

# **A417 Missing Link**

## **Preliminary Environmental Information (PEI) Report**

**19/09/19**

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# 1 Introduction

## 1.1 Overview and Need for the Scheme

- 1.1.1 In December 2014, the Department for Transport (DfT) published the first Road Investment Strategy (RIS1) setting out a five-year £15.2 billion investment programme (2015-2020) for improvements to the strategic road network (SRN) throughout England. The approach to RIS1 delivery is set out in Highways England's Delivery Plan (2015-20). The A417 Missing Link is one of 15 new proposed schemes identified in the Delivery Plan for development in RIS1 and delivery in the next Road Investment Strategy period (RIS2 2020-2025).
- 1.1.2 Together, the A417 and A419 make up one of the south-west's most important road corridors. They link the M5 at Gloucester (Junction 11A) to the M4 at Swindon (Junction 15). They help south-west businesses connect with markets and opportunities in the Midlands and North, and they attract investment for Gloucestershire and its neighbours by linking them to London and the South East.
- 1.1.3 Most of the A417/A419 route is dual-carriageway, but there is one section that is not. Known as the Missing Link, this stretch of 3.6 miles (5.6km) of single carriageway on the A417 between the Brockworth bypass and Cowley roundabout restricts the flow of traffic causing pollution and congestion. Delays of 20 minutes or more are not unusual. This results in some motorists diverting onto local roads to avoid tailbacks, causing difficulties for neighbouring communities. Poor visibility and challenging gradients also mean that a disproportionately high number of collisions are seen along this stretch of road.
- 1.1.4 Upgrading this section of A417 to dual-carriageway, in a way that is sensitive to the surrounding Cotswolds Area of Outstanding Natural Beauty (AONB), will help improve safety, support the economy, ease congestion and reduce pollution. On this stretch of road alone, there were 49 personal injury collisions between 2013 and April 2018, 10 of which were fatal. It would also support the predicted growth in jobs and housing in the Gloucestershire area by improving this key road connection. This will bring significant benefits for road users, local communities and businesses.
- 1.1.5 The proposed scheme would provide 3.6 miles (5.6km) of new, rural all-purpose dual carriageway for the A417. The new dual carriageway would connect the existing A417 Brockworth bypass with the existing dual carriageway A417 south of Cowley. The new dual carriageway would be completed in-line with current trunk road design standards. The section to the west of the existing Air Balloon roundabout would follow the existing A417 corridor, but to the south and east of the Air Balloon roundabout, the corridor would be offline, away from the existing road corridor.
- 1.1.6 The project would incorporate a new junction at Shab Hill, providing a link from the A417 to the A436 (towards the A40 and Oxford), and to the B4070 (for Birdlip and other local destinations). A green bridge would provide landscape and ecology connectivity and link public rights of way in the vicinity of Crickley Hill. A new junction would be included near Cowley, replacing the existing Cowley roundabout, making use of an existing underbridge to provide access to local destinations such as Nettleton and Brimpsfield. The use of the existing underbridge will allow for all directions of travel to be made.

- 1.1.7 The existing A417 would be detrunked for its entire length. Some lengths of the existing road would be converted into a route for walkers, cyclists and horse-riders. Other sections would be retained as lower-class public roads, maintaining local access for residents.
- 1.1.8 A location plan and aerial photography of the area are shown in figure 1.1 and figure 1.2 respectively.

## 1.2 Purpose of the Preliminary Environmental Information Report

- 1.2.1 This Preliminary Environmental Information Report (PEI Report) has been prepared duties to enable the local community and any other interested person and stakeholders to understand the environmental effects of the proposed scheme and enable an informed response to consultation. The document sets out how each environmental topic area is being assessed, the potential environmental effects of the proposed scheme base on the information available at the time, and measures proposed to avoid or reduce such effects. This is to support consultees in developing an informed view of the likely significant environmental effects of the proposed scheme.
- 1.2.2 It should be noted that the proposed scheme design is currently under development, environmental information is still being assembled and impacts are still being identified. The information contained within this PEI Report should be regarded as a preliminary account of the principal environmental issues identified to date. The PEI Report details a number of uncertainties and assumptions and may be subject to change as the environmental assessment work progresses. The PEI Report may also be subject to change as a result of consultation responses which will in turn inform the ongoing environmental assessment process. The results will be reported within the Environmental Statement (ES) which will be submitted to the Planning Inspectorate as part of the Development Consent Order (DCO) application.

## 1.3 Scope and Content of the PEI Report

- 1.3.1 The scope of the PEI Report is defined by Regulation 12(2) of the EIA Regulations which define PEI as “*information referred to in Part 1 of Schedule 4 (information for inclusion in environmental statements) which:*
- *has been compiled by the applicant; and*
  - *is reasonably required to assess the environmental effects of the development (and of any associated development)”.*
- 1.3.2 The scope of the EIA has been informed by way of engagement with the Planning Inspectorate through a request to them for a Scoping Opinion. The request was made on 14 May 2019 and was accompanied by an Environmental Impact Assessment Scoping Report. The Scoping Opinion was received on 24 June 2019. Both the Environmental Impact Assessment Scoping Report and the Scoping Opinion have been made available by the Planning Inspectorate on their website, via the following link:

<https://infrastructure.planninginspectorate.gov.uk/projects/south-west/a417-missing-link/>

This PEI Report has taken into consideration the comments provided by stakeholders through the scoping opinion. Work is ongoing to ensure that these

comments are considered throughout the development of the proposed scheme and the Environmental Statement will include detailed information on how the comments have been taken into account. The PEI Report is arranged into different topic chapters, which reflect those which will be used for the Environmental Statement, as follows:

- air quality
- cultural heritage
- landscape
- biodiversity
- geology and soils
- material assets and waste
- noise and vibration
- population and human health
- road drainage and the water environment
- climate

1.3.3 Each environmental topic chapter within the PEI Report describes the local environment, and identifies any sensitive receptors such as designated sites, for example Sites of Special Scientific Interest, Air Quality Management Areas or Noise Important Areas. Baseline environmental surveys that have been carried out for each topic are then described, along with detail of consultation with Local Authorities and other stakeholders. Any likely impacts of the proposed scheme on the local environment and required mitigation are then described.

1.3.4 The Environmental Constraints Plans (figure 1.3) illustrate the environmental constraints for the wider study area.

## 1.4 Legislative and Policy Framework

### Overview

1.4.1 To support the preparation of the PEI Report, it is necessary to review National and Local Planning Policy and how this has informed the overall approach. Further topic specific policies have been considered within each of the topic chapters (set out within chapter 5 to chapter 14 of this PEI Report).

### Planning Act 2008

1.4.2 The proposed scheme is defined as a Nationally Significant Infrastructure Project (NSIP) under Section 14(1)(h) and Section 22 of the Planning Act 2008 (the Act) by virtue of the fact that:

- a) it comprises the construction of a highway;
- b) the highway to be constructed is wholly in England;
- c) the Secretary of State is the highway authority for the highway; and
- d) the speed limit for any class of vehicle on the highway is to be 50 miles per hour or greater, and the area for the construction of the highway is greater than 12.5 hectares.

1.4.3 As the proposed scheme is an NSIP, Highways England is required to make an application for a Development Consent Order (DCO) to the Planning Inspectorate. The Planning Inspectorate has responsibility for administering the examination of

DCO applications and supporting the examining authority that will be appointed to make a recommendation to the Secretary of State as to whether to grant development consent and “make” the order. If granted by the Secretary of State, the DCO will provide the necessary authorisation to allow the proposed scheme to be constructed and operated.

### **The EIA Regulations**

- 1.4.4 The proposed scheme falls within Schedule 2 of the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (EIA Regulations) on the basis that it has been identified as having the potential for significant adverse effects on the environment. As such, an ES is being prepared to accompany the application for a Development Consent Order (DCO).

### **National Policy Statements**

- 1.4.5 The National Policy Statements (NPS) are of primary importance to the decision-making process when DCO applications are being examined. Section 104 of the Act states that:
- “(2) In deciding the application the Secretary of State must have regard to –*
- (a) any national policy statement which has effect in relation to development of the description to which the application relates (a “relevant national policy statement”) ...*
- (3) The Secretary of State must decide the application in accordance with any relevant national policy statement, except to the extent that one or more of subsections (4) to (8) applies.”*
- 1.4.6 There is one NPS which is relevant to the proposed A417 Missing Link, which is the National Policy Statement for National Networks (NPSNN). This NPS sets out the need for and the Government’s policies to deliver Nationally Significant Infrastructure Projects (NSIPs) on the national road and rail networks in England. The NPSNN is used by the Secretary of State as the primary basis for making decisions on DCO applications for NSIPs.
- 1.4.7 Given the proposed scheme is a road network NSIP, the EIA approach adopted is in accordance with the NPSNN. In particular, the EIA adheres to all of the methodology requirements cited within NPSNN Section 5: Generic Impacts.
- 1.4.8 Mitigation measures will be developed in accordance with the mitigation requirements also set out in Section 5 of the NPSNN.
- 1.4.9 In addition, the National Planning Policy Framework (NPPF) originally published in March 2012 and updated in February 2019, sets out the Government’s planning policies for England. The NPPF is ‘*an important and relevant*’<sup>1</sup> matter to be considered in decision making for NSIPs. The NPPF is supplemented by the Planning Practice Guidance (PPG)<sup>2</sup> web-based resource launched in February 2014. The PPG is updated by the Department for Communities and Local Government as necessary.
- 1.4.10 It is important to understand that applications under the Act are not subject to s38(6) of the Planning and Compulsory Purchase Act 2004, which states that

<sup>1</sup> National Planning Policy Framework (2019) Paragraph 5.

<sup>2</sup> Department for Communities and Local Government: Planning Practice Guidance: February 2014.

determination of a planning application must be made in accordance with the local development plan, unless other material considerations indicate otherwise. Local planning policy may be an important and relevant matter during the consideration of applications for development consent, but such applications do not have to be in accordance with the development plan.

- 1.4.11 If there is a conflict between the NPS and local policies, however, the NPS takes precedence.
- 1.4.12 Further details on the legislative and planning policy framework are provided in appendix 1.1.

