV and production or process-related energy use).
End of life stage – deconstruction (module C1)	Represents the carbon emissions resulting from activities of deconstructing, demolishing and decommissioning the Proposed Scheme. Essentially these are on-site carbon emissions from plant equipment[3].
End of life stage – transport (module C2)	Represents carbon emissions resulting from the transportation of materials from their place of demolition to waste processing facility[2].
End of life stage – waste processing (module C3)	Represents the carbon emissions associated with waste processing for reuse, recovery or recycling[2].
End of life stage – disposal (module C4)	Represents the carbon emissions associated with waste disposal[2].
Benefits/ loads beyond the project boundary – (module D)	Includes: - avoided carbon emission impacts associated with the Proposed Scheme including potential for re-use, recovery and recycling of materials and/or energy beyond the system boundary; - savings in carbon emissions from modal shift of passenger and freight journeys associated with the Proposed Scheme; - electricity and fuel use for surface access journeys to depots; and

3.2 Cut-off rules

3.2.1 Criteria for the exclusion of inputs and outputs (cut-off rules) in the LCA and information modules and any other additional information are intended to support an efficient calculation procedure.

3.2.2 The following provisions will be applied for any exclusions of inputs or outputs to the assessment:

- all inputs and outputs to a process for which data are available are always included;
- data gaps may be filled by conservative assumptions using generic data;
- where an activity is estimated to account for no more than 1% of the total input (mass or energy) of that module, that activity may be omitted from the assessment. Sensitivity analysis based on assumptions combined with plausibility considerations and professional judgement will be provided to demonstrate that exclusions do not affect the result of the assessment; and
- the proportion of total neglected activities within a module (e.g. per module A0, A1-A3, A4-A5, B1-B5, B6-B7, B8, B9, C1-C4 and module D) will not exceed 5% of the total impact within that module.

[3] The Proposed Scheme has a design life of 120 years and infrastructure assets are rarely decommissioned, however it is considered best practice to include the theoretical end of life impacts of the Proposed Scheme.

3.2.3 Any exclusions together with assumptions for choices and criteria leading to exclusion of inputs and outputs are documented under Annex 1 (Table 7 and Table 8).

3.3 Study period

3.3.1 The GHG assessment will report carbon emissions from construction and 120 years of operation to align with the assumed design life of the Proposed Scheme.

4 Data

4.1.1 Two types of data will be collected for the GHG assessment: activity data (see Section 4.3) and carbon emissions factors (see Section 4.4). A set of standard data quality principles will be applied to ensure results from the GHG assessment are as accurate and representative as possible.

4.2 Data quality

4.2.1 The following principles will be applied in order to ensure the most relevant and best quality data is used:

- age – the GHG assessment will be based on activity data and carbon emissions factors applicable to the study period;
- geography – activity data will reflect the design of the Proposed Scheme. Carbon emissions factors will be representative of the UK construction industry and UK transport sector;
- technology – the default solution will be to apply data which is representative of the UK construction industry and transport sector. However, technology specific data may be used for the purpose of developing scenarios of the future;
- methodology – activity data will be gathered directly from the Proposed Scheme's engineering and design teams to ensure consistency and completeness of data collection; and
- competency – activity data will be generated by the engineering and design teams in-line with applicable industry standards in order to ensure consistency in the methodology used. Data gaps will be replaced with either peer reviewed publications (e.g. paper published in recognised journals) or industry specific literature (e.g. UK construction trade associations). Carbon emissions factors will be sourced from range of sources: Environmental Product Declarations (EPDs) which adhere to the BS EN 15804 standard, Life Cycle Assessment (LCA) tools to aligned with best practice, and industry specific and Government sources which are widely accepted and used.

4.3 Activity data

4.3.1 Annex 1 presents activity data sources, by life cycle stage used in the GHG assessment of the ES.

4.4 Carbon emissions factors

4.4.1 Annex 1 (Table 9) presents a list of sources of carbon emissions factors used in the GHG assessment of the ES.

4.5 Assumptions

4.5.1 Annex 1 includes a list of assumptions alongside activity data sources used in estimating the carbon emissions for assessment within the ES.

4.6 Limitations

4.6.1 With large-scale projects such as HS2 there are inherent limitations. One of these reflects the long timescales associated with the Proposed Scheme. With a design life of 120 years there are no published GHG emissions factors which project that far into the future. The most forward-looking projections do not exceed 2050 in order to align with the UK's carbon reduction target of 80% by 2050 relative to 1990 levels (Climate Change Act[4]). There is a level of uncertainty with all projected GHG emissions factors linked but not limited to: technology development and deployment, economic uncertainty, political drive and future energy demands.

4.6.2 Although the design life of the proposed scheme is 120 years, it is noted that the non-carbon GHG emission factors used (sourced from the Intergovernmental Panel on Climate Change second assessment report)[5] are based on a 100 year time horizon. Whilst the IPPC GHG emission factors are generally accepted as 'best practice' and are widely used for this kind of assessment, their use in the context of the current project results in an inconsistent scope of reporting between the stated objective of the assessment and the emissions factors used. GHG emission factors with a longer duration time horizon are not widely available and the impact of this inconsistency is considered unlikely to be material.

4.6.3 For some sources of carbon emissions, carbon emissions factors only report carbon dioxide (CO_2) and thus do not account for the impact of non-carbon dioxide greenhouse gases. This is an inherent limitation of GHG assessment; it is not expected to have a material impact on the overall results.

4.6.4 The GHG assessment will be based on early design information and a number of assumptions. As a result the GHG assessment will adopt a 'reasonable worst case scenario'[6]. A series of alternative future scenarios will also be assessed to illustrate the sensitivity of the Proposed Scheme's carbon footprint to key assumptions.

[4] Climate Change Act 2008. London, Her Majesty's Stationery Office. Available online at: http://www.legislation.gov.uk/ukpga/2008/27/contents
[5] IPCC (1996), Climate Change 1995, The Science of Climate Change – Contribution of Working Group I to the Second Assessment Report of the Intergovernmental Panel on Climate Change. Available online at: https://www.ipcc.ch/ipccreports/sar/wg_I/ipcc_sar_wg_I_full_report.pdf
[6] For example, it is assumed that there will be no carbon emissions reduction improvements within the cement and steel industries between the time of this assessment and the construction of the Proposed Scheme and that the carbon intensity of UK grid electricity will reduce in accordance with Government projections.

5 Methodology, reporting and interpretation

5.1 Calculation methodology

5.1.1 Carbon emissions will be assessed using a calculation-based methodology as per the below equation:

> 'activity' data x GHG emissions factor = GHG emissions value

5.2 Reporting

5.2.1 The results of the GHG assessment will be reported in the ES. The reporting of GHG emissions will be undertaken in tonnes of carbon dioxide equivalents (tCO_2e) and aligned with the life cycle stages presented in Table 2. Unless excluded in accordance with the cut-off rules (see Section 3.2) the following carbon footprints will be reported:

- construction (A0-A5);
- operation (B1-B9);
- end of life (C1-4); and
- benefits and loads beyond the system boundary (D).

5.2.2 A residual carbon footprint (i.e. carbon emissions minus carbon benefits) will also be reported.

5.2.3 The functional units used for the GHG assessment will be:

- tCO_2e; and
- $kgCO_2e$ per passenger-km;

5.3 Interpretation

5.3.1 There currently are no agreed significance criteria with respect to carbon emissions for the purpose of Environmental Impact Assessment. The Proposed Scheme's carbon emissions will therefore be assessed in the context of:

- UK national GHG emissions;
- the UK construction sector; and
- the UK transport sector.

5.3.2 In addition, the operational efficiency ($kgCO_2e$/passenger-km) of the Proposed Scheme will be compared against other modes of transport.

Annex 1: List of activity data sources, assumptions and carbon factors

Table 3: Assumptions associated with material densities

Element	Material	Assumption/ rationale behind the allocated material to each element	Unit	Tonnes per Unit	Source
Concrete	Concrete	N/A	m3	2.38	Ecoinvent 3 process
Rebar	Steel	N/A	Tonnes	1.00	N/A
Formwork	Timber	timber formwork with a thickness of 300mm	m2	0.72	Inventory of Carbon and Energy, January 2011, Bath University
Precast Beams	Reinforced concrete with steel rebar	Pre-cast beams are typically 25m long with SU12 beams, with an area of 800,000 mm^2, hence approximately 20m^3 of reinforced concrete per beam. Therefore 20*2.3 (t/m^3 – based on ICE v2.0 Bath University density of reinforced steel) = 46t per beam.	Nr	46	Design information
Parapets	Reinforced concrete with steel rebar	Parapets have an average height of 1.5m and thickness of 0.35m giving 0.525 m^3/m of parapet. Therefore: 0.525*2.3 (t/m^3 – based on ICE v2.0 Bath University density of reinforced steel) = 1.21 t/m	m	1.21	Design information
Noise Barriers	Rockwool Duoslab	Noise barriers the average height per wall is 3.75m (range between 2.5m and 5m), thickness of 0.224m and 0.362m, and weight of 60km/m^3. Therefore 3.75*0.275*0.06 = 0.062 t/m	m	0.062	Design information
Imported Fill	Gravel	Assume gravel is an appropriate classification	m3	2.24	Inventory of Carbon and Energy, January 2011, Bath University
Box Culverts	N/A	Consultant decision to classify as concrete- removed to avoid double count- (concrete already considered)	N/A	N/A	N/A
Piped Culverts	Plastic	Pipes are plastic, with an average size of 450mm and a weight of 9.3 kg/m	m	0.0093	Design information
Rail track pipe	Plastic	Pipes are plastic, with an average size of 450mm	m	0.0093	Design information

Element	Material	Assumption/ rationale behind the allocated material to each element	Unit	Tonnes per Unit	Source
		and a weight of 9.3 kg/m			
Drainage Stone	Gravel	Assume gravel is an appropriate classification	m3	2.24	Inventory of Carbon and Energy, January 2011, Bath University
Sub-ballast	Gravel	Assume gravel is an appropriate classification	m3	2.24	Inventory of Carbon and Energy, January 2011, Bath University
Granular Fill	Gravel	Assume gravel is an appropriate classification	m3	2.24	Inventory of Carbon and Energy, January 2011, Bath University
HRA (Hot Rolled Asphalt)	Hot Rolled Asphalt	N/A	m3	2.50	Design information
Precast Kerbs	Concrete	Assume concrete is an appropriate classification	Tonnes	1.00	N/A
Boundary Fencing	Plywood	Fences will be plywood with a density of 12.5 to 15mm and 2.4 to 3.6m high. The density of plywood is 0.54 t/m^3	m	0.02	Design information Inventory of Carbon and Energy, January 2011, Bath University
Haul Road / Platforms Granular Fill	Gravel	Assume gravel is an appropriate classification	m3	2.24	Inventory of Carbon and Energy, January 2011, Bath University
Compound Granular Fill	Gravel	Assume gravel is an appropriate classification	m3	2.24	Inventory of Carbon and Energy, January 2011, Bath University
Grout	Grout	N/A	m3	1.80	http://www.ukqaa.org.uk/wp-content/uploads/2014/02/Datasheet_3-0_Jan_2006.pdf
Cut and Fill	N/A	Excluded- no embedded emissions	N/A	N/A	N/A
Roof	Concrete	The roof of the portal buildings is assumed to be concrete with a depth of 25 cm, hence 0.25m^3 per m^2 The density of concrete is 2.38 t/m^3	Roof	0.59	Design information Inventory of Carbon and Energy, January 2011, Bath University

Element	Material	Assumption/ rationale behind the allocated material to each element	Unit	Tonnes per Unit	Source
OLE Attachments	Steel	Attachments are made of steel with a typical weight of 70 kg per unit	Nr	0.07	Design information
OLE Wires	Copper	Main overhear line electrification (OLE) cable mass is 4 kg/m. Assume 1 unit is 500m based on average size cable drum length. Therefore 2000 kg per unit	Nr	2.00	Design information
OLE Cables	Copper	Main OLE cables mass is 0.5 kg/m. Assume 1 unit is 500m based on average size cable drum length. Therefore 250 kg per unit. This includes cables at location cases and cabinets (LOC - used for housing electrical equipment) spurs, hence LOC spurs where not assessed separately to avoid double counting	Nr	0.25	Design information
Slab tunnel reinforcement	Steel	Assumed 100% steel	Tonnes	1.00	N/A
Ballast	Gravel	N/A	Tonnes	1.00	Inventory of Carbon and Energy, January 2011, Bath University
Ballast Track Sleepers	Concrete	291.5 kg per concrete sleeper	Nr	0.29	Design information
OLE Masts	Steel	740 kg per steel mast excluding cables and ancillary wires	Nr	0.74	Design information
LOC Locations	Steel	270 kg per LOC	Nr	0.27	Design information
108m Rail Lengths	N/A	Excluded: only 216m rail lengths used in final design	N/A	N/A	Design information
216m Rail Lengths	Steel	60-65kg per m of rail, so assumed mean of 62.5 kg	Nr	13.51	Design information
Factory Welds	N/A	Excluded: professional judgement deems welds do not constitute a material impact	N/A	N/A	Design information
Number of Shear Keys	N/A	Excluded: these are constituted of grout,	N/A	N/A	Design information

Element	Material	Assumption/ rationale behind the allocated material to each element	Unit	Tonnes per Unit	Source
		therefore emissions from individual shear keys not covered to avoid double count			
Grout	Grout	N/A	m3	1.80	Based on consultant research: http://www.ukqaa.org.uk/wp-content/uploads/2014/02/Datasheet_3-0_Jan_2006.pdf
Railhead 308kg Sleepers	Concrete	Assume 100% concrete	Tonnes	0.31	N/A
Railhead 18m Rail lengths	Steel	Assume 60-65kg per m of rail, so assumed mean of 62.5kg	Tonnes	1.13	Design information
Transformer, high voltage use {GLO}| production | Alloc Def, U	Auto-transformer	Conservative assumption of 5000kg per transformer	Nr	5.00	N/A

Table 4: Assumptions associated with plant equipment fuel use during infrastructure construction and installation

Plant equipment type	Closest matching plant equipment	Unit	Fuel consumptions	Source
Flood lighting	Generating Set, 50kW @ 12 litres diesel/hour	Litres Diesel/hr	0.12	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Delivery lorry	Hydrema 922D	Litres Diesel/hr	13.5	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Pick up	Hydrema 922D	Litres Diesel/hr	13.5	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
20t 360 deg Excavator	Excavation hydraulic backbone, 100kw	Litres Diesel/hr	21	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Concrete Mixer Truck	Concrete mixers, 15 kw	Litres Diesel/hr	3.8	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant

Plant equipment type	Closest matching plant equipment	Unit	Fuel consumptions	Source
Tracked Mobile Crane 55t	Cranes: Tracked, 50kw	Litres Diesel/hr	8	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Fork lift	Fork lift, 50kw	Litres Diesel/hr	8.8	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Hiab	cranes lorry mounted, 200kw	Litres Diesel/hr	39	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
15t 360 deg Excavator	cranes lorry mounted, 150kw	Litres Diesel/hr	30	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
25t Dumper	Rear dump truck, 300kw	Litres Diesel/hr	25	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Compressor 185 cfm	Compressor, 75 kw	Litres Diesel/hr	16	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Concrete Batching Plant Concrete Batching Plant	Concrete mixer, 15 kw	Litres Diesel/hr	3.8	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Front End Loader	Wheeled Loader, 75kw	Litres Diesel/hr	14.5	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Dumper 30t	Rear dump truck, 400kw	Litres Diesel/hr	32	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Cherry Picker Diesel	Access platform, 40kw	Litres Diesel/hr	7	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Dumper 2t	Small dumper, 15 kw	Litres Diesel/hr	15	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
MEWP	Access platform, 40kw	Litres Diesel/hr	7	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
30t Tracked excavator with pneumatic breaker with	Excavation hydraulic backbone, 150kw	Litres Diesel/hr	32	Institute Civil Engineering Surveyors (1998) The

Plant equipment type	Closest matching plant equipment	Unit	Fuel consumptions	Source
hydraulic breaker				Reference Manual for Construction Plant
D6 Dozer 20T towing roller20T	Crawler Dozer, 125kw	Litres Diesel/hr	25	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Lorry Delivery	Hydrema 922D	Litres Diesel/hr	13.5	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Compaction of concrete - compressor & poker vibrator Compressor, small petrol driven poker vibrators	Compressor, 100 kw	Litres Diesel/hr	20	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Compressor 600 cfm silenced electric	Compressor, 150kw	Litres Diesel/hr	30	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Generator (power for bentonite plant) diesel generator	Generating set 50kw	Litres Diesel/hr	12	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Mobile Crane 200t	Cranes: Tracked, 75kw	Litres Diesel/hr	13	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Gantry Crane 25t	Cranes: Tracked, 50kw	Litres Diesel/hr	8	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Vibrating Roller Medium (Bomag 120)	Vibrating plate compactor, 1kw	Litres Diesel/hr	5	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Generator (power for site cabins) diesel generator	Generating set 50kw	Litres Diesel/hr	12	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Mobile Crane 800t	Cranes: Tracked, 250kw	Litres Diesel/hr	40	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Concrete Pump Diesel	Pump, 15 kw	Litres Diesel/hr	3.2	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant

Plant equipment type	Closest matching plant equipment	Unit	Fuel consumptions	Source
Concrete Pump180mm diam. / 59 bar	Pump, 15 kw	Litres Diesel/hr	3.2	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Scissor lift	Access platform, 50kw	Litres Diesel/hr	8.8	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Diaphragm wall Tracked rig	Tracked Excavator	Litres Diesel/hr	46	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Mobile Crane 100t	Cranes: Tracked, 50kw	Litres Diesel/hr	8	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Dumper 35t	Rear dump truck, 500kw	Litres Diesel/hr	40	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
20t 360 deg Excavator removing spoil	Excavation hydraulic backbone, 100kw	Litres Diesel/hr	21	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
25t Dumper	Rear dump truck, 400kw	Litres Diesel/hr	32	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Telehandler	Fork lift, 50kw	Litres Diesel/hr	8.8	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Tracked Mobile Crane 600t	Cranes: Tracked, 200kw	Litres Diesel/hr	33	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Mobile Crane 80t	Cranes: Tracked, 50kw	Litres Diesel/hr	8	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Cherry Picker Diesel. Track mounted	Access platform, 40kw	Litres Diesel/hr	7	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Generator (power for site cabins / security) Diesel generator	Generating set 50kw	Litres Diesel/hr	12	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant

Plant equipment type	Closest matching plant equipment	Unit	Fuel consumptions	Source
Vibrating Roller Small	15kw roller	Litres Diesel/hr	3	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Tracked Mobile Crane 110t	Cranes: Tracked, 50kw	Litres Diesel/hr	8	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Dozer 14t	Crawler Dozer, 75kw	Litres Diesel/hr	15	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Concrete Mixer Truck 8m3	Concrete mixer, 20kw (20kw selected to account for description as 'truck')	Litres Diesel/hr	5	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Mobile Crane 55t All Terrain	Cranes: Tracked, 50kw	Litres Diesel/hr	8	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Paver (concrete) Diesel	Asphalt pavers & planters, 100kw	Litres Diesel/hr	20	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Concrete Mixer Truck Diesel	Concrete mixer, 20kw (20kw selected to account for description as 'truck')	Litres Diesel/hr	5	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
D6 Dozer 28t	Crawler Dozer, 175kw	Litres Diesel/hr	35	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Mobile Crane 80t	Cranes: Tracked, 50kw	Litres Diesel/hr	8	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Road Rail Excavator OLE Mast Installation Train	Excavation hydraulic backbone, 100kw	Litres Diesel/hr	21	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Mobile Crane 80t All Terrain	Cranes: Tracked, 50kw	Litres Diesel/hr	8	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Compressor 185 cfm for blowing out	Compressor, 75 kw	Litres Diesel/hr	16	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant

Plant equipment type	Closest matching plant equipment	Unit	Fuel consumptions	Source
Tracked Excavator (inserting cylindrical metal cages)	Excavation hydraulic backbone, 100kw	Litres Diesel/hr	21	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Compressor & pneumatic breaker/hammer	Compressor, 100 kw	Litres Diesel/hr	20	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Vibrating Roller Medium (Bomag) 12,050kW	Vibrating plate compactor, 1kw	Litres Diesel/hr	5	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
D6 Dozer 28T Dozer, 179kW	Crawler Dozer, 175kw	Litres Diesel/hr	35	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Cement deliveries - bulk tanker cement blowing into silo	Hydrema 922D (same as for Lorry deliveries)	Litres Diesel/hr	13.5	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Water pump, water treatment plant	Pump, 15 kw	Litres Diesel/hr	3.2	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Mobile Crane 70t	Cranes: Tracked, 50kw	Litres Diesel/hr	8	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Scabbling concrete compressor & pneumatic hammer	Compressor, 75 kw	Litres Diesel/hr	16	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Compressor 185 cfm	Compressor, 75 kw	Litres Diesel/hr	16	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Gantry Crane 25t Rubber wheeled / track mounted	Cranes: Tracked, 50kw	Litres Diesel/hr	8	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant
Ballast Regulator	Multi-purpose loader backhoes, 50kw (assume applicable due to Multipurpose application)	Litres Diesel/hr	10.9	Institute Civil Engineering Surveyors (1998) The Reference Manual for Construction Plant

Table 5: Assumptions relating to tree planting, carbon sequestration and land use change

Aspect	Assumptions	Source
Tree planting	Number of trees planted: 2,178,836	Design information
Tree planting	Tree planting spacing: 1.5m	Design information
Tree planting	Area required for planting: 356 Ha	Design information
Tree planting	Tree species mix assumed: oak (20%), Ash (20%), Birch (20%), Aspen (8%), Alder (10%), Rowan (10%), Hazel (7%) and Willow (5%)	Forestry Commission (2014), Woodland Carbon Code – Requirements for voluntary carbon sequestration projects.
Tree planting	No maintenance has been assumed beyond planting and establishment. Carbon emissions are deducted for planting seedlings (0.67 tCO_2e per ha), ground preparation (0.06 tCO_2e per ha) and herbicide application at planting and beat up (0.001 tCO_2e per ha).	Forestry Commission (2014), Woodland Carbon Code – Requirements for voluntary carbon sequestration projects.
Carbon sequestration	Carbon factors provided by the Woodland Carbon Code tool	Forestry Commission (2014), Woodland Carbon Code – Requirements for voluntary carbon sequestration projects.
Land use change	The land required for construction along the Proposed Scheme is approximately 2,400 hectares (ha).	Design information
Land use change	Carbon content of different land uses: Neutral grassland: 60 tC per ha; Arable and Horticultural land: 45 tC per ha; Coniferous Woodland: 75 tC per ha; Mixed Broadleaved and Woodlands: 65 tC per ha; Fen Marsh and Swamps: 75 tC per ha; and Dwarf Shrub Heath: 85 tC per ha. The carbon content of different land types was converted in to carbon dioxide using the following ratio: 44/12. This is to account for the released carbon from land use change reacting with oxygen for form carbon dioxide (CO_2).	Land Use Policy 26S (2009) S274-S283. UK land use and soil carbon sequestration by N.J.Ostle, P.E.Levy,C.D. Evans and P.Smith.

Table 6: Assumptions by life cycle stage

Aspect	Assumption
Construction plant	Although it was possible to estimate the duration and use of this equipment through the construction programme, actual energy consumption information was not available. Most of the information available reports diesel fuel consumption per hour, and as such, it was assumed that all construction machinery and equipment would be diesel powered.
Mass Haul	Assume average laden >33 tonne articulated lorry.
Mass Haul	Assume exported fill is transported 100 km.
Material transport	Assume average laden >33 tonne articulated lorry.
Material transport	Average distance the HGVs travel has been assumed at 200 km which is approximately the return journey between Stone, Staffordshire and the port of Liverpool. This is based on the professional judgement assumption that the port of Liverpool as a large container port close to the route would be used and a mid-point along the route was selected as the destination. Non-UK transport was excluded for other materials apart from steel based on professional judgement. It is expected that other construction materials transport impact would be less than 1% of the total carbon emissions.
Material transport	It is assumed that steel is transported from Germany to the port of Bremen (342 km by lorry) and from Bremen to port of Liverpool (1,693 km by ship) (Google Maps and Portworld). Germany is a major supplier of steel to the UK and it deemed, based on professional judgement, the most probable source of steel for a reasonable worst case scenario.
Waste transport	Assume waste is transported 100 km based on professional judgement of how far waste could be economically feasible to transport away from the construction site.
Waste transport	Assume average laden >33 tonne articulated lorry.
Waste materials	An uplift factor has been used for embodied emissions from construction materials to account for wasted materials as no specific data were available. Factors were calculated from the proportion of those specific construction materials from the total, which was then applied to construction waste tonnages. For example, it was calculated that approximate 25% of total materials used in construction was concrete, so it was assumed that 25% of the construction waste was also concrete and the embodied emissions to produce that wasted concrete was added to the total embodied material emissions. Waste data from the construction of the rail track and track systems was not available. An uplift factor based on the percentage of construction waste to construction material from the civil structures assessment was applied (7%) to the volume of track construction material in order to estimate track construction waste. The underlying assumption is that track construction would generate the same ratio of waste a civil structures construction.
Rolling stock	Assumed maximum speed: 330 to 360 kph using a scenario that 360 kph would only be used when trains are delayed to catch up with the timetable.
Rolling stock	All rolling stock are 200m unit trains.

Aspect	Assumption
Rolling stock	Assumed energy consumption on the classic network: 15.27 kWh/ km.
Rolling stock	Assumed energy consumption on the HS2 network: 24.97 kWh/ km.
Modal shift Rolling Stock	UK grid emission projections from UK government do not extend to 2146, which would cover the whole of the 120 year assumed operating period. Thus, emissions are projected to steadily fall to 18 gCO_2e per kWh by 2050 without any further decarbonisation. The UK government projections are used as the 'reasonable worst case' (see Figure 4).
Modal shift Rolling Stock	HS2 vehicle kilometres are assumed to ramp up over the first three years of operation between 2026 and 2029. It is assumed based on professional judgement that HS2 would be at 80% capacity by 2026, 90% by 2027, 95% by 2028 and 100% by 2029.
Modal shift	UK highway stock and fuel efficiency (passenger cars) is only modelled by UK government as far as 2050. The GHG assessment assumes no change thereafter as a reasonable worst case (see Figure 2 and Figure 5).
Modal shift	No projections for the decarbonisation of airline emissions were available. Thus model assumes no change from 2016 UK government corporate reporting guidelines for domestic air travel.
Freight modal shift	Assumed that 70% of Phase One freight paths extend north of Rugby (35% to Hams Hall and 35% to Birch Coppice).
Freight modal shift	Assumed 14 freight trains per day, equivalent to 504 containers per day, each container with a 20t capacity.
Freight modal shift	Route lengths assumed: 57km from Rugby to Hams Hall, and 47km from Rugby to Birch Coppice. It is assumed that there is a staged approach to the uptake of released rail freight capacity. This starts at 20% in 2027 and increases at 10% per year until 2035.
Operational energy consumption	An operational energy uplift factor has been included to account for consumption from signalling, communications and switch heating (technical railway operations). The factor used was 6%, which was calculated from the results of the UIC report, which reports an 85% / 15% split between traction and non-traction energy consumption. Within non-traction energy consumption 40% of this comes from signalling, communications and switch heating[7].

[7] International Union of Railways (2012), *Study on Non-traction energy consumption and related CO_2 emissions from the European railway sector*. Available online at: http://uic.org/IMG/pdf/uic_non-traction_energy_study_final_report_june_2012.pdf

Figure 2: UK highway car stock mix projection according to the DfT[8]

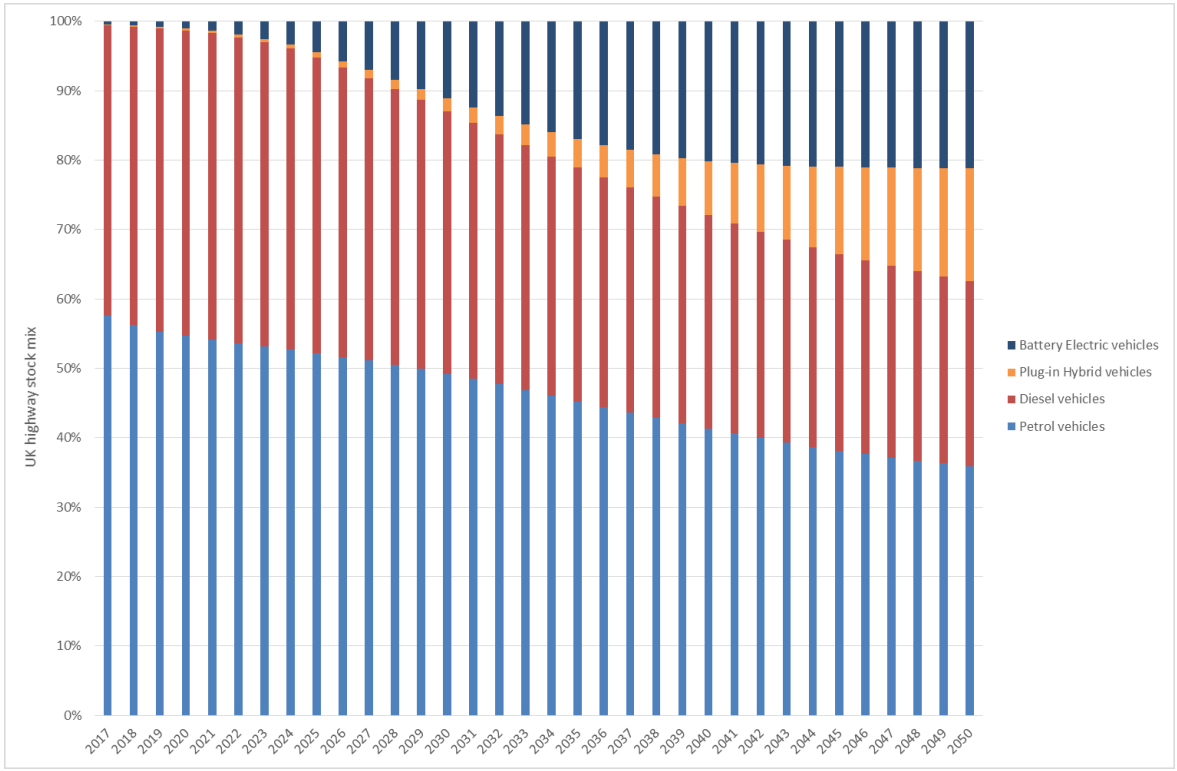
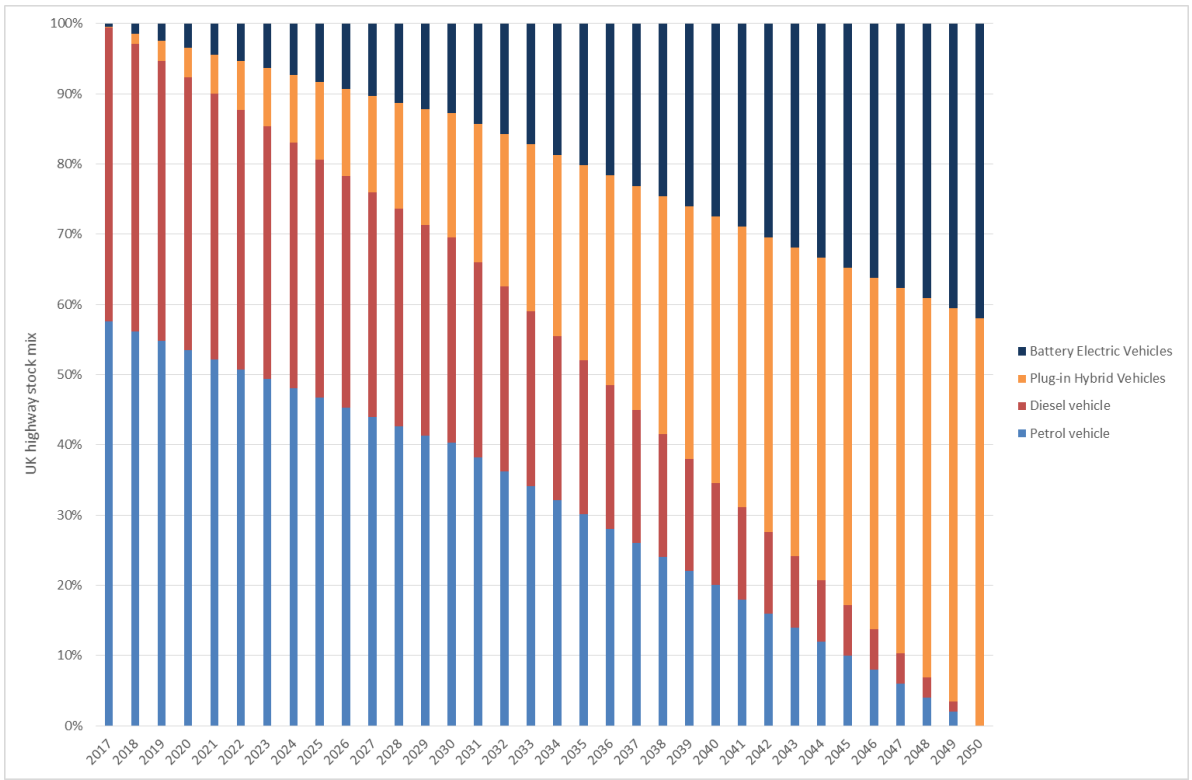


Figure 3: UK highway car stock mix projection based on the Committee on Climate Change[9]



[8] Department for Transport (2017) *Fleet fuel efficiency model (FFEM) outputs*. Data issued on 2 March 2017.
[9] Committee on Climate Change (2015) *Sectoral scenarios for the Fifth Carbon Budget – Technical Report*.

Table 7: Assumptions used when scoping the GHG assessment for fixed infrastructure assets of the Proposed Scheme

Asset	Assumption
Utilities Adjustment	These are only within scope where it is the responsibility of HS2 and fall within the land required for construction for the Proposed Scheme.
Balancing Ponds Embankments Utilities Adjustment Culverts Inverted siphons Drop inlet culverts Pipelines Road Adjustments Auto-transformer Stations Footpath adjustments Bridges, Viaducts and Aqueducts Cuttings Retaining walls Rail Heads Tunnels Tunnel portals and portal buildings	The construction and materials use are scoped into the GHG assessment as provided by the design information. This includes both permanent and temporary assets.
Stone Infrastructure Maintenance Base (IMB-R)	Data for construction of Stone IMB-R is based on design information.
Rail	The track has been assumed to be 100% composed of concrete slab. The scope of this assessment also includes the embodied emissions associated with steel rails (216m per unit of rail delivered), reinforcement steel for the concrete slabs, shear keys and concrete grouting.
Track railway systems	This is included in line with design information. This includes the length of copper cables for power and communication systems.
Rolling Stock	Embodied emissions from the manufacture of trains are excluded from this assessment as they were included within the scope of the HS2 Phase One GHG Assessment and no additional trains are expected to be used for the Proposed Scheme.

Table 8: Life cycle stage scoping exclusions

Life cycle stage	Assumption
Pre-construction	This is excluded as no sources of carbon emissions more than 1% of total can be identified from this module based on professional judgement.
Construction transport	Worker commute to compounds has been excluded as these are not required to be reported within PAS 2080 and BS 15978 standards. Carbon emissions have been estimated to be less than 1% and are not thought to be a major contributor to the footprint. This also excludes the transport of equipment to and from site, which is expected to be less than 1% of the total footprint.
Construction plant equipment	This excludes operation of Tunnel Boring Machines (TBM). Their embodied impact from manufacture and operations are not expected to have emissions more than 1% of the total

Life cycle stage	Assumption
	according to professional judgement. This was based on estimates using HS2 Phase One GHG Assessment data where TBM energy consumption was 3100 tCO_2e per km of tunnel.
Maintenance	This is excluded due to the emissions from the maintenance of bridges, viaducts and tunnels were deemed by the project engineers to be the structures requiring the most regular maintenance, being estimated to be no more than 1% and not material. Maintenance of the rolling stock is included within the Phase One emissions and no additional trains are expected to operate as part of the Proposed Scheme, therefore the maintenance of rolling stock is excluded from this assessment.
Repair	The repair of any fixed infrastructure assets are excluded as it is assumed they would be maintained to prevent failure. Any preventable failures are not included within scope as it cannot be anticipated and therefore assessed.
Replacement	A number of assets will require replacement over the assumed 120 year design life. The assets for which replacement has the potential to have a material impact include: Auto-transformer stations – 40 years; Steel rails - 17.5 years; and Slab track – 10% would require replacement over 120 years.
Refurbishment	This has been excluded as the only potential source of emissions identified was associated with the refurbishment of Stone IMB-R. It is expected that this would be less than 1% of total carbon emissions based on professional judgement.
Operational energy consumption	Operational energy of fixed assets e.g. lighting / heating of IMB-R, drainage pumps, tunnel fans has been excluded as it is expected to not use a large amount of energy compared to rolling stock operation. The operation of tunnel fans was assessed in Phase One as being less than 1% of total carbon emissions.
Operational water consumption	This is excluded as the GHG impacts of water during operation are expected to be very low, based on professional judgement that it is not a major water consumer. The main uses would be washing trains and staff use at IMB-R for the Proposed Scheme. Consumption would not be expected to be more than 1% of carbon emissions based on professional judgement.
Other operational processes	This is excluded as operational waste is expected to contribute less than 1% of total carbon emissions based on professional judgement due to low annual tonnages and high diversion from landfill.
Operation of rolling stock	Carbon emissions associated with the energy consumption from operation of HS2 rolling stock beyond the Proposed Scheme (i.e. HS2 journeys on Phase One and the conventional rail network) have been excluded as these are accounted for in the HS2 Phase One GHG assessment
End-of-life	Deconstruction and the end-of-life impacts are excluded as the fixed infrastructure assets are assumed based on professional judgement to be extended beyond the 120 year design lifetime with regular maintenance and replacement where necessary.

Figure 4: UK electricity grid decarbonisation projections applied from UK government and the Committee on Climate Change

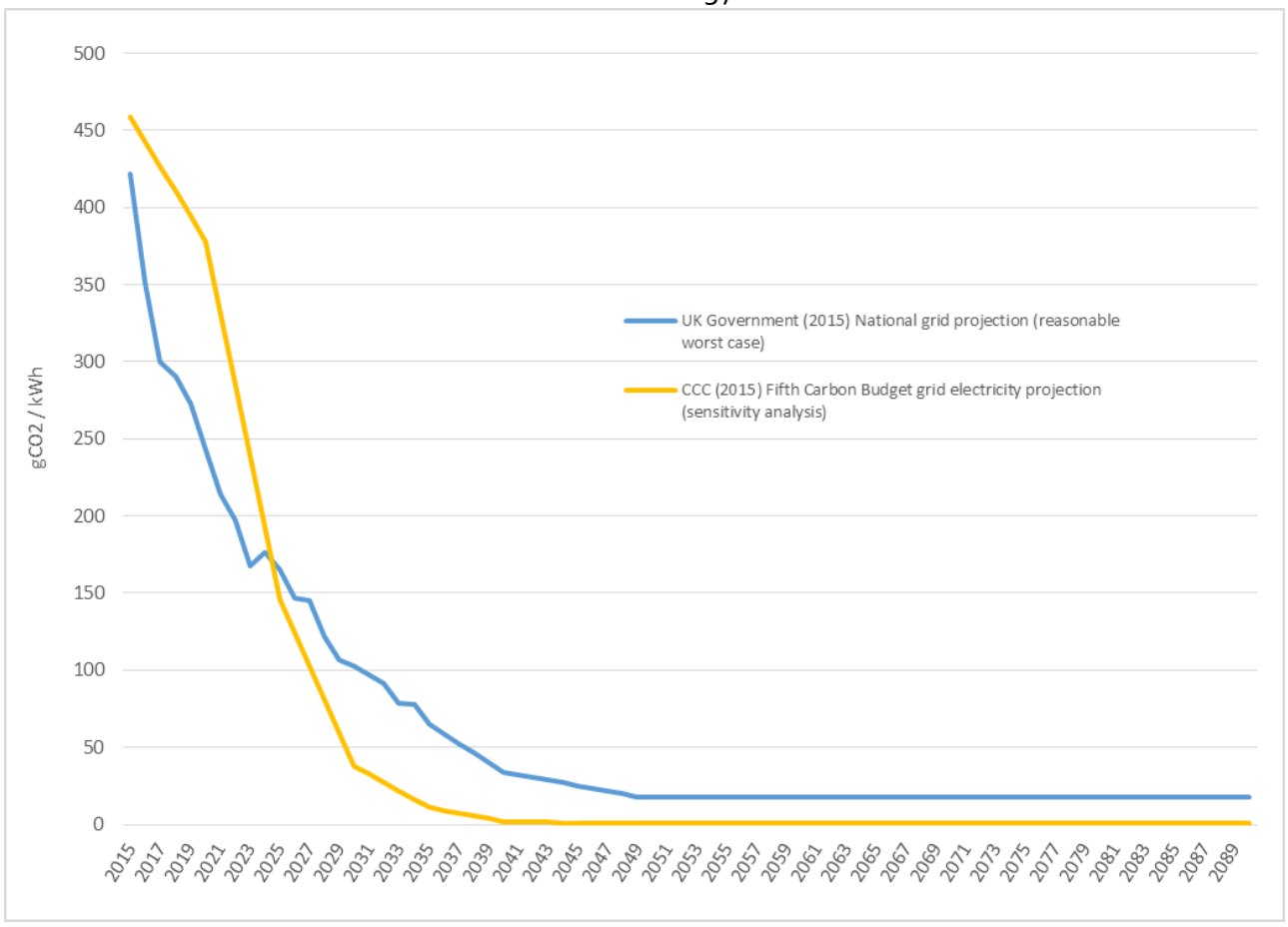


Figure 5: Projected UK car fleet fuel efficiency (gCO_2e/ passenger-km) from DfT

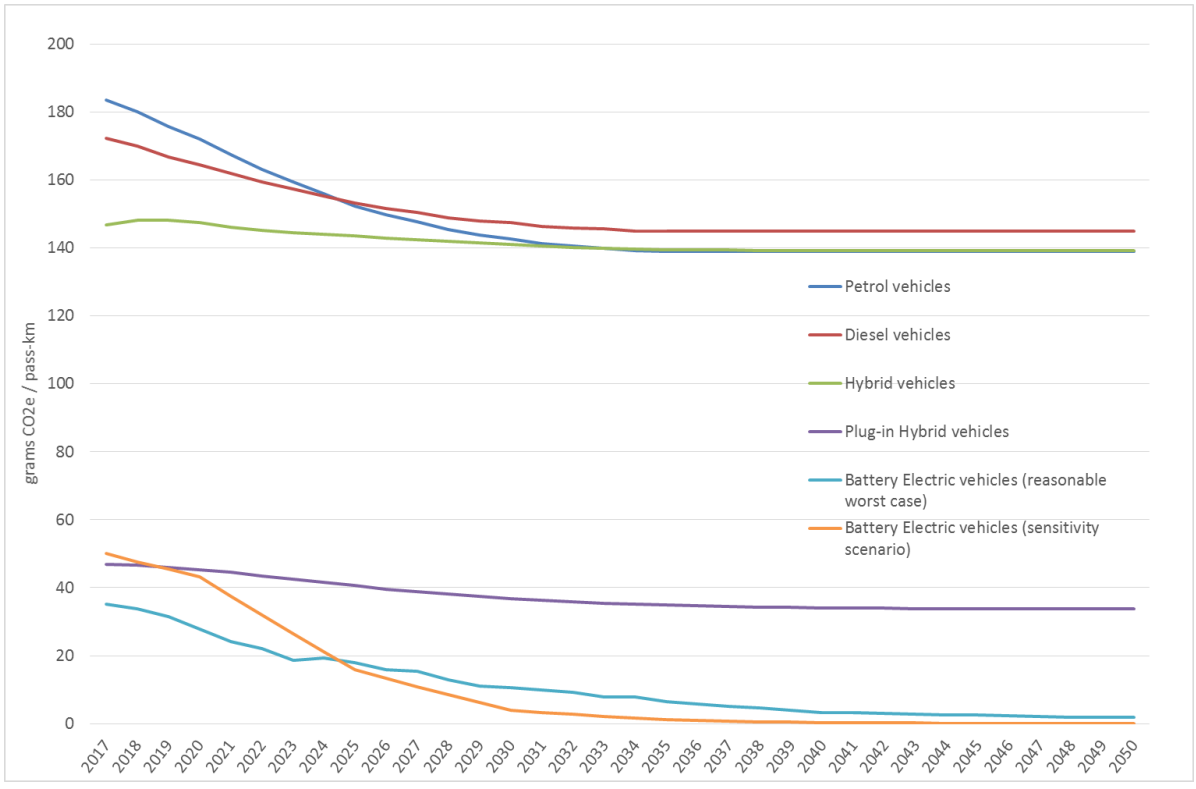


Table 9: Carbon factors applied by construction material type

Element description	Material type	Unit	Carbon emissions factor		Source
			$KgCO_2$/ unit	$kgCO_2e$/ unit	
Construction materials	Concrete	kg	0.070		MPA The Concrete Centre, (2017) Concrete Industry Sustainability Performance Report – 9th report: 215 performance data MPA Cement (2013) The UK cements industry aims to reduce greenhouse gases by 81% by 2050
Construction materials	Steel	kg		1.26	The Boston Group & Stahl Steel Institute VHEh (2013) Steel's Contribution to a Low-Carbon Europe 2050
Construction materials	Concrete with reinforcement	kg	0.077		MPA The Concrete Centre, (2017) Concrete Industry Sustainability Performance Report – 9th report: 215 performance data MPA Cement (2013) The UK cements industry aims to reduce greenhouse gases by 81% by 2050
Construction materials	Aggregate (road stone) (fine)	kg		0.009	Ecoinvent 3 process database
Construction materials	Timber	kg		0.05	Ecoinvent 3 process database
Construction materials	Asphalt	kg		0.066	University of Bath, (2011) Inventory of Carbon & Energy (ICE) Version 2.0
Construction materials	Rock wool	kg		1.260	Ecoinvent 3 process database
Construction materials	Plywood	kg		0.80	Ecoinvent 3 process database
Construction materials	Copper	kg		2.17	University of Bath, (2011) Inventory of Carbon & Energy (ICE) Version 2.0
Construction materials	Cement mortar (grout)	kg		0.24	Ecoinvent 3 process database

Element description	Material type	Unit	Carbon emissions factor		Source
			$KgCO_2$/ unit	$kgCO_2e$/ unit	
Construction work	Diesel used in machinery (<18.64 kW)	hr		4.090	Ecoinvent 3 process database
Construction work	Diesel used in machinery (18.64–74.57 kW)	hr		17.200	Ecoinvent 3 process database
Construction work	Diesel used in machinery (>74.57 kW)	hr		65.700	Ecoinvent 3 process database
Construction work	Diesel used in machinery	l		4.467	Calculated using the three above factors. Assumes diesel density of 0.832 kg/l
Material transport	Heavy goods vehicle (HGV) (all diesel) (all HGV)	tonne.km		0.138	Defra DECC, (2016) UK Government GHG Conversion Factors for Company Reporting
Material transport	Artic >33t 100% laden	tonne.km		0.073	Defra DECC, (2016) UK Government GHG Conversion Factors for Company Reporting
Material transport	Artic >33t average laden	tonne.km		0.098	Defra DECC, (2016) UK Government GHG Conversion Factors for Company Reporting
Material transport	Rail (freight train)	tonne.km		0.038	Defra DECC, (2016) UK Government GHG Conversion Factors for Company Reporting
Waste emissions from landfill	Landfill - inert waste	kg		0.003	Ecoinvent 3 process database
Movements of excavated material	Diesel (average biofuel blend)	l		3.166	Defra DECC, (2016) UK Government GHG Conversion Factors for Company Reporting
Movements of excavated material	Rigid (>17 tonnes) 0% laden	km		0.930	Defra DECC, (2016) UK Government GHG Conversion Factors for Company Reporting

Element description	Material type	Unit	Carbon emissions factor		Source
			$KgCO_2$/ unit	$kgCO_2e$/ unit	
Movements of excavated material	Rigid (>17 tonnes) 100% laden	km		1.331	Defra DECC, (2016) UK Government GHG Conversion Factors for Company Reporting
Movements of excavated material	Artic >33t 0% laden	km		0.828	Defra DECC, (2016) UK Government GHG Conversion Factors for Company Reporting
Movements of excavated material	Artic >33t 100% laden	km		1.371	Defra DECC, (2016) UK Government GHG Conversion Factors for Company Reporting
Movements of excavated material	Artic >33t average laden	km		1.175	Defra DECC, (2016) UK Government GHG Conversion Factors for Company Reporting
Released capacity for freight	Gas oil	l		3.523	Defra DECC, (2016) UK Government GHG Conversion Factors for Company Reporting
	Gas oil	l		2.783	WebTAG Unit, (2013)
Waste disposal, Construction, Open Loop	Aggregates - Recovery	tonnes		1	Defra DECC, (2016) UK Government GHG Conversion Factors for Company Reporting
Waste disposal, Construction, Open Loop	Average construction - Recovery	tonnes		1.37	Defra DECC, (2016) UK Government GHG Conversion Factors for Company Reporting
Waste disposal, Construction, Open Loop	Asphalt - Recovery	tonnes		1.37	Defra DECC, (2016) UK Government GHG Conversion Factors for Company Reporting
Waste disposal, Construction, Open Loop	Bricks & concrete - Recovery	tonnes		1	Defra DECC, (2016) UK Government GHG Conversion Factors for Company Reporting

Element description	Material type	Unit	Carbon emissions factor		Source
			$KgCO_2$/ unit	$kgCO_2e$/ unit	
Waste disposal, Construction, Open Loop	Tyresand wood - Recovery	tonnes		21	Defra DECC, (2016) UK Government GHG Conversion Factors for Company Reporting
Waste disposal, Landfill	General construction material	tonnes		2	Defra DECC, (2016) UK Government GHG Conversion Factors for Company Reporting
Waste disposal, Landfill	Plasterboard - Landfill	tonnes		71.95	Defra DECC, (2016) UK Government GHG Conversion Factors for Company Reporting
Waste disposal, Landfill	Wood - Landfill	tonnes		627	Defra DECC, (2016) UK Government GHG Conversion Factors for Company Reporting
Inert	Inert/ Out of Scope	NA		0	FC 14/02/2017
Worker Accommodation	Municipal Waste	tonnes		21	Defra DECC, (2016) UK Government GHG Conversion Factors for Company Reporting
Route-wide track	Auto-transformer	tonnes		5690	Ecoinvent 3 process database

Table 10: Assumptions associated with the sensitivity analyses

Sensitivity analysis	Assumptions	Data source
Cement and steel	Assumes that the cement industry is on track to achieve an 80% reduction in carbon emissions by 2050 over 1990 levels. Projected carbon emissions in 2020 (construction opening year for the Proposed Scheme) are 0.067 $kgCO_2$ per kg of concrete. For concrete with reinforcement projected carbon emissions in 2020 are 0.074 $kgCO_2$ per kg of reinforced concrete.	MPA The Concrete Centre, (2017) Concrete Industry Sustainability Performance Report – 9th report: 215 performance data MPA Cement (2013) The UK cements industry aims to reduce greenhouse gases by 81% by 2050.
	Assumes that the steel industry is on track to achieve an 80% reduction in carbon emissions by 2050 over 1990 levels. Projected carbon emissions in 2020 are 1.17 $kgCO_2e$ per kg of steel.	The Boston Group & Stahl Steel Institute VHEh (2013) Steel's Contribution to a Low-Carbon Europe 2050.
Grid electricity	Assumes that the rate and extent of decarbonisation of UK grid electricity as projected by the CCC (UKTM model)[10], and presented in Figure 4, is achieved. Grid electricity carbon emissions are expected to reach 1 gCO_2 per kWh by 2045 without any further reductions thereafter (see Figure 4).	Committee on Climate Change (2015) Sectoral scenarios for the Fifth Carbon Budget – Technical Report (supporting charts and data).
Modal shift – increased uptake of electric vehicles	Assumes plug-in hybrid electric vehicles (PHEV) and battery electric vehicles (BEV) account for 30% of the UK car fleet by 2030 (the remaining 70% being diesel and petrol) reaching 100% by 2050 (see Figure 3). This aligns with the CCC's Fifth Carbon Budget and the requirement to decarbonise the transport sector 2050.	Committee on Climate Change (2015) Sectoral scenarios for the Fifth Carbon Budget – Technical Report. Department for Transport (2017) Fleet fuel efficiency model (FFEM) outputs. Data issued on 2 March 2017.

[10] UKTM: UK TIMES energy systems model (UKTM), developed by UCL Energy Institute's ESEM team, has been one of the principal tools used by DECC in setting the 5th carbon budget.

Annex C: Community – technical note

The following technical note is contained in this Annex:

- Further assessment guidance.

HS2 Phase 2a West Midlands - Crewe: Technical note - Community - Further assessment guidance

Contents

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1 Introduction

1.1 Introduction

1.1.1 This technical note provides further guidance on the assessment methodology for assessing potential community impacts and effects considered likely to arise from the construction and operation of the HS2 Phase 2 West Midlands to Crewe (the Proposed Scheme). It provides further guidance on the method and approach set out within Section 9 of the HS2 Phase 2a Environmental Impact Assessment (EIA) Scope and Methodology Report (SMR)[1].

1.1.2 The technical note builds upon and updates the guidance set out within section 7 (Community) of the HS2 Phase One SMR Addendum Phase 1 (Phase One Environmental Statement (ES), Volume 5: Appendix CT-001-000/1)[2].

1.2 Community

1.2.1 Community effects are defined as non-economic effects upon people and organisations operating community facilities and will be considered against four principal types of infrastructure:

- residential property;
- community infrastructure;
- recreation infrastructure; and
- open and play space.

1.3 Other environmental impacts

1.3.1 There are a number of other environmental topics, such as air quality, noise and vibration, visual and transport that inform the community assessments. An understanding of these methodologies and topics will be required to give context for potential in combination effects arising from impacts related to these topics.

1.4 Structure of this technical note

1.4.1 This technical note is structured as follows:

- Section 2 provides core definitions for the receptors and resources which are relevant in assessing potential community effects;
- Section 3 sets out further details of the community assessment criteria and guidance on how this will be applied; and
- Section 4 provides a list of assumptions which will be applied to the community assessment.

[1] Scope and Methodology Report, Volume 5: Appendix CT-001-001.
[2] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/260153/Vol5_Scope_and_methodology_report_addendum_CT-001-000.2.pdf

2 Receptor and resource definitions

2.1 Introduction

2.1.1 Community resources and receptors are set out below against the infrastructure themes of residential property, recreational infrastructure; community infrastructure; open and play space.

2.2 Community resources and receptors

Residential property

2.2.1 **Resources**: Residential property includes:

- private, rented and shared ownership residential dwellings and their surrounding grounds/gardens;
- student accommodation;
- extra care/retirement housing;
- mobile homes where there is an established and recognised location for them to use, (e.g. barge moorings, caravan sites, traveller sites); and
- homes used in conjunction with a business or other function, for example, bed and breakfasts, farm houses and church rectories.

2.2.2 **Receptors**: includes the residents or tenants of properties. It also includes employees who permanently reside in a residential property, for example, care givers and janitors.

2.2.3 **Exclusions**: Residential health/social care facilities are covered under community infrastructure. Other community property will be considered under community infrastructure or recreation infrastructure. Travel accommodation such as hotels, bed and breakfasts and serviced apartment hotels will be included as businesses under the socio-economic assessment, except where the accommodation in question provides permanent residential dwelling for the owner/manager and/or staff when they are considered under community as well as socio-economic. Landlords or owners who do not reside in the property are also excluded.

Community infrastructure

2.2.4 **Resources**: Community infrastructure includes:

- health and social care facilities including GP practices and health centres, hospitals, hospices, residential care facilities, sure start centres, social work centres, health-related emergency services, dentists;
- educational facilities including day nurseries, primary schools, secondary schools, colleges, universities, other organised learning environments and education resource centres;

- community centres, youth centres, and other relevant facilities used for local community meetings and activities;
- institutional uses defined as government local authority and emergency services which are open to the public;
- local high streets and local centres which provide local services including convenience retail and services such as post offices and hairdressers; and
- places of worship (with some potential overlap with open space, e.g. burial grounds, cemeteries).

2.2.5 **Receptors**: users and beneficiaries of resources which include local residents, organised (community) groups, pupils, patients, congregations and employees who used community infrastructure. Receptors also include owners and organisations running the resources.

2.2.6 **Exclusions:** employment impacts will be covered under the socio-economic assessment.

Open space and play space

2.2.7 **Resources**: open space including areas of land and water (such as rivers, canals, lakes and reservoirs) which offer opportunities for sport and recreation and could also act as a visual amenity.

2.2.8 Open spaces are limited to publicly accessible spaces.

2.2.9 The following typology illustrates the broad range of open space resources that may be of public value, including play spaces:

- parks and gardens – includes urban parks, country parks and formal gardens;
- accessible countryside in urban fringe areas;
- accessible wider countryside;
- accessible natural and semi-natural urban green spaces – includes woodlands, urban forestry, scrub, grasslands (e.g. downlands, commons and meadows), wetlands, open and running water, wastelands and derelict open land and rock areas (e.g. cliffs, quarries and pits);
- access routes used for recreation – includes river and canal banks, recreational (off road) cycle routes, bridleway, and promoted recreational walking routes;
- outdoor sports facilities (with natural or artificial surfaces and either publicly or privately owned) – including tennis courts, bowling greens, sports pitches, golf courses, athletics tracks, school and other institutional playing fields;
- amenity green space (most commonly, but not exclusively in housing areas) – including informal recreation spaces, green spaces in and around housing, and village greens;
- allotments, community gardens, and city (urban) farms;

- cemeteries and churchyards;
- civic spaces, included civic and market squares, and other hard surfaced areas designed for pedestrians; and
- outdoor play spaces included provision for children and teenagers – including play areas, skateboard parks, outdoor basketball hoops, and other more informal areas.

2.2.10 **Receptors**: users and beneficiaries of resources which include local residents, organised (community) groups, pupils, patients, congregations and employees who use community infrastructure. Receptors also include owners and organisations running the resources.

2.2.11 **Exclusions**: employment impacts will be covered under the socio-economic assessment.

Recreational infrastructure

2.2.12 **Resources**: recreation infrastructure related to public and commercial recreational facilities where not covered under open space and play space. Recreation infrastructure includes:

- sports centres and facilities, leisure centres and fitness clubs. (some recreation facilities may include both indoor and outdoor recreation facilities, e.g. golf clubs, paintballing venues);
- stadia, arena and professional sports clubs which host games and events open to the public;
- indoor (publicly owned and commercial) children's play areas;
- museums, art galleries, theatres, cinemas, historic buildings and stately homes open to the public, other cultural venues and facilities;
- food venues, cafes, restaurants;
- music venues, bars, pubs, night clubs, social clubs (e.g. Irish clubs, Conservative clubs, Labour clubs, Working Men's clubs); and
- other recreational facilities, for example, theme parks, animal sanctuaries, zoos, aquariums, visitor centres, camp sites, equestrian facilities and showgrounds.

2.2.13 **Receptors**: users and beneficiaries of resources which include local residents, organised (community) groups, pupils, patients and employees who used recreation infrastructure. Receptors also include owners and organisations that run the resources.

2.2.14 **Exclusions:** outdoor and open spaces used for recreation which are already covered under open space, e.g. a public bridleway used for horse riding. Employment impacts will be covered under the socio-economic assessment.

3 Community assessment criteria

3.1 Introduction

3.1.1 The Environmental Statement (ES) will use both the terms 'impact' and 'effect' in all environmental topics. An impact will be generally considered to be a physical change caused by the scheme (and in this context, changes in air quality, noise levels or the quality of a view for example will be 'impacts'). The consequences of impacts on the receptors will be generally termed 'effects'.

3.1.2 For the community assessments, resources will be the assets and facilities which are affected. Receptors are the operators, users or beneficiaries of those resources. Resources and receptors will vary for each type of impact and effect. So for example, the impact of 'increased construction traffic' may have a range of impacts, such as congestion on the roads. The effects of this congestion could be disturbance and annoyance to local residents and disruption for users of community resources.

3.2 Impacts and effects

3.2.1 Impacts relevant to the community assessments fall broadly within the following categories:

- demolition and direct land possession;
- damage to property as a result of construction; and
- intrusion / disturbance to communities, and community facilities caused by presence of construction workers or other environmental impacts.

3.2.2 Impacts will generate the following broadly defined effects on receptors and resources:

- **loss or gain**: a loss or gain to a resource or receptor. For example a decrease in housing stock as a result of demolitions, a reduction in playing pitches available within an open space or, a loss of all or part of a recreational resource, such as a golf course.
- **displacement**: the re-location of receptors from one location to another location within the study area, for example people moving from their homes to replacement homes (permanently or temporarily), or community venues moving from their existing premises;
- **in-combination effects**: the amenity value that resources offer receptors may be affected by a combination of factors including: noise and vibration; HGV traffic; air quality; and visual impacts. Amenity value relates to the enjoyment of a resource by a receptor. The assessment of in-combination effects on community receptors will draw on the conclusions from other assessment topics taking into account professional judgement about the sensitivity of the individual resource or receptors to the predicted effects; and
- **isolation**: in the context of this assessment, isolation effects will be assessed by the barriers local communities face in making their usual journeys. This

includes physical, psychological and social barriers (i.e. non-economic) and the effects of this on local communities. Isolation of commercial and industrial buildings and land, and agricultural property and land, are addressed within the scope of the socio-economics and agriculture, forestry and soils assessments.

- **capacity**: the ability of community facilities to accommodate any increased demand associated with the presence of construction workers.

3.2.3 Community effects will also need to be taken account of in the assessment of health. Integrated working between the community and health assessments will ensure that the assessment methodologies are aligned through[3]:

- establishment of a common baseline for the community areas that will meet the requirements for all disciplines;
- ensuring that the community assessment takes account of, where relevant and where information is available, health characteristics of community facilities; and
- ensuring significant community effects are taken into account as part of the health assessment.

3.2.4 The community assessment will also inform the Equality Impact Assessment (EQIA) which will be separately reported from the ES.

3.3 Assessment of significance

3.3.1 Significance should be determined by assessing both the magnitude of the impact and the sensitivity of resources and receptors for each effect. Taken together magnitude and sensitivity will determine whether effects were considered to be 'significant' or 'not significant'. All effects are to be assessed, including adverse and beneficial.

Magnitude of impact

3.3.2 In considering the magnitude of an impact on a resource and its receptors, assessors should consider each impact against the checklist of magnitude questions presented in List A. The questions are designed to assist in deciding on magnitude and judging whether there could be any specific circumstances in which the magnitude ranking should differ from the thresholds identified in Table 1. Not every question will be relevant to the circumstances of each individual impact.

3.3.3 Some situations/outcomes may not be known for certain. Assessors should base their work on an assessed mostly likely situation/outcome.

List A: Questions relevant to the assessment of magnitude of impact

Scale of the impact/ implications for receptors and functioning of the resource:

- Is the impact of such a scale that it will affect the functioning of the resource?

[3] Although not part of the ES findings of the Community assessment will also inform the EQIA, to be reported separately.

- What is the scale of the impact on people's lives and activities?
  - Do other ES topics conclude a significant effect?

Duration of the impact:

- What is the duration of the impact on a receptor?
  - Does the impact occur at specific times of the day?
  - For how long does the impact occur (short, medium or longer term)?
  - How regularly does the impact occur?
  - Is the impact temporary or permanent?

Number of people affected/extent of use

- What is the spatial scope of the impact (i.e. to help inform judgement on the number of people affected)?
- How many people/what proportion of people, are likely to experience the impact?
- generally, the greater the number of people which experience an impact the greater the magnitude.

The assessment will also consider people experiencing an impact as a proportion of the total people in a relevant community and/or group, i.e. if the number of people experiencing an impact is low but the proportion is high, then it may be appropriate to consider the magnitude as higher.

Sensitivity of receptors

3.3.4 In considering the sensitivity of receptors to an impact, assessors should consider each impact against the checklist of sensitivity questions given in List B. Not every question will be relevant to the circumstances of each receptor. The questions are designed to assist in deciding on sensitivity and judging whether there could be any specific circumstances in which the sensitivity ranking should differ from the thresholds provided in Table 1.

3.3.5 Some situations/outcomes may not be known for certain. Assessors should base their work on assessed mostly likely situations/outcomes.

3.3.6 For the assessment of in-combination impacts, sensitivity should be considered as a separate step in the community assessment process. Where there is an overlap with other disciplines and this is considered by assessors to be important they should ensure that the overall significance rating is consistent with the other relevant assessments.

List B: Questions relevant to the assessment of sensitivity

Availability of resources affected

What is the scarcity of the affected resource and what is the availability of alternatives? Factors to consider include:

- What is the catchment area of the affected resource?
- Are there comparable alternative resources available within the relevant catchment area?
- How easy is it to replace the resource? e.g. does it have special site requirements that are difficult to replicate or are its locational requirements generic and relatively easily met elsewhere?
- What is the spare capacity of the alternative resources and is this potentially available to the users of the affected resource?

Capacity of receptors to respond to change

- What is the capacity of the resource and the receptors that use it to experience a loss or gain of the affected resource?
- Nature of users – are they concentrated in the local area? Are they a specialised interest group? Are they local/ regional/ national/ international? Does this nature then influence their capacity to experience a loss or gain in the affected resource?
- Are users concentrated in potentially more sensitive groups, such as people on low incomes, unemployed, or in areas of multiple deprivation? [4]
- How mobile are the receptors? e.g. are they likely to have access to a car? Do they have any physical constraints on their movement?

3.4 Assessment criteria and thresholds

3.4.1 Specific magnitude and sensitivity criteria and thresholds have been developed for each of the types of community impacts to be assessed. The assessment criteria described in Table 1[5] identify the types of impacts and effects on resources and relevant receptors. This includes guidance on the factors to consider and thresholds to ensure a consistent approach to assessing significance.

3.4.2 This table has been established using professional judgement and existing precedents and should be used as the starting point for assessment. In some instances it may be considered appropriate to adjust sensitivity and magnitude in the light of specific circumstances.

[4] Where receptors are within Protected Characteristics groups as in Equality Act 2010, effects will be assessed and reported within a separate EQIA Report.
[5] Table 1 builds upon the assessment guidance set out in the HS2 Phase One EIA Scope and Methodology Report, Section 7: Community.

3.4.3 The approach is similar to that used for the community assessment reported in the Environmental Statement for HS2 Phase One. There have been some improvements and clarifications to the approach which are incorporated through minor revisions to the table that was used for Phase One.

3.4.4 Table 1 will be used to determine both construction phase effects and operational effects. Whether a particular resource and receptor needs separate assessment for construction and operation will depend upon the specifics of the scheme. Some receptors need different assessments for both construction and operation while other receptors will only require an assessment for one of the two. There will also be instances in which it will be appropriate to take into account the construction effects when carrying out the assessment of the operational impact, for example if a facility will be closed down during construction and would only be partly reopened during the operational of the railway.

3.5 Community-wide effects

Defining community-wide effects

3.5.1 There may be instances where separate effects on individual community resources cumulatively have a wider impact on the broader community.

3.5.2 Community-wide effects will be reported as 'cumulative effects' or 'synergistic effects' in the ES. These are defined as occurring, as set out in Section 4.4 of the HS2 Phase 2a SMR, "where a combination of effects on individual resources have a wider impact on a community, such that they change the experience of a significant proportion of people within that community in terms of their day to day functions (live, work, leisure, travel)".

Outline guidance

3.5.3 Using the individual assessments conducted at community area (CA) level, community assessors should undertake a qualitative assessment of community-wide effects. This will require assessors to use professional judgement to consider whether the assessment findings on community resources and receptors in the CA have in aggregate identified matters that could be applicable/relevant at a community-wide level (i.e. having an appreciable effect across the majority of the community) as opposed to only affecting individually identified resources and receptors.

Defining community geography

3.5.4 Assessment will either be undertaken at sub-CA or CA level. At sub-CA level this will involve carrying out assessments at the level of smaller community areas. These smaller community areas would be typically aligned with obvious or clear spatial boundaries that separate or join-up geographic areas into distinct communities.

Table 1: Guidance on assessing sensitivity and magnitude

Theme	Impacts	Effects:		Spatial scope	Magnitude of impact	Sensitivity of receptors/resources
		On resources	On receptors			
1. Residential property	1.1 Residential property (including gardens) lost in part or whole to land required for construction or operation of the Proposed Scheme	Reduction in housing stock available for people	Displacement of home owners/ tenants, inconvenience and loss of their assets	Land required for the Proposed Scheme.	• HIGH: – Permanent loss of 25 residential units or more – Temporary loss of garden space of 50 residential units or more – for more than 3 months • MEDIUM: – Permanent loss of 10 residential units or more – Temporary loss of garden space of 20 residential units or more for more than 3 months • LOW: – Permanent loss of 5 residential units or more – Temporary loss of garden space of 10 residential units or more for more than 3 months • NEGLIGIBLE: – Permanent loss of 4 residential units or less – Temporary loss of garden space of 9 residential units or less for more than 3 months – Possible variations: Where the number of dwellings affected is a high proportion of the size of a local community it may be appropriate to adjust the magnitude of impact	• HIGH Possible variations: – Residents who only live for short periods of time in the properties (e.g. student accommodation) will experience less/limited disruption and so it may be appropriate to reduce sensitivity.
	1.2 In-combination effects of noise and vibration, HGV traffic,	Character or quality of residential properties change as	Receptors' enjoyment of resource is changed	Relevant impact area from the edge of the route of the Proposed	At least five properties need to experience an effect for a resource to potentially experience a community impact. The primary test of magnitude will be the nature of the effects on the	• HIGH

Theme	Impacts	Effects:		Spatial scope	Magnitude of impact	Sensitivity of receptors/resources
		On resources	On receptors			
	air quality and visual impacting on residents	a result, for example due to noise and vibration; HGV traffic; reduction in air quality; visual impacts		Scheme. Relevant impact area from the edge of the route of the Proposed Scheme is a minimum of 250m in both urban and rural areas unless subsequent analysis from other topic areas suggests a greater or lesser extent at specific locations	function of the resource. Also of relevance is the duration of the impact. **Effect on function** of resource and implications for receptors: • HIGH: Three or more residual significant other effects • MEDIUM: Two significant residual other environmental effects The in-combination assessment will only consider the in-combination significant residual effects from other topics so the LOW and NEGLIGIBLE categories are not considered to be applicable with regards to magnitude of impact. Potentially other topic effects[6] could include relevant elements of: air quality; landscape and visual; sound, noise and vibration (SNV); and traffic and transport (in terms of impacts of HGV (construction traffic) movements[7]). **Duration**: The duration of the impact should be taken into account. Generally speaking where duration is less than six months it may be appropriate to reduce the magnitude of the impact below the initial effect thresholds. **Possible variations**: Where the number of dwellings affected is a high proportion of the size of a local community it may be appropriate to adjust the magnitude of impact.	