### **Planning Practice Guidance**

- 1.4.13 Each topic chapter of this PEI Report refers to the relevant sections of the Planning Practice Guidance where considered important and relevant to the assessment of the proposed scheme.

### **Relevant Planning Authorities**

- 1.4.14 Although a DCO application is not subject to Section 38(6) of the Planning and Compulsory Purchase Act 2004, development plans may be considered an important and relevant matter.
- 1.4.15 The proposed scheme is situated within the boundaries of three authorities in a two-tier local authority system:
- **Gloucestershire County Council:** the upper tier planning authority for the county of Gloucestershire. The County Council has duties in relation to planning policy for managing minerals, waste and transport networks across the administrative area. Gloucestershire County Council has a current Waste Core Strategy and a current Local Transport Plan. While a new Minerals Plan is currently undergoing Examination, the Council is reliant on saved policies from the most recent Minerals Local Plan (1997-2006).
  - **Cotswold District Council:** the lower tier planning authority for the Cotswold borough, which includes the towns of Cirencester and Tetbury. Cotswold District Council is the local planning authority, responsible for planning policy and development management in the district. Cotswold District Council has a current Local Plan, which was adopted in August 2018.
  - **Tewkesbury Borough Council:** the lower tier planning authority for the Tewkesbury borough, which includes the town of Tewkesbury. Tewkesbury Borough Council is the local planning authority, responsible for planning policy and development management in the borough. Tewkesbury Borough Council is one of three authorities which produced a Joint Core Strategy (2017), a co-ordinated strategic development plan for the administrative areas of Tewkesbury Borough, Cheltenham Borough and Gloucester City.
  - The most recent Tewkesbury Borough Council Local Plan is the 2004-2011 Local Plan. Although a new Local Plan is in production (having recently consulted on Preferred Options), the authority is current reliant on saved policies from the 2004-2011 Plan.

### **Local Development Plan**

- 1.4.16 Taking account of the adopted and 'saved' policies of the three relevant authorities, the Local Development Plans of relevance include:

- Gloucestershire County Council
  - Minerals Local Plan 1997-2006 Saved Policies (adopted 2007);
  - Waste Core Strategy (adopted 2012);
  - Minerals Plan (2018 – 2032) (undergoing Examination as of June 2019);
  - Waste Local Plan 2002-2012 Saved Policies (adopted 2004); and
  - Local Transport Plan, 2015-2031 (adopted 2016, updated 2017).
- Cotswold District Council
  - Local Plan 2011 – 2031 (adopted 2018).
- Tewkesbury Borough Council
  - Joint Core Strategy (2017);
  - Tewkesbury Local Plan 2006 – 2011 Saved Policies (2006); and
  - Tewkesbury Local Plan 2011 – 2031 Preferred Options (2018).

### **Non-Statutory Plans**

1.4.17 Details of non-statutory plans are provided in appendix 1.1. This includes details on the following:

- Cotswolds AONB Management Plan (2018-2023)
- A Green Future: Our 25 Year Plan to Improve the Environment

## **1.5 The Applicant**

1.5.1 Highways England is the Applicant and the Strategic Highways Company as defined in the Infrastructure Act 2015, and is charged with operating, maintaining and improving England's motorways and major A roads on behalf of the DfT.

1.5.2 Highways England is responsible for motorways and major (trunk) roads in England. Their road network totals over 4,400 miles. Whilst this represents only two percent of all roads in England by length, these roads carry a third of all traffic by mileage and two thirds of all heavy goods traffic.

## **1.6 Scheme Vision, Objectives and Design Principles**

1.6.1 The Cotswolds AONB is the largest of 38 AONBs in England and Wales, and the second largest protected landscape in England after the Lake District National Park. In view of its special landscape character, there is a clear need to balance economic and social benefits of an improved road against potentially negative environmental impacts.

1.6.2 The integrated project team have worked closely with key stakeholders including Gloucestershire County Council, Cotswolds Conservation Board, National Trust, Gloucestershire Local Nature Partnership, Gloucestershire Wildlife Trust and G-First LEP to develop a scheme specific vision statement, four scheme specific objectives and a number of sub-objectives.

1.6.3 The scheme vision, design principles, four scheme specific objectives and associated sub-objectives are identified in Table 1-1.

**Table 1-1 Scheme Vision, Design Principles, Objectives and Sub-Objectives**

Scheme vision					
<p><i>A landscape-led highways improvement scheme that will deliver a safe and resilient free-flowing road whilst conserving and enhancing the special character of the Cotswolds AONB; reconnecting landscape and ecology; bringing about landscape, wildlife and heritage benefits, including enhanced visitors' enjoyment of the area; improving local communities' quality of life; and contributing to the health of the economy and local businesses.</i></p>					
Scheme design principles					
<p>Any solution involving a new road must ensure that the proposed scheme is designed to meet the character of the landscape, not the other way round.</p> <p>Any proposed scheme should bring about substantial benefits for the Cotswolds landscape and environment as well as people's enjoyment of the area.</p> <p>Any proposed scheme must have substantially more benefits than negative impacts for the Cotswolds AONB.</p>					
A417 scheme objectives					
<p><b>Safe, resilient and efficient network:</b> to create a high-quality resilient route that helps to resolve traffic problems and achieves reliable journey times between the Thames Valley and West Midlands as well as providing appropriate connections to the local road network.</p>	<p><b>Improving the natural environment and heritage:</b> to maximise opportunities for landscape, historic and natural environment enhancement within the Cotswolds AONB and to reduce negative impacts of the proposed scheme on the surrounding environment.</p>	<p><b>Community &amp; access:</b> to enhance the quality of life for local residents and visitors by reducing traffic intrusion and pollution, discouraging rat-running through villages and substantially improving public access for the enjoyment of the countryside.</p>	<p><b>Supporting economic growth:</b> to facilitate economic growth, benefit local businesses and improve prosperity by the provision of a free-flowing road giving people more reliable local and strategic journeys.</p>		
A417 scheme sub-objectives					
1	Road safety will be improved by designing to current standards and better separating strategic and local traffic.	The proposed scheme will have an identity which reflects, conserves and enhances the character of the local landscape.	The proposed scheme will enhance community cohesion by improving local connectivity and accessibility by helping to separate strategic and local traffic.	The proposed scheme will contribute towards national transport policies that support economic growth.	
2	The scheme will be designed to provide greater road traffic capacity, improved network resilience and better journey time reliability for strategic and local journeys.	The scheme will improve landscape and ecological connectivity through landscape and habitat restoration and creation.	The scheme will reduce rat-running on local roads through provision of a more reliable strategic route with improved capacity, thereby enhancing the amenity of local settlements.	The scheme will complement Development Plans published by local authorities in the region to support regional and local economic growth and prosperity.	
3	The scheme will enhance operational efficiency, improve maintenance safety and support best	The horizontal and vertical alignments of the scheme will pay due regard to the nature of the local landform.	The scheme will contribute towards community and recreational opportunities through	The scheme will contribute to the health of the local visitor economy through improved access and	



	value whole-life cost benefits.		improved provision for motorised and non-motorised users.	visitor experience of the Cotswolds AONB.
4	The scheme will consider appropriate relaxations or departures from highways standards to reduce the environmental impact of the road without compromising safety.	The siting and form of structures, cuttings, embankments and landscape mounding will reflect local topography and landform.	The scheme will reduce road noise by applying sensitive noise mitigation measures where required.	The scheme will reduce disruption to local economic interests and businesses during both construction and operation.
5		The design of structures will be of lasting architectural quality.	The scheme will reduce light pollution through sensitive structural, junction, and lighting design and sign illumination.	The scheme will restore redundant highways land to agricultural, public access, community or nature benefit uses where appropriate.
6		The scheme will avoid significant interruption to groundwater flows or negative impacts on the aquifer, springs and watercourses.	The scheme will improve air quality by reducing pollution from traffic congestion.	The scheme will support the development and employment of local skills in its construction.
7		The scheme will avoid or, where absolutely necessary, reduce the direct loss of National Trust land, other areas owned and managed for conservation, open access land and country parks and at the same time reduce intrusion upon such land.	The scheme will improve continuity of access to the Public Rights of Way network, the Cotswold Way National Trail and the Gloucestershire Way.	The scheme will seek sustainable opportunities to use locally sourced construction materials to support the local economy.
8		The proposed scheme will enable enhanced preservation of heritage assets and their settings and adopt designs that reflect and enhance the historic character of the area.		

1.6.4 The further development of the proposed scheme design will consider the feedback received during consultation and ongoing assessments, to produce a preliminary design which will be used as the basis of the DCO application. As such the draft design described below will be subject to refinement prior to the DCO application. The preliminary design, and the assessment of its likely significant environmental effects, will be presented in the ES submitted with the DCO application.

## 1.7 Stakeholder Engagement

### Context

1.7.1 Stakeholder engagement for the proposed scheme is based on the following principles:

- Early and ongoing engagement to inform and influence the proposed scheme development process;
- Seeking an appropriate level of feedback at each stage in the iterative design process and ensuring that comments received are taken into consideration;
- Building of long-term relationships with key stakeholders throughout the different stages of the proposed scheme to help better understand their views;
- Where possible and practicable ensuring concerns are addressed; and
- Ensuring appropriate statutory consultation is undertaken in accordance with requirements of the PA 2008 and associated guidance.

### Consultation to Date

1.7.2 Public consultation on proposals for the A417 Missing Link was carried out between 15 February and 29 March 2018. Various groups were contacted and invited to participate in the consultation so that their views on the proposals could be understood. The groups and organisations fell into the following categories:

- local residents and businesses;
- elected representatives;
- hard-to-reach groups;
- statutory bodies;
- other organisations, groups and businesses;
- landowners; and
- the wider public.