[6] Some of the other topics will not assess all community resources potentially susceptible to in-combination impacts. For the community resources which fall into this category, the community assessor should liaise with the relevant topic assessors who can provide expert judgement on whether there is likely to be a residual significant effect.

[7] The HGV (construction traffic) movements' assessment assesses routes to be used by HGV construction traffic which will be significantly affected by the Proposed Scheme. Assessors should identify and map community resources whose sensitivity is considered susceptible to HGV construction traffic flows.

Theme	Impacts	Effects:		Spatial scope	Magnitude of impact	Sensitivity of receptors/resources
		On resources	On receptors			
	1.3 Isolation of residential properties from other properties and infrastructure[8]	Physical e.g. islanding or isolation of resource	Social and community functioning/ integrity is damaged	Anticipated to cover some households up to 1km from the route and construction sites and depending upon specific context and proposals.	At least five properties need to experience an effect for a resource to potentially experience a community impact. • HIGH: – Isolation (>12 months) of residences from their communities and services covering many of the other properties and/or much of the infrastructure that they typically connect with/access on an at least weekly basis. Occurs as a result of either road closure and/or lengthy delay/disruption to journeys on at least a weekly basis. Can also occur as a visual barrier due to construction works surrounding residential dwellings. – Isolation (6 to 12 months) of residences from their communities and services covering many of the other properties and/or much of the infrastructure that they typically connect with/access on an at least daily basis. Occurs as a result of either road closure and/or lengthy delay/disruption to journeys on at least a daily basis. Can also occur as a visual barrier due to construction works surrounding residential dwellings. • MEDIUM: – Isolation (> 12 months) of residences from their communities and services leaving them partially isolated from some of the other properties and/or infrastructure that they typically connect with/access on an at least a weekly basis. Occurs as a result of either road closure and/or moderate delay/disruption to journeys on at least a weekly basis. Can also occur as a visual	• HIGH: – No comparable and accessible alternatives exist within the relevant catchment area – Resources/receptors have no or very little ability to absorb the change – With a high proportion of more vulnerable user groups, e.g., children, elderly, disabled. • MEDIUM: – Limited comparable and accessible alternatives exist within the relevant catchment area – Resources/receptors have limited ability to absorb the change – With a mix of user groups • LOW: – Many comparable and accessible alternatives exist within the relevant catchment area – Resources/receptors has sufficient means and capacity to absorb the change – A narrow population of users with no specific vulnerable groups where access is a key issue; or a general mix of users

[8] This type of impact is different from the severance impacts assessed in the traffic and transport topic, which are focused solely on impacts on journeys.

Theme	Impacts	Effects:		Spatial scope	Magnitude of impact	Sensitivity of receptors/resources
		On resources	On receptors			
					barrier due to construction works surrounding residential dwellings. – Isolation (6-12 months) of residences from their communities and services leaving them mostly isolated from some of the other properties/infrastructure that they typically connect with/access on a weekly basis. Occurs as a result of road closure or moderate delay/disruption to journeys on a weekly basis. Can also occur as a visual barrier due to construction works surrounding residential dwellings. – Isolation (1 to 6 months) of residences from their communities and services leaving them mostly isolated from some of the other properties and/or infrastructure that they typically access on a daily basis. Occurs as a result of road closure or moderate delay/disruption to journeys on at least a daily basis. Can also occur as a visual barrier due to construction works surrounding residential dwellings. • LOW: – Isolation (> 12 months) of residences from their communities and services from a small number of the other properties and/or amount of infrastructure that they typically connect with/access on a weekly (or less frequent) basis. Occurs as a result of either road closure or minor delay/disruption to journeys. – Isolation (1-12 months) of residences from their communities and services leaving them partially isolated from a small number of the other properties and/or amount of infrastructure that they typically connect with/access on a weekly (or less frequent) basis. Occurs as a result of either road closure or minor delay/disruption to journeys. Can also occur as a visual barrier	

Theme	Impacts	Effects:		Spatial scope	Magnitude of impact	Sensitivity of receptors/resources
		On resources	On receptors			
					due to construction works surrounding residential dwellings. – Isolation (< 1 month) of residences from their communities and services partially isolated from a small number of the other properties and/or infrastructure that they typically access on a weekly (or less frequent) basis. Occurs as a result of road closure or minor delay/disruption to journeys. Can also occur as a visual barrier due to construction works surrounding residential dwellings. • NEGLIGIBLE: – No long term isolation (> 12 months) of any residences from their communities and services from the other properties and/or infrastructure that they typically connect with or access on an infrequent basis. There may be short delay/disruption to routes to access services. Can also occur as a visual barrier due to construction works surrounding residential dwellings. – Isolation (1-12months) of any residential properties/communities from a small number of the other properties and/or infrastructure that they typically access on an infrequent basis. There may be short delay/disruption to routes to access services. Can also occur as a visual barrier due to construction works surrounding residential dwellings. – Isolation (< 1 month) of any residential properties/communities from a small number of the other properties and/or infrastructure that they typically access on an infrequent basis. There may be short delay/disruption to access services. Can also occur as a visual barrier due to construction works surrounding residential dwellings.	

Theme	Impacts	Effects:		Spatial scope	Magnitude of impact	Sensitivity of receptors/resources
		On resources	On receptors			
					Possible variations: Where the number of dwellings affected is a high proportion of the size of a local community it may be appropriate to adjust the magnitude of impact. Assessors should review traffic and transport assessments of severance and journey delays to check for consistency with findings. These assessments are anticipated to be helpful for context and issues.	
2. Community infrastructure, recreation infrastructure and open/play space	2.1 Infrastructure lost due to land required for construction or operation of the Proposed Scheme in part or in whole	Decline in facilities available for community use or temporary impairment of use	Loss of facilities and benefits for users, workers owners, and groups/ organisations. Any differential equality and health effects are reported in the health section of the ES or in the EQIA Report.	Direct land required by the Proposed Scheme	Below are details of characteristics (function and duration) typically associated with each magnitude of impact. Depending on the nature of the impact, the weight given by the assessor to each characteristic will vary so that it is not necessary that the assessed degree of impact takes account of both thresholds given under each magnitude. • HIGH: – Function/ability to absorb: Resource is completely closed/compromised and unusable for its intended purpose(s) – Duration: Long term (>1 year)/permanent • MEDIUM: – Function/ability to absorb: Resource is partially closed/compromised and unusable for a proportion of its intended purposes – Duration: Medium term (6 months to 12 months)	Below are details of characteristics typically associated with each sensitivity of impact: • HIGH: – No comparable and accessible alternatives exist within the relevant catchment area – Highly or regularly used and valued resource • MEDIUM: – Limited comparable and accessible alternatives exist within the relevant catchment area – Moderately or semi-regularly used and valued resource • LOW: – Many comparable and accessible alternatives exist within the relevant catchment area – Sparingly or infrequently used and valued resource

Theme	Impacts	Effects:		Spatial scope	Magnitude of impact	Sensitivity of receptors/resources
		On resources	On receptors			
					• LOW: – Function/ability to absorb: Resource is compromised and its functionality is partly impaired or compromised – Duration: Short term (1 month to 6 months) and reversible • NEGLIGIBLE: – Function/ability to absorb: Resource is not closed and can continue to be used for its intended purpose without any significant inconvenience or detriment to the users – Duration: Short term (<1 month and fully reversible)	Possible variations: It may be appropriate to vary sensitivity if receptors have limited ability to absorb change
	2.2 In-combination effects of noise and vibration, HGV traffic, air quality and visual impacting on community infrastructure operations	Character or quality of cities/towns/ neighbourhoods/ paths changes as a result of noise and vibration; HGV traffic; reduction in air quality; visual impacts	Receptors' enjoyment of resource is changed. Any differential equality and health effects are reported in the health section of the ES or in the EQIA Report.	Relevant impact area from the edge of the route of the Proposed Scheme is a minimum of 250m in urban and rural areas unless subsequent analysis from other topic areas suggests a greater or lesser extent at specific locations	The primary test of magnitude will be the nature of the effects on the function of the resource. Also of relevance is the duration of the impact. Effect on function of resource and implications for receptors: • HIGH: Three or more residual significant other effects • MEDIUM: Two significant residual other environmental effects The in-combination assessment will only consider the in-combination significant residual effects from other topics so the LOW and NEGLIGIBLE categories are not considered to be applicable with regards to magnitude of impact. Potentially other topic effects could include relevant elements of: air quality; landscape and visual; sound, noise and vibration; and traffic and	Below are details of characteristics typically associated with each sensitivity of impact: • HIGH: – There are limited/no comparable and accessible alternatives that exist within the relevant catchment area – Resource/receptor has limited ability to absorb the change (e.g. this may be applicable for quiet gardens, quiet/solitary natural beauty spots, etc.) – Highly or regularly used and valued resource • MEDIUM: – There are limited comparable and accessible alternatives within the relevant catchment area

Theme	Impacts	Effects:		Spatial scope	Magnitude of impact	Sensitivity of receptors/resources
		On resources	On receptors			
					transport (in terms of impacts of HGV (construction traffic) movements. **Duration**: The duration of the impact should be taken in to account. Generally speaking where duration is less than 6 months it may be appropriate to reduce the magnitude of the impact below the initial effect thresholds.	– Resources/receptors have limited ability to absorb the change. – Moderately or semi-regularly used and valued resource • LOW: – Resource/receptor are able to relatively easily absorb the change (e.g. this may be applicable for active recreational sports fields and grounds and open spaces) – There are many comparable and accessible alternatives exist within the relevant catchment area. – Sparingly or infrequently used and valued resource
	2.3 Isolation of community infrastructure from other properties and infrastructure[9]	Physical e.g. Islanding or isolation of resource	Social and psychological e.g. communities' integrity is damaged.	Catchment area of affected resource where it is subject to severance	• HIGH: – Isolation (>12 months) of services from its community covering much of the relevant local community that it typically serves on at least a weekly basis. Occurs as a result of either road closure and/or lengthy delay/disruption to journeys on at least a weekly basis. Can also occur as a visual barrier due to construction works surrounding community infrastructure. – Isolation (6 to 12 months) of services from its community covering much of the relevant local community that it typically serves on at least a daily basis. Occurs as a result of either road closure and/or lengthy delay/disruption to journeys on at least a daily basis. Can also occur as a visual barrier due to construction	• HIGH: – No comparable and accessible alternatives exist within the relevant catchment area – Resources/receptors have limited ability to absorb the change – With a high proportion of more vulnerable user groups, e.g., children, elderly, disabled • MEDIUM: – Limited comparable and accessible alternatives exist within the relevant catchment area

[9] This type of impact is different to the severance impacts assessed in traffic and transport topic assessment, which are focused solely on impacts on journeys.

Theme	Impacts	Effects:		Spatial scope	Magnitude of impact	Sensitivity of receptors/resources
		On resources	On receptors			
					works surrounding community infrastructure. • MEDIUM: – Isolation (> 12 months) of services from its community leaving it partially isolated from some of the relevant local community that it typically serves on at least a weekly basis. Occurs as a result of either road closure and/or moderate delay/disruption to journeys on at least a weekly basis. Can also occur as a visual barrier due to construction works surrounding community infrastructure. – Isolation (6-12 months) of services from its community leaving it mostly isolated from some of the relevant local community that it typically serves on at least a weekly basis. Occurs as a result of road closure or moderate delay/disruption to journeys on an at least a weekly basis. Can also occur as a visual barrier due to construction works surrounding community infrastructure. – Isolation (1 to 6 months) of services from its community leaving it mostly isolated from some of the relevant local community that it typically serves on at least a daily basis. Occurs as a result of road closure or moderate delay/disruption to journeys on at least a daily basis. Can also occur as a visual barrier due to construction works surrounding community infrastructure. • LOW: – Isolation (> 12 months) of services from its community leaving it partially isolated from a small part of the relevant local community that it typically serves on a weekly (or less frequent) basis. Occurs as a result of either road closure or minor delay/disruption to journeys. Can also occur as a visual barrier	– Resources/receptors have limited ability to absorb the change – With a mix of user groups • LOW: – Many comparable and accessible alternatives exist within the relevant catchment area – Resource/receptor are able to relatively easily absorb the change – A narrow population of users with no specific vulnerable groups where access is a key issue; or a general mix of users

Theme	Impacts	Effects:		Spatial scope	Magnitude of impact	Sensitivity of receptors/resources
		On resources	On receptors			
					due to construction works surrounding community infrastructure. – Isolation (1-12 months) of services from its community leaving it partially isolated from some of the relevant local community that it typically serves on a weekly (or less frequent) basis. Occurs as a result of either road closure or minor delay/disruption to journeys. Can also occur as a visual barrier due to construction works surrounding community infrastructure. – Isolation (< 1 month) of services from its community leaving it partially isolated from some of the relevant local community that it typically serves on a weekly (or less frequent) basis. Occurs as a result of either road closure or minor delay/disruption to journeys. Can also occur as a visual barrier due to construction works surrounding community infrastructure. • NEGLIGIBLE: – No long term isolation (> 12 months) of services from its community that it typically serves on an infrequent basis. There may be short delay/ disruption to routes to access services. Can also occur as a visual barrier due to construction works surrounding community infrastructure. – Isolation (1-12months) of services from its community that it typically serves on an infrequent basis. There may be short delay/ disruption to routes to access services. Can also occur as a visual barrier due to construction works surrounding community infrastructure. – Isolation (< 1 month) of services from its community that it typically serves on an infrequent basis. There may be short delay/disruption to access services. Can also occur as a visual barrier due to construction	

Theme	Impacts	Effects:		Spatial scope	Magnitude of impact	Sensitivity of receptors/resources
		On resources	On receptors			
					works surrounding community infrastructure. Possible variations: Where the number of users is a high proportion of the size of a local community it may be appropriate to adjust the magnitude of impact Assessors should review traffic and transport assessments of severance and journey delays to check for consistency with findings. These assessments are anticipated to be helpful for context and issues.	
3. Presence of Construction Workers	Presence of construction workers with consequent requirements	Increased demand from construction workers	Reduced availability for users, workers, owners, and groups/organisations	Catchment area of affected resources	The number of construction workers along the route and an assessment of: - Estimates of proportion of workers that will be local and commute to work - Estimate of proportion of workers that are expected to reside at worker accommodation sites - Estimate of workers that will chose to find temporary accommodation (e.g. lodgings or bed and breakfast) - Working hours of construction workers and whether workers are likely to reside in construction camps at weekends. - Estimated demand for use of community facilities (e.g. education and health).	Services and accommodation available in the local area that could be used by construction workers and their ability to absorb change in demand/ requirements.

4 Community assumptions

4.1 Introduction

4.1.1 The key assumptions underlying the community assessment are set out below.

4.2 Community assumptions

4.2.1 The assessment will draw on other assessment topics where necessary to identify the primary sources of community impacts. Although the level and intensity of proposed construction will vary during the construction period, the assessment focusses on the construction activities and durations which could lead to the greatest potential impact.

4.2.2 The spatial scope of the assessment will vary, depending on the nature of the receptors and the impacts being considered. Whilst effects associated with construction or the land used for construction/operation will be confined to the immediate vicinity of the route, effects resulting from a combination of impacts or relating to the overall functionality of a community will typically apply to wider areas such as neighbourhoods or parishes.

4.2.3 The community assessment will consider the function of land rather than its ownership as the key parameter for assessing impacts associated with the Proposed Scheme.

4.2.4 The hybrid Bill will identify various categories of land required to facilitate the construction and operation of the Proposed Scheme. Some of these categories of land will have no impact on the ability of existing and future baseline uses of that land to continue both during construction and operation. For example, one category to which this applies is land above the line of tunnels.

4.2.5 Where practicable, land required solely during the construction period will 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.

4.2.6 The assessment will consider the construction phase, including a period of commissioning (2020-26) and the first year of operation (2027), with one exception. For the assessment of in-combination effects, the operational noise assessment will be based upon the service frequency associated with all Phase Two of the Proposed Scheme operating. For other assessment topics, it is generally assumed that effects are unlikely to persist for a long time into the future as communities adjust to the presence of the Proposed Scheme and as new or replacement community facilities will have been developed where necessary.

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

4.2.8 Effects relating to the severance of public rights of way (PRoWs) (public footpaths and bridleways) and highway and pedestrian diversions, are assessed under the traffic and

transport topic. However, where PRoWs are a "promoted" destination in their own right as a recreational resource, they will be considered within the community assessment. Where impacts on open space and PRoWs are considered, these have been informed by open space and PRoW quality and usage surveys, where it has been possible to undertake such surveys. The forms to be completed for surveys of open space quality and usage are set out at Appendix A and B.

4.2.9 Open space surveys will be undertaken by community assessors in order to collect primary survey data on use of such spaces. Assessors will survey each site on one week day during the spring term and one summer weekend day. Surveying will aim to avoid adverse weather conditions and weather conditions were recorded for each survey. Any variations from the above and the reasons for this will be reported on in the individual open space survey records to be included in the Volume 5 Community appendices in the ES.

4.2.10 Where open space is privately owned and not available for use by the general public, it will be excluded from the assessment (e.g. woodlands on farmland). However, where land is privately owned but open for public use (e.g. parks or gardens surrounding country houses) it will be included in the assessment.

4.2.11 The community assessment will report on all significant community effects as well as those effects which are not significant but are considered of importance to reference given their relevance to the study area which represents each CA.

4.2.12 The different assessments within the community section (residential property and community infrastructure affected by land required for construction and operation of the Proposed Scheme, isolation and in-combination effects) are not directly comparable when considering significance of effect. Assessments will be considered in aggregate as part of the community-wide analysis which will be presented in the community section (cumulative impact section) in the CA reports (ES Volume 2).

4.2.13 Isolation effects will be included within the scope of this assessment and the analysis will consider physical separation, major increases in delay/disruption (as identified in the Traffic and transport assessment), and the psychological barrier effects (including those which may be caused by visual barriers, such as residential properties located amongst construction works) that might impair links between residents and their facilities. Isolation is assumed to be a phenomenon that will occur as a result of the construction of the Proposed Scheme and can be either a temporary or permanent effect.

4.2.14 The in-combination assessment will draw on the residual significant effect findings from other topics (i.e. after mitigation has been taken into account by those topics) and combines these findings to determine whether there is a significant in-combination effect on the community. Findings from other topic assessments are not directly comparable in terms of the specific scale of effect.

4.2.15 Increases in HGV construction traffic flows as a result of construction of the Proposed Scheme will affect the amenity of local communities. Community assessors should obtain this information from the Traffic and transport assessment. This aspect of the assessment is concerned with the presence of HGV on highways and their proximity to community resources.

4.2.16 Information on duration of significant residual effects will be provided by other topics where available. Where the relevant information is available, community assessors will use this identify when significant residual effects from other topics occurred simultaneously.

4.2.17 Professional judgement will be provided by other topics (i.e. sound, noise and vibration (SNV), landscape and visual and air quality) to inform the in-combination assessment. Any significant effects findings established through professional judgement will be used in the same way as assessment findings derived through quantitative assessment.

4.2.18 The SNV topic assumes all PRoW (with the exception of those that exist in tranquil areas) to be, by their nature, transitory routes with users not staying in any one location for a long period of time and hence these PRoW will not be included within the SNV assessment scope. Consequently, noise effects on PRoW will not be considered to be significant (unless the assessment identifies significant SNV on areas prized for their tranquillity and hence the PRoW therein) as a result of construction and operation of the Proposed Scheme.

4.2.19 The assessment methodology will exclude, for the purposes of reporting in-combination effects, residential properties where the total number of dwellings is fewer than five. There will be a number of individual properties scattered along the route where impacts may be experienced from other topics. These impacts will be assessed, where relevant, in other topic sections.

4.2.20 Residential properties which will be impacted by the Proposed Scheme will be grouped together either by street, hamlet or village. In some circumstances along the route other topics, such as sound, noise and vibration (SNV), will group residential properties slightly differently. In these situations, community assessors will liaise with the relevant topic to determine professional judgement with regards to the residential grouping.

4.2.21 The community assessment will consider three different types of cumulative effects. These are inter-project, in-combination (amenity) and community-wide (synergistic), as described in Section 9 of the SMR.

4.2.22 Community resources identified as part of inter-project (cumulative) schemes may interact with the Proposed Scheme during their construction and as a result of their occupation by new receptors during the time when the Proposed Scheme is being constructed and beyond.

4.2.23 During their construction, cumulative projects have the potential to create their own environmental impacts. Additional air quality, dust, HGV traffic movements and SNV impacts risk compounding those effects generated by the Proposed Scheme. However, given these projects are far into the future, a lack of information prevents any assessment of effect being undertaken.

Appendix A: Open Space Quality Survey Form

Name of site		**Observer**	
Location/address		**Observer organisation**	
OS map reference		**Package**	
Owner/manager organisation		**Type**	
Access type		**Entry points**	

A. Facilities on site

	Tick box	**Description and comment on quality (excellent, good, fair, poor)**
Children's play area (LEAP, NEAP, LAP, water play. Adventure play, skate park)		
Cultural or heritage asset (e.g. public art, stately home, sculpture)		
Multi use games area		
Urban farm, animals		
Other sports facilities (specify sports type, sport, number size scale)		
Litter bins		
Café/pub/restaurant		
Signage and way finding		
Visitor centre/education facility		
Benches/seating/picnic areas		
Car parking/cycle space		
Lakes/water/ponds		
Toilets/changing rooms		
Other facilities/assets (specify)		

B. Determine magnitude of impact – to be completed prior to visit

Summarise impact in terms of land take, amenity, severance, construction activities	
Proximity to effect (distance from route, station, construction, depot, holding area)	
Extent of impact	
Permanent or temporary	

Other local factors that may affect the magnitude of impact		
C. Determine sensitivity of resource and receptors		
Size of open space		
Quality of open space		
Quality	**Score 1 (poor) to 5 (good)**	**Comment**
Graffiti and vandalism		
Dog fouling and litter		
Management and maintenance		
Quality of seating		
Overall quality of facilities on site		
Lines, markings and posts (sporting facilities only)		
Overall cleanliness		
Welcoming (gateway entrances, signage, accessibility for user types)		
Security (CCTV, sense of security, natural surveillance, presence of wardens/police)		
Local context		
Urban, rural, town centre, residential neighbourhood		
Broad user pattern (tourist/visitor attraction, everyday amenity, events)		
Classifications/standards (e.g. environmental designations or awards such as Green Flag)		
Management/stakeholders, other groups/organisations (e.g. Forestry Commission, National Trust, friends of groups)		
Surrounding linked features		
Availability of alternatives in walking distance		
Catchment		
Overall sensitivity rating		

Appendix B: Open Space User Form

Date of observation							Time of observation						
Day							Duration of observation						
Weather conditions							Observer ID & organisation						
Season							Term time/out of term						
Activity type	Informal recreation						Formal/organised active recreation						Total
	Walking/ dog walking	Running	Cycling	Sitting/ relaxing/ picnicking	Child play area	Other (specify)	Pitch based sport[10]	Court based sport[11]	Golf/ putting	Water based sport[12]	Noisy sport[13]	Other	
No. people observed													

[10] e.g. football, cricket, rugby.
[11] e.g. tennis, squash, bowls.
[12] e.g. swimming, sailing, canoeing, fishing/angling, boating.
[13] e.g. go carting, motor cross, quad biking.

Annex D: Cultural heritage – technical notes

The following technical notes are contained in this Annex:

- Assessment of the historic landscape character; and
- Risk based approach to prioritising archaeological surveys.

HS2 Phase 2a West Midlands to Crewe: Technical note – Cultural heritage - Assessment of the Historic Landscape Character

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1 Introduction

1.1 The historic landscape and HS2

1.1.1 Engagement with consultees following the submission of HS2 Phase One Environmental Statement (ES) identified an opportunity to enhance the Phase 2a ES by investigating new ways to consider how we understand the effects of the Proposed Scheme on the historic landscape. This technical note provides a methodology for undertaking the assessment of effects on historic landscape.

2 Background

2.1 Historic Landscape Characterisation

2.1.1 Historic Landscape Characterisation (HLC) was a national programme sponsored by English Heritage (now Historic England) and carried out in partnership with local government archaeological services at county, unitary authority and National Park level. The principles behind HLC are straightforward, in that it is concerned with mapping the historic dimension of the present day landscape to be comprehensive and not selective (no blank spaces) and to view areas, not individual sites. The key principles of HLC are that:

- projects are desk-based studies using Geographical Information Systems (GIS) and historic maps;
- the landscape is assessed by looking at all its major component features (for example fields, woodland, parklands, industry and urban areas) and by determining their origin and development through morphological analysis supported by documentary evidence, aerial photographs, historical mapping and chronological editions of Ordnance Survey maps; and
- the information gained is mapped as HLC types and recorded in GIS. This results in the production of multifaceted maps that enables sophisticated analysis and interpretation of the predominant historic character.

2.1.2 The HLC methodology records only historic patterns that are visible within the present day landscape. By examining the differences between early and modern cartographic sources it is possible to map and assess change within the landscape through time - the 'time depth' that survives in the modern landscape (see explanation in Section 2.2 below). Of note is that HLC projects represent a picture of the landscape at the time of their completion; some of the earliest projects were undertaken in 1993/94. HLC principles, method and a variety of applications are presented in Clark, J., Darlington, J. & Fairclough, G. 2004[1].

2.1.3 The HLC methodology has developed during the course of the national programme, with changes to the methodology applied by different counties. This applies in part to the mapping used, for example the Kent HLC programme used the first edition

[1] Clark, J., Darlington, J. & Fairclough, G. 2004, *Using Historic Landscape Characterisation,* London: English Heritage / Lancashire County Council.

Ordnance Survey mapping, whereas later projects such as Buckinghamshire also made use of earlier cartographic sources. The major conurbations of England (those formerly covered by 'metropolitan' county councils) have been covered by a form of HLC. The approach is exactly the same as for rural landscapes, but the projects use character types which are appropriate to the urban character of the area, and are at a larger scale that reflects the complexity of urban evolution from settlement origins to present day. Examples of HLC projects are available on- line through the Archaeology Data Service Historic Landscape Characterisation archives.[2]

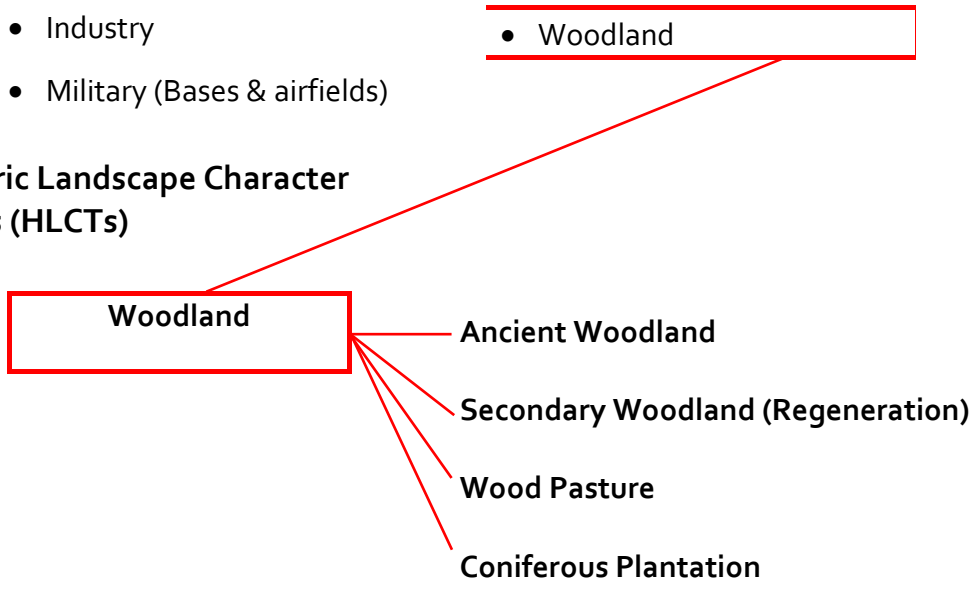
2.2 Existing HLC Methodology

General approach

2.2.1 Despite the variations in methodology there are elements that are common to all HLC projects. There is a data hierarchy, firstly landscape is classified into broad character types and further elaborated into more detailed historic landscape character types (HLCTs):

Broad Types:

- Enclosures (Fields)
- Designed Landscapes
- Land Use
- Industry
- Military (Bases & airfields)
- Recreation
- Settlement
- Water (canals, lakes)
- Woodland



Time depth

2.2.2 HLC is also concerned with 'time depth' in the landscape. Time depth can be defined as the landscape changes associated with different eras which affect and change the landscape. The HLC seeks to record previous episodes of land use which contribute to the character of landscape but which are not the dominant HLCT. An example of this is fossilised strip fields, fields which have enclosed the pattern of former 'strips' or land

[2] Archaeology Data Service Historic Landscape Characterisation archive. http://archaeologydataservice.ac.uk/archives/view/HLC/

parcels from medieval/post medieval open fields. Where relict elements survive within the historic landscape, such as ridge and furrow earthworks, these are sometimes recorded as attributes within the HLC database. This helps to build up a picture of the complex interaction between people and place and time.

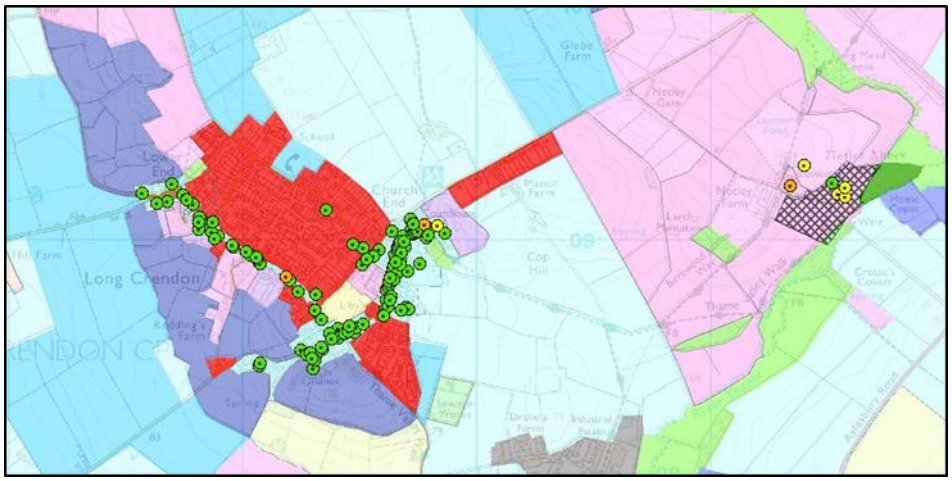
2.2.3 HLC is concerned with the totality of the present day landscape, not merely the special or the unique. As with any characterisation, it is relatively broad brush and is designed to be used at a landscape scale and to provide a greater understanding of the setting and context of individual places and sites.

2.3 The value of assessing the historic landscape

2.3.1 The mapping and character information produced by assessing the historic landscape supports and supplements existing heritage asset data. This assists in identifying what characteristics make each place special and distinct as well as providing a stronger baseline for the ES.

Figure 1: Landscape with cultural heritage designation data – Listed Buildings and Scheduled Monument (hachured area)

Figure 2: An example of HLC data overlain



Designation and Characterisation

2.3.2 Characterisation can provide context to designated sites and elaboration of wider landscape (Figures 1 and 2). Designated assets by their very nature are selective, and, in isolation, may not necessarily contribute to the overall story of landscape development.

Scheduled Monuments

2.3.3 Individual schedule entries, particularly more recent updated entries, can provide guidance about the sensitivity of particular locations, but the pattern revealed by plotting them all is limited and unrepresentative as a representation of the wider historic environment. The value of the pattern is limited as the schedule is invariably composed of comparatively small entities, definable sites which rarely have a significant impact at a landscape scale. With some exceptions, such as deserted medieval villages (DMV), large earthwork sites, and scheduled built heritage, most of the scheduled monuments are not readily visible and consequently, whilst in their own terms significant, have more limited influence on the historic landscape as most people perceive it. It has been estimated that only 3% of recorded archaeological sites in England are protected by scheduling[3]. Even at best the schedule is limited by current archaeological knowledge and may alter as new sites are discovered. These missing elements undermine any attempt to derive meaningful patterns from the scheduled monument distribution.

Listed Buildings and Conservation Areas

2.3.4 A distribution of listed buildings provides some indication of the historic settlement pattern with a given area, although it is noted that the post-1600 date of most listed buildings limits this. As with scheduled monuments, this pattern must be treated with caution. The process of listing is reactive and despite useful programmes of thematic survey and similar, gaps on maps do not necessarily equate with voids in the historic resource. Equally apparent clustering of entries can be enhanced by multiple components relating to a single holding. Similarly, conservation areas represent clusters of designations. However, the same care must be taken around biases as with listed buildings, and it should be noted that not all assets within a conservation area are of heritage significance.

Registered Battlefields and Registered Parks and Gardens

2.3.5 As landscape scale assets in their own right, these tend to be integrated into a broader understanding of the historic landscape as a part of their designation. Holistic views of the landscape can contribute to the understanding of their historic development, particularly with reference to surviving landscape features established when the boundaries of parks fluctuated as land was acquired or divested.

[3] Darvill and Fulton, 1995, *The Monuments at Risk Survey of England (MARS)* (English Heritage).

HLC and the European Landscape Convention

2.3.6 Consideration of historic landscape character is also of value for its own sake, allowing a more robust base line. The HLC approach accords with the tenets of the European Landscape Convention which defines landscape as 'an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors'[4]. The Convention states (Article 2 – Scope) that it covers natural, rural, urban and peri-urban areas. It includes land, inland water and marine areas. It concerns landscapes that might be considered outstanding as well as every day or degraded landscapes. Historic landscape is defined both by people's perceptions of the evidence of past human activities in the present landscape and the places where those activities can be understood in the landscape today. This definition highlights the role of perception and emphasises the rich cultural dimension implanted in landscape character by several millennia of human actions. The Convention's aspirations are to help create high quality landscapes for the future; their historic character will be an important part of that quality[5].

HLC and Landscape Visual Impact Assessment

2.3.7 HLC has a direct relevance to Landscape and Visual Impact Assessment (LVIA).The latest LVIA guidelines, issued by the Landscape Institute, have specifically stressed the importance of HLC contributing towards the baseline of Landscape Character Assessment (LCA), and the need for collaboration with historic environment specialists to fully understanding how the past has contributed to the character of today's landscape [6]. In response, the HS2 Phase 2a ES landscape and visual assessment has adopted an interdisciplinary approach to the LCA element with a number of topics contributing to the understanding of landscape character, e.g.: topography, geology/soils, natural environment, land use, tranquillity studies as well as cultural heritage.

2.3.8 HLC contributes one component or piece of evidence for LCA, it does not 'double count' or duplicate the cultural heritage assessment within the ES.

2.3.9 In addition, the holistic approach used in LCA, may result in defining landscape character areas that are spatially different to historic landscape character areas (HLCAs). There may, however, be circumstances where boundaries do align, such as the extent of a historic park and garden.

2.4 Using HLC in the ES

2.4.1 Although HLC is a national programme, there is not a definitive methodology. Instead the approach to HLC has been iterative, evolving as the HLC programme has progressed over c. 20 years. Successive projects have built upon previous work, inheriting some approaches while accommodating new ideas and theories. In parallel to this, there has been the increased sophistication and capabilities of GIS software which has enabled newer projects to record more information and capture data at a much more detailed resolution. However, the methodologies employed in HLC

[4] Council of Europe web page. European Landscape Convention Treaty No. 176. http://conventions.coe.int/Treaty/EN/Treaties/Html/176.htm
[5] Highways Agency and Historic England, 2007, *Assessing the Effect of Road Schemes on Historic Landscape Character.*
[6] Landscape Institute, 2013, *Guidelines for Landscape and Visual Impact Assessment* – Third Edition (Landscape Institute IEMA) p. 76 paras 5.9 -5.10

projects in the last ten years have crystallised, with English Heritage (now Historic England) recommending a commonality of approach, advocating a toolkit method for recording character[7].

2.4.2 While this strategy of varied methodologies has been beneficial in developing HLC, there has been criticism of the HLC approach by academics and cultural heritage professionals[8]. Some of the perceived shortcomings include: a lack of consistency in the quality of data; subjective interpretation by the mapper or digitiser and disparity in resolution of data capture between HLC projects, making reconciliation of the data difficult. This last point is particularly germane when using existing HLC project data as an evidence base for strategic road and rail projects, whose routes may require the use of data from several HLC projects.

2.4.3 Simple replication of HLC polygons within the ES will result in the processing of large quantities of data for relatively limited knowledge benefit, and will result in an overly simplistic list of significant effects without space to articulate more nuanced variations in historic landscape character. As with the HLC methodology, there is no definitive approach to understanding the impact on the historic landscape character. Examples of HLC integration undertaken have been experimental and iterative, including the Stansted Milton Keynes Growth Area Study[9].

2.4.4 For consolidating HLC as consistent baseline, data needs to be rationalised, along with the creation of a hybrid system of historic landscape types. A starting point is the evaluation of the county HLC datasets to establish common themes that are translate at a regional level HS2 route. There are precedents where this integration has been successfully applied; a number of previous studies include Chilterns Historic Landscape Characterisation Project (Green 2009)[10] which involved integrating data from Buckinghamshire, Hertfordshire and Bedfordshire and a regional HLC for the East of England, completed by Wessex Archaeology in 2009. The Staffordshire and Cheshire County HLC projects are two of the more recent ones to be completed, and adopted a more consistent approach to their methodologies.

2.4.5 Building on this past work, Section 3 defines a revised methodology to better understand the impact of HS2 Phase 2a on the historic landscape.

3 Methodology for understanding historic landscape within the Phase 2a ES

3.1 Introduction

3.1.1 The approach uses a character based method. As HLC projects are large datasets with many records, the ES will 'group up' HLC types and use professional judgement to consider broad landscape areas which mirror the approach to landscape character assessment (LCA). These historic landscape character areas (HLCAs) are broad

[7] Aldred, O. & Fairclough, G. 2003, *Historic Landscape Characterisation: Taking Stock of the Method.* (London: English Heritage / Somerset County Council).
[8] Williamson, T. 2007, 'Historic Landscape Characterisation: some queries' in: *Landscapes* 8 (2). pp. 64-71.
[9] Green, D. & Kidd S., 2004, Milton Keynes South Midlands Growth Study, (English Heritage).
[10] Green, D. 2009, *Chilterns Historic Landscape Characterisation* (Chiltern Conservation Board, Buckinghamshire County Council, English Heritage).

statements or descriptions of an area enabling consideration of HLCA value and assessment of impact and significance of effect of the Proposed Scheme in accordance with the Phase 2a Scope and Methodology Report (SMR)[11].

3.1.2 No additional data gathering beyond that under the Phase 2a Scoping and Methodology Report will be required.

3.2 Defining Historic Landscape Character Areas (HLCAs)

3.2.1 HLCAs are distinct heritage assets from archaeological remains and historic buildings in that they are concerned with history and character on a larger landscape scale. HLCAs provide a focus on managing change to historic landscape character, ensuring that design choices are taken with an awareness of the needs of a scheme to integrate with and, if possible, enhance the local historic landscape character.

Key considerations

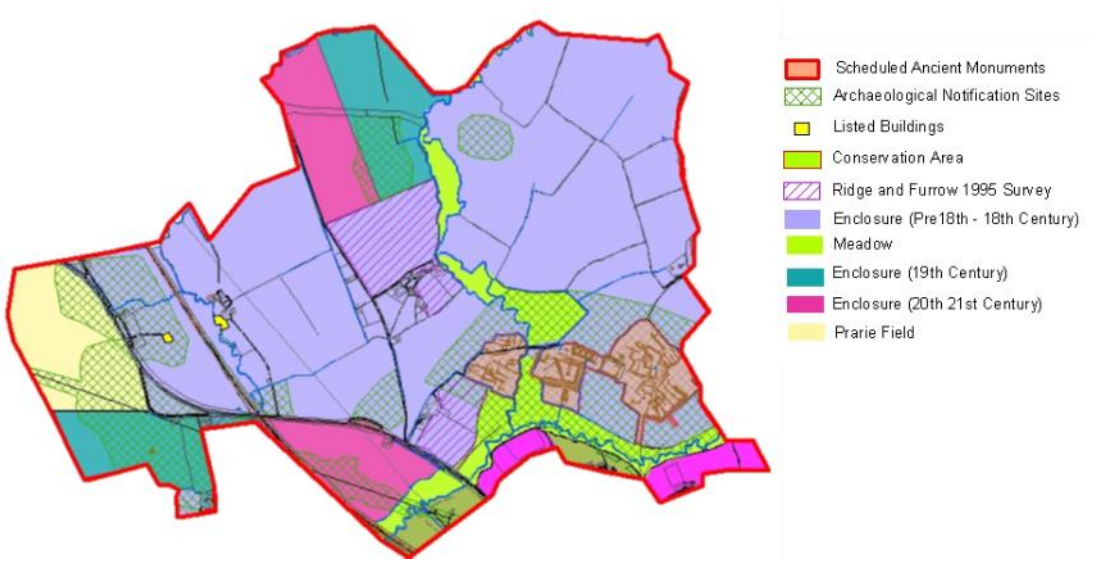
3.2.2 HLCAs will be determined where the historic landscape has broadly distinct area of homogeneity (and in some cases areas of heterogeneous landscape where the countryside has greater diversity).

3.2.3 In terms of scale, an intelligent, flexible approach is advocated. Professional judgement will dictate the scale of the areas. Extents either side of the centreline should be followed to their natural extents. The entire area within the land required for the Proposed Scheme should be characterised in this way, although it is accepted that some defined areas will not be of sufficient heritage value to warrant further consideration.

3.2.4 The boundaries of HLCAs will not always correspond to boundaries between HLC categories because areas are defined either where landscape is generally homogeneous (e.g. extensive areas of parliamentary enclosure) or where it displays similar patterns of diversity as a result of common historical processes (e.g. areas of old enclosures fragmented by 'prairie fields' with relict islands of medieval woodland). Other information gleaned from historical sources such as the extent of parishes, the boundaries of estates, designed landscapes, forests and the influence/presence of historic buildings and archaeological sites /monuments also have a bearing on the definition of HLCAs. In some cases HLCAs may not be predominantly influenced by factors such as topography and geology and for this reason HLCAs will sometimes differ from Landscape Character Areas LCAs, although these physical factors influence agriculture, industry and settlement and there will often be broad agreement between the approaches. Figure 3 is an example of a Historic Landscape Character Area (HLCA) defined by the similarity of character types.

[11] Scope and Methodology Report, Volume 5: Appendix CT-001-001.

Figure 3: This HLCA defines surviving Pre 18th century enclosures are contemporaneous with the Scheduled Monument earthworks of DMV and Manor House ©Bucks County Council & OS Copyright



3.2.5 The precision of boundaries drawn around HLCAs varies with the scale and level of detail of the assessment. As with Landscape Character Assessment, rather than a hard line demarcating places, these boundaries should be seen providing an approximation or guide to where one character area changes from the next.

3.2.6 As part of the programme of validation of heritage assets through field survey, there may be opportunity to identify or validate potential HLCAs. This will specifically focus on:

- making refinements to HLCA boundaries;
- recording landscape character; and
- assessing the sensitivities and strength of historic landscape character to inform the ES process.

3.2.7 The HLCA should contribute to the historical dimension of a LCA. There should be collaboration with the landscape and visual assessment team so that the there is an initial broad understanding of the Landscape Character Areas (LCAs), as well as helping the landscape team obtain an understanding of the historic features within the landscape.

Methodology to develop HLCA polygons

3.2.8 This requires the defining those elements which represent evidence for time-depth within a given historic landscape character area. An understanding of a unique HLCA is drawn primarily from:

- historic mapping including tithe maps and first edition Ordnance Survey;
- Cheshire and Staffordshire HER data;
- project specific data drawn from aerial photography, LiDAR and fieldwalking research;

- a review of existing LCA boundaries/typologies; and
- the reconciled Cheshire and Staffordshire Historic Landscape Characterisation datasets (Appendix 1).

3.2.9 From these sources, the author should identify the boundaries of the HCLA based on an analysis of overall historic development trends based on the following factors:

- historic landscape development processes (e.g. enclosure of a certain period, emparkment, industrial development);
- use of high level attributes of HER and other heritage data;
- homogeneity of dominant HER Historic Landscape types (i.e. field types, settlement types); and
- professional judgement.

3.3 Reporting the baseline

3.3.1 Baseline assessment will be carried out as a text based study within a pro-forma table (Table 1, below) which evaluates the key characteristics for a number of categories to achieve a rounded picture of the historic environment. This includes both designation and characterisation data, along with some initial statements on heritage value directed by conservation principles. These will be reported in an HLCA map sheet which will be included within the technical appendices to the ES (Volume 5).

Table 1: Example of HLCA table

Name of HLCA
Key Characteristics
[An integrated bullet point summary of key characteristics of each HLCA this includes significant and non-significant elements] • **18th century Parliamentary Enclosure Landscape** • **Medieval Ridge and Furrow of Regional Significance** • **Roman Villa (Scheduled Monument)** • **Medieval Holy Well of St Catherine**
Description:
Narrative description of the HLCA, and justification for its definition, to include the physical landscape, landuse and form, extant elements which contribute to the time depth of the HLCA, a brief discussion of its history. Discussion of below ground archaeological remains/evidence is not required, unless it informs the existing landscape. Discussion of the heritage values of the landscape is required : The Barsetshire Valley is likely to have provided a focus for settlement from prehistoric times. It is a historically distinct area which has traditionally been defined to the north by the higher claylands rising towards Hoy, and to the south by the Tun Brook. Two Roman roads traverse this area. Medieval evidence is focused on the villages, surviving patches of ridge and furrow cultivation and, on the extreme eastern edge of the area, around the site of St.Catherines Holy Well from where there are good views of the historic town of Hogglestock. About a third of this landscape has retained features of a pre 18th century landscape. This is mainly in the form of meadows adjacent to the river but also some pre 18th century enclosure mainly around the villages of Houghton and Stoughton. There is also a small area of fossilised strips (as fields) to the south of Stoughton. Later enclosure is predominantly parliamentary enclosure in the west of the area. There are also scattered fragments of 20th century fields. Recently large areas of prairie farming have been created around Houghton. There is also a golf course on the sloping valley side, to the south of Stoughton. There are conservation areas and listed buildings in

Name of HLCA
the small villages of Stoughton and Houghton; the later comprises a nucleated row set along the Roman road linking to Barcester. The dismantled Silverbridge- Greshambury Junction railway runs along the valley. The value of this landscape is in its illustration of the changing nature of settlement within a distinct river valley. The multiple phases of settlement visible as extant elements within this relatively constrained landscape, including Roman roads, medieval ecclesiastical sites and village, reflect the valley as a transit corridor and valued resource. The later prairie farms are of less value, and are not considered to contribute to the historical and illustrative values of this HLCA.

3.4 Assessing impact and effect on HLCAs

Principles

3.4.1 Assessment follows the landscape character assessment approach: this can apply both to the individual components i.e. receptors within each HLCA e.g. a historic building, monument, or be applied to the sum of its parts (the HLCA including historic landscape character). For the purposes of this methodology, the assessment will be carried out at the HLCA level.

3.4.2 The recent revision to the Landscape Institute Landscape and Visual Impact Assessment guidelines has adopted a new approach to reporting on the significance of the identified effects, which places emphasis on clear accessible explanations that draw out the key issues and ensure that the significance of the effects are understood. The recent methodology has moved away from complex matrices or tabular summaries of effects and more weight given to narrative text describing the landscape and visual effects[12] . This approach is deemed to be more helpful to non-experts in aiding the understanding of the issues.

3.4.3 The following should, be discussed within the narrative assessment of the effect on the HLCAs: the value of the HLCA (derived from its value based upon the criteria for valuing Heritage Assets in the SMR and professional judgement); the magnitude of impact (derived from the specifics of the project proposals within the HLCA, their reversibility and duration); and a discussion of the resulting significance of effect. These assessments should be included within the technical appendices to the ES (Volume 5).

Value of the HLCA

3.4.4 The heritage value(s) of the HLCA will be articulated in line with the HS2 Phase 2a SMR and professional judgement. Key attributes that contribute to this value are defined through the Conservation Principles[13] as follows:

a. Evidential - intactness of historic landscape assets, defines the types of historic elements surviving in the area;

b. Aesthetic - significance encompasses all the sensory responses generated by a place or object;

[12] Landscape Institute 2013 *Guidelines for Landscape and Visual Impact Assessment* – Third Edition. p.41.
[13] Historic England, 2008, *Conservation Principles: Policy and Guidance for the Sustainable Management of the Historic Environment*.

c. Communal - significance encompasses the collective sense of attachment to a place or object that is felt by a group of people;

d. Historical and Cultural Associations - significance relates to the value of a place's association with important historical events and themes, eras, patterns of use and development or individual people. It incorporates the history of aesthetics, artistic and literary, architecture, archaeology, science and society, so it overlaps (or underlies) the other categories of cultural heritage significance; and

e. Research potential - significance relates to the technical achievements associated with a place, or to its educational potential. It also encompasses places important to furthering the understanding of the natural and altered environment, and the embodiment of heritage research;

3.4.5 Each of the attributes a) to e) will be graded as High, Moderate, Low, Not significant. This will contribute to defining overall value of the HLCA and will be shown in the HLCA map sheet. Although there is no set methodology for valuing historic landscape parcels, the Highways Agency have produced guidance which may be useful for the purposes of this HLCA assessment. This is supplied in Table 2.

Magnitude of impact of the Proposed Scheme

Scale of effect

3.4.6 The scale of effect on the HLCA should be a discussion of the elements of the Proposed Scheme which will extend into the HLCA, and how these will physically alter the elements of the landscape which have been identified as contributing to its time depth, or the sense of place of the HLCA, or another aspect or element identified in the baseline table. A judgement of the robustness or capacity to accommodate the Proposed Scheme must be considered. This is, broadly, whether change will be at odds with the existing historic landscape. A landscape with linear industrial features such as major roads and canals is likely to have more capacity to absorb a new railway without a meaningful change in its heritage values. Useful guidance is supplied in Table 2.

Duration/reversibility of effect

3.4.7 These aspects can be discussed together, and should outline the permanence or otherwise of the scheme elements, and if and how they will change through their development. While the main trace is permanent and largely unchanging, screening planting etc. will, while still resulting in a permanent effect on archaeological remains, have a different and changed effect on the historic landscape character of the HLCA.

Statement of significance of effect on HLCA

3.4.8 Incorporating the understanding of both the value of the HLCA and the magnitude of impact of the Proposed Scheme, a section articulating the change to the heritage values of the HLCA as a result of the Proposed Scheme is required. This will result in a statement on whether the change will result in a significant environmental effect. Any effect greater than minor is considered to be a significant effect.

Table 2: General value rating table for historic landscape, adapted from Historic England, 'Assessing the effect of Road Schemes on Historic Landscape Character' (Figure 6.6)14

Value	**Typical Heritage landscape values- Evidential, Aesthetic, Communal, Historical**	**Typical design considerations – rarity of historic elements, age/period coherence, legibility of historic landscape, capacity to absorb change**
High	Designated or non-designated historic landscapes of outstanding interest Non-designated landscapes of high quality and importance, and of demonstrable national importance Well preserved historic landscapes, exhibiting considerable coherence, time depth or other critical factor(s)	Less static areas of landscape which are capable, in principle, of absorbing some well-managed changes Sensitive to the cumulative impact of small-scale changes Presumption against development that significantly alters the character and fabric of the historic landscape May need to provide some heritage improvements/dividends
Moderate	Designated special historic landscapes Non-designated historic landscapes that would justify special historic landscape designation landscapes of regional importance Averagely well-preserved historic landscapes with reasonable coherence, time-depth or other critical factor(s)	Dynamic landscape in which a mixture of modern and historic elements pre-supposes a capacity, in principle, to absorb most types/scales of essential, well-managed change Desirable that development enhances the residual character and fabric of historic landscape where possible
Low	Non-designated historic landscapes of local importance Historic landscapes with specific and substantial importance to local interest groups, but within limited wider importance Historic landscapes whose importance is limited by poor preservation and/or poor survival of contextual associations Historic landscapes where further investigation would add no significant additional information	High potential to absorb essential change based on former trends towards removal of the historic dimension Considerable scope for historic landscape enhancement, especially where it is possible to draw on the qualities of adjacent historic landscape character
Not Significant	Landscapes with little or no significant historic character or sensitivity	Very little scope for historic environment enhancement

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Appendix A: Reconciling Staffordshire and Cheshire HLC datasets

1 Context

1.1.1 To make a meaningful use of HLC in cultural heritage assessment or landscape character assessment, it is necessary to reconcile to datasets into a single methodology. This appendix sets out the methodology used in the HS2 Phase 2a ES. Note that in this appendix, 'project' refers to the task of reconciling Staffordshire and Cheshire HLC datasets.

1.2 Introduction

Project background

1.2.1 Historic Landscape Characterisation (HLC) provides a broad-brush overview of complex aspects of development of the landscape to provide better understanding of the historic landscape resource and its capacity for change, and to establish an integrated approach to its sustainable management in partnership with other organisations.

1.2.2 This project aims to create a regionalised historic landscape characterisation (HLC) for the counties of Staffordshire and Cheshire for use during environmental assessment for HS2 Phase 2a. The primary product of HLC is a digital dataset for each county comprising small landscape units, or polygons, about which a range of attributes about the nature of observed land-use are recorded. Attributes of groups of land parcels exhibiting broadly similar characteristics are identified, and the resulting data is entered onto a GIS map layer with linked textual information in the regional HER.

Summary

1.2.3 HLC is a form of landscape archaeology. It uses modern and historic mapping, aerial photographs and other sources to understand how the present landscape has developed and the approximate age of its components. In general terms, it works by an area being divided first according to its overall character, such as woodland, fieldscapes and settlement. These broad units, called 'broad types', are then sub-divided according to pre-defined attributes into narrower classifications, called 'types'. For example, woodlands would be split up into ancient woodland, secondary woodland or tree plantations, and fieldscapes into such categories as modern enclosures, planned rectilinear fields or ancient co-axial enclosures. HLC datasets are usually displayed and assessed at the type level of resolution.

1.2.4 Although sponsored by English Heritage, HLC projects have been carried out on a county-by-county basis with project officers employed and based within local authority historic environment services. The method used to develop an HLC has evolved from county to county and there are regional differences in methodology and execution. This variation in development can result in significant differences in HLCs on either side of a county boundary.

1.2.5 The specialist knowledge that regional HER officers have about their survey area, coupled with variations in the available cartographic evidence, such as Ordnance Survey map epochs, inevitably lead to bespoke HLC types used in the characterisation of the local landscape.

1.3 Project aims and methodology

Project aim

1.3.1 The aim of this project is to produce a regionalised historic landscape characterisation for the counties of Staffordshire and Cheshire by reconciling the existing HLC broad types and types to a new regionalised set of both. This can subsequently be used to perform HLC assessments across the entirety of the HS2 Phase 2a route.

Methodology

1.3.2 The regionalised HLC will be constructed using the data from the existing HLCs for the two counties, no reinterpretation of the features held within them will be undertaken.

1.3.3 As this regionalised HLC will only be displayed in its current type, with no opportunity to display it using relic types or by period, effort will be made to retain the relic character visible within landscape features. For example, without care during reconciliation, rural landscapes can be presented as modern rather than modernised even though the ancestry of the landscape is clearly visible.

1.3.4 Where reconciliation between two differing datasets is sought, the easiest method is the aggregation of types. Where one HLC has less resolution than another, it is the aim of the regional HLC to preserve resolution, where appropriate, drawing on available attribution within the datasets, rather than simply resolving types together at their broadest level.

1.4 Results

Initial analysis

1.4.1 The characterisation within the county HLC maps produced for Staffordshire and Cheshire is broadly similar due to the two counties having a similar historical nature, but differences in both the content of the datasets and the underlying approaches to the development of types.

1.4.2 The Staffordshire dataset was originally completed in 2006 but was updated in 2011 with new 'refined types' defined that were considered to convey a better degree of meaning and which were subsequently more appropriate for use in a GIS. The dataset from the Staffordshire HLC therefore contains, in addition to the broad type and refined type, the original HLC types and the period to which each feature is ascribed. The periods used by the Staffordshire Historic Environment Record are:

- Prehistoric – 500,000 BC to 42 AD;
- Roman – 43 AD to 409 AD;
- Early Medieval – 410 AD to 1065 AD;

- Medieval – 1066 AD to 1485 AD;
- Post-Medieval – 1486 AD to 1799 AD;
- Industrial – 1800 AD to 1913 AD; and
- Modern - 1914 AD to Present.

1.4.3 Cheshire HLC retains its original form, having not been updated, but does not attribute periods to its features beyond the periodisation inherent in the different types. It does in some case further divide its types into 'sub-types' which adds more resolution to the features but would not be displayed at the type level which will be used to assess the regionalised HLC.

1.4.4 Further to the sub-types, Cheshire HLC also contains 'relic types', those which are visible on individual mapping epochs, and in the case of Cheshire these are the Ordnance Survey first and third edition county maps (1870-1875 and 1904-1909 respectively).

1.4.5 Both datasets use early Ordnance Survey mapping epochs as key pieces of evidence, with both using these as dates to define the period attached to types. Whereas Cheshire uses the first and third edition county maps, usually using the latter as the defining period, Staffordshire uses the 1880s first edition county map, which was surveyed between 1861 and 1886.

1.4.6 Several key differences are initially evident in the approaches to the two county HLCs. Cheshire often uses the third edition OS map as the division between types labelled as 'post-medieval' and '20th Century', and it is often the case in corresponding broad types within Staffordshire that no corresponding resolution by period is evident with a single type being used.

1.4.7 Reconciliation across the two datasets may have difficulty in finding commonality between types which have periods defined by specific evidence or one county HLC has periods attached to its types where the other does not. Attribution can be used to a certain extent to solve this problem, for example the end of the industrial period for the Staffordshire HLC aligns approximately with the publication of Cheshire's third edition county map.

1.4.8 Though the use of specific dates as defining points within a landscape is often counter-intuitive, the necessity of using key pieces of evidence means both HLCs rely on these fixed points and this is reflected somewhat in the regionalised HLC.

Broad type reconciliation

1.4.9 The first stage of HLC involved a concordance at the 'broad type', this being the widest character level. The result of the reconciled broad types for the two counties was the creation of a new 'refined regional broad type'.

1.4.10 The results of the broad type concordance are listed in Table 1. Staffordshire has 9 broad types and Cheshire 12, with the major difference between the two counties being the sub-division of fieldscapes. Cheshire subdivides fieldscape into the three components: Ancient, Post-Medieval and 20th Century, whereas Staffordshire has a

single broad type for the category: Field Systems. At this level,the vast majority of HLCs across the country contain a single broad type to describe field systems.

1.4.11 With the three subdivisions: Ancient Fieldscapes; Post-Med Fieldscapes; C20th Fieldscapes in the Cheshire HLC needing to find concordance with the single Staffordshire broad type: Field Systems, it was decided that a single 'refined regional broad type', Field Systems, would be suitable for this reconciliation. This allowed the regionalised HLC to follow the common methodology employed for defining areas of enclosed land at the broad type level.

1.4.12 Cheshire HLC also subdivides Ornamental Landscapes, which are mostly parkland, from recreation areas, which Staffordshire does not. In this case, it was decided that the two broad Types from Cheshire could be combined without compromising the character of the features it contains at this widest level of classification.

Table 3: Broad Type reconciliation

Staffordshire Broad Type	Cheshire Broad Type	Refined Regional Broad Type
Communications	Communications	Communications
Industrial and Extractive	Industry	Industrial
Military	Military	Military
Unenclosed Land	Non-improved Land	Unenclosed Land
Ornamental, Parkland and Recreational	Ornamental Landscapes	Ornamental, Parkland and Recreational
	Recreation	Ornamental, Parkland and Recreational
Settlement	Settlement	Settlement
Water and Valley Floor Fields	Water Bodies	Water Bodies
Woodland	Woodland	Woodland
Field Systems	Ancient Fieldscapes	Field Systems
	Post-Medieval Fieldscapes	
	C20th Fieldscapes	

1.5 Type Reconciliation

Introduction

1.5.1 The second stage involved the reconciliation of the types contained within the newly defined regional broad types. The result of the reconciled types for the two counties was the creation of a new 'refined regional type'.

Communications

1.5.2 The Communications 'broad type' relates to features specifically related to transport. This includes items such items as major roads junctions, airfields, canal and river

navigations and railways. Both counties are uniform in their definition at broad type level, but at type level Cheshire sub-divides into two categories Post-Medieval and 20th Century, where Staffordshire has a single category, Communications.

1.5.3 The use of a single category by Staffordshire is due to the majority of their entries originating in their modern period, (1914 – 1999), with many of these being road roundabouts. This type did also include some features originating in their industrial period, (1800 – 1913), such as features relating to canal and railway infrastructure.

1.5.4 Conversely, Cheshire identifies rail, canal and river navigations originating prior to the twentieth century in a separate type: Post-Medieval Communications. These features are identified by their presence on the Ordnance Survey first and third edition county maps. Features visible on the Ordnance Survey 1:10,000 map that were not identified on the 3rd edition were attributed to the 20th Century Communications type.

1.5.5 Neither county identified other historic route ways, such as the remains of Roman roads or eighteenth and nineteenth century turnpikes during characterisation.

1.5.6 Though the majority of features within Staffordshire have their origins in the defined Modern period the features belonging to the Industrial period play an important part in the development of the landscape. The opportunity to re-categorise them by type to a separate, earlier period using the same broad resolution as seen in the Cheshire HLC should be taken with a near concordance existing between the Staffordshire Industrial period features and those in Cheshire's Post-Medieval type.

Table 4: Reconciliation of Communications Types

Staffordshire Type	Cheshire Type	Refined Regional Type
Communications (Modern period)	20th Century Communications	Modern Communications
Communications (Industrial Period)	Post-Medieval Communications	Post-Medieval Communications

Field Systems

1.5.7 This includes a single broad type from Staffordshire HLC: Field Systems, and three broad types from Cheshire HLC: Ancient Fieldscapes, Post-Medieval Fieldscapes and C20th Fieldscape.

1.5.8 Staffordshire HLC has 15 refined types within its Field Systems broad type;

- 18th /19th Century Planned Enclosure – Fields that were created, or appear to have been created, during the 18th and 19th centuries mostly as a result of parliamentary enclosure acts. These fields are geometrically regular and are generally created from common land though some may have formerly been Medieval open fields;
- 18th /19th Century Semi Planned Enclosure – Fields that are geometrically regular having been established in the 18th or 19th centuries but do not form part of an overall planned area suggesting that they were not planned by a surveyor;

- Drained Wetlands – Although no period is specified, the draining of wetlands across Staffordshire began around the end of the 18th century, accelerating from the mid-19th century as advancements were made in the technology used;
- Early Assarts – Assarting, the clearance of woodland for agricultural use, has been recorded in Staffordshire from the 11th century onwards and this refined type relates to the assarting of Medieval and Post-Medieval woodland. It is possible that unrecognised assarting from this period is included in the types, Early Irregular Enclosure or Early Small Rectilinear Fields;
- Early Irregular Enclosure – Mostly Post-Medieval, the identification of these enclosures is problematic due to their being most easily recognised when being contextualised within a particular landscape. This is exemplified by this type being recognised as the earliest enclosure of moorland during the Post-Medieval period in northern Staffordshire whereas in other areas it may represent other unrecognised types, such as Piecemeal Enclosure or Early Assart.
- Early Reorganised Piecemeal Enclosure – Represents the re-planning of earlier field systems, it dates specifically to the 18th and 19th centuries. It relates uniquely to the reorganisation of piecemeal enclosures, and is identified by having a mix of straight boundaries, commonly seen in 18th/19th century planned enclosures, and piecemeal enclosure style boundaries;
- Early Small Rectilinear Fields – Predominantly Post-Medieval, these are often associated with stone walls in upland areas;
- Piecemeal Enclosure – Refers exclusively to features which can be identified as the enclosure of open arable fields originating in the medieval period. These enclosures are recognisable a semi-regular pattern of fields which have enclosed individual or groups of cultivated strips within a medieval open field;
- Post 1880s Reorganised Fields – This refined type identifies areas which have been reorganised since the release of the 1880s first edition Ordnance Survey county map but have not caused an enlargement of sub-division of the fields;
- Post 1880s Reorganised Piecemeal Enclosure – These are enclosures that have are visible on the first edition 6" ordnance survey map as belonging to the Piecemeal Enclosure refined type but have been reorganised by the end of the 20th century. Though there has been a changes made to the boundaries since the OS first edition mapping epoch some historic characteristics associated with the enclosure of the former medieval open fields, as represented by the Piecemeal Enclosure refined type, can still be seen;
- Post 1880s Small Replanned Enclosure - Created since the first edition Ordnance Survey, these enclosures are characterised by the reorganisation of earlier field systems or the conversion of industrial or extractive features to farmland. This refined type also includes the creation of horse paddocks by the subdivision of larger fields;

- Post War Amalgamated Fields – Represents post-1945 consolidation of fields as agriculture intensified and modernised after the end of World War II. This resulted in the loss of boundaries and the creation of larger, regular fields;
- Pre 1880s Paddocks and Closes – Seen on the 1880s first edition Ordnance Survey map, the features are probably small meadows or paddocks. They are located at the edge of settlements and originate in the medieval and post-medieval periods;
- Recent Woodland Clearance – This refined type represent the clearance of woodland to create farmland form the 1880s onwards; and
- Squatter Enclosure – Predominantly found in the Industrial period, these enclosures are often encroachments onto unenclosed land that are related to small farmsteads or holdings. The existence of this feature type is vulnerable to the subsequent reorganisation or removal of boundaries.

1.5.9 The first of the three Cheshire HLC Broad Types, Ancient Fieldscapes, contains the following types:

- Ancient Field Systems – This type represents all enclosures originating prior to the start of the 17th century. It is divided into four sub-types: Regular, Semi-Regular, Irregular and Moss Rooms. The Regular sub-type represents enclosures that exist with a regular field network with straight boundaries and are often small in size, with an area below 4 ha. Semi-regular enclosures are found within a field system that displays some characteristics of overall organisation but are not as formalised as the Regular sub-type. Irregular is represented by enclosures with sinuous boundaries with no discernible pattern to the field system in which they occur. The final sub-type, Moss Rooms, occurs rarely within the Cheshire HLC and is the result of the enclosure of the strips, or 'rooms' of moss from which an individual had the right to extract peat. This sub-type can be multi-period in date but even in later instances than the 17th century its boundaries reflect the earlier organisation of the landscape;
- Medieval Townfields – These enclosures have a distinct form, reflecting the medieval open field system of farming; and
- Ancient Enclosed Parkland – This type represents the enclosure of former deer parks, with the new field system preserving the form and extent of the deer park with its boundaries.

1.5.10 The second Cheshire HLC Broad Types, Post-Medieval Fieldscapes, contains the following four types:

- 19th Century Field Systems – This HLC type represents all enclosure from the late eighteenth century until the end of the 19th century. It is divided into four sub-types: Parliamentary Enclosure, 19th Century Planned Enclosure, 19th Century Planned Enclosure of Marsh and 19th Century Enclosure. Parliamentary Enclosure represents fields identified within a geometric field system that has been enclosed by an Act of Parliament. The 19th Century

Planned Enclosure sub-type identifies field systems comprising of regular, rectangular fields, that are created within areas visible as belonging to the Unenclosed or Woodland Broad Types on Burdett's 1777 or Yates' 1786 map of Lancashire. Also visible on this mapping are areas of estuarine marsh, the 19th Century Planned Enclosure of Marsh sub-type represents planned, regular field systems that have been subsequently created in these areas. The fourth sub-type, 19th Century Enclosure, represents the piecemeal enclosure of township common and waste areas on Burdett's 1777 or Yates' 1786 map of Lancashire.

- Post-Medieval Field Systems – This represents enclosures dating between the start of the 17th century and the late 18th century. It is divided into three sub-types: Post-Medieval Planned Enclosure, Post-Medieval Planned Enclosure of Marsh and Post-Medieval Enclosure. The Post-Medieval Planned Enclosure sub-type represents fields identified within a geometric field system that has enclosed areas of heath or moss or has been created within areas of cleared woodland. Post-Medieval Planned Enclosure of Marsh is the enclosure of areas of estuarine marsh within this period with a regular, geometric field system. The Post-Medieval sub-type represents the piecemeal enclosure of common and waste land associated with at township and has a less formal pattern.

- Late Post-Medieval Agricultural Improvement – This HLC type denotes enclosures created during the reorganisation and enlargement or replacement of earlier field systems. These enclosures may still contain boundaries originally belonging to former field systems and the historic character of these field systems may still be discernible.

- Post-Medieval Enclosed Parkland – This contains field systems created as part of the conversion of deer parks and designed parkland to agricultural farmland. These features often contain relics of the landscape use they have replaced, with features such as boundaries following the form and extent of the former recreational areas.

1.5.11 The final Cheshire broad type, 20th Century Fieldscapes, contains the following Types:

- 20th Century Field Systems – This comprises large fields created through extensive field enlargement and the creation of new field systems, primarily to accommodate modernisation of farming practices. This is reflected in the field sizes averaging over 8 ha in size. With this type little to no evidence of previous field systems or land use is evident.

- C20th Agricultural Improvement – This type represents the enlargement or reorganisation of field systems into larger enclosures to facilitate the modernisation of agricultural practices. It preserves some character of the previous field systems, such as retained boundaries.

- C20th Enclosed Parkland - This contains field systems created as part of the conversion of deer parks and designed parkland to agricultural farmland. These features often contain relics of the landscape use they have replaced,

with features such as boundaries following the form and extent of the former recreational areas.