1.7.3 The consultation was supported by a Technical Appraisal Report (February 2018) which provided further detail and technical information on the identification of route options and the sifting and appraisal process for determining which should be taken forward to consultation. This is available at the following link:

[https://highwaysengland.citizenspace.com/he/a417-missing-link/supporting\\_documents/A417%20Technical%20Appraisal%20Report.pdf](https://highwaysengland.citizenspace.com/he/a417-missing-link/supporting_documents/A417%20Technical%20Appraisal%20Report.pdf)

1.7.4 Two proposed options were presented to the public as part of the non-statutory consultation. Details are presented in chapter 3.

1.7.5 Almost 2,000 responses were received in total. Comments which informed the choice of the preferred route were separated into key issues for the public and stakeholders, relating to the choice of option 12 or option 30.

- Landscape considerations, in particular the minimising of the visual impact of the proposed scheme in the Cotswolds AONB;
- Environmental and geological impacts on nearby sites, including Crickley Hill and Barrow Wake Sites of Special Scientific Interest (SSSIs), and Emma's Grove Scheduled Ancient Monument (SAM);
- Traffic delays and disruption during construction of the proposed scheme

- Public Rights of Way, in particular national trails (such as the Cotswold Way and Gloucestershire Way), and their preservation and interaction with the proposed scheme;
- Impacts on local communities such as Birdlip, Stockwell, Brimpsfield and Cowley;
- Access to the new road from the local network, including from the A436, the B4070, and various local communities;
- Cost and value for money of the proposed scheme; and
- Effects on local businesses and amenities.

1.7.6 These considerations from consultation were reviewed alongside the findings of further assessment work undertaken during and since consultation. Following this a scheme assessment report was published in March 2019 which provides a full description and assessment of the alternative options, including the public consultation and the recommendations of a preferred route. This can be found at the following link:

[https://highwaysengland.citizenspace.com/he/a417-missing-link/results/a417\\_missing\\_link\\_scheme\\_assessment\\_report.pdf](https://highwaysengland.citizenspace.com/he/a417-missing-link/results/a417_missing_link_scheme_assessment_report.pdf)

1.7.7 The public consultation is documented in full in the 'A417 Missing Link: Report on Public Consultation' (March 2019) which is available at the following link:

[https://highwaysengland.citizenspace.com/he/a417-missing-link/results/a417\\_missing\\_link\\_report\\_on\\_public\\_consultation.pdf](https://highwaysengland.citizenspace.com/he/a417-missing-link/results/a417_missing_link_report_on_public_consultation.pdf)

## **Ongoing Consultation**

### Strategic Stakeholder Panel

1.7.8 The Strategic Stakeholder Panel (SSP) is an advisory group for high-level two-way dialogue between the A417 project team and key stakeholder groups. The membership of the SSP reflects that this is a landscape-led highways scheme as follows:

- Highways England;
- Gloucestershire County Council;
- Cotswolds District Council;
- Cotswolds Conservation Board;
- National Trust; and
- Gloucestershire Wildlife Trust.

1.7.9 The SSP meets approximately every two months and is a non-political forum in which participants can provide advice on the strategic direction of the project and monitor the project's progress towards the achievement of its visions, objectives and design principles. It provides advice and guidance on key issues that arise from the Technical Working Group meetings.

### Technical Working Groups

1.7.10 Three Technical Working Groups (TWG) have been established with membership from statutory (prescribed) bodies and non-statutory bodies. These cover the following topics:

- landscape, biodiversity and cultural heritage;
- water environment; and

- walking, cycling and horse riding.

- 1.7.11 The TWGs provide a forum for discussions between stakeholders and Highway's England technical leads to gather information and where possible reach a consensus on important and relevant issues. The wide membership of the groups also provides opportunities to consider cross cutting themes in a collaborative way.
- 1.7.12 TWGs are held on a monthly basis or when needed throughout the pre-application stage and into the examination in order to progress Statements of Common Ground that will inform the design and environmental assessment of the proposed scheme that is applied for, and to assist the examining authority (once appointed) in the examination of the application.

#### Bilateral Topic Focused Groups

- 1.7.13 In addition to the TWG, smaller groups are feeding into the proposed scheme design and seeking to resolve particular areas of concern. These are meeting on an ongoing basis to discuss specific issues, such as provisions for walkers, cyclists and horse riders and mitigation for ecological species.

## **1.8 Next Steps**

- 1.8.1 This PEI Report has been prepared to support consultees in developing an informed view of the likely significant environmental effects of the proposed scheme.
- 1.8.2 A six-week consultation on the proposed scheme runs from 27 September to 8 November 2019 to enable people to review the proposals and provide feedback. Highways England invites comments on the proposed scheme and the environmental issues addressed in the PEI Report.
- 1.8.3 Further details on the consultation and downloadable copies of the PEI Report, the non-technical summary of the PEI Report, the draft Environmental Masterplan, the consultation booklet and response form and further information on the proposed scheme can be downloaded at:
- <https://highwaysengland.co.uk/projects/a417-missing-link/>
- 1.8.4 To support the consultation a series of events are being held where people will be able to view information on the proposed scheme, speak to members of the project team and provide responses to the consultation.
- 1.8.5 Hard copies of the consultation documents are also available for viewing at a number of locations. Full details of the consultation events and locations where copies of the consultation documents can be viewed are available in the Statement of Community Consultation (SoCC) which is available on the project website (see link above).
- 1.8.6 Responses to the consultation can be made by completing the response form online or by email or letter using any of the following addresses:
- Online: <https://highwaysengland.co.uk/projects/a417-missing-link/>
  - Email: A417MissingLink@highwaysengland.co.uk
  - Post: completed feedback forms can be sent by Freepost (you do not need a stamp) to the following address: FREEPOST A417 MISSING LINK (the address must be written in capital letters and you do not need a stamp).

- 1.8.7 After the consultation period, all responses will be considered in finalising the proposed scheme design and progressing the EIA. Comments will be taken into account when considering the need for further assessment or modification to the proposed scheme design or mitigation measures.
- 1.8.8 The comments received will also be used to produce a Consultation Report, which will be submitted to with the DCO application. The Consultation Report will summarise the views and comments received and outline how regard has been had to those comments in the proposed scheme design and the EIA.
- 1.8.9 Following submission of the DCO application, the Planning Inspectorate will consider, on behalf of the Secretary of State, whether the application should be accepted for examination. If the application is accepted, consultees including the general public will then be able to make relevant representations about the proposed scheme and its potential impacts. The documents accompanying the DCO application will be publicly available on the Planning Inspectorate's website, and consultees will be able to submit comments to the Planning Inspectorate. These comments will then be considered as part of the examination into the DCO application. Following examination, the Planning Inspectorate will make a recommendation to the Secretary of State, who will then decide whether to grant a DCO.
- 1.8.10 If the DCO is granted, construction is planned to start in late 2021 and the proposed scheme is due to open to traffic in 2024.

## 2 The Project

### 2.1 Introduction

2.1.1 This chapter of the PEI Report provides a description of the proposed scheme based on information available at the time of writing (August 2019). This includes the preliminary environmental and engineering design and the proposed scheme design principles and landscape-led approach. An overview of the site location and context and the high-level programme is also provided.

### 2.2 Scheme Location

2.2.1 The Preferred Route for the proposed scheme was announced by the Secretary of State on the 21<sup>st</sup> March 2018. The A417/A419 is located along a strategic route between Gloucester and Swindon that provides an important link between the Midlands/north and south of England. The route is an alternative to the M5/M4 route via Bristol. The section of the A417 near Birdlip, known as the 'Missing Link', forms the only section of single carriageway along the route and is in the Cotswolds AONB. The location of the proposed scheme is shown in figure 1.1.

2.2.2 The surrounding area of the existing A417 route contains a mix of agricultural land, woodland and common land. The nearest village is Birdlip, situated approximately midway between Cowley roundabout to the east and Brockworth bypass to the west. Cowley village is located east of the proposed scheme, between Cockleford and Coberley. Crickley Hill Country Park is situated immediately west of the Air Balloon roundabout.

2.2.3 The land likely to be required temporarily and/or permanently for the construction, operation and maintenance of the proposed scheme is within the proposed scheme boundary shown in figure 2.1. It is important to note that the land required may eventually be slightly less than shown due to the design and construction methodology development. The maximum area of land likely to be required has therefore been assessed.

### 2.3 Scheme Design Principles

2.3.1 Chapter 1 defines the scheme objectives and vision and states how this is a landscape led highways improvement. Here the overarching scheme design principles are specified. These have been developed as part of engagement exercises undertaken with key stakeholders and include:

- any solution involving a new road must ensure that the scheme is designed to meet the character of the landscape, not the other way around;
- any scheme should bring about substantial benefits for the Cotswolds landscape and environment as well as people's enjoyment of the area; and
- any scheme must have substantially more benefits than negative impacts for the Cotswolds AONB.

2.3.2 These design principles would be considered and applied throughout the design of the proposed scheme and would be the key areas of focus in delivering a 'landscape-led' scheme. The Environmental Statement (ES) would report how these principles have been considered and applied.

## Landscape-led highway scheme approach

- 2.3.3 Landscape is a primary consideration in every design decision. The landscape led approach for the proposed scheme is to sensitively integrate the proposed scheme into this nationally important AONB landscape, looking to ensure that the proposed scheme is designed to '*meet the character of the landscape*' and reduce negative impacts of the proposed scheme on the surrounding environment. The scheme vision aims to maximise opportunities for landscape, historic and natural environment enhancements within the Cotswolds AONB. The scheme vision would look to improve landscape and ecological connectivity through landscape and habitat restoration and creation including measures to enhance local communities' quality of life and visitors' enjoyment of the area.
- 2.3.4 The proposed scheme would traverse four Cotswolds AONB Landscape Character types: LCT 7 High Wold; LCT Escarpment; LCT 8 High Wold Valley and LCT 18 Vale. Design responses will emerge from a thorough understanding of these character areas considering the key features that make the most important contribution to the character of the landscape, their sensitivity, and the local forces for change.
- 2.3.5 The scheme vision would also be achieved through a collaborative multi-disciplinary working approach with stakeholders at working groups to explore options to reach balanced design solutions. The landscape design would act to bring together the requirements of other disciplines including highway and structural engineering, bridge architecture, geotechnics, ecological, heritage and access proposals to produce a landscape-led integrated design for the proposed scheme.
- 2.3.6 A range of design guides and supporting information is being followed. This includes: Highways England 'Design Manual for Roads and Bridges (DMRB) Volume 10'; the 'AONB Landscape Strategy and Guidelines'; and associated AONB guidance produced by the Cotswold Conservation Board 'A Shared Vision for a Restored Landscape within the Cotswold AONB' co-developed by Gloucester Wildlife Trust, National Trust, Natural England, Environment Agency and Historic England'. Other publications providing design guidance for the landscape vision include 'Green Bridges – a Literary Review' by Natural England and associated guidance produced by the Landscape Institute.