1.5.12 It would require extensive discussion to describe all of the reconciliations required within this broad type. It is responsible for the majority of the coverage across the two counties and covers an evolving landscape with enclosures often containing the relics of previous field systems.

1.5.13 One key area requiring discussion is the reconciliation of the time periods contained within the two HLCs, with both defining types by specific periods of time that are not similar enough to be easily resolved.

1.5.14 What is evident within both datasets is the broader development of the types with each falling into a category that belongs to a sub-division with the post-medieval period of either early, (which also incorporates enclosures that show medieval origins), or late, or the period that is being described as Modern within the regional HLC.

1.5.15 There exists a problem of semantics with the use of the words 'early' and 'late' although these seem preferable to the use of the phrase ancient for the period that describes enclosures with clear medieval origins or were enclosed in the earlier part of the post-medieval period. It is possible that this was appropriated from the definition for Ancient Woodland for use by the Cheshire HLC.

Table 5: Reconciliation of field systems types

Staffordshire Type	**Cheshire Type**	**Refined Regional Type**
Piecemeal Enclosure		Early Piecemeal Fields
Early Irregular Enclosure		Early Irregular Fields
Early Small Rectilinear Fields		Early Regular Fields
Early Assarts		Early Assarts and Field Development
Early Reorganised Piecemeal Enclosure		Late Reorganised Fields
18th / 19th Century Planned Enclosure		Late Planned Fields
18th/19th Century Semi-Planned Enclosure		Late Semi-Planned Fields
Pre 1880s Paddocks & Closes		Late Semi-Planned Fields
Post 1880s Reorganised Piecemeal Enclosures (Pre-1931)		Late Reorganised Fields
Post 1880s Reorganised Piecemeal Enclosures (Post-1931)		Modern Reorganised Fields
Post 1880s Small Replanned Enclosure (Pre-1931)		Late Reorganised Fields

Staffordshire Type	Cheshire Type	Refined Regional Type
Post 1880s Small Replanned Enclosure (Post-1931)		Modern Reorganised Fields
Post 1880s Reorganised Fields (Pre-1931)		Late Reorganised Fields
Post 1880s Reorganised Fields (Post-1931)		Modern Reorganised Enclosures
Post War Amalgamated Fields		Modern Reorganised Fields
Drained Wetlands		Late Drained Wetland / Floodplain Fields
Miscellaneous Floodplain Fields		Late Drained Wetland / Floodplain Fields
Enclosed Hill Pasture		Early Irregular Fields
Recent Woodland Clearance (Pre-1931)		Late Assarts and Field Development
Recent Woodland Clearance (Post-1931)		Modern Assarts and Field Development
Squatter Enclosure		Late Semi-Planned Fields
	Ancient Field Systems (Regular)	Early Regular Fields
	Ancient Field Systems (Semi-Regular)	Early Irregular Fields
	Ancient Field Systems (Irregular)	Early Irregular Fields
	Ancient Field Systems (Moss Rooms)	Moss Room Fields
	Medieval Townfields	Early Piecemeal Fields
	Ancient Enclosed Parkland	Early Redeveloped Deer Park
	C19th Field Systems (Parliamentary Enclosure)	Planned Fields
	C19th Field Systems (19th Century Planned Enclosure)	Late Assarts and Field Development
	C19th Field Systems (19th Century Planned Enclosure of Marsh)	Late Marshland Fields
	C19th Field Systems (19th Century Enclosure)	Late Semi-Planned Fields
	Post-Med Field System (Post-Medieval Planned Enclosure)	Late Assarts and Field Development
	Post-Med Field System (Post-Medieval Planned Enclosure of Marsh)	Late Marshland Fields
	Post-Med Field System (Post-Medieval Enclosure)	Late Semi-Planned Fields

Staffordshire Type	Cheshire Type	Refined Regional Type
	Late Post-Medieval Agricultural Improvement	Late Reorganised Fields
	Post-Medieval Enclosed Parkland	Late Redeveloped Deer park
	C20th Field System	Modern Planned Fields
	C20th Agricultural Improvement	Modern Reorganised Fields
	C20th Enclosed Parkland	Modern Redeveloped Deer Park

Industrial

1.5.16 This refined broad type is concordant with the industry broad type for Cheshire and the Industrial and Extractive broad type for Staffordshire. It covers for both counties all industrial and extractive activity including, but not limited to, quarrying, mining, manufacturing, docks and nurseries.

1.5.17 Cheshire splits this broad type into two types: Post-Medieval Industry and 20th Century Industry. As with other broad types, such as Communications, the Post-Medieval type is identified by features being present on the Ordnance Survey first and third edition county maps. Features visible on the Ordnance Survey 1:10,000 map that were not identified on the first and third 3rd edition, are attributed to the 20th Century type.

1.5.18 Staffordshire only has a single type, Industrial and Extractive, and this is due to the majority of the features identified having been attributed to Staffordshire HLC's modern period of 1914 to present. Some features do originate in the Industrial period (1800-1913) and these periods are described in the features attribution. As such, it is possible to use these attributes to concord the Industrial period features with the post-medieval features in a single type with similarity in mapping epochs allowing the Modern period features from Staffordshire to be mapped as concordant with the 20th Century Industry Cheshire HLC type.

1.5.19 Flashes are now incorporated into this broad type, having previously been within Unimproved Land within the Cheshire HLC. Though they only represent less than 1% of the Cheshire HLC project area, they are of regional significance with some, such as the Sandbach Flashes, having Site of Special Scientific Interest status, so it was decided not to amalgamate these with another type.

Table 6: Reconciliation of industrial types

Staffordshire Type	Cheshire Type	Refined Regional Type
Industrial and Extractive (Post-Industrial Periods)	C20th Industry	Modern Industry
Industrial and Extractive (Industrial Period)	Post-Medieval Industry	Post-Medieval Industry
	Flashes	Flashes

Military

1.5.20 The Military broad type group relates in the Staffordshire HLC to current and former military buildings such as airfield, barracks and depots. These features have all been identified as belonging to the Modern period and include features, or elements of features, belonging to the two World Wars. Consequently, a single type level was defined called Military.

1.5.21 Cheshire similarly has a type that covers all 20th/21st Century military landscapes, called 20th Century Military, but also has another type, Other Military, that includes all military installations prior to the 20th century which are indicated on the Ordnance Survey first edition county map (1870-1875). This category represents approximately 26 ha of above surface remains of features as diverse as iron age hillforts and medieval castles with no sub-types dividing these features further by period.

1.5.22 It is arguable that the Other Military type would not be visible if considering the data at a regional scale and, although this category covers a wide period of time, with the features worthy of their type due to the significance they would have played in the landscape, further sub-division would not be possible from the current HLC dataset and would require revisiting the interpretation of the original data.

1.5.23 Furthermore, the features of the Other Military Type held much more value to the contemporary communities than as military facilities with them acting as social and economic centres, as such they are best served to understanding the character of the landscape by being included in the Settlement broad type and they are discussed further there.

Table 7: Reconciliation of military types

Staffordshire Type	Cheshire Type	Refined Regional Type
Military	20th Century Military	Modern Military
	Other Military	Not applicable – moved to Settlement broad type

Ornamental, Parkland and Recreational

1.5.24 This is a concordance of the broad type of the same name from the Staffordshire HLC with both the Ornamental Landscapes and Recreation broad type of the Cheshire HLC.

1.5.25 The Staffordshire HLC contains two types: Historic Parks and Gardens, and Other Parkland. The Historic Parks and Gardens Type refers to all of the county's parks and gardens, the majority of which were created from the 18th century onwards. These include, but are not limited to, the features contained with the Historic England list of registered parks and gardens.

1.5.26 The Other Parkland type refers to all recreational areas other than a park or garden, such as sports grounds and golf courses, most of which were created in the 20th Century.

- Cheshire HLC has three types within the Ornamental Landscape broad type: Deer Parks, Post-Medieval Ornamental Parkland and 20th Century Ornamental Parkland. With Cheshire's Recreational broad type now included here, this adds a further three types: Post-Medieval Recreation, 20th Century Recreation and Golf Course. These six types are defined as:

  - Deer Parks – in the Cheshire HLC this type refers not to a current deer park but the area of a former deer park that has retained its character without being supplanted by another fieldscape. It is sub-divided by sub types: Medieval Deer Park and Post-Medieval Deer Park.

  - Post-Medieval Ornamental Parkland – This includes parkland visible on the Ordnance Survey first and third edition county maps (1870-1875 & 1904 – 1909 respectively) and entries within the Historic England Parks and Gardens Register and the local authority Historic Environment Records. It includes features such as sizeable parks associated with country houses and parks and gardens surrounding 19th century villas.

  - 20th Century Ornamental Parkland – Parkland created post-third edition county map visible on the Ordnance Survey 1:10,000 in 2002.

  - Post-Medieval Recreation – This type includes all recreational areas visible on the Ordnance Survey first and third edition county maps. Features within this type include town parks, such as Queens Park in Crewe, and racecourses, such as Roodee in Chester, along with various small recreation features.

  - C20th Recreation – Recreational areas created post-third edition county map visible on the Ordnance Survey 1:10,000 in 2002. Includes landscape features such as recreation and sports grounds, parks, marinas, camp sites and entertainment complexes.

  - Golf Course – This type includes all golf courses in Cheshire and is split into two sub-types: Post-Medieval Golf Course and C20th Golf Course.

1.5.27 It is impractical to find a resolution between the golf courses in the data within the Cheshire HLC, with the necessity to do so questionable. As such, the golf courses are combined with other recreational areas.

1.5.28 Staffordshire has used an expansive approach to the types contained here, choosing not to attribute periods to its types, which is in contrast to Cheshire who split their types into Post-Medieval and 20th Century using the third edition county map. To maintain the wide resolution offered by the Cheshire types, the period attribution attached to the Staffordshire features is utilised to divide the contents of its types at the end of the Industrial period in near concordance with the Cheshire periods.

Table 8: Reconciliation of Ornamental, Parkland and Recreational Types

Historic Parks and Gardens (Post-1913)	**20th Century Ornamental Parkland**	**Modern Parkland**
Historic Parks and Gardens (Pre-1913)	Post Medieval Ornamental Parkland	Post-Medieval Parkland
Other Parkland (Pre-1913)	Post-Medieval Recreation	Post-Medieval Recreation

Historic Parks and Gardens (Post-1913)	20th Century Ornamental Parkland	Modern Parkland
Other Parkland (Post-1913)	C20th Recreation	Modern Recreation
	C20th Golf Course	Modern Recreation
	Post-Medieval Golf Course	Post-Medieval Recreation
	Deer Parks	Deer Parks

Settlement

1.5.29 For the Staffordshire HLC, the Settlement broad type has two refined types. These are Pre-1880s Settlement and Post-1880s Settlement. The Pre-1880 type describes areas of the earliest settlement and is likely to retain historic buildings and street patterns. The Post-1880s type includes areas of redevelopment that has occurred since the 1880s first edition OS map and along with newly developed green field sites.

1.5.30 The Cheshire HLC similarly has two types: Post-Medieval Settlement and 20th Century Settlement. Post-Medieval Settlement refers to the areas of settlement visible on the 1904-1909 OS third edition county map. It defines the maximum extent of each settlement area by the beginning of the 20th century. The 20th Century Settlement Type defines the extent of settlement as visible on the OS 1:10,000 mapping of 2002 and displays the expansion of settlement areas identified in the Post-Medieval Settlement type along with areas developed since then.

1.5.31 Following the methodology used in previous types, reconciliation is found between the two HLCs using Staffordshire's period attribution and the correspondence between the beginning of its modern period in 1914 and the publication of the third edition county map of Cheshire in 1909.

1.5.32 As previously discussed, the Other Military type from the Cheshire HLC has been incorporated here as it contains features which, although are defensive in form, represent the remains of prehistoric and Medieval community centres, a fact which is lost if described as simply military without reference to period.

Table 9: Reconciliation of Settlement Types

Staffordshire Type	Cheshire Type	Refined Regional Type
Pre-1880s Settlement	Post-Medieval Settlement	Post-Medieval Settlement
Post-1880s Settlement (Pre-1913)		Post-Medieval Settlement
Post-1880s Settlement (Post-1914)	20th Century Settlement	Modern Settlement
	Other Military	Prehistoric and Early Historic Settlement

Unenclosed Land

1.5.33 The refined Unenclosed Land broad type includes the Non-Improved Land broad type from the Cheshire HLC and the Unenclosed Land broad type from Staffordshire. This broad type is concerned with areas of the landscape, both natural and anthropogenic, that are unenclosed such as moors, heaths, estuaries and open hill pasture.

1.5.34 Staffordshire has three types for Unenclosed Land: Early Unenclosed Land, Recent Regenerated Unenclosed Land and Enclosed Hill Pasture. The Early Unenclosed Land type depicts landscape features that have shown little change since their depiction on the first edition 6" OS Map (1880) and may represent fragments of larger unenclosed land features seen on the 1775 Yates map of Staffordshire. The Recent Regenerated Unenclosed Land type describes land which has been identified as having a different use prior to it currently being unenclosed. These uses are identified on the 1880 OS first edition and are commonly industrial or extractive works.

1.5.35 The third Staffordshire type, Enclosed Hill Pasture, refers to land confined to the Staffordshire moors and is assumed to be of medieval origin. As this type refers to the enclosure of land to be used as pasture, it has been moved to the Field Systems broad type and is discussed further there.

1.5.36 Cheshire HLC also contains three types, though they are different in nature to those within Staffordshire. These are: Unimproved Land, Unimproved Coastal Land and Flashes. Unimproved land includes all non-coastal areas of unenclosed land, regardless of period of origin. Unimproved Coastal Land refers exclusively to the area of the Wirral coast, and Mersey and Dee estuaries and includes salt marsh, tidal mud and sand banks, estuarine marsh and sand dunes.

1.5.37 The Flashes type refers to features that are often water-filled and are the result of subsidence due to the extraction of brine from halite deposits. These features represent a small proportion of the Cheshire HLC area, covering less than 1% and they represent a change in the landscape from the late 18th century onwards with them still developing in the first half of the 20th century. This means that this feature spans the periods for the two Unenclosed Land types from the Staffordshire HLC. It is also the direct result of industrial / extractive activity and it would seem to have a better place in this broad type and as a result has been moved there. Consideration has been given to incorporating the Flashes type within the Water Bodies broad type as they often fill with water which, due to its saline content, creates rare inland saline habitats. The fact that they are not uniquely filled with water makes their definition as a water body difficult.

1.5.38 The sub-division created by the two Unenclosed Staffordshire types to show some historical context to non-coastal element of this broad type is consistent with the aims of the regionalised HLC, more so than the single non-coastal type for Cheshire. The attribution associated with features in the Cheshire HLC does indicate the type for the first and third edition OS maps, so it possible to identify if there has been continuity of Unimproved Land for a feature from the late 19th century onwards. As such features that display this continuity can be placed in concordance with the Staffordshire Early Unenclosed Land type. Features which are identified as having a different type, such as Natural Water Bodies or 19th Century Field System, on the first and third edition OS maps and are subsequently identified as Unimproved Land on the 2002 1:10,000

mapping can be reconciled with the Staffordshire Recent Regenerated Unenclosed Land type.

1.5.39 In other broad types features identified through early Ordnance Surveys maps have been given the title of Post-Medieval for consistency, and where this period has been used it is expected that all features contained within them are from this period. In the case of Early Unenclosed Land regional refined type, the attribution of this period to features such as moors and heaths was counter-productive. It may be the case that the boundaries around these features has changed during the Post-Medieval but the historic character of many of these features extends much further into the past than this.

Table 10: Reconciliation of unenclosed land types

Staffordshire Type	Cheshire Type	Refined Regional Type
Early Unenclosed Land	Unimproved Land (continuous from 1st and 3rd Edition OS)	Pre-Modern Unenclosed Land
Recent Regenerated Unenclosed Land	Unimproved Land (different from 1st and 3rd Edition OS)	Modern Regenerated Unenclosed Land
	Unimproved Land Coastal	Unenclosed Coastal Land
Enclosed Hill Pasture		N/A – moved to Field Systems

Water Bodies

1.5.40 The Water Bodies broad type covers the broad type from Cheshire of the same name and the Water and Valley Floor Fields from Staffordshire. This broad type includes all bodies of water, both natural and man-made.

1.5.41 The Cheshire HLC contains three types: Natural Water Bodies, 20th Century Artificial Water Bodies and Other Artificial Water Bodies. Staffordshire HLC also contains three types: Natural Open Water, Artificial Water Bodies and Miscellaneous Floodplain Fields.

1.5.42 The two types referring to natural water bodies are concordant, covering all naturally created water features and are resolved to the Natural Water Bodies refined type.

1.5.43 Cheshire HLC attributes two periods by type to artificial water bodies with features in Other Water Bodies being visible on the Ordnance Survey first and third 3rd edition county maps (1870-1875 & 1904-1909 respectively) whilst the 20th Century Artificial Water Bodies are visible on the Ordnance Survey 1:10,000 map c. 2002 but were not constructed before the production of the first and third edition county maps.

1.5.44 Staffordshire HLC does not identify period by type to artificial water bodies, simply attributing all artificial water bodies to a single type of the same name, even though the period data for this type assigns features to a range of periods including post - medieval, industrial and post-war. As such, resolving this single, multi-period type within the Staffordshire HLC against the two, period based, types contained within the Cheshire HLC is problematic. As with the Communications broad type, though, the period attribution attached to the entries in the Staffordshire HLC can be used to sub-divide the Artificial Water Bodies type into a reasonable concordance with the

Cheshire HLC periods. This method adds historical character to the data from the Staffordshire HLC rather than aggregating the Cheshire types to create a concordance with the single Staffordshire type.

1.5.45 The Miscellaneous Floodplain Fields type relates to multi-period fields lining the sides of river valleys which have been extensively drained since the 17th century or employed as water meadows, and this has no direct concordance with a type or attribute data from the Cheshire HLC. It is similar in form and function to Drained Wetland within the Staffordshire HLC Field Systems broad type and, as it is concerned with development of field systems, it is removed from the Water Bodies Broad Type and moved to the Field Systems where it is discussed further.

Table 11: Reconciliation of Water Bodies Types

Staffordshire Type	Cheshire Type	Refined Regional Type
Natural Open Water	Natural Water Bodies	Natural Water Bodies
Artificial Water Bodies (Post -1913 Onwards)	20th Century Artificial Water Bodies	Modern Water Bodies
Artificial Water Bodies (Pre-1913)	Other Artificial Water Bodies	Post-Medieval Water Bodies
Miscellaneous Floodplain Fields		N/A – moved to Field Systems broad type

Woodland

1.5.46 Staffordshire HLC currently has 5 refined types within the Woodland broad type:

- Ancient Woodland – These are woodlands identified within the Natural England Ancient Woodland Inventory as ancient. These are defined as 'Land that has had continuous woodland cover since at least 1600 AD';
- Other Early Woodland – These are woodlands identified on the 1880s First Edition OS and the 1775 Yates' Map of Staffordshire that do not appear in the Natural England Ancient Woodland Inventory. It is possible that these woodlands are replanted between the start of the 17th century and the time of this mapping and may retain aspects of previous ancient woodland;
- Recent or Replanted Woodland – Woodlands identified within the Natural England Ancient Woodland Inventory as ancient replanted. These are defined as 'ancient woodland sites where the original native tree cover has been felled and replaced by planting, usually with conifers and usually this (20th) century';
- Other Recent Woodland – Woodland established since the 1880s first edition OS, usually in the second half of the 20th century, where no previous woodland existed. This woodlands type is derived from the earlier Staffordshire HLC types where the woodlands have sinuous boundaries, suggesting they respect existing landscape features; and.
- Plantations – Plantations are simply a woodland that has been deliberated planted, as opposed to having natural origins. These are differentiated from the deliberate planting in the Other Recent Woodland Type, which are also

technically plantations, by their straight boundaries. Predominantly 20th Century in origin, this Type contains some 18th and 19th Century plantations often associated with historic parks.

1.5.47 Cheshire HLC has four refined types within the Woodland broad type;

- Ancient Woodland – Similarly to the Staffordshire Ancient Woodland type this includes woodlands identified within the Natural England Ancient Woodland Inventory as ancient. In addition, it recognises that the inventory does not contain woodland of a size of less than 2 ha and has included woodlands below this size that have been identified as ancient during the compilation of the HLC;
- Post-Medieval Plantation – Deliberately planted woodland post-dating 1600AD, these are identified on the Ordnance Survey first and third edition county maps (1870-1875 & 1904 – 1909 respectively) but are not considered ancient;
- 20th Century Plantation – Deliberately planted woodland originating in the 20th Century. Identified on Ordnance Survey 1:10,000 scale mapping at the time of the HLCs construction in 2007 but not present on the early 20th century third edition OS map; and
- Other Woodland – Areas of regenerated woodland, woodland scrub and woodlands of unknown origin, this Type has two sub-types which further divides it into Post-Medieval and 20th Century identified from the same mapping criteria applied to the plantations at type level.

1.5.48 A simple concordance exists between the Ancient Woodland types within the two HLCs but the different approaches applied to creating types post-1600 means that finding concordance between them is problematic. The regionalised types, and how they reconcile the two HLCs are defined as:

- Ancient Woodland – This incorporates the Ancient Woodland types for the two HLCs, both of which draw upon the Natural England Ancient Woodland Inventory. The only difference between the two is that the Cheshire HLC has made some effort to include woodlands that can be considered ancient that are smaller than 2 ha in size. The Natural England Inventory does not include woodlands below this size and Staffordshire does not indicate that their HLC has taken this into consideration;
- Pre-Modern Other Woodland – This type incorporates the Other Early Woodland and the pre-1913 Recent or Replanted Woodland from the Staffordshire HLC along with the Other Woodland from Cheshire HLC which are attributed with the Post-Medieval sub-type. This type defines woodland sites that have or potentially have, early origins, possibly ancient, and were established or regenerated prior to the end of the post-medieval period;
- Post-Medieval Plantation – This type contains woodlands that were deliberately planted in the post-medieval period where no former woodland existed. This distinction between is made here between modern and post-

medieval at the publication of the third edition county map for Cheshire and the end of the industrial period for Staffordshire, as it is elsewhere with the regionalised HLC;

- Modern Plantation - This type contains woodlands that were deliberately planted in the Modern period where no former woodland existed; and
- Modern Regenerated Woodland – This refers to woodland which has been regenerated in the defined Modern period. It characterises woodland which has earlier origins, possibly ancient, that has been replanted during the time since the start of the defined modern period.

Table 12: Reconciliation of woodland types

Staffordshire Type	Cheshire Type	Refined Regional Type
Ancient Woodland	Ancient Woodland	Ancient Woodland
Other Early Woodland		Pre-Modern Other Woodland
Recent or Replanted Woodland (Pre-1913)	Other Woodland (Post-Medieval sub-type)	Pre-Modern Other Woodland
Recent or Replanted Woodland (Post-1913)	Other Woodland (20th Century sub-type)	Modern Regenerated Woodland
Plantations (Pre-1913)		Post-Medieval Plantation
Plantations (Post-1913)	20th Century Plantation	Modern Plantation
Other Recent Woodland (Pre-1913)	Post-Medieval Plantation	Post-Medieval Plantation
Other Recent Woodland (Post-1913)		Modern Plantation

1.6 Discussion

Summary

1.6.1 The project successfully found reconciliation between the types found within the Staffordshire and Cheshire HLCs. This was partly achieved by relying upon the attribution available within the datasets rather than by reconciling only the types as they stand, which would have resulted in a large amount of aggregation and generalisation.

1.6.2 To achieve concordance, some resolution was required between the periods that were assigned to types in the two HLCs, which were usually dictated by the dates of key evidence, such as mapping epochs. This was largely achieved by the use of the periods defined within the Staffordshire HER to classify the periods followed within the regionalised HLC which allowed reconciliation between cartographic evidence used in the Cheshire HLC with period attribution in the Staffordshire.

1.6.3 To achieve concordance, some reconciliation was required between the different date-periods assigned to types in the two HLCs. These usually derived from the dates of key evidence, such as mapping epochs. The regionalised HLC follows the period divisions used within the Staffordshire HER, and the period attribution of cartographic

sources within the Cheshire HLC has also been harmonised with the Staffordshire HLC.

HS2 Phase 2a West Midlands to Crewe: Technical note – Cultural heritage - Risk based approach to prioritising archaeological surveys

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1 Introduction

1.1 Scope and Purpose

1.1.1 This technical note sets out the methodology required to prioritise areas of the Proposed Scheme for archaeological evaluation surveys. These surveys will be undertaken to inform the assessment of value and significance of effects which will be presented in the Phase 2a Environmental Statement.

1.1.2 For HS2 Phase One, a zone-based methodology for the assessment of archaeological risk was developed in collaboration with English Heritage (now Historic England) and the Local Planning Authority (LPA) archaeological officers. The results of the assessment were reported in Volume 5 of the Phase One ES[1]. The original aim of the Phase One approach sought to move beyond the use of known 'point data' and apply a wider knowledge-based approach to establish areas of archaeological potential, which would be defined as landscape units. These landscape units were identified as high level Archaeological Character Areas (ACA) and more detailed Archaeological Sub-zones (ASZ). The latter were used to identify site-specific areas selected for further archaeological field survey (non-intrusive or intrusive).

1.1.3 This technical note sets out a revised methodology used in the Phase 2a assessment, which builds upon the Phase One model, incorporating lessons learned and comment from stakeholders.

1.1.4 This document replaces the Phase One Cultural heritage technical note entitled 'Risk Based Approach'[2].

1.2 Definition of risk

1.2.1 For the purpose of this methodology risk is defined as:

1.2.2 Those areas of the project (within the land required for the construction or for the operation of the Proposed Scheme) where knowledge regarding the potential presence and/or characteristics of archaeological assets is insufficient to form a professional judgement as to their extent or significance (as defined in National Planning Policy Framework Annex 2: Glossary), or to understand the level of harm to that significance which might be anticipated.

1.3 Background

1.3.1 One of the inherent problems of producing archaeological predicative models is data bias. The knowledge of known archaeological assets is, in the main, informed by developer funded archaeological survey and excavation. As a result there are often areas where limited information is available from Historic Environment Records (HER) due to the lack of fieldwork associated with development in these areas. A number of

[1] https://www.gov.uk/government/publications/hs2-phase-one-environmental-statement-volume-5-cultural-heritage/hs2-phase-one-environmental-statement-volume-5-cultural-heritage
[2] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/260153/Vol5_Scope_and_methodology_report_addendum_CT-001-000.2.pdf

large-scale infrastructure projects[3] have included areas where it was previously thought to be devoid of archaeological activity, but investigations have subsequently identified evidence of wide-scale activity[4]. The application of this approach, particularly on linear projects that traverse areas of differing landscape characteristics, can result in missed opportunities to extend understanding of the character and extent of buried archaeological assets across the landscape as a whole. Further limitations of the data include the capture and dissemination of information by HERs; in a number of cases information is held as point and line data rather than as polygons identifying either the extent of the identified archaeological remains, or scheme footprint. Further detail on archaeological predicative modelling can be found in Kamermans et al (2009) and Verhagen and Whitley (2011).

1.3.2 The process of defining Archaeological Character Areas (ACA) and Archaeological Subzones (ASZ) draws on the principle of the 'bottom-up' approach. This process involves the analysis of the baseline data on individual heritage assets and progressively integrates them to construct an appreciation of the broader historical character of the landscape[5]. This methodology facilitates the collation of a range of disparate information sources collected during the ES process to be ordered and characterised. As noted above, this methodology was developed with Historic England during Phase One and has been refined based on review of the Phase One model.

2 Methodology

2.1 Baseline data collection

2.1.1 The baseline data collection will be focussed on a range of existing publically available data sources collected to inform the ES. These will include geological maps and available historic borehole data, HERs and data held in the Historic England archives, data held by the Portable Antiques Scheme, historic maps, grey-literature and academic publications. Techniques such as LiDAR, aerial photograph analysis and hyperspectral surveys will also be used to provide further information about the form of the historic environment.

2.1.2 ACA and ASZ will be defined based on the data gathered as part of the ES process. No additional data gathering will be required to inform the initial risk model.

[3] Predominantly highways and rail schemes.
[4] Examples of this include A421 Great Barford Bypass (Brown et al 2007) and A428 Caxton common to Hardwick (Abrahms and Ingham 2008) where areas of clay lands not thought suitable for agriculture have identified evidence of activity from the Neolithic to medieval periods.
5 See DMRB Vol. 11-Section 3-Part 2-HA208/07 and Rippon 2004 for further detail on this approach

2.2 Defining Archaeological Character Areas (ACA)

Purpose

2.2.1 ACAs are intended to provide a high level geographically based contextual framework for the analysis of known remains. They are intended to provide an understanding of the character of the historic environment in the area, which facilitates the identification of areas of archaeological potential to be identified as ASZs.

Guidance on defining ACAs

2.2.2 ACAs are required to be defined for the entire length of the Proposed Scheme. Due to the large scale nature of ACA, it will generally only be necessary to define their extent as sections along the route.

2.2.3 The function of the ACA is to define areas of archaeological character, such as prehistoric activity in river valleys or areas of dispersed medieval settlement. As a result, it is anticipated that the ACAs will be defined on a suitable scale pertinent to the archaeological character. This archaeological understanding needs to include consideration of the differing periods and types of remains.

2.2.4 The definition of ACAs will be informed by consideration of the geology, topography, geography, and supported by the results of relevant or notable fieldwork. Both solid and drift geology, and overlying soils needs to be discussed, and terminology must be consistent between Community Areas.

2.2.5 The definition of each ACA will not be described as an exhaustive lists of the results of every archaeological intervention, and should not be used to predict the potential of archaeological remains within a specific land parcel. Rather, an overarching view of what has been found in the ACA in general, and how that makes the ACA distinct from what has been found in other ACA.

2.2.6 Similarly, while land use and topography will contribute to definitions, these need to be clearly linked to how they have influenced the archaeological character of the ACA, including the potential visibility of archaeological remains. The ACA should not be a description of the landscape itself, but a description of the potential archaeological remains within the defined area.

2.2.7 Current land use may inform the archaeological understanding of the ACA, but this will not be sufficient to define the ACA. Not all archaeological sites are influenced by land use – the location of prehistoric funerary monuments will not have been confined to upland arable fields on chalk, but that is where they are most visible to current surveys. Discussion of current land use needs to be considered in terms of what it may indicate about the archaeological potential of the ACA.

2.2.8 HS2 Phase 2a traverses contrasting regions and crosses areas with diverse geology and topography. As a result, it is anticipated that there will be a number of ACAs identified across the route ranging from the river valley around the River Trent at Pipe Ridware to the medieval and post-medieval park lands south of Newcastle-Under-Lyme. It is unlikely that ACAs will correspond with the respective community areas () as these often follow LPA and/or parish boundaries. Community areas can be used to

order the data into meaningful areas/zones, however, the definition of each area is to be based on the likely locations, nature and significance of archaeological assets.

2.3 Defining Archaeological Sub-zones (ASZ)

Purpose

2.3.1 ASZ shall identify the potential for archaeological remains in specific locations, and state where further survey is required. For areas of known archaeological remains the ASZ shall clarify requirements for further survey(s). The ASZs will give consideration to the range of surveys and will make recommendations based on the suitability of the techniques to address the archaeological resource.

Guidance on defining ASZ

2.3.2 ASZs will be defined for the entire length of the scheme. The width can be limited to land required for the proposed scheme, however, where appropriate consideration should be given to extending areas to include the wider landscape, particularly in areas which are outside the land required for the proposed scheme, but are the subject of ongoing design discussion. The ASZ will also need to include off-route elements (depots, utility diversions etc.).

2.3.3 Although the background ACAs will contribute to the discussion of general potential for archaeological remains within the ASZ, ASZs themselves are to be defined through an understanding of locally specific conditions. In order to provide consistency across the scheme, it is vital that terminology is consistent between Community Areas.

2.3.4 As with ACA, current land use will likely to inform the archaeological understanding of the ASZ. Unlike ACA, where development or other works have removed archaeological remains, ASZ may be defined by current land use or boundaries. It would be beneficial to map landfills, negative evidence from previous archaeological investigations, and other areas where archaeological remains have been removed.

2.3.5 ASZ are intended to be tailored to local conditions/understanding, and a flexible approach is required. In areas of limited archaeological visibility and homogenous terrain, for example, it may not be possible to differentiate the potential of a relatively large area, which may be best understood through a single ASZ. Alternatively, the crossing of a Roman road would require a more tightly defined ASZ, possibly down to tens of metres, particularly where intelligence elsewhere along the road in question indicates roadside settlement is possible. Discrete archaeological sites, archaeological interventions or areas which have been previously investigated should, in most cases, be individual ASZ.

2.3.6 Other aspects for consideration when defining ASZ specifically in terms of their implications for the archaeological potential of the ASZ are presented below:

- geology, soils, topography, hydrology indicators, noting for example, deep deposits, potential areas for palaeo-environmental and/or waterlogged survival, as well as, for example, hilltop defensive locations, routeways. Watercourses need to be discussed where relevant for each ASZ;

- both solid and superficial geology need to be described, both in terms of British Geological Survey (BGS) units. Where present, alluvium or colluvium must be noted. The soil type, as derived from the BGS, in each ASZ needs to be described;
- locations where there is a lack of archaeological knowledge due to, for example an absence of previous archaeological investigations. If no previous archaeological work has been undertaken, this must be clearly stated;
- investigations in the surrounding locality where the presence of a specific monument and/or type of evidence is suggested – known patterns of discovery;
- the context of these investigations i.e. have the investigated locations themselves been biased by misconceptions regarding potential landscape models?;
- where previous archaeological investigation has taken place, this must be discussed; and
- influence of past landuse, e.g. quarrying, urban expansion, agricultural regime – influence on heritage asset survival.

3 Assessing level of risk and further work

3.1 Assignment of risk

3.1.1 The assignment of risk should be proportionate to the knowledge and understanding of the heritage assets that form the ASZ. The function of the process is to identify areas where further survey is required to inform the assessment of the significance of the heritage asset.

3.1.2 No field evaluation surveys will be required in support of the ES if there is sufficient information to allow for an informed opinion of potential character, form, value and vulnerability of buried remains. This decision will be informed by the baseline data collection as identified above.

3.1.3 Risk rating is presented in Table 1 below:

Table 1: Risk levels

Ranking	Risk rating	Criteria to define rank/risk rating
1	High	An area where there is no site specific data available to characterise archaeological assets, but data from other sources, for example boreholes and historic landscape analysis, indicates the potential for significant remains to be present.
2	Medium	An area where archaeological character is partially or poorly understood, and where data collected indicates that the area is likely to contain archaeological remains of significance.
3	Low	An area where archaeological character is very well understood and sufficient data is available to characterise these to inform the assessment.
4	None	An area where archaeological remains are known to have been removed by past activity and the chances of encountering assets are reduced to essentially nil.

3.2 Further survey

3.2.1 Where the requirement to undertake surveys has been in the ES, recommendations will be made to identify the appropriate survey technique. The purpose of the surveys is to:

- clarify the presence/absence of heritage assets;
- establish the significance of heritage assets where confirmed, through understanding of their date and character;
- inform the understanding of the potential harm to the significance of heritage assets;
- contribute to the reduction of the risk of unexpected discoveries as far as is practicable; and,
- inform the design and mitigation and/or investigation and recording strategies.

3.2.2 Although not an exhaustive list, the following comprises the likely suite of evaluation techniques:

Non-intrusive

- field walking/surface artefact collection;
- geophysical survey, including detailed magnetometry, resistivity, and GPR;
  - magnetic susceptibility on its own, however, is not considered appropriately detailed enough to characterise potential archaeological remains;
- metal detecting (for distribution only).

Intrusive

- metal detecting;
- geoarchaeological investigations including borehole/augering;
- test-pitting; and
- trial trenching.

3.2.3 Once the initial map of ACA and ASZ is complete with recommendations for survey, this will be cross referenced with land access data to identify where the surveys may be feasible to undertake to inform the EIA. HS2 Ltd. will maintain a pragmatic approach and undertake survey where it considers this is practicable and access is available within the land required for construction of the Proposed Scheme.

3.3 Continued development of the risk model

3.3.1 Where practicable, the results of the initial phases of the identification of the ACAs and ASZs will be presented in a workshop to the Phase 2a heritage stakeholder group. Where practicable, the results of the workshop would be used to refine the development of the risk model.

3.3.2 The risk model is intended to be a 'live document' which will be updated on completion of the archaeological surveys. This will allow for the level of risk to change as a result of the greater understanding of the identified heritage assets that form the ASZs.

3.3.3 On completion of the archaeological surveys research questions will be produced to make recommendations for further archaeological investigations; it is accepted that this may not be possible for all ASZs identified. The research questions should be informed by the archaeological regional research framework and national research. The research questions will be structured to address specific questions, and would be used to form the basis of the Historic Environment Research and Delivery Strategy (HERDS) to be applied to Phase 2a. Examples of questions in the Phase 1 HERDS include:

- KC12: What is the evidence for pre-Iron Age phases of enclosure at the margins of the Trent Valley, and to what extent were Iron Age and Romano-British field systems and settlement influenced by earlier structuring of the landscape?; and
- KC19: The Romano-British period saw the beginning of a more established infrastructure network. Can we investigate the development of these routes, trackways and roads and the influence they had on landscape change?

3.4 Engagement

3.4.1 As part of an ongoing programme of engagement with heritage stakeholders, meetings will be held with the Local Planning Authority (LPA) Archaeologists and Historic England to discuss the development and application of the ACAs and ASZs. These discussions will take place within the wider consultation on the historic environment through the HS2 Ltd Historic Environment team.

4 Outputs

4.1.1 The output of the study shall comprise a report on the results of the modelling to form part of the Volume 5 Cultural heritage appendices of the ES. The report shall include:

- list of baseline data sources used to inform the study;
- methodology including limitations and assumptions;
- a discussion of the definition of each ACA/ASZ, presenting the rationale for each ACA and ASZ (to include results of survey work where appropriate);
- risk areas not included in the original survey due to access constraints;
- research questions identified and recommendations, where appropriate;
- a tiered map (comprising overarching ACA, subdivided into more specific ASZ of archaeological potential within the scheme footprint.

4.1.2 The ACAs and ASZs shall be illustrated on maps of a suitable scale. These outcomes shall be supplied as pdf and native files in line with HS2 Ltd requirements and this will include the model in GIS format.

5 References

Abrahms, J and Ingham, D 2008 Farming on the Edge: Archaeological Evidence from the Clay Uplands west of Cambridge, East Anglian Archaeology Report No. 123

Brown, R, Hardy, A, Leech, S and Timbey J R, 2007 Settlement on the Bedfordshire Claylands: Archaeology Along the A421 Great Barford Bypass, Bedfordshire Archaeology Monograph

Highways Agency 2007 Design Manual for Roads and Bridges Volume 11 Environmental Assessment Section 3 Environmental Topics Part 2 HA 208/07 Cultural Heritage

Kamermans, H., M. van Leusen., and Verhagen, P. 2009 Archaeological Prediction and Risk Management Alternatives to Current Practice. Archaeological Studies Leiden University 17

Verhagen, P. and Whitley, T.G. 2011 Integrating Archaeological Theory and Predictive Modeling: a Live Report from the Scene J Archaeol Method Theory (2012) 19: 49. doi:10.1007/s10816-011-9102-7 (https://link.springer.com/article/10.1007/s10816-011-9102-7)

Annex E: Ecology and biodiversity – technical notes

The following technical notes are contained in this Annex:

- Ecological assessment methodology;
- Methodology for demonstrating no net loss in biodiversity;
- Ecological principles of mitigation; and
- Ecological field survey method and standards.

HS2 Phase 2a West Midlands - Crewe: Technical note – Ecology and biodiversity - Ecological impact assessment

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1 Introduction

1.1 Purpose of the technical note

1.1.1 This technical note sets out the methodology used in assessing the ecological effects (the Ecological Impact Assessment (EcIA)) of the HS2 Phase 2a West Midlands to Crewe within the Environmental Statement (ES).

1.1.2 This technical note expands on the information included in the Phase 2a West Midlands to Crewe Environmental Impact Assessment (EIA) Scope and Methodology Report (SMR[1]).

1.2 Purpose of Ecological Impact Assessment

1.2.1 As part of the EIA process, the purpose of the EcIA methodology is 'to provide decision-makers with clear and concise information about the likely significant ecological effects associated with a project'.

1.2.2 It is also important that all other interested parties, including members of the public, are able to understand:

- the findings of the assessment;
- the process by which the assessment was undertaken; and
- the actions required to deliver the mitigation and compensation designed to ensure an appropriate biodiversity outcome.

1.2.3 This methodology has therefore been designed with the aim of providing a clear and transparent assessment of the ecological effects of the Proposed Scheme to all readers.

1.3 Other relevant guidance

1.3.1 The impact assessment methodology incorporates the key principles of the standard method for ecology as set out by the Chartered Institute of Ecology and Environmental Management (CIEEM) in their revised Guidelines for Ecological Impact Assessment (2016)[2] – Where relevant any changes arising from the CIEEM guidance has been adopted.

1.4 Structure of the report

1.4.1 This technical note provides information on evaluating ecological features in Section 2; on predicting impacts of the Proposed Scheme in Section 3 and on defining and assessing the significance of the resulting ecological effects in Section 4.

[1] Scope and Methodology Report, Volume 5: Appendix CT-001-001.
[2] CIEEM (2016) Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal, 2nd edition. Chartered Institute of Ecology and Environmental Management, Winchester.

1.4.2 Section 5 introduces the approach to recording mitigation, compensation and enhancement within the assessment and Section 6 provides information on the consideration of residual effects.

1.4.3 This note does not address the earlier stages of EcIA, notably definition of the scope of the assessment, as this is covered in other documents such as the HS2 Phase 2a SMR.

2 Determining value of ecological resources

2.1 Introduction

2.1.1 This section provides guidance on how to assign value to ecological features. As acknowledged in the CIEEM guidelines, defining the value of ecological features does not follow a simple mechanistic approach but rather derives from professional judgement based on available guidance and information, along with supporting expert opinion. Nonetheless, it is recognised that on this project (given its scale and the number of survey teams involved), guidance is required in order to ensure a consistency of approach.

2.1.2 Ecologists undertaking the assessment should use their knowledge of the local context of the sites, species and habitats they are evaluating in determining the value of ecological features. Internal discussion between ecological teams about the evaluation of ecological features will be encouraged to maximise consistency in evaluation.

2.1.3 In determining the value of ecological features, the CIEEM approach should be adopted, whereby the ecosystem services value of ecological features are considered separately from the 'ecological' value, and the significance of any social and economic effects is (where applicable) are defined and reported within the Community and Socio-economics sections of the ES.

2.2 Evaluation: scale and reporting

2.2.1 A common difficulty in undertaking EcIA for large-scale or linear projects is the need to define a scale at which the baseline evaluation is undertaken or reported, i.e. what constitutes an individual ecological feature. This is particularly the case where there is a wealth of baseline data which relate to different or overlapping sampling areas.

2.2.2 For a small development site, it is easy to define and present the ecological features considered within the EcIA. Essentially, the development site is evaluated according to:

- any designations;
- other habitats within the site; and
- other species within the site.

2.2.3 Effects are then identified for each of the features (habitats and species) present. However, the geographic boundaries of the site which forms the basis of the assessment do not have any ecological validity – they are defined by the development proposal.

2.2.4 The conclusions of the EcIA for the Proposed Scheme will be reported in the ES within separate reports (Volume 2 of the ES), which sub-divide the route and report effects based on community area (CA). The cumulative effects on ecological features at the route-wide level (i.e. those effects above and beyond those reported within the CA reports) will be considered in Volume 3 of the ES.

2.2.5 Within each CA, there will be many individual features of ecological significance identified. These will include:

- designated sites;
- areas of semi-natural habitat; and
- areas of habitat or other features supporting notable species.

2.2.6 The designated sites will be evaluated based on the level of nature conservation value assigned through designation. Impacts and any resulting effects on designated sites will be assessed taking into consideration the combination of habitats and/or species which are identified as reasons for designation.

2.2.7 Whilst the CA boundaries will be used to sub-divide the ES, the evaluation process, including decisions on an appropriate scale to provide evaluation of ecological features, will not be defined by their extent.

2.2.8 For the habitats, species and other features of interest professional judgement will be used to identify the most ecologically meaningful scale to evaluate the ecological features present.

2.2.9 In the vast majority of situations evaluation of ecological features should be conducted according to one of the two approaches listed below:

- the areas of habitat and other features could be evaluated individually (i.e. a discrete block of a particular habitat type, or the population of great crested newt supported by a single pond); or
- grouping blocks of similar habitat, or areas supporting protected species on the basis of sound ecological reasoning (e.g. evaluating blocks of habitat of similar nature that occur in close proximity either side of a CA boundary as a single receptor; or evaluating the great crested newt population of a series of ponds together when it is clear that these are likely to function as a metapopulation).

2.2.10 Evaluation at the CA level may be appropriate for some widespread ecological features. However, this should be the exception and should not be the default approach.

2.3 General principles of evaluation

2.3.1 Evaluation of all potential ecological receptors should be conducted against the following frames of geographic reference:

- International or European;
- national;
- regional;
- county/metropolitan;
- district/borough;
- local/parish; and
- negligible.

2.3.2 The above represent a minor variation to those identified within the CIEEM guidelines. The frames of reference 'within zones of influence' and 'site' have been omitted for the purposes of this assessment due to potential confusion associated with the use of these terms in relation to a linear scheme on a large scale.

2.3.3 In line with the principles laid out within the CIEEM guidelines it is not considered possible to rigidly assign habitats or species to a specific level of value, as the value of the ecological feature may vary depending on where on the route it occurs. Evaluation should be based on available information and guidance, including published criteria where available and professional judgement. Appendix A seeks to provide an outline framework for the evaluation of receptors.

2.3.4 In line with the CIEEM guidelines for valuing ecological features, a clear rationale for the valuation reached should be presented in all cases.

2.4 Designated sites

2.4.1 For formally designated sites the valuation afforded should be based on the value prescribed by the designating body. Where a feature has value at more than one level, its overriding value is that of the highest level. Where sites overlap and the features for which the site has been designated at each level differ these should be valued and assessed accordingly.

2.4.2 Potential Sites of Special Scientific Interest (pSSSI), candidate Special Areas of Conservation (cSAC)[3], proposed Special Areas of Conservation (pSAC)[4], potential Special Protection Areas (pSPAs) and proposed Ramsar sites should be considered to be of the same value as corresponding sites that have already been designated.

2.4.3 Habitats and species occurring within sites which have not been formally designated (e.g. potential local wildlife sites) should as a general rule be evaluated as part of the habitats and species assessments. Where surveys by the designating body have

[3] Sites are submitted to the European Commission as candidate Special Areas of Conservation (cSACs). Only following approval by the European Commission are they designated by the Member State as Special Areas of Conservation.
[4] 5 Prior to its submission to the European Commission as a cSAC, a proposed SAC (pSAC) is subject to wide consultation.

identified that a site meets the criteria for formal designation and it is in the process of being formally designated, then such sites can be assumed to be of the value prescribed by the designating body.

2.4.4 All habitats and species occurring within the boundaries of the designated site (including both features for which the site is designated and those that are not a reason for designation) should also be considered under the evaluation of habitats and species (as described below) to ensure that the subsequent assessment provides a true indication of potential effect on conservation status of these habitats/species.

2.4.5 It is not the role of the EcIA process to validate site designations but if a designated site is considered no longer to meet the criteria for designation, then the issue should be discussed with the relevant designating authority. Unless agreement is reached that the site does not match its current designation, then the current designated value should be used in the assessment.

2.5 Habitats

2.5.1 Habitats should be evaluated using published criteria for the recognition of sites supporting habitats of value at particular geographic scales. This will include criteria developed to identify habitats of international[5] or national[6] value. Similarly, some County Wildlife Trusts and/or local authorities have prepared criteria for the selection of local sites on the basis of their habitats.

2.5.2 Published criteria often make reference to UK priority habitats. The UK Biodiversity Action Plan[7] defines habitats and species that are conservation priorities because of their rarity and rate of decline. A review of the list of priority habitats in 2007 led to the identification of 65 habitats that meet the criteria at UK level. While the UK BAP has now been superseded, the priority habitat definitions remain relevant as they also underpin the Habitats of Principal Importance under Section 41, (S41) of the Natural Environment and Rural Communities Act (2006)[8], which mirror the categories originally defined for the UK BAP. Fifty-six habitats of principal Importance are included on the S41 list. These are all the habitats in England that have been identified as requiring action in the UK Biodiversity Action Plan (UK BAP). They range from habitats such as upland hay meadows to lowland mixed deciduous woodland and from freshwater habitats such as ponds to marine habitats such as subtidal sands and gravels.

2.5.3 The published selection criteria typically take account of the following:

- rare or uncommon habitats;
- typical or characteristic habitats;
- species-rich habitats;
- habitats that develop slowly and are thus difficult to replace; and

[5] 6 McLeod, CR, Yeo, M, Brown, AE, Burn, AJ, Hopkins, JJ, & Way, SF (eds.) (2005), The Habitats Directive: selection of Special Areas of Conservation in the UK. 2nd edn. Joint Nature Conservation Committee, Peterborough. www.jncc.gov.uk/SACselection.
[6] 7 JNCC, Guidelines for selection of biological SSSIs. http://jncc.defra.gov.uk/page-2303
[7] 8 JNCC (1994), UK Biodiversity Action Plan.
[8] 9 Natural Environment and Rural Communities Act (2006), (Chapter 26). HMSO.

- local context.

2.5.4 Where criteria for recognising habitat receptors of value at a county or district level do not exist, experience and professional judgement should be used for their evaluation. Justification for the value assigned to any habitat or site should be clearly and concisely set out, focusing on the factors listed in paragraph 2.5.3.

2.5.5 The evaluation of habitats should be made independent of any related value that the habitat has as a consequence of the protected species which it supports.

2.5.6 Assessment should include consideration not only of similar habitats but also the potential for a greater overall value of a wider habitat mosaic, as a consequence of what might be regarded as a synergistic assessment. Thus, an area that is of district value for several different habitats might be considered, overall, to be of county value as a consequence of the combination of habitats. Such judgements should be documented clearly.

2.5.7 Habitats within designated sites should also be considered within the evaluation of the wider habitat resource. Cross referencing to the designated sites section should be used as appropriate to prevent the need to repeat baseline descriptions.

2.6 Species

2.6.1 As with habitats, there will usually be published criteria for assessment of sites supporting species and assemblages of species that are considered as qualifying features for designated sites of nature conservation value at different geographic scales (e.g. The Birds Directive: selection guidelines for Special Protection Areas (JNCC, 1999)[9] .

2.6.2 Published criteria often make reference to UK priority species. The UK Biodiversity Action Plan (1994)[10] defines habitats and species that are conservation priorities because of their rarity and rate of decline. A review of the list of priority species in 2007[11] led to the identification of 1,150 species that meet the criteria at UK level. Species were assessed according to four criteria:

- threatened internationally;
- international responsibility and a 25% decline in the UK;
- more than 50% decline in the UK; or
- other important factors, where quantitative data on decline were lacking but there is other evidence of extreme threat.

[9] Joint Nature Conservation Committee (1999), The Birds Directive: Selection Guidelines for Special Protection Areas, 6 pages, A5 leaflet, ISBN 1 86107 477 8

[10] HMSo (1994), Biodiversity: The UK Action Plan, Her Majesty's Stationery Office.

[11] Report on the species and habitat review. Report by the Biodiversity Reporting and Information Group (BRIG) to the UK Standing Committee June 2007

2.6.3 While the UK BAP has now been superseded, the priority species definitions remain relevant as they also underpin the Species of Principal Importance under Section 41 of the Natural Environment and Rural Communities Act (2006), which mirror the categories originally defined for the UK BAP. There are 943 species of Principal Importance included on the S41 list. These are the species found in England which have been identified as requiring action under the UK BAP. In addition, the Hen Harrier has also been included on the S41 list because without continued conservation action it is unlikely that the Hen Harrier population will increase from its current very low levels in England.

2.6.4 Other criteria typically take account of the following:

- rare or uncommon species;
- species suffering a marked decline;
- endemic species;
- typical or characteristic species;
- species for which the area holds a significant proportion (e.g. European species for which England holds a significant proportion); and
- large or notable populations of species.

2.6.5 Protected and/or notable species should be evaluated wherever possible at the population level. Assessment teams should liaise to ensure that similar assumptions are made in relation to the scale of evaluation for highly mobile species such as bats and birds.

2.6.6 Protected species populations occurring within designated sites should also be evaluated within this section at an appropriate scale (i.e. the boundaries of the designated site should not be a constraint to the way in which the ecological feature is evaluated).

2.6.7 Species populations found at the edge of or beyond their natural range may be worthy of valuing highly or not. A case-by-case judgement is likely to be appropriate in this situation and should be briefly explained in the baseline evaluation.

2.6.8 All the criteria listed previously should be employed in the context of professional understanding. Some species that have suffered a decline in numbers may still be common or may be expected to recover and so may not be valued as highly as other species in this category.

2.6.9 The CIEEM Guidance distinguishes between the evaluation of species of biodiversity value and those that are legally protected. In many cases, species fall in to both categories, thus, for example, great crested newt (*Triturus cristatus*) is protected under the Habitats Directive and the Wildlife and Countryside Act 1981 (as amended) because it is considered to be of biodiversity value. The distinction between biodiversity value and legal protection allows one to draw the necessary distinction between the importance of a single pond with great crested newt and a series of ponds with a metapopulation that would quality for designation as a SSSI.

2.7 Baseline trends

2.7.1 The impact assessment considers the baseline conditions that would exist with and without the Proposed Scheme. It is therefore important to predict baseline conditions for the construction period (for construction impacts) and for the date of opening and beyond (for operational impacts). Key dates are provided in Table 1.

Table 1: Assessment years

Phase	Year(s)
Base year	2016
Construction	2020-2027
Operation Year 1	2027

Source: HS2 Phase 2a EIA Scope and Methodology Report.

2.7.2 Due to the complexity of the scheme and the potential for changes in construction phasing when detailed design is progressed, the ecological assessment will be based on the assumption that construction activity across the route will commence in 2020.

2.7.3 In predicting future baseline conditions at the start of construction and operation, consideration should be given to environmental trends (range expansion, population declines etc.) as well as influences such as policy that will influence land use, and consented or highly likely development proposals.

2.7.4 Based on current best evidence, it is considered unlikely that ecological features will be significantly different by either 2020 (construction baseline) or 2027 (operational baseline). The EcIA therefore concentrates on reporting the likely effects of climate change at the route-wide level within Volume 3 of the ES.

2.8 Precautionary valuation

2.8.1 Due to access restrictions, access delays and seasonal restrictions on survey, there will be areas of the route where the desired survey scope will not be completed at the point of the ES submission.

2.8.2 In order to ensure that all likely significant effects of the Proposed Scheme have been identified, where baseline information is incomplete a precautionary approach of assuming a 'reasonable worst-case' valuation should be adopted. This approach should be utilised to assign precautionary valuations to both known ecological features, and potential ecological features based on the best available information.

2.8.3 Where reasonable worst-case valuations are necessary they should be made based on the information available. This should include consideration of any available field or desk study data (including aerial photography), a comparison with similar habitat areas occurring in the wider local area, and a qualitative consideration against any factors that indicate suitability for the particular habitat or species in question. The degree of precaution built into the assessment should be linked to the level of confidence in the existing data upon which the assessment is based. Further guidance is provided in Appendix B.

3 Impacts

3.1 Construction impacts

3.1.1 Site preparation and construction activities will include:

- demolition of buildings;
- clearance of vegetation;
- site levelling;
- earthworks including: excavation, topsoil/subsoil stripping;
- laying of substrates and construction materials;
- introduction of railway infrastructure, including caternary system;
- storage of machinery and materials;
- security and site lighting;
- installation of site fencing (temporary and permanent);
- construction and installation of noise fence barriers;
- planting of landscaping areas;
- construction of roadways, underpasses and bridges where realignment or diversion of existing roads are required;
- construction of paths, underpasses and bridges where realignment or diversion of public rights of way (footpaths and bridleways) are required;
- culverting of watercourses under the railway line;
- construction of ditches, drains and watercourses where new or realigned drainage is required; and
- transport of materials and workers to and from site.

3.1.2 The area required for construction will include land required for mitigation, notably noise barriers and landscaping areas. It will also include land required for road and utility realignments and diversions.

3.1.3 Impacts arising from the permanent presence of the railway line, associated structures (including catenary), and landscaping etc. are considered to be permanent construction effects and will be reported in the construction section.

3.1.4 Potential impacts resulting from site preparation, construction activities and the permanent presence of the route are likely to include:

- loss of habitat to land required for the construction and operation of the Proposed Scheme;

- severance of ecological corridors and networks, resulting in a reduction in habitat connectivity;
- fragmentation of habitats and sites;
- barrier effects (to movement of fauna);
- direct mortality from collision with overhead structures, including catenary system;
- noise and visual disturbance;
- vibration disturbance;
- disturbance from lighting;
- dust deposition;
- air pollution;
- water quality changes from surface water run-off carrying sediments and pollutants;
- hydrological effects, from changes in water levels and/or flows;
- changes in management, often resulting in habitat degradation;
- changes in public access;
- introduction of 'alien' geology where use of imported substrates results in mixed geologies; and
- introduction and spread of non-native invasive species.

3.1.5 It should be noted that changes in public access may affect sites some distance from the Proposed Scheme. If, for example, an area of much-used public open-space is lost to the community, either temporarily or permanently, other sites may see a consequent increase in use. Thus, the usual potential effects of increased recreational use (disturbance to sensitive species, eutrophication, erosion, increased risk of fire etc.) may occur well away from the Proposed Scheme where alternative sites are in short supply.

3.1.6 It will be assumed for the purposes of the EcIA that all existing habitats within the extent of the Proposed Scheme (i.e. both areas of land required for the construction and operation of the Proposed Scheme) would be permanently lost. This represents a precautionary assessment and it is likely that during detailed design it will be possible to identify some features that can be retained.

3.2 Operational impacts

3.2.1 Operational activities will include:

- passage of trains; and
- maintenance activities.

3.2.2 Operational impacts derive only from these activities and do not include the permanent presence of the railway line, associated structures (including catenary, landscaping etc.).

3.2.3 Potential impacts resulting from operational activities are likely to include:

- barrier effects (to movement of fauna);
- direct mortality or injury from collision with trains;
- mortality or injury from potential turbulence effects;
- noise and visual disturbance;
- vibration disturbance;
- water quality changes from surface water run-off carrying sediments and pollutants (both from routine activity and accidental spillages); and
- introduction and spread of non-native invasive species.

3.3 Characterising impacts

3.3.1 Having identified the impacts that are likely to arise from construction and/or operational activities at any one location, it is necessary to consider the characteristics of impacts in terms of:

- positive or negative;
- magnitude;
- spatial extent;
- duration;
- timing (both in terms of time of day and time of year); and
- frequency and periodicity.

3.3.2 These characteristics are important in determining likely ecological effects.

3.3.3 Magnitude refers to the 'size' or 'amount' of the impact and should be reported on a quantitative basis wherever possible. The extent of an impact is the area over which the impact occurs and this again should be reported on a quantitative basis.

3.3.4 The duration of impact should be considered in relation to ecological characteristics (for example species lifecycles) as opposed to human timeframes (CIEEM guidelines). It should be noted that the duration of the impact and the resulting effect on receptor may differ. For example, if disturbance during construction results in several years of reduced juvenile recruitment for a species then the effect on the conservation status of the species concerned may continue to be significant for generations.

3.3.5 When describing the reversibility of impacts, the terms 'permanent' (i.e. irreversible) and 'temporary' (i.e. reversible) should be used when characterising an impact.

3.3.6 Within the characterisation of impacts an indication should be provided of the likelihood that a change/activity will occur as predicted.

3.3.7 In line with the overall ES of the Proposed Scheme, the EcIA will make a clear distinction between the terms 'impact' and 'effect', using the definitions below:

- impact = activity associated with the Proposed Scheme resulting in changes acting on an ecological feature; and
- effect = outcome resulting from an impact acting upon a receptor.

4 Assessment of effects

4.1 Definition of significance

4.1.1 Having defined and assessed both the baseline ecological features and the predicted impacts, it is necessary to consider how the predicted impacts could affect the valued ecological features and thus to identify likely significant ecological effects.

4.1.2 Following the CIEEM guidance, a significant ecological effect is defined as an effect that either supports or undermines biodiversity conservation objectives for 'important ecological features' or for biodiversity in general. Conservation objectives may be specific (e.g. for a designated site) or broad (e.g. national/local nature conservation policy) or more wide-ranging (enhancement of biodiversity). Effects can be considered significant at a wide range of scales from international to local.

4.1.3 Impacts on designated sites will be considered in relation to the site's conservation objectives, and the conservation status of species or habitats for which the site is designated, or effects on the condition of the site or its interest/qualifying feature. Effects on species and habitats will be considered in relation to the concept of 'conservation status'. Effects on ecosystems will be considered in relation to changes to ecosystem structure and function.

4.2 Assessment of whether ecological effects are significant

4.2.1 In line with the approach laid out in the CIEEM guidelines, the value of ecological features will be used to identify the geographic scale at which the effect is significant.

4.2.2 Effects of the Proposed Scheme will be assessed following the incorporation of avoidance/mitigation measures that are included within the design. This will include all relevant measures even if their primary purpose was not to reduce or avoid ecological impacts. For example, this may include the following:

- changes to the route (i.e. horizontal alignment) of the Proposed Scheme;
- changes to the vertical alignment (e.g. depth of cuttings);
- use of tunnels;

- design of standard bridges, overpasses etc. (excludes green bridges[12] or the greening of structures already proposed);
- use of specific construction methodology to minimise the land required (e.g. retaining walls);
- underpasses/conduits where the primary purpose is not for ecological benefit;
- fencing where the primary purpose is not ecological; and
- implementation of the Code of Construction Practice (CoCP).

4.2.3 Effects should be reported prior to any additional mitigation, compensation or enhancement proposed, which will be introduced later in the assessment process.

4.2.4 Key to predicting significant ecological effects is understanding what might affect the integrity of a defined site and/or the conservation status of the habitats or species supported by the defined site or area.

4.2.5 CIEEM guidance recommends that the process of identifying significant ecological effects should make explicit reference to aspects of ecological structure and function on which the feature depends.

4.2.6 The integrity of a site is defined as 'the coherence of its ecological structure and function, across its whole area, that enables it to sustain the habitat, complex of habitats and/or the levels of populations of the species for which it was classified'[13]. For all designated sites the assessment of the effect on site integrity should only consider the features for which the site is designated.

4.2.7 Once impacts that could affect a site have been identified, they can be evaluated against the environmental factors necessary to maintain the integrity of the site, with consideration being given to the timing, duration, reversibility, extent and magnitude of any effect. Professional judgement will be used, as appropriate, to make the final judgement as to whether there will be a significant effect.

4.2.8 For designated sites of international and national value, assessment of the potential effects on integrity should make explicit reference to any published conservation objectives.

4.2.9 Similarly, for some species and habitats (notably those with Biodiversity Action Plans) there may be objectives for the conservation status of the species/habitat.

4.2.10 Where impacts are anticipated to result in an adverse effect on site integrity, then this should be considered significant at the same geographical scale at which the site is valued. However, when considering adverse effects on conservation status of habitat and species, where an effect is not found to be significant at the level at which the resource/receptor has been valued, it may in some cases be significant at a lower level.

[12] Green bridge is a structure with vegetation, providing habitat connectivity across the route of the Proposed Scheme.
[13] ODPM Circular 06/2005; Biodiversity and geological conservation – Statutory obligations and their impact within the planning system.

4.2.11 A 'worst case' rule is to be applied to assessment of the future baseline, in order to take account of uncertainty: significance of effect outcomes arising through the future baseline will only be reported where effects worsen over those reported against the current baseline. As a result of this rule, mitigation and compensation will be provided in line with a 'worst case' assessment.

4.3 Cut-offs for reporting purposes

4.3.1 Individual effects at the local/parish level are as a general rule not to be reported in Volume 2 CA reports as they are not considered to represent material considerations in the decision-making process for the Proposed Scheme. Exceptions may be made where it is considered necessary to demonstrate that particular issues have been considered, such as where an adverse effect occurs at a lower geographic scale than that at which the receptor was valued.

4.3.2 A register of local/parish level effects will be produced and will form an appendix to the ES. Potential cumulative and in-combination effects of multiple local/parish level effects will be considered in the route-wide assessment (Volume 3 of the ES).

4.4 Cumulative effects

4.4.1 Cumulative effects[14] include:

- the combined ecological effect on a single receptor of a number of individual environmental impacts (e.g. the loss of habitat to land required for construction and operation of the Proposed Scheme, combined with noise and airborne dust) arising from the Proposed Scheme;
- the cumulative effects of localised ecological impacts along the length of the Proposed Scheme; and
- interaction between ecological effects arising from the Proposed Scheme and those from other relevant projects and plans which take place during the construction or operational phases.

4.4.2 The cumulative effects resulting from the accumulation of effects summed in a regional context or over the whole route, resulting in an effect or effects of greater significance than the sum of the individual effects, will be reported in the route-wide report (Volume 3 of the ES).

4.4.3 The wider effects of climate change on the likely effects as a consequence of the Proposed Scheme, and the effects of the scheme on the ability of habitats and species to respond to future pressures of climate change, will be reported primarily as part of the route-wide ecology assessment in Volume 3 of the ES.

4.4.4 Studies concluded that the effects of climate change, when considered in combination with predicted effects arising from construction and operation of the Proposed Scheme, may exacerbate the ecological effects of the Proposed Scheme but

[14] A future development is considered to be part of the future baseline if it changes the local environment (or creates additional receptors) prior to 2020 or 2027 (for construction and operational future baselines, respectively); it is considered to contribute cumulative effects if its construction or operation occur contemporaneously with HS2 and increase the effects of HS2 on receptors.

are unlikely to result in any effects of greater significance. Nonetheless, consideration will be given to the situations in which ecological effects arising from future climate change may exacerbate the effects of the Proposed Scheme (see Table 6 within the HS2 Phase 2a SMR relating to climate change) and any consequent changes in levels of significance will be reported within the CA reports. In particular, if the in-combination analysis suggests that existing mitigation measures need to be enhanced or additional mitigation is required, this will be clearly identified. For the purposes of this analysis, '2020' climate predictions will be used for construction effects and '2050' for operational effects. In addition, any regional or local policies and guidance on climate change impacts, risks and adaptation will be considered.

5 Mitigation, compensation and enhancement

5.1 Introduction

5.1.1 A future development is considered to be part of the future baseline if it changes the local environment (or creates additional receptors) prior to 2020 or 2027 (for construction and operational future baselines, respectively); it is considered to contribute cumulative effects if its construction or operation occur contemporaneously with HS2 and increase the effects of HS2 on receptors.

5.2 Approach to mitigation, compensation and enhancement

5.2.1 Following the assessment of effects, the ecology sections of the Volume 2 CA reports will present details of the further mitigation, compensation and enhancement measures (i.e. those in addition to the fundamental engineering design) that are proposed to address the anticipated effects. In describing such measures terminology should explicitly distinguish between mitigation, compensation and enhancement as defined within the CIEEM guidelines.

5.2.2 For each significant adverse ecological effect, appropriate mitigation or compensation will be identified where feasible. This mitigation or compensation proposed will be informed by professional judgement, experience, and an understanding of the factors that contribute to the integrity of a site and to the conservation status of a species or habitat.

5.2.3 Overall, in line with Government policy, the project is seeking to achieve no net loss in biodiversity at the route-wide level.

5.2.4 In defining and making recommendations for appropriate measures to address significant effects their deliverability should be considered, along with certainty about their likely success. Measures which are unlikely to be successful (probability estimated at below 50%) should not be included. Rather, certain/near-certain (probability estimated at 95% chance or higher) or probable (probability estimated above 50% but below 95%) measures should be recommended. For measures for which the success is regarded as 'probable', recommendations for monitoring/corrective action are likely to be appropriate.

5.2.5 Recommendations about timing of mitigation/compensation/enhancement measures should be made where these are relevant to the likely effectiveness of the proposed measures to address predicted adverse effects.

5.2.6 Where there remain significant ecological effects, which it is not possible to reduce below the level of significance by mitigation, compensation or enhancement will be provided.

5.2.7 Proposals for enhancement and measures designed as compensation for residual effects are sometimes confused. They are distinct, in that appropriate compensation measures should address specific residual impacts and should be designed to provide, as far as possible, direct replacement of any habitats lost. In contrast, enhancement measures could be entirely unrelated to any adverse effects of the Proposed Scheme.

5.2.8 Planting provided for the primary purpose of landscaping should also be reported as compensation where its provision is also of ecological benefit.

5.3 Location of compensation/enhancement provision

5.3.1 The provision of mitigation, compensation and enhancement required to address the effects of the scheme will primarily be reported at the level of the individual CA (Volume 2 of the ES). Where possible, compensation and enhancement will be provided in accordance with CIEEM guidance in relation to ecological equivalence and location. However, such provision will not necessarily be provided within the same CA as the adverse effects occurred, where greater ecological benefits can be achieved by pooling habitat creation or providing in another location. In such circumstances, compensation/enhancement provisions should be described in the CA in which the provision will be made. They should then be cross-referenced in the mitigation, compensation and enhancement section of the CA where the effect occurred, in order to ensure that the reasoning for residual effects is clear.

6 Residual effects

6.1 Introduction

6.1.1 Following the description of all mitigation, compensation and enhancement measures proposed, the residual effects section will consider the net effects of the Proposed Scheme once these measures have been implemented.

6.1.2 Significant effects on habitat types which are considered irreplaceable (e.g. ancient woodland) should be listed as a significant residual effect even where compensation or enhancement is proposed. In such cases the loss of irreplaceable habitat should be identified as an adverse effect. Where compensation has been provided to address this effect then a corresponding 'beneficial' effect (and a geographic level of significance) may be identified for any compensation/enhancement provision proposed to offset the losses.

6.1.3 This approach is likely to be utilised mainly in relation to impacts of the Proposed Scheme on ancient woodlands. It is intended to reflect the view that some habitats (e.g. ancient woodland) and features are irreplaceable and as such cannot be offset on a 'like for like' basis. In this instance, the 'beneficial' effect will be included to

demonstrate the positive value of the proposed compensation, while acknowledging that the new habitat cannot replace ancient woodland.

6.1.4 For all other significant effects identified prior to the incorporation of mitigation, compensation and enhancement, consideration should be given as to whether the proposed measures are sufficient to offset effects. Where this is the case these effects will be considered to have been addressed, and no significant residual effect will be reported. Where mitigation, compensation or enhancement provision is not likely to reduce the effect below the level of significance, this will be reported as a significant 'residual effect'.

6.2 Consequences of significant residual effects

6.2.1 The consequences in legal and policy terms of significant residual effects of the Proposed Scheme will be presented within the route-wide assessment in Volume 3 of the ES. As described in the CIEEM guidelines (paragraph 6.1), such explicit presentation enables the decision-making body to ensure that the Proposed Scheme:

- complies with legal requirements e.g. the need to obtain a licence for any work affecting protected species or the implications in respect of the Conservation (Natural Habitats) Regulations[15];
- meets international, national and local policy objectives; and
- requires conditions and legal obligations attached to the consent that deal with aspects of the detailed design and implementation of the project.

[15] HMSO (1994), The Conservation (Natural Habitats, &c.) Regulations 1994 No. 2716.

Appendix A: Resource evaluation criteria

Table A1: Resource evaluation criteria table

Value of resource	Selection criteria
International or European	An internationally designated site or candidate/proposed site (SPA, pSPA, SAC, cSAC, pSAC and/or Ramsar site, pRamsar site). A sustainable area of a habitat which is significant at an international level and which is capable of meeting the criteria for designation as a site of international value. A sustainable population of a species which is significant at an international level and which is capable of meeting the relevant criteria for designation as a site of international value.
National	A nationally designated site (SSSI, NNR, Marine Nature Reserve). A sustainable area of a habitat which is significant at a national level and which is capable of meeting the criteria for designation as a site of national value. A sustainable population of a species which is significant at a national level and which is capable of meeting the relevant criteria for designation as a site of national value.
Regional	Sites/populations which exceed the County or Metropolitan-level designations but fall short of SSSI selection guidelines. A sustainable population of a species which is significant at a regional level and which is capable of meeting the relevant criteria for designation as a site of regional value.
County/ metropolitan	Some locally designated sites (including Local Wildlife Sites and Sites of Metropolitan Value for nature conservation). A sustainable area of a habitat which is significant at a county level and which is capable of meeting the criteria for designation as a site of county value. A sustainable population of a species which is significant at a county level and which is capable of meeting the criteria for designation as a site of county value.
District/borough	Some designated sites (e.g. Sites of Borough Value). Sites/features which are scarce within the District/Borough or which appreciably enrich the District/Borough habitat resource.
Local/parish	Sites/populations, which appreciably enrich the immediate vicinity or parish habitat resource (e.g. moderately species-rich hedgerows) but which are not in themselves of district/borough value.
Negligible	Habitats or species populations that do not appreciably enrich the ecological value of the immediate vicinity.

N.B. Local Nature Reserves may be of value at a range of geographic levels and professional judgement should be applied based on consideration of the specific features for which the site is designated.

Appendix B: Approach to precautionary assessment

1 Introduction

1.1.1 Due to access delays and refusals it will not be possible to access all areas identified as falling within the desired scope of ecology surveys. As a consequence, the ecological impact assessment (EcIA) will in some situations be based upon limited or incomplete data.

1.1.2 In order to comply with requirements of the Environmental Impact Assessment Directive (85/337/EEC)[16] it is necessary for the ecology sections of the Environmental Statement (ES) to identify the 'likely significant effects of the proposed project'. In order to comply with the requirements of the Directive in the absence of a full data set it is necessary to adopt a precautionary approach and attempt to identify those effects which are likely to be significant based on the available information. Case law demonstrates that it is not acceptable to simply rely upon the defence that survey work to be undertaken at a later date will identify where significant effects are likely to occur.

2 Baseline valuation

2.1.1 The level of information available to inform the valuation of ecological features within the EcIA will vary widely.

2.2 Complete access – complete field survey information available

2.2.1 Where full baseline information (i.e. information to the level that would typically support an ES) is available to inform the valuation process, then the standard approach to valuation as outlined within the CIEEM guidelines should be followed.

2.2.2 For all such valuations, ecological features should be firmly attributed to the most appropriate geographical frame of reference. The use of precautionary terminology such as 'up to' or 'likely to be' should not be utilised for the valuation of receptors that fall into this category.

2.3 Partial or no access – incomplete field survey or desk study information only

2.3.1 Where it has not been possible to complete field survey to a level that would normally be appropriate in support of an environmental statement, then it will be necessary to make a precautionary assessment.

[16] On 12 March 2014, the European Parliament voted to adopt substantive amendments to the Environmental Impact Assessment ("EIA") Directive 2011/92/EU. These amendments made by EIA Directive 2014/52/EU were transposed into UK legislation by the Town and Country Planning (Environmental Impact Assessment) Regulations 2017 (SI 2017/571 (the 'EIA Regulations').

2.3.2 For habitats, it is likely that it will be possible to identify potential ecological features to a reasonable level of detail through analysis of aerial photography (e.g. woodland at Location 1).

2.3.3 For species receptors where some field survey has been undertaken, but it is incomplete, it is likely to be possible to identify the ecological feature or potential ecological feature to a reasonable level of detail. (e.g., bat assemblage at Location 2, or potential amphibian population associated with ponds at Location 3).

2.3.4 Where no field survey access has been possible, in the first instance an attempt should be made to identify individual ecological features through review of aerial photography and other relevant available existing information (e.g. potential bat assemblage associated with unsurveyed woodland at Location 3).

2.3.5 Where this is not possible then it will be necessary to provide a collective precautionary valuation at the community area (CA) level (e.g. other bat populations within the Location4 area).

2.3.6 In all such situations, a precautionary valuation that represents a 'reasonable worst-case' is to be provided, i.e. one that is precautionary but it is reasonable to assume could occur, rather than an extreme scenario that is on balance unlikely. In all such cases where the baseline is incomplete the degree of precaution built into the assessment should be linked to the level of confidence in the existing data upon which the assessment is based.

2.3.7 For example, it is considered reasonable to assume that, within a network of partially surveyed ponds (in a locality where several small great crested newt populations have been found to occur), further populations of great crested newt may be identified, and that these would likely be of small or medium population size class. However, it would not normally be reasonable to assume that every pond where survey is incomplete is likely to support a high population of great crested newts.

2.3.8 For each potential receptor, a reasonable worst-case valuation should be attributed based on the information available. This should include consideration of any available field or desk study data (including aerial photography), a comparison with similar habitat areas occurring in the wider local area, and a qualitative consideration against any factors that indicate suitability for the particular habitat or species in question.

2.3.9 In all cases throughout the paragraph and table text in the Volume 2 CA reports it should be made clear where a precautionary approach has been adopted through the use of the qualifier 'up to' alongside the relevant geographic frame of reference.

2.4 Impact assessment

2.4.1 Where a precautionary valuation has been made, and an effect significant at the district/borough level or higher is possible, then a description of the likely impacts as a consequence of the Proposed Scheme should be provided. The description of impacts should be as specific as the knowledge of the baseline allows. For example, it may be possible to say that a specific pond of up to district/borough value for amphibians is to be lost. However, a general statement may need to be made in relation to bats to say that activities in this area will result in the loss of trees and buildings which could support bat roosts.

2.4.2 The term 'could' (as opposed to 'will') is to be utilised in the assessment conclusions wherever a precautionary assessment of 'up to' X value has been necessary (e.g. this could result in an adverse effect that is significant at up to the county/metropolitan level).

2.5 Mitigation and compensation provision

2.5.1 For habitat losses, it is likely that it will be possible to provide a clear indication as to how potential effects occurring on receptors that have not been accessed for survey will be mitigated or compensated. In most cases, as the broad habitat type will be discernible from aerial photography, it is likely that habitat losses will have been accounted for within the mitigation and compensatory provision that has been incorporated into the mitigation schedules.

2.5.2 For protected species, in many cases it will not be possible to specifically identify the required level of mitigation/compensation, as the exact nature of the impacts will not be discernible until it is possible to access land and gain a fuller understanding of the baseline. Therefore, a commitment will be made to providing mitigation/compensation in line with a set of agreed principles of mitigation for the species concerned.

HS2 Phase 2a West Midlands - Crewe: Technical note – Ecology and biodiversity - Methodology for demonstrating no net loss in biodiversity

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1 Introduction

1.1 Purpose of this technical note

1.1.1 The UK Government is committed to halting overall loss in biodiversity by 2020. Inline with government policy, High Speed Two Limited (HS2 Ltd) is seeking to ensure that HS2Phase 2a West Midlands scheme- (hereafter referred to as the Proposed Scheme) results in no net loss in biodiversity at a route-wide level.

1.1.2 Demonstrating no net loss in biodiversity represents a significant challenge to a large project such as the Proposed Scheme. This technical note sets out the approach that HS2 Ltd proposes to use to compare biodiversity losses and gains, as a consequence of the Proposed Scheme.

1.2 Biodiversity offsetting

1.2.1 Biodiversity offsets are conservation activities designed to deliver biodiversity benefits in compensation for losses, in a measurable way[1]. Offsetting methodologies compare the losses resulting from the impact of a development with the gains achieved through the provision of offsets, thus aiming to provide a transparent mechanism by which the impacts of a development can be quantified, and an appropriate level of compensation agreed.

1.2.2 Biodiversity in its entirety is impossible to measure so offsetting utilises a 'metric' to represent, and provide a measure of, overall biodiversity[2]. Metrics are surrogates[3], or combinations of measurements, that together provide an assessment of the biodiversity value of a particular area. The metric allows the biodiversity impact of a development to be quantified so that the offset requirement, and the value of the compensatory action, can be clearly defined. Metrics are transferable between sites and habitats, allowing an impact on one habitat type to be offset with conservation action elsewhere, or involving a different habitat type and/or quality of habitat.

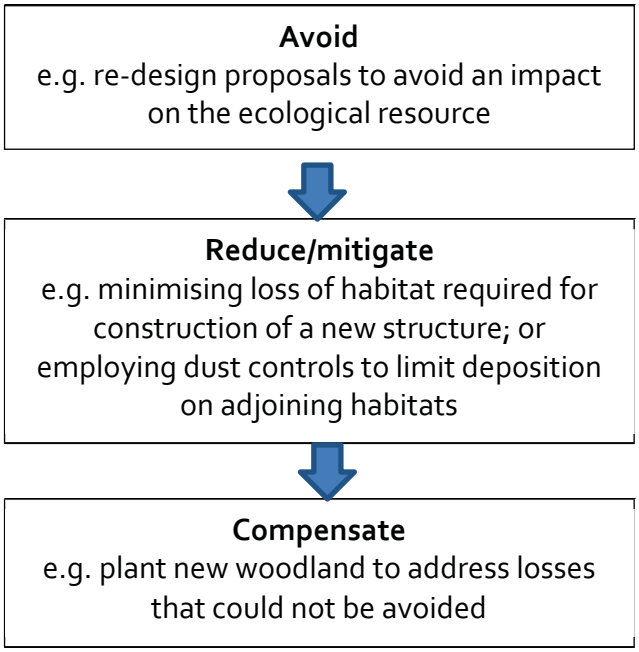
1.2.3 Use and further development of offsetting methodologies is considered vital to ensuring that the planning system secures meaningful compensation which can contribute to the Government's commitment to expand and restore the ecological network in England, and to halt overall biodiversity loss by 2020[4].

1.3 Position within the mitigation hierarchy

1.3.1 In seeking to minimise the effects of the Proposed Scheme on biodiversity, the 'mitigation hierarchy' outlined in Figure 1 will be applied.

[1] Defra (2012a), Biodiversity Offsetting Pilots: Information note for Local Authorities.
[2] Defra (2012b), Biodiversity Offsetting Pilots: Technical Paper: the metric for the biodiversity offsetting pilot in England.
[3] Surrogates are measurements that act as substitute for a complete measurement of the total biodiversity found within a particular area.
[4] Defra (2011), Biodiversity 2020: A strategy for England's wildlife and ecosystem services.

Figure 1: Mitigation hierarchy



1.3.2 Offsetting (and the use of offsetting metrics) represents a method of defining an acceptable level of compensatory provision. It occupies a position at the bottom of the mitigation hierarchy, providing the opportunity to quantify compensation, when it has been determined that compensation is required. It does not represent an alternative to the normal application of the mitigation hierarchy. In all cases, the earlier stages in the mitigation hierarchy should be considered sequentially before the end point of a requirement for compensation, and thus a need to adopt an offsetting approach is reached.

1.3.3 Where it is accepted that reasonable efforts have been made to explore alternatives during the design process and the mitigation hierarchy has been applied, then the offsetting metric outlined in this technical note will be utilised to compare the losses and gains in biodiversity that occur as a consequence of the Proposed Scheme.

1.3.4 The approach advocated in this technical note should be considered in this context and separated from considerations associated with the avoidance, reduction and mitigation aspects of the hierarchy, which will have been explored in depth independently at earlier stages in the process.

1.4 Defra offsetting pilot

1.4.1 The development of a consistent framework for biodiversity offsetting was identified as a priority in the Natural Environment White Paper[5] (2011). In line with this goal, in April 2012, Defra launched a two-year pilot study to trial the use of offsetting in six test areas. The pilot is based upon use of a habitat based 'metric' for considering losses and gains in biodiversity.

[5] HM Government (2011), The Natural Choice: Securing the value of nature. Her Majesty's Stationery Office, London.

1.4.2 The approach involves measuring each area of habitat present before the development against pre-defined scales based on 'distinctiveness' and 'condition'. The scores obtained are then multiplied to give a number of biodiversity units per hectare, and adjusted on the basis of the area of that habitat type present.

1.4.3 For example, for a development which will result in the loss of 6 hectares of lowland meadow in moderate condition (further details of the scoring system are provided in Section 3), the number of biodiversity units is calculated as follows:

> Distinctiveness score (6) x habitat condition score (2) x habitat extent (6) = 72 biodiversity units

1.4.4 This step is then repeated for each habitat area within the extent of the development to calculate the number of biodiversity units that will be lost.

1.4.5 The calculation as a whole is then repeated to consider the number of biodiversity units that will be provided by the habitat creation or habitat restoration which has been committed to as part of the proposed development. This calculation considers the extent, distinctiveness and target condition for proposed habitats and a series of multipliers are utilised to ensure the compensation strategy takes into account spatial, temporal and delivery risks associated with the provision of the replacement habitats.

1.5 Biodiversity offsetting and the Proposed Scheme

1.5.1 The Defra offsetting pilot methodology is considered to represent the best available basis for an offsetting methodology that will allow the biodiversity losses and gains of the Proposed Scheme to be robustly assessed. However, a number of amendments to the published pilot methodology were considered necessary to address matters that arose from the use of the methodology within the pilot areas, and to ensure that it is suitable for use in support of a landscape-scale project.

1.5.2 The key amendments to the Defra pilot methodology which were used, in the first instance, for calculating losses and gains for HS2 Phase One were:

- adding an additional 'very high' score under habitat distinctiveness to take account of those habitats of principal importance identified in Section 41 of the Natural Environment and Rural Communities (NERC) Act (2006)[6] which cannot be adequately re-created if lost;
- Increasing the distinctiveness score attributed to all habitats that form part of an area that qualifies as the habitat of principal importance type 'open mosaic habitat on previously developed land', thus ensuring the value of these habitats is fully recognised within the calculation;
- removing the application of a variable condition weighting for habitats of low distinctiveness - all low distinctiveness habitats will instead automatically attract a condition weighting of 'poor', thus recognising that condition has negligible effect on the overall value of those habitats which are intrinsically of low distinctiveness;

[6] Natural Environment and Rural Communities Act (2006) Chapter 16. Her Majesty's Stationery Office, London.

- incorporating greater consideration of the importance of both habitats lost and gained (in relation to the function of ecological networks) into the spatial multipliers, in order to recognise the landscape scale of the project and its impacts;
- removing the blanket one-step restriction on the change in condition and replacing this with the condition that for high distinctiveness target habitats a maximum future target condition of moderate can be claimed; and
- considering watercourses as a linear rather than an area-based measure.

1.5.3 In 2016, Natural England undertook a review[7] of the HS2 Ltd No Net Loss (NNL) in Biodiversity Calculation[8]. In response to that review, HS2 Ltd incorporated the following changes to the NNL metric:

- ancient woodland and all associated compensatory habitat provision were removed from the NNL calculation and dealt with in separate reporting (an ancient woodland strategy). No metric was used to compare losses of ancient woodland with compensatory measures as ancient woodland is an irreplaceable resource;
- bespoke time to target condition multipliers were to be added in for some 'low' distinctiveness habitats subject to temporary land take; and
- HS2 Ltd indicated its intention to publish more detailed reporting on the methodology utilised, quality assurance processes followed and further commentary on how and why changes to the Defra metric had been made.

1.5.4 In addition, Natural England's review recommended that they coordinate the development of several elements of the metric, including a new spatial multiplier to better account for the growing body of scientific evidence on ecological connectivity.

1.5.5 It should therefore be considered that the methodology presented in this note is iterative and may be revised as new peer reviewed evidence becomes available. Any proposed alterations will be given careful consideration, taking into account the programme for the Proposed Scheme. In doing so, HS2 Ltd will continue to work in close consultation with Natural England.

1.5.6 Pending any updates outlined in Sections 1.5.3, 1.5.4 and 1.5.5, HS2 Ltd intends to utilise the methodology contained within this technical note to calculate and compare the likely biodiversity losses and gains that will occur as a consequence of the Proposed Scheme. In doing so, it will seek to demonstrate in a transparent manner the current position that the Proposed Scheme has reached in relation to its commitment to seek no net loss in biodiversity at the route-wide level.

[7] Natural England, 2016 Review of the High Speed 2 No Net Loss in Biodiversity Metric https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/565691/review-of-hs2-no-net-loss-metric.pdf

[8] HS2 Ltd. (2015) *HS2 London-West Midlands: No net loss in biodiversity calculation: Methodology and results,* https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/490928/No_net_loss_in_biodiversity_calculation_-_methodology_and_results_v2.pdf

1.5.7 The post-development calculation will include consideration of the bespoke areas of ecological compensation to be provided, areas of planting which have been primarily provided to address landscaping considerations, and those habitats that will form part of the operational railway (e.g. cutting slopes). Both spatial risk and delivery risk multipliers will be applied to address the inherent uncertainty involved in habitat creation. These multipliers will serve to temper the number of biodiversity units that can be achieved through the creation of habitats where there is an increased risk of failure.

1.5.8 The focus of ecological compensation for habitat losses to be provided by the Proposed Scheme will be the provision of areas of habitat of principal importance in a manner that will contribute to the 'bigger, better and more joined up' ideals identified in Making Space for Nature (Lawton, 2010)[9].

1.5.9 While an offsetting metric has been used as the means of comparing habitat losses and gains as a consequence of the Proposed Scheme, it is the intention of HS2 Ltd to deliver the new habitats through powers under the hybrid Bill rather than via the establishment of formal offsetting agreements with third parties. The use of formal offsetting agreements with third parties is not envisaged to deliver any of the required measures at this stage, although such agreements may be required to deliver additional measures should these be required.

1.5.10 Natural England's review included recommendations where Sites of Special Scientific Interest (SSSI) were directly affected. Although there were three such sites for HS2 Phase One, none are directly affected by HS2 Phase 2a. These recommendations are therefore not relevant to this technical note.

2 Units within the metric

2.1 Habitat parcels

2.1.1 The metric to be utilised for the Proposed Scheme represents a modified version of the Defra pilot methodology, and will predominantly utilise habitat parcels as the basis for comparing losses and gains in biodiversity as a consequence of the Proposed Scheme.

2.1.2 Phase 1 habitat survey[10] and National Vegetation Classification (NVC) data (where available) will be utilised to identify all habitats parcels that meet one of the following criteria:

- habitats located within the extent of the land required for the construction of the Proposed Scheme[11];

[9] Lawton J (Chair) (2010), Making Space for Nature: A review of England's Wildlife Sites and Ecological Network. Report to Defra.
[10] Phase 1 Habitat Survey is a habitat classification and associated field survey technique which provide a standardised system to record semi-natural vegetation and other wildlife habitats. JNCC (2010) Handbook for Phase 1 habitat survey - a technique for environmental audit.
[11] The land required for the construction of the Proposed Scheme is defined as the combined extent of all areas of land required either temporarily during construction or permanently during operation.

- habitats located within the extent of any areas proposed for habitat creation or habitat enhancement (where these lie outside the boundaries of the land required for the construction of the Proposed Scheme); and
- areas of habitat outside the land required for the construction of the Proposed Scheme where the Environmental Statement (ES) identifies that the habitat is likely to be subject to adverse effects considered to be significant at the district/borough level or above[12] as a consequence of the Proposed Scheme.

2.1.3 Each habitat parcel which meets one of the criteria identified in paragraph 2.1.2 will be allocated a weighted score on the basis of each of the following criteria:

- habitat distinctiveness;
- habitat condition; and
- position within an ecological network

2.1.4 The modified metric will be used to calculate the number of biodiversity units afforded to the habitat parcels that will be affected by the Proposed Scheme. This total will subsequently be compared with the number of biodiversity units that are achieved by habitat parcels present post-development.

Arable field margins

2.1.5 Arable field margins specifically managed for wildlife and likely to qualify as the habitat of principal importance type arable field margins are infrequent across the route of the Proposed Scheme. Where field survey or interpretation of aerial photographs identifies the presence of margins that may qualify, then a standard width of 10m will be used to provide an estimate of the number of biodiversity units that are contributed by such features.

2.1.6 For all other arable fields falling within the scope of the pre-development calculations, it will be assumed that an uncultivated arable margin of 1m width and moderate distinctiveness is present. Such features are too small to map accurately but given the scale of the Proposed Scheme could contribute a significant number of biodiversity units at the route-wide level.

2.1.7 The biodiversity units generated by arable field margins will be considered as part of the overall biodiversity units score generated by habitat parcels.

2.2 Linear features – hedgerows and watercourses

2.2.1 Hedgerows and watercourses will be considered as linear features and each will form a separate accounting element of the calculation.

2.2.2 Both hedgerows and watercourses will generate their own number of biodiversity units pre- and post-development. Due to the unique nature of both habitat types it will only be suitable to offset losses on these habitat types through the provision of the

[12] The significance of effects described in the ecological impact assessment of the Proposed Scheme follows the methodology set out in: Chartered Institute of Ecology and Environmental Management, (2016), Guidelines for Ecological Impact Assessment in the UK and Ireland Second Edition. CIEEM, Winchester.

same habitat type (i.e. loss of hedgerow can only be offset by creation of more hedgerows).

2.2.3 Losses and gains will generate biodiversity units based on the length of hedgerow or watercourse lost or gained. Other multipliers will be utilised where applicable, and in order to ensure clarity, consideration of hedgerows and watercourses as part of the calculation is covered separately in this technical note.

3 Calculating pre-development biodiversity units

3.1 Habitat distinctiveness

3.1.1 Habitat distinctiveness will be scored against a four category scale as detailed in Table 1.

3.1.2 Under the Defra pilot methodology all areas of habitat of principal importance fall within a 'high' category which scores a weighting of 6.

3.1.3 Where semi-natural ancient woodland is lost, the losses will be reported separately and no metric will be used to compare these losses with gains due to provision of compensatory measures.

Table 1: Habitat type bands

Distinctiveness	Habitats types included	Weighting
High	Habitats of principal importance i.e. those which meet the criteria[13] to qualify as habitats of principal importance (excluding ancient woodland).	6
Moderate	Other semi-natural habitats that do not fall within the scope of habitats of principal importance definitions, i.e. all other areas of woodland (e.g. non-native coniferous plantation), other grassland (e.g. species poor semi-improved), uncultivated field margins, road verge and railway embankments (excluding those that are intensively managed).	4
Low	Habitats including improved grassland, arable fields (excluding any uncultivated margins), built up areas, domestic gardens, regularly disturbed bare ground (e.g. quarry floor, landfill sites etc.), verges associated with transport corridors.	2
None	Habitats that are of no or negligible value for biodiversity e.g. roads and other hardstanding, transport corridors (without associated verges), landfill sites, spoil heaps.	0

3.1.4 Phase 1 habitat survey and National Vegetation Classification (NVC) (where available) data will be utilised as the basis for allocating a distinctiveness score to all habitat parcels that meet the criteria outlined in paragraph 2.1.2.

3.1.5 Where Phase 1 habitat data collected during field surveys in support of the Proposed Scheme are available, this data will be utilised. Where no field survey information is available, gaps will be filled utilising either Phase 1 habitat data derived from aerial

[13] UK BAP (2011), UK Biodiversity Action Plan – Priority Habitat Descriptions. http://jncc.defra.gov.uk/PDF/UKBAP_PriorityHabitatDesc-Rev2011.pdf

photography analysis or through use of Phase 1 habitat data derived from habitat inventories where available.

3.1.6 The categories utilised within the metric for the Defra pilot are principally aligned with the use of the Integrated Habitat System (IHS)[14] (an alternative habitat classification methodology) which splits out habitats of principal importance from those that do not qualify under these criteria. Appendix A provides guidance to be utilised in translating Phase 1 habitat data into the habitat distinctiveness categories identified in Table 1. It aims to ensure each habitat type is broadly aligned with the guidance provided in Appendix 1 to the Defra guidance for offset providers and developers[15].

3.1.7 As Phase 1 habitat categories and habitats of principal importance definitions do not always strongly correlate, in some cases a single Phase 1 habitat type could include both areas that qualify as habitats of principal importance and other areas that do not. As a consequence, in allocating distinctiveness ratings it will be necessary to subdivide some Phase 1 habitat polygons for the purposes of the offsetting calculation.

3.1.8 Phase 1 habitat categories which are recorded as point data (e.g. scattered scrub or individual trees) will be considered on the basis of the distinctiveness rating of the underlying habitat polygon. Where the presence of a point data category is considered to add to the distinctiveness rating of the underlying habitat type (e.g. the presence of the scattered scrub within an area of ephemeral/short perennials) then the distinctiveness rating of the underlying habitat type polygon will be adjusted manually to account for this.

3.1.9 For those Phase 1 habitat types where more than one potential weighting score has been identified it will be necessary for an ecologist to review available habitat data (including information from any subsequent Phase 2 surveys conducted) and allocate a score, based on the guidance provided in Table 1.

3.1.10 When scoring habitat polygons, consideration will be given to those locations where the combination of habitats present may fall within the definition of the habitat of principal importance 'open mosaic habitat on previously developed ground'.

3.1.11 Where a combination of habitat polygons are considered to collectively meet the criteria for the open mosaic on previously developed ground (habitat of principal importance type) then all habitat parcels which fall under the scope of the definition should be upgraded to a high distinctiveness rating (6 points) (e.g. areas of tall ruderals and short ephemerals which may alone have scored 2 for distinctiveness would each be upgraded to a score of 6, while the areas of interconnecting bare ground would continue to score 2).

3.1.12 The habitat definition for open mosaic habitat on previously developed ground sets a minimum threshold for this habitat type of 0.25ha. The minimum size refers to the potential open mosaic habitat which could be part of a larger site, containing other elements such as woodland or developed land.

[14] http://ihs.somerc.co.uk/
[15] Defra (2012), Appendix 1 - Distinctiveness Bands for the Biodiversity Offsetting Pilot. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69531/pb13745-bio-technical-paper.pdf

3.1.13 Continuous blocks of a closed plant community greater than 0.25 ha should as a general rule be classified according to the relevant habitat category, although those containing very fine-grained mosaics might qualify under the open mosaic on previously developed ground definition.

3.2 Habitat condition

3.2.1 All habitat parcels classified as falling within distinctiveness bands high and moderate will be rated against a three-point condition scale with reference to the Higher Level Stewardship (HLS) agri-environment scheme condition assessment tool (Natural England, 2010)[16] utilised within the pilot methodology.

3.2.2 The condition scale is basic and where it is applicable, habitat survey notes will be utilised to allocate a condition score to each habitat parcel (see Table 2 below). Where all of the stated criteria are met then a condition assessment category of good (or A rating) is given. Where one of the criteria is missed or failed then a moderate (B rating) is given, and where two or more criteria are failed/missed then a low condition (C rating) is allocated.

Table 2: Condition weighting scale

Condition score	HLS condition assessment category	Framework for those habitats which are not covered by HLS condition assessment
3	A rating	Good
2	B rating	Moderate
1 N.B: A condition score of 1 will also be automatically applied to all habitats of low distinctiveness	C rating	Poor

3.2.3 The HLS guidance does not cover all habitat types that fall within the scope of this assessment, and where the HLS assessment guidance provides no relevant criteria then professional judgement will be applied to allocate a condition score against the three-point scale. Ecologists undertaking the condition scoring will be encouraged to discuss those situations where it is necessary to apply professional judgement, and a decision log will be maintained in order to ensure such judgements are consistently applied across the route.

3.2.4 All habitats identified as being of low habitat distinctiveness will automatically be allocated a condition weighting of 1. This modification to the metric reflects the view that for habitats of low distinctiveness the condition of the habitat has negligible influence on the overall value of that habitat type. For similar reasons, no condition rating will be applied to assumed arable field margins.

3.2.5 Where access has not been obtained for survey then it will be necessary to allocate a condition score based on a precautionary approach informed by professional judgement. A condition score of 3 (good) is likely to be achieved only by those

[16] Natural England (2010), Higher Level Stewardship – Farm Environment Plan (FEP) Manual – Technical guidance on the completion of the FEP and identification, condition assessment and recording of HLS FEP features. Natural England.

habitats which are being actively managed to maximise their value for nature conservation. As a consequence, where existing data suggest that land is likely to be subject to management aimed to maximise its nature conservation value, then a score of 3 will be allocated.

3.2.6 As a general rule, in the absence of access to conduct surveys a moderate condition (2 points) will be assumed. A condition score of poor (1 point) will be allocated where there is a very clear justification for this conclusion based on the information available.

3.3 Position within existing ecological network

3.3.1 A key consideration of current nature conservation policy and guidance is the goal of working towards the creation of 'bigger, better and more joined up'[17] ecological networks.

3.3.2 While the Defra offsetting pilot methodology considers spatial risks associated with the location of compensation provision, it does not implicitly consider the importance of the habitats lost to existing ecological networks. Based on the landscape scale of the Proposed Scheme, HS2 developed a multiplier to be utilised in both the pre- and post-development calculations to take account of the importance of habitats lost to existing ecological networks.

3.3.3 Incorporating consideration of the spatial distribution of habitats both before and after development, and their potential role in the function of ecological networks is considered to represent a more accurate method of quantifying how the project as a whole will affect progress towards the goals of 'bigger, better and more joined up'.

3.3.4 Therefore, for each habitat parcel, a score would be allocated based on the importance of the habitat lost for the surrounding ecological network, according to the criteria shown in Table 3.

3.3.5 The criteria sought to acknowledge the inherent value of larger and well- connected habitat blocks, particularly those that support habitats of principal importance. The criteria are intended as a means of ensuring these broad concepts are taken into account in the offsetting calculation. They should not be interpreted as an attempt to consider species-specific requirements within the calculation.

3.3.6 However, as outlined in Section 1.5.4, a new multiplier is currently being developed to better consider spatial position in the context of ecological networks for both pre and post development biodiversity units. Therefore, the contents of this technical note, particularly with reference to the 'position within the ecological network' multiplier, may be revised as new evidence becomes available.

[17] Lawton J (2010), Making Space for Nature: A review of England's Wildlife Site's and Ecological Network.

Table 3: Consideration of position within ecological network prior to development

Importance within existing ecological network	**Multiplier**
Habitat areas which form part of a contiguous area of habitat(s) of principal importance which is of more than 1ha in size[18] (core habitat block') and have connectivity with other areas of semi-natural habitat[19]	3
Habitat areas which form part of a contiguous area of habitat(s) of principal importance which is of more than 1ha in size but have little or no connectivity with other areas of semi-natural habitat (i.e. those that do not fall under score of 3above); Habitat areas which form part of a contiguous area of habitat(s) of principal importance which is of between 0.25ha and 1ha in size (regardless of connectivity – these are considered as 'stepping stones'); Habitat which forms part of an area of semi-natural habitat[20] which provides continuous physical connectivity between existing 'core habitat blocks'[21].	2
Any other areas which do not meet the criteria identified for either a multiplier of 2 or 3 above.	1

3.4 Hedgerows

3.4.1 For hedgerows, as the vast majority of all hedgerows will meet the definition for this habitat of principal importance type, the distinctiveness criteria will not be utilised within the calculation.

3.4.2 Gaps of greater than 15m will be considered to represent a break in the hedgerow. Where double hedgerows occur then the length of each constituent hedgerow will be fed into the metric.

3.4.3 As in the Defra pilot methodology, the condition of each hedgerow (or hedgerow section) will be scored against a three-point condition scale (see Table 4), with reference to the guidance provided in the Higher Level Stewardship – Farm Environment Plan (FEP) Manual.

Table 4: Multiplier to be applied for condition of hedgerows and watercourses

Condition of feature lost	Multiplier applied
Good	3
Moderate	2
Poor	1

3.4.4 Where field survey was undertaken, notes from hedgerow surveys will be utilised to inform the scoring for habitat condition. Where no access was available for survey, then this will be informed solely by information obtained from aerial photographs and a precautionary approach will be adopted.

[18] For the purposes of the calculation where areas of habitat of principal importance are separated by gaps of non-qualifying habitat of 15m or less then these should be considered to be contiguous (unless professional judgement of an ecologist considers otherwise).
[19] Based on professional judgement those core areas which have little or no connectivity with other areas of semi-natural habitat should be downgraded to a multiplier of 2 where it is considered that their lack of connectivity is likely to limit their value within the existing ecological network (e.g. for example a severed area of woodland surrounded by an arable field would be downgraded to a multiplier of 2).
[20] Defined for the purposes of this calculation as any area allocated a, high or moderate distinctiveness score.
[21] Physical connectivity is defined for this purpose as a 'continuous' corridor of moderate or high distinctiveness habitat parcels. As a general rule a gap in qualifying habitat of more than 15m in extent, or a section where the minimum width of connective habitat drops below 5m in width (note hedgerows are considered as part of a separate calculation) should be considered to represent a break in connectivity.

3.4.5 In addition to the condition score for hedgerows, a multiplier will be attributed (see Table 5) for the position in the ecological network in order to ensure that the value of the features lost within existing ecological networks are considered fully within the offsetting calculation.

Table 5: Position of hedgerow within existing network

Position within existing network	Multiplier applied
Hedgerows which under the Hedgerows Regulations (1997[22]) scoring achieves a connection score of 4 points or more[23]	3
Hedgerow achieving a connection score of 3 or 2	2
Hedgerow achieving a connection score of 1 point or less	1

3.5 Watercourses

3.5.1 For watercourses, it is assumed that all watercourses will be considered as being of high distinctiveness. As a consequence, distinctiveness multipliers will not be used in the calculation.

3.5.2 For watercourses, the use of the position in the network multiplier is also not considered worthwhile given that all watercourses will provide linear connectivity along their route, and that compensation is likely in each case to be provided through the realignment of the same channel. As such, position in the landscape is unlikely to change.

3.5.3 As a consequence, the number of biodiversity units generated by the watercourses currently present would be calculated by multiplying the length (m) by a condition score using the scale shown in Table 4. This should utilise the criteria set out in the Higher Level Stewardship – Farm Environment Plan (FEP) Manual (Natural England, 2010), alongside professional judgement where necessary.

3.6 Deriving the total biodiversity units present pre-development

Habitat parcels/polygons

3.6.1 Following the scoring of all habitat parcels for habitat distinctiveness, condition and position within existing ecological networks, the total number of pre-construction biodiversity units will be calculated for each parcel/polygon (including those assumed for arable field margins) using the following formula:

> **Number of biodiversity units generated by habitat polygon** = Habitat distinctiveness rating x habitat condition x habitat area x position within existing ecological network.

[22] The Hedgerows Regulations (1997) (SI 199 No. 1160). Her Majesty's Stationery Office. London.
[23] Under the criteria used to define connections within The Hedgerows Regulations (1997) a connection with another hedgerow scores one point and a connection with a pond or a woodland in which the majority of trees are broadleaved trees scores 2 points; and a hedgerow is connected with something not only if it meets it but also if it has a point within 10 metres of it and would meet it if the line of the hedgerow continued.

3.6.2 The scores generated by each individual habitat parcel will then be summed to provide the total number of biodiversity units generated by the habitat parcels present pre-development.

Linear features

3.6.3 The number of biodiversity units present pre-development should be calculated for both hedgerows and watercourses.

3.6.4 The number of hedgerow units present prior to construction of the Proposed Scheme would be calculated as follows:

> **Number of biodiversity units generated by individual hedgerow feature** = length of hedgerow (m) x condition multiplier attributed x position in ecological network.

3.6.5 For watercourses, the number of units present pre-development should be calculated as follows:

> **Number of biodiversity units generated by individual watercourse** = length (m) x condition multiplier attributed

3.6.6 Separate totals will then be calculated for biodiversity units generated by a) hedgerows and b) watercourses present prior to development.

4 Calculating post-development biodiversity units

4.1 General

4.1.1 The post-development calculation of NNL will be based upon the final design, and will incorporate consideration of the habitats that are to be created as part of the Proposed Scheme. This will include both those habitat areas to be created with the primary purpose of providing ecological compensation, and those where the primary purpose is non-ecological (e.g. planting to address landscape effects).

4.2 Habitat distinctiveness

4.2.1 For all habitat parcels to be created as part of the Proposed Scheme a target distinctiveness score will be allocated according to the 'high', 'moderate', 'low' or 'none' categories provided in Table 1.

4.2.2 New habitats or enhanced habitats created in response to loss of semi-natural ancient woodland will be excluded from the post-development calculation as they are a response to loss of irreplaceable habitats.

4.2.3 In line with the principles set out in the Defra pilot methodology, the offsetting approach will seek to improve the extent or condition of the ecological network.

4.2.4 If the habitat impacted by the Proposed Scheme is in the high distinctiveness band, the offset will usually be 'like for like' i.e. it will aim to create or restore the same type of habitat.

4.2.5 For habitat of medium distinctiveness, the offset will largely be made up of habitat from the same distinctiveness band or higher (i.e. habitat from the medium or high distinctiveness band). Where the habitat lost was low distinctiveness, the offset should involve a 'trade up' in distinctiveness (i.e. be largely made up of habitat from the medium or high distinctiveness band).

4.3 Target condition

4.3.1 The offsetting approach for the Proposed Scheme will not utilise the two-step constraint that has been implemented within the Defra offsetting pilot. Instead a cap will be placed on the target condition that can be predicted for the creation of high distinctiveness habitats, with a maximum of a moderate target condition utilised for any such habitats. This approach seeks to recognise the fact that there can be limited confidence in achieving high distinctiveness habitats.

4.3.2 Where habitat restoration or enhancement is proposed then a habitat condition of high can be targeted for habitats of high, moderate or low distinctiveness.

4.3.3 All predictions of target condition should assume that suitable management will be available as a minimum for the period required to ensure target condition is achieved. It should thus be assumed that all habitats that are to be created for the primary purpose of ecological mitigation will aim to achieve the maximum target condition available (i.e. a score of 2 for habitats of moderate distinctiveness and 3 for habitats of high distinctiveness). Given the provision of appropriate management these are considered realistic targets.

4.4 Position within the surrounding ecological network

4.4.1 Where new habitats are created or restoration works are undertaken, the position within the surrounding ecological network, as defined in Table 6, will be utilised to promote compensation provision that will contribute to the principles of 'bigger, better and more joined up'. The criteria used mirror those used in the pre-development side of the calculation, with the addition that a score of 3 will be gained for areas of compensation that fall within the aims of a specified Nature Improvement Area (NIA) or Biodiversity Opportunity Area (BOA) scheme.

4.4.2 Each element of compensation or enhancement provision that is provided as part of the Proposed Scheme should be allocated a score (on a scale of 1-3) to identify the role that the habitat area will play in the ecological network that is present post-development.

4.4.3 However, as outlined in Section 1.5.4, a new multiplier is currently being developed to better consider spatial position in the context of ecological networks for both pre and post development biodiversity units. Therefore, the contents of this technical note, particularly with reference to the 'position within the ecological network' multiplier may be revised as new evidence becomes available.

Table 6: Consideration of position within ecological network post-development

Importance within ecological network	Multiplier
Habitat areas which form part of a contiguous area of habitat(s) of principal importance which is more than 1ha in size[24] (this may be as a result of either creation of new areas of habitat or the expansion of existing habitat areas) and have connectivity with other areas of semi-natural habitat[25]; Areas of habitat creation or expansion within the aims of a specified Nature Improvement Area (NIA) or Biodiversity Opportunity Area (BOA) scheme.	3
Habitat areas which form part of a contiguous area of habitat(s) of principal importance which is of more than 1ha in size but have little or no connectivity with other areas of semi-natural habitat (i.e. those that do not fall under score of 3 above); Habitat areas which form part of a contiguous area of habitat(s) of principal importance which is between 0.25ha and 1ha in size (regardless of connectivity – these are considered as 'stepping stones'); Habitat which forms part of an area of semi-natural habitat[26] which provides continuous physical connectivity between existing 'core habitat blocks'.[27]	2
Any other areas which do not meet the criteria identified for either a multiplier of 2 or 3 above.	1

4.5 Hedgerows

4.5.1 The post-development number of biodiversity units generated by hedgerows should be calculated based on the following criteria:

- length of hedgerow to be created (m);
- target condition – based on the three-point scale provided in Table 4; and
- position of the hedgerow within the post-development network – based on the same criteria used in Table 5.

4.6 Watercourses

4.6.1 For watercourses, the post-development number of biodiversity units generated should be calculated through multiplying the length (m) by the multiplier for target condition shown in Table 4.

4.7 Difficulty of re-creating/restoring

4.7.1 The multipliers proposed in the Defra pilot methodology will be utilised to recognise delivery risk. Habitats will be assigned to the following broad categories of re-creation/restoration risk based on professional judgement, input of Natural England specialists and previous research work. Full details are presented in the Technical Paper which accompanies the Defra offsetting pilot methodology.

[24] For the purposes of the calculation where areas of habitat of principal importance are separated by gaps of non-qualifying habitat of 15m or less then these should be considered to be contiguous (unless professional judgement of an ecologist considers otherwise).
[25] Based on professional judgement those core areas which have little or no connectivity with other areas of semi-natural habitat should be downgraded to a multiplier of 2 where it is considered that their lack of connectivity is likely to limit their value within the existing ecological network (e.g. for example a severed area of woodland surrounded by an arable field would be downgraded to a multiplier of 2).
[26] Defined for the purposes of this calculation as any area allocated a very high, high or moderate distinctiveness score.
[27] Physical connectivity is defined for this purpose as a 'continuous' corridor of moderate, high or very high distinctiveness habitat parcels. A gap in qualifying habitat of more than 15m in extent, or a section where the minimum width of connective habitat drops below 5m in width (note hedgerows are considered as part of a separate calculation) should as a general rule be considered to represent a break in connectivity.

Table 7: Consideration of difficulty of re-creating/restoring

Difficulty of re-creation/restoration	Multiplier
High	0.33
Medium	0.67
Low	1.00

4.8 Time to target condition

4.8.1 In delivering offsets there may be a mismatch in the timing of impact and offset. This is defined in the offsetting pilot methodology as the difference in time between the negative impact on biodiversity and the offset reaching the required quality or level of maturity. This mismatch results in loss of biodiversity for a period of time.

4.8.2 It is intended that the time discounting rate of 3.5% proposed in the pilot methodology and detailed in Table 8 below is utilised unchanged for the Proposed Scheme. This is based on the discounting rate recommended in the Treasury's Green Book[28]. For practical purposes, a lower cap on the multiplier has been placed at 0.33.

Table 8: Consideration of time to target condition

Years to target condition	Multiplier
0	1.00
1	0.97
2	0.93
5	0.83
10	0.71
15	0.58
20	0.50
25	0.41
30	0.36
32 or above	0.33

4.8.3 Table 9 provides the main habitat types and associated time to target condition categories that will be applied in the calculation. For hedgerows and grassland, the most appropriate category should be selected based on the type of hedgerow/grassland that has been targeted.

[28] HM Treasury (2011) The Green Book: Appraisal and Evaluation in Central Government, Her Majesty's Stationery Office, London.

Table 9: Time to target condition multipliers for main compensation habitats proposed

Habitat type	**Years to target condition category**
Open mosaic habitats on previously undeveloped ground	5
Ponds	5
Grasslands	5 or 10
Hedgerows	5 or 10
Woodland (for landscaping)	10
Young heathland/acid grassland	15
Mature heathland	32 or above
Woodland (for ecological purposes)	32 or above

4.8.4 Time to target condition multipliers are to be added to some low distinctiveness habitats. These have been added in response to Natural England's recommendation that time to target condition multipliers are applied to low distinctiveness habitats in the calculation. These multipliers are shown in Table 10. Where other low distinctiveness habitat types occur, a suitable bespoke multiplier will be applied.

4.8.5 Note that the appearance of a habitat type within Table 10 should not be taken to imply that all such occurrences of that habitat type should be scored as being of low distinctiveness.

Table 10: Revised time to target condition times for habitat distinctiveness

Habitat description	**Revised time to target condition (years)**	**Revised time to target condition based on 3.5% discounting rate (multiplier)**
A2.2 - Scrub - scattered	5	0.83
B1.2 - Acid grassland - semi-improved	5	0.83
B4 - Improved grassland	1	0.97
C1.1 - Bracken - continuous	5	0.83
C1.2 - Bracken - scattered	5	0.83
C3.1 - Other tall herb and fern - ruderal	2	0.93
G1 - Standing water	0	1.00
I2.1 - Quarry	0	1.00
J1.1 - Cultivated/disturbed land - arable	0	1.00
J1.2 - Cultivated/disturbed land - amenity grassland	2	0.93
J1.3 - Cultivated/disturbed land - ephemeral/short perennial	1	0.97
J1.4 - Introduced shrub	1	0.97

Habitat description	Revised time to target condition (years)	Revised time to target condition based on 3.5% discounting rate (multiplier)
J3.6 - Buildings	0	1.00
J4 - Bare ground	0	1.00
J5 - Other habitat	5	0.83
K1.3 - Replacement floodplain storage	5	0.83
K2.6 - Grassed areas	2	0.93
K4.2 - Depot, station, headhouse or portal building	0	1.00
K4.4 - Electricity substation	0	1.00
K5.2 - Public realm	0	1.00
K5.3 - Engineering earthworks[29]	5	0.83

4.9 Deriving the total number of biodiversity units present post-development

Habitat parcels/polygons

4.9.1 The scores of each polygon/habitat parcel present post-development will be calculated utilising the following formula:

> **Number of biodiversity units generated by habitat polygon post-development** = target habitat distinctiveness rating x target habitat condition x habitat area x position within existing ecological network x difficultly of re-creating/restoring x time to target condition

4.9.2 The scores of each polygon will then be added to give the total number of biodiversity units provided by the habitats present, post-construction.

Linear features

4.9.3 The number of biodiversity units present post-development should be calculated for both hedgerows and watercourses as follows:

> **Number of biodiversity units generated by individual hedgerow feature** = length of hedgerow (m) x condition multiplier attributed x position in the network
> x difficulty of re-creating/restoring x time to target condition
>
> **Number of biodiversity units generated by individual watercourse** = length (m) x condition x difficulty of re-creating/restoring x time to target condition[30]

[29] Time to target condition for engineering earthworks will differ dependent on the treatment of these areas. A precautionary approach has been adopted in setting these scores.
[30] While these features will be included within the calculation undertaken for all watercourses both the time to target condition and the difficulty of restoration use multipliers of 1.0 and therefore do not influence the total number of biodiversity units generated.

4.9.4 The figures for the biodiversity units present post-development will then be compared with the overall pre-development score for the scheme to establish the overall balance of biodiversity units (negative or positive).

4.10 Deriving the change in biodiversity units as a consequence of the Proposed Scheme

4.10.1 In order to establish the change in biodiversity units as a consequence of the Proposed Scheme the number of biodiversity units generated post-development will be subtracted from the number available pre-development:

> **Net change in biodiversity units** = post-development total units – pre- development total units for the same area

4.10.2 This calculation will be conducted at the route wide level for each of the following separate elements of the calculation:

- habitat parcels (including arable field margins);
- hedgerows; and
- watercourses.

4.11 Land use category layer

4.11.1 To aid stakeholders in their interpretation of the data, a new land use category polygon layer will be created. This layer will indicate broadly why a particular area of land is required for the scheme.

4.11.2 The new layer will be based on a copy of the post-construction habitat polygon layer. This process will be undertaken following application of all other changes to layers in order to ensure it reflects these changes.

4.11.3 In addition to the standard attribute fields required in all HS2 GIS layers, it will include the attribute fields detailed in Table 11.

Table 11: Land use category layer - attribute field

Attribute field	Description
Land_Use_Cat (Text, 255)	This attribute field will be populated with simplified categories indicating why the land is required for the Proposed Scheme. It will be populated utilising data derived from the post-construction polygons layer. The field will be populated by one of the following responses: • Habitat required permanently for the operation of the scheme; • habitat within the scheme boundary that will be retained (i.e. not impacted); • habitat required during construction only; • habitat required for mitigation/compensation - joint primary purpose landscape and ecology; • habitat required for mitigation/compensation - primary purpose ecology; • habitat required for mitigation/compensation - primary purpose landscape; and • other land required for the construction and operation of the Proposed Scheme.

5 Undertaking the calculation

5.1.1 The principles of the metric described in this technical note have been utilised to guide the size, location and type of compensatory habitat provision that has been incorporated into the design of the Proposed Scheme.

5.1.2 HS2 Ltd is committed to utilising the metric to provide a calculation showing what the project has achieved in working towards the goal of seeking no net loss in biodiversity.

5.1.3 It may be appropriate to undertake the calculation both as the hybrid Bill progresses through Parliament, and as a result of detailed design. The metric therefore has the potential to provide an iterative mechanism to review changes in the balance of ecological loss versus compensation associated with the Proposed Scheme.

6 References

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Appendix A: Habitat distinctiveness scores for Phase 1 habitat survey categories

Table A1: Habitat distinctiveness scores for Phase 1 Habitat categories

Phase 1 code	Habitat description	Distinctiveness	Weighting	Guidance
A1.1.1	Broadleaved woodland - semi-natural	High	6	Areas qualifying as ancient semi-natural woodland will not be considered as part of the calculation.
A1.1.2	Broadleaved woodland - plantation	Moderate	4	-
A1.2.1	Coniferous woodland - semi-natural	High	6	-
A1.2.2	Coniferous woodland - plantation	Moderate	4	-
A1.3.1	Mixed woodland - semi-natural	high/ moderate	6/4	Consider potential to split out areas of woodland that qualify as a habitat of principal importance and validity of including as part of the underlying habitat of principal importance where the coniferous cover is less than 25%. Such areas could score a high distinctiveness rating. All others will score a moderate rating.
A1.3.2	Mixed woodland - plantation	High/moderate	6/4	High distinctiveness rating to be allocated to those sites which meet the criteria to qualify under habitat of principal importance type 'traditional orchard'. Moderate rating to be applied for all others.
A2.1	Scrub - dense/ continuous	Moderate	4	-
A2.2	Scrub - scattered	Low	2	This habitat type could have been created as either a polygon or point data. Only polygon data should be utilised within the assessment.
A3.1	Broadleaved parkland/ scattered trees	High/moderate	6/4	This habitat type only to be utilised where mapped as a polygon. High distinctiveness rating to be applied to habitats falling under the wood pasture and parkland habitat of principal importance type. Moderate rating to be applied in all other cases.
A3.2	Coniferous parkland/ scattered trees	Moderate	4	This habitat type only to be utilised where mapped as a polygon.
A3.3	Mixed parkland/ scattered trees	Moderate	4	This habitat type only to be utilised where mapped as a polygon.
A4.1	Broadleaved woodland - recently felled	Moderate	4	

Phase 1 code	Habitat description	Distinctiveness	Weighting	Guidance
A4.2	Coniferous woodland - recently felled	Moderate	4	
A4.3	Mixed woodland - recently felled	Moderate	4	
B1.1	Acid grassland - unimproved	High	6	
B1.2	Acid grassland - semi-improved	High	6	
B2.1	Neutral grassland - unimproved	High	6	
B2.2	Neutral grassland - semi-improved	High/moderate	6/4	Split out those areas of grassland that fall within the lowland meadows habitat of principal importance type, and identify these as being of high distinctiveness. Moderate rating to be applied in all other cases.
B3.1	Calcareous grassland - unimproved	High	6	
B3.2	Calcareous grassland - semi-improved	High/moderate	6/4	Split out those areas falling under the definition of lowland calcareous grassland habitat of principal importance type. All other areas of grassland which contain elements of a calcareous sward should be considered to be of moderate distinctiveness.
B4	Improved grassland	Low	2	
B5	Marsh/marshy grassland	High/moderate	6/4	Split out any areas that represent habitats of principal importance (in particular purple moor grass and rush pasture) and identify these as of high distinctiveness. All others should be considered to be of moderate distinctiveness.
B6	Poor semi-improved grassland	Moderate	4	
C1.1	Bracken - continuous	Low	2	
C1.2	Bracken - scattered	Low	2	Only those areas mapped as polygons should be used within the calculation.
C3.1	Other tall herb and fern - ruderal	Low	2	
C3.2	Other tall herb and fern - non ruderal	Low	2	
D1.1	Dry dwarf shrub heath - acid	High	6	
D1.2	Dry dwarf shrub heath - basic	High	6	

Phase 1 code	Habitat description	Distinctiveness	Weighting	Guidance
D2	Wet dwarf shrub heath	High	6	
D5	Dry heath/acid grassland	high	6	
D6	Wet heath/acid grassland	high	6	
E2.1	Flush and spring - acid/neutral flush	High	6	
E2.2	Flush and spring - basic flush	High	6	
F1	Swamp	High/moderate	6/4	Identify those areas that qualify under the reedbed or purple moor grass and rush pasture habitat of principal importance definitions as being in the high category. Identify all others areas as being of moderate distinctiveness.
F2.1	Marginal and inundation - marginal vegetation	High/moderate	6/4	Emergent vegetation that is less than 5m in width. Identify those areas that qualify under purple moor grass and rush pasture habitat of principal importance definitions as being of high distinctiveness.
F2.2	Marginal and inundation - inundation vegetation	High/moderate	6/4	Consider potential for this habitat to fall under any habitat of principal importance definition (considered unlikely). All other to be identified as moderate.
G1	Standing water	High/moderate	6/4	Habitats of principal importance should be identified as being of high distinctiveness. All other occurrences of this habitat type should be identified as being of moderate distinctiveness.
G1.1	Standing water - eutrophic	High/moderate	6/4	
G1.2	Standing water - mesotrophic	High/moderate	6/4	
G1.3	Standing water - oligotrophic	High/moderate	6/4	
G1.4	Standing water - dystrophic	High/moderate	6/4	
G1.5	Standing water - marl	High/moderate	6/4	
I1.1.1	Inland cliff - acid/neutral	High	6	
I1.1.2	Inland cliff – basic	High	6	
I1.4.1	Other exposure - acid/neutral	Moderate	4	
I1.4.2	Other exposure - basic	Moderate	4	
I1.5	Cave	Moderate	4	

Phase 1 code	Habitat description	Distinctiveness	Weighting	Guidance
I2.1	Quarry	High/moderate/low/ none	6/4/2/0	Re-allocate these areas based on the habitats present and score accordingly.
I2.2	Spoil	None	0	
I2.3	Mine	High/moderate/low/ none	6/4/2/0	Re-allocate these areas based on the habitats present and score accordingly.
I2.4	Refuse-tip	None	0	-
J1.1	Cultivated/ disturbed land - arable	Moderate/low	4/2	Where uncultivated field margins are present these areas should be split off and classified as of moderate distinctiveness. All other arable or un-vegetated ground should be classified as being of low distinctiveness.
J1.2	Cultivated/ disturbed land - amenity grassland	Low	2	
J1.3	Cultivated/ disturbed land - ephemeral/ short perennial	High/moderate/low	6/4/2	Areas which form part of an open mosaic habitat on previously developed ground (a habitat of principal importance) should be identified as of high distinctiveness. Other stands should be classified as moderate or low distinctiveness based on the species present.
J1.4	Introduced shrub	Low	2	
J2.8	Earth bank	Low	2	
J3.4	Caravan site	High/moderate/low/none	6/4/2/0	Re-allocate these areas based on the habitats present and score accordingly.
J3.6	Buildings	Low	2	
J4	Bare ground	Low	2	
J5	Other habitat	High/moderate/low/none	6/4/2/0	Based on habitats and species present.
N/A	Roads and other hardstanding	Low	0	

Appendix B: Description of key fields used within GIS schema

Table B1: Description of fields utilised within the HS2 no net loss GIS schema

Field Alias	Field Name	Field relevant to pre or post construction?	Description
Ecology ID	Ecology_ID	Pre/Post	Unique alphanumeric identifier code for each feature in database. Internal reference only.
CFA	CFA	Pre/Post	Identifies Community Area (CA) in which habitat features is located.
Habitat description	Hab_Desc	Pre/Post	Coding to describe the allocated habitat type. Codes commencing with letters A to J relate to the standard Phase 1 habitat category codes. For further details refer to : JNCC (2010) *Handbook for Phase 1 habitat survey. A technique for environmental audit*. JNCC, Peterborough. Codes commencing with letter' K' relate to HS2 created categories utilised in the CT-06 Proposed Scheme model. Further details relating to these category names is provided within the data dictionaries provided within community area report map books issued as part of the HS2 Phase 2a Environmental Statement.
Source	Source	Pre/Post	Primary source that has been used to determine the extent of the feature.
Pre or post-construction	Pre_Post	Pre/Post	This field indicates if the feature is relevant to the pre- construction or post-construction element of the calculation.
Preconstruction biological units	PreCon_Bio_Unit s	Pre	This field documents the number of biodiversity units generated by the polygon/polyline in question. The formula utilised to calculate this output differs between polygons and for polyline features. For polygons Number of preconstruction biodiversity units generated by habitat polygon = PreCon_Distinct_Rate x PreCon_Hab_Cond x PreCon_Hab_Area x PreCon_Eco_Pos. For watercourses: Number of pre-construction biodiversity units = PreCon Hab Length x PreCon Hab Condition For hedgerows: Number of pre-construction biodiversity units = PreCon Hab Length x PreCon_Hab_Cond x PreCon_Eco_Pos
Preconstruction distinctiveness rating	PreCon_Distinct_ Rate	Pre	This field records the pre-construction habitat distinctiveness weighting allocated to the polygon/polyline in question. A weighting of 0, 2, 4, 6, or 8 has been utilised where the habitat distinctiveness is used as part of the biodiversity units calculation for that particular feature. Scores have been allocated against the criteria set out in Appendix A An entry of 'Null' is used where distinctiveness is not utilised in the biodiversity units for that particular habitat type (e.g. hedgerows).
Preconstruction distinctiveness rating comment	Distinct_Comment	Pre	Where appropriate this provides a text comment to explain the preconstruction distinctiveness score allocated. Where no comment is necessary the field is marked 'Null'
Preconstruction ecological position in network	PreCon_Eco_Pos	Pre	This field records the pre-construction ecological position in the network weighting allocated to the polyline/polygon in question. A weighting of 1, 2 or 3 has been utilised where ecological position in the network is used as part of the biodiversity units calculation

Field Alias	Field Name	Field relevant to pre or post construction?	Description
			for that particular feature. Scores have been allocated against the criteria set out in Appendix A. An entry of 'Null' is used where ecological position in the network is not utilised in the biodiversity units calculation for that particular habitat type.
Preconstruction ecological position in network comment	Eco_Pos_Comment	Pre	Where appropriate this provides a text comment to explain the preconstruction ecological position in the network score allocated. Where no comment is necessary the field is marked 'Null'
Preconstruction habitat area	PreCon_Hab_Area	Pre	For preconstruction polygon features this field shows the area of the polygon in hectares (ha) 'Null' for linear features
Preconstruction Habitat condition	PreCon_Hab_Con	Pre	For pre-construction features this field records the habitat condition score allocated to the polygon/polyline in question. A weighting of 1, 2, or 3 has been utilised where habitat condition is used as part of the biodiversity unit's calculation for that particular feature. Scores have been allocated against the criteria set out in Appendix A. An entry of 'Null' is used where distinctiveness is not utilised in the biodiversity units for that particular habitat type.
Preconstruction Habitat condition comment	Condition_Comment	Pre	Where appropriate this provides a text comment to explain the preconstruction habitat condition score allocated. Where no comment is necessary the field is marked 'Null'
Preconstruction habitat length	PreCon_Hab_Length	Pre	For polyline features this field records the length of the pre-construction feature in metres (m). For polygon features this field is marked 'Null'.
Post-construction biological units	PostCon_Bio_Unit	Post	This field documents the number of biodiversity units generated by the polygon/polyline in question. The formula utilised to calculate this output differs between polygons and for polyline features. **For polygons** Number of post-construction biodiversity units generated by habitat polygon = PostCon_Distinct_Rate x PostCon_Hab_Cond x PostCon_Hab_Area x PostCon_Eco_Pos x PostCon_Diff_Rating x PostCon_Time_TargCond **For watercourses:** Number of post-construction biodiversity units = PostCon_Hab_Length x PostCon_Hab_Cond **For hedgerows:** Number of post-construction biodiversity units = PostCon_Hab_Length x PostCon_Hab_Cond x PostCon_Eco_Pos x PostCon_Diff_Rating x PostCon_Time_TargCond
Post-construction difficulty rating	PostCon_Diff_Rating	Post	This field records the allocated difficultly of restoration multiplier used in for the feature in question. Values have been attributed according to the guidance set out in this technical note. Where the difficult to restoration field is not used in the biodiversity units calculation for a feature the field is marked 'Null'
Post-construction	PostCon_Distinct	Post	This field records the post-construction habitat distinctiveness weighting allocated to the polygon/polyline in question.

Field Alias	Field Name	Field relevant to pre or post construction?	Description
distinctiveness rating	_Rate		A weighting of 0, 2, 4, 6, or 8 has been utilised where the habitat distinctiveness is used as part of the calculation for that particular feature class, and has been scored against the criteria set out in Appendix A. An entry of ''Null' is used where distinctiveness is not utilised in the biodiversity units for that particular habitat type (e.g. hedgerows).
Post-construction distinctiveness rating comments	Distinct_Comment	Post	Where appropriate this provides a text comment to explain the post- construction habitat condition score allocated. Where no comment is necessary the field is marked 'Null'
Post-construction ecological position	PostCon_Eco_Pos	Post	This field records the post-construction ecological position in the network weighting allocated to the polyline/polygon in question. A weighting of 1, 2 or 3 has been utilised where ecological position in the network is used as part of the biodiversity units calculation for that particular feature. Scores have been allocated against the criteria set out in Appendix A. An entry of 'Null' is used where ecological position in the network is not utilised in the biodiversity units calculation for that particular habitat type.
Post-construction ecological position comment	Eco_Pos_Comment	Post	Where appropriate this provides a text comment to explain the post- construction ecological position in the network score allocated. Where no comment is necessary the field is marked 'Null'
Post-construction habitat area	PostCon_Hab_Area	Post	For post-construction polygon features this field shows the area of the polygon in hectares (ha) 'Null' for linear features
Post-construction habitat condition	PostCon_Hab_Cond	Post	For post-construction features this field records the habitat condition score allocated to the polygon/polyline in question. A weighting of 1, 2, or 3 has been utilised where habitat condition is used as part of the biodiversity units calculation for that particular feature. Scores have been allocated against the criteria set out in Appendix A. An entry of 'Null' is used where distinctiveness is not utilised in the biodiversity units for that particular habitat type.
Post-construction habitat condition comment	Condition_Comment	Post	Where appropriate this provides a text comment to explain the post- construction habitat condition score allocated. Where no comment is necessary the field is marked 'Null'
Post-construction habitat length	PostCon_Hab_Length	Post	For polyline features this field records the length of the post-construction feature in metres (m). For polygon features this field is marked 'Null'.
Post-construction time to target condition	PostCon_Time_TargCond	Post	This field records the allocated time to target condition multiplier used in for the feature in question. Values have been attributed according to the guidance set out in this technical note. Where the time to target condition is not used in the biodiversity units calculation for a feature the field is marked 'Null'
Shape_Length	Shape_Length	Pre/Post	For Linear features this field contains the length of the feature in metres **N.B**. This is an auto-generated field within ArcGIS and are not used

Field Alias	Field Name	Field relevant to pre or post construction?	Description
			directly in the calculation formula.
Shape_Length	Shape_Length	Pre/Post	For Polygon features this field contains the perimeter length of the feature in metres **N.B**. This is an auto-generated field within ArcGIS and are not used directly in the calculation formula.
Shape_Area	Shape_Area	Pre/Post	For Polygon features this field contains the area of the feature in metres^2 **N.B**. This is an auto-generated field within ArcGIS and are not used directly in the calculation formula.

Appendix C: Habitat categories used in polygon data analysis

Table C1: Habitat categories used in the polygon data analysis

Habitat category used for data analysis	**Phase 2a habitat categories and CT-06 Map Series Proposed Scheme codes that fall within habitat category**
Woodland and scrub	A1.1.1 Woodland - Broad-leaved - Semi-natural
	A1.1.2 Woodland - Broad-leaved - Plantation
	A1.2.1 Woodland - Coniferous - Semi-natural
	A1.2.2 Woodland - Coniferous - Plantation
	A1.3.1 Woodland - Mixed - Semi-natural
	A1.3.2 Woodland - Mixed - Plantation
	A1.2.1 Scrub - Dense/continuous scrub
	A1.2.2 Scrub - Scattered scrub
	A1.3.1 Parkland/scattered trees - Broad-leaved
	A1.3.2 Parkland/scattered trees - Coniferous
	A1.3.3 Parkland/scattered trees - Mixed
	K2.1 Woodland habitat creation
	K2. 4 Landscape mitigation planting (scrub/woodland)
Grassland	B1.1.1 Acid grassland - Unimproved
	B1.1.2 Acid grassland - Semi-improved
	B1.2.1 Neutral grassland - Unimproved
	B1.2.2 Neutral grassland - Semi-improved
	B1.3.1 Calcareous grassland - unimproved
	B1.3.2 Calcareous grassland - semi-improved.
	B1.4 Improved grassland
	B1.5 Marsh/marshy grassland
	B1.6 Poor semi-improved grassland
	J1.2 Cultivated/disturbed ground - Amenity grassland
	K2.3 Grassland Habitat Creation
	K2.6 Grassed Areas
	K5.3 Engineering earthworks
Other	All other Phase 1 (J codes) and CT-06 (K codes) habitat types not included within the woodland and grassland habitat categories above.
Other habitat	All other Phase 1 habitat codes and CT-06 codes that are not listed under either 'woodland and scrub' or 'grassland 'habitat categories.

HS2 Phase 2a West Midlands - Crewe: Technical note – Ecology and biodiversity - Ecological principles of mitigation

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1 Introduction

1.1.1 This technical note documents the ecological principles that will be applied in designing the mitigation and compensation to be provided in support of the Proposed Scheme.

1.1.2 Application of the principles outlined in this document to the design of ecological mitigation and compensation aim to ensure that adverse effects that have been identified within the Environmental Statement (ES) are addressed.

1.1.3 During 2016 a combination of field survey and desk based study (to identify pre-existing relevant information) was undertaken to inform the Phase 2a ES. However, due to access constraints and seasonal constraints, it has not been possible to achieve access to all areas where survey was proposed. As a consequence, in the absence of full data, it will be necessary in some cases to apply a precautionary approach within the ES. Available information will be utilised to provide an assessment on a predicted precautionary basis, based on a 'reasonable worst-case' scenario.

1.1.4 In addition, at hybrid Bill submission the Proposed Scheme will still be subject to completion of detailed design, which includes landscape design. An outline landscape design will be available on submission of the hybrid Bill.

1.1.5 For the above reasons, the ES does not contain all of the details of the mitigation or compensation required for impacts on protected and/or notable habitats and species.

1.1.6 This document sets out the principles of the ecological mitigation strategy in order to provide decision makers with confidence that adverse effects will be adequately addressed. It also aims to support the conclusions in the ES where it is stated there will no significant effects.

1.1.7 At all stages in the application of these principles full consideration has been and will be given to the implementation of the mitigation hierarchy (i.e. avoid-reduce-mitigate-compensate). Where it is reasonably practicable to do so then attempts have been made to avoid impacts. Where impacts cannot be avoided then efforts have been made to limit the extent and magnitude of the impact and to mitigate the resultant effects through the provision of appropriate measures. Where effects cannot be mitigated to a level where they are not significant then compensatory measures have been employed to offset any remaining adverse effects, as far as is reasonably practicable.

1.1.8 This document deals principally with the last two steps in this mitigation hierarchy namely the provision of mitigation and compensation. The land considered to be required for the implementation of such measures has been included in the Proposed Scheme, including where it is required on a precautionary basis. Application of the principles of mitigation contained within this document will, once access to complete surveys has been gained, act to guide the development of the detailed design of mitigation/compensation measures to be provided in these areas.

1.1.9 Where mitigation and/or compensation are required, then the intention is to provide them within the confines of the land required for the Proposed Scheme, as defined on the Parliamentary plans. Further means of providing mitigation/compensation beyond the land required by the Proposed Scheme, will be considered where it is not reasonably practicable to provide it within the land required for the Proposed Scheme, or if there are ecological benefits in doing so. Such provisions will be subject to agreements with relevant stakeholders.

2 Great crested newt

2.1 Key principles

2.1.1 The nominated undertaker will ensure that impacts as a consequence of the Proposed Scheme do not result in any long term adverse effect on the favourable conservation status (FCS) of those great crested newt populations located in the vicinity of the route of the Proposed Scheme.

2.1.2 The nominated undertaker will seek to provide new aquatic and terrestrial habitat for great crested newt primarily within locations that have connectivity with retained habitat that is already utilised by the populations affected (i.e. in-situ). In doing so compensatory habitat creation will seek to avoid any long term effect on FCS through ensuring that the key impacts of habitat loss (both aquatic and terrestrial) and potential severance are addressed. Such provision will include both the creation of new core areas of habitat specifically designed for great crested newt, and the enhancement of compensation areas which have already been incorporated to address losses of particular habitat types. For example, the design of areas of broadleaved woodland planted to compensate for losses of this habitat type may be altered to allow these areas to also incorporate great crested newt breeding ponds.