## 2.4 Scheme Description

- 2.4.1 The proposed scheme would provide 3.6 miles (5.6km) of new, rural all-purpose dual carriageway for the A417. The new dual carriageway would connect the existing A417 Brockworth bypass with the existing dual carriageway A417 south of Cowley. The new dual carriageway would be completed in-line with current trunk road design standards. The section to the west of the existing Air Balloon roundabout would follow the existing A417 corridor, but to the south and east of the Air Balloon roundabout, the corridor would be offline, away from the existing road corridor.
- 2.4.2 The project would incorporate a new junction at Shab Hill, providing a link from the A417 to the A436 (towards the A40 and Oxford), and to the B4070 (for Birdlip and other local destinations). A green bridge would provide landscape and ecology connectivity and link public rights of way in the vicinity of Crickley Hill. A new junction would be included near Cowley, replacing the existing Cowley roundabout, making use of an existing underbridge to provide access to local

destinations such as Nettleton and Brimpsfield. The use of the existing underbridge will allow for all directions of travel to be made.

2.4.3 The existing A417 would be detrunked for its entire length. Some lengths of the existing road would be converted into a route for walkers, cyclists and horse-riders. Other sections would be retained as lower-class public roads, maintaining local access for residents.

2.4.4 Figure 2.1 shows the General Arrangement for the proposed scheme.

### **Mainline Alignment**

2.4.5 The route consists of the widening of the existing A417 on Crickley Hill and a new section of all-purpose dual carriageway (D2AP). Typically, each carriageway comprises two standard 3.65m wide lanes in each direction, 1m hardstrips and a central reserve. A minimum verge width of 2.5m is provided which is increased as required to provide adequate visibility splays, highway drainage, communication ducts and street furniture. An additional climbing lane is also present on the steep section of the route at Crickley Hill.

2.4.6 In cutting sections of the route earthwork slopes are generally at 1:2/1:2.5. For embankments a 1:3 slope is proposed. Through the large cutting on Crickley Hill (up to 25m high) 4m wide benches are currently proposed.

2.4.7 The distance along the mainline alignment is measured in metres referred to as chainage (Ch) as shown on figure 2.1. The proposed scheme can be described from west to east as follows:

- between Ch0+000 and Ch0+900, the route would closely follow the existing road alignment, with widening proposed on the southern side. The gradient would be 7%;
- between Ch0+900 and Ch1+700, the route starts to deviate slightly from the existing A417 alignment on fill (up to 8m) transitioning into cut (up to 3m). At Ch1+350 an access to Crickley Hill Tractors as proposed from the west bound carriageway;
- between Ch1+700 and Ch3+000 the road would be in deep cutting (maximum 25m). The alignment would deviate from the existing A417 alignment at Ch 2+000 and would continue east between the existing Air Balloon roundabout and Emma's Grove on a right-hand curve, and then head in a southerly direction. The existing A417 would become Cold Slad Lane;
- at approximately Ch1+800 a green bridge is proposed which would span over the mainline and Cold Slad Lane. The green bridge would connect the Cotswold Way National Trail on the escarpment over the proposed Scheme. It would provide walking, cycling & horse riding (WCH) access, and ecology connectivity across the proposed scheme;
- between Ch3+000 and Ch3+600 a grade separated junction is proposed which sits between Rushwood Kennels and Birdlip Radio Station. Referred to as Shab Hill Junction it would connect the A436 and the proposed B4070 link to Birdlip to the mainline.
- between Ch3+600 and Ch5+000 the mainline alignment continues towards the south-east and would be at grade or in cut (up to 6m). Two overbridges are proposed to connect the local network (Cowley Lane Overbridge, Ch4+040) and offer private means of access (Stockwell Farm Overbridge, Ch 4+725);
- from Ch5+000 to Ch5+500, the proposed Cowley Junction would provide left in and left out access on each side of the mainline. This junction would serve



as an access the local road network providing links to Stockwell and other local settlements including Cowley, Caudle Green and Brimpsfield making use of the existing Cowley link road underbridge. The junction would generally be in cut (up to 5m); and

- from Ch5+500 to Ch5+760 the alignment ties into the existing A417.

### Climbing lane

- 2.4.8 To accommodate slow moving vehicles travelling up Crickley Hill, a climbing lane is currently proposed in an eastbound direction. The full width climbing lane would start at Ch0+180, just to the south of Holly Brae and continue until Ch3+500, just prior to the eastbound merge entry onto the A417 mainline.

### **Side Roads**

#### Cold Slad Lane

- 2.4.9 Cold Slad Lane currently serves a number of properties to the north of the existing A417 on the western side of Crickley Hill Country Park. It is connected to the existing A417 by means of a T-junction. This junction would be removed, and a new connection would be created at the proposed A436 roundabout.
- 2.4.10 This connection would be using the existing eastbound carriageway of the A417 which would join up with the new A436 roundabout. The connection would consist a 4m single carriageway with passing places to match the existing character of Cold Slad. A further connection would be made with Dog Lane. The proposed connection between Dog Lane and Cold Slad Lane would be for WCH use and maintenance access only.

#### A436 Link Road

- 2.4.11 A new single carriageway is proposed to connect the existing A436 just east of the existing Air Balloon roundabout to the proposed Shab Hill Junction. This A436 side road would run parallel to the mainline between Ch2+150 and Ch3+150. At its northern end it would tie in into a proposed roundabout just north of the existing Air Balloon roundabout. At its southern end it would tie into the proposed Shab Hill Junction. This would provide direct access onto the A417 mainline and also the B4070 Birdlip link to the west.
- 2.4.12 The proposed A436 link road would also include a climbing lane in the southern direction as the gradient climbs at 8%.

#### B4070 Connection to Birdlip – Chainage 3+180

- 2.4.13 The B4070 link provides connectivity from Birdlip to the A417 at the proposed Shab Hill Junction. Its alignment would mainly follow the existing lane which connects Barrow Wake to the Birdlip Radio Station.
- 2.4.14 The link would be single carriageway, 7.3m wide with 2m verges on each side. It would also provide access to Birdlip Radio Station as well as Shab Hill Barn & Farm using an at-grade junction (staggered cross road).

## Junctions

### A436 Roundabout – Chainage 2+175

- 2.4.15 The A436 roundabout would be a four arm roundabout connecting the existing A436 and Leckhampton Hill with the new A436 Link Road and Cold Slad Lane.

### Shab Hill Junction – Chainage 3+180

- 2.4.16 Shab Hill Junction would be grade separated. It would connect the proposed A436 link and the proposed B4070 to Birdlip to the mainline. The junction would consist of a 'half clover-leaf' arrangement with associated slip roads. Each side of the junction would be connected via a bridge under the A417 (underbridge).
- 2.4.17 Shab Hill Junction would provide access to Birdlip village via the B4070 and also other properties including Rushwood Kennels and farmland.

### Cowley Junction – Chainage 5+200

- 2.4.18 Cowley Junction would be a free flow "local grade separated" junction at the southern end of the proposed scheme. This junction is made up of a left in left out arrangement on either side of the A417. The junction provides full movement for users by means of the existing Cowley Underbridge
- 2.4.19 This junction would serve as an access to the local network and nearby private means of access.

## Local Access

### Crickley Hill Tractors and Grove Farm – Chainage 1+350

- 2.4.20 The access to Crickley Hill Tractors/Grove Farm would be a left in left out junction which would provide access from the westbound mainline carriageway.

### Rushwood Kennels and Cuckoopen Farm – Chainage 3+175

- 2.4.21 A new access would be proposed off the eastern Shab Hill Junction roundabout which would connect Rushwood Kennels and Cuckoopen Farm to the proposed A417 and provide a link across the mainline.

## Structures

- 2.4.22 In order to accommodate the proposed scheme, there are a number of structures required. These are still undergoing design; however, preliminary details are listed in Table 2.1.

**Table 2-1 Proposed Structures**

Chainage	Structure Name	Purpose
Ch0+425 to Ch0+535	Dog Lane Retaining Wall	This retaining wall would support the new A417 carriageway (eastbound).
Ch0+760 to Ch0+970	Fly Up 417 Retaining Wall	This retaining wall would support the new A417 carriageway (westbound).
Ch1+185 to Ch2+080	Cold Slad Link Retaining Wall	The Cold Slad Link Retaining Wall would be to the north to support the proposed Cold Slad Link Road.
Ch1+675 to Ch1+950	Emma's Grove Retaining Wall	The Emma's Grove retaining wall would be provided to support new A417 (westbound).
Ch3+180	Shab Hill Junction Underbridge	The Shab Hill Junction Underbridge would provide a connection to the village of Birdlip by linking the existing A436 and B4070 link roads to the new A417 dual-carriageway.
Ch4+040	Cowley Lane Overbridge	The Cowley Lane Overbridge would carry a single-carriageway (Cowley Lane minor road) over the new A417 mainline.
Ch4+725	Stockwell Farm Overbridge	The Stockwell Farm Overbridge would carry a single carriageway private means of access leading to Stockwell Farm over the new A417 mainline.

2.4.23 In addition to this a green bridge is proposed as detailed in the following sub-section.

#### Green Bridge – Chainage 1+800 (Approximate)

2.4.24 Part of the vision for this proposed scheme is to reconnect landscape and ecology, bringing about landscape, wildlife and heritage benefits, as well as increasing the number of visitors in the area. To realise this vision, a structure in the form of a green bridge would be constructed across the new A417 carriageway. The connectivity provided by the green bridge would enhance biodiversity and the experience of the landscape.