2.1.3 However, for a scheme of this scale it is likely that there will be locations where there is no-satisfactory alternative to providing compensatory habitat in locations that are distant from the impact. Where this approach is necessary then disease screening (including that for chytridiomycosis) will be undertaken in line with current best practice to ensure that all populations involved are free from disease at time of translocation.

2.1.4 Where it is not reasonably practicable to address the possible impact of the local population in-situ then opportunities will be taken to consolidate compensation provision as part of larger scale habitat creation areas. Where reasonably practicable to do so, all such compensation areas will be provided in close proximity to the route of the Proposed Scheme, through the creation of areas of high quality terrestrial and aquatic habitat.

2.1.5 Once constructed the railway is for the majority of the route considered unlikely to form an absolute barrier to great crested newt movement. Amphibians are known to utilise habitats that are common to operational railway corridors. However, the presence of the operational railway is likely to reduce exchange of individuals between water bodies either side of the route of the Proposed Scheme, and in some cases (e.g.

where the route is in deep cutting or on steep sided embankment) then it has the potential to act as a barrier to movement.

2.1.6 Where severance is identified as having the potential to result in an adverse effect on conservation status, the nominated undertaker will seek to minimise its effects through implementing habitat creation/restoration to increase connectivity with other known areas of suitable habitat in the landscape, and maintain the viability of these severed elements. This could be, for example, by providing linear connectivity and new ponds which will promote connectivity between two previously separate meta-populations.

2.1.7 In extreme situations where it is not considered possible to maintain the viability of severed fragments of a population affected by the Proposed Scheme then the nominated undertaker will consider the trapping of great crested newts from land that lies outside the extent of the Proposed Scheme, in order to allow the full population to be relocated to the same receptor site.

2.1.8 The use of amphibian tunnels as a potential method for addressing the effects of severance will be considered on a case by case basis and reviewed against the current evidence basis for their effectiveness at the time of construction. However, based on the current limited evidence for their effectiveness such measures are currently not relied upon in the mitigation/compensation strategy outlined in the ES.

2.2 Aquatic habitat creation

2.2.1 Where ponds supporting great crested newt are lost then they will be compensated through either:

- provision of two replacement ponds (of similar size) for each pond lost (a minimum pond surface area of 100m² would be applied); or
- provision of approximately double the surface area of suitable aquatic habitat through the creation of larger ponds than those lost (a minimum pond surface area of 100m² and a maximum of 300m² will apply).

2.2.2 Where possible replacement ponds will be provided in locations that maintain connectivity with retained elements already utilised by the populations affected (i.e. in-situ).

2.2.3 The construction schedule will ensure that where ponds are to be lost then any new ponds will, wherever reasonably practicable to do so, be created six months prior to the commencement of any translocation works in order to allow the plant and invertebrate populations to establish.

2.2.4 The planting regime will be appropriate to the local area, and in each case, will include a variety of marginal, floating and submerged vegetation with some areas of open water. Where possible plant material and/or water from ponds to be lost will be used to promote rapid establishment of newly created ponds.

2.2.5 When siting new ponds those locations which are likely to be subject to high levels of human or animal disturbance will be avoided, where practicable to do so. In addition, surrounding terrestrial habitat creation and on-going management will be designed to avoid dense shading.

2.3 Terrestrial habitat creation

2.3.1 Where an adverse effect is anticipated on great crested newt as a result of the loss of terrestrial habitat then the nominated undertaker will provide compensatory habitat.

2.3.2 The nominated undertaker will seek to maximise the quality of terrestrial habitat provided with regard to great crested newt, and ensure this is provided in close proximity to either retained or newly created ponds. However, provision of habitat in close proximity must be balanced with the need to ensure that links with other areas of surrounding suitable terrestrial habitat are maintained.

2.3.3 The loss of intermediate and distant terrestrial habitat is unlikely to result in adverse effects on those great crested newt populations where the quality and availability of terrestrial habitat in close proximity to the pond is high. However, in some cases such areas may play a key role. As such in all cases the requirement and scale of replacement terrestrial habitat will be considered on a case-by-case basis by ecologists experienced in European protected species mitigation (EPSM) licensing.

2.3.4 Where the requirement for compensatory habitat provision is identified, the nominated undertaker will endeavour to provide habitat of equal or higher quality than that which is lost. Habitats of similar type to those that are lost will be provided and hibernacula and other above ground refugia will be provided in each area of terrestrial habitat creation in order to maximise their potential carrying capacity.

2.3.5 Where replacement habitat is of equal quality to those areas lost then the area of replacement provision will be at least as large as the area lost (i.e. minimum of 1:1 ratio).

2.3.6 Where the quality of the terrestrial habitat to be provided post-construction will clearly be higher than that available pre-development, or habitat will be provided closer to the breeding pond, then compensation habitat areas provided may be on a less than 1:1 ratio. This may only be undertaken where it is not considered to be detrimental to the population concerned, or the potential movement of amphibians through the wider landscape.

2.3.7 Planting of terrestrial compensation areas will utilise species appropriate to the local area, and where possible will seek to maximise the value of such areas for other species, without compromising their value for great crested newt.

2.3.8 All hibernacula, bunds and other refugia incorporated into the detailed design will be constructed in accordance with current best practice guidelines (e.g. English Nature; 2001[1]; Langton et al 2001[2]).

[1] English Nature (2001), Great Crested Newt Mitigation Guidelines. English Nature, Peterborough.

2.3.9 Where newly created habitats are to act as receptor areas for great crested newt these areas will, wherever reasonably practicable to do so, be constructed a minimum of 6-12 months in advance of the commencement of translocation (depending on the type and seasonal timing of the works conducted).

2.4 Capture and exclusion

2.4.1 Capture and exclusion works will be undertaken in accordance with best practice guidelines, as currently detailed in the Natural England advice notes referenced at Section E4 in tab "E-Mitign & compn", of Form WML-A14-2[3]. Implementation of these methods will prevent any legal offences resulting from the killing/injury of great crested newt during site clearance.

2.4.2 Novel sustainable solutions to minimise the extents of exclusion fencing required by the Proposed Scheme will be explored and agreed with Natural England. Exclusion fencing (or equivalent) will be maintained for the duration of construction at those locations where there is considered to be a risk of amphibians re-entering construction areas post habitat clearance.

2.4.3 Permanent exclusion fencing will be incorporated in those locations where the operation of the Proposed Scheme represents a significant risk to the favourable conservation status of the populations concerned, or where the presence of great crested newt within key areas of operational infrastructure has the potential to significantly constrain operational requirements.

2.5 Management, maintenance and monitoring

2.5.1 The nominated undertaker will commit to providing appropriate on-going management, maintenance and monitoring of compensatory habitats.

2.5.2 Details of route-wide commitments to on-going management, maintenance and monitoring will be developed in consultation with key statutory bodies, and will form part of the Environmental Minimum Requirements (EMR)[4] to be agreed at Royal Assent.

2.5.3 Detailed management, maintenance and monitoring strategies will be provided alongside derogation licence applications post Royal Assent.

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[2] Langton, T.E.S., Beckett, C.L., and Foster, J.P. (2001), Great Crested Newt Conservation Handbook. Froglife, Halesworth.
[3] Natural England (2012), Template for method statement to support application for licence under Regulation 532(2)e in respect of great crested newts Triturus cristatus. Form WML-A14-2 (Version December 2015).
https://www.gov.uk/government/publications/great-crested-newts-apply-for-a-mitigation-licence.
[4] The Environmental Minimum Requirements are a series of commitments which will be agreed with stakeholders and made by HS2 Ltd at the point of Royal Assent. They aim to ensure that impacts that have been identified within the Environmental Statement are addressed and will not be exceeded.

3 Common amphibians

3.1 Key principles

3.1.1 Where populations of common amphibians utilise the same areas of habitat used by great crested newts then effects on these species will be addressed through adherence to the principles of mitigation outlined in Section 2.1.

3.1.2 Where common amphibians occur in areas where great crested newt are absent then mitigation and compensatory habitat provision will seek to avoid significant effects on the populations concerned.

3.1.3 All new water bodies provided for common amphibians will be placed within areas of suitable terrestrial habitat that are being provided primarily to compensate for habitat losses as a consequence of the Proposed Scheme. These areas will be enhanced as necessary to also provide suitable replacement habitat for common amphibian populations.

3.1.4 Where translocation will involve movement of individuals to locations outside of the normal extent of that population then disease screening (including that for chytridiomycosis) will be undertaken in line with current best practice to ensure that all populations involved are free from disease at time of translocation.

3.2 Aquatic habitat creation

3.2.1 Where ponds containing other common amphibians are lost then these would be replaced on at least a 1:1 basis, and be of similar size and form to those lost.

3.2.2 This will be achieved through the provision of new water bodies suitable for use by common amphibians within the areas identified for provision of ecological mitigation/compensation.

3.3 Terrestrial habitat creation

3.3.1 Where the quality of the terrestrial habitat to be provided post-construction will be higher than that available pre-development, or habitat will be provided closer to the breeding pond, then compensation habitat areas may be on a less than 1:1 ratio. This may be undertaken where it is not considered to be detrimental to the population concerned, or the potential movement of amphibians through the wider landscape.

3.3.2 Planting of terrestrial compensation areas will utilise species appropriate to the local area. Hibernacula, bunds and other refugia will be provided as required in line with current best practice guidelines (e.g. Baker J et al, 2011[5], English Nature, 2001[6]; Langton et al, 2001[7]).

[5] Baker, J., Beebee T., Buckley, J., Gent, A. and Orchard, D. (2011) Amphibian Habitat Management Handbook. Amphibian and Reptile Conservation, Bournemouth.
[6] English Nature (2001), Great Crested Newt Mitigation Guidelines. English Nature. Peterborough.
[7] Langton, T.E.S., Beckett, C.L., and Foster, J.P (2001), Great Crested Newt Conservation Handbook, Froglife, Halesworth.

3.3.3 Where newly created habitats are to act as receptor areas for common amphibians, these will, wherever reasonably practicable to do so, be constructed a minimum of 6-12 months in advance of the commencement of translocation (depending on the type and seasonal timing of the works conducted).

3.4 Capture and exclusion

3.4.1 Wherever it is reasonable to do so, a controlled drain down of water bodies known to support breeding populations of common amphibians will be undertaken during the period mid-September to February inclusive, in order to minimise impacts on existing populations.

3.4.2 Based on the legal status of common amphibians the use of exclusion fencing and pitfall trapping will only be utilised where there is considered to be the potential for sufficiently high numbers of common amphibians to be killed or injured during construction such that there would be a significant adverse effect on the population concerned. As a general rule, the requirement for exclusion fencing and pitfall trapping will be considered in those locations which are known to support good or exceptional common amphibian populations.

3.5 Management, maintenance and monitoring

3.5.1 The nominated undertaker will commit to appropriate on-going management, maintenance and monitoring of compensatory habitats.

3.5.2 Details of route-wide commitments to on-going management, maintenance and monitoring will be developed in consultation with key statutory bodies, and will form part of the EMR to be agreed at Royal Assent.

3.5.3 Detailed management, maintenance and monitoring strategies will be provided alongside derogation licence applications post Royal Assent.

4 Bats

4.1 Key principles

4.1.1 The nominated undertaker will ensure that impacts as a consequence of the construction and operation of the Proposed Scheme do not result in any long term adverse effect on the FCS of bat populations in the vicinity of the Proposed Scheme.

4.1.2 The nominated undertaker will seek to provide new roosting and commuting habitats for bat species primarily within locations that have connectivity with retained habitat that is already utilised by the populations affected (i.e. in-situ). In doing so compensatory habitat creation will seek to avoid any long term effect on FCS through ensuring that the key impacts of habitat loss (in relation to foraging, commuting and roosting activity), disturbance and potential severance are addressed. Such provision will include both the creation of new roost sites and the enhancement of those compensation areas provided to address general habitat loss as a consequence of the Proposed Scheme, in order to make these areas more suitable for bats. For example, the design of areas of broadleaved woodland planted to compensate for loss of

woodland habitat may be altered to provide a graded woodland edge that will be suitable for foraging activity of a range of bat species, or bat boxes may be incorporated to provide immediate replacement roosting opportunities.

4.1.3 Where it is not reasonably practicable to mitigate the likely effect on the local population in-situ then opportunities will be taken to consolidate compensation provision as part of larger scale habitat creation areas. All such compensation areas would, where reasonably practicable to do so, be provided in the closest most suitable location taking into consideration the following factors:

- type of roost;
- position in landscape; and
- design of the railway (for example in a cutting or at grade).

4.1.4 Large scale habitat creation areas have been provided as part of the wider ecological mitigation/compensation package in order to address a 'reasonable worst-case' scenario for all species in those areas where access has prevented full survey being conducted. Such areas have been provided at regular intervals throughout the route in order to minimise impacts on the FCS of the populations concerned at the local level.

4.2 Replacement roosting provision

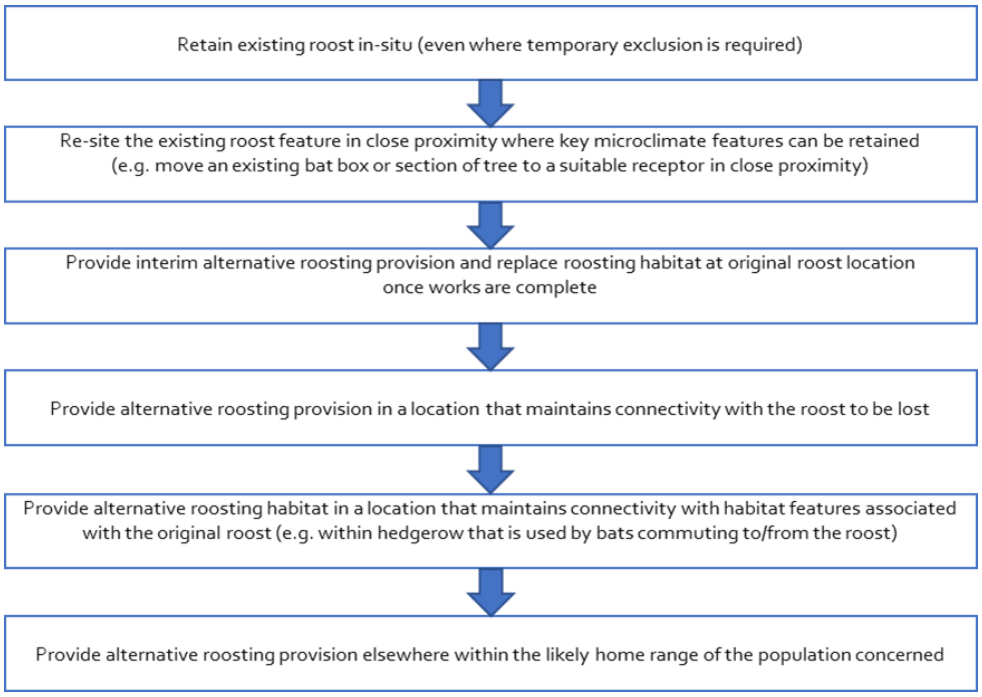
4.2.1 Where bat roosts are lost they will be compensated in a form appropriate to the species of bat and type of roost in accordance with the guidance provided in Figure 4 of the Bat Mitigation Guidelines (Mitchell-Jones 2004)[8].

4.2.2 Each roost to be lost will be compensated for as part of the mitigation scheme submitted as part of an EPSM licence application. The timing of operations such as provision of new roosting habitat, exclusion from roosts, and destruction will be appropriate to the nature of the roost to be lost with works conducted in accordance with the recommendations of the Bat Workers Manual (JNCC 2004)[9].

4.2.3 Where a roost will be lost or disturbed as a consequence of works required in support of the Proposed Scheme, the hierarchy, shown in Figure 1 will be applied in considering the most appropriate way to mitigate for its loss.

[8] Mitchell-Jones, A.J. (2004), Bat Mitigation Guidelines. English Nature, Peterborough.
[9] Joint Nature Conservation Committee (2004), Bat worker's Manual, 3rd Edition, edited by A.J. Mitchell-Jones and A.P. McLeish.

Figure 1: Mitigation hierarchy to be applied when a bat roost is lost



4.2.4 In considering the above hierarchy, in relation to individual roosts lost, the following key factors will be considered:

- type of roost;
- species;
- likely sensitivity to disturbance;
- risk of train strike during operation (including risk of drawing more bats close to the line through the provision of roosting provision in proximity to the Proposed Scheme);
- nature of surrounding habitat;
- likely or known pattern of dispersal within the habitat;
- proposed planting scheme; and
- design of the Proposed Scheme in this area (e.g. is the line in cutting or at grade).

4.2.5 Replacement roosting habitat will be provided in a form and quantum that is most appropriate to the specific location in question. Across the route of the Proposed Scheme it is anticipated that a wide range of replacement roost types will be utilised including the production of bespoke 'bat houses' and hibernation sites, incorporation of roosting habitats into existing structures, the provision of a variety of bat boxes, and the use of tree surgery to provide artificial roosting features within retained trees.

4.2.6 Replacement roosting habitat will be provided both where roosts are lost and where there is considered to be a significant reduction in the available potential roosting

resource that could affect the long term status of bat assemblages which occur in the local area. Where the reduction in the available roosting resource has the potential to result in significant adverse effects, compensatory roosting provision will be provided at appropriate levels on a case by case basis. No strict provision ratios are proposed (e.g. 2 bat boxes for each high potential tree lost), and efforts will be made to consolidate roosting provision and ensure a range of compensatory habitat provision is provided, rather than simple deployment of bat boxes only.

4.3 Replacement foraging habitat

4.3.1 Habitat losses within the land required for the construction of the Proposed Scheme may require some bats to travel further, and expend more energy during regular foraging and movement throughout their home range for the duration of construction. However, such effects alone (in isolation of those resulting from habitat fragmentation/severance resulting from these losses) are for all species considered unlikely to result in sufficient disturbance of the populations concerned during the period of construction to result in an adverse effect on their conservation status.

4.3.2 Compensatory habitat creation that will be provided to address significant effects on specific habitat types (e.g. ancient semi-natural woodland) will act to prevent any longer term effect on bat populations as a consequence of the losses anticipated. Compensatory habitats to be created will include a range of new woodland, grassland, and water bodies.

4.3.3 No mitigation/compensatory planting will be provided with the primary aim of addressing losses of bat foraging habitat since planting to be provided to address other significant effects will act to fulfil this function. Where there is particular benefit in doing so, the final planting scheme and maintenance regime will, whilst taking account of the multiple functions of such areas, incorporate details that maximises the value of these habitat features in relation to bats (e.g. through scalloping woodland edges to provide sheltered areas that will support concentrations of insects and promote bat foraging).

4.4 Mitigating for habitat fragmentation/severance (construction)

4.4.1 The removal or disturbance of habitat features that are utilised by bats during breeding, hibernation or during seasonal migrations between roosts (e.g. moving from hibernation to maternity roost locations) have the potential to result in adverse effects on the bat populations or assemblages during construction. However, the point at which such impacts are likely to result in a significant adverse effect on the conservation status of the population concerned will differ dependent on the status and behaviour of the species concerned. As such the requirement for mitigation measures to address the effects of habitat fragmentation/severance arising as a result of construction will be considered based on both the species and its conservation status.

4.4.2 Where habitat severance/fragmentation arising as a result of construction is identified as having the potential to result in an adverse effect on bat populations the nominated

undertaker will seek, wherever it is reasonably practical to do so, to minimise its effects through:

- influencing the construction programme in order to ensure works are sensitively seasonally timed in order to minimise impacts;
- retaining key habitat elements that are demonstrated to be of significant value for the movement of bats through the landscape for as long as possible during construction, giving time for replacement linear features to become established and minimising disruption to ecological functionality (e.g. construction of a new over-bridge in parallel with one known to be utilised by bats crossing the existing railway line in order to minimise disruption);
- implement replacement habitat creation/restoration early in the project programme, in order to minimise the duration and scale of habitat fragmentation/severance effects;
- use of measures such as 'artificial hedgerows', wattle screens or other artificial measures to provide linear flight lines of use to bats during construction and until such point that planting is sufficiently established to fulfil this function;
- reinstating suitable hedgerows on the route of known existing flight lines and increasing the connectivity with other known areas of suitable habitat in the wider landscape; and
- avoiding night time working in proximity to key commuting/foraging features.

4.5 Minimising disturbance of roosts during construction

4.5.1 During the construction phase the following mitigation measures will, wherever it is reasonably practicable to do so, be implemented in order to prevent the disturbance of retained roosts:

- avoiding night-time working in proximity to known roosts;
- security lighting to be directed away from roost entrances; and
- timing of activities which could result in disturbance of known roosts to be controlled and wherever possible to be conducted during the times of the year when bats would not be present, e.g. October to April inclusive for maternity roosts.

4.5.2 Where this guidance cannot be followed and the proposed works are likely to cause disturbance, a licence will be sought from Natural England.

4.6 Minimising risk of collisions with trains/vortices during operation

4.6.1 The potential for the operation of the Proposed Scheme to result in adverse effects on bats as a consequence of train strike and associated vortices will be considered for each location on a species by species basis taking into account the following factors:

- flight habit and preference;
- position within geographical range of the species;
- conservation status; and
- baseline information on activity of the population concerned.

4.6.2 Where there is considered to the potential for an adverse effect on the conservation status of the bat species concerned then the following measures will, where reasonably practicable to do so, be utilised to ensure there is no long term effect on the favourable conservation status of the species concerned:

- provision of green bridges, underpasses and culverts, or the enhancement or 'greening' of existing structures in order to facilitate passage of bats across the route;
- where the above features are required efforts will be made to include these early in the construction programme in order to maximise the time available for the establishment of associated landscaping;
- use of planting to create 'hop-overs' at key locations where bats are known to be at risk when crossing the route of the Proposed Scheme;
- provision of new planting to 'funnel' bats to the new crossing points, and the use of artificial measures (e.g. wattle screens) on a temporary basis until establishment of planting, in order to facilitate use of the above features;
- planting to strengthen existing alternative flight routes through the wider landscape that are sufficiently separated from the effects of disturbance or vortices associated with the operational railway;
- degradation and removal of some existing vegetation in proximity to the route of the Proposed Scheme in order to reduce the suitability of habitats for foraging bats in areas of high risk for sensitive species; and
- avoiding operational lighting close to proposed bat crossing points and, conversely, using lighting in other locations in order to direct bats to cross the route at proposed bat crossing points.

4.6.3 Mitigation/compensation provision will be provided at a level appropriate to ensure that by the commencement of operation likely effects are reduced to a level where any killing/injury through train strike and/or the effects of turbulence will be sufficiently low to have confidence that there will be no detrimental effect on the favourable conservation status of the species concerned. As such the level and form of mitigation/compensation required will differ between species based on the status of the populations concerned.

4.7 Management, maintenance and monitoring

4.7.1 The nominated undertaker will commit to appropriate on-going management, maintenance and monitoring of mitigation features and compensatory habitat provision.

4.7.2 Detail of route-wide commitments to on-going management, maintenance and monitoring will be developed in consultation with key statutory bodies, and will form part of the EMR agreed at Royal Assent.

4.7.3 Detailed management, maintenance and monitoring strategies for individual locations will be provided alongside derogation licence applications post Royal Assent.

5 Otter

5.1 Key principles

5.1.1 The nominated undertaker will ensure that impacts as a consequence of the Proposed Scheme do not result in any long term adverse effect on the FCS of otter populations in the vicinity of the route of the Proposed Scheme.

5.1.2 The nominated undertaker will seek to provide safe passage for otter across the route of the Proposed Scheme throughout construction and during operation. This commitment will apply to all points at where the Proposed Scheme crosses watercourses that are either known to be utilised by otter, or are considered to have the potential to be utilised by otter in the future. This commitment acknowledges the on-going expansion of otter populations across the UK that is likely to continue during construction and into the period of operation of the Proposed Scheme.

5.1.3 Where works are likely to cause disturbance of otter or interference or damage to a holt a EPSM licence will be sought from Natural England.

5.2 Provision of replacement holts

5.2.1 Loss of otter holts has the potential to result in an adverse effect on FCS of the population concerned. Where the loss of holts cannot be avoided then the nominated undertaker will seek to mitigate adverse effects on the FCS of the populations concerned by creating artificial holts.

5.2.2 Replacement provision will seek to maximise the quality and likelihood of use of an artificial holt, in accordance with the following key principles:

- provision of two new artificial holts for every one lost;
- artificial holts will be sited in an undisturbed area, free from flooding and close to a good supply of food;
- where reasonably practicable to do so, one of the replacement holts will be provided in close proximity to the original holt that was lost when construction in the vicinity is complete. The other will be provided in a nearby area of

suitable habitat that will not be subject to disturbance during the period of construction;

- design of replacement holts will seek to replicate the form and complexity of the holt lost, ranging from simple log piles with entrance points, to more complex structures consisting of pipes and engineered cavities;
- artificial holt will be located on the same watercourse as the holt to be lost; and
- artificial holts will be created at least 12 months in advance of scheduled holt loss in order to give otters time to investigate and become acclimatised to the artificial holts.

5.2.3 The design and siting of artificial holts, alongside the methodology for excluding otters from existing holts will be co-ordinated by a consultant with experience in mitigation design for otters.

5.3 Mitigating disturbance during construction

5.3.1 Where watercourses known to support otter cross the route of the Proposed Scheme there is the potential for disturbance, killing and injury of otter. This will be avoided through implementing the following principles, wherever it is reasonably practicable to do so, at those locations where otters are known to be present:

- avoiding lighting of watercourses known to be utilised by otter through directing lights away from the watercourse and any associated holt locations;
- avoiding placement of site compounds in close proximity to watercourses;
- using fencing to guide otters to temporary safe crossing points for the duration of construction works or watercourse realignment works;
- providing a safe means by which otter can escape any deep excavations in the vicinity of suitable watercourses;
- securing chemicals and machinery overnight when working near watercourses; and
- limiting noise and vibration in the vicinity of retained known holts.

5.4 Maintaining safe passage

5.4.1 Design will aim to ensure that where the route of the Proposed Scheme crosses watercourses which support otter, or are potentially suitable to do so in the future, a means of safe passage for otter will be maintained.

5.4.2 Where the route of the Proposed Scheme crosses a watercourse a culvert or dry tunnel will be provided to allow passage of mammals such as otter and water vole. culverts will be designed so as to allow passage for mammals such as otter and water vole, taking into account flood events.

5.4.3 Mammal proof fencing in line with the specification provided in the Design Manual for Roads and Bridges (Highways Agency, 1999)[10] will be provided in association with crossing points wherever deemed necessary to ensure their effectiveness, and where necessary to prevent otters gaining access to the active railway line.

5.5 Management, maintenance and monitoring

5.5.1 The nominated undertaker will commit to appropriate on-going management, maintenance and monitoring of mitigation features and compensatory habitat provision.

5.5.2 Detail of route-wide commitments to on-going management, maintenance and monitoring will be developed in consultation with key statutory bodies, and will form part of the EMR agreed at Royal Assent.

5.5.3 Detailed management, maintenance and monitoring strategies for individual locations will be provided alongside derogation licence applications post Royal Assent.

6 Hazel dormouse

6.1 Key principles

6.1.1 The nominated undertaker will ensure that impacts as a consequence of the Proposed Scheme do not result in any long term adverse effect on the FCS of populations of hazel dormouse in the vicinity of the route of the Proposed Scheme.

6.1.2 If hazel dormouse are found to be present in surveys conducted as part of the ecological assessment for the Proposed Scheme, the nominated undertaker will seek to mitigate and/or compensate for any effects on hazel dormouse arising from the construction of the Proposed Scheme. The following principles of mitigation demonstrate how mitigation/compensation will be provided if hazel dormouse are encountered.

6.1.3 In line with the approach advocated in Bright et al (2006)[11] the mitigation hierarchy in Figure 2 will be applied.

[10] Highways Agency (2001), Design Manual for Roads and Bridges. Volume 10 Environmental design. Section 4 - Nature Conservation. Part 4 HA81/99 Nature Conservation advice in relation to otters. Her Majesty's Stationery Office.
[11] Bright, P., Morris, P., and Mitchell-Jones, T. (2006), Dormouse Conservation Handbook- Second Edition. English Nature, Peterborough.

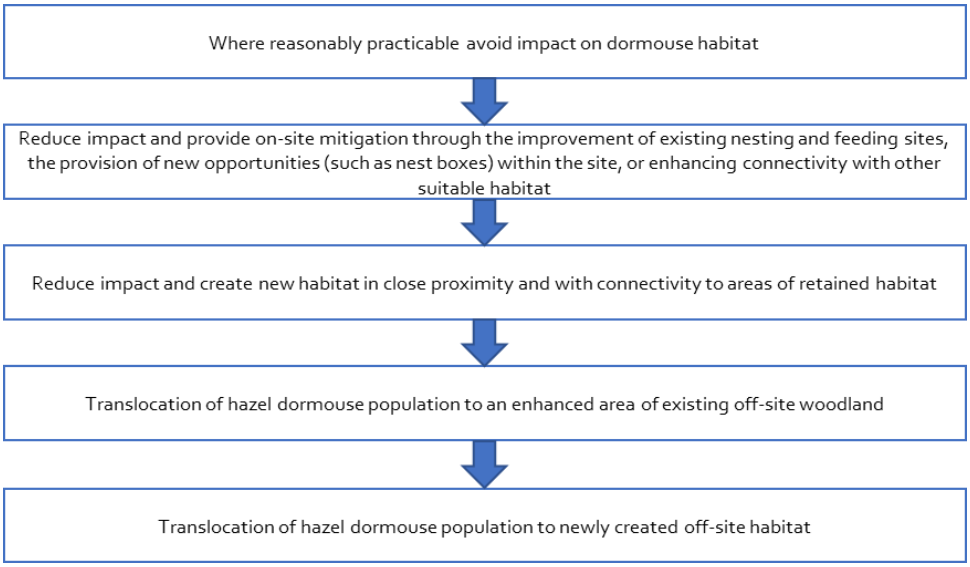
6.2 Terrestrial habitat creation and/or enhancement

6.2.1 Where hazel dormouse are confirmed to be present and the Proposed Scheme will result in losses of suitable habitat the nominated undertaker will act to ensure that these losses do not result in a detrimental effect on the FCS of the population concerned through providing replacement habitat. This may be achieved through either creation of new habitat or the enhancement of existing habitat to increase its potential value for hazel dormouse.

6.2.2 Where reasonably practicable the enhancement of existing woodland areas to make them more suitable for use by hazel dormouse will be favoured, in order to reduce the lag-period until these areas reach their target condition. Both habitat creation and enhancement will be undertaken with the aim of seeking to create habitats that meet the majority of the following criteria:

- a diverse, unshaded and productive understorey, preferably dominated by hazel, and including a range of other suitable plants to provide food sources and suitable nesting material;
- good connectivity to other areas of suitable habitat through either links to existing woodland or wide hedgerow connections;
- good arboreal connectivity;
- mixed age range of trees; and
- species rich edge strips or ride sides.

Figure 2: Mitigation hierarchy for hazel dormouse



6.2.3 Where existing habitat is to be subject to works to increase its suitability to support hazel dormouse then the nominated undertaker will also provide an appropriate number of nest boxes within suitable habitat to augment the availability of suitable habitat.

6.2.4 Where habitat creation or enhancement is necessary to compensate for the loss of habitat supporting hazel dormice this new habitat must be of greater value and size than that of the area previously lost.

6.2.5 Where reasonably practicable replacement habitat will be provided in locations that maintain connectivity with retained elements already utilised by the populations affected (i.e. in-situ).

6.2.6 The construction schedule will ensure that where habitat is to be lost then any associated restoration/enhancement of woodlands will be conducted at least 12 months prior to translocation in order to allow the plant and invertebrate populations to establish.

6.2.7 Where new habitat is created then the period until such habitats are suitable for use for hazel dormice will depend on the nature of the adjoining habitat, and the method of habitat creation. This may require a lead in period of several years. Where habitat supporting hazel dormice is to be lost, mature trees and shrubs, in particular hazel coppice stools will, where reasonable and practicable to do so, be translocated and used to speed up the establishment of new habitats.

6.3 Capture/exclusion and persuasion/displacement

6.3.1 Where areas of existing hazel dormouse habitat are affected there will be a need to clear hazel dormouse from this area prior to commencement of construction.

6.3.2 Where enhanced or new habitat is provided that has connectivity with the areas affected then efforts will be made to persuade hazel dormice to move into newly created habitats. For small to medium sized habitat areas, progressive vegetation removal will be used to encourage this, making use of appropriate seasonal windows for undertaking such activities.

6.3.3 Where utilised, persuasion/habitat degradation will be conducted in accordance with the following key principles (Bright et al, 2006):

- clearance should be progressive, wherever it is reasonably practicable to do so;
- where reasonably practicable to do so, all clearance should be undertaken using hand tools only in line with best practice guidelines. In all cases clearance work should be attended by a suitably qualified ecologist;
- each clearance strip should be narrower than the radius of a typical home range for that habitat (an average of 50m);
- for an area of up to one hazel dormouse home range (approximately 1 to 1.5ha of woodland or 300m of hedge clearance of bushy vegetation and tree felling in winter (November to March) is recommended as the least damaging option;

- clearance should be planned as a two-stage operation, with removal of surface vegetation in winter (November to March) followed by progressive stump extraction and earth removal in the following summer, during periods where dormice are active and able to respond immediately (i.e. taking into account breeding and presence of dependent young); and
- for small areas (e.g. less than 50m^2 of high quality woodland, larger areas of low quality woodland and short lengths of hedge (Standing Advice from Natural England and Department for Environment, Food and Rural Affairs, 29 July 2015[12]) small amounts should be taken out each day during the active period to allow animals time to escape and a search should be made for nests. The best periods for this work are May and late September when the presence of young is less likely.

6.3.4 Where large areas of habitat are to be lost, or compensatory habitat will be provided at an off-site receptor with no connectivity to the area affected, then translocation will be necessary. If required, translocation will be conducted in accordance with best practice guidelines (Bright et al, 2006), which includes the requirement for undertaking appropriate disease risk analysis prior to translocation.

6.3.5 In all cases where areas of hazel dormouse habitat are affected hazel dormice nest boxes will be erected within the receiving area at a density of 20 to 25 boxes per hectare. These measures will increase carrying capacity and provide safe shelter.

6.4 Maintaining habitat connectivity

6.4.1 Where severance is identified as having the potential to result in an adverse effect on conservation status of the population concerned, the nominated undertaker will seek to minimise its effects. This will be through implementing habitat creation/restoration to increase connectivity with other known areas of suitable habitat in the landscape, and maintain the viability of these severed elements, for example by providing new woodland links and hedgerows. Use of a green bridge would be considered if all other options for maintaining FCS of the population concerned have been exhausted.

6.5 Mitigation, monitoring and management

6.5.1 The nominated undertaker will commit to appropriate on-going management, maintenance and monitoring of mitigation features and compensatory habitat provision.

6.5.2 Detail of route-wide commitments to on-going management, maintenance and monitoring will be developed in consultation with key statutory bodies, and will form part of the EMR agreed at Royal Assent.

[12] Standing Advice from Natural England and Department for Environment, Food and Rural Affairs (29 July 2015), – Hazel or common dormouse: surveys and mitigation for development projects. https://www.gov.uk/guidance/hazel-or-common-dormice-surveys-and-mitigation-for-development-projects

6.5.3 Detailed management, maintenance and monitoring strategies for individual locations will be provided alongside derogation licence applications post Royal Assent.

7 Badgers

7.1 Key principles

7.1.1 The nominated undertaker will ensure that mitigation and compensation provided for badger populations affected by the Proposed Scheme will avoid significant adverse effects.

7.1.2 The nominated undertaker will provide compensation for the loss of main and annex setts and seek to maintain safe passage for badgers across the route of the Proposed Scheme.

7.1.3 Due to the limited legal protection afforded to badger and its widespread nature throughout the route of the Proposed Scheme, mitigation/compensation for the effects of habitat severance will only be provided where it is clear that in the absence of its provision a legal offence would occur.

7.2 Creation of artificial setts

7.2.1 Where main or annex setts are to be lost as a consequence of works associated with the construction of the Proposed Scheme the nominated undertaker will provide an artificial sett.

7.2.2 As far as is reasonably practicable artificial setts will be provided in locations that maintain connectivity with retained setts, key foraging areas and well used paths utilised by the badgers affected. Artificial setts will be constructed to include chambers and tunnels and will aim to replicate as much as possible the characteristics of the natural setts they replace. In all cases replacement setts will be provided within the appropriate social group territory.

7.2.3 Artificial setts will be created at least six months prior to closures of the setts they replace in order to provide some time to allow badgers to investigate and become acclimatised to the artificial sett. Baiting will be conducted periodically following the construction of the new sett up to the point of closure of the existing sett, in order to encourage the badgers to locate and begin to utilise the new sett.

7.2.4 Artificial setts will be positioned in suitable locations to ensure that there will be sufficient drainage to avoid flooding. Planting will be provided to ensure cover and lack of disturbance.

7.2.5 When siting new setts those locations which are subject to high levels of human or animal disturbance will be avoided.

7.2.6 Where the proposed works are likely to cause sett interference a licence to disturb a badger sett will be sought from Natural England.

7.3 Loss of habitat - maintaining safe passage across the route of the Proposed Scheme

7.3.1 No specific habitat creation for badger will be undertaken. Losses in habitats that were suitable for use by badger prior to construction will be addressed through compensation provided to address wider habitat loss as a consequence of the Proposed Scheme. This will provide large areas of woodland and grassland which will within five years (fewer in some cases) become suitable to provide replacement habitat for badger.

7.3.2 Where the territory of a social group will be severed to the extent that it may result in a significant adverse effect on the conservation status of the population concerned then the use of measures to maintain safe passage of badger across the route of the Proposed Scheme will be explored. Where significant effects are anticipated then the effects of habitat severance and fragmentation will be minimised by the installation of appropriately designed and positioned passageways beneath or over the railway.

7.3.3 Where badger tunnels are provided then the following features will be considered:

- siting tunnel on or near a known badger path, where reasonably practicable to do so;
- good habitat connectivity with existing landscape features such as hedges and ditches;
- good vegetation cover around the tunnel entrance;
- ensuring adequate drainage is incorporated into the design; and
- tunnel diameter of at least 600mm.

7.4 Mitigating effects arising during the construction of the Proposed Scheme

7.4.1 During the construction phase, activities that may pose a temporary threat to badgers or disturb them whilst they are in nearby setts will be controlled. These will include some or all of the following:

- security lighting to be directed away from setts;
- chemicals to be stored as far away from setts and badger paths as possible;
- trenches to be covered at the end of each working day, or to include a means of escape from the animal falling in,
- water sources for badgers to be safeguarded;
- trees to be felled away from setts and must not block badger paths; and
- disturbances such as loud noise or vibration that might agitate badgers occupying a sett to be avoided or limited to areas well away from setts.

7.5 Management, maintenance and monitoring

7.5.1 The nominated undertaker will commit to appropriate on-going management, maintenance and monitoring of compensatory habitats. Detailed management, maintenance and monitoring strategies for individual locations will be provided alongside derogation licence applications post Royal Assent.

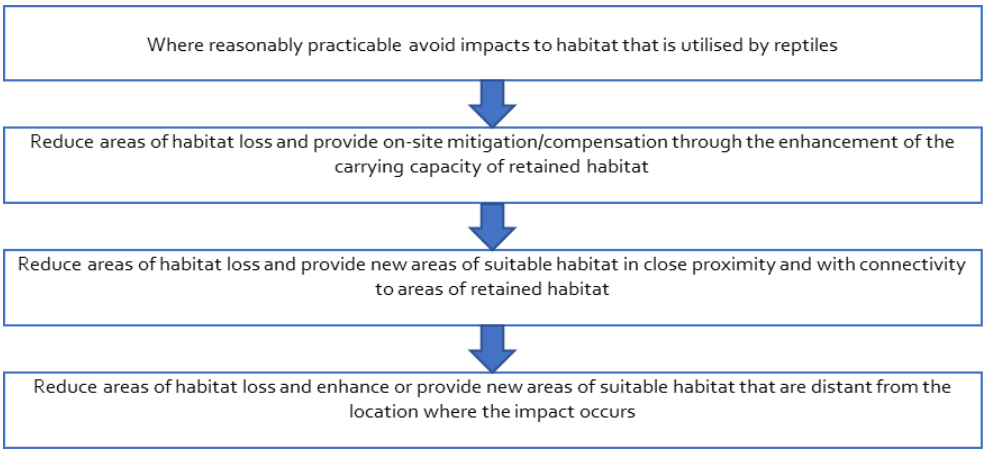
8 Reptiles

8.1 Key Principles

8.1.1 The nominated undertaker will ensure that impacts as a consequence of the Proposed Scheme do not result in any long term adverse effect on the conservation status of populations of common reptile (slow worm, adder, grass snake and sand lizard) in the vicinity of the route of the Proposed Scheme.

8.1.2 In addressing the potential loss of areas of habitat known to be used by common reptiles the mitigation hierarchy, shown in Figure 3, will be applied:

Figure 3: Mitigation hierarchy for habitat utilised by reptiles



8.1.3 Where translocation will involve movement of individuals to locations outside of the normal extent of that population then disease screening will be undertaken in line with current best practice to ensure that all populations involved are free from disease at time of translocation.

8.1.4 Once constructed the railway is for the majority of the route considered unlikely to form an absolute barrier to reptile movement. Reptiles are known to utilise habitats that are common to operational railway corridors such as south facing embankments for basking.

8.1.5 Where severance is identified as having the potential to result in an adverse effect on conservation status the nominated undertaker will seek to minimise its effects through implementing habitat creation/restoration to increase connectivity with other known areas of suitable habitat in the landscape and maintain the viability of these severed elements.

8.1.6 The use of reptile tunnels as a potential method for addressing the effects of severance has been rejected on the basis of a lack of clear evidence demonstrating their effectiveness.

8.2 Creation of replacement habitat

8.2.1 Where a significant adverse effect on common reptiles will occur then the nominated undertaker will act to provide sufficient replacement habitat to ensure the conservation status of the population is maintained in the long term.

8.2.2 No adherence to a strict ratio for balancing losses to gains is proposed. Consideration of the extent of terrestrial habitat required to address losses as a consequence of the Proposed Scheme will be undertaken by an experienced ecologist and will take into account both the habitat area and quality that is to be provided.

8.2.3 Where replacement habitat is of equal quality to those areas lost then the area of replacement provision will be at least as large as the area lost (i.e. minimum of 1:1 ratio).

8.2.4 Where it is not reasonably practicable to mitigate the impact on the local population in-situ then opportunities will be taken to consolidate compensation provision as part of larger scale habitat creation areas. All such compensation areas will be provided, where reasonably practicable to do so, in close proximity to the route of the Proposed Scheme, through the creation of high quality areas of terrestrial habitat, integrated with mitigation/compensation provision for other species.

8.2.5 Habitats of similar type to those that will be lost will be provided and bunds, hibernacula and other above ground refugia will be provided in each area of terrestrial habitat creation in order to maximise their potential carrying capacity.

8.2.6 Planting of terrestrial compensation areas will utilise species appropriate to the local area and where possible will seek to maximise the value of such areas for other species, without compromising their value for reptiles.

8.2.7 All hibernacula, bunds and other refugia incorporated into the detailed design will be constructed in accordance with current best practice guidelines (e.g. Herpetofauna Workers Manual, Gent and Gibson 2003[13]).

8.3 Capture, exclusion and habitat manipulation

8.3.1 Where areas of habitat loss are limited and compensation will be provided within areas with direct connectivity to the areas lost then, where reasonably practicable to do, progressive degrading of the habitat to be lost will be conducted in order to encourage reptiles to move into new habitats. The requirement for additional capture and exclusion to augment this process will be considered on a case by case basis taking into consideration the population size, habitat quality and complexity of habitats concerned.

[13] Gent, T. and Gibson, S. (2003), Herpetofauna Workers Manual. Joint Nature Conservation Committee, Peterborough.

8.3.2 Where required capture and exclusion will be undertaken in accordance with the current best practice guidelines at the time of construction.

8.3.3 Wherever it is reasonably practicable to do so translocation will commence a minimum of 12 months prior to the required start of construction. For complex sites supporting high population size classes then a longer lead in period may be necessary in order to ensure the site is cleared prior to construction.

8.3.4 Exclusion fencing will be maintained for the duration of construction at those locations where there is considered to be a risk of reptiles re-entering construction areas post habitat clearance.

8.3.5 Permanent exclusion fencing will be provided in those locations where the operation of the Proposed Scheme represents a significant risk to reptile populations or where the presence of reptiles within key areas of operational infrastructure have the potential to significantly constrain operational requirements.

8.4 Management, maintenance and monitoring

8.4.1 The nominated undertaker will commit to appropriate on-going management, maintenance and monitoring of compensatory habitats.

8.4.2 Detail of route-wide commitments to on-going management, maintenance and monitoring will be developed alongside key statutory bodies, and will form part of the EMR agreed at Royal Assent.

8.4.3 Detailed management, maintenance and monitoring strategies for individual locations will be provided alongside derogation licence applications post Royal Assent.

9 Water vole

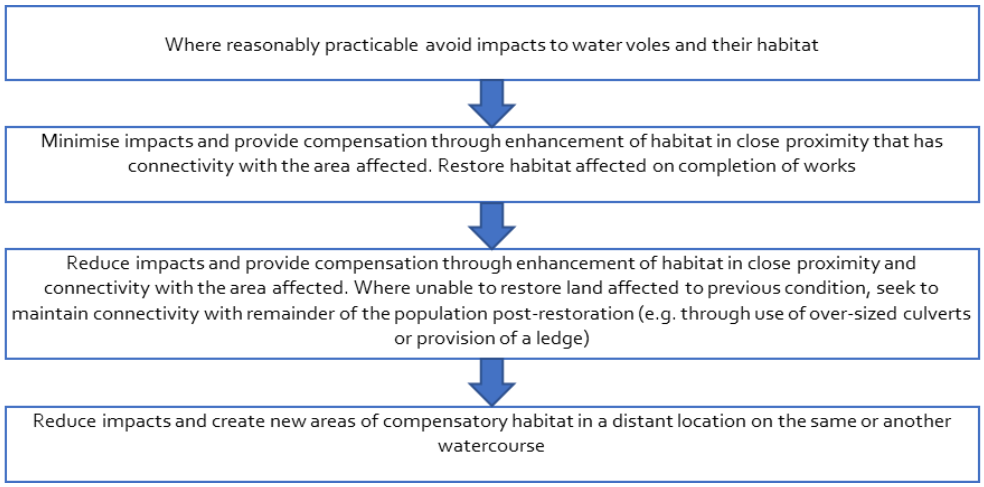
9.1 Key principles

9.1.1 The nominated undertaker will ensure that impacts as a consequence of the Proposed Scheme do not result in any significant effects on the conservation status of water vole populations in the vicinity of the route of the Proposed Scheme.

9.1.2 The nominated undertaker will mitigate for effects on water vole by applying the mitigation hierarchy, shown in Figure 4, as described in The Water Vole Conservation Handbook (Strachan et al, 2011)[14]:

[14] Strachan, R., Moorhouse, T., and Geling, M. (2011), Water Vole Conservation Handbook - Third Edition. Wildlife Conservation Research Unit, Abington.

Figure 4: Mitigation hierarchy for water vole



9.1.3 Where it is not reasonably practicable to mitigate the impact on the local population in-situ then opportunities will be taken to consolidate compensation provision as part of larger scale habitat creation areas. All such compensation areas will, where reasonably practicable to do so, be provided in close proximity to the route of the Proposed Scheme, through the creation of areas of suitable bank and riparian habitat.

9.2 Provision of replacement habitat

9.2.1 Where reasonably practicable to do so, the nominated undertaker will compensate for the loss and/or disturbance of existing water vole habitat through the creation of replacement habitat of a similar quantity and quality. This may be achieved either through the enhancement of existing habitat within the same or linked watercourses, or through the creation of new habitat, following guidance in The Water Vole Mitigation Handbook (Dean et al, 2016) [15].

9.2.2 Replacement habitat will be provided as close to the area affected as it is reasonably practicable to do so.

9.2.3 Where it is reasonably practicable to restore the habitats which are to be affected during construction then this will be conducted as soon as possible following the completion of construction.

9.2.4 Where enhancement of existing habitats is proposed and there is likely to be seasonal use, then such enhancements works that are required will be undertaken outside of this season in order to avoid potential killing or injury of individuals.

9.2.5 Where replacement habitat or improvement of existing habitat is undertaken then these works will be undertaken prior to the removal of the habitat to be affected by construction. Where it is reasonably practicable to do so new habitats will be created at least a full growing season in advance of the proposed translocation in order to allow the new areas of habitat to establish.

[15] Dean M, Strachan R, Gow D and Andrews R (2016), The Water Vole Mitigation Handbook (The Mammal Society Mitigation Guidance Series). The Mammal Society, London.

9.3 Capture and habitat manipulation/displacement

9.3.1 The most appropriate method for clearing water voles from areas to be affected by the proposed works will be considered on a site by site basis taking into account the following factors:

- size of habitat area affected;
- likely number of individuals affected; and
- seasonal timing of the works;

9.3.2 Where it is reasonably practicable to do so, and thought likely to be successful based on expert opinion, habitat manipulation will be used to encourage the displacement of individuals to areas of suitable retained or enhanced habitat in adjoining sections of the same watercourse through progressive removal of bankside vegetation. Use of displacement will be favoured where the area affected is limited in extent, only likely to support a relatively small number of animals, where there is sufficient alternative habitat available, and/or relocating animals by trapping is likely to be disproportionately expensive. Where utilised, habitat manipulation will be conducted in accordance with the best practice guidelines provided in The Water Vole Mitigation Handbook (Dean et al, 2016).

9.3.3 Where displacement is considered unsuitable based on consideration of the factors identified in paragraph 9.3.1, trapping of water voles will be undertaken in accordance with the guidelines provided in The Water Vole Mitigation Handbook (Dean et al, 2016) and standing advice from Natural England/Department for Environment, Food and Rural Affairs (2015) on water voles[16].

9.3.4 Where translocation to a site distant to the area affected is proposed and there is the potential for interaction of a previously isolated population, appropriate disease screening will be conducted prior to commencement of the full scale capture and release programme.

9.3.5 In some circumstances where it is not appropriate to translocate the population or to encourage the use of adjacent habitats, it may be necessary to take water voles into a captive breeding programme. This approach may be suitable where it is possible to return water voles to their original location following the completion of temporary works, but no options for displacement or off-site translocation are viable. In addition, captive breeding may be appropriate where the trapped population is of limited size and therefore will be of increased risk of detrimental effect from the pressures of immediate translocation. Where this is necessary captive breeding will be undertaken by those experienced and qualified to do so, in order to build up the number of water voles to a level where it is considered that the population can be self-sustaining on their release.

[16] Standing Advice from Natural England and Department for Environment, Food and Rural Affairs (28 March 2015), Water voles: surveys and mitigation for development projects. https://www.gov.uk/guidance/water-voles-protection-surveys-and-licences.

9.4 Minimising effects of habitat fragmentation

9.4.1 Where it is reasonably practicable to do so, the nominated undertaker will seek to ensure that the construction of the Proposed Scheme avoids fragmentation of water vole habitat, which has the potential to result in adverse effects on the functioning of the water vole population of the wider local area.

9.4.2 The potential for fragmentation will be considered during mitigation design. In extreme situations where it is not reasonably practicable to maintain the viability of severed fragments of a population affected by the Proposed Scheme then the nominated undertaker will consider the trapping of water voles from isolated fragments of habitat outside the extent of Proposed Scheme. This will allow the full population to be relocated to the same receptor site, and maintain its viability in the long term.

9.4.3 Where the route of the Proposed Scheme crosses a watercourse a culvert or dry tunnel will be provided to allow passage for mammals such as otter and water vole. Culverts will be designed taking account of the guidance in The Water Vole Mitigation Handbook (Dean et al, 2016), and taking into account flood events. Management, maintenance and monitoring

9.4.4 The nominated undertaker will commit to appropriate on-going management, maintenance and monitoring of compensatory habitats, taking account of the guidance in The Water Vole Conservation Handbook (Strachan et al, 2011).

9.4.5 Detail of route-wide commitments to on-going management, maintenance and monitoring will be developed alongside key statutory bodies, and will form part of the EMR agreed at Royal Assent.

9.4.6 Detailed management, maintenance and monitoring strategies for individual locations will be provided alongside derogation licence applications post Royal Assent.

10 White-clawed crayfish

10.1 Key principles

10.1.1 The nominated undertaker will ensure that impacts as a consequence of the Proposed Scheme do not result in any long term significant adverse effects on the conservation status of white-clawed crayfish populations in the vicinity of the Proposed Scheme.

10.1.2 Where it is reasonably practicable to do so, bank and channel works will be conducted in small sections, with progressive reinstatement to limit the reduction in the availability of suitable habitat. In addition, measures will be implemented to prevent siltation and pollution of watercourses.

10.1.3 Where it is necessary to conduct works in areas where white-clawed crayfish are confirmed to be present, the nominated undertaker will seek to provide replacement suitable habitat in close proximity to the areas of habitat affected (within a few hundred metres) and within sections of the same watercourse (or tributaries of it) that are already used by individuals of the same population. Such provision will be made in advance of the proposed works, allowing any crayfish captured during clearance works to be released into these locations. In doing so the aim will be to avoid any long term effect on the conservation status of the population concerned.

Capture and exclusion

10.1.4 Where required white-clawed crayfish removals will consist of a combination of both trapping and destructive searching of potential refuges prior to construction, and controlled draw-down under ecological supervision. Works will be conducted according to the key principles identified in Peay (2000)[17] which include the following:

- undertaking trapping and destructive clearance of refuges immediately in advance of the proposed works;
- retention of stones suitable for use during restoration;
- where possible erect a temporary barrier to prevent access from adjoining sections of the channel which are not subject to works;
- ecological supervision throughout draw-down to catch white-clawed crayfish as they emerge from refuges;
- destructive clearance of all structures and habitats suitable for possible use by white-clawed crayfish on completion of draw-down; and
- relocate white-clawed crayfish to identified receptor site as soon as reasonably practicable.

10.1.5 Exclusion of white-clawed crayfish from construction areas will be conducted during the suitable seasonal windows of either April or July to October inclusive, when the water temperature is 4°C or higher (Standing Advice from Natural England and Department for Environment, Food and Rural Affairs - 9 October 2014[18]). Works will not take place during late May or June to avoid disturbance to breeding females with attached young. Current best practice guidance for disease screening and biosecurity will be implemented at all times.

10.1.6 Where an adverse effect is anticipated on white-clawed crayfish then the requirement for creation of replacement habitat in close proximity on the same watercourse will be considered, in order to provide an appropriate receptor site.

[17] Peay, S. (2002), Guidance on Habitat for White Clawed Crayfish and its restoration. Environment Agency Technical Report W1-067/T.
[18] Standing Advice from Natural England and Department for Environment, Food and Rural Affairs (9 October 2014) – White-clawed crayfish: surveys and mitigation for development projects. https://www.gov.uk/guidance/white-clawed-crayfish-protection-surveys-and-licences..Aquatic habitat creation and restoration.

10.1.7 Where enhancement of existing habitat is undertaken this will seek to achieve the following in order to provide suitable habitat to support white-clawed crayfish:

- improved water quality;
- reduced siltation;
- increased refuge availability;
- removal of any alien crayfish; and
- more appropriate type and structure of aquatic and bankside vegetation.

10.1.8 All enhancement works will be completed prior to the commencement of the clearance of affected habitat. Suitable measures for each location where such works are required will be agreed in conjunction with Natural England and the Environment Agency prior to the commencement of construction.

10.1.9 Where additional refuges are provided these will be of sizes to support both adults and juveniles, and may be provided through a variety of measures including: provision of stone on the bed or in banks; engineering suitable crevices into below water man-made structures; and additional wood or vegetation along the banks.

10.1.10 Once construction works have been completed, where compatible with the design and operation of the Proposed Scheme, areas of habitat affected by the construction of the Proposed Scheme will be reinstated so that the bank and channel are suitable for white-clawed crayfish.

10.1.11 If the use of an 'ark site' is deemed necessary, then a suitable site will be selected in consultation with relevant consultees, in accordance with the guidance provided in Ark sites for white-clawed crayfish - guidance for the aggregates industry (Whitehouse et al 2009)[19].

Avoiding and mitigating effects during construction phase

10.1.12 During the construction phase where white-clawed crayfish are known to be present the following measures will be implemented as appropriate with the aim of avoiding or mitigating adverse effects which could occur during construction:

- security lighting to be directed away from riverbanks and watercourses;
- chemicals to be stored as far away from watercourses as possible;
- monitoring to ensure no adverse siltation of downstream locations;
- reducing disturbance to riverbank;
- maintaining existing water levels and water flow; and
- reducing removal of bankside vegetation and trees.

[19] Whitehouse, A.T., Peay, S. and Kindemba, V. (2009), Ark sites for White-Clawed Crayfish - Guidance for the aggregates industry. Buglife - The invertebrate Conservation Trust, Peterborough.

10.2 Management, maintenance and monitoring

10.2.1 The nominated undertaker will commit to appropriate on-going management, maintenance and monitoring of compensatory habitats.

10.2.2 Detail of route-wide commitments to on-going management, maintenance and monitoring will be developed alongside key statutory bodies, and will form part of the EMR agreed at Royal Assent.

10.2.3 Detailed management, maintenance and monitoring strategies for individual locations will be provided alongside derogation licence applications post Royal Assent.

11 Fish

11.1 Key principles

11.1.1 The nominated undertaker will ensure that mitigation and compensation provided for fish populations affected by the Proposed Scheme will seek to ensure no permanent significant adverse effects occur.

11.1.2 The extent of areas affected by culverts, watercourse realignment and dewatering will be reduced as far as reasonably practicable. In addition, where reasonably practicable, works will be sensitively timed in order to minimise impacts on the species concerned.

11.2 De-watering

11.2.1 Where dewatering is required to facilitate construction then current best practice methods will be implemented to ensure that all fish from such areas are safely removed and relocated. The capture methodology utilised will take into account: the physical features of the watercourse involved; the species involved; likely numbers; and timing of proposed works. The final methodology will be agreed with the Environment Agency.

11.2.2 Permits will be obtained from the Environment Agency for all fish movements undertaken in support of the Proposed Scheme. This process includes the requirement for disease screening.

11.3 Fish passage

11.3.1 Where reasonably practicable, temporary diversions will be utilised to maintain the safe passage of fish and reduce effects during construction. Where appropriate this may involve the creation of a temporary diversion channel with suitable sized replacement substrate or transplanted substrate from the section being dewatered in order to ensure that the size and flow in the diversion channel replicates the existing channel as closely as possible.

11.3.2 Reinstated watercourses and new alignments will be designed where reasonably practicable to provide habitats of increased complexity and quality.

11.3.3 If potential significant effects on fish populations are identified as a consequence of potential restrictions to fish movement then the potential to provide fish passage will need to be reconsidered. If required the fish passages will be designed to facilitate the upstream and downstream movement of fish and other aquatic fauna.

11.4 Mitigation during construction

11.4.1 During the construction phase activities that may pose a temporary threat to fish, in particular migratory species, or disturb them will be mitigated against. These will include some or all of the following:

- artificial lighting directed away from water surfaces during construction/operation of the Proposed Scheme;
- chemicals to be stored as far away from watercourses as reasonably practicable; and
- activities that may cause pollution and sedimentation will be controlled by approved measures.

11.5 Management and maintenance

11.5.1 The nominated undertaker will commit to appropriate on-going management, maintenance and monitoring of compensatory habitats.

11.5.2 Detail of route-wide commitments to on-going management, maintenance and monitoring will be developed alongside key statutory bodies, and will form part of the EMR agreed at Royal Assent.

12 Invertebrates

12.1 Key principles

12.1.1 The nominated undertaker will ensure that mitigation and compensation provided for aquatic and terrestrial invertebrate populations affected by the Proposed Scheme will mean there are no permanent adverse effect on the aquatic and terrestrial invertebrate populations in the vicinity of the Proposed Scheme.

12.1.2 Given the wide range of protected and/or notable invertebrate species it is not feasible to provide specific mitigation principles for all species in this note. Instead broad principles are provided that will apply to the majority of aquatic and terrestrial invertebrate species. In all cases where significant effects are identified then specific mitigation proposals will be developed that reflect the limited ecological niche occupied by many invertebrate species.

12.1.3 Potential significant effects on protected and/or notable species will be reduced, wherever reasonably practicable, by ensuring that at least some areas of the existing suitable habitat for the species concerned is retained to provide a 'source' to colonise areas of mitigation/compensatory habitat to be provided.

12.1.4 In addition, where reasonably practicable to do so, suitable compensatory habitat provided to address significant effects will be created as early as possible within the project programme in order to maximise time available for these areas to establish in advance of losses. Such provision will, where reasonably practicable to do so, be provided in suitable proximity to allow an element of natural dispersal of the species concerned prior to any habitat loss as a consequence of the Proposed Scheme.

12.1.5 Compensatory habitat provision provided to address significant effects on invertebrates will in general look to mimic the structure and form of the existing nearby habitats which support the population concerned.

12.1.6 Where reasonably practicable to do so some plant material or elements of the areas affected may be transferred to the area of mitigation/compensatory provision in order to increase the likelihood that the target species will occupy the new habitat areas provided (e.g. the transfer of standing dead wood from ancient woodlands to be lost, where this habitat element is known to play an important part in the lifecycle of the species concerned; or the transfer of water or aquatic vegetation to speed the establishment of aquatic invertebrate populations in newly created ponds).

12.1.7 In addition, the following measures will be implemented, where it is reasonably practicable to do so:

- conducting clearance of affected habitats at an appropriate time of the year based on the life-cycle of the species concerned; and
- retaining elements of suitable habitat for the species concerned, as long as reasonably practicable during construction, in order to maximise the potential for newly created habitats to become established.

12.1.8 Habitat creation to be provided for other primary purposes (i.e. not specifically to address significant effects on invertebrates) will in the longer term also serve to provide habitat suitable for a range of invertebrate species.

12.2 Management and maintenance

12.2.1 The nominated undertaker will commit to appropriate on-going management, maintenance and monitoring of compensatory habitats.

12.2.2 Detail of route-wide commitments to on-going management, maintenance and monitoring will be developed alongside key statutory bodies, and will form part of the EMR agreed at Royal Assent.

13 Birds

13.1 Key principles

13.1.1 The nominated undertaker will ensure that where reasonably practicable the Proposed Scheme will avoid permanent significant adverse effects on birds, including those species listed in Schedule 1 of the Wildlife and Countryside Act (1981 as amended)[20].

13.1.2 Due to the scale and complexity of the Proposed Scheme it will not be feasible to avoid all such impacts and as such mitigation and/or compensation will be provided where, in the absence of this provision, there is the potential that a significant adverse effect may arise.

13.1.3 Where there is a significant reduction in the availability of nesting or roosting habitat, as a consequence of the Proposed Scheme, then consideration will be given to the requirement for specific mitigation and or compensation in relation to birds, i.e. in addition to those ecological mitigation/compensation measures that will mitigate impacts on birds population but for which they are not the primary purpose.

13.1.4 Where reasonably practicable to do so habitat clearance will be conducted outside of the periods where the species or species concerned will be breeding. Through sensitive timing of works it is aimed to reduce disturbance of birds, and the potential for wasted breeding effort.

13.1.5 The loss of potential breeding habitats from within land required for the construction of the Proposed Scheme will as a general rule be addressed in the long term through the replacement habitat provided for landscaping and ecology purposes. Where there is the potential for additional adverse effects to occur prior to these habitats maturing then the option of providing alternative suitable habitat will be considered.

13.1.6 Evidence suggests that mortality of barn owl may result in the loss of all breeding populations of barn owls within 3km of the Proposed Scheme. As a consequence, to address these losses opportunities to provide barn owl nesting boxes in areas greater than 3km from the route will be explored with local landowners to enhance barn owl populations in existing habitats that would not be affected by the Proposed Scheme.

13.2 Management and maintenance

13.2.1 The nominated undertaker will commit to appropriate on-going management, maintenance and monitoring of compensatory habitats.

13.2.2 Detail of route-wide commitments to on-going management, maintenance and monitoring will be developed alongside key statutory bodies, and will form part of the EMR agreed at Royal Assent.

[20] Wildlife and Countryside Act (1981), Chapter 69. Her Majesty's Stationery Office, London.

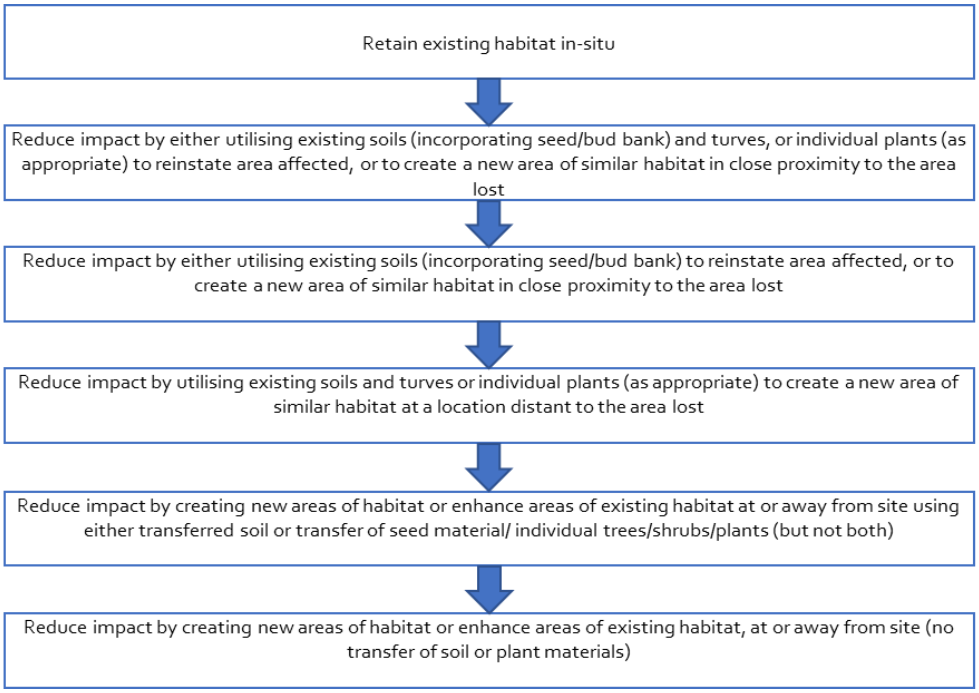
14 Habitats

14.1 Key principles

14.1.1 The nominated undertaker will seek to ensure that at the route-wide level impacts on habitats as a consequence of the Proposed Scheme will not result in a permanent significant adverse effect on the conservation status of the habitats concerned.

14.1.2 The mitigation hierarchy shown in Figure 5 will be applied in considering the most suitable approach to mitigating potential habitat loss:

Figure 5: Mitigation hierarchy for habitats



Translocation

14.1.3 Translocation of habitats is a costly process and does not always provide a habitat that is of higher value than that which can be reached through alternative approaches. As such it would not be reasonable or practical, for example, to undertake translocation of all grassland areas affected by the Proposed Scheme. As a consequence, in the consideration of the hierarchy for each site the following factors will be considered in deciding at which level in the hierarchy it is most appropriate to provide mitigation/compensation provision:

- ecological value/distinctiveness of habitat type;
- designation status;
- size;
- condition;

- nature of available receptors sites (e.g. topography, drainage, underlying soil type and species composition);
- likely content and condition of the seed bank; and
- ease and speed of recreating a similar habitat type through alternative means.

14.1.4 Where there is the potential for significant adverse effects on habitats of high ecological value then translocation of the affected area may be justified. Where translocation is considered to be justified then it will be necessary to determine the most suitable form of translocation for the habitat type and area concerned. There are four main alternative types of translocation as follows (Anderson 2003[21] and JNCC 2003[22]):

- turf translocation (i.e. where effort is made to partially maintain the integrity of the vegetation layer during the transfer by keeping the vegetation layer and the mass of underlying soil separated);
- soil translocation (where both the soils and the vegetation are scraped up and transferred together with no effort made to separate the two);
- moving trees and shrubs; or
- moving individual plants.

14.1.5 The most appropriate method of compensating for the loss of habitats of ecological value will be considered on a site by site basis taking into account the nature and value of the habitats involved and the financial and other practical implications associated with each of the above methods.

14.1.6 Where translocation is undertaken the turves, soil or plants should be stripped and transferred to the receptor site immediately unless there are clear practical reasons for delay. Storage will increase risk of failure, but where necessary in the short term will be conducted according to best practice guidance (Anderson, 2003).

14.1.7 Detail of proposed translocation strategies for each site will be drawn up by ecologists experienced in works involving the translocation of the habitats concerned, with reference to current best practice guidance (e.g. Anderson, 2003).

Receptor sites

14.1.8 When translocating a habitat, the process will be dependent upon the suitability of the chosen receptor site. Efforts have been made to select receptor sites that are compatible with the target habitat types concerned based on comparison of the following factors:

- hydrological conditions;
- soil type;

[21] Anderson, P. (2003), Habitat translocation: a best practical guide. CIRIA, London.
[22] Joint Nature Conservation Committee (2003), A habitats translocation policy for Britain. JNCC, Peterborough.

- topography;
- connections to other ecological habitats;
- size of site; and
- accessibility.

14.1.9 In all cases prior to translocation soil sampling and works to establish groundwater levels should be undertaken and used in the detailed design of mitigation areas. In addition, in some instances trials may be necessary in order to establish the content and viability of the seed bank.

14.1.10 Where identified receptors sites are not fully compatible with the target community then remedial works will be undertaken to ensure that the surrounding, physical, chemical and hydrological soil and substrate conditions are similar or more suitable than those at the donor site.

14.2 Key habitat types

14.2.1 A wide range of habitats will be affected by the Proposed Scheme. Further details are provided in relation to four key habitat types that will be subject to significant effects as a consequence of the Proposed Scheme. There will be many parallels in the approach adopted for other habitats.

14.2.2 Where it is not reasonably practicable to mitigate the impact of local habitat loss in-situ then opportunities will be taken to consolidate compensation provision as parts of larger scale habitat creation areas. All such compensation areas will be provided in close proximity to the route, where it is reasonably practicable to do so.