2.4.25 The green bridge is proposed at Chainage 1+800 (approximately). This location is considered to be the most appropriate due to the following reasons:

- The bridge would offer a strategic landscape position, linking Crickley Hill ridge with Barrow Wake ridge and offers panoramic views to the west (ridge landscape).
- The bridge would link with Cotswold Way National Trail which runs along the ridge (called the Cotswold's Edge) through the Cotswolds AONB. The bridge could directly enhance the visitor experience of the Cotswold Way, keeping visitors on the ridge instead of sending them towards traffic (i.e. Air Balloon roundabout).
- The bridge would link the two Sites of Special Scientific Interest (SSSI) more effectively, both visually and physically.
- The bridge would be straight and shorter at this location, simplifying design and construction. It is also noted that the selected location reduces the amount of land-take.
- The selected location would provide opportunities for footpath links between Gloucestershire Way / Cotswold Way National Trail and potentially have a positive reuse of the A417 redundant sections.

### **Drainage Design**

- 2.4.26 The highway drainage would be designed to manage a 1 in 100-year return period event plus climate change within the site and would ensure that there is no surface water flooding for a one in five-year return period event.
- 2.4.27 The highway drainage design is designed in accordance to DMRB HD33/16, which is the design manual for highway drainage systems.
- 2.4.28 The A417 mainline and slip road drainage systems would be adopted and maintained by Highways England. The side road drainage systems would be adopted and maintained by Gloucestershire County Council (GCC). The road drainage for the proposed scheme would be managed predominantly by infiltration, using a series of attenuation basins, which are assumed to remain dry most of the time.
- 2.4.29 The HE and GCC drainage systems would be kept separate, wherever practicable.

### **Walking, Cycling and Horse-Riding**

- 2.4.30 A vast network of PRow span the A417 corridor. The network comprises primarily footpaths in addition to a small number of bridleways and restricted byways, however safe crossing points are limited where these routes interface with the existing A417. A key feature of the PRow network in the area is the Cotswold Way, a National Trail. There is also a promoted route, forming a collection of footpaths, namely the Gloucestershire Way.
- 2.4.31 The proposed scheme aims is to ensure that routes remain accessible for the community and visitors to the area. Mitigation required and opportunities for enhancement of the WCH network are being explored with stakeholders. The details would be fully developed into Public Rights of Way Management Plan as part of the DCO.
- 2.4.32 Refer to chapter 12 Population and Human Health for more details.

### **Lighting**

- 2.4.33 Given the AONB context, street lighting is an important consideration within the proposed scheme design and its application will be subject to good practise associated with any appropriate safety assessments. It is currently assumed the proposed A417 would not have road lighting and would follow the “Dark-Skies” scheme.

### **Vehicular Restraint Systems**

- 2.4.34 Vehicular restraint system (VRS) barriers are proposed in the central reserve between the two carriageways and in the verges to protect traffic from potential hazards. In the central reserve, it is currently proposed that a rigid concrete vertical safety barrier would extend the entire length of the proposed scheme. In the verges, this would be a steel open box beam or tension corrugated barrier system, situated in front of all hazards such as traffic signs and street furniture, significant earthworks, bridge abutments etc.

## Fencing

- 2.4.35 There would be fencing around the highway boundary that would generally comprise of timber post and four rail fencing. At certain locations additional stockproof treatments would be proposed to prevent local fauna crossing/penetrating the fence line. This may include mammal proof fencing or landscape-led elements such as hedgerows and dry-stone walling.

## Road Signs and Markings

- 2.4.36 Large Advanced and Local Direction Signs (ADS/LDS) are proposed in advance of the junctions on the mainline and the associated side roads and within the junctions, and at isolated locations along the mainline for destination information. Warning signs and regulatory signs are provided within the junctions and the side roads. The large ADS/LDS signs would be unlit but the smaller regulatory and warning signs (speed limit, give way, stop, roundabout ahead etc.) would require lighting.

## Technology

- 2.4.37 The current proposed scheme includes limited technology to support the maintenance and operation of the new road and has been developed in agreement with the Highways England Maintenance, Operations and Technology teams.

## Detrunking of A417

- 2.4.38 The existing A417 would be detrunked with some sections retained as lower-class public roads, maintaining local access for residents. Other sections would be returned to soft landscaping, with the road removed and partially re-surfaced with locally appropriate surfacing, bringing biodiversity and landscape benefits. Opportunities for WCH links along the detrunked route are also currently being explored with stakeholders.
- 2.4.39 The current A417 severs two SSSI's. The detrunking would link these SSSI's connecting habitats, particularly the Calcareous grassland.
- 2.4.40 Access would be granted for the maintenance of existing utilities within the existing A417 corridor. An easement would be agreed with the relevant utility companies. It is yet to be confirmed if a maintenance bay is required or would be provided. This would be confirmed at a later design stage.

## 2.5 Construction

### Construction Activities

- 2.5.1 The construction activities for the scheme would be typical of a major highway scheme and consist of the following
- advance/preparatory works to be undertaken prior to construction including advanced ecology mitigation (moving of badger setts and vegetation clearance etc.) and archaeological investigation;
  - aite establishment and any further vegetation clearance
  - main construction works involved in the scheme drainage and bulk earthworks and where needed statutory utility diversions;
  - junction bridge structure constructed at Shab Hill;

- road works and other associated side roads (including overbridges), WCH routes and ecology structures; and
- final tie-ins and soft landscape works

### **Construction Programme**

- 2.5.2 The start date for the construction phase would depend upon a number of factors including the grant of a development consent order. It is currently anticipated that the construction activities for the proposed scheme would commence in late 2021.
- 2.5.3 The construction programme would be finalised by the contractor in advance of the works. The duration of the works is currently estimated to require a construction period of at least 36 months.

### **Construction methods**

- 2.5.4 The construction of the proposed scheme would use typical construction techniques associated with major infrastructure projects.
- 2.5.5 Construction of the proposed scheme would require a large quantity of plant and equipment. The high volume of material to be moved would require large excavators, dump trucks, dozers, compactors plus graders, bowsers and stabilising plant. Plant numbers will be determined by the construction methodology.

### **Construction Environmental Management Plan**

- 2.5.6 The construction of the proposed scheme would be subject to measures and procedures defined within a Construction Environmental Management Plan (CEMP). The CEMP will be prepared in accordance with Interim Advice Note IAN 183/14. This would include the implementation of industry standard practice and control measures for environmental impacts arising during construction, such as the control of dust and the approach to waste management on site.
- 2.5.7 An outline CEMP will be prepared as part of the development of the construction methodology, whilst measures to be included within the outline CEMP will be defined in part by the requirements for mitigation which arise from the technical assessments within the EIA. The PEI Report discusses proposed mitigation to be included in the CEMP as appropriate in relation to the preliminary assessments, and the technical assessments presented in the ES will take account of the agreed measures within the Outline CEMP as '*embedded mitigation*'.

### **Temporary Works**

- 2.5.8 Full details of the temporary works including the temporary compounds and topsoil storage areas would be considered and reported in the Environmental Statement.

### Construction Compounds

- 2.5.9 It is currently proposed to include two main compounds and a crusher/material stockpile compound. The main compounds are proposed to be located at:
- chainage 0+000, located in the adjacent fields to the west bound carriageway; and

- chainage 5+200, located in the adjacent fields to the proposed Cowley Junctions on the eastbound carriageway.

2.5.10 A crusher/material stockpile compound is located:

- Chainage 2+700, located in the adjacent fields to the A436 side road.

2.5.11 Satellite compounds for the junction and side road overbridges and underbridge construction are located at the following locations:

- Green bridge;
- Shab Hill junction;
- Stockwell Farm overbridge; and
- Cowley Lane overbridge

#### Temporary Drainage

2.5.12 Where possible, the permanent earthworks drainage would be installed early, with cut-off ditches and filter drains, and these would manage the surface water run-off towards and within the site and discharge it into the existing watercourses via the temporary/permanent basins as required.

2.5.13 The contractor would also need to obtain temporary discharge consents from Gloucestershire County Council and Environment Agency. Temporary settlement basins / tanks would be used to ensure any site surface water discharge to the adjacent watercourses is of the required quality, with any suspended solids given the opportunity to settle out.

2.5.14 At watercourse crossings, during the construction of the permanent culverts, it is assumed that multiple temporary smaller pipes (same cross-sectional area as the existing) would be used adjacent to the new crossing with the watercourses locally temporarily realigned to suit.

#### **Diversion of Statutory Utilities**

2.5.15 Four Statutory Undertakers (SU's) with apparatus are identified as potentially being impacted as a result of the proposed scheme:

- Openreach;
- Western Power Distribution;
- Severn Trent Water; and
- Gigaclear.

2.5.16 The affected SU's plant is predominately located in Crickley Hill and alongside roads. The main exceptions are high voltage electricity cables and water mains which run through fields. Until the NRSWA Section 85 notice is served, there is a risk of additional services being installed in the area.

#### **Permanent and Temporary Land-Take**

2.5.17 Permanent land-take is required to construct, operate and maintain the proposed scheme and includes the footprint of all the proposed highway infrastructure, earthworks and drainage works, also includes the areas for environmental mitigation, such as landscape planting and areas of habitat replacement.

2.5.18 Temporary land-take is required to assist the contractor in the construction of the proposed scheme, including working areas, site compounds and topsoil storage

areas, and can also be required for the construction of part of the works with a permanent easement right acquired for operation and maintenance.

### **Demolition**

- 2.5.19 It is anticipated that the proposed scheme would require the demolition of one house (Woodside House) and one commercial property (The Air Balloon public house).
- 2.5.20 More details on the anticipated demolition would be provided within the Environmental Statement and the location would also be indicated on a plan within the Environmental Statement.

## **2.6 Decommissioning**

- 2.6.1 The traffic and economic assessment demonstrate the proposed improvements would operate adequately for the first 15 years of opening to the Design Year of 2039. Typically, highway schemes are designed to have a material life-span of between 20 and 40 years before major maintenance and upgrading is required dependant on material properties, maintenance and usage. Elements including structural concrete and steelwork have extended design lives of up to 120 years.
- 2.6.2 It is considered highly unlikely that the proposed scheme would be decommissioned after the various design life listed as the road is likely to have become an integral part of the infrastructure in the area. Decommissioning would not be either feasible or desirable and is therefore not considered further within this PEI Report.



## 3 Assessment of Alternatives

### 3.1 Introduction

- 3.1.1 This chapter presents a summary of the alternative options which have been considered and the justification for the A417 Missing Link scheme (the 'proposed scheme'). Developing alternative modes of transport to solve the identified capacity problem on the existing A417 Missing Link has been considered.
- 3.1.2 This chapter fulfils a condition of the Environmental Impact Assessment Regulations, which state, in section 5 (18.d), 'a description of the reasonable alternatives studied by the developer [must be provided], which are relevant to the proposed development and its specific characteristics, and [give] an indication of the main reasons for the option chosen, taking into account the effects of the development on the environment'.

### 3.2 Scheme History

- 3.2.1 The proposed scheme has been under consideration for over 20 years. Though 90% of the length of the A417/A419 – M4/M5 link had seen dual-carriageway improvements by 1998, the A417 Missing Link section, near Birdlip in Gloucestershire, had not been included. A study by the Highways Agency (now Highways England) between 2001 and 2003 concluded that a surface on-line dualling option would be appropriate for this section but development on the project, named the 'Modified Brown Route', stalled when it was not included in the National Roads Programme.
- 3.2.2 In December 2014, it was announced that the A417 Missing Link would be 1 of 15 new schemes to be included for development in the Department for Transport's £15.2 billion Road Investment Strategy (RIS1) as part of improvements to the strategic road network in England for delivery in the next Road Investment Strategy period (RIS2 2020-2025).

### 3.3 Selection of the Proposed Scheme

- 3.3.1 The process of options identification and route selection leading to the proposed scheme is in three stages:
- options identification;
  - options selection; and
  - option development.

#### Options identification

- 3.3.2 The process of options identification and route selection leading to the proposed scheme is summarised below. The process followed the following stages:
- option identification, initial sifting and appraisal;
  - options appraisal and sifting to identify options to take forward for further appraisal;
  - the selection of two preferred routes, which were taken to non-statutory public consultation in February and March 2018;
  - the selection of a Preferred Route which was announced by the Secretary of State in March 2019 and which forms the basis of the proposed scheme.

## Development of the Preferred Route

- 3.3.3 Table 3-1 summarises the process that has led to the development of the Preferred Route and includes the main reasons for selection of chosen options and the rejection of the alternatives, taking into account the effects of the development on the environment.

**Table 3-1 Development of the Preferred Route**

Options Identification Stage	Details
Option identification, initial sifting and appraisal	<p>A review of 30 route options was undertaken which included a mixture of on-surface and tunnel designs within five corridors. Due to the differing topography of the area, which requires different types of solutions, the various route options were characterised into different ‘escarpment zones’ in relation to where they crossed the escarpment, as shown in figure 3.1. This enabled the review and comparison of smaller groups of routes categorised by escarpment zone. These 30 route options are shown in figure 3.2.</p> <p>A multi-criteria assessment using the Client Scheme Requirements and the Early Assessment and Sifting Tool (EAST) from WebTAG was carried out. The EAST tool was modified (EAST+) for the A417 to provide a ranking between options and include additional criteria to represent the proposed scheme specific objectives developed collaboratively with stakeholders to reflect a landscape-led approach to the proposed scheme development. For further details on how the tool was modified, see section 6.3 of the Technical Appraisal Report<sup>3</sup>.</p> <p>From the initial sift of the 30 options, there were multiple high scoping options within single corridors. To ensure the sifting process was inclusive and robust, the best performing options from each corridor, under the above scoring system, were taken into the next element of evaluation. Thus, five corridor options were collated for evaluation. This ensured that a representative route option from each corridor was taken forward, resulting in six options being taken forward for further assessment.</p> <p>The Scheme Assessment Report provides an overview of the sifting process, associated assessment and stage conclusions. For full details refer to the Technical Appraisal Report.</p>
Options appraisal and sifting to identify options to take forward for further appraisal	<p>The Scheme Assessment Report states how six options – 3, 12, 21, 34, 29 and 30 were fully assessed and appraised following guidance set out in WebTAG to inform the choice of options to be taken to public consultation. These options are shown in figure 3.3 and comprised four tunnel options and two surface options.</p> <p>Appraisal Summary Tables (ASTs) were produced for each of the six options and can be found in appendix 3.1. The assessment and appraisal in Stage 2 are summarised below:</p> <ul style="list-style-type: none"> <li>• <u>Economic Appraisal</u> The tunnel options (options 3, 21, 24 and 29) all had high benefit values, however they were also shown to give poor value for money for the taxpayer. The most significant factor causing this was the high estimated costs of the tunnel options, all of which were estimated to cost significantly more than the upper limit of the cost range of £500 million. Options 12 and 30, the surface routes, had lower benefits but significantly lower costs.</li> </ul>

<sup>3</sup> Technical Appraisal Report, [https://highwaysengland.citizenspace.com/he/a417-missing-link/supporting\\_documents/A417%20Technical%20Appraisal%20Report.pdf](https://highwaysengland.citizenspace.com/he/a417-missing-link/supporting_documents/A417%20Technical%20Appraisal%20Report.pdf)

Options Identification Stage	Details
	<p>Option 30 was the only route to offer positive value for money, meaning the returns were estimated to be greater than the cost.</p> <ul style="list-style-type: none"> <li> <p><u>Environmental Assessment</u></p> <p>Across the areas assessed, option 21 was found to generally outperform the other options due to the length of the route within a tunnel, and the route avoiding sensitive areas. All options were identified to have net benefits in noise reduction compared to the existing route, however in all other areas the options showed disbenefits.</p> <p>Of the tunnelled solutions, options 24 and 29 were found to perform less well across all measures than options 3 and 21. Between the two surface options, there was little difference in the appraisal results. Option 30 was identified to outperform option 12 in noise reduction, however it was found to have lower air quality disbenefits.</p> </li> <li> <p><u>Social Assessment</u></p> <p>The routes largely performed at a similar level within the social appraisal area. The key differentiator between the routes in this area was the reduced journey time for commuters. Relative to the current route, the six options were found to deliver significant benefits in terms of net present value. The tunnel options were identified as delivering greater benefits than the surface routes; out of the two surface routes, option 30 delivered greater benefits than option 12.</p> </li> </ul> <p>The tunnel options were shown to give poor value for money for the taxpayer due to their estimated cost which was significantly more than the upper limit of the cost range of £500 million. Consequently, despite their high monetised and intangible benefits, these routes could not be recommended for further development. The two highest scoring surface options were taken forward.</p>
Recommended Route Options for Consultation	<p>The following options were taken forward for further appraisal and were presented at consultation:</p> <ul style="list-style-type: none"> <li> <p><u>Option 12</u>: a surface route with a mixture of widening of the existing road and construction of new sections of road, broadly following the route of the existing road whilst bypassing Nettelton Bottom. A map of option 12 can be seen in figure 3.4.</p> </li> <li> <p><u>Option 30</u>: a surface route characterised with the existing road on Crickley Hill widened. The road then takes a new route to the east, re-joining the existing A417 near Cowley roundabout. The existing road between Air Balloon roundabout and Cowley roundabout would be returned to the ownership of Gloucester County Council. A map of option 30 can be seen in figure 3.5.</p> </li> </ul> <p>These are described in section 6.3 and section 6.4 of the Scheme Assessment Report<sup>4</sup>. Appraisal and assessment of the two route options</p>
Identification of the Preferred Route	<p>The environmental assessment of the options presented for consultation led to a preferred option. The reasoning for the preferred option is set out in the Scheme Assessment Report which was published in March 2019 and provides a full description and assessment of the alternative options, including the public consultation and the recommendations of option 30 as the preferred route.</p> <p>Option 30 has greater support from the public, as shown by the results of the non-statutory public consultation. From an engineering perspective it provides a safer and higher quality road for all road users and road workers.</p>

<sup>4</sup> A417 The Missing Link: Scheme Assessment Report, Highways England (March 2019) Available at [https://highwaysengland.citizenspace.com/he/a417-missing-link/results/a417\\_missing\\_link\\_scheme\\_assessment\\_report.pdf](https://highwaysengland.citizenspace.com/he/a417-missing-link/results/a417_missing_link_scheme_assessment_report.pdf)

- 3.3.4 Full details of the options identification and selection process, along with the development of the Preferred Route can be found in the Scheme Assessment Report available at:

[https://highwaysengland.citizenspace.com/he/a417-missing-link/results/a417\\_missing\\_link\\_scheme\\_assessment\\_report.pdf](https://highwaysengland.citizenspace.com/he/a417-missing-link/results/a417_missing_link_scheme_assessment_report.pdf)

- 3.3.5 The preferred route for the A417 Missing Scheme was announced as a modified version of the route presented at consultation. Further details can be found in the Preferred Route Announcement<sup>5</sup>.

### 3.4 Development of the Proposed Scheme

- 3.4.1 The Secretary of State announced the Preferred Route on 4 March 2019 and it is this route which forms the basis for the proposed scheme considered within this PEI Report. Design development is ongoing, and is being informed by an iterative EIA process, consultation and evolving knowledge of the environment that would be affected by the proposed scheme.
- 3.4.2 The local design refinement options which have been considered within the development of the proposed scheme will be reported in the ES. The development of the proposed scheme design is being undertaken in accordance with the criteria for 'good design', outlined in the NPSNN.
- 3.4.3 The main reasons for the selection of chosen option and the rejection of the alternative, taking into account the consultation feedback and the effects of the development on the environment, will be reported in accordance with the requirements of the EIA regulations in the ES.