Woodland

14.2.3 Where areas of woodland habitat are affected by the Proposed Scheme the most appropriate form of mitigation will be decided through consideration of the factors identified in paragraph 14.1.3. For woodland areas in particular the consideration of the likely time-lag to establishment and the distinctiveness of the habitat type concerned are likely to be key drivers that mean that translocation is undertaken at some locations.

14.2.4 The nominated undertaker recognises that creation of newly planted woodland and translocation of ancient woodland habitat components cannot be considered as mitigation for these impacts. Ancient woodland in its entirety cannot be translocated and as a consequence it is recognised as irreplaceable within the time frame of the Proposed Scheme.

14.2.5 However, in order to provide compensation in the long term (outside the timeframe of the Proposed Scheme) the translocation of ancient woodland soils will be undertaken. In addition, new areas of woodland that will be created will be targeted at providing

new areas of habitat of principal importance as defined under Section 41 of the Natural Environment and Rural Communities Act (1996)[23].

14.2.6 Where translocation is identified as being a reasonable and worthwhile approach for the habitat area concerned this may involve implementation of one or more of the following measures for woodland, as appropriate:

- soil translocation;
- translocation of veteran trees;
- translocation of coppice stools, and other small trees; and/or
- translocation of fallen or standing deadwood.

14.2.7 Translocation of some or all of the above elements of ancient woodland will enable some of the valuable elements of the existing ancient woodland ecosystems to be retained within the newly created areas.

14.2.8 Soil testing and seed viability trials will be conducted prior to translocation at all locations identified in order to ensure that conditions are suitable.

14.2.9 The nature of wet woodland means that the methods of translocation differ from that for dry woodlands. Where translocation of wet woodland is proposed the mechanisms and logistics of translocation will have particular emphasis on the consideration of the hydrological, hydrochemical and hydrogeological conditions. In addition, the gradient of the land and flooding probability will be explored in detail in order to ensure that the donor site is sufficiently inundated to maintain wet woodland habitat.

14.2.10 Woodland translocation should take place in the dormant season in autumn/early winter under normal weather conditions.

14.2.11 Where translocation is not a justifiable option based on the factors identified in paragraph 14.1.3 then new woodland habitat will be created.

14.2.12 In all cases planting will only utilise native species that are characteristic and appropriate to the area concerned. Both areas of new woodland habitat creation and those translocated should be planted as early as practicable within the project programme.

Grasslands

14.2.13 Where translocation of grassland areas of high ecological value is justified and reasonably practicable then the most suitable method of translocation, as identified in paragraph 14.1.4,will be considered, taking into account the generic factors identified at paragraph 14.1.3.

14.2.14 The translocation of turves will normally be the preferred option. However, for grassland areas the cohesiveness of the sward will also be taken into account. Turf translocation will not be reasonably practicable where turf contains significant

[23] Natural Environment and Rural Communities Act (1996), Chapter 16. Her Majesty's Stationery Office, London.

elements of bare ground or lacks turf cohesiveness (Anderson, 2003). In addition, it may not be possible to utilise turf translocation where steep slopes or undulating ground are present.

14.2.15 Where soil translocation is proposed, prior to translocation a selection of seed bank tests will be conducted in order to test the viability and content of the existing seed bank.

14.2.16 Where wet or marshy grassland are to be translocated then specific focus will be given to ensuring that the hydrological regime of the receptor site is manipulated in order that it provides suitable groundwater conditions to support the target habitat in question.

14.2.17 The detailed mechanics of each translocation will be influenced by best practice guidance (e.g. Anderson, 2003) in consultation with experienced ecologists, and contractors experienced in large scale habitat translocation.

14.2.18 Where translocation is not justified or reasonably practicable taking into consideration the factors outlined in paragraph 14.1.3, compensatory grassland will be provided through the preparation and sowing of a suitable area. Such areas will be targeted at providing new areas of habitat of principal importance as defined under Section 41 of the Natural Environment and Rural Communities Act (1996).

14.2.19 In all such cases efforts will be made to ensure that areas identified for provision of grassland habitat creation are compatible with the target community identified. This as a minimum will include consideration of topography, drainage, aspect, and underlying soil type.

14.2.20 Only native species will be utilised and seed mixes will aim to broadly mimic the species composition of those areas to be lost. Where enhancement of the sward is proposed through the provision of a more diverse sward than was present previously only native species which are characteristic to the local area will be utilised. Where reasonable and worthwhile to do so, the collection of seed and/or plants from suitable donor sites will be considered.

14.2.21 Grassland compensation areas will be planted as early as is reasonably practicable within the construction programme in order to allow maximum time for them to establish prior to the losses associated with the Proposed Scheme.

Hedgerows

14.2.22 The translocation of specific hedgerows will be considered where the age, diversity and structure of these features is such that their loss as individual features will result in significant adverse effects. In addition, translocation of hedgerows may be undertaken where there are benefits for other protected species resulting from reducing the lag time for linear features to establish.

14.2.23 Where justified, translocation will be undertaken according to current best practice guidance, with detailed mechanisms for these works devised by experienced ecologists in conjunction with contractors that are experienced in undertaking such works.

14.2.24 In order to mitigate for the wider loss of hedgerow habitat and the associated fragmentation of the existing hedgerow network the undertaker will, where design of the Proposed Scheme and other practical considerations allow, replace those hedgerows which are lost.

14.2.25 Reinstatement will utilise species of native provenance and where reasonably practicable will aim to provide hedgerow networks containing a wider range of appropriate native species than are currently present.

14.3 Management and maintenance

14.3.1 The nominated undertaker will commit to appropriate on-going management, maintenance and monitoring of compensatory habitats.

14.3.2 Detail of route-wide commitments to on-going management, maintenance and monitoring will be developed alongside key statutory bodies, and will form part of the EMR agreed at Royal Assent.

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HS2 Phase 2a West Midlands - Crewe: Technical note – Ecology and biodiversity - Ecological field survey methods and standards

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1 Executive summary

1.1.1 This document contains methods for scoping and undertaking ecological surveys for a range of flora and fauna in support of the HS2 Phase 2a West Midlands to Crewe scheme (hereafter the 'Proposed Scheme').

1.1.2 This document provides standard methodologies for those ecological surveys which will be conducted most frequently along the route of the Proposed Scheme in order to gather baseline information in support of the Ecological Impact Assessment (EcIA).

1.1.3 It is not intended to provide an exhaustive compendium of all survey methodologies utilised to inform the Environmental Statement for the Proposed Scheme. Where additional methodologies have been utilised in specific locations these details will be summarised in the ecology chapter of the appropriate Volume 2 Community Area (CA) reports, and detailed in the Volume 5 appendices.

2 Introduction

2.1 Purpose of the technical note

2.1.1 This technical note outlines proposals for the ecological Field Survey Methods and Standards (FSMS) to be adopted for baseline ecological field surveys HS2 Phase 2a West Midlands and Crewe (hereafter the 'Proposed Scheme') Environmental Statement (ES).

2.1.2 This document contains the methods which will be used for scoping and undertaking ecological surveys for a range of flora and fauna. It aims to ensure consistency of approach to field survey methods.

2.1.3 Surveys in support of the Ecological Impact Assessment (EcIA) baseline will be coordinated by multiple teams of ecologists. This document has been prepared after discussion with the ecological consultants commissioned to undertake field surveys. Cognisance has also been had to feedback from Natural England and the Environment Agency during development of the FSMS technical note[1] prepared for the Phase 1 ES and consultation with Natural England in 2016 in relation the survey methodologies for bats and polecat.

2.1.4 This document sets out the key survey methodologies and data recording requirements for those field surveys which are considered most likely to be required to inform the EcIA. It is not intended to be an exhaustive list of surveys that will be conducted. Based on the scale of the proposed works it is likely that in some locations additional surveys, not detailed here, will be required. Where further surveys are conducted these will be listed in the ecology section of the appropriate Volume 2 Community Area (CA) reports, and detailed in the corresponding Volume 5 appendices of the ES.

2.1.5 This document deals solely with field survey methodology and standards.

2.1.6 Details of the proposed approach to associated desk study are reported within the HS2 Phase 2a Environmental Impact Assessment (EIA) Scope and Methodology Report (SMR)[2] and the supporting technical note 'Approach to ecological desk study'.

2.2 Land required for the construction of the Proposed Scheme

2.2.1 The extent of surveys required should in all situations take into consideration the most up to date information available regarding the extent of the land required for the construction of the Proposed Scheme[3]. For the purposes of the EcIA it is assumed that all land required for the construction of the Proposed Scheme will be lost. This assumption means that survey prescriptions within the land required have been based solely on likely ecological value of the habitats and species present, rather than likely impact.

[1] HS2 Phase One Scope and Methodology Report Addendum (CT-001-000/2), Available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/260153/Vol5_Scope_and_methodology_report_addendum_CT-001-000.2.pdf

[2] Scope and Methodology Report, Volume 5: Appendix CT-001-001.

[3] Defined as all land that will be required to construct the Proposed Scheme i.e. all areas of land that will be directly affected by the Proposed Scheme, including that required for operation and that required solely during construction.

2.2.2 As ecological survey commenced in spring 2016 prior to detailed engineering design, in the first instance the extent of the land required for the construction of the Proposed Scheme was assumed. As a consequence, survey extents are in general defined on the basis of buffers from the outer boundary of the land required for the construction of key elements (e.g. the operational railway, all associated infrastructure, and site compounds) of the Proposed Scheme (e.g. land required + 100m). Due to an evolving design, the desired survey extent has therefore altered throughout the period of survey. With each design change survey scopes have been revised, and where necessary scoping for survey requirements updated. The stability of the design at each location was considered in deciding if further extension of the survey extent was necessary in order to be sure all potential significant effects were identified.

2.2.3 Professional judgement has been used where appropriate to rationalise the requirements for survey associated with ancillary works, generally those associated with diversions to services that extend away from the route of the Proposed Scheme. For example, in some areas land could be included to facilitate such works as minor pylon realignment. Such works could extend some distance from the route of the Proposed Scheme and may be unlikely to result in significant effects on ecological receptors. As a consequence, in each case an ecologist will review the extent and nature of the works proposed and apply professional judgement to derive an appropriate survey effort for these elements of the scheme.

2.3 Screening for survey requirements (general)

2.3.1 Ecological consultants undertaking survey work to inform the ES are expected to utilise the approach and guidance provided in this document to identify where field surveys are required and what type of survey is appropriate.

2.3.2 Ecological field investigations should in the first instance be presumed to be required where:

- a potential ecological receptor is confirmed or it is thought there is a reasonable likelihood that such a receptor may be present; and
- significant effects on ecological integrity or conservation status may arise from the construction or operation of the Proposed Scheme.

2.3.3 Where access is available the presence of existing ecological data (either from biological records centres or pre-existing survey reports) should only be utilised to preclude the requirement for surveys specifically in support of the Proposed Scheme where:

- it is clear that the survey methodology utilised is consistent with that proposed in this document and the data available; and
- the pre-existing data set is sufficiently up to date to still be considered valid (refer to the HS2 Phase 2a SMR).

2.3.4 In all such cases, a precautionary approach should be adopted and field survey repeated where there is any doubt over the validity of existing data.

2.3.5 Where surveys in support of another development require survey of the same areas of land the sharing of survey data may be required (e.g. to limit disturbance to a great crested newt breeding pond as a consequence of multiple surveys of the same water body). In all such cases, where there is a requirement to share data, consultants should liaise with the other projects' ecologists to ensure that the methods utilised are consistent with those specified in this document.

2.3.6 Due to the design evolving the required extent of surveys will vary over the period that surveys will be undertaken. Survey buffers established from the boundary of the land required for the construction of the Proposed Scheme will help to limit the impact of design changes, as the majority of changes are likely to lead to extensions into areas which already fall within the required scope of surveys.

2.3.7 Guidance on the ecological assessment methodology is provided in the HS2 Phase 2a SMR and the supporting ecological impact assessment technical note.

2.3.8 Where a documented screening/scoping exercise has been conducted, and the outcome indicates that significant adverse effects on a potential ecological receptor are not likely to occur, reduced field survey effort, or scoping is likely to be appropriate.

2.3.9 Care should be taken to ensure that receptors potentially subject to indirect effects are also included within the survey scope. An example is areas distant from the route of the Proposed Scheme which are potentially subject to impacts arising from hydrological changes.

2.4 Safety

2.4.1 The safety of the workforce and the public is paramount. Consultants undertaking field survey will be required to ensure that a health and safety risk assessment is in place prior to commencement of each field survey visit and to satisfy themselves that all appropriate access provisions are made.

2.4.2 All risk assessments should address key health and safety issues such as potential for slips, trips and falls; working in close proximity to water; working within fields occupied by livestock; working at height; potential exposure to asbestos; and night time working. In particular, lone working is to be avoided.

2.4.3 It is recognised that survey methods may need to be modified in some areas to allow surveys to be conducted safely, for example works on or near highways and railroads, or inspections of structurally unstable buildings. A record should be made of all such deviations.

2.5 Access to land

2.5.1 All access to undertake field surveys will be organised by the land referencing team. A protocol for requesting and reporting upon access will be prepared and provided to consultants undertaking survey work.

2.5.2 Consultants undertaking survey work will be briefed on the acceptable use of Public Rights of Way (PRoW) during surveys.

2.6 Biosecurity

2.6.1 Field surveyors are to take all reasonable measures to ensure compliance with species specific best practice guidelines for preventing the spread of disease and of invasive species of flora and fauna.

2.6.2 This is particularly true of work in water. Current best practice bio-security measures are to be taken throughout, with disinfection of footwear and equipment between surveys, where they are used on more than one watercourse or water body. All amphibian surveys are to follow the guidelines for amphibian survey bio-security as set out in ARG-UK Guidance Note 4 (2010)[4].

2.7 Invasive non-native species

2.7.1 Where any animals which are not ordinarily resident in Great Britain and are not a regular visitor to Great Britain in a wild state, or is listed in Schedule 9 of the Wildlife and Countryside Act (1981) as amended by the Wildlife and Countryside Act 1981 (Variation of Schedule 9) (England and Wales) Order 2010,)[5]are captured during the surveys in support of the project (in line with legislation) they will not be released back into the wild. Where such species are encountered (but not captured) during surveys the species and location will be recorded.

2.7.2 Where plant species occurring on Part 2 Schedule 9 of the Wildlife and Countryside Act (1981 as amended) are encountered during habitat surveys the species, location and extent will be recorded.

2.8 Competency standards

2.8.1 Specific competency standards, qualifications and licensing are detailed for each survey type below where applicable. For surveys not dealt with in detail within the following document it is expected that consultants undertaking field surveys must meet the minimum relevant Chartered Institute of Ecology and Environmental Management (CIEEM) Competency for Species Survey (CSS) standards[6] that apply.

2.9 Combining surveys

2.9.1 Although the methodologies for the various surveys are described separately in this document, there is clearly scope for combining surveys and particularly screening to confirm the need to undertake specialist surveys.

2.9.2 Whilst combining surveys is encouraged where it is practical, it should not take place where this would result in a lack of adequate focus on particular surveys (e.g. survey for badger signs).

[4] ARG-UK (published 2010 modified 27th June 2016) *ARG-UK Advice Note 4: Amphibian disease precautions: a guide for UK fieldworkers.* http://www.arguk.org/info-advice/advice-notes/324-advice-note-4-amphibian-disease-precautions-a-guide-for-uk-fieldworkers-pdf-2/file

[5] Wildlife and Countryside Act 1981 (Variation of Schedule 9) (England and Wales) Order 2010, Her Majesty's Stationery Office.

[6] CIEEM (2013) Competencies for species surveys in Britain and Ireland. http://www.cieem.net/data/files/Resource_Library/Technical_Guidance_Series/CSS/CSS_-_OVERVIEW_April_2013.pdf

2.10 Identification of potential mitigation areas and receptor sites

2.10.1 During the process of screening and conducting field surveys consultants should consider the potential suitability of land within the vicinity of the prescribed survey extents to be utilised to provide mitigation or compensation, including use as receptor sites for protected species translocated from habitats lost as a consequence of the scheme.

2.10.2 Where ecologists identify potential receptor sites or mitigation areas they should submit details. This should include a brief rationale for their selection and proposals for any additional survey work they consider to be required to confirm the suitability of the identified sites for this purpose (e.g. reptile presence/absence survey).

2.11 Compliance and variations

2.11.1 Consultants undertaking field surveys should comply with the methods within this document, with deviations only permitted with approval from HS2 Ltd.

2.11.2 It is recognised that limitations in relation to access and health and safety may require a variation in survey scope and method. In particular, there could be access and timing restrictions beyond the control of the consultants. Close liaison between all parties will be required to identify as early as possible any limitations to the work and to discuss appropriate means to mitigate such constraints.

2.11.3 It is also recognised that in some areas (particularly suburban and urban areas), it will be appropriate to reduce the spatial scope defined in this document to reflect the fact that any potential significant effects in such areas are likely to be more closely associated with the route of the Proposed Scheme. For example, in urban or suburban areas where large numbers of residential dwellings (which are to be retained) are present within the standard survey buffer, it is not anticipated that all such buildings will require internal inspection for bats.

2.11.4 In these situations, consultants undertaking field surveys are expected to make judgements regarding the required spatial scope on a site by site basis and record the rationale for these decisions.

2.11.5 Where requirements arise for surveys not covered in this document, then discussion will be required between all teams of ecologists in order to ensure a consistent approach to survey.

2.12 References

ARG-UK (published 2010 modified 27th June 2016) ARG-UK Advice Note 4: Amphibian disease precautions: a guide for UK fieldworkers. http://www.arguk.org/info-advice/advice-notes/324-advice-note-4-amphibian-disease-precautions-a-guide-for-uk-fieldworkers-pdf-2/file

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Wildlife and Countryside Act 1981 (Variation of Schedule 9) (England and Wales) Order 2010, Her Majesty's Stationery Office.

3 Survey referencing and recording (general)

3.1 Survey referencing

3.1.1 Survey information collected has been allocated an ecology survey code to provide a unique identifier for use on project mapping and within Geographical Information Systems (GIS):

3.1.2 Route zone code (3 digits) - Survey type code (3 digits) - Location reference code (6 digits) - (+ 3-digit record number reference where applicable – see Table 2).

3.1.3 The ecology survey codes and reference numbers are listed in Table 1 and Table 2. The ecology site referencing code will form one of several identifier fields to be included in the final project wide GIS database.

Table 1: Route zone codes

Section of the route	Route zone code
Community Area 1 (CA1) to CA5 inclusive	210

Table 2: Survey type codes and reference numbers

Survey	Survey type code	Location reference code	Use of 3-digit record number reference required
Amphibian - Aquatic survey (during mid-March to mid -June)	AA1	3 digit km no. + 3 digit site no.	No
Amphibian - Aquatic survey outside of the period mid-March to mid-June	AA2	3 digit km no. + 3 digit site no.	No
Amphibian – Habitat Suitability Index (HIS)/walkover	AH1	3 digit km no. + 3 digit site no.	No
Amphibian - Terrestrial survey (refuges only)	AT1	3 digit km no. + 3 digit site no.	No
Amphibian - Terrestrial survey (temporary amphibian fencing and pitfall traps/refuges)	AT2	3 digit km no. + 3 digit site no.	No
Badger - Field survey for signs of activity	BD1	3 digit km + 3 digit record no.	No
Badger - Extended field survey in support of territory analysis	BD2	3 digit km + 3 digit record no.	No
Badger - Field survey in support of bait marking exercise	BD3	3 digit km + 3 digit site no.	Yes
Bat - Initial assessment of structures including buildings, bridges and caves	BS1	3 digit km + 3 digit site no.	No

Survey	Survey type code	Location reference code	Use of 3-digit record number reference required
Bat - Further inspection of structures including buildings, bridges and caves	BS2	3 digit km + 3 digit site no.	No
Bat - Emergence survey of structures including buildings, bridges and caves	BS3	3 digit km + 3 digit site no.	No
Bat - Initial assessment of trees	BT1	3 digit km + 3 digit site no.	No
Bat - Further inspection of trees	BT2	3 digit km + 3 digit site no.	No
Bat – Emergence survey of trees	BT3	3 digit km + 3 digit site no.	No
Bat - Activity (transect)	BA1	3 digit km + 3 digit site no.	Yes
Bat - Activity (static detector)	BA2	3 digit km + 3 digit site no.	Yes
Bat - Activity (swarming)	BA3	3 digit km + 3 digit site no.	Yes
Bat - Activity (mist net/harp trapping/radio tracking)	BA4	3 digit km + 3 digit site no.	Yes
Bat – Hibernation	BH1	3 digit km + 3 digit site no.	No
Breeding bird - Discrete area/Common Birds Census	BB1	3 digit km + 3 digit site no.	Yes
Breeding bird – Habitat sampling	BB2	3 digit km + 3 digit site no.	Yes
Breeding bird - Species specific	BB3	3 digit km + 3 digit site no.	Yes
Ditch vegetation survey	DS1	3 digit km + 3 digit site no.	No
Fish survey	FI1	3 digit km + 3 digit site no.	Yes
Hazel dormouse – Habitat appraisal	HD1	3 digit km + 3 digit site no.	No
Hazel dormouse – Nest tube survey	HD2	3 digit km + 3 digit site no.	No
Hazel dormouse – Nut search	HD3	3 digit km + 3 digit site no.	No
Hedgerow survey	HS1	3 digit km + 3 digit hedge no.	No
Invertebrates - Aquatic survey	IA1	3 digit km + 3 digit site no.	No

Survey	Survey type code	Location reference code	Use of 3-digit record number reference required
Invertebrates - Terrestrial survey	IT1	3 digit km + 3 digit site no.	No
Otter – Habitat appraisal	OT1	3 digit km + 3 digit site no.	No
Otter – Detailed survey	OT2	3 digit km + 3 digit site no.	Yes
Pond survey (Rapid assessment method)	PS1	3 digit km + 3 digit site no.	No
Pond survey (Predictive SYstem for Multimetrics)	PS2	3 digit km + 3 digit site no.	No
Pond survey (National Pond Survey)	PS3	3 digit km + 3 digit site no.	No
Reptiles – Habitat appraisal	RE1	3 digit km + 3 digit site no.	No
Reptiles – Detailed survey	RE2	3 digit km + 3 digit site no.	No
River Corridor Survey	RS1	3 digit km + 3 digit site no.	No
River Habitat Survey	RS2/RH1	3 digit km + 3 digit site no.	No
Scoping survey	SCO	3 digit km + 3 digit site no.	No
Water vole- Habitat appraisal	WV1	3 digit km + 3 digit site no.	No
Water vole – Detailed survey	WV2	3 digit km + 3 digit site no.	Yes
White-clawed crayfish – Habitat appraisal	WC1	3 digit km + 3 digit site no.	No
White-clawed crayfish – Manual search	WC2	3 digit km + 3 digit site no.	No
White-clawed crayfish – Trapping survey	WC3	3 digit km + 3 digit site no.	No
Wintering and passage birds – General	WB1	3 digit km + 3 digit site no.	Yes
Wintering and passage birds - Species specific	WB2	3 digit km + 3 digit site no.	Yes
Phase 1 habitat survey – Habitat parcel/feature	PH1	3 digit km + 3 digit habitat parcel ID	No
Vegetation (Phase 2 – National Vegetation Classification survey)	PH2	3 digit km + 3 digit site number	Yes – 3 digit habitat parcel ID

3.1.4 The 6 digit location reference will follow the route and the numbering will sequentially increase. The route has been split into 1 km sections, each of which is allocated a three-digit km number. Surveys of each type conducted within that km of the route have then been sequentially numbered. So, the first survey site in the first 1km section would have a location reference of 001001, the first site in the second 1km section would be 002001, and the first site in the 99th 1km section would be 099001.

3.1.5 Using these conventions, the third amphibian aquatic survey location in the 200th 1km section within the zone would be:

- 210-AA1-200003

3.1.6 The 99th tree subject to initial assessment for bats in the 50th km in the zone would be:

- 210-BT1-050099

3.1.7 Where multiple survey visits are required at a discrete location (e.g. six amphibian visits to the same pond) then the results of all visits will be recorded under the single reference code for this survey location.

3.1.8 Where the extent of surveys is anticipated to be more continuous (e.g. hedgerow survey, Phase 1 habitat survey, badger survey), and therefore the concept of a site is redundant, the final three digits of the location reference field will be utilised to record the record number (e.g. target note number for Phase 1 habitat survey or field sign number for badger).

3.1.9 For example, the 47th target note recorded during Phase 1 habitat survey in the 50th km in the CA1 to CA5 zone would be:

- 210-PH1-050047

3.1.10 Note that for badgers at a sett location the sett itself should be allocated a record number. Details of individual entrances and other signs of activity associated with the sett (e.g. hairs and prints in entrances etc.) will all be described under a single six digit location reference. Where other field signs are identified away from a sett (e.g. latrine, hair on fence of badger path) these should be allocated a separate six digit location reference.

3.1.11 For some surveys, it will be necessary to incorporate a fourth section to the code to allow both the site number and record number to be recorded. Surveys requiring this additional field within the referencing code are indicated in Table 2 above.

3.1.12 For example, records of bat activity at the fourth listening station within the second bat activity transect route within the 54th km of the zone would be:

- 210-BA1-054002-004

3.1.13 Where repeat survey visits are conducted (e.g. repeat surveys of a bat activity transect) records from all surveys at the same location will be recorded under the same survey code.

4 Phase 1 (extended) habitat survey

4.1 Introduction and guidelines

4.1.1 The methods to be used to map the habitats and vegetation present along the route of the Proposed Scheme are set out below. As the Phase 1 habitat survey is often the first opportunity to visit the route, also included is the requirement to search for and record signs of protected or otherwise notable species, and to assess habitats for their potential to support protected or otherwise notable species, as well as invasive species of flora and fauna. This information will be used as part of the decision process for targeting future surveys.

4.2 Qualifications and experience

4.2.1 Surveyors are to be experienced in Phase 1 habitat survey, be competent botanists and have previously undertaken surveys in the types of habitats likely to be present. For extended[7] Phase 1 habitat survey, surveyors will also be experienced in the identification of potential for habitats to support protected or otherwise notable species (including badger, otter, hazel dormouse, bats etc.).

4.3 Licensing requirements

4.3.1 There are no licensing requirements for Phase 1 habitat survey.

4.4 Screening for survey and defining the survey area

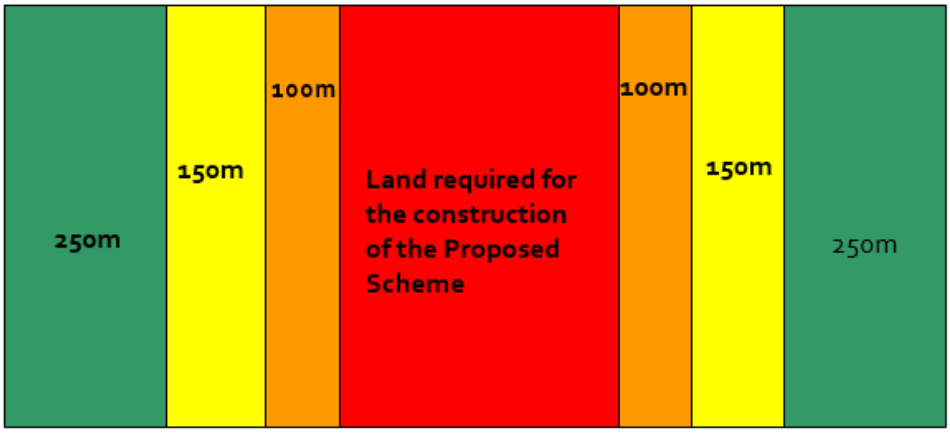
4.4.1 Subject to access restrictions, Phase 1 habitat survey and mapping is required for the entire route of the Proposed Scheme within the survey buffers defined below.

4.4.2 As a minimum (subject to the caveats identified in Section 2.11) consultants will be required to produce a set of route maps identifying habitat types within a 500m buffer of the land required for the construction of the Proposed Scheme. The level of field survey required is not the same across the whole 500m buffer either side of the land required, but is zoned according to likely impacts, as described below.

4.4.3 Figure 1 below shows the standard division of zones within the 500m buffer beyond the boundary of the land required for the construction of the Proposed Scheme.

[7] Extended Phase 1 habitat survey is the traditional survey of botanical habitats extended to include an evaluation of the potential of the habitats to support protected or otherwise notable species.

Figure 1: Standard extents of Phase 1 habitat survey



4.4.4 In rural areas, within the land required for the construction of the Proposed Scheme and 100m either side, the level of survey should, as a minimum, follow the full, extended Phase 1 habitat survey method.

4.4.5 Within a zone extending to a further 150m (i.e. 101-250m from the boundary of the land required for the construction of the Propose Scheme), a "classic" Phase 1 habitat survey will be undertaken. In this zone, therefore, it is sufficient to map broad habitat types and make target notes of any features of interest.

4.4.6 From 250m to 500m from the boundary of land required for the construction of the Proposed Scheme the habitats will be mapped from aerial photograph interpretation alone and there will be no requirement to undertake a field-based Phase 1 habitat survey. However, where possible a note should be made of any obvious changes in habitat type from that shown from interpretation of aerial photographs e.g. woodland felled; hedgerow removed; improved grassland now under arable cultivation.

4.4.7 In urban areas, the survey zones are likely to be restricted in extent and for many areas limited to the route and areas with public access. Where feasible, up to 100m from the route, the level of survey should follow the full extended Phase 1 habitat survey method but as a minimum, a note should be made of any obvious changes in habitat type from that shown from interpretation of aerial photographs.

4.4.8 Following initial site visits and mapping it may be necessary to revisit and modify the survey zones locally in order to capture sufficient information to inform the scope of other investigations and assess likely significant effects. For example, the 100m survey zone may be expanded to include the whole of a sensitive habitat that is within, but extends beyond the 100m zone described above.

4.4.9 The approach described shall be principally applied in relation to the land required for the construction of the key elements (e.g. the operational railway, all associated infrastructure, site compounds and storage areas) of the Proposed Scheme.

4.4.10 Professional judgement has been used where appropriate to rationalise the requirements for survey associated with ancillary works, generally associated with diversions to services that extend away from the route of the Proposed Scheme.

4.5 Survey methods

4.5.1 The survey is to be undertaken following the published methodology for Phase 1 habitat survey[8] and Guidelines for Preliminary Ecological Appraisal[9]. This includes mapping the habitat type according to the definitions in the Handbook for Phase 1 habitat survey (Joint Nature Conservation Committee, 2010); noting dominant species; and providing target notes where appropriate to identify particular features/species.

4.5.2 Information on habitats and species composition to be collected during Phase 1 habitat survey has, as far as possible, to be sufficient for an assessment to be made as to requirements for further survey (e.g. National Vegetation Classification).This will apply within the land required for the construction of the Proposed Scheme and a 100m-wide 'buffer zone' but further from the land required consultants undertaking field survey are to determine whether such surveys could be required, depending on the value and sensitivity of the habitat (and associated species of flora and fauna) and the nature of the impacts predicted to result from the Proposed Scheme.

4.5.3 Target notes should be used to identify modified habitats such as low diversity/value road verge grasslands, to distinguish them from unimproved or other higher value habitats.

4.5.4 Invasive plant species such as Japanese knotweed are to be mapped as 'tall ruderal' with associated target notes.

4.5.5 In addition, the Phase 1 habitat survey is to be extended to include recording signs of and suitability for protected/notable species according to methods in Guidelines for Baseline Ecological Assessment[10]. Such signs and features should be accurately located on a plan and GPS coordinate(s) recorded.

4.5.6 Where no access is available for survey, any existing data and review of aerial photography should be used to allocate areas to Phase 1 habitat codes.

4.6 Survey programme and effort

4.6.1 Species associated with different habitats are more easily identified at various times in the growing season. In order to identify most habitats accurately, Phase 1 habitat survey should ideally be undertaken between April and early October. However, in order to prevent delay in the identification of protected species constraints, in all cases Phase 1 habitat survey should be completed as early as access is forthcoming (i.e. even when outside of the April to early October window), and repeated during the following optimum window for habitat survey where required.

4.6.2 For some habitats (e.g. areas dominated by amenity grassland, hard standing or buildings), it will be possible to gather sufficient information of value outside the April to early October window, and no repeat survey will be required. In these situations,

[8] Joint Nature Conservation Committee (2010), Handbook for Phase 1 habitat survey - a technique for environmental audit. Peterborough.
[9] Institute of Ecology and Environmental Management (2012). Guidelines for preliminary ecological appraisal. Institute for Ecology and Environmental Management. https://www.cieem.net/
[10] Institute of Environmental Assessment (1995), *Guidelines for Baseline Ecological Assessment*. E and FN Spon, London.

consultants should make a clear record in each case of why survey information collected outside of the optimum window is considered to represent a valid survey.

4.7 References

Institute of Environmental Assessment (1995). Guidelines for Baseline Ecological Assessment, E and FN Spon, London.

Institute of Ecology and Environmental Management (2012). Guidelines for preliminary Ecological Appraisal, Institute for Ecology and Environmental Management.

Joint Nature Conservation Committee (2010). Handbook for Phase I Habitat Survey: A technique for environmental audit, Joint Nature Conservation Committee, Peterborough.

5 National Vegetation Classification survey

5.1 Introduction and guidelines

5.1.1 Habitats identified at the Phase 1 stage as being particularly species diverse and/or sensitive, of a type restricted in the UK/Region, and which could be directly or indirectly affected by the Proposed Scheme are likely to require further survey to Phase 2 National Vegetation Classification (NVC) level.

5.1.2 Where it is identified that Phase 2 (NVC) surveys are required, the survey methods are as a general rule to follow the published methodology appropriate to the vegetation being surveyed[11,12].

5.1.3 Reference should also be made to National Vegetation Classification: User's Handbook [13] and the web site of the Joint Nature Conservation Committee[14] , where up-to-date information can be obtained regarding changes/additions to the vegetation types presented in the original published volumes.

5.1.4 It is acknowledged that in some habitats NVC may not represent the most appropriate method of Phase 2 vegetation survey to provide quantitative data in support of impact assessment. In all such cases, a deviation request should be submitted.

5.2 Qualifications and experience

5.2.1 Surveyors are to be competent botanists and experienced in undertaking Phase 2 (NVC) surveys across the range of habitats likely to be encountered.

5.3 Licensing requirements

5.3.1 There are no licensing requirements for Phase 2 (NVC) survey.

5.4 Screening for survey and defining the survey area

5.4.1 The results of the desk study and/or the Phase 1 habitat survey should be used along with consideration of the nature, location and extent of the habitat within the land required for the construction of the Proposed Scheme and surrounding land to identify areas for survey to NVC level.

5.4.2 Habitats that are likely to require survey at Phase 2 include ones where there are:

- potential significant direct or indirect effects on designated statutory and non-statutory wildlife sites; and/or
- potentially significant effects on habitats of principal importance identified within Section 41 of the Natural Environment and Rural Communities (NERC) Act (2006)[15]. As a guide, areas of greater than 1ha in area are more likely to

[11] Rodwell, J.S. (1991 et seq), British Plant Communities. Publication in Five Volumes. Cambridge University Press. Cambridge.
[12] Rodwell, J.S. (2006), National Vegetation Classification: User's handbook. Joint Nature Conservation Committee. Peterborough. Available at http://jncc.defra.gov.uk/pdf/pub06_NVCusershandbook2006.pdf
[13] Rodwell. J.S., Dring., J.C., Averis, A.B.G., Proctor, M.C.F., Malloch, A.J.C., Schaminee, J.H.J. and Dargie, T.C.D. (2000). *Review of coverage of the National Vegetation Classification*. Joint Nature Conservation Committee, Peterborough.
[14] http://jncc.defra.gov.uk/page-4259
[15] Natural Environment and Rural Communities Act (1996), Chapter 16. Her Majesty's Stationery Office, London.

require NVC survey but the consultants undertaking field survey should decide whether areas smaller than this should also be surveyed on a case-by-case basis depending on habitat quality and complexity. It should be noted that even where significant effects are anticipated NVC survey will not be appropriate for all extents of habitats of principal importance (e.g. reedbed);

- potential significant direct effects on other habitats considered to be particularly high quality/value examples of their type or likely to contain uncommon plant species; and/or
- potential indirect impacts on extensive wetland areas.

5.4.3 Where a discrete survey area is not easily determined (for example, where a habitat extends beyond the Phase 1 habitat survey area), comparative data are likely to be required from the wider extent (potentially the whole extent of the habitat 'unit') to enable an assessment of the scale of impact from the development. This will be decided on a case-by-case basis by the consultants undertaking the survey.

5.5 Survey method

5.5.1 At each site identified for survey, homogenous stands of vegetation are to be identified and sampled with a minimum of five quadrats, size appropriate to the vegetation being surveyed (see Rodwell 1991 et seq. or Rodwell, 2006). Quadrats are to be recorded in typical vegetation and are not required to be random or evenly spread.

5.5.2 Where woodland is encountered and is directly impacted by the route, it is expected that NVC level data will be collected. Guidance for sampling woodlands is given in Rodwell (2006). Within small woodland blocks it is likely that five 50m x 50m samples cannot be taken and the whole stand can be the quadrat for canopy and understorey but within such areas replicate 4m x 4m or 10m x 10m quadrats can be recorded for the field and ground layers and then combined.

5.5.3 Within each quadrat all species are to be recorded with an estimate of percentage cover/abundance using the Domin scale (1 = few individuals; 2 = some individuals; 3 = many individuals; 4 = 4% - 10%; 5 = 11% - 25%; 6 = 26% - 33%; 7 = 34% - 50%; 8 = 51% - 75%; 9 = 76% - 90%; 10 = 91% - 100%). Subsequent areas of the same vegetation within a site do not require five additional quadrats but should be sampled for consistency and at least one quadrat recorded and, based on size, possibly more at the discretion of the surveyor.

5.5.4 The location of each quadrat should be recorded accurately on a plan and a GPS coordinate taken.

5.5.5 Voucher specimens should be taken for species for which identification may be contentious, including some bryophytes and lichens.

5.5.6 A sketch plan of the whole area surveyed should be made and a record made of physical parameters including slope and aspect (see Rodwell, 2006) where necessary to allow assessment of significant effects. Consultants undertaking field surveys should also consider whether pH and soil depth data are required to assess effects on the vegetation.

5.6 Data analysis

5.6.1 The data collected is to be analysed to provide the 'best' approximation to a published NVC type.

5.6.2 The data recorded in the quadrats from each homogenous stand of vegetation are to be tabulated and a constancy value for each species calculated for each defined group of quadrats, as follows:

- Scale: I = 1% - 20%. II = 21% - 40%. III = 41% - 60%. IV = 61% - 80%. V = 81% - 100.

5.6.3 The tables produced will then be used to assign the vegetation types to one of the published plant community types through use of the keys provided in the published volumes and by visual comparison of the collected data with the published data. In addition, there are also computer programs (MATCH or TABLEFIT) that can be used to facilitate comparison of the data sets with published data. Alternative software should not be utilised without prior approval.

5.7 Survey programme and effort

5.7.1 The accurate definition of plant communities requires comprehensive species lists, including grasses and lower plants. As far as possible, Phase 2 surveys should therefore take place when most species, and particularly any characteristic species, are at their most visible. For most habitats, this will cover the period May to July.

5.8 References

Natural Environment and Rural Communities Act (1996) Chapter 16. Her Majesty's Stationery Office, London.

Rodwell, J.S. (1991 et seq). British Plant Communities. Published in Five Volumes. Cambridge University Press, Cambridge.

Rodwell, J.S. (2006). National Vegetation Classification: User's Handbook. Joint Nature Conservation Committee, Peterborough. Downloadable at http://jncc.defra.gov.uk/pdf/pub06_NVCusershandbook2006.pdf

Rodwell, J.S., Dring, J.C., Averis, A.B.G., Proctor, M.C.F., Malloch, A.J.C., Schaminee, J.H.J. and Dargie, T.C.D. (2000). Review of Coverage of the National Vegetation Classification. Joint Nature Conservation Committee, Peterborough.

6 River Habitat Survey

6.1 Introduction and guidelines

6.1.1 River Habitat Survey (RHS) is a method designed to characterise and assess, in broad terms, the physical structure of freshwater streams and rivers.

6.1.2 The proposed approach will follow the survey methodology outlined within River Habitat Survey in Britain and Ireland; Field Survey Guidance Manual; Version 3 (Environment Agency, 2003)[16]. River Corridor Survey (RCS) will be conducted on the same sections of watercourse, and details of this methodology are provided within Section 6.

6.1.3 RHS is carried out along a standard 500m length of river channel. Observations are made at ten equally spaced spot-checks along the channel, whilst information on valley form and land-use in the river corridor provides additional context.

6.2 Qualifications and experience

6.2.1 All initial scoping and subsequent field survey should be conducted by persons who have attended training in the 2003 Version of the Environment Agency methodology and passed an accreditation test.

6.3 Licensing requirements

6.3.1 There are no licensing requirements for RHS.

6.4 Screening for survey and defining the survey area

6.4.1 The desk study will identify watercourses identified as 'main' rivers and the results of the Phase 1 habitat survey will indicate the nature of any other watercourses. Lengths of a watercourse should be surveyed if:

- the watercourse is defined as 'main' river; or
- the watercourse has flowing water and a channel width of more than 1m;
- the watercourse is not obviously canalised or heavily managed; and
- the watercourse is to be lost/culverted/diverted or potentially experience a significant change in water quality or quantity that could affect the flora and fauna within the watercourse and/or designated wildlife sites downstream.

6.4.2 At each location selected for survey the survey will as a minimum cover a 500m section of the watercourse centred on the centreline of the route of the Proposed Scheme (i.e. 250m either side of the route). Consultants undertaking survey should consider the need to extend this to incorporate further 500m sections at those locations where this extent does not include as a minimum the land required for the construction of the Proposed Scheme and a 100m buffer either side of the boundary of the land required,

[16] Environment Agency (2003), River Habitat Survey in Britain and Ireland. Field Survey Guidance Manual; 2003 Version. Environment Agency.

or watercourse diversions are proposed and there is considered to be the potential for likely significant effects further upstream or downstream.

6.5 Survey Methods

6.5.1 The survey should be undertaken according to the methodology provided in River Habitat Survey in Britain and Ireland; Field Survey Guidance Manual; Version 3 (Environment Agency, 2003).

6.5.2 Results should be recorded using the standard 2003 Version survey forms with the survey unique reference recorded (following the conventions shown in Section 2) within the survey number/site reference fields.

6.6 Survey programme and effort

6.6.1 Where possible RHS surveys should be undertaken during the months of May or June, in order to avoid vegetation obscuring channel features.

6.6.2 Where emergent and bankside vegetation is limited, or regularly managed then survey may be suitable over a much longer season. Where surveys are undertaken outside of the non-optimal months of May and June, subsequent interpretation of the results should take into account the seasonal aquatic and bankside vegetation growth (Environment Agency, 2003).

6.6.3 High water levels and turbidity will also obscure many of the features RHS is designed to record (Environment Agency, 2003). Survey should therefore not be conducted during periods following periods of heavy rain and should be delayed until water level and turbidity have returned to acceptable levels.

6.7 References

Environment Agency (2003) River Habitat Survey in Britain and Ireland. Field Survey Guidance Manual; 2003 Version. Environment Agency, Bristol.

7 River Corridor Survey

7.1 Introduction and guidelines

7.1.1 River Corridor Survey (RCS) will be conducted in accordance with published guidance (National Rivers Authority, 1992[17]. River Habitat Survey (RHS) (Environment Agency, 2003)[18] will be conducted on the same sections of watercourse, and details of this methodology are provided within Section 6.

7.1.2 Invertebrate surveys of affected watercourses may also be a requirement. The methods for these are provided in Section 20.

7.2 Qualifications and experience

7.2.1 The surveyors must be experienced in undertaking RCS. Where boats are to be used, they should be manned by appropriately trained/certificated boat handlers and surveyors should all have received adequate training in surveying from a boat.

7.3 Licensing requirements

7.3.1 There are no licensing requirements for the RCS but training is available by undertaking the course run by the Environment Agency.

7.4 Screening for survey and defining the survey area

7.4.1 The desk study will identify watercourses identified as 'main' rivers and the results of the Phase 1 habitat survey will indicate the nature of any other watercourses. Lengths of a watercourse should be surveyed if:

- the watercourse is defined as 'main' river; or
- the watercourse has flowing water and a channel width >1m; and
- the watercourse is not obviously canalised or heavily managed; and
- the watercourse is to be lost/culverted/diverted or potentially experience a significant change in water quality or quantity that could affect the flora and fauna within the watercourse and/or designated wildlife sites downstream.

7.4.2 The survey will at each location cover a minimum 500m section of watercourse centred on the proposed route (i.e. 250m either side of the route). Consultants undertaking survey work should consider the need to extend this further at those locations where this extent does not include at least a 100m buffer either side of the boundary of land required for the construction of the Proposed Scheme or watercourse diversions are proposed and there is considered to be the potential for likely significant effects further upstream or downsteam.

[17] National Rivers Authority (1992), River Corridor Surveys. Conservation Technical Handbook Number 1.
[18] Environment Agency (2003), River Habitat Survey in Britain and Ireland. Field survey Guidance Manual: 2003 Version. Environment Agency,

7.5 Survey method

7.5.1 The survey will be undertaken and recorded using the published methodology (National Rivers Authority, 1992), with an annotated map forming the basis of the survey output.

7.5.2 GPS coordinates are to be recorded at the beginning and end of each survey section.

7.6 Survey programme and effort

7.6.1 Where possible, the survey should be undertaken during the period May - September.

7.6.2 This allows adequate survey of the aquatic flora and also survey at the time when high water levels or spate conditions are least likely to occur. Where conducted outside of this period, particular care should be taken to record any limitations to the interpretation of the results obtained.

7.7 References

Environment Agency (2003) River Habitat Survey in Britain and Ireland. Field Survey Guidance Manual; 2003 Version. Environment Agency, Bristol.

National Rivers Authority (1992). River Corridor Surveys. Conservation Technical Handbook Number 1.

8 Hedgerows survey

8.1 Introduction and guidelines

8.1.1 The survey of hedgerows may be undertaken concurrently with the Phase 1 habitat survey but there are specific details to record over and above that usually recorded at Phase 1 level.

8.1.2 Please refer to the Hedgerows Regulations 1997[19] for the full definition and for survey methods.

8.2 Qualifications and experience

8.2.1 Surveyors are to be experienced in Phase 1 habitat survey and able to identify woody hedgerow species and woodland ground flora.

8.3 Licensing requirements

8.3.1 There are no licensing requirements for hedgerow survey.

8.4 Screening for survey and defining the survey area

8.4.1 All hedgerows that fall within or partly within the land required for the construction of the Proposed Scheme and a surrounding 100m buffer are to be surveyed to comply with the requirements of the 'Wildlife and Landscape Criteria' in the Hedgerows Regulations (1997). Survey should not be limited to just those hedgerows that are more than 30 years old. However, hedgerows that have obviously been recently planted (e.g. tree guards and stakes still present) may be excluded.

8.4.2 It is recognised that full surveys for all potential fauna species are unlikely to be necessary for all hedgerows; assessment and requirements for further survey is to be based upon the desk-study results and outcomes of the habitat appraisal for protected and notable species.

8.4.3 Hedgerows that fall wholly outside a 100m buffer from the boundary of the land required for the construction of the Proposed Scheme, but which at least partly fall within a buffer of 100-250m should be noted, a list of woody species made and an estimate of general height and width given.

8.4.4 Hedgerows more than 250m from the boundary of the land required for the construction of the Proposed Scheme are unlikely to require full survey. Location of hedgerows will be captured by Phase 1 habitat survey conducted from aerial photographs. Where possible field surveys should seek to confirm that these hedgerows remain present.

8.5 Survey method

8.5.1 Surveys should comply with the requirements of the 'Wildlife and Landscape Criteria' in the Hedgerow Regulations 1997.

[19] The Hedgerows Regulations (1997). SI1997 No 1160. Her Majesty's Stationery Office.

8.5.2 Depending on length, this involves recording the number of woody species along at least one typical 30m section and recording associated data including hedgerow height and width, number of mature trees, ditch, bank etc.

8.5.3 The start and end points of each hedgerow are to be recorded with at least an 8 figure OS grid reference using GPS.

8.5.4 The total number of other hedgerow connections to the hedgerow being surveyed should also be recorded, as recommended in the Defra Hedgerow Survey Handbook (Defra, 2007)[20].

8.5.5 Hedgerows are to be recorded and mapped with a unique ecology survey code attributed, following the general description given in Section 3. It is helpful to map hedgerows from aerial photography in advance of survey so that survey sections and nodes can be identified.

8.6 Survey programme and effort

8.6.1 The survey of the hedgerows is ideally to be undertaken within the timescales required to adequately record both woody vegetation and ground flora.

8.7 References

Department for Environment, Food and Rural Affairs (2007). Hedgerow Survey Handbook. A Standard Procedure for local surveys in the UK. Defra, London.

The Hedgerows Regulations (1997). Statutory Instrument 1997 No 1160. Her Majesty's Stationery Office.

[20] Department for Environment, Food and Rural Affairs (2007), *Hedgerow Survey Handbook*. A Standard Procedure for local survey in the UK. Defra, London.

9 Ditch vegetation survey

9.1 Introduction and guidelines

9.1.1 The method to be used to survey the vegetation of ditches is that published in A Manual for the Survey and Evaluation of the Aquatic Plant and invertebrate Assemblages of Grazing Marsh Ditch Systems Version 6[21]. This is based on an earlier methodology[22].

9.1.2 This methodology has been utilised to provide a uniform approach to obtaining data.

9.1.3 It is acknowledged that the method was devised for use in grazing marsh and as such the evaluation of conservation value will not use the criteria which form part of the methodology.

9.1.4 The methodology for the selection and sampling of ditches for invertebrate assemblages is provided in Section 20.

9.2 Qualifications and experience

9.2.1 Surveyors are to be competent botanists and experienced in undertaking standardised vegetation surveys.

9.3 Licensing requirements

9.3.1 There are no licensing requirements for the ditch survey.

9.4 Screening for survey and defining the survey area

9.4.1 The results of the Phase 1 habitat survey will indicate the nature of ditches. The surveyor is to judge whether a ditch requires additional survey work in order to assess significant effects. As a guide, further survey is likely to be required where a ditch:

- is likely to hold permanent water; and
- has not been heavily managed; and
- supports a diverse and/or otherwise notable aquatic, emergent and marginal flora that cannot be adequately described by Phase 1 habitat survey; and
- is likely to be subject to significant effects due to habitat loss/culverting/diversion or experience a significant change in water quality or quantity.

9.4.2 The requirement for survey is likely to be limited to ditches that fall within or partly within the land required for the construction of the Proposed Scheme and surrounding 100m buffer. Only in exceptional circumstances is it envisaged that survey will be required beyond the 100m buffer. This is likely to be where the ditch network is

[21] Buglife – A Manual for the Survey and Evaluation of the Aquatic Plant and invertebrate Assemblages of Grazing Marsh Ditch Systems Version 6, May 2013.
[22] Alcock, M.R. and Palmer, M.A. (1985), A standard method for the survey of ditch vegetation CST Notes No.37. Nature Conservancy Council, Peterborough.

extensive and part of a large wetland complex. Where there is a complex of ditches, more extensive survey may be required to assess effects on to the wider network, though sampling rather than survey of every ditch may be sufficient. Judgement is to be made by the surveyors on a case-by-case basis.

9.5 Survey method

9.5.1 A representative 20m section of ditch is chosen for the detailed survey described in 9.5.2 and the whole ditch (as far as access allows) should be surveyed to list other plant species. If the nature of the ditch changes, then further sections are surveyed as necessary. All plants growing in the ditch and on the banks up to the top of the bank are recorded to species level wherever possible, along with their abundance on the DAFOR scale (Dominant, Abundant, Frequent, Occasional or Rare).

9.5.2 As well as vegetation, the following parameters are measured/assessed, as described in the manual:

- adjacent land-use;
- ditch features, bank top width, freeboard, bank angles (above and below water level), water depth, silt depth, water width;
- a cross-section description (sketch);
- conductivity, pH, turbidity, water colour; and
- vegetation cover, grazing/vegetation cover, management.

9.5.3 A standard recording form is completed for each surveyed section.

9.6 Survey programme and effort

9.6.1 Where possible, ditches selected for further survey should be surveyed in the period June to the end of July for ease of identification of plant species but May and August are also often acceptable months.

9.6.2 Where survey has been undertaken outside of the periods identified in 9.6.1 the limitations should be identified and discussed to place any results obtained into context.

9.7 References

Alcock, M.R. and Palmer, M.A. (1985). A standard method for the survey of ditch vegetation. CST Notes No. 37. Nature Conservancy Council, Peterborough.

Buglife - The Invertebrate Conservation Trust (2013). Manual for the Survey and Evaluation of the Aquatic Plant and invertebrate Assemblages of Grazing Marsh Ditch Systems Version 6, (Buglife, 2013).

10 Pond survey

10.1 Introduction and guidelines

10.1.1 Methods for detailed survey of ponds are based on the methods developed by the Pond Conservation Trust. Details of the methods in the National Pond Monitoring Network can be found on their website[23] .

10.1.2 The method to be used will depend on the preliminary assessment from the Phase 1 habitat survey, the location of the pond in relation to the route and whether the pond is to be lost. All methods involve sampling of the aquatic macro-invertebrate fauna, with some also requiring botanical survey, as well as measurement of physical and chemical parameters.

10.2 Qualifications and experience

10.2.1 Surveyors are to be competent and experienced in undertaking aquatic macro-invertebrate surveys and in botanical identification. There is also a requirement for personnel who can identify invertebrate specimens to the taxonomic level appropriate to the method used but this does not have to be in the field and can be laboratory-based.

10.3 Licensing requirements

10.3.1 There are no licensing requirements for the pond survey unless the surveyor considers that the survey methods could affect protected species utilising the pond.

10.4 Screening for survey and defining the survey area

10.4.1 The results of the Phase 1 habitat survey will identify and provide an initial description of ponds.

10.4.2 Ponds are to be subject to further survey where a pond is likely to experience significant effects and where the pond:

- holds water for four consecutive months or longer; and
- has not been heavily managed; and
- supports a diverse or otherwise notable aquatic, emergent and marginal flora.

10.4.3 Where the pond is likely to be lost or significantly affected then it should be subject to a survey using the Predictive SYstem for Multimetrics (PSYM)[24] or National Pond Survey (NPS)[25] methodology, with the NPS method limited to ponds with the most diverse and/or notable flora, and which, in the professional opinion of the surveyor, cannot be adequately assessed using PSYM. Ponds not threatened with loss and only minor effects should be subject to the rapid assessment method.

[23] http://freshwaterhabitats.org.uk/habitats/surveys/npmn/.
[24] Pond Action (2002), A Guide to Monitoring the Ecological Quality of Ponds and Canals Using PSYM. Pond Action, Oxford.
[25] Pond Action (1998), Guide to the Methods of the National Pond Survey. Pond Action, Oxford.

10.4.4 Ponds for survey will lie within the land required for the construction of the Proposed Scheme or within a 100m buffer. The consultant undertaking field surveys should also assess whether any ponds outside this area also need to be surveyed, based on the likelihood of significant effects.

10.5 Survey methods

Rapid assessment method

10.5.1 The rapid assessment for ponds requires invertebrate sampling only and is a rapid assessment of 'naturalness' using invertebrate diversity and families similar to the Biological Monitoring Working Party system for running water.

PSYM

10.5.2 The Predictive SYstem for Multimetrics (PSYM) method includes collection of physical data, invertebrate sampling and plant recording (Pond Action, 2002)[26]. These data are used to undertake an analysis to compare the pond against a national database held by the Pond Conservation Trust (PCT). The data are submitted to PCT for analysis.

National Pond Survey

10.5.3 The National Pond Survey (NPS) method provides the most detailed assessment of a pond and includes environmental and chemical data from the pond in addition to plant and invertebrate survey (Pond Action, 1998)[27].

10.6 Survey programme and effort

10.6.1 The survey should be undertaken in accordance with the programme recommended in the relevant survey guidelines.

10.7 References

Pond Action (1998). Guide to the Methods of the National Pond Survey. Pond Action, Oxford.

Pond Action (2002). A Guide to Monitoring the Ecological Quality of Ponds and Canals Using PSYM. Pond Action, Oxford.

[26] Pond Action (2002), A Guide to Monitoring the Ecological Quality of Ponds and Canals Using PSYM. Pond Action, Oxford.
[27] Pond Action (1998), Guide to the Methods of the National Pond Survey. Pond Action, Oxford.

11 Amphibians (great crested newt)

11.1 Introduction and guidelines

11.1.1 The Proposed Scheme has the potential to result in adverse effects on populations of amphibians as a consequence of loss and/or disturbance of breeding ponds, loss of terrestrial habitat and severance/fragmentation of habitat. Of particular importance are impacts with the potential to affect great crested newt (*Triturus cristatus*).

11.1.2 The survey approach is based on guidance provided within Great Crested Newt Mitigation Guidelines (English Nature, 2001)[28], and Natural England's European Protected Species Mitigation Licence (EPSML) application template for method statement to support application for licence under Regulation 532(2)e in respect of great crested newts *Triturus cristatus*. Form WML-A14-2 (Version December 2015)[29].

11.1.3 Scoping is to be undertaken using a sensible combination of traditional survey methods and eDNA survey and analysis following Natural England's approved protocol[30]. This is discussed further in section 11.4 below.

11.1.4 The survey methods employed will vary depending on the likely impact to a population utilising the water body in question. Where initial visits and/or the results of eDNA sampling and analysis confirm the presence of great crested newt, further visits should be undertaken in order to provide an estimate of the size of the population using the pond.

11.1.5 Where the seasonal timing of surveys is constrained by access, then non-standard methods will be utilised where appropriate to confirm presence; such methods should not be utilised to assume likely absence.

11.2 Qualifications and experience

11.2.1 Surveyors should be experienced in conducting pond surveys and habitat suitability assessment, and able to identify confidently all relevant amphibian species.

11.3 Licensing requirements

11.3.1 Amphibian surveys in support of the scheme will involve survey of large numbers of water bodies. As such survey is anticipated to involve work by a large number of licensed surveyors.

11.3.2 In all cases survey within a specific geographical area will be coordinated by a holder of a Natural England licence to take and disturb great crested newt (for the purposes of science and conservation) with experience of co-ordinating large scale surveys.

11.3.3 Ideally, at least one of the two persons within any survey team will be a holder of a Natural England scientific licence to take and disturb great crested newt. Use of

[28] English Nature (2001), Great Crested Newt Mitigation Guidelines. English Nature, Peterborough.
[29] Natural England (2012) Template for method statement to support application for licence under Regulation 532(2)e in respect of great crested newts Triturus cristatus. Form WML-A14-2 (Version December 2015). https://www.gov.uk/government/publications/great-crested-newts-apply-for-a-mitigation-licence
[30] Biggs J, Ewald N, Valentini A, Gaboriaud C, Griffiths RA, Foster J, Wilkinson J, Arnett A, Williams P, and Dunn F 2014 Technical advice note for field and laboratory sampling of great crested newt (Triturus criistatus) environmental DNA. Freshwater Habitats Trust, Oxford.

accredited agents to lead pond survey visits (i.e. a team of two accredited agents working together) will only be acceptable where a curriculum vitae demonstrating their suitability for this role is submitted and approved by the overseeing consultants.

11.3.4 If survey of terrestrial habitat which would require use of pitfall trapping is required then an application will be submitted to Natural England.

11.4 Screening for survey and defining the survey area

Desk based scoping exercise

11.4.1 A desk based scoping exercise to identify those water bodies requiring amphibian survey, and the likely appropriate survey effort will be undertaken and updated periodically as required in order to take account of on-going changes to the design and extent of land required for the construction of the Proposed Scheme.

11.4.2 For the purpose of scoping all impacts on habitats were considered as likely to be permanent based on the anticipated four to six year construction period during which any 'temporary' working areas would be utilised.

11.4.3 Geographical Information Systems (GIS) data showing all inland water features (including ponds, lakes, ditches, canals, streams and rivers) located within a 500m radius of the assumed extent of habitat loss were extracted from OS Mastermap data from 2016. The location of any additional water features evident on aerial photographs were then added through a manual review of areas within 500m of the boundary of the land required. Subsequently, GIS was utilised to calculate the distance of each water feature from the boundary of land required for the construction of the Proposed Scheme and the area of land falling within the extent of the land required for the construction of the Proposed Scheme falling within 100m, 250m and 500m of each water feature. This provided an indication of the maximum extent of terrestrial habitat losses that could occur in relation to each pond.

11.4.4 Each water feature identified was then examined against aerial photographs and allocated to one of the following survey categories:

- no survey;
- Habitat Suitability Index (HSI)/walkover only;
- eDNA sampling[31];
- eDNA sampling + presence/absence;
- HSI + presence/absence; and
- HSI + population size class assessment.

[31] See also explanation of use of eDNA survey provided in Hs2 Phase One Supplementary Environmental Statement 3 and Additional Provision 4 Environmental Statement, Volume 5 | Technical appendices Addendum 4 to the EIA Scope and Methodology Report (CT-001-000/5) October 2015. Available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/466966/Addendum_4_to_the_EIA_Scope_and_Methodology_Report__CT-001-0005_.pdf

11.4.5 The approach taken to scoping sought to ensure that survey effort is proportionate to the predicted level of impact as a consequence of the Proposed Scheme.

11.4.6 The 'HSI/Walkover survey only' category should in general only be used as a survey prescription for those features where habitat is considered likely to have marginal potential to support great crested newt (e.g. canals, ditches), but field data are required to confirm this assessment.

11.4.7 The use of eDNA screening may be employed as described in the Hs2 Phase One Supplementary Environmental Statement 3 and Additional Provision 4 Environmental Statement, Volume 5 | Technical appendices Addendum 4 to the EIA Scope and Methodology Report.

11.4.8 The method may be employed separately to screen ponds or in tandem with presence/absence surveys. In the latter case receipt of a negative result would allow presence/absence surveys of those ponds to cease without the full four visits being completed.

11.4.9 For ponds located within the land required for the construction of the Proposed Scheme or within a 250m buffer of the boundary of the land required the basis for selecting water bodies requiring survey was in line with current Natural England guidance provided within Survey Data (1) tab of spreadsheet Form WML-A14-2 (Version December 2015). However, for completeness all surveys incorporated a Habitat Suitability Index (HSI) survey (see Table 3) where this methodology was applicable to the water body in question.

Table 3: Survey guidance for ponds within the land required for the construction of the Proposed Scheme or within 250m of the boundary of the land required

Scenario	Presence/ Absence	Population Size Class Assessment[32]	HSI
Pond lost or damaged as a consequence of development	✓	✓	✓
Pond not lost or damaged but within a 50m radius of the land required for the construction of the Proposed Scheme (land required) and terrestrial habitat lost	✓	✓	✓
Pond not lost or damaged but within 50-100m radius of land required and terrestrial habitat losses of ≤0.2ha	✓		✓
Pond not lost or damaged but within 50-100m radius of land required and terrestrial habitat loss of >0.2ha of terrestrial habitat	✓	✓	✓
Pond not lost or damaged but within 100-250m radius of land required and terrestrial habitat loss of ≤ 0.5ha	✓		✓
Pond not lost or damaged but within 100-250m radius of land required and losses of	✓	✓	✓

[32] Survey will only progress to Population Size Class Assessment if presence of great crested newt is identified during presence/absence survey.

>0.5ha			

Source: Based on survey guidance table provided within Survey Data (1) tab of spreadsheet *Form WML-A14-2 (Version December 2015)*.

11.4.10 For the vast majority of the alignment the route passes through arable and pasture fields that represent sub-optimal habitat for great crested newt. In general, therefore it is considered that newt habitat losses associated with ponds more than 250m from the land required for the construction of the Proposed Scheme are unlikely to be significant.

11.4.11 For the purposes of the initial scoping exercise, survey of those water bodies occurring more than 250m from the boundary of the land required for the construction of the Proposed Scheme has only been proposed where:

- the terrestrial habitat around those ponds appear to be of poor value for great crested newts, and areas of more suitable terrestrial habitat are present within the Proposed Scheme; or
- the Proposed Scheme are considered to have the potential to fragment connectivity between ponds, such that there is a potential risk of fragmentation of metapopulations[33] through loss of terrestrial habitat; or
- a pond is considered to be part of a cluster of linked ponds, and so may form part of the habitat used by a great crested newt metapopulation.

11.4.12 Appendix A details the framework utilised for determining the scope of great crested newt survey for those water features located more than 250m from the boundary of the land required for the construction of the Proposed Scheme. Table 4 details the criteria used to define potential value of terrestrial habitat located more than 250m from the pond, and the scale of barriers to movement relevant to each category.

Table 4: Defining potential value of terrestrial habitats located more than 250m from pond

Potential value of distant terrestrial habitats within the vicinity of the land required for the construction of the Proposed Scheme	**Relationship to other suitable habitat**
Low/Negligible	Habitats within land required for the construction of the Proposed Scheme of low or negligible suitability for great crested newt foraging and shelter (e.g. bare ground, improved grassland, arable fields, hard standing or buildings); and/or There is poor or no connectivity of suitable habitat with the land required (e.g. presence of a major barrier to movement such as an A road or motorway, or an extensive area of hard-standing and buildings); and/or Where unaffected areas of immediate and intermediate terrestrial habitat offering good connectivity with the water body and good opportunities for foraging and shelter (e.g. rough grassland, scrub, woodland, brown field habitats) are widely available closer to the pond in question such that it is considered unlikely newts would utilise distant habitat in anything other than very low numbers.

[33] A metapopulation is a group of spatially separated populations of the same species which interact at some level.

Potential value of distant terrestrial habitats within the vicinity of the land required for the construction of the Proposed Scheme	Relationship to other suitable habitat
Medium	Where areas of immediate and intermediate terrestrial habitat offering at least some connectivity and good opportunities for foraging and shelter (e.g. rough grassland, scrub, woodland, brown field habitats) are available but are sufficiently limited in area (or patchy in distribution) that it is considered possible newts may also utilise distant habitat in low to medium numbers; or Where habitats within the land required and unaffected immediate or intermediate terrestrial habitat associated with the pond in question contain limited features suitable great crested newt foraging and shelter (e.g. bare ground, improved grassland, arable fields, hard standing or buildings).
High	Habitats within land required considered to offer good connectivity of habitat and in general better opportunities for foraging and shelter (e.g. rough grassland, scrub, woodland, brown field habitats) than those located closer to the pond in question. It is therefore considered likely these habitats would be utilised for foraging/shelter; or Availability of immediate and intermediate habitat suitable for foraging and shelter is considered sufficiently limited that alone it would not be sufficient to support any population associated with the pond in question.

11.4.13 In all cases the outputs of the flowchart provided as Appendix A were reviewed by an ecological consultant alongside aerial photography and OS mapping, and taken into consideration alongside a review of the spatial layout of suitable habitat (and the potential for fragmentation effects) and the presence of barriers to dispersal.

11.4.14 Table 5 details the basis for gauging the scale of likely impact of barriers to movement. However, in all cases a final judgement on the importance of the barrier was taken in light of the wider geographical context and its distance from the breeding pond. For example, the presence of a B road in close proximity to a breeding pond would be unlikely to represent an absolute barrier to movement. However, it may be more significant when also located further from the breeding pond, or when habitat located on the far side of the barrier is of low or negligible value to newts.

11.4.15 Following consideration of all the above each water body within the confines of the scoping was allocated to one of the survey prescription categories identified in paragraph 11.4.4.

Table 5: Guide to scale of potential barriers to amphibian movement

Scale of barrier to movement	Examples
Major	Motorway, dual carriageway, A Road, river or extensive areas of hard standing or intervening buildings (e.g. housing or industrial estate)
Moderate	B Road, major railway, major stream, moderate expanses of hard standing (e.g. small complexes of buildings or large car park)
Minor	Local road/track, minor railway, canal, minor stream or single buildings and small areas of hard standing

11.4.16 As for those water bodies within 250m the 'HSI/Walkover survey only' category was in general only used for those features where habitat is considered likely to have marginal potential to support great crested newt (e.g. canals, ditches), but field data are required to confirm this assessment.

Ongoing field scoping and survey

11.4.17 Outcomes of the desk based scoping exercise should be used as the basis for requesting land owner access, and survey planning. Where necessary when access is obtained, the survey prescription should be reviewed. Where deviations are made a full justification should be documented.

11.4.18 Any additional water bodies identified during the course of other surveys (e.g. those identified during Phase 1 habitat survey) were given an appropriate survey allocation following an HSI/walkover survey.

11.4.19 For all water bodies where 'HSI/Walkover survey' is prescribed an HSI assessment should be conducted (where appropriate) and a record made of the outcome of the survey (i.e. level of further survey prescribed or the rationale for scoping out). Where an HSI score of less than 0.5 (i.e. rating of 'poor') is achieved, and inspection of the water body by an ecologist suggests that it is unlikely to support great crested newt, the water body may be scoped out.

11.4.20 In addition, throughout the course of field surveys consideration should be given to the need to increase the level of survey effort at those ponds initially only subject to presence/absence survey, due to changes in design or potential impact. Additional survey effort should be specified where this is considered necessary to provide a robust baseline for the assessment of potential significant effects.

11.5 Survey methods

Presence/absence survey

11.5.1 During each survey visit until presence is confirmed at least three survey methods are to be employed. In the first instance, this should consist of the following:

- torchlight survey;
- bottle trapping; and
- egg searching.

11.5.2 In some cases, conditions at the pond or physical constraints to access (e.g. presence of dense scrub adjoining part of the ponds, or unstable margins) may mean that it is not possible or appropriate to utilise these preferred methods. In these cases, the unsuitable method should be substituted for an alternative method according to the following:

- netting should be utilised as the first alternative survey methodology; and
- refuge search should only be utilised where two or more other survey methodologies are inappropriate.

11.5.3 In each case where a deviation from the standard three survey methodologies is required, the survey notes are to include a justification for this deviation.

Population size class assessment

11.5.4 All survey visits are to utilise torchlight survey, bottle trapping and egg search unless these methods are not feasible. As soon as presence of great crested newt eggs is confirmed, egg searching will cease.