#### **A436 Alternative**

- 3.4.4 An assessment of the alternative routes for the A436 link road which were presented at the preferred route announcement in March 2019 has been carried out (see appendix 3.2). This has been informed by engagement with stakeholders such as local councils, environmental bodies, and other organisations as part of our ongoing engagement and assessment process. As a result of this assessment and engagement, Alternative 2 has been proposed as the preferred link to the A436.
- 3.4.5 This proposed link runs parallel to the new A417, linking the existing A436 by way of a new, smaller roundabout to the north of the Air Balloon roundabout. This preferred solution would reduce impact on the landscape by ensuring that as much of the surrounding land as possible is left as is. The preferred link would be single carriageway, with verges on each side. A junction would provide access to Birdlip Radio Station, as well as Shab Hill Barn and Farm. Our considerations for this decision are set out

#### Environment

- 3.4.6 Alternative 2 is preferred because it would provide greater opportunities to protect and enhance the environment. Alternative 2 would enable the removal of sections

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<sup>5</sup> A417 The Missing Link: Preferred Route Announcement, Highways England [https://highwaysengland.citizenspace.com/he/a417-missing-link/results/a417\\_pra\\_leaflet\\_digital\\_final.pdf](https://highwaysengland.citizenspace.com/he/a417-missing-link/results/a417_pra_leaflet_digital_final.pdf)

of the existing A417, meaning that there is potential to improve routes for walkers, cyclists and horse riders, as well as provide ecological benefits.

- 3.4.7 There are also a number of important cultural heritage sites close to the scheme. Alternative 2 would have less of an impact on these areas, as the new road infrastructure is proposed to be located closer to the new A417 main carriageway. This would also reduce how much land is needed to build the scheme and the impact on private properties.

#### Traffic

- 3.4.8 The traffic assessments show that Alternative 2 would reduce rat running through local villages, providing significant benefits for surrounding communities. However, Alternative 2 would increase traffic flows around Leckhampton Hill and it is expected to see slightly longer journey times for some local journeys, except between the A436 and the A417.

#### National Policy Statements for National Networks (NPSNN)

- 3.4.9 Alternative 2 would be more likely to fulfil the requirements of the NSPNN. The risks of not complying with the NPSNN for Cultural Heritage, Population and Health, Landscape and Visual and Biodiversity would all be reduced for Alternative 2 due to the opportunities for mitigation and enhancement in these areas. Air quality would likely be improved by all three alternatives, reducing the amount of NO<sub>2</sub> to below the air quality objective level. There would be no difference in terms of water quality and flood risk compliance between the 3 alternatives.

#### Design

- 3.4.10 The assessments show that Alternative 2 would be the least disruptive to the environment, wildlife, walkers, cyclists, horse riders and other road users during construction because large amounts of it are proposed to be offline. It would have the least number of new bridges and provides opportunities to reuse materials during construction, minimising the amount taken off site.
- 3.4.11 The scoring for this assessment in the table below uses scores from 1 – 3, with 1 being positive and 3 being negative.
- 3.4.12 Alternatives were scored in terms of the opportunity they presented. A rating of 1 offers the most opportunity, whereas a rating of 3 offers the least. This is presented in Table 3-2.

**Table 3-2 Alternatives summary matrix**

Topic	Alternative 1	Alternative 2	Alternative 3
Environment	3	1	2
Traffic	3	2	1
NPSNN	3	1	2

## 4 Environmental Assessment Methodology

### 4.1 Introduction

- 4.1.1 This chapter of the PEI Report details the approach taken to undertake the Environmental Impact Assessment (EIA) of the proposed scheme. The chapter introduces the requirements of the Design Manual for Roads and Bridges (DMRB) and sets out the overall approach to the assessment of the likely effects of the Proposed scheme.
- 4.1.2 The adopted scope, approach and method of assessment for each topic are outlined in the topic specific chapters (chapters 5-14), with further details such as survey methods provided.

### 4.2 Environmental Scoping

- 4.2.1 A scoping report<sup>6</sup> was prepared for the proposed scheme to inform the request for a scoping opinion from the Planning Inspectorate (PINS). The scoping report sets out the proposed scope of work and methods to be applied in carrying out the EIA, and the proposed structure of the Environmental Statement. The scoping report was submitted to PINS on 14 May 2019.

#### Scope of assessment

##### Scoped in

- 4.2.2 The environmental assessment will consider the following environmental topics in line with the requirements of the EIA Directive (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):
- air quality
  - cultural heritage
  - landscape
  - biodiversity
  - geology and soils
  - material assets and waste
  - noise and vibration
  - population and human health
  - road drainage and the water environment
  - climate
- 4.2.3 The PEI Report also considers the vulnerability of the proposed development to major accidents or disasters (within the appropriate chapters) that are relevant to that development. This is covered in further detail in section 4.7.

##### Scoped out

- 4.2.4 The Infrastructure Planning (EIA) Regulations 2017 have also introduced the requirement for the emission of heat and radiation to be considered. The

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<sup>6</sup> Available at <https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/TR010056/TR010056-000009-A417%20-%20Scoping%20Report.pdf>

proposed scheme does not introduce any sources of heat and radiation and there are no sensitive receptors (for example, hospitals or schools) within the route corridor. Hence the topic of heat and radiation has been scoped out based on negligible risk.

- 4.2.5 In response to the scoping report, the Inspectorate stated that *“owing to the nature of the Proposed Development it is considered unlikely that heat and radiation effects associated with the proposals are likely to arise. Given this, any further assessment has been scoped out. The Inspectorate considers that this is a reasonable approach to adopt.”*
- 4.2.6 In response to the scoping report, Public Health England (PHE) requested that the possible health impacts of Electric and Magnetic Fields (EMF) should be considered. The proposed development does not impact any receptors from potential sources of EMF. The proposed scheme would not give rise to significant effects of this sort. Therefore, an assessment of EMF would not be carried out. EMP have subsequently been scoped out of the assessment.

### 4.3 Surveys and Predictive Techniques and Methods

#### Requirements of DMRB

- 4.3.1 All aspects of the development and design of major highway projects are governed by guidance set out in the volumes of the DMRB. Guidance on EIA for highway projects is given in volume 11<sup>7</sup>, with guidance on environmental design in volume 10<sup>8</sup>. DMRB is constantly being amended and additional supplementary guidance is provided by Interim Advice Notes (IANs)<sup>9</sup>.
- 4.3.2 All EIA work and environmental reporting on the proposed scheme has been undertaken in accordance with guidance set out in DMRB and the relevant IANs.
- 4.3.3 DMRB guidance on EIA sets out three ‘levels’ of EIA assessment and reporting: *‘scoping’*, *‘simple’* and *‘detailed’*. These levels are not intended to be sequential (i.e. applied one after another in order), but ‘consequential’, in that the level to be applied at any stage of environmental reporting is determined on a topic-by-topic basis according to the following factors:
- the results of any previous assessment work (especially the scoping report);
  - the likely scale or significance of impact (not the scale of development);
  - the nature of the decision-making process to which the report relates; and
  - the degree of uncertainty about the potential impact of the proposed scheme.
- 4.3.4 Guidance published in DMRB or in Highways England’s IANs for most topics defines topic specific requirements for each level of assessment and reporting. The levels of assessment to be applied to the various topics in this scoping report are given in each of the specialist topic chapters (chapters 5 -14).

<sup>7</sup> <http://www.standardsforhighways.co.uk/ha/standards/dmr/vol11/index.htm>

<sup>8</sup> <http://www.standardsforhighways.co.uk/ha/standards/dmr/vol10/index.htm>

<sup>9</sup> <http://www.standardsforhighways.co.uk/ha/standards/ians/>

### **Study area and proposed scheme boundary**

- 4.3.5 The study area assessed for the PEI Report for each environmental topic is described in the relevant topic chapter (chapters 5 to 14). The study area is based on the proposed scheme boundary presented in figure 2.1 General Arrangement.
- 4.3.6 The proposed scheme boundary was based on the land anticipated to be potentially required temporarily and/or permanently for the construction, operation and maintenance of the proposed scheme at the time of preparation of the EIA scoping report.
- 4.3.7 Since completing the PEI Report, the design of the proposed scheme has continued to be developed and the proposed scheme boundary has been reviewed and refined as appropriate to reflect the latest scheme requirements at the time of consultation.
- 4.3.8 Study areas have been defined individually for each environmental topic, taking account of guidance published in DMRB, new emerging guidance, the geographic scope of the potential impacts relevant to that topic or of the information required to assess those impacts. The study areas are described within each relevant chapter of this report.
- 4.3.9 The study area for environmental impact assessment for each environmental topic incorporates the proposed scheme boundary as a minimum for the proposed scheme.
- 4.3.10 The EIA and ES will be based on the final proposed scheme boundary presented in the DCO application.

### **Identification of baseline and future conditions**

- 4.3.11 In order to identify the effects of the proposed scheme on the environment, it is important to understand the environment that would be affected by the proposed scheme (the 'baseline conditions'). Understanding the baseline allows the measurement of changes that would be caused by the proposed scheme.
- 4.3.12 The baseline conditions are not necessarily the same as those that exist at the current time; they are the conditions that would exist in the absence of the proposed scheme either (a) at the time that construction is expected to start, for impacts arising from construction or, (b) at the time that the proposed scheme is expected to open to traffic, for impacts arising from the operation of the proposed scheme. Therefore, the identification of the baseline conditions involves predicting changes that are likely to happen in the intervening period, for reasons unrelated to the proposed scheme. This will entail taking current conditions and committed development into consideration and using experience and professional judgment to predict what the baseline conditions might look like prior to start of construction and operation.
- 4.3.13 The PEI Report presents baseline information representing the understanding at the time of writing. The baseline will become further developed as additional surveys are undertaken and data obtained and will be presented in the ES.
- 4.3.14 It is essential for an EIA that sufficient data is obtained to form the basis of the assessment. Each topic chapter will include a description of the current (baseline) environmental conditions. This is based on the study area identified for each topic chapter.



4.3.15 This PEI Report presents baseline information representing the understanding at the time of writing. This baseline will become further developed as additional surveys are undertaken and data obtained and will be presented in the ES.

### **Defining assessment years and scenarios**

4.3.16 The assessment of effects involves comparing a scenario with the proposed scheme against one without the proposed scheme over time. The absence and presence of a proposed scheme are referred to as the 'Do Minimum' and 'Do Something' scenarios respectively. The 'Do Minimum' scenario represents the future baseline with minimal interventions and without new infrastructure.