11.5.5 Where one of the three survey methods identified in paragraph 11.5.1 is considered inappropriate the following guidance should be followed:

- if the peak recorded great crested newt count by a single survey method is fewer than 10 individuals, netting or, if this is not possible, refuge search should be used; but
- if a peak count of 10 or more great crested newt has previously been recorded using a single survey method, then use of alternative survey methodologies is not required.

Terrestrial habitat survey

11.5.6 In a small number of locations where access to a pond is not possible, it may be necessary to deviate from the standard methodology for presence/absence survey and conduct terrestrial habitat survey utilising pitfall traps on adjacent land to determine presence/absence.

11.5.7 In all such cases recommendations for terrestrial habitat survey of this type should be brought to the attention of Natural England immediately, along with recommendations for the proposed terrestrial habitat survey. The default position will be terrestrial presence/absence survey in accordance with Great Crested Newt Mitigation Guidelines (English Nature, 2001).

Late season amphibian survey

11.5.8 Where pond based presence/absence surveys are not completed during the available mid-March to mid-June survey window, at locations within or in close to the land required for the construction of the Proposed Scheme, late season amphibian survey (i.e. survey between mid-June and end of September) should be utilised where possible in order to gain an early indication of where great crested newts are present.

11.5.9 The methodology for late season amphibian survey is provided in Appendix B of this document.

11.5.10 Late season survey will only be used to confirm presence, and will not be utilised to assume absence. All ponds subject to late survey will also be subject to full survey during the mid-March to mid-June period.

11.6 Field survey techniques

11.6.1 Field survey techniques to be utilised are based on those provided within Great Crested Newt Mitigation Guidelines (English Nature, 2001), with additional guidance provided in order to ensure consistency.

Torchlight survey

- all torchlight surveys should utilise torches of at least 1 million candle power;
- torchlight survey should not commence until at least 1 hour after published local sunset time;
- where areas of the pond are omitted (due to restricted accessibility or health and safety constraints) an estimate of the percentage of the pond margin omitted and a justification for this is to be included within the notes section of the recording form;
- during each survey visit the turbidity and vegetation cover of the water body is to be scored against the five point scales advocated by Natural England;
- where a turbidity or vegetation cover score of 4 is allocated, torchlight survey is still to be conducted but due to potential unreliability it should be complemented by use of an additional survey method (e.g. netting); and
- where a turbidity or vegetation cover score of 5 is allocated, torchlight survey is to be replaced by an appropriate alternative method (e.g. netting).

Egg searching

- egg searching is to be halted when searches confirm presence of great crested newt eggs, and from this point forward not be repeated during subsequent visits; and
- the use of 'egg strips' should only be considered where conventional egg searching is not appropriate and other constraints mean it is not possible to complete survey using three of the remaining available conventional survey methods (i.e. bottle trapping, torching, netting, refuge survey).

Bottle trapping

- all bottle traps used are to be created from clear plastic 2 litre round bottles and be secured utilising a bamboo cane or similar;
- where utilised, bottle traps are be positioned at a frequency of one every 2m in areas of suitable habitat; for large water bodies where this is not practical, areas of trapping should focus on targeted survey of sections of the margin which support the most suitable habitat;
- where areas of the pond are omitted (due to restricted accessibility or health and safety constraints), an estimate of the percentage of the pond margin omitted and a justification for this is to be included within the notes section of the recording form;
- bottle trapping is only to be utilised on nights where overnight temperature is forecast to be 5°C or above;
- all bottle traps are to be set to include an air bubble; and

- bottle trapping should seek to avoid capture of water shrews; where they are known to occur, or are identified during survey, bottle trapping should be replaced by an alternative survey method.

Netting

- all netting is to be conducted at night; as netting causes widespread disturbance of the pond, where used in combination with torchlight survey it should only be conducted following completion of torching; and
- nets utilised should have a mesh size of 2-4mm.

Refuge search

- where utilised as a pond survey methodology refuge search will be conducted during each of the proposed four/six survey visits;
- survey should incorporate checks of both natural refuges (such as logs, bark, rocks, debris) and where possible artificial refugia placed around the margins of the pond; and
- where it is clear that refuge search will be utilised as a survey methodology for subsequent visits, carpet tiles should be placed face down every 2m around the pond margin and the refuges allowed to settle 7 days before the next survey visit.

Habitat Suitability Index

11.6.2 A Habitat Suitability Index (HSI) is to be calculated for all ponds within the land required for the construction of the Proposed Scheme, or within a 250m buffer of its boundary that are identified as requiring presence/absence or population size class assessment survey, according to the criteria set out in Table 3, as well as any other ponds that are subject to full survey.

11.6.3 All surveyors are to use the simplified HSI methodology described in ARG UK Advice Note 5: Great Crested Newt Habitat Suitability Index (2010)[34].

11.6.4 Where possible HSI scores for the ten component indices are to be calculated from data collected during a survey visit during the period mid-April to mid-May. During subsequent surveys notes are to be made of factors/events that may have resulted in a significant change to the HSI score previously calculated.

11.6.5 Where a suitability index cannot be allotted for any of the ten component indices then a comment should be recorded to explain this. In addition, a comment should be recorded where the surveyor considers that the atypical nature of a water body may result in an unreliable HSI score.

[34] Amphibian and Reptile Groups of the United Kingdom (2010). ARG UK Advice Note 5: Great Crested Newt Habitat Sustainability Index. Amphibian and Reptile Groups of the United Kingdom.

Dealing with non-native amphibians

11.6.6 If non-native amphibian species occurring on Schedule 9 Part 1 of the Wildlife and Countryside Act (1981) as amended by the Wildlife and Countryside Act 1981 (Variation of Schedule 9) (England and Wales) Order 2010 are captured during the course of the survey (e.g. within bottle traps or nets) they will not be released back into the wild.

11.7 Survey programme and effort

Presence/absence survey

11.7.1 Presence/absence surveys are to comprise four visits in suitable weather conditions as defined in Great Crested Newt Mitigation Guidelines (English Nature, 2001).

11.7.2 Visits are to be conducted during the period mid-March to mid-June, with at least two visits during the period mid-April to mid-May.

11.7.3 Visits should ideally be well spaced (no more than one per week and no more than four weeks apart). Survey visits to the same pond on consecutive nights should be avoided. In the event that the required survey effort is not completed then the use of non-standard methodologies which may provide early warning to the presence of great crested newts will be considered (see Appendix B). These methods cannot be utilised to determine absence, and in all cases water bodies subject to these methods will be subject to full survey utilising standard methods.

11.7.4 Where presence/absence survey is not completed during one season the survey must be repeated in full during the next season.

Population size class assessment

11.7.5 Population size class assessment is to comprise six pond visits in suitable weather conditions (English Nature, 2001). These are to be conducted between mid-March to mid-June, with at least three of these visits during the period mid-April to mid-May.

11.7.6 Visits should ideally be well spaced (no more than one per week and no more than four weeks apart). Survey visits to the same pond on consecutive nights should be avoided.

11.7.7 In the event that the required survey effort is not completed during one season then the survey should be repeated in full during the following season.

Habitat Suitability Index

11.7.8 HSI scores for the ten component indices are to be calculated from data collected during a survey visit. Where constraints allow this should be conducted during the period mid-April to mid-May.

11.8 References

Amphibian and Reptile Groups of the United Kingdom (2010). ARG UK Advice Note 5: Great Crested Newt Habitat Suitability Index. Amphibian and Reptile Groups of the United Kingdom

Biggs J, Ewald N, Valentini A, Gaboriaud C, Griffiths RA, Foster J, Wilkinson J, Arnett A, Williams P, and Dunn F 2014 Technical advice note for field and laboratory sampling of great crested newt (Triturus criistatus) environmental DNA. Freshwater Habitats Trust, Oxford.

English Nature (2001). Great Crested Newt Mitigation Guidelines. English Nature, Peterborough.

Gent T and Gibson S (2003). Herpetofauna Workers Manual. JNCC, Peterborough.
Natural England (2012) Template for method statement to support application for licence under Regulation 532(2)e in respect of great crested newts Triturus cristatus. Form WML-A14-2 (Version December 2015). Available at https://www.gov.uk/government/publications/great-crested-newts-apply-for-a-mitigation-licence

Natural England (2012) Template for method statement to support application for licence under Regulation 532(2)e in respect of great crested newts Triturus cristatus. Form WML-A14-2 (Version December 2015). Available at https://www.gov.uk/government/publications/great-crested-newts-apply-for-a-mitigation-licence

12 Reptiles

12.1 Introduction and guidelines

12.1.1 It is anticipated that a range of habitats within the land required for the construction of the Proposed Scheme will represent suitable habitat to support widespread reptile species, namely adder (*Vipera berus*), slow worm (*Anguis fragilis*), grass snake (*Natrix natrix*) and common lizard (*Zootoca vivipara*). The route is located outside of areas known to support sand lizard (*Lacerta agilis*) and smooth snake (*Coronella austriaca*). As a consequence, it is unlikely that survey for these species will be required.

12.1.2 Reptile survey in support of the scheme will be conducted according to a bespoke methodology which draws heavily upon guidance provided in documents listed in Section 12.7.

12.2 Qualifications and experience

12.2.1 All surveyors involved in screening and scoping for reptiles should be experienced in the following:

- field identification of all widespread reptile species and field signs (e.g. sloughs, burrows and eggs);
- assessing the potential suitability of on-site habitats for widespread reptile species;
- determining appropriate spatial scope for survey; and
- identifying appropriate survey techniques to achieve a robust survey in a variety of habitat types.

12.3 Licensing requirements

12.3.1 Survey is only anticipated to involve widespread reptile species; as such no survey licence is required.

12.4 Screening for survey and defining the survey area

12.4.1 Analysis of aerial photographs was initially undertaken to identify and map the extent of key habitat areas within close proximity to the route of the Proposed Scheme that were considered potentially suitable to support reptiles. Consultants should review preliminary work, alongside desk study data and the results of Phase 1 habitat survey to identify any additional areas of potentially suitable habitat within the land required for the construction of the Proposed Scheme and a surrounding 100m buffer.

12.4.2 For all such areas identified as containing habitat potentially suitable to support reptiles, a walkover survey should be conducted by an appropriately experienced ecologist in order to appraise the suitability of the habitats present on the ground. The habitat assessment should be based on consideration of the following characters:

- location in relation to species range;
- vegetation structure;

- insolation (sun exposure);
- aspect;
- topography;
- surface geology;
- connectivity to nearby good quality habitat;
- prey abundance;
- refuge opportunity;
- hibernation habitat potential;
- disturbance; and
- egg-laying site potential (grass snake only).

12.4.3 For each habitat area, the output of the habitat assessment should be a grading of each habitat area as having either 'poor', 'good' or 'exceptional' potential to support widespread reptiles, based on reasoned consideration of the above factors. Examples are provided in Table 6.

Table 6: Grading of reptile habitat suitability

Habitat Grading	Definition
Poor	Habitat which is unfavourable for reptiles based on the majority of the habitat assessment characters listed above, or is limited in size and highly isolated from other areas of suitable habitat.
Good	Habitat which is favourable or sub-optimal for many of the habitat assessment characters listed above; or is sub-optimal for some of the characters and has good connectivity with areas of more suitable habitat.
Exceptional	Habitat which is favourable for reptiles based on the majority of habitat assessment characters listed above.

12.4.4 The grading of each habitat area should note for which species the habitat area is potentially suitable.

12.4.5 Where habitat areas identified for walkover survey are found to contain distinct areas of habitat that do not contribute to the overall value of the habitat parcel for reptiles, the habitat area should be divided. A unique reference code and habitat grading should then be allocated to each habitat area. For example, an area of improved grassland within a block of rough grassland and scrub would be given its own unique reference code and graded as being of 'poor' value based principally on the habitat structure.

12.4.6 All habitat areas falling within the identified survey extent identified as having 'good' or 'exceptional' potential to support reptiles and no significant barriers preventing dispersal to land require for the construction of the Proposed Scheme will be selected for further presence/absence survey utilising artificial refugia.

12.5 Survey method

12.5.1 Where health and safety and access constraints allow, all habitat areas identified as having 'good' or 'exceptional' potential to support reptiles using the table above will be subject to survey utilising artificial refugia.

12.5.2 In each habitat area, a combination of corrugated iron and roofing felt refugia all measuring a minimum of 0.5m x 0.5m are to be placed out in areas identified as suitable habitat. At sites where the habitat assessment has identified potential for grass snake to occur surveyors should deploy an appropriate number (based on extent of suitable habitat) of larger refugia, to increase the likelihood of detecting this species.

12.5.3 In non-linear habitats refugia should be placed at a density of at least 100/ha or a minimum 30 mats in very small sites. In linear habitats of less than 10m in width (e.g. hedgerows, road verges etc.) refugia should be placed at a frequency of at least one every 10m of suitable habitat.

12.5.4 The default should be a 50: 50 ratio of corrugated steel/iron to roofing felt. Where varying from this standard a justification should be provided, based on the habitat type and target species concerned.

12.5.5 All refugia should be number marked using spray paint and their location accurately recorded to an accuracy of <5m where terrain/vegetation allows, to allow later translation to GIS. It is recommended that locations are recorded using a GPS device.

12.5.6 Once placed out artificial refugia will be left to settle for 14 days prior to conducting the first check.

12.5.7 Each site containing refugia will then be checked for reptiles on the required number of occasions (see Section 12.6). Binoculars should be used to check for reptiles between refugia, as well as careful checks by lifting each refugium.

12.5.8 Each refugia check should be conducted during the following conditions:

- time: conducted between 07:00 and 18:00;
- air temperature: 10°c - 20°C;
- wind: Still to moderate (equivalent to Beaufort 4; 13 - 17mph); and
- rain: No or light rain only at time of survey. Surveys between periods of heavy rain (when all other conditions are suitable) are also acceptable.

12.5.9 During each check, the surveyor should record details of all reptiles encountered during the survey, including refugia number, species, number, life stage (adult, sub-adult, juvenile) and when possible, sex.

12.5.10 If non-native species listed on Schedule 9 are found during the survey then details will be recorded as described in paragraph 12.5.9. As no handling of reptiles is anticipated as part of the survey all non-native species will be left in-situ. Where necessary provisions for their removal will be included within the ES and any subsequent mitigation statements.

12.5.11 All records of reptiles should be provided with GPS-derived grid coordinates. Where topography and vegetation structure may have reduced the accuracy of records below an accuracy of <5m, this information should be noted.

12.5.12 Where areas of suitable reptile habitat are located within the boundaries of the existing operational rail or road estate it is anticipated that there may be both health and safety and access issues that will prevent refugia survey of all those areas of habitat identified as potentially suitable for reptiles. In these cases, the consultants undertaking surveys will be expected to liaise with the overseeing consultant in order to determine a suitable survey approach for these areas. It is anticipated that this will involve consideration of the following potential approaches:

- sampling of areas of similar adjacent habitat;
- visual search only; and
- risk assessment based on habitat suitability.

12.6 Survey programme and effort

Presence/absence survey

12.6.1 At all locations selected for refugia survey initially, seven visits (during suitable weather conditions) should be conducted to determine presence/absence.

12.6.2 Each visit should adhere to the weather requirements detailed in paragraph 12.5.8 and should be conducted during the period April to September.

12.6.3 Where access allows surveys should be programmed to maximise the number of visits conducted during April, May, June and September, when weather conditions are likely to be more favourable for survey. However, visits during July and August are not precluded assuming they are conducted according to the weather requirements detailed in section 12.5.8.

12.6.4 There should be at least 30 days between the first and last survey visits and there must be a minimum of two days between each visit.

12.6.5 A robust survey to determine likely absence should include at least four visits conducted during the 'optimum' survey months of April, May, June or September. As a consequence, at sites where surveys commence during July or August if no reptiles are found during the first three visits then the remainder of visits should be delayed and conducted during September.

Estimating population size class

12.6.6 Where presence/absence survey confirms presence of one or more reptile species and all survey visits have been conducted during the 'optimum' survey months of April, May, June or September (under suitable conditions) then (unless the surveyor considers it necessary) no further visits will be required.

12.6.7 In order to give a robust estimate of population size where any survey visits have been conducted during the sub-optimal months of July or August, additional visits will be required until at least seven visits (under suitable conditions) have been conducted during optimum months.

12.6.8 Where initial survey results suggest that a site has the potential to support a 'high' reptile population then the consultants undertaking the survey should consider the requirement for further visits to provide a robust population size class estimate.

12.6.9 Population size class should be assessed utilising the peak adult count for each species across all visits. These figures should be divided by the survey area in ha to give an indication of density identified within the survey, then compared with the criteria outlined in 'Evaluating local mitigation/translocation programmes: Maintaining best practice and lawful standards' (HGBI, 1998)[35]. A summary is provided in Table 7.

Table 7: Estimating population size

Species	Population size class	Density recorded
Slow worm	High	more than 100/ha
	Medium	50-100/ha
	Low	less than 50/ha
Common lizard	High	more than 80/ha
	Medium	20-80/ha
	Low	less than 20/ha
Grass snake	High	more than 4/ha
	Medium	2-4/ha
	Low	less than 2/ha
Adder	High	more than 4/ha
	Medium	2-4/ha
	Low	less than 2/ha

Source: Derived from HGBI (1998) Evaluating local mitigation/translocation programmes: Maintaining best practice and lawful standards.

Surveys split between seasons

12.6.10 Where surveys are commenced but not completed in one year, they can be 'topped up' with visits in the subsequent year, assuming that the resulting data set meets the relevant conditions for timing, survey conditions and number of visits as set out above.

12.7 References

Froglife (1999). Reptile survey; an introduction to planning, conducting and interpreting surveys for snake and lizard conservation. Froglife Advice Sheet 10. Froglife, Halesworth.

[35] Herpetofauna Groups of Great Britain and Ireland (1998). Evaluating local mitigation/translocation programmes: Maintaining best practice and lawful standards. HGBI, Halesworth.

Gent T and Gibson S eds (2003). Herpetofauna Workers Manual. JNCC, Peterborough. Herpetofauna Groups of Great Britain and Ireland (1998). Evaluating local mitigation/translocation programmes: Maintaining best practice and lawful standards. HGBI, Halesworth.

Natural England (2011). Natural England Technical Information Note TIN102: Reptile Mitigation Guidelines. Natural England, Peterborough. (Note this guidance was published and subsequently withdrawn in September 2011).

13 Breeding birds

13.1 Introduction and guidelines

13.1.1 The purpose of breeding bird surveys within the context of ES is to establish baseline data on the species, numbers and distribution of birds within and adjacent to the land required for the construction of the Proposed Scheme so that potential significant impacts of the scheme can be assessed.

13.1.2 Particular attention is required where species listed on Schedule 1 of the Wildlife and Countryside Act (1981 as amended) are suspected or found.

13.1.3 A review of methods available for survey of breeding birds can be found in Bibby, et al (2000)[36].The principal method employed for the ES of the Proposed Scheme will be a variation of the Common Bird Census (CBC) methodology[37], involving five visits during the breeding season. Where initial survey visits are conducted during one season in order to provide an early understanding of bird use of the route of the Proposed Scheme, the full five visits should be repeated during the subsequent year in order to provide reliable data for use in territory analysis. Where appropriate, further specific surveys will be undertaken for protected and/or notable species (e.g. barn owl, hobby, nightjar, black redstart).

13.2 Qualifications and experience

13.2.1 Surveyors should be able: to identify birds confidently from visual observation as well as songs/calls; to identify specific bird habitats that could support nesting birds listed on Schedule 1; to identify bird behaviours, including territorial displays and nesting behaviour; to use with confidence common survey techniques including territory mapping, point counts and transect surveys; and to interpret bird survey data.

13.3 Licensing requirements

13.3.1 A Natural England licence is required where surveys are likely to disturb Schedule 1 species, including nesting barn owls. In the vast majority of cases survey according to the Common Bird Census (CBC) methodology proposed is considered unlikely to constitute a legal offence. Where it is necessary, survey routes should be sensitively modified in order to limit disturbance. However, ultimately individual surveyors should for all proposed surveys judge where disturbance is likely to occur and provide appropriately licensed survey staff where necessary.

13.4 Screening for survey and defining the survey area

13.4.1 The extent of the CBC style survey (as described in Section 13.5) should be defined by the outcome of Stage 1 and Stage 2 below.

[36] Bibby, C.J., Burgess, N.D., Hill, D.A., and Mustoe, S.H. (2000). Bird Census Techniques, 2nd ed. Academic Press, London.
[37] Marchant, J.H. (1983). Common Bird Census Instructions. BTO, Tring.

Stage 1 – Sites of known importance for breeding birds

13.4.2 Surveyors should initially undertake a review of existing information (designation details, desk study records of notable species, county bird reports) to identify sites of known importance for birds where there is considered to be the potential for adverse effects as a consequence of the Proposed Scheme. The necessary extent of this search area will vary based on the nature of the sites present and the proposed engineering design of the scheme. However, as a minimum this search should encompass a 250m buffer either side of the land required for the construction of the Proposed Scheme.

13.4.3 Any such sites where there is considered to be the potential for adverse effects as a consequence of the Proposed Scheme will be included within the scope of the CBC style survey.

Stage 2 – Other areas identified as being of potential importance for breeding birds

13.4.4 Surveyors should undertake a review of the following information sources to identify locations of potential importance for breeding birds (i.e. areas which are considered to have potential to support notable species such as those listed on Annex 1 of the Birds Directive, Schedule 1 of the Wildlife and Countryside Act, or red or amber listed species on the Birds of Conservation Concern list; or which may support notable assemblages of common birds) within the land required for the construction of the Proposed Scheme and a 250m buffer either side of it that are potentially subject to adverse effects:

- aerial photography and Ordnance Survey mapping;
- Phase 1 habitat survey results;
- feedback from wintering bird surveys conducted during 2016/2017; and
- discussion with local consultees.

13.4.5 Any such sites will be included in the scope of the CBC style survey.

Stage 3 – Sampling of other habitats (i.e. those not covered by Stage 1 and Stage 2)

13.4.6 Following completion of Stages 1 and 2 a survey strategy should be established to ensure that survey includes a sample of all other habitats within the land required for the construction of the Proposed Scheme and a 250m buffer either side of it. This is intended to provide an indication of the birds using these habitats and should give preference to areas within the land required for the construction of the Proposed Scheme. As a guide, the sampling of other habitats that are not identified in Stage 1 and Stage 2 should seek to achieve a minimum of 20% coverage within each community area. It should be noted that this is in addition to the coverage required to satisfy Stage 1 and Stage 2. Coverage may be increased where appropriate.

Stage 4 – Further detailed survey for protected and/or notable species

13.4.7 In addition to the CBC type surveys described above consultants undertaking survey should consider the requirement for additional survey work in order to assess potential impact on species listed on Schedule 1 of the Wildlife and Countryside Act (1981 as amended)[38]and Annex 1 of the Birds Directive[39].

13.4.8 Consultants should undertake a desk based exercise to identify the likely extent of Schedule 1/Annex 1 species surveys required within the areas for which they are responsible. The results of the desk based exercise should initially consider records from within 5km and a desk based appraisal of suitable habitat availability within 1.5km to determine the scope of detailed field surveys required.

13.5 Survey methods

Common Bird Census style survey

13.5.1 Survey will comprise five visits between mid-March and the end of June with at least ten days between each visit. Where access allows these should be spread as evenly as possible throughout the survey season. Unless a site specific deviation is agreed then where access allows the full five visits should be conducted even where some survey visits were achieved in the previous year.

13.5.2 Survey visits will be undertaken on dry days with no more than moderate wind. Survey during dawn mist is acceptable but survey during dense fog should be avoided. Site visits should commence no later than one hour after sunrise. In order to avoid confusion and reduce survey bias in areas with high densities of birds the survey should be commenced towards the end of this window. In addition, the starting position should be varied between visits in order to reduce survey bias. In all cases survey should ideally be completed by 11am (12 noon at the latest).

13.5.3 Due to the scale of the survey proposed it will not be practical to approach all areas within 50m. As a consequence, in large expanses of open grassland or arable fields the boundaries will be walked and all birds within the field recorded. In other habitat where access and views allow, efforts will be made to record all bird activity within 50m of the survey route. Where no access is available, Public Rights of Way (PRoW) and local roads (where it is deemed safe to do so) will be utilised.

13.5.4 In all cases all birds seen or heard will be identified and recorded on a suitable scale map of the site to allow the information to be clearly recorded using standard British Trust for Ornithology (BTO) species and activity codes.

13.5.5 Large wetland areas can be covered by the CBC style survey as proposed above, but will be a combination of recording the activity of individual birds and counts of birds on the water from the lake edge.

[38] Wildlife and Countryside Act (1981) Chapter 69. Her Majesty's Stationery Office.
[39] Directive 2009/147/EC of the European Parliament and of the Council on the conservation of wild birds (2009). Official Journey of the European Union.

Species specific surveys

13.5.6 Species specific surveys should be conducted as appropriate, and where considered to be required (based on the results of scoping and results from Phase 1 habitat survey and initial breeding bird surveys) should include both the land required for the construction of the Proposed Scheme and a surrounding 250m buffer. As a minimum, this should include consideration of potential nesting locations for Schedule 1 species such as barn owl, red kite, hobby and peregrine.

13.5.7 Survey for Schedule 1 species should follow established best practice survey methodologies as follows:

- barn owl – Shawyer (2011);[40] and
- red kite/hobby/peregrine/black redstart/nightjar/kingfisher[41].

13.5.8 Where crepuscular or nocturnal species such as nightjar are suspected then evening survey visits (in addition to those forming part of the CBC survey) should be undertaken. At each appropriate site, at least two evening visits including the hour after sunset should be conducted.

13.6 References

Bibby, C.J., Burgess, N.D., Hill, D.A., and Mustoe, S.H. (2000). Bird Census Techniques, 2nd ed. Academic Press, London.

Directive 2009/147/EC of the European Parliament and of the Council on the conservation of wild birds (2009). Official Journey of the European Union.

Gilbert, G., Gibbons, D.W., and Evans J (1998). Bird Monitoring Methods. RSPB, Sandy.

Marchant, J.H. (1983). Common Birds Census instructions. BTO, Tring.

Shawyer, C. R. (2011). Barn Owl Tyto alba: Survey Methodology and Techniques for use in Ecological Assessment. Developing Best Practice in Survey and Reporting. IEEM, Winchester.

Wildlife and Countryside Act (1981) Chapter 69. Her Majesty's Stationery Office.

[40] Shawyer, C.R. (2011). Barn Owl Tyto alba: Survey Methodology and Techniques for use in Ecological Assessment. Developing Best Practice in Survey and Reporting. IEEM, Winchester.
[41] Gilbert, G., Gibbons, D.W. and Evens, J. (1998). Bird Monitoring Methods. RSPB, Sandy.

14 Wintering and passage birds

14.1 Introduction and guidelines

14.1.1 Survey methods are to be appropriate for lowland rural habitats including farmland and wetlands. These should be based on the methods in Gilbert et al (1998)[42] and the Wetland Bird Survey (WeBs) methodology[43].

14.2 Qualifications and experience

14.2.1 Surveyors are to be experienced in bird survey techniques and identification.

14.3 Licensing requirements

14.3.1 There are no licensing requirements for wintering bird survey.

14.4 Screening for survey and defining the survey area

14.4.1 Consultants undertaking surveys should aim to screen and consider discounting areas from survey where it is likely that the habitats support only low numbers of common birds whose conservation status would not be significantly affected by the Proposed Scheme. It is anticipated that wintering bird survey will focus on survey of water bodies with sampling of woodland and farmland habitats.

14.4.2 The decision on which areas to include within the scope of wintering bird surveys should be based on:

- records of notable species from desk study (bird data from the local Biological Records Centre and the County Bird Report);
- the presence of good quality habitat, as identified during the Phase 1 habitat survey; and
- discussions with local consultees.

14.4.3 All areas identified based on the above criteria should be included within the wintering bird survey. In addition, within each 10km section of the route the survey should include a representative sample of approximately 20% of all farmland and woodland habitats located within the land required for the construction of the Proposed Scheme and within a 100m buffer of the land required. Where access is freely available the areas selected for survey should cover a range of different habitat types and focus on locations within or directly adjacent to the land required.

14.4.4 Consultants undertaking surveys should use professional judgement to determine those locations where a more intensive survey sample (i.e. above the level defined in paragraph 13.4.2) is required.

[42] Gilbert, G., Gibbons, D.W. and Evans, J. (1998), Bird Monitoring Methods: A Manual of Techniques for Key UK Species. Royal Society for the Protection of Birds, The Lodge, Sandy, Beds.
[43] Pollit, M.S., Hall, C., Holloway, S.J., Hearn, R.D., Marshall, P.E., Robinson, J.A., Musgrove, A., Robinson, J., and Cranswick, P.A. (2003), The Wetland Bird Survey 2000-2001: Wildfowl & Wader Counts. Slimbridge.

14.5 Survey method

14.5.1 Wintering and passage bird survey will focus on wetland sites, and will utilise the WeBS methodology.

14.5.2 In each case the survey is to be undertaken at all wetland sites within the land required for the construction of the Proposed Scheme and within the 100m buffer of the land required. Survey will be conducted once per month through the period October to February, with additional visits during September and/or March where necessary to detect anticipated target species.

14.5.3 Outside wetland areas known to be of importance for wintering or passage birds, surveys within farmland, woodland and any other areas of suitable habitat identified by surveyors, will be based on a sampling approach. Outside wetland areas, surveys should aim to sample approximately 20% of the suitable habitat located within 100m of the land required for the construction of the Proposed Scheme for each 10km section. The length of the total survey route required to obtain this coverage will vary depending on the extent of views. Visible areas should be mapped by surveyors during the first survey visit to show the survey extent. Surveyors are to determine whether sampling density needs to increase locally to address habitat variety or complexity.

14.5.4 The route of the survey will be chosen to sample the range of suitable habitat types present. All visits are to be completed between one hour after sunrise and one hour before sunset.

14.5.5 On each of the survey visits the surveyor is to walk the survey area at a steady pace recording the location of all birds seen or heard on a plan using standard BTO species codes.

14.5.6 Vantage point survey should be conducted in wetland areas where construction of viaducts is proposed. Survey should comply with current Natural England guidance as outlined within TIN008 Assessing ornithological impacts associated with wind farm developments: surveying recommendations[44] and include at least 36hrs of survey at each vantage point location over the period September to mid-March inclusive.

14.6 Survey programme and effort

14.6.1 The survey programme for wintering bird surveys is described above.

14.7 References

Bibby, C.J., Burgess, N.D., Hill, D.A., and Mustoe, S.H. (2000). Bird Census Techniques, 2nd ed. Academic Press, London.

Gilbert G., Gibbons D.W. and Evans J. (1998). Bird Monitoring Methods: A Manual of Techniques for Key UK Species. Royal Society for the Protection of Birds, The Lodge, Sandy, Beds.

[44] Natural England (2007). Technical Information Note TIN008 Assessing ornithological impacts associated with wind farm developments: surveying recommendations. First edition 15 October 2007, www.naturalengland.org.uk

Marchant, J.H. (1983). Common Birds Census instructions. BTO, Tring.

Natural England (2007). Technical Information Note TIN008 Assessing ornithological impacts associated with wind farm developments: surveying recommendations. First edition 15 October 2007, www.naturalengland.org.uk.

Pollit, M.S., Hall, C., Holloway, S.J., Hearn, R.D., Marshall, P.E., Robinson, J.A., Musgrove, A., Robinson, J. and Cranswick, P.A. (2003). The Wetland Bird Survey 2000-2001: Wildfowl and Wader Counts. Slimbridge.

15 Hazel dormouse

15.1 Introduction and guidelines

15.1.1 Survey for hazel dormouse (*Muscardinus avellanarius*) will need to consider both perceived optimal woody habitats (e.g. hazel coppice dominated woodland) and areas of fragmented or sub-optimal habitat within the vicinity of the Proposed Scheme. This will include consideration of how habitat losses associated with the scheme may affect the movement of hazel dormice associated with retained habitat through the route corridor.

15.1.2 The proposed approach will broadly follow the nest tube survey methodology developed during the South West Dormouse Project[45]. It will also take into account Natural England's advice note on hazel dormouse surveys for mitigation licensing [46].

15.2 Qualifications and experience

15.2.1 All initial scoping and habitat assessment work should be conducted by persons with previous experience of the range of habitats utilised by hazel dormouse and field signs indicating potential presence of hazel dormouse.

15.2.2 The erection of hazel dormouse nest tubes should be coordinated by persons experienced in nest tube survey.

15.3 Licensing requirements

15.3.1 Checking of nest tubes will require at least one surveyor within a survey team to hold a licence to 'take and disturb' hazel dormouse. Assistants may only be utilised where they are working in close proximity to a licence holder at all times. When working distant from each other (including in different areas of the same survey site) all other surveyors within a survey team should be named accredited agents to the licence holder each of whom has been trained and is experienced in identification and handling of hazel dormouse.

15.4 Screening for survey and defining the survey area

15.4.1 Analysis of aerial photographs has been used to identify and map the extent of key areas of habitat within the route corridor that are considered potentially suitable to support hazel dormouse. Review of desk study data and the results of Phase 1 habitat survey by consultants undertaking survey work may result in additional areas. This assessment should include habitat potentially of value for nesting and foraging, and should take into account fragmented habitats and areas of potentially sub-optimal habitat that may be of importance in a wider landscape context.

[45] Chanin, P. and Woods, M. (2003), Surveying dormice using nest tubes: results and experiences from the South West Dormice projects. English Nature Research Report No. 524. English Nature, Peterborough.
[46] Standing Advice from Natural England and Department for Environment, Food and Rural Affairs (29 July 2015) – Hazel or common dormouse: surveys and mitigation for development projects. https://www.gov.uk/guidance/hazel-or-common-dormice-surveys-and-mitigation-for-development-projects

15.4.2 For all areas identified as containing habitat potentially suitable to support hazel dormouse, a walkover survey should be conducted by an appropriately experienced ecologist in order to appraise the suitability of the habitats present on the ground, and to determine the need for nest tube survey. The habitat assessment should be based on consideration of the following characters:

- availability of key food sources;
- vegetation structure (in particular the extent of arboreal linkage);
- level of shading; and
- connectivity with other areas of suitable or sub-optimal habitat.

15.4.3 Where walkover survey and habitat assessment indicate that not all of an identified habitat area requires nest tube survey, the habitat area should be subdivided and a unique reference code and assessment outcome allocated to each habitat area.

15.5 Survey method

Nest tube/nest box survey

15.5.1 At each site selected for nest tube survey, tubes of standard design (i.e. made from stiff double walled black plastic measuring approximately 5cm width x 5cm height x 25cm length with a small plywood tray blocking one end and projecting 5cm from the other) are to be deployed in potentially suitable habitat (as defined by the outcome of the habitat assessment).

15.5.2 Tubes should be deployed in clusters 15-20m apart, sampling both areas of best quality habitat and associated areas that may appear less suitable according to traditional concepts of hazel dormouse habitat quality (e.g. hedgerows linking to areas of deciduous woodland).

15.5.3 A minimum of five hazel dormouse nest boxes will be deployed (at a minimum of 20m spacings) in areas of deciduous woodland survey sites to increase the potential for detecting hazel dormouse presence in these locations.

15.5.4 All tube and box locations should be mapped and OS grid references recorded by GPS to an accuracy of <5m where terrain and vegetation cover allows. Where necessary, markers such as coloured string or high visibility tape should also be deployed to aid the process of locating nest tubes and boxes during subsequent visits.

15.5.5 During each check, all nest tubes and boxes should be inspected for potential signs of use by hazel dormouse including the following:

- presence of individuals in-situ;
- characteristic nesting material;
- presence of characteristic gnawed hazel nuts; and
- presence of droppings.

15.5.6 During each check, the above information will be recorded alongside similar information that indicates use of nest tubes or boxes by other species (e.g. squirrel, field mouse etc.).

15.5.7 During each visit, a record should be made of the number and location of any tubes or boxes that have been dislodged or interfered with since the previous survey visit.

15.5.8 The first survey visit should not be conducted until at least one calendar month after completion of tube or box installation in that area.

15.5.9 All records of hazel dormouse and other species identified utilising nest tubes or boxes should be provided with GPS-derived grid coordinates accurate to <5m. Where topography and vegetation structure may have reduced the accuracy of records below this level this information should be noted.

15.5.10 Where potential hazel dormouse droppings are found that cannot be definitively identified in the field, a small sample (considered to represent droppings from a single species) should be collected and sealed in a plastic bag marked with the following details:

- date sample collected (day/month/year);
- survey location and tube/box number;
- GPS coordinates of tube/box concerned;
- suspected species; and
- surveyor name.

15.5.11 Dropping samples should be stored in a cool, dry place and submitted as soon as possible for DNA analysis to determine if hazel dormouse is present.

Nut searches

15.5.12 Nut searches will only be utilised to confirm presence, and will not in the first instance be utilised to assume absence.

15.5.13 Nut searches should be conducted prior to the installation of nest tubes or boxes at any new sites. Where nest tube or box survey of sites has commenced and detailed surveys have not confirmed presence by the end of September then consultants undertaking survey should (where appropriate) conduct nut searches during October or November. Nut searches should be targeted at the location of mature and heavily fruiting hazels where these are present.

15.5.14 Where nuts opened by hazel dormice are identified during a nut search a specimen nut should be collected for future reference and sealed in a plastic bag with the following details:

- date sample collected (day/month/year);
- survey location and survey code (route zone-survey code-6 digit number);
- suspected species; and

- surveyor name.

15.5.15 Where hazel dormouse presence is confirmed during the nut search any on-going or proposed nest tube/box survey at the survey site may be halted.

15.6 Survey programme and effort

15.6.1 Chanin and Woods (2003) defined a scoring system for nest tube and box survey based on the probability of finding hazel dormice in a nest tube or box in any one month (see Table 8). Under this methodology a minimum cumulative score of 20 points must be reached to robustly determine presence/likely absence.

Table 8: Index of probability of finding dormice during nest tube or box survey in any one month

Month	Index of Probability
April	1
May	4
June	2
July	2
August	5
September	7
October	2
November	2

15.6.2 All nest tube or box surveys will be expected to obtain a cumulative score of 20 or above. Survey effort is determined by summing the index of probability scores from the month nest tubes or boxes are deployed to when they are removed (i.e. not just the months where the tubes are physically checked) as such nest tubes and boxes should ideally be placed out as soon as possible in the season at the required spacing and left for the duration.

15.6.3 All nest tubes and boxes should be checked once during August and again during September. Outside of these months checks should be conducted at least once every two months and immediately prior to removal.

15.6.4 Where the minimum cumulative score of 20 points is not achieved by the end of November 2016 and nut searches do not confirm presence then it will be necessary to conduct additional visits during 2017 until the required score is achieved.

15.6.5 Where visits during 2016 are required nest tubes and boxes should be left in-situ over the winter months and a check conducted during March 2017 to reposition or replace any tubes or boxes which have been dislodged or damaged.

15.6.6 Where conducted, nut searches should be carried until either (a) a confirmed nut opened by hazel dormouse is located; or (b) until 100 nuts opened by other small mammals (i.e. not hazel dormouse) have been found; or (c) until at least one and half hours has been spent searching.

15.6.7 Where access restrictions significantly constrain the period available for survey the number of tubes used should be doubled by reducing the spacing interval and thus doubling the monthly score. This will need to be highlighted as a potential limitation of survey.

15.7 References

Bright, P, Morris, P, and Mitchell-Jones, T, (2006). Dormouse Conservation Handbook. Second Edition. English Nature, Peterborough.

Chanin, P. and Woods, M. (2003). Surveying dormice using nest tubes: Results and experiences from the South West Dormouse Project. English Nature Research Report No. 524. English Nature, Peterborough.

Chanin, P. (2012). Personal correspondence.

Standing Advice from Natural England and Department for Environment, Food and Rural Affairs (29 July 2015) – Hazel or common dormouse: surveys and mitigation for development projects. https://www.gov.uk/guidance/hazel-or-common-dormice-surveys-and-mitigation-for-development-projects

16 Bats

16.1 Introduction and guidelines

16.1.1 Proposed survey methodologies are largely based on the Bat Workers Manual[47], Bat Mitigation Guidelines[48] and Bat Surveys: Good Practice Guidelines 3rd Edition[49]. Reference has also been made to the survey methods recommended within Design Manual for Roads and Bridges Volume 10[50], and the DEFRA research report WC1060[51].

16.1.2 The following section details the scope of survey work and methodologies for these surveys. Determining the extent of survey will be an iterative process. Results of initial bat survey work are likely to identify the requirement for further surveys in some locations. Bat surveys focus on identifying features used by bats for roosting, as well as understanding how bats use the wider landscape for feeding and commuting. Initially, visual inspection is used to identify features with potential as bat roosts; this may then be supplemented by closer and more detailed inspection of some features with higher potential; and when inspection is not possible or the findings are not conclusive, dusk and dawn bat surveys are undertaken to identify any bats emerging and re-entering roost features. Following desk study, targeted bat activity surveys are used to identify movement and activity by bats around a site, including bat commuting routes and features that may be important in bat navigation/orientation.

16.1.3 It is known that bat species listed under Annex II of the EC Habitats Directive (92/43/EEC) occur at locations in proximity to the proposed route. Detailed bespoke methodologies for such locations (and any others where the presence of Annex II species is suspected) will be devised in liaison with Natural England and, where appropriate, with local bat groups and researchers working in the area.

16.1.4 Consultants undertaking surveys should ensure that all descriptions of roost types utilised during the project are in line with the terms and definitions provided in Collins (2016), as detailed in Table 9.

16.2 Qualifications and experience

16.2.1 All bat survey work conducted in support of the scheme will be conducted by suitably qualified persons. All work that is considered likely to result in disturbance of bats or their roosts will be conducted by holders of Natural England licences to 'take and disturb' bats for the purpose of science and conservation.

16.2.2 Some activities (e.g. initial assessments) may be suitable to be conducted by non-licensed but suitably experienced ecologists.

[47] Mitchell –Jones, A.J., and McLeish, A.P. (2004), Bat Workers' Manual. Peterborough: Joint Nature Conservancy Council.
[48] Mitchell-Jones, A.J. (2004), Bat Mitigation Guidelines (IN136). English Nature, Peterborough.
[49] Collins, J. (Ed) 2016. Bat surveys for professional ecologists: good practice guidelines (3rd Edition). Bat Conservation Trust, London.
[50] Highways Agency (2001), Design Manual for roads and Bridges – Volume 10, Section 4, Part 3. Nature Conservation Advise in relation to bats. Highways Agency, London.
[51] Defra (2015), WC1060 Development of a cost-effective method for monitoring the effectiveness of mitigation for bats crossing linear transport infrastructure.

Initial bat roosting potential assessments

16.2.3 Assessment of trees and buildings for roosting potential which does not result in disturbance may be conducted by all suitably qualified persons. All persons conducting such a survey should be experienced in field survey of roosting potential of trees and buildings, including a good knowledge of the following:

- the legislation and protection afforded to bats;
- bat life cycle;
- locating and identifying field signs of roosting bats (droppings, scratch marks, urine staining etc.);
- using signs of bats found to locate likely roosting positions, likely genus of bat and type of roost;
- species-specific and seasonal requirements of roosting bats and the various natural features and manmade structures used for roosting;
- the range of survey methods that can be used to identify and study bats, and their strengths, weaknesses and limitations;
- describing construction of buildings and other structures, including the materials utilised and the form of features present (e.g. hipped roof, gable end, trussed rafters); and
- current relevant guidance for surveying bats.

16.2.4 If non-licensed surveyors identify evidence of an active roost during initial assessments then it will be necessary for them to cease surveying. The survey will subsequently be completed when a licensed surveyor is present.

Internal survey

16.2.5 Surveys of known roosts, or potential hibernation roosts, should be undertaken by ecologists with the appropriate Natural England licence.

16.2.6 Survey teams conducting internal inspection of buildings/structures between May and September (when bats are most likely to be present) should include at least one Natural England licensed bat worker.

Emergence/activity survey

16.2.7 It is recommended that each team of surveyors conducting emergence/return or activity surveys at a discrete location (i.e. a single tree, group of trees, building or structure) should include at least one licensed bat worker to coordinate the survey. At complex or large sites, a higher proportion of licensed bat works should be utilised.

16.2.8 All other surveyors assisting in the implementation of emergence/activity surveys should have a sound knowledge and understanding of the following:

- the legislation and protection afforded to bats;
- bat life cycle;

- feeding strategies used by difference bat species;
- the physiology and flight characteristics of UK bats;
- the range of survey methods that can be used to identify and study bats, and their strengths, weaknesses and limitations;
- species specific and seasonal requirements of roosting bats and the range of features utilised by each species;
- using a range of bat detectors to identify species and record behaviour; and
- current relevant guidance for surveying bats.

Further surveys

16.2.9 Any subsequent bespoke surveys for Annex II species will be overseen by licensed bat workers who are experienced in surveying, and assessing the impacts of development on, the species concerned. Licensed bat workers devising survey scope and methodologies on the project should have experience of undertaking ecological impact assessment in support of linear infrastructure projects, and designing successful mitigation schemes.

16.3 Licensing requirements

16.3.1 Requirements for the involvement of licensed surveyors are discussed within Section 16.2.

16.4 Screening for survey and defining the survey area

16.4.1 Aerial photograph interpretation (and where available Phase 1 habitat mapping and desk study records) will be utilised to identify all buildings, trees and other features with potential to provide a place of shelter for bats within the land required for the construction of the Proposed Scheme and within a surrounding 100m buffer of the boundary of the land required.

16.4.2 In addition, consultants undertaking surveys should conduct a review of all habitats, buildings, trees etc., and existing desk study records within a 500m buffer either side of the land required for the construction of the Proposed Scheme to identify any additional features where the following apply:

- there is the potential for significant effects on populations utilising these features; or
- information regarding bat use of the features/habitat in question will be important in determining a robust baseline that allows the significance of impacts within and in proximity to the Proposed Scheme to be accurately assessed.

16.4.3 An assessment of the need for survey of features more than 100m from the boundary of the land required for the construction of the Proposed Scheme should include consideration of the following:

- existing information on bat species, populations and roosts;

- protected sites, for example a Special Area of Conservation designated for bats;
- the context of the site in its surroundings;
- extent and quality of habitat within and around the site including water features, hedges, woodland and/or veteran trees;
- presence of known roosts or suitable buildings and other structures for roosts; and
- types of roost and species present (Collins, 2016).

16.4.4 The scope of surveys will in the first instance be confined to habitats within a 100m buffer either side of the boundary of the land required for the construction of the Proposed Scheme, and features of particular interest within a 500m buffer of the boundary of the land required that are identified by the consultants responsible for bat survey in the area concerned. As the extent of the land required for construction will alter with design changes it will be necessary to regularly review which features require survey.

16.4.5 In urban sections, the scope of survey will be limited to the land required for the construction of the Proposed Scheme (and the adjacent Network Rail estate where the Proposed Scheme will run adjacent to existing rail lines) and any significant features/areas of semi-natural habitat adjoining the land required for the construction of the Proposed Scheme that are identified during aerial photograph interpretation. Within urban areas survey of retained residential housing adjoining the route should only be conducted where there is considered to be the potential for significant adverse effects.

16.5 Survey methods

16.5.1 The following methodologies are intended to provide robust baseline data on widespread UK bat species. If bat species listed on Annex II of the Habitats Directive[52]are found/ suspected to be present, additional survey work targeted at these species will be required to supplement the baseline.

Definition of potential to support roosting bats

16.5.2 Whilst undertaking preliminary survey work, the surveyor should assign value to each feature within each building/tree in accordance with the scale set out in Table 1. Where surveyors consider it appropriate, the potential rating of a particular feature may be upgraded based on professional judgement and/or prior knowledge of the site (e.g. an optimal feature on a tree located within sub-optimal surrounding habitat may normally be graded as moderate, but may be upgraded to high where the surveyor has prior knowledge of unusually high bat activity in its vicinity).

[52] Lesser horseshoe bat (Rhinolophus hipposideros),gGreater horseshoe bat (Rhinolophus ferrumnequinum), Barbastelle (Barbastella barbastellus) and Bechstein's bat (Myotis bechsteinii).

Table 9: Potential to support roosting bats

Potential to Support Roosting Bats	Equivalent tree categories within Collins (2016)	Description
Confirmed	Known or confirmed roost	A feature/structure within which bats are seen to be present (either live bats, or bat carcasses) or heard 'chattering' will be classified as a confirmed roost. In addition, any feature/structure found to contain droppings during inspections will in the first instance be considered as a confirmed roost. N.B. In some cases, it may be appropriate to revise this assessment following further survey (e.g. for buildings containing low numbers or old droppings and showing no evidence of use during emergence surveys).
High	High	A feature/structure which, due to its size, depth, shape, orientation or other physical properties (such as ability to maintain a constant temperature, accessibility for bats) is considered to be ideal for use by bats in larger numbers and on a more regular basis and potentially for longer periods of time. Potential feeding remains, urine staining or scratch marks (in the absence of droppings) within or around the feature are likely to indicate presence of bat occupation and therefore suggest high potential that a roost is present. In the absence of such signs, assigning a feature high potential will also be informed by the surveyor's knowledge of bat ecology and preferred roost types (relative to the feature being assessed). The quality of the surrounding habitat for bats will also be considered. For example, a building within an area of woodland is more likely to be occupied by bats than one adjacent to large areas of hard standing (as the bats would use the woodland for feeding, and potentially roosting). Potential examples of high potential features are: • a south-facing opening on a tree trunk that appears to form a significant wound within the tree, with uncluttered drop zone and good connectivity to other areas of suitable habitat; or • a gap below a ridge tile that provides a potential point of access to a pitched roof, with marked cleaner tile below indicating potential use by bats.
Moderate	Moderate	A structure or tree with one or more potential roost sites that could be used by bats due to their size, shelter, protection, conditions and surrounding habitat but unlikely to support a roost of high conservation status. A feature/structure that would be ideal for bats but where other factors such as sub-optimal habitat limit the potential to be used by bats.
Low	Low	A tree/structure containing features where opportunistic use by individual bats cannot be ruled out but where the roost sites are of limited potential as they do not provide enough space, shelter, protection, appropriate conditions (e.g. temperature, humidity, light levels or disturbance) and/or lack suitable surrounding habitat to be used on a regular basis or by larger numbers of bats. For example, often metal warehouse structures with suitable access/egress points will be classed as having low potential to support roosting bats.
Negligible	Negligible	A tree/structure which is considered to lack any features suitable for use by roosting bats.

16.5.3 It should be noted that the initial assessment of potential considers only the potential to support any bat roost. The significance of any roost will depend on the species, number and use (e.g. maternity, hibernation) identified by subsequent survey.

Assessment of buildings/structures for potential to support roosting or swarming bats

16.5.4 Buildings/structures (including natural structures such as caves or adits) identified as requiring survey (according to the criteria provided in Section 1.5) should be given a unique reference code as described in Section 3 and assessed for their potential to support bat roosts and/or act as a swarming site. Surveys should include bridges and tunnels passing over/under the route of the Proposed Scheme.

16.5.5 Internal and external inspection of the structure for potential bat access/egress points and signs of bat activity should be undertaken and recorded as shown in Figure 2 (Collins, 2016). A drawing should be made to show the layout of the structure, and the location, aspect and height of any features/signs of bats, and potential access/egress points.

16.5.6 Digital photographs should be taken (cross-referenced to a plan) to record all features within the exterior and interior of the structure for future reference. Photographs should be taken of any evidence of bats (such as distribution of droppings, urine staining etc.). However, all photography should ensure that it does not result in the disturbance of any bats currently in-situ.

16.5.7 Reference should be made to the glossary of architectural terms within the Bat Workers Manual (2004) when describing the construction of buildings.

16.5.8 Where droppings are found and cannot be identified definitively a small sample (considered to represent droppings from a single species) should be collected and sealed in a plastic bag marked with the following details:

- date sample collected (day/month/year);
- survey location reference (see Section 3 of this technical note);
- GPS coordinates;
- suspected species; and
- surveyor name.

16.5.9 The sample should subsequently be stored in a cool, dry place. DNA analysis will be conducted where appropriate on these samples to help confirm species present.

Figure 2: Standard information to be recorded during roost assessments of buildings and built structures

Box 8.4 Standard information to be recorded in preliminary roost assessments of buildings and built structures

Evidence of use by bats:	**Features of the building or built structure:**
Location and number of any live bats. Location and number of any corpses or skeletons. Location and number of droppings. Notes on relative freshness, shape and size of droppings. Location and quantity of feeding remains. Location of clean, cobweb-free timbers, crevices and holes. Location of characteristic staining from urine and/or grease marks. Location of known and potential access points to the roost. Location of the characteristic smell of bats if no other evidence is recorded.	Type. Age. Aspect. Wall construction, in particular the type of brick or stone used to build the walls and whether it has cavity walls or rubble-filled walls. Form of the roof, in particular the presence of gable ends, hipped roofs, etc. and the nature and condition of the roof covering. Presence of hanging tiles, weather-boarding or other forms of cladding. Nature of the eaves, in particular if they are sealed by a soffit or boxed eave and the tightness of the fit to the exterior walls. Presence and condition of lead flashing. Gaps under eaves, around windows, under tiles, lead flashing etc. Presence and type of roof lining. Presence of roof insulation. Presence of water tanks in loft (note if covered or uncovered). Structure of the roof including the truss type, age and nature of timber work. Information or evidence of work having been undertaken that could affect use of the structure by bats.

Source: Bat Surveys – Good Practice Guidelines 3rd Edition (Collins, 2016).

16.5.10 Where ever possible and safe to do so, surveys should access all areas including cellars/underground structures and loft spaces. High-powered torches with red filters, binoculars and endoscopes should be used to investigate all accessible areas. Where there are any constraints to the survey these should be clearly identified in the survey notes and consideration given to the effect these constraints may have had on the results obtained.

16.5.11 Each building/structure should be classified according to its potential to support roosting bats during the active season as confirmed, high, moderate, low or negligible based on Table 9.

16.5.12 In addition, surveyors should, where possible, also give an indication of the type of roost the building structure is considered most likely to support based on current evidence (e.g. summer maternity roost, transitory roost, feeding perch, swarming site or hibernation roost) and/or the number of bats it is considered to have the potential to support on a three point scale of small, medium or large. It is acknowledged that for many features classification under these criteria may not be possible based on initial inspection alone.

16.5.13 Where buildings are confirmed roosts, or are considered to have moderate or high potential to support a roost; or where a full inspection cannot be undertaken due to access restrictions (e.g. unsafe structure), then subsequent evening emergence and dawn re-entry surveys will be required. Given the evolving nature of the design, the requirement for emergence survey in relation to buildings applies in the first instance to all buildings within the survey scope (i.e. with the exception of urban areas, those located within the land required for construction of the Proposed Scheme or within a 100m buffer either side of the current boundary of the land required, or specific features within a 500m buffer where potential significant effects are anticipated). As design stabilises professional judgment may be applied to limit survey outside of the land required for the construction of the Proposed Scheme to those locations where there is considered to be the potential for significant effects.

16.5.14 No further survey is required of buildings/structures assessed to have low or negligible potential but sufficient information will need to be collected to give confidence to this assessment. As a precaution, the procedure for demolition of low potential buildings is likely to include reasonable avoidance measures, such as toolbox talks for contractors and procedures for dealing with chance finds of bats.

16.5.15 Each building/structure subject to initial assessment should also be assessed for its potential to support hibernating bats or act as a swarming site. Assessment should in this case simply classify sites as having potential for hibernation/swarming or lacking hibernation/swarming potential. All buildings/structures identified as having hibernation or swarming potential will require further survey as described later in this section.

Assessment of trees for potential to support roosting bats

16.5.16 As a general rule in the first instance all trees of diameter at breast height of 0.25m or above within the land required for the construction of the Proposed Scheme or within a 100m buffer either side of it should be subject to survey from ground level by a suitably experienced ecologist (i.e. one with knowledge of tree roosting in bats).

Binoculars will be used to inspect the canopy of the tree for evidence of the features listed in the box overleaf, with each feature graded based on its potential to support roosting bats (see Table 9).

16.5.17 All trees should be given unique reference codes (see Section 3 of this technical note), with the location mapped and cross referenced to photographs taken. Preliminary surveys of trees should, ideally, be undertaken in the December to March optimal period before trees come into full leaf. Where this is not possible the limitations on survey should be acknowledged and where leaf cover is considered to significantly obscure initial inspection then trees should be given a precautionary 'high' grading, triggering the requirement for future climb-and-inspect survey.

16.5.18 In addition, surveyors should, where possible, also give an indication of the type of roost the feature is considered most likely to support based on current evidence (e.g. summer maternity roost, transitory roost, feeding perch, swarming site or hibernation roost) and/or the number of bats it is considered to have the potential to support on a three point scale of small, medium or large. It is acknowledged that for many features classification under these criteria may not be possible based on initial inspection alone.

Climb-and-inspect survey (trees)

16.5.19 Any trees where the presence of a roost has been confirmed during the initial assessment will not be subject to climb-and-inspect survey and should instead progress directly to emergence survey.

16.5.20 Subject to the exceptions listed in paragraph 16.5.21 below all trees that are considered to contain the following features will be subject to further inspection:

- trees identified during the initial inspections as containing features with high or moderate potential to support roosting bats during the 'active' period; or
- features with potential to support hibernating bats.

16.5.21 It is acknowledged that not all trees will be considered safe to climb and for all trees where this is true a clear record should be made. In addition, where the only features on a tree triggering the requirements for climb-and-inspect survey are either ivy cover or relatively open features that can be viewed fully from the ground using a torch (e.g. a callus roll) then no climb-and-inspect survey is required.

16.5.22 All inspections should be conducted either by a trained tree climber who is also a Natural England licensed bat worker, or by a tree climber under the direct supervision of a licensed bat worker. In order to minimise the risk of disturbance during inspections all tree climbers who are not licensed bat workers will be briefed by a bat worker who is experienced in undertaking tree inspections.

16.5.23 Climb-and-inspect surveys should, ideally, be undertaken between May and September when bats are more likely to be present. They will continue to provide useful information regarding the exact nature of features outside of this period. However, a more precautionary approach should be taken to the scoping out of further survey when inspections are conducted outside of this ideal period. Based on

the results of the climb-and-inspect survey initial gradings will be reviewed and re-graded where necessary according to Table 9.

16.5.24 Where confirmed evidence of bats is found during the climb-and-inspect survey, or features cannot be investigated in full, emergence/re-entry surveys will be required. Emergence survey will also be conducted on the following:

- all trees containing high potential features (based on the outcome of the further inspection) which will either be subject to works or may be subject to potentially significant effects (e.g. through severance of habitat features utilised during foraging, commuting or navigation; disturbance through lighting or noise etc.); and
- all trees containing moderate potential features which could not be investigated fully during climb-and-inspect surveys.

16.5.25 Features assessed to have low or negligible potential to support roosting bats (following inspection and re-grading), will be scoped out of further survey work.

16.5.26 Should climbing surveys be deemed unsafe or otherwise not possible, any trees containing either high or moderate potential features should be subject to dusk emergence and dawn re-entry surveys.

Dusk emergence and pre-dawn re-entry surveys

16.5.27 The minimum level of survey for buildings/structures and trees requiring additional survey in the form of evening emergence and dawn re-entry surveys is detailed in Table 10. In each case the level of survey for the tree, building or structure in question will be defined by the highest potential feature which it supports (i.e. survey effort for a tree containing both high and moderate potential features will be three dusk emergence and/or pre-dawn emergence surveys). It should be noted that trees containing moderate potential features should only be subject to emergence survey where it was not possible to fully inspect these features during climb-and-inspect surveys. Surveys should be undertaken between May and August[53].

Table 10: Minimum number of emergence and re-entry survey visits for high and moderate potential trees and buildings

High bat roosting potential	Moderate bat roosting potential
Three dusk emergence and/or pre-dawn re-entry surveys during May to September, with at least two of the surveys between May and August.	Two dusk emergence and/or pre-dawn re-entry surveys during May to September, with at least one of the surveys between May and August.

Source: Bat Surveys – Good Practice Guidelines 3rd Edition (Collins, 2016).

16.5.28 In each case at least one of the surveys should be a pre-dawn re-entry survey. In addition, it should be noted that two surveys carried out within the same 24 hour period only constitutes one survey (i.e. a dusk emergence immediately followed by a pre-dawn re-entry only represents a single survey visit). Wherever possible, visits should be undertaken a minimum of two weeks apart.

[53] Where access constraints and exceptional weather are a factor, consultants undertaking survey should consider the merits of conducting surveys into September/October with repeat visits during 2017. In many cases, the minimum requirement in relation to emergence survey will be achieved through a combination of visits from both 2016 and 2017.

16.5.29 Once the minimum standard is completed consultants undertaking survey work should consider the requirement for additional visits on a case by case basis.

16.5.30 Surveyors will use frequency division or time expansion echolocation detectors.

16.5.31 Detectors will be either recording detectors or be connected to a digital recording devices (such as the Edirol R-09), allowing recordings to be made as .WAV files or in a format that can be converted to .WAV format. This will enable calls to be analysed in suitable sound analysis software such as Bat Sound or Bat Scan.

16.5.32 Static monitoring devices (such as Titley Anabat SD2, Anabat Express or Wildlife Acoustics SM2BAT+ or improved variants may be utilised as a mobile recording device during emergence surveyors. However, in all cases surveyors should also be equipped with a stand-alone detector and headphones. Static monitoring devices should only be used to replace surveyors during emergence surveys at locations where there are health and safety issues.

16.5.33 Surveyors are to be positioned in sufficient numbers that all potential roost features can be seen by at least one surveyor. All surveyors will be briefed prior to the start of survey as to the findings of the preliminary assessment and shown the presence of any potential access/egress points. Surveyors will remain at their survey station throughout the emergence survey period (i.e. dusk emergence and pre-dawn re-entry surveys should not be combined with activity surveys and surveyors moving between multiple roost features during a survey represents insufficient coverage).

16.5.34 In some locations consultants undertaking survey may find it useful to conduct emergence survey of trees or buildings which contain suitable features and occur in close proximity as part of a single larger survey. This approach is acceptable assuming that the number of surveyors utilised remains sufficient to ensure that all potential roost features are visible by at least one surveyor at all times.

16.5.35 Evening emergence surveys are to be undertaken from 15 minutes before sunset until two hours after sunset; and pre-dawn re-entry surveys undertaken from two hours before sunrise until sunrise. Where bats are still active at sunrise the time should be extended by 15 minutes after sunrise. A record of weather conditions including air temperature, cloud cover and wind speed is to be made at the start and end of the survey period together with casual recordings made of any changes in weather conditions for the duration of the period, such as rain showers, and sunset and sunrise times. During the survey, a record of the number of bat passes of each species is to be made together with additional information such as direction of flight, emergence/re-entry point and activity recorded. Data is to be submitted in the approved proforma format with supporting maps and documentation.

16.5.36 Following survey work, all recordings are to be analysed by an experienced ecologist using call analysis software to confirm species (where possible) and number of passes made. All recordings are to be retained for future reference.

16.5.37 All emergence surveys should be conducted during suitable weather conditions as defined in Collins (2016).

Back tracking surveys

16.5.38 At locations where a group of trees meet the criteria for further survey, it may be appropriate to utilise back tracking survey as an alternative to emergence/pre-dawn re-entry surveys in order to locate roosts and gain a greater understanding of the bat assemblage supported by these features.

16.5.39 Collins (2016) explicitly acknowledges that establishing absence of bats in trees is very difficult and that, given the ecology of tree-roosting bats, all trees with bat rooting potential should be considered a resource that will be used at one time or another by tree-roosting bats.

16.5.40 To assist in meeting the requirements of both impact assessment and informing the need for licensing in relation to groups of trees and woodland blocks, the following method will be used.

16.5.41 Trees within the land required for the construction and operation of the scheme plus 100m buffer will be subject to scoping assessments to establish their potential roost feature (PRF) status as described in Section 1.62. Low potential trees as defined in Collins (2016) as those containing no PRF's or PRF's unlikely to support more than opportunistic use by small numbers of bats and these will be excluded from further survey.

16.5.42 Tree climbing surveys will be undertaken on moderate or high potential trees to establish if roosts are present and confirm if assessment is correct (e.g. aerial inspection may reveal PRF's are not suitable).

16.5.43 Where multiple moderate or high potential PRF's and/or roosts are confirmed, a perimeter will be established around the relevant blocks of trees (where only a small number of roosts or potential roost are identified standard emergence surveys would apply).

16.5.44 Back tracking surveys utilising a minimum two dusk/dawn or dawn/dusk surveys would be conducted along this perimeter with surveyors spaced at intervals no greater than 50m. Surveyors will backtrack any commuting routes to potential roost sources. Surveys to be undertaken May to September with at least one of the surveys occurring during May to August.

16.5.45 Back tracking surveys at dusk will start 15 minutes before sunset until it is too dark to observe bats or when the source roost(s) have been found. Dawn surveys will start two hours before sunrise and cease when either bats are no longer active or the source roost has been found.

16.5.46 Static detectors will be placed in woodland or blocks of trees for a minimum of five days (where suitable conditions exist - e.g. equipment can be secure). This information would inform back tracking surveys by identifying species, activity (e.g. social calls, feeding) and potential roost sites or commuting routes.

16.5.47 In large complex woodlands, this approach will identify significant roosts (e.g. maternity and satellites), but is unlikely to identify all trees used by bats in low numbers or on a transient basis.

16.5.48 In these circumstances the identified roosts, plus the overall woodland resource available as indicated by the distribution of PRF's within the woodland, would be used to identify the species present, the type of roosts present and the approximate size of the populations present. This data will inform both the impact assessment and the mitigation required to maintain the favourable conservation status of the species.

16.5.49 Where Annex II species are detected, or there is a requirement gather additional information (e.g. to differentiate Myotis species where a rarer species such as Alcathoe bat may be suspected), trapping or other advanced bat licence techniques may be considered under the existing FSMS protocol.

Bat activity surveys (walked transect)

16.5.50 Within each 10km section of the route, a minimum of 3km of bat activity transect should be undertaken. This does not need to be a continuous 3km, and can be divided into sections to target features of particular interest and potential impact within and outside the land required for the construction of the Proposed Scheme, based on review of desk study data, aerial mapping and Phase 1 habitat survey data (where available). Where the 10km section contains significant extents of bored tunnel the minimum effort may be reduced.

16.5.51 In areas of high quality habitat for bats or where significant effects are otherwise considered likely (e.g. as a consequence of severance, loss of foraging habitat or disturbance), the consultant undertaking the survey is to undertake additional transect routes (i.e. in addition to the minimum of 3km within every 10km section) to assess likely significant effects on bats.

16.5.52 The aim of the surveys is to give an indication of species and numbers of bats utilising habitat within and in the vicinity of the land required for the construction of the Proposed Scheme, and to give an indication of existing features within the landscape that may be important in bat foraging, navigation and orientation and may be adversely affected as a consequence of the construction and/or operation of the Proposed Scheme.

16.5.53 The transect routes should in general focus on features which may act as bat flight lines (such as hedgerows and watercourses) which may be severed or adversely affected as a consequence of construction and/or operation of the Proposed Scheme, and potential roost sites such as bridges, buildings and mature trees within the land required for the construction of the Proposed Scheme and a 100m buffer either side of it.

16.5.54 Features outside the land required + 100m buffer are only to be included where they are considered to be of value in identifying and assessing significant effects on bats (in particular as a consequence of severance).

16.5.55 Transect routes should be planned by an experienced bat ecologist utilising aerial photographs, Phase 1 habitat survey data and site photographs. Between 10 and 12 listening station stops (three minutes per stop) should be incorporated per transect route. Each transect route should take two to three hours to complete (Collins, 2016).

16.5.56 Prior to conducting the first survey visit at least one member of the survey team should have visited the transect route during daylight hours in order to ensure that

access constraints (e.g. fencing, hedges and other obstacles) have been considered and confirm that the locations of listening station stops are appropriate. If one of the survey team is already familiar with the site from previous visits for other surveys then no additional visit will be required. Once the transect route and listening station stops have been selected, transects will be walked at a steady speed by an experienced ecologist using a bat detector and recording device.

16.5.57 All surveys should be conducted during suitable weather conditions as defined in Collins (2016).

16.5.58 Surveyors will use frequency division or time expansion echolocation detectors. Detectors will be connected to a digital recording devices (such as the Edirol R-09), allowing recordings to be made as .WAV files or in a format that can be converted to .WAV format. This will enable calls to be analysed in either Bat Sound or Bat Scan software.

16.5.59 Monitoring devices (such as Titley Anabat SD2, Anabat Express or Wildlife Acoustics SM2BAT+ or improved variants) may be utilised as a mobile recording device during activity survey. However, in all cases at least one surveyor should also carry a hand held detector (and headphones) with frequency division or time expansion capability and linked recording device.

16.5.60 Transect surveys are to be undertaken from sunset until two hours after sunset or until the full transect length has been walked (whichever is later) and for at least two hours before sunrise until sunrise. A record of weather conditions including air temperature, cloud cover and wind speed is to be made at the start and end of the survey period together with casual recordings made of any changes in weather conditions for the duration of the period, such as rain showers, along with sunset and sunrise times. During the survey, a record of the number of bat passes of each species is to be made together with additional information such as direction of flight, any emergence/re-entry points and activity recorded.

16.5.61 Where access allows each activity transect should be repeated as a minimum once a month between April and October at least one of the surveys comprising dusk and dawn surveys within one 24-hour period (i.e. dusk activity followed immediately by pre-dawn survey equates to one visit). The start point and direction of transects should be varied between visits.

16.5.62 Where habitat quality is high, or there is considered to the potential for significant effects on bats then the requirement to undertake additional visits (i.e. above the 1 per month minimum requirement) should be considered.

16.5.63 During activity surveys, where bat roosting is confirmed through observation, additional emergence/re-entry surveys may be required and should be undertaken in line with the methodology outlined above.

16.5.64 If Annex II bat species are recorded or suspected, the scope of additional survey work should be agreed through the deviation request process.

16.5.65 Following survey work, all recordings are to be analysed by an experienced ecologist and confirmation of species and number of passes made. All recordings are to be retained for future reference.

Bat activity (car-based transect)

16.5.66 In those areas of significant land access refusals, driven transects on local roads should be utilised where appropriate to maximise available baseline data.

16.5.67 A methodology for car based transects is provided in Appendix C.

16.5.68 It should be noted that prior to conducting any car based transects consultants undertaking the survey must submit a risk assessment for the proposed survey. It will be the responsibility of the consultant undertaking the survey works to notify the local highways authority and any other necessary parties (including the Police as appropriate).

16.5.69 It should be noted that in busy urban areas the use of this methodology is considered unlikely to be acceptable on health and safety grounds.

Automatic detectors

16.5.70 Within each 10km of route requiring bat activity surveys, a minimum of two automated echolocation detectors are to be installed at suitable points (e.g. at hedgerow crossings) along the route alignment as determined by an ecologist experienced in their use, in order to provide additional data to assist in assessing the impact of habitat severance.

16.5.71 Consultants undertaking the surveys should also consider the requirement for additional echolocation detectors (i.e. in addition to the minimum of two per 10km route section) at suitable points to assist in determining the impact of habitat loss, severance or activity in the vicinity of known/suspected roosts.

16.5.72 Where only the minimum number of automated detectors are deployed they should be placed at least 2km apart unless the landscape pattern means that there is good reason to have closer spacing. Where additional detectors are utilised, these may be deployed as required in order to help in the assessment of likely significant effects on bats.

16.5.73 Detectors should be in place and recording for at least five consecutive nights per month between April and October. Detectors will need to be positioned in water-proof cases and checked on a monthly basis to collect data.

16.5.74 To give consistency across hardware, automated detectors should be as a minimum Titley Anabat SD2 or Wildlife Acoustics SM2BAT+ recording in zero crossing mode although full spectrum recorders (such as Elekon batlogger C's) will be preferred.

16.5.75 Analysis should be undertaken using the Analook software for zero crossing or full spectrum packages such as Bat Explorer or BatSound, and bat calls recorded tabulated against time and the location of the recording device.

Hibernation site surveys

16.5.76 If initial survey identifies buildings/structures with the potential to act as bat hibernation sites, these will need to be surveyed by an ecologist with a Natural England licence to disturb hibernating bats.

16.5.77 Two visits are required, one in mid-January and one in mid-February, although December visits are acceptable. At sites with a moderate or high likelihood of bats being present and particularly where bats could be concealed in crevices, consideration should be given to the use of automated detectors. These can be deployed for a minimum of two weeks in each month from December to February.

16.5.78 The site should be searched systematically from the entrance, with the locations of any bats seen marked on a plan of the site. Before entering sites, surveyors should familiarise themselves with White Nose Syndrome and procedures for decontamination and recording. Details are provided on the Bat Conservation Trust[54] website and should be checked for updates.

16.5.79 Careful inspection for droppings or oil staining around cracks and crevices, including rock piles, may also yield evidence of use by bats. Detailed records will be made of the location of any bats and/or signs of bats identified. In addition, accurate temperature (°C) and relatively humidity (%) readings should be taken during each visit. It is assumed that a full description of the potential hibernation site, including details of construction and potential perching points will have been made as part of the initial assessment.

Autumn swarming survey

16.5.80 If initial survey or desk study/consultation identifies potential autumn swarming sites, the following survey methodology should be applied in line with Collins (2016).

16.5.81 At least five nights of survey with an automated/static detector in each month between mid-August and end of October should be undertaken.

16.5.82 Automated/ static detectors surveys should be undertaken on relatively warm, calm and rain-free evenings.

Mist netting/harp trapping/radio-tracking

16.5.83 If more detailed survey work including mist netting, harp trapping or radio-tracking is required this will need to be agreed via the deviation request process. Use of such methods will only be accepted where there is no alternative suitable means of collecting these data. In these circumstances, an application for a project specific licence to undertake these surveys would need to be submitted to Natural England.

16.6 Survey programme and effort

16.6.1 Timing of survey work is detailed in the survey methodology section above, summarised in Table 11 below.

Table 11: Summary of bat survey programme and effort

Survey	Programme	Effort[55]
Building inspections.	Year round (optimum period between May and September).	Any buildings identified during the habitat surveys as likely to be suitable for occupation by bats and which may be affected by the Proposed Scheme (demolition,

[54] http://www.bats.org.uk/pages/about_bats-white-nose_syndrome-586.html

[55] Access constraints mean that the full survey effort will not be achieved at all sites selected for survey.

Survey	Programme	Effort[55]
		disturbance, modification) should be investigated in more detail for evidence of use by bats.
Assessment of trees for potential to support roosting bats.	Year round (assuming a precautionary approach is adopted during periods of dense leaf cover). Optimum period December to March.	Any tree of 0.25m DBH or above within the land required for the construction of the Proposed Scheme and a 100m buffer either side of the land required and any other significant trees will be investigated in more detail for evidence of use by bats.
Tree climber inspections.	Year round (optimum period between May and September).	Trees with moderate or above potential to support roosting bats.
Dusk emergence and dawn re-entry surveys.	May to September.	High roosting potential: three dusk emergence and or pre-dawn emergence between May to September, with at least two of the surveys between May and August. Moderate roosting potential two dusk emergence and/or pre-dawn surveys May to September, with at least one of the surveys between May and August.
Activity surveys.	June to August.	Where access allows each activity transect should be repeated as a minimum on three occasions between June and August with at least one of the three surveys comprising dusk and dawn surveys within one 24-hour period (i.e. dusk activity followed immediately by pre-dawn survey equates to one visit). The consultant undertaking surveys should consider the requirement for additional survey visits in areas of particularly suitable habitat.
Automated detector survey.	May-October.	Detectors should be in place and recording for at least five consecutive nights per month between May and October and checked on a monthly basis to collect data.
Autumn swarming.	August to October.	At least five nights of survey with an automated/static detector in each month between mid-August and end of October.
Hibernation survey.	January-February	Two visits are required, one in mid-January and one in mid-February. At moderate and high potential sites consideration should be given to the use of automated detectors deployed for a minimum of two weeks in each month from December to February.

16.7 References

Highways Agency (2001). Design Manual for Roads and Bridges – Volume 10- Section 4 Part 3 Nature conservation advice in relation to bats. Highways Agency, London.

Collins, J. (ed.) (2016). Bat Surveys for Professional Ecologists: Good Practice Guidelines 3rd Edition. Bat Conservation Trust, London.

Mitchell-Jones A, J. (2004). Bat Mitigation Guidelines (IN136). English Nature, Peterborough.

Mitchell-Jones, A. J., and McLeish, A. P. (2004). Bat Workers' Manual. Peterborough: Joint Nature Conservancy Council.

17 Otter

17.1 Introduction and guidelines

17.1.1 There is the potential for adverse effects on otter (*Lutra lutra*) particularly where watercourses pass through or in close proximity to the land required for the construction of the Proposed Scheme. Given the on-going expansion in the distribution of the otter, it is considered important to identify both locations which are currently utilised by otter and those which are suitable for use by otter in the future.

17.1.2 In addition, the survey will take into account the use of terrestrial habitat by otter including location of both actual and potential holts (i.e. underground resting sites) and of couches (i.e. above-ground resting sites), and linear routes that may be important for movement between watercourses.

17.1.3 The proposed survey methodology draws largely upon the guidance provided in the Design Manual for Roads and Bridges (DMRB) Volume 10 Section 4 Part 4 (Highways Agency, 1999[56].

17.2 Qualifications and experience

17.2.1 Habitat assessment and selection of sites for further survey is to be conducted by persons with awareness of the range of habitats utilised by otter, including knowledge of terrestrial features utilised during breeding.

17.2.2 All surveyors should have experience of the following:

- identification of otter field signs;
- differences between signs of otter and other species which can be confused with otter, including mink;
- otter behaviour and habitat requirements; and
- identifying potential impacts of seasonal conditions or weather conditions on the validity of survey results.

17.2.3 An otter specialist is to lead surveys wherever possible due to the complexity of finding and identifying holts and couches in particular when distant from watercourses.

17.3 Licensing requirements

17.3.1 No licence is required to conduct otter survey assuming that care is taken to avoid disturbance of potential couches and holt locations. No survey that would result in disturbance of otter, or their places of rest is proposed as part of the current survey. Where monitoring of holts is required, non-invasive techniques such as the use of appropriately placed infra-red cameras will be utilised.

[56] Highways Agency (1999), Design Manual for Roads and bridges – Volume 10, Section 4, Part 4. Nature Conservation Advise in relation to Otters. Highways Agency, London.

17.4 Screening for survey and defining the survey area

17.4.1 Initially a review of desk study data, OS mapping and aerial photography is to be undertaken to identify all watercourses and water bodies that fall within a 100m buffer of the land required for the construction of the Proposed Scheme and any others where there is considered to be the potential for the Proposed Scheme to result in significant adverse effects on otter. Where available, results of the Phase 1 habitat survey, River Corridor Survey, and ditch and pond surveys will inform this screening exercise.

17.4.2 It is expected that all watercourses which pass within a 100m buffer of the land required for the construction of the Proposed Scheme will require habitat assessment. Watercourses/water bodies would only be scoped out where significant barriers to movement occur between this feature and the land required for construction of the Proposed Scheme.

17.4.3 A walkover of each site selected for survey will be conducted by an experienced surveyor, and a decision taken on the need for subsequent detailed survey. This assessment should include consideration of each site against the following criteria:

- proximity to the land required for construction of the Proposed Scheme;
- presence of significant barriers to dispersal and movement through the territory;
- habitats present and suitability for use by otter (including terrestrial habitats);
- adjoining land use;
- level of disturbance;
- features of watercourse/water body (estimated depth, level of flow, width of channel);
- connectivity with other areas of suitable or sub-optimal habitat; and
- pollution.

17.5 Survey methods

Aquatic/riparian habitats

17.5.1 For watercourses selected for detailed survey, initially a 2km section either side of the boundary of the land required for the construction of the Proposed Scheme was surveyed. Where a confluence with a river was reached more than 1km from the boundary of the land required and there are no signs of otter activity in the vicinity of the confluence, the survey was terminated at this point.

17.5.2 Surveys conducted post-November should utilise a revised survey extent of a minimum of 300m either side of the boundary of the land required for the construction of the Proposed Scheme. The reduction in extent follows correspondence with Natural England. The reduced survey effort is appropriate given that a commitment has been made that the undertaker will ensure that the Proposed Scheme maintains safe

passage for otter at all watercourses potentially suitable (i.e. including those which are yet to be repopulated by otter).

17.5.3 Where possible both banks should be surveyed. Where necessary spot checks should be conducted at suitable publicly accessible areas within 5km of the land required for the construction of the Proposed Scheme (Highways Agency, 1999).

17.5.4 For water bodies, the survey should include all areas that fall within a 100m buffer from the land required for the construction of the Proposed Scheme and a minimum 300m section either side of this (Highways Agency, 1999).

17.5.5 For all sections of aquatic/riparian habitat subject to survey, all evidence of otter and other notable species such as water vole and mink should be recorded. This should as a minimum include the number and location of the following field signs:

- natal holts, holts and potential holt sites (using the criteria provided in Appendix D);
- couches;
- spraints;
- anal jelly;
- tracks/footprints;
- silt/sand heaps; and
- slides.

17.5.6 All field signs of otter, along with those of any other notable species (in particular mink and water vole) should be provided with GPS derived grid coordinates accurate to less than 5m. Where topography and vegetation structure may have reduced the accuracy of records below this level, this information should be noted.

17.5.7 When searching for potential holt sites the criteria devised by Chanin (2012)[57] provided in Appendix E should be utilised as the basis for identifying potential holt sites and determining whether or not they are in use.

17.5.8 Where the presence of otter is confirmed, and significant adverse effects are likely, there may be a requirement to extend the extent of survey into other adjacent watercourses (which may have been scoped out at an earlier stage), and for the use of additional survey methods including use of camera traps.

Terrestrial habitat

17.5.9 Where land required for the construction of the Proposed Scheme is located within 100m of a watercourse or water body that is confirmed as being utilised by otter, a review of aerial photography, and walkover survey (where required) should be conducted to check for the presence of any features within the land required that may be utilised as couches, resting places or natal holts.

[57] Chanin, P. (2012). Personal correspondence.

17.5.10 The following criteria devised by Chanin (2012) should be utilised to identify potential otter breeding sites:

- any single area of extensive concealing habitat (woodland, scrub, reedbed);
- which is greater than 1ha in area and within 100m of a watercourse; and
- any combination of extensive concealing habitats which are within 100m of one another, total at least 1ha and are within 100m of a watercourse.

17.5.11 For all potential breeding sites identified using these criteria a site visit should be conducted by an experienced otter surveyor to check for signs of breeding activity (e.g. well used paths, play areas, or large accumulations of spraint). During this visit their overall suitability should be scored on a scale of 0= unsuitable to 5 = highly suitable taking into consideration the criteria for assessing cover and suitability of food shown in Appendix D devised by Chanin (2012).

17.5.12 The location of any such feature identified should be recorded, along with details of the feature and associated habitat (e.g. large wood pile within area of semi-natural woodland).

17.5.13 In addition, the survey should look to identify and map any linear features that may be important in the movement of otters between adjacent watercourses.

17.6 Survey programme and effort

17.6.1 Where access restrictions allow, a total of four survey visits should be conducted at approximately three-monthly intervals. However, where no habitat suitable for the creation of holts or couches is present within the land required for the construction of the Proposed Scheme then survey may be curtailed once the presence of otter has been confirmed.

17.6.2 Survey should not be conducted during or following periods of heavy rainfall, as field signs will have been washed away. In general, where possible survey visits should be timed to avoid survey when water levels are high.

17.7 References

Chanin P (2003). Monitoring the Otter (*Lutra lutra*). Conserving Natura 2000 Rivers Monitoring Series No. 10, English Nature, Peterborough.

Chanin P (2005). Otter surveillance in SACs: testing the protocol. English Nature Research Reports - Number 664, English Nature, Peterborough.

Chanin P (2012) Personal correspondence.

Highways Agency (1999). Design Manual for Roads and Bridges – Volume 10 – Section 4 Part 4 – Nature Conservation Advice in Relation to Otters. Highways Agency, London.

CIEEM (2013). Competencies for Species Surveys: Eurasian otter CIEEM, Winchester. Available at at https://www.cieem.net/data/files/Resource_Library/Technical_Guidance_Series/CSS/CSS_-_EURASIAN_OTTER_April_2013.pdf

18 Water vole

18.1 Introduction and guidelines

18.1.1 Survey for water vole (*Arvicola amphibius*) will need to take account of all watercourses that pass through or in close proximity to the land required for the construction of the Proposed Scheme including canals, where populations are thought to be surviving better than on rivers.

18.1.2 The proposed approach will follow the Water Vole Mitigation Handbook[58] survey methodology, taking into account current Natural England advice [59, 60].

18.2 Qualifications and experience

18.2.1 All initial scoping and habitat assessment work should be conducted by persons with previous experience of the range of habitats utilised by water vole and of field signs indicating potential presence of water vole.

18.2.2 A detailed search of the survey area in question should be undertaken by an experienced water vole surveyor. This should be a surveyor who has undertaken sufficient similar surveys in the past to enable a suitable level of confidence in identifying the field signs of water vole.

18.3 Licensing requirements

18.3.1 No licence is required to survey for water vole. Care should be taken during survey not to disturb water vole if present.

18.4 Screening for survey and defining the survey area

18.4.1 Initially review of desk study data, aerial photography and habitat mapping was undertaken to identify and map all areas of habitat potentially suitable to support water vole that are located within the land required for the construction of the Proposed Scheme, or within a 500m buffer of the boundary of the land required. This initial assessment included identification of all watercourses, ponds and lakes within this extent, and any other suitable riparian habitat (e.g. reedbed).

18.4.2 Where the above desk based exercise or the results of other surveys (e.g. Phase 1 habitat survey) identify the potential for, or signs indicating the presence of water vole, a specific walkover survey will be conducted in order to appraise the potential suitability of the habitat present for water vole in more detail, and determine the scope of detailed survey. The habitat assessment should be based on consideration of the following factors:

- bank profile, channel profile and characteristics, and water levels;
- availability of food sources;

[58] Dean M, Strachan R, Gow D and Andrews R (2016). The Water Vole Mitigation Handbook (The Mammal Society Mitigation Guidance Series). The Mammal Society, London.
[59] Natural England (2008). Water voles – the law in practice. Guidance for planners and developers (NE 86). Natural England, Peterborough.
[60] Natural England (2011). Natural England Technical Information. Note TIN042: Water voles and development: licencing policy. Natural England, Peterborough.

- vegetation structure (in particular the extent of suitable marginal vegetation);
- level of shading;
- disturbance levels;
- bordering land use; and
- connectivity with other areas of suitable or sub-optimal habitat.

18.4.3 Based on the above factors and any others which the surveyor considers to be important in the local context, habitat areas requiring detailed survey are to be determined, as well as areas that can be discounted from further investigation.

18.5 Survey method

18.5.1 At each site selected, a detailed water vole survey should take place following the survey guidelines set out in the Water Vole Mitigation Handbook.

18.5.2 Survey extent has been reduced to the land required and a 300m extent upstream and downstream (where access allowed). The reduction in scope followed correspondence with Natural England and a commitment that the undertaker will ensure that all culverts of suitable watercourses will maintain safe passage.

18.5.3 Each survey area should be split into 50m-100m lengths with the start and end of each stretch marked on a map and the GPS coordinate recorded for the beginning and the end of the length. The lengths/areas surveyed are to be mapped and all signs of water vole plotted accurately on a plan with a GPS coordinate taken.

18.5.4 Wherever possible, the survey should be undertaken from within the watercourses, in order to allow for a close search for signs of water vole. Consultants undertaking survey should consider carrying out surveys from a boat in places where water is deep and the margins cannot be safely surveyed from the bank.

18.5.5 During each survey visit the banks of each watercourse/water body (up to a distance of 2m from the edge of the water) should be inspected for signs of use by water vole including the following:

- presence of latrines;
- presence of burrows (both active and inactive);
- presence of runs;
- presence of footprints;
- presence of feeding remains;
- individual droppings; and
- sightings and/or sounds (characteristic sound entering the water) of individuals.

18.5.6 As well as marking all signs on a map, a note should be made of the number of each type of sign recorded so that abundance can be estimated.

18.5.7 The above information will be recorded alongside similar information indicating use by other species (e.g. bank vole, field vole, mink, otter, brown rat, etc.). The location of all positive evidence of the presence of both water vole and any other species identified during the survey (e.g. bank vole, mink, brown rat, etc.) should be recorded by GPS (to an accuracy of <5m where terrain/vegetation allows).

18.5.8 For each watercourse/water body subject to survey the following additional information should be collected during the first survey visit:

- habitat types present;
- predominant bank substrate;
- adjoining land use;
- vegetation types present and indication of abundance of each using DAFOR scale;
- disturbance at the site;
- bank profile;
- depth;
- width;
- rate of flow;
- signs of recent habitat damage; and
- sketch map of the site.

18.5.9 During each subsequent visit this information should be reviewed and any significant changes since the last survey visit recorded.

18.5.10 Where there is any uncertainty over water vole droppings found that cannot be definitively identified in the field, a small sample (considered to represent droppings from a single species) should be collected and sealed in a plastic bag marked with the following details:

- date sample collected (day/month/year);
- survey location;
- GPS coordinates;
- suspected species; and
- surveyor name.

18.5.11 The sample should be stored in a cool, dry place until the completion of the survey in that area. DNA analysis will subsequently be conducted if considered appropriate, that is, on those dropping samples where the survey has found no other definitive evidence of the presence of water vole within the respective survey area in order to help determine presence/absence.

18.5.12 Once field sign data have been obtained, the population size of the voles in that stretch of watercourse should be calculated. This should be based on the standard recognised method for calculating the population size, namely Morris et al[61].

18.6 Survey programme and effort

18.6.1 Surveys should ideally be undertaken between mid-April and September with at least two survey visits to each water body/watercourse undertaken, in one season. Where access consents allow, a survey should be undertaken in the early season (mid-April to June) and another in late season (July to September). Where constraints prevent this timing, attempts should be made to ensure that visits are conducted at least two months apart.

18.6.2 At sites where no visits were achieved during the period mid-April to September, late visits can be undertaken in October, though an additional spring visit should be undertaken in these situations.

18.6.3 Two survey visits should be conducted during the period mid-April to mid-June 2017 (at least one month apart) if no survey visits are achieved during 2016 during the optimum survey period.

18.6.4 Survey should not be conducted during or following periods of heavy rainfall, as field signs will have been washed away. In general, where possible survey visits should be timed to avoid survey when water levels are high, or when management works have recently taken place.

18.7 References

Morris, P., Morris, M., MacPhearson, D., Jeffries, D., Strachan, R. and Woodroff, G. (1998) Estimating numbers of the water vole *Arvicola terrestris*: a correction to the published method. Journal of Zoology. 246, 61-62.

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Natural England (2011). Natural England Technical Information Note TIN042; Water voles and development: licensing policy. Natural England, Peterborough.

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CIEEM (2013). Competencies for Species Surveys: Water Vole CIEEM, Winchester. Available at https://www.cieem.net/data/files/Resource_Library/Technical_Guidance_Series/CSS/CSS_-_WATER_VOLE_April_2013.pdf

[61] Morris, P., Morris, M., MacPhearson, D., Jefferies, D., Strachan, R., and Woodroff, G. (1998), Estimating numbers of water voles Arvicola terrestris: a correction to the published method. Journal of Zoology, 246, 61-62.

Standing Advice from Natural England and Department for Environment, Food and Rural Affairs (28 March 2015) - Water voles: surveys and mitigation for development projects. https://www.gov.uk/guidance/water-voles-protection-surveys-and-licences.

19 Badger

19.1 Introduction and guidelines

19.1.1 Potential impacts on badgers are likely to be loss of setts within the land required for the construction of the Proposed Scheme, potential for disturbance of setts in close proximity to the land required, and severance/fragmentation of territories.

19.1.2 Survey for badgers will need to identify both sett locations and, where there is the potential for significant severance/fragmentation of territories, an understanding of territory use through detailed survey, including use of bait marking studies if necessary.

19.1.3 Sett surveys are to be conducted in line with guidance provided in Harris et al (1989)[62].

19.2 Qualifications and experience

19.2.1 All personnel involved in scoping and defining the survey area should be experienced in assessing habitat potential for badgers, and the potential impacts of severance/fragmentation of territories.

19.2.2 All personnel conducting detailed badger survey should be competent and experienced in the identification of the full range of badger field signs including setts, latrines, hairs, badger paths and foraging signs including 'snuffle' holes. In addition, they should be competent in identifying field signs of other species, such as foxes, rabbits, otters, dogs and cats.

19.2.3 All personnel conducting badger survey should be familiar with the definitions of sett type detailed by Harris et al (1989), and the classification of setts utilising this methodology in the field.

19.2.4 All bait marking surveys should be coordinated by ecologists with experience of utilising this technique.

19.3 Licensing requirements

19.3.1 Proposed survey methodologies will not involve either the destruction or disturbance of setts, so that no licence is required. If it is necessary to monitor activity at setts, camera traps at sett entrances should be used. Application for a licence to interfere with a badger sett (under the Protection of Badgers Act, 1992)[63] would only be required if there is a need for the use of more intrusive methods such as internal camera investigations of setts.

19.4 Screening for survey and defining the survey area

19.4.1 Utilising results from the Phase 1 habitat survey, desk study records and analysis of aerial photographs, consultants undertaking survey work will identify areas within the land required for the construction of the Proposed Scheme, or within a 100m surrounding buffer that are likely to be used by badgers and where there is the

[62] Harris, S., Cresswell, P., and Jefferies, D. (1989). Surveying Badgers. Occasional publication of the Mammals Society.
[63] Protection of Badgers Act (1992) Chapter 51. Her Majesty's Stationery Office.

potential for significant effects to occur. This assessment should take into account the following criteria:

- suitability of habitat and topography for creation of setts;
- availability of other habitat suitable for badger within close proximity to the land required for the construction of the Proposed Scheme;
- connectivity with other areas of suitable habitat; and
- potential for severance/fragmentation of territories.

19.4.2 Areas selected based on the above criteria will be subject to a detailed survey for field signs.

19.4.3 Where main or annex setts are identified within the initial survey area, there is likely to be a need to conduct further survey to establish the likely extent of territories. Such decisions on an acceptable extent of further survey should be determined by an experienced badger surveyor.

19.5 Survey methods

Detailed survey for field signs

19.5.1 For all areas subject to survey, a systematic walkover will be conducted of all suitable habitats to obtain records of the following:

- setts;
- hairs;
- badger paths/runs;
- mammal paths (possible badger);
- foraging signs;
- latrines;
- footprints;
- bedding material; and
- evidence of rabbit and fox.

19.5.2 For all setts identified during the walkover survey, entrances and the orientation of entrance holes should be mapped. The sett should be classified against the criteria laid out in Harris et al (1989) as either a 'main', 'annexe', 'subsidiary' or 'outlying' sett. The level of use for each entrance should be classified as either 'active', 'partially active' or 'disused'.

19.5.3 During the walkover surveyors should also record the location and current use of any large entrances not currently utilised by badger, in order that these entrances can be monitored for future use during the period up to construction.

19.5.4 All field signs of badger, along with those of any other notable species are to be recorded with GPS-derived grid coordinates accurate to less than 5m. Where topography and vegetation structure may have reduced the accuracy of records below this level this information should be noted.

Territory analysis

19.5.5 Following completion of the detailed survey for field signs, results should be reviewed to identify those locations where further survey will be required in order to determine the extent of territories and thus the significance of any effects of the Proposed Scheme on the badger population.

19.5.6 The requirement for detailed survey for field signs over an extended area (i.e. beyond a 100m buffer from the land required from the construction of the Proposed Scheme) should be considered at all locations where detailed survey for field signs identifies a main or annex sett within the land required for the construction of the Proposed Scheme or within a 100m buffer of the land required.

19.5.7 The aim of such further surveys would be to better understand those territories that may be subject to significant effects as a consequence of the construction or operation of the Proposed Scheme, either through loss or disturbance of setts, loss of foraging habitat, or severance of commuting routes. It is envisaged that in the first instance this would involve extending the survey extent in the vicinity of identified main setts to determine likely territory boundaries, principally through the identification and mapping of boundary latrines. The extent of survey appropriate at each location is likely to vary and should be determined and justified by an experienced badger surveyor.

Bait marking

19.5.8 It is likely that in some locations following survey of an extended area for field signs, it will be necessary to conduct bait marking exercises to aid in the identification of territory boundaries. Active main setts and annexes within the survey area that could be significantly affected should be selected for bait-marking studies, with each main sett being designated with a uniquely coloured plastic marker; other setts are to be included as required. On the first two days of feeding, bait should be deposited down any active holes; after this period, bait should be distributed up to a distance of 15 – 20m from active holes.

19.5.9 Once the survey is completed, the location of each latrine and the origin of the coloured return are to be charted on a map.

19.6 Survey programme and effort

Survey for field signs

19.6.1 Detailed survey for field signs is to be conducted during early spring or autumn/winter, where possible.

Bait marking

19.6.2 Bait-marking should generally be conducted during late February, March and April when territorial activity is typically at its peak.

19.6.3 Active sett entrances to be baited should be visited daily preferably in the late afternoon. Approximately 25 – 30 bait points should be applied for each main sett.

19.6.4 Bait should be laid daily for approximately two weeks. Approximately one week after commencements of baiting, daily checks should commence to identify any latrines containing bait. Latrine checks should continue for approximately seven days after the cessation of baiting. Marked droppings may contain low numbers of beads therefore, each latrine/dropping should be inspected thoroughly using a pallet knife or trowel.

19.7 References

Harris, S., Cresswell, P., and Jefferies, D. (1989). Surveying Badgers. Mammal Society.

CIEEM (2013) Competencies for Species Surveys: Badger CIEEM, Winchester. Available at https://www.cieem.net/data/files/Resource_Library/Technical_Guidance_Series/CSS/CSS_-_BADGER_April_2013.pdf

Protection of Badgers Act (1992) Chapter 51. Her Majesty's Stationery Office.

20 Polecat

20.1 Introduction and guidelines

20.1.1 Polecats are protected (in part) in the UK under the Wildlife and Countryside Act, 1981, and classified as a Priority Species in the UK Biodiversity Action Plan[64], as well as a Species of Principal Importance under the NERC Act[65].

20.1.2 With reference to the Proposed Scheme, records of polecats are relatively widely distributed in Staffordshire and widely distributed in Cheshire.

20.1.3 The following sets out the methods to be used in attempting to record occurrences of polecat along the route of the Proposed Scheme.

- qualifications and experience
- surveyors must have the skills and experience enabling them to:
- assess habitat potential for polecats; and
- identify polecats, especially the distinguishing features between polecats and polecat-ferrets.

20.2 Licensing requirements

20.2.1 A licence is not required for surveys involving the recording of field signs (including the use of camera traps). A licence is required if polecats are to be trapped or taken. The methods outlined below are all non-licensable.

Screening for survey and defining the survey area

20.2.2 Polecats are habitat generalists that set up home in lowland woodlands, marshes, along riverbanks or even in farm buildings or dry stone walls. In England, networks of farmland with hedgerows and small woods are preferred. Polecats are commonly associated with rabbit burrows/warrens and are often attracted to road kill/carrion (hence the high levels of road casualties in polecats).

Survey methods

20.2.3 Road casualties and live sightings are by far the most effective means of detecting the species (in the 2014/15 national survey (co-ordinated by the Vincent Wildlife Trust), 50% of records received were road casualties, 36% were live sightings). Most live sightings are of polecat crossing roads or of polecats in gardens (where denning in outbuildings, beneath sheds, decking etc). With this in mind, the following survey protocol should be followed:

20.2.4 Every effort should be made by surveyors to look for and record the species when in areas of suitable habitat, as part of other ecological surveys carried out. Furthermore, surveyors should actively look for signs of the presence of the species, focusing on

[64] JNCC (1994), *UK Biodiversity Action Plan.*
[65] *Natural Environment and Rural Communities Act* (2006), (Chapter 26). HMSO.

potential den sites and field signs in association with these sites, such as footprints and scats. Polecats typically den in rabbit burrows, log piles, hay stacks and farm buildings and there are often piles of scats adjacent to den sites as well as tracks and prints.

20.2.5 In order to align with recent survey protocols for the species, surveyors must provide a six-figure grid reference location for each sighting (live or dead), along with photographs where applicable (especially for road casualties). Photographs must also be taken of any other potential field signs that may aid identification, such as prints and scats, and scats should be collected for subsequent DNA analysis, with clear labelling of location and date of collection.

20.2.6 Where supported by a sighting/visual evidence, animals should be classified into a phenotype category on the basis of pelage characteristics (true polecat, polecat-ferret or ferret (encompassing feral and domestic ferrets)).

20.2.7 Camera traps should also be considered by exception in the following scenarios, but only where it is considered likely that cameras may realistically assist in detection (such as along linear features likely to be regularly followed by animals):

- where recent confirmed sightings have occurred (e.g. reported presence by landowners);
- where evidence is found that is considered to be strongly indicative of presence (e.g. piles of scat outside of rabbit burrows, footprints suggestive of the species); or

20.2.8 If cameras are deployed, they must be left in situ for a period of several nights, on two or more occasions within the appropriate season (see survey programme and effort). To further increase the likelihood of success, consideration should be given to leaving bait in the field of view of the camera, such as eggs or peanut butter.

20.2.9 Consideration will be given to live-trapping at certain sites, but only where absolutely necessary to verify unconfirmed records. Further guidance will be added (here or separately) if this methodology is to be implemented at any site.

Survey programme and effort

20.2.10 Information on casualties and live sightings can be provided at any time of the year, as part of recording for other target habitats and species.

20.2.11 Camera traps, where deployed, are most likely to achieve results in the late summer period, when the young have dispersed and the number of active individuals is at its peak. It is therefore recommended that, in 2016, traps be set between the months of July and September, though May, June and October could be considered sub-optimal alternatives, where access between July and September may not be possible.

References

http://www.wildlifetrusts.org/species/polecat

http://www.mammal.org.uk/sites/default/files/factsheets/polecat_complete.pdf

http://www.vwt.org.uk/wp-content/uploads/2016/04/Polecat-Report-2016.pdf.

https://www.cieem.net/data/files/Resource_Library/Technical_Guidance_Series/CSS/CSS_-_POLECAT_April_2013.pdf

Cresswell, W.J., Birks, J.D.S., Dean, M., Pacheco, M, Trewhala, W.J., Wells, D & Wray, S. (2012). UK BAP Mammals - Interim Guidance for Survey Methodologies, Impact Assessment and Mitigation. The Mammal Society.

JNCC (1994), UK Biodiversity Action Plan.

Natural Environment and Rural Communities Act (2006), (Chapter 26). HMSO

21 Invertebrates

21.1 Introduction and guidelines

21.1.1 The invertebrate surveys to be conducted are aimed at identifying significant effects on invertebrates as a result of the construction or operation of the Proposed Scheme. Therefore, survey design and analysis should be directed towards the aim of providing sufficient information to allow an assessment of significant effects on invertebrate species and assemblages to be made. Most of the methods described are derived from 'Surveying terrestrial and freshwater invertebrates for conservation evaluation' (Natural England, NERR005 2007)[66], but focussed upon the need to support an ES.

21.1.2 Many invertebrate taxa are poorly understood in terms of their ecology and distribution. Although records of the presence of such species are a valuable addition to distributional knowledge, it is often not possible to accurately assess the value of a species record in a taxon which does not have a good database of distributional information. Even the first record of a species in a poorly known group does not necessarily confer significance to the site from which it was recorded without suitable contextual information. To avoid unnecessary and/or unhelpful records, the best solution is to use the recommended taxa for each habitat in the NERR005 document.

21.2 Qualifications and experience

21.2.1 Field surveyors should ideally be experienced entomologists but where sample collection is made for later identification, the surveyors are to be trained and/or have extensive experience in the techniques which are to be employed, including the collection, preservation and labelling of specimens. Identification should only be undertaken by experienced taxonomists. There is currently no formal competency framework and so fulfilment of at least one of the following is required:

- member/Fellow of the Royal Entomological Society;
- employed as an entomologist by a museum/local authority/conservation organisation;
- working as a professional consultant entomologist with track record in the groups under consideration; or
- having a substantial record of publications in the groups to be worked.

21.3 Licensing requirements

21.3.1 All surveys should follow the guidelines provided by the Joint Committee for Conservation of British Insects (2002)[67].

21.3.2 The following legal constraints are based on Natural England research report NERR005 (2007) and should be considered when conducting surveys:

[66] Natural England Research Report NERR005 (2007), Surveying terrestrial and freshwater invertebrates for conservation evaluation.
[67] Joint Committee for Conservation of British Insects (2002). A Code of Conduct for Collecting Insects and other Invertebrates. British Journal of Entomology and Natural History. 15 (1), 1-6.

- legally protected invertebrates (see the JNCC website): a license issued by the relevant statutory conservation agency is needed to collect species fully protected under the Wildlife and Countryside Act. This will also cover invertebrates listed in Annex IV of the Habitats and Species Directive and for which a license is required under European regulations;
- legally protected vertebrates: it is an offence to collect or disturb protected species even as an incidental part of a lawful operation. A licence is needed if there is risk of capturing protected species (such as great crested newt) in pitfall and other passive open traps. A wire mesh placed over pitfall and water traps will reduce or prevent this risk, but may also reduce the catch of larger invertebrates;
- bye-laws and rules: capturing animals is prohibited by bye-laws and the rules of several organisations, including the Forestry Commission, Forest Enterprise, the National Trust, the Environment Agency, county wildlife trusts and local authorities (for Nature Reserves). Permission is required for surveys on sites covered by such bye-laws and rules;
- National Nature Reserves and Sites of Special Scientific Interest: collecting on these sites is classed in England as an 'operation likely to damage'. Permission to collect must be obtained from the local office of the statutory conservation agency. Permission is unlikely to be refused for a 'bona fide' survey; and
- criminal damage: under the Wildlife and Countryside Act, it is an offence to uproot a wild plant without the landowner's permission. If surveys require digging up plants, splitting branches etc. it is advisable to inform the landowner in advance.

21.4 Screening for survey and defining the survey area

21.4.1 The requirement for invertebrate surveys will be based on the results of the desk study, habitats identified by the Phase 1 habitat survey and their location, and are likely to be focused at survey within the land required for the construction of the Proposed Scheme and a 100m buffer either side of this.

21.4.2 A survey should be considered if the desk study provides records of protected species, species of principal importance, UK Biodiversity Action Plan species, Red Data Book species, or nationally scarce invertebrates within 2km of the route and the habitats present within the land required for the construction of the Proposed Scheme and surrounding 100m buffer either side of it are capable of:

- providing suitable breeding areas; or
- hold a significant resource for maintenance of at least one part of their life cycle (e.g. foraging habitat, overwintering habitat for eggs/larvae etc.).

21.4.3 Additionally, if the Phase 1 habitat survey identifies potentially significant habitats for invertebrates (e.g. marshy grassland, species-rich grassland, diverse woodland/scrub), then these habitats should be subject to a specific habitat assessment for invertebrate

interest and the findings of this assessment used to determine whether specific sampling surveys are required.

21.4.4 Surveys of invertebrates of aquatic habitats (watercourses and standing water bodies) will be targeted to areas with records of significant species (as defined above for terrestrial surveys) occurring anywhere in the watercourse/catchment and having similar habitat requirements as those present within the land required for the construction of the Proposed Scheme or the 100m buffer surrounding it. In respect of watercourses, additional data from the Environment Agency should be sought. In cases where an assemblage of aquatic macro-invertebrates of high ecological value (as evidenced by an above average BMWP score occurring on a regular basis within a timescale of the last 5-10 years) occurs within the same catchment/tributary as the study site, then aquatic invertebrate surveys should be undertaken.

21.4.5 It is recognised that survey areas for invertebrates will vary greatly, dependent upon the habitats considered to be of importance, and the species under consideration, for example a small area of river shingle for certain beetle species or a series of marshy grasslands for marsh fritillary metapopulation assessments. Decisions on survey area should be made by the entomologists conducting the survey, but the key focus of any survey work should be within the land required for the construction of the Proposed Scheme and a 100m buffer either side of it. Outside this zone, consultants undertaking survey works should submit a deviation request where they feel there is the requirement for additional survey to identify potential significant effects.

21.5 Survey methods

21.5.1 Species information from each site should be in a format suitable for input to ISIS. This is a computer application developed by Natural England. ISIS interprets species lists by recognising assemblage types within a list and scoring each type according to its conservation value. It provides a standardised, and accepted, method of evaluation across the scheme. Further details on these data requirements are presented in Natural England (2007).

Terrestrial habitat survey

21.5.2 Where it is assessed, that detailed surveys are required, then the appropriate methods relevant to the taxa and habitats under consideration are to be adopted. These methods could include but are not necessarily limited to:

- sweep netting - standardised through timed netting in appropriate habitats, if required;
- hand searches of specific host plants (for leaf mines, galls) of particular species;
- egg searches (e.g. black hairstreak);
- conspicuous aggregations (e.g. marsh fritillary 'webs');
- pitfall trapping;
- white tray trapping;
- suction sampling; and

- light trapping.

21.5.3 Methods selected are to be as species specific and/or focussed as possible on habitats of actual or potential importance. Natural England (2007) provides details of standard methodologies, and the selection of appropriate methods in terms of habitats and taxa. The methods adopted should follow this guidance wherever possible. Methods such as light trapping, which attract specimens from a large distance, should be used with caution.

21.5.4 In addition, general butterfly surveys will be required in identified suitable habitats and include brownfield sites in urban areas where species such as grizzled and/or dingy skipper are known or suspected.

21.5.5 Generally, the surveys for butterflies are to be based upon the establishment of transect walks that are surveyed a minimum of three times (May, June, July) recording species at an appropriate time (10.00-16.00) and during suitable weather conditions (temperatures not below 13°C and 13-17°C only if at least 60% sunshine; clear or light cloud; still or light wind (less than Beaufort Scale 5); no rain).

Aquatic invertebrates

21.5.6 Rivers and streams are to be sampled according to the published methodology applicable to the size of the watercourse (e.g. 3-minute kick sampling, surber sampling) and specimens identified to species level or the lowest possible taxonomic unit and counted. Measurements of the environmental variables required for input into RIVPACS are also to be taken and then the data set(s) analysed using the RIVPACS program, if this is considered necessary to predict likely significant effects.

21.5.7 Surveys of ditches selected (see Section 9) are to follow the published methodology in 'A Manual for the Survey and Evaluation of the Aquatic Plant and Invertebrate Assemblages of Grazing Marsh Ditch Systems' Version 6 May 2013 Buglife – The Invertebrate Conservation Trust[68].

21.5.8 It is acknowledged that the above methodologies were devised for use in a programme of survey and evaluation work relating to the ditches associated with grazing marshes. However, the general survey strategy is considered to remain valid and the evaluation procedures outlined within the manual will be modified so that they are appropriate. A modified version of the evaluation criteria appropriate to the ditch types surveyed are to be utilised.

21.5.9 Surveys of ponds (see Section 10 for selection process) are to follow one of the methods approved by the Freshwater Habitats Trust as part of the National Pond Monitoring Network[69]:

- the rapid assessment for ponds requires invertebrate sampling only and is a rapid assessment of 'naturalness' using invertebrate diversity and families similar to the Biological Monitoring Working Party system for running water;

[68] Palmer, M., Drake, M., Stewart, N. (2013). A manual for the survey and evaluation of the aquatic plant and invertebrate assemblages of grazing marsh ditch systems. Version 6. Buglife.
[69] National Pond Monitoring Network (2013). Pond conservation. Available at http://freshwaterhabitats.org.uk/habitats/surveys/npmn/

- the Predictive SYstem for Multimetrics (PSYM) method includes collection of physical data, invertebrate sampling and plant recording. These data are used to undertake an analysis to compare the pond against a national database held by the Freshwater Habitats Trust (formally the Pond Conservation Trust). The data are submitted to the Freshwater Habitats Trust for analysis; and
- The National Pond Survey method provides a more detailed assessment of a pond and includes environmental and chemical data from the pond in addition to plant and invertebrate survey and ideally requires sampling of the invertebrate fauna over three seasons.

21.5.10 The method used will depend on the location of the pond (e.g. within the land required for the construction of the Proposed Scheme, or outside of it) and the potential impact upon it.

21.6 Survey programme and effort

21.6.1 The number and timing of visits will be dependent on the habitats to be surveyed, and the taxa under consideration. The guidance and advice presented in the Natural England research report NERR005 (2007) should be used on a case by case basis. Typically, where surveys are required, three sample sessions spaced out between May and September are likely to be appropriate for terrestrial habitats; two visits (spring and autumn) for aquatic habitats.

21.7 References

Joint Committee for Conservation of British Insects (2002). A Code of Conduct for Collecting Insects and Other Invertebrates. British Journal of Entomology and Natural History 15(1), 1-6.

Natural England Research Report NERR005 (2007). Surveying terrestrial and freshwater invertebrates for conservation evaluation.

Freshwater Habitats Trust (2013). http://freshwaterhabitats.org.uk/habitats/surveys/

Palmer, M., Drake, M., Stewart, N. (2013). A manual for the survey and evaluation of the aquatic plant and invertebrate assemblages of grazing marsh ditch systems. Version 6. Buglife.

22 White-clawed crayfish

22.1 Introduction and guidelines

22.1.1 Where white-clawed crayfish may be present and significant effects could occur, then survey is likely to be required. The scope of survey required is defined in Peay (2004)[70] and is set out below.

22.2 Qualifications and experience

22.2.1 The competency standards for white-clawed crayfish have been issued by the Chartered Institute for Ecology and Environmental Management[71] and at least one surveyor should meet or exceed those minimum standards and have held and used a survey licence for white-clawed crayfish survey for at least one year. The licence holder will ensure that any assistants have had sufficient training in biosecurity, crayfish habitat appraisal and survey practice to carry out work properly and that they are supervised as appropriate.

22.3 Licensing requirements

22.3.1 The ecologist responsible for the crayfish surveys must hold a protected species survey licence from Natural England for surveys at locations with the potential for white-clawed crayfish. In addition, consent for trapping and manual searching will be required from the Environment Agency Fish Movement Team at Brampton.

22.4 Screening for survey and defining the survey area

22.4.1 The relevant scale for distribution data on white-clawed crayfish is the sub-catchment. Most data are held by the Environment Agency in the Area offices. Desk studies should search for records for white-clawed crayfish, signal crayfish and other non-native crayfish species. The best composite database was compiled for a Defra project and includes a classification of sub-catchments (Rogers and Watson, 2011)[72].

22.4.2 Surveys for white-clawed crayfish can be screened out when any of the following apply:

- best available information indicates there are no white-clawed crayfish remaining in the sub-catchment (although allowance should be made for the possibility of small relict populations in headwater streams if the species has been lost from the main river, if there have not been any recent surveys to check status);

[70] Peay, S. (2004), A cost-led evaluation of survey methods and monitoring for white-clawed crayfish – lesson from the UK. Bulletin Français de la Pêche et de la Pisciculture 372-373, 335-352. Available to download from the national crayfish website (hosted by Buglife, www.crayfish.org.uk and from free access journal BFPP, now Knowledge and Management of Aquatic Ecosystems).
[71] CIEEM (2013), Technical Guidance Series. Competencies for Species Survey: White-clawed Crayfish. CIWEEM, Winchester. April 2013.
[72] Rogers, D. and Watson, E. (2011). Distribution database for crayfish in England and Wales. In: Rees M, Nightingale J, Holdich (eds) Species survival: securing white-clawed crayfish in a changing environment. Proceedings of a conference held on 16 and 17th November 2010 in Bristol, UK. Available to download from the national crayfish website (hosted by Buglife, www.crayfish.org.uk)

- the watercourse within the land required for the construction of the Proposed Scheme and adjoining 100m buffer either side is dry during any period of the year;
- there are confirmed records of non-native crayfish within 1km of the land required for the construction of the Proposed Scheme as measured along a watercourse (note this can include records of non-native crayfish in angling ponds and fish farms where there is an inflow or outflow that offers a potential route for escape, i.e. from almost all sites with non-native crayfish) and other surveys indicate that there have been no white-clawed crayfish present within the past 5 years in the study area;
- there are records of non-native crayfish up to 5 km from the land required for construction of the Proposed Scheme, both upstream and downstream on the same watercourse and there are grounds to expect that there is a continuous population of non-native crayfish between them. Any tributary of a known invaded watercourse should be surveyed unless there are grounds to expect the tributary has been invaded as far as the land required for the construction of the Proposed Scheme and beyond it for a period of 5 years or more;
- water quality is poor (GQA D or less, or Water Framework Directive (WFD) equivalent) currently;
- water quality has been poor (GQA D or less, or WFD equivalent) within the past
- 10 years and there are no populations of white-clawed crayfish in connected tributaries within 2km;
- water chemistry is unsuitable due to mean pH6.5 or less and/or calcium less than $5mgl^{-1}$;
- extended Phase 1 habitat survey and/or River Corridor Survey shows that there is no potentially suitable habitat for white-clawed crayfish (e.g. channel is a highly modified open culvert with walls of mortared stone, intact brick or sheet piling, and a channel bed which also has no refuge potential for crayfish; note however that banks of unmortared stone revetment and damaged brick or concrete can be very favourable habitat, even if there is only small substrate such as sand or gravel);
- there has been an incident of crayfish plague within the past five years and there is no known or potential surviving relict population in the watercourse or connected tributaries within 2km; and/or
- specific surveys for crayfish have been carried out within the past three years in the watercourse at more than one site, at least one of which is within 2km of the land required for the construction of the Proposed Scheme, and no crayfish have been found.

22.4.3 The requirement to survey static water bodies such as farm ponds, quarries and other wholly enclosed still water sites should be considered, taking into account the location, permanence, water quality, the degree of isolation from other water bodies,

and desk study data for white-clawed and non-native crayfish species in the local area. Where such water bodies are considered potentially suitable to support white-clawed crayfish (including where sites may have been suitable to be utilised as an Ark site[73]) and full survey is considered to be required the consultant undertaking surveys should submit a deviation request. For all static water bodies scoped out a rationale for this decision should be recorded making reference to the criteria listed above.

22.4.4 Records of white-clawed crayfish within the past ten years are of potential value, but even populations surveyed within the past two years are not necessarily present. By contrast, all validated records of signal crayfish or other non-native crayfish should be assumed to be still present and more extensive than they were when last recorded.

22.4.5 Watercourses or other water bodies that lie within the land required for the construction of the Proposed Scheme and surrounding 100m buffer either side of it and have not been screened out (as described above) should be surveyed if there is potential for significant effects. Where habitat suitable for survey is limited within this zone, but there is potentially favourable habitat beyond, the survey area should be extended out, up to a 250m buffer from the land required for the construction of the Proposed Scheme. Depending upon predicted impacts, there may be a need to survey more than one site on the watercourse. Selection of reaches to survey should use the approach in Peay (2003)[74].

22.4.6 If there are difficulties in obtaining permission to survey some areas, the location of the survey site can be shifted upstream or downstream in a reach; provided at least part of the site is within 500m of the land required for the construction of the Proposed Scheme and there are no differences in water quality, the habitat is similar and there are no barriers that might affect the distribution of crayfish (e.g. a weir might have been enough to stop an outbreak of crayfish plague infecting the population upstream).

22.5 Survey methods

22.5.1 The survey method(s) used are to be the most appropriate for the type of habitat present (see Peay, 2004). The potential habitat for crayfish and the scope for using different survey methods should ideally be assessed in advance, e.g. as part of extended Phase 1 habitat survey.

22.5.2 Survey sites will be a minimum of 100m (where there is abundant manually searchable habitat of good quality); generally, up to 200m for most small watercourses; or up to a maximum of 400m where suitable areas for survey are localised or widely dispersed, e.g. in large watercourses.

22.5.3 A site-scale habitat appraisal for crayfish is to be carried out. This includes a description plus site photographs, but in addition, any water body surveyed within the land required for the construction of the Proposed Scheme should be mapped in the style of a River Corridor Survey with annotation of features relevant to crayfish habitat

[73] One approach to conserving the white-clawed crayfish is to establish isolated new refuge sites, known as 'Ark sites', where new populations can be established, safe from non-native crayfish and crayfish plague.

[74] Peay, S. (2003). Monitoring the White-Clawed Crayfish *Austropotamobius pallipes*. Conserving Natura 2000 Rivers. Monitoring Series No. 1. English Nature, Peterborough.

quality, e.g. pool under bridge with many cobble-sized stones and cracked mortar below water; alder trees with dense swags of submerged roots, sewage fungus downstream of pipe discharge along right bank, etc.

22.5.4 Particular attention is to be given to whether conditions will be suitable for manual survey, i.e. there must be ample loose, 'searchable' potential refuges in shallow water less than 0.5m deep in water that is clear, with little settled silt and with extensive lengths (greater than 100m) that can be safely accessed from the bank and waded. Where these conditions are not met, some searching of debris and undercut banks by kicking and netting is to be undertaken where possible. If netting is not feasible, or does not yield crayfish, then trapping is required. If crayfish are identified by manual survey or netting, or by other signs of crayfish, e.g. exuvia, claws etc., it is not necessary to carry out trapping as well.

22.5.5 All crayfish surveys are to be carried out in dry weather and normal to low flow. If there is any rainfall overnight during a trapping survey the survey is invalid if rain falls within four hours of sunset.

22.5.6 Biosecurity measures are to be implemented throughout, with disinfection (iodine based disinfectant) of all equipment between water bodies (see guidance at http://www.nonnativespecies.org/checkcleandry/biosecurity-for-anglers.cfm). Where more than one site is surveyed on a watercourse, surveys will be carried out at upstream sites first. If a downstream site is surveyed first, there will be disinfection between sites. As far as practicable, traps are to be placed where they are least likely to be seen or tampered with, to minimize the risk of losses or subsequent use for illegal trapping. Signal crayfish should not be released back to the wild.

22.5.7 Where there is a relatively abundant population of crayfish and plenty of stony habitat to search, a standardised manual survey of five habitat patches of ten good refuges gives a high probability of detecting crayfish. However, where populations are at low abundance and conditions are sub-optimal for manual search, the chances of detecting a crayfish with this level of effort are less. Furthermore, as the method described in Peay (2003) includes searching cobbles and pebbles under large cobble and boulder as one refuge, the actual number of stones searched in a standardised survey may be 2-3 times higher. Where status of crayfish is unknown, survey effort is to be double the minimum, preferably with more patches searched rather than just more refuges in one area.

22.5.8 Trapping surveys are to target the areas with the highest potential for crayfish, avoiding any areas with fast flow or anoxic silt. Traps need not be wholly immersed, but trap apertures must be entirely below water level throughout the trapping session. Traps should be sited to avoid overlap of trapping zone. Traps will be left for one night only and will be lifted the next morning. Trap mesh size should ideally be less than 22mm.

22.5.9 One or more digital photographs are to be taken to confirm the species of crayfish recorded. Photographs should be taken such that the diagnostic features are clearly visible. If there is any doubt about identification, reference specimens should be taken and preserved. This may be necessary with juvenile crayfish especially with the less common non-native species, such as *Orconectes virilis cf O. limosus*. Preservation uses

90% ethanol solution, preferably with 10% formalin to fix. Alcohol will need to be changed/topped up, especially if large specimens are preserved.

22.5.10 Where signal crayfish are recorded during a survey then that survey session at the location should be completed in full. However, assuming that no white–clawed crayfish are found then no repeat survey sessions should be conducted at that site. If there are other sites to be surveyed in the same watercourse, they should still be surveyed if records or other information suggests that it is likely white-clawed crayfish were present within the past five years. This is to help find any semi-isolated relict populations of white-clawed crayfish.

22.6 Survey programme and effort

22.6.1 All surveys should ideally be carried out in good conditions in the period July to September inclusive. Whilst intensive manual surveys on sites with high densities of crayfish may detect presence at most times of year, nil catches outside the main season of activity are invalid. All surveys conducted outside the July to September period should acknowledge that negative results are not suitable to confirm absence.

22.6.2 Manual surveys will use standardised manual survey, extended to double effort where conditions are suitable and crayfish are not detected in the first session. Where there is enough habitat to carry out a manual survey, but 'survey ability' is less than expected and there is potentially good habitat in the banks, a trapping session should be added.

22.6.3 At sites where trapping is carried out, a survey will use a minimum of 20 traps per site in favourable habitat. If crayfish are not detected, a second session should be carried out at least one week after first session (provided it is within the survey season).

22.6.4 Stages of work on site are as follows:

- walkover of the survey site for prior assessment of potential for crayfish habitat at site scale and safety check;
- carry out manual survey if suitable habitat is available and suitable for survey;
- complete five patch standardised survey, with supplement by netting if necessary;
- if crayfish are not found, extend the manual survey extent and coverage to double session;
- if crayfish are not found, or if conditions are not suitable for manual survey, set minimum 20 traps in best habitat;
- if crayfish not found, repeat trapping session after one week or more; and
- if crayfish are not found, conclude that they are likely to be absent.

22.7 References

CIEEM (2013), Technical Guidance Series. Competencies for Species Survey: White-clawed Crayfish. CIWEEM, Winchester. April 2013.

Rogers, D. and Watson, E. (2011). Distribution database for crayfish in England and Wales. In: Rees M, Nightingale J, Holdich (eds) Species survival: securing white-clawed crayfish in a changing environment. Proceedings of a conference held on 16 and 17th November 2010 in Bristol, UK. Available to download from the national crayfish website (hosted by Buglife, www.crayfish.org.uk).

Peay, S. (2003). Monitoring the White-clawed Crayfish *Austropotamobius pallipes*. Conserving Natura 2000 Rivers. Monitoring Series No. 1. English Nature, Peterborough.

Peay, S. (2004). A cost-led evaluation of survey methods and monitoring for white-clawed crayfish – lessons from the UK. Bulletin Français de la Pêche et de la Pisciculture 372-373, 335-352. Available to download from the national crayfish website (hosted by Buglife, www.crayfish.org.uk and from free access journal BFPP, now Knowledge and Management of Aquatic Ecosystems).

Buglife and Environment Agency: Crayfish Identification, Distribution and Legislation. Available at: https://www.buglife.org.uk/sites/default/files/Final%20Crayfish%20ID%20distribution%20and%20Legislation%2023%2006%2015_JG.pdf

23 Fish

23.1 Introduction and guidelines

23.1.1 The requirements for fish survey are to be assessed following a review of existing data, and where possible an initial habitat assessment. Following the review of existing data, the consultants responsible for survey work will agree with the local Environment Agency team the most appropriate scope and method of survey on a location by location basis for assessing the potential for significant impacts on fish.

23.2 Qualifications and experience

23.2.1 Surveyors are to be appropriately experienced in fish habitat assessment and survey.

23.3 Licensing requirements

23.3.1 No licences are required for the initial habitat assessment.

23.3.2 Relevant consents from the Environment Agency are to be obtained prior to commencement of any further fish surveys such as electrofishing.

23.4 Screening for survey and defining the survey area

23.4.1 Requirements for fish surveys are likely to be strongly influenced by the availability and quality of fisheries data from the Environment Agency. Where insufficient data exist to assess likely effects, surveys are more likely to be required for water bodies meeting one or more of the following criteria:

- water bodies designated under the EC Freshwater Fish Directive (2006/44/EC);
- water bodies designated as Special Areas of Conservation (SAC) or Site of Special Scientific Interest (SSSIs) for fish species or their water habitat; and/or
- water bodies likely to host protected fish species/fish species of conservation concern.

23.4.2 Water bodies affected by the route should be categorised for fish habitat quality and the potential for utilisation by fish. Surveys may be necessary for moderate and good habitats that could be directly or indirectly affected by the proposals where no existing recent data are held by the Environment Agency. Further surveys are unlikely to be required for poor habitats.

23.4.3 Typical descriptors for good, moderate and poor quality habitats are as follows:

- good: for running waters the habitats include varying flow types to include rifles pools, runs, and glides. Substrate diversity is more complex and there is good cover to provide refuge for juvenile and adult fish (both in-stream/body and marginal vegetation). Substrate is present for spawning salmonids. No evidence of pollution or other degradation. No obvious barriers to migration (where applicable to species concerned);
- moderate: for running waters the habitats include a number of flow types throughout the survey reach. Limited substrate diversity. Sparse cover for both

juvenile and adult fish. Lower in-stream/body and marginal vegetation diversity. Limited substrate present for spawning salmonids. No evidence of pollution; other degradation (e.g. poaching) may be present. Potential barriers to upstream migration present (where applicable to species concerned); and

- poor: habitats with minimal variation. Substrate diversity limited. No bankside/marginal cover for fish. In-stream and marginal vegetation (where present) typically limited to single dominating species. No substrate available for spawning salmonids. Water body may receive diffuse, land-based pollution (run-off) and exhibit a high degree of other degradation such as poaching. Barriers to upstream migration (debris/man-made dams) present (where applicable to species concerned).

23.4.4 The consultants undertaking survey work should recommend the survey area on a site by site basis depending on habitat quality, upstream and downstream characteristics and likely effects on fish. Where access and seasonal constraints dictate it may be necessary for fish habitat assessments to be undertaken in parallel with detailed survey work.

23.5 Survey method

23.5.1 As most affected water bodies requiring survey are likely to be small the primary method is likely to be electrofishing (utilising stop nets where necessary). This should be undertaken in accordance with British Standard BS EN 14011:2003, BS 6068-5.32:2003 'Water Quality: Sampling of fish with electricity'[75]and 'Guidelines for Electric Fishing Best Practice (Beaumont et al., 2002)[76] published by the Environment Agency. It is likely that a single pass of approximately 100m^2 will be sufficient.

23.5.2 If fish survey is necessary and conditions are not suitable for electrofishing then a seine-netting sweep is likely to be employed. Detailed survey methods used will dependent on the watercourse characteristics and will be agreed with the local Environment Agency team.

23.6 Survey programme and effort

23.6.1 Survey programme and effort are to be confirmed following discussion with local Environment Agency teams.

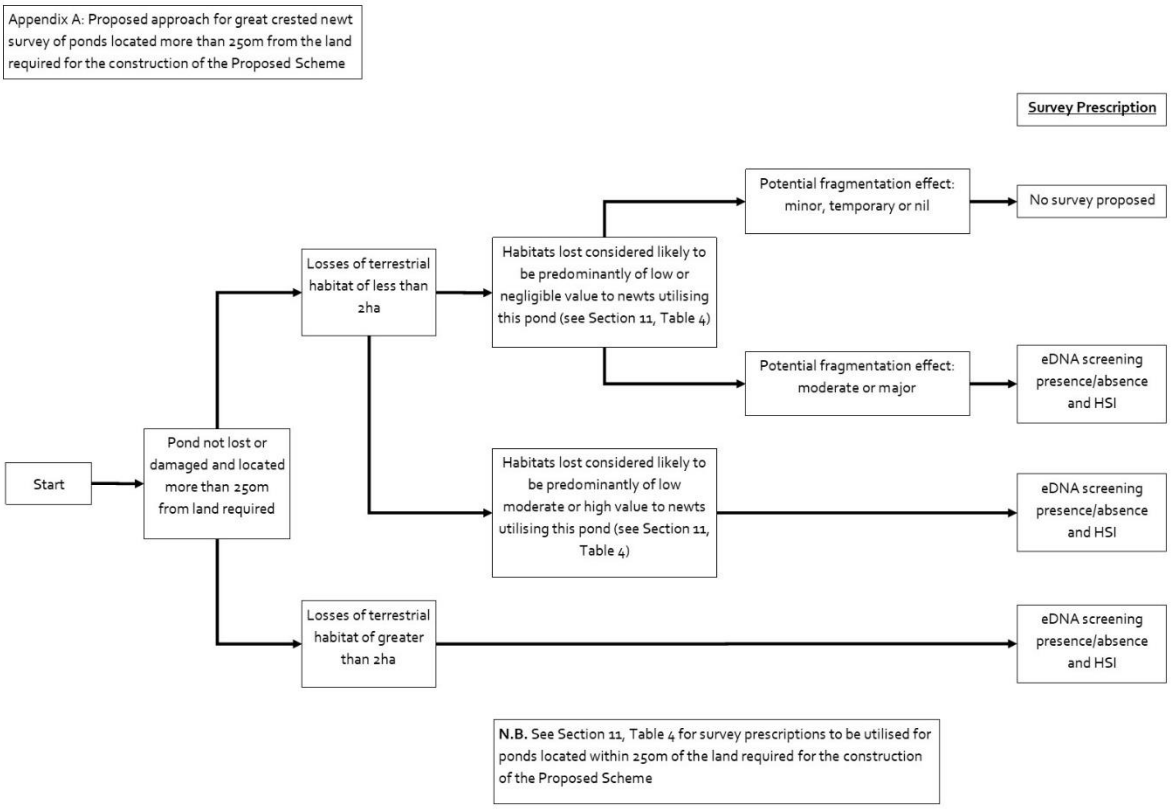
23.7 References

Beaumont, W.R.C., Taylor, A.A.L., Lee, M.J., Welton, J.S. (2002). Guidelines for Electric Fishing Best Practice. RandD Technical Report W2 – 054/TR. Environment Agency, Almondsbury.

British Standard BS EN 14011:2003, BS 6068-5.32:2003 'Water Quality: Sampling of fish with electricity'.

[75] British Standard BS EN 14011:2003, BS 6068-5.32:2003 'Water Quality: Sampling of fish with electricity'.
[76] Beaumont, W.R.C., Taylor, A.A.L., Lee, M.J., Welton, J.S. (2002). *Guidelines for Electric Fishing Best Practice. RandD Technical Report W2 – 054/TR.* Environment Agency, Almondsbury.

Appendix A: Great crested newt survey decision flowchart



Appendix B: Use of non-standard survey methods to provide early warning of the presence of great crested newt

B.1 Introduction

1.1.1 Where it has not been possible to complete amphibian survey of a water body during the mid-March to mid-June survey window, efforts will be taken to provide early warning of potential presence of great crested newt through late season surveys.

1.1.2 Ecological surveyors should submit their proposals to overseeing consultants for approval where non-standard survey methods can be employed to gain further information prior to the following mid-March to mid-June survey window. It is unlikely that use of non-standard survey methods will be justifiable at all water bodies. Consultants undertaking surveys should consider the likely potential for significant impacts on any populations that are present and/or for significant mitigation requirements, based on the current assumed land required for the construction of the Proposed Scheme.

Survey method

1.1.3 For each pond identified as being suitable for late amphibian survey a single night time visit should be conducted during September to conduct survey utilising the following methods:

- netting for larvae – netting would utilise a 2-4mm long handled dip net and be conducted during day or night. A single perimeter walk would be conducted with at least 15 minutes of netting conducted per 50m of shoreline; and
- torching – a single torchlight survey during September.

1.1.4 Survey may be conducted on any nights where air temperature is 5°C or above at point of survey until the end of September.

1.1.5 It is likely that at some water bodies, the use of one of the above methods may be unsuitable as a consequence of site specific constraints. In all such cases a record should be made of the rationale for excluding a particular method.

1.1.6 Late season survey will only be utilised to provide early warning of potential amphibian constraints, and to identify those areas where further mitigation effort may be required.

1.1.7 Where access is available, all water bodies where standard pond survey was not completed (or commenced) during the current survey season will be subject to full presence/absence or population size class assessment (as appropriate) during the subsequent mid-March to mid-June period. The use of eDNA screening may be employed as described in the Hs2 Phase One Supplementary Environmental

Statement 3 and Additional Provision 4 Environmental Statement, Volume 5 | Technical appendices Addendum 4 to the EIA Scope and Methodology Report [77].

[77] Hs2 Phase One Supplementary Environmental Statement 3 and Additional Provision 4 Environmental Statement, Volume 5 | Technical appendices Addendum 4 to the EIA Scope and Methodology Report (CT-001-000/5) October 2015. Available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/466966/Addendum_4_to_the_EIA_Scope_and_Methodology_Report__CT-001-0005_.pdf

Appendix C: Methodology for car based bat transect surveys

C.1 Screening for survey and defining the survey area

1.1.1 Where there are significant restrictions on access, consultants undertaking survey should consider the use of car based transects to provide some baseline information on bat assemblages within these areas. As the methodology will involve driving at slow speed the use of the methodology must be limited to local roads (i.e. excluding motorways, dual carriageways and A roads), and in all cases it will be necessary to submit a detailed risk assessment for the approval of the HS2 Ltd. It will be the responsibility of the consultant undertaking survey works to notify the appropriate authorities (e.g. local Highways Authority and local police[78]) prior to commencing the survey.

Method

1.1.2 All surveys will require a minimum of two surveyors. One of the surveyors will be exclusively driving and have no involvement in the operating of bat survey equipment.

1.1.3 Car transect routes should be planned using aerial photographs and should focus on local roads passing through the land required for the construction of the Proposed Scheme and a 100m buffer either side. Where appropriate features of particular bat interest within 500m of the land required for the construction of the Proposed Scheme were identified during scoping these should also be included. Where possible the transect route should incorporate stopping points (three minutes per stop) in close proximity to the land required and at other features of potential bat interest. A day time drive through of the proposed survey route should always be conducted prior to the first survey visit in order to identify suitable safe stopping points. The risk assessment will be reviewed and updated after the day time drive through.

1.1.4 All car transect surveys should commence at 45 minutes after sunset and continue for at least two hours. The length of each car transect should be planned to ensure that at least two passes of the entire transect route can be completed during each survey visit. In order to maximise recording within close proximity to the land required, the transect route may be not continuous.

1.1.5 Car based surveys should be conducted using a GPS enabled EM3 or SM2BAT+ or similar detector recording in full spectrum mode. The microphone should be held within a car mount or clamp at window level at a 45 degree angle on the passenger's side or, where the microphone can be attached (as for the SM2BAT+) to a cable, it may be securely taped to the vehicle at window level.

1.1.6 Sections of the transect route subject to survey should be driven at a steady speed of 15mph (24km/h) utilising a vehicle mounted with flashing orange double beacon, reflective chevrons and a reflective sign stating 'Surveying'.

[78] Where appropriate the police should be contacted via non-emergency number to log details of the route and gain an incident number.

Summary of survey programme and effort

1.1.7 Each car based transect route should be subject to a total of two dusk surveys per month during September and October and April, May and June. The starting point and direction of the transect route should be varied between survey visits.

1.1.8 Where habitat quality is high, or the presence of Annex II species is suspected, consideration should be given to the requirement to undertake additional visits each month.

Appendix D: Criteria for potential otter holt locations and determining usage

D.1 Description of criteria

1.1.1 The following criteria devised by Paul Chanin (unpublished) should be utilised to identify potential holt locations and determine when they are considered likely to be potentially active.

1.1.2 Features meeting the following criteria should be identified during surveys as 'potential holts':

- tunnel with internal diameter of at least 250mm and extending 1m into the bank or where the end is out of sight; or
- any cavity of similar dimensions: drain pipe; log pile; rock/boulder pile; under structures such as bridges or buildings etc.

1.1.3 Where any of the following signs are found at features meeting the potential holt criteria they should be considered potentially active:

- presence of otter spraints or footprints beside or inside tunnel;
- evidence of an animal's body rubbing against wall or roots;
- presence of hairs ca 25mm long and mid brown in colour; or
- presence of scratch marks.

Appendix E: Criteria for assessing potential otter breeding sites

E.1 Description of criteria

1.1.1 The following criteria devised by Paul Chanin (unpublished) should be used in assessing the potential for habitats in the vicinity of the route to support otter breeding sites.

Table E1: Cover

High	Dense impenetrable cover over more than 50% of the area, immediately adjacent to the river bank; or Presence of features with potential to conceal a breeding den such as fallen hollow trees, very large trees with spreading roots on river bank, small dense thickets of impenetrable vegetation, piles of boulders or other debris with space for a den beneath which are immediately adjacent to a waterway or connect to it by concealing routes.
Medium	Dense impenetrable cover over 20-50% of the area, immediately adjacent to the river bank or dense impenetrable cover over less than 50% of the area within 50m of the river with concealing routes between the bank and the area of dense cover; or Presence of features with potential to conceal a breeding den such as fallen hollow trees, small dense thickets of impenetrable vegetation, piles of boulders or other debris which are not adjacent to a waterway or connected to it by concealing routes.
Low	Dense impenetrable cover over less than 20% of the area. No features with potential to conceal a breeding den.
None	No dense impenetrable cover

Table E2: Food supply

High	Within 500m of high quality food supply (pond/lake of at least 1ha or river with depth greater than 0.5m and width greater than 5m).
Moderate	High quality food supply within 2km; or Within 500m of moderate food supply: (pond/lake of at least 0.5ha or productive river with depth greater thano.3m and width greater than 3m).
Low	High quality food supply > 2km away; or Moderate quality food supply > 500m away.

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