4.3.17 Depending on the topic, the effects in this PEI Report (and in the ES) are assessed for the 'Do Minimum' and 'Do Something' scenarios in the baseline year.

4.3.18 The following scenarios have been considered (without the proposed scheme), where relevant, for comparison against the situation with the proposed scheme in place:

- The baseline year for the assessment is topic specific and is dependent on the availability of existing data and new surveys.
- The start of construction is late 2021.
- The whole scheme is operational from 2024.
- The design year, 15 years after opening is 2039.

### **Combined and cumulative effects**

4.3.19 Combined and cumulative effects result from multiple actions on receptors over time and are generally additive or interactive (synergistic) in nature. They can also be considered as effects resulting from incremental changes caused by other past, present or reasonably foreseeable actions together with the project, identified as:

- combined effects from a single project (the interrelationship between different environmental factors); and
- cumulative effects from different projects (with the project being assessed).

4.3.20 Further details on the method for this assessment is provided in chapter 15. The combined and cumulative effects of the proposed scheme in conjunction with other proposed developments would be assessed and the findings will be presented within the ES.

## **4.4 Other Studies**

### **Habitats Regulations Assessment**

4.4.1 A Habitat Regulations Assessment (HRA) Screening will be undertaken for each Special Area of Conservation (SAC) and Special Protection Area (SPA) which could be affected. Where there is a likely significant effect this will determine any requirement for an Appropriate Assessment. The HRA Screening and any subsequent assessments will define any requirement for mitigation that is necessary to ensure there is no adverse effect on the integrity of these sites, alone or in combination with other plans and projects. Any required mitigation would then be incorporated into the proposed scheme. Details of these

assessments will be included within the ES and the full reports will accompany the DCO application.

### **Water Framework Directive Assessment**

- 4.4.2 A Water Framework Directive (WFD) Assessment will be undertaken and a WFD assessment report produced alongside the ES. This report will consider the extent to which the proposed scheme could impact on the current and future target WFD status of the water bodies. Where potential adverse effects are identified, an assessment of these will inform what mitigation measures need to be incorporated into the design and construction methods of the proposed scheme to remove or minimise the effect. The results will be presented in the ES.

## **4.5 General Assessment Assumptions and Limitations**

### **Dealing with uncertainty**

- 4.5.1 In assessing the effects of the proposed scheme from an environmental perspective, the principle of the 'Rochdale Envelope' would be applied, in accordance with PINs advice note nine: Rochdale Envelope<sup>10</sup>.
- 4.5.2 At the current stage in the design process, absolute certainty about construction timing, phasing and methodology is not possible. It is anticipated that as the design develops more certainty will be gained. This will be documented in the environmental statement.

### Limits of Deviation

- 4.5.3 The draft Development Consent Order (DCO) will define limits of deviation (LOD). All limits of deviation are within the Rochdale envelope approach.
- 4.5.4 LOD are the limits within which the DCO authorises the A417 to be constructed. The LOD allows limited flexibility in the positioning of the highway in order that it can be positioned optimally reflecting factors identified during the detailed design of the proposed scheme or even during construction. Changes to the indicative route may occur typically as a result of ground conditions or environmental factors which it may not be possible to identify in the period prior to the DCO application. The LOD allow for a small tolerance with respect to any distances and points shown on the plans accompanying the application, although all works will take place within the LOD, the extent of which will be subject to full consideration as part of the Environmental Impact Assessment (EIA) for the proposed scheme.
- 4.5.5 The DCO will allow for the proposed scheme to be constructed within the LOD. This will include a vertical deviation and a lateral deviation. As a result, there is some necessary flexibility as to the exact proposed scheme detail taken through to construction.
- 4.5.6 The LOD, will be contained in the DCO, and will be considered within the topic specific chapters of the ES by those undertaking assessments, having regard to the scope for change from the highway alignment.

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<sup>10</sup> Planning Inspectorate (July 2018) Using the Rochdale Envelope, Version 3  
<https://infrastructure.planninginspectorate.gov.uk/wp-content/uploads/2013/05/Advice-note-9.-Rochdale-envelope-web.pdf>

## 4.6 Significance Criteria

### Environmental Assessment Methodology

#### Relevant EIA guidance

4.6.1 The EIA process has taken into account relevant guidance, including the following.

- Design Manual for Roads and Bridges (DMRB) Volume 11, Section 1 Introduction, LA 101 Introduction to Environmental Assessment<sup>11</sup>.
- DMRB Volume 11, Section 2 General Principles of Environmental Assessment, including LA 102<sup>12</sup>, LA 103<sup>13</sup> and LA 104<sup>14</sup>.

4.6.2 Other topic specific legislation and good practice guidance has been considered and details of these can be found in the topic chapters within this PEI Report.

#### Key elements of the general approach

4.6.3 The assessment of each environmental topic forms a separate chapter of this PEI Report. For each environmental topic chapter within this PEI Report, the following has been addressed in conformity to DMRB and EIA Regulations.

- legislative and policy framework;
- definition of the study area;
- identification of potential impacts (including effects arising during the construction and operational phases);
- assessment methodology;
- description of the baseline environmental conditions;
- details of any consultation;
- assessment assumptions and limitations (include the gaps and uncertainties for the purpose of this PEI Report);
- identification of design, mitigation and enhancement measures, where appropriate;
- an assessment of the effects of the proposed scheme; and
- details of any monitoring requirements.

4.6.4 Each topic chapter provides details of the methodology for baseline data collection and evaluation of effects based on EIA good practice guidance documents, new emerging guidance and relevant topic specific guidance where available.

4.6.5 The methodology for cumulative effects with other proposed developments is presented in chapter 15.

### **Assessment of effects**

4.6.6 The EIA process requires the identification of the likely significant environmental effects of the proposed scheme. This includes consideration of the likely effects during the construction and operational phases of the proposed scheme.

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<sup>11</sup> Available at: <http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol11/section1/la101.pdf>

<sup>12</sup> Available at: <http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol11/section2/la102.pdf>

<sup>13</sup> Available at: <http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol11/section2/la103.pdf>

<sup>14</sup> Available at: <http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol11/section2/la104.pdf>

4.6.7 Volume 11, section 2 of DMRB LA 104<sup>15</sup> provides guidance on the determination of significance of environmental effects for highway schemes. This includes consideration of the following;

- Assigning value (or sensitivity) of receptors;
- Assigning magnitude of impact; and
- Assigning significance.

#### Assigning value of receptors

4.6.8 Receptors are defined as individual environmental features that have the potential to be affected by a proposed scheme. For each topic, baseline studies have informed the identification of potential environmental receptors. Some receptors will be more sensitive to certain environmental effects than others. The sensitivity or value of a receptor may depend, for example, on its frequency, extent of occurrence or conservation status at an international, national, regional or local level.

4.6.9 Sensitivity is defined within each PEI Report topic chapter and takes into account factors including the following:

- Vulnerability of the receptor to change;
- Recoverability of the receptor (ability of recover from a temporary impact); and
- Importance of the receptor.

4.6.10 As a general guide, the definitions set out in Table 3.2N of DMRB LA 104 have been taken into account (except where topic guidance requires otherwise). This includes a five-point scale for assigning environmental value or sensitivity as shown in Table 4-1 below.

**Table 4-1 Environmental value (sensitivity) and descriptions**

<b>Value (sensitivity) of receptor/resource</b>	<b>Typical description</b>
Very High	Very high importance and rarity, international scale and very limited potential for substitution.
High	High importance and rarity, national scale, and limited potential for substitution.
Medium	High or medium importance and rarity, regional scale, limited potential for substitution.
Low	Low or medium importance and rarity, local scale.
Negligible	Very low importance and rarity, local scale.

Based on Table 3.2N of DMRB LA 104

#### Magnitude of impact

4.6.11 In line with DMRB LA 104 the magnitude of impacts on receptors shall be reported within the environmental assessments. The descriptions for magnitude of impact (as outlined in Table 4-1) shall be applied by the project. Where relevant, individual environmental factors can set out variations in magnitude description requirements.

<sup>15</sup> Available at: <http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol11/section2/la104.pdf>

- 4.6.12 For each topic, the likely environmental impacts have been identified and will be refined further within the ES. The likely environmental change arising from the proposed scheme has been identified and compared with the baseline (the situation without the proposed scheme). Impacts are divided into those occurring during the construction and operation phases.
- 4.6.13 As a general guide, the definitions set out in Table 3.4N of DMRB LA 104 have been taken into account (except where topic guidance requires otherwise). This includes a five-point scale for assigning impact magnitude as shown in Table 4-2.

**Table 4-2 Magnitude of Impact and typical descriptions**

Magnitude of Impact		Typical criteria descriptions
Major	Adverse	Loss of resource and/or quality and integrity of resource; severe damage to key characteristics, features or elements.
	Beneficial	Large scale or major improvement of resource quality; extensive restoration or enhancement; major improvement of attribute quality.
Moderate	Adverse	Loss of resource, but not adversely affecting the integrity; partial loss of/damage to key characteristics, features or elements.
	Beneficial	Benefit to, or addition of, key characteristics, features or elements; improvement of attribute quality.
Minor	Adverse	Some measurable change in attributes, quality or vulnerability; minor loss of, or alteration to, one (maybe more) key characteristics, features or elements.
	Beneficial	Minor benefit to, or addition of, one (maybe more) key characteristics, features or elements; some beneficial impact on attribute or a reduced risk of negative impact occurring.
Negligible	Adverse	Very minor loss or detrimental alteration to one or more characteristics, features or elements.
	Beneficial	Very minor benefit to or positive addition of one or more characteristics, features or elements.
No change		No loss or alteration of characteristics, features or elements; no observable impact in either direction.

Based on Table 3.4N of DMRB LA 104

### Assigning Significance

- 4.6.14 In DMRB LA 104<sup>16</sup> it states the significance of effects must be reported in accordance with the EIA Directive. The descriptions for significance to be applied are outlined in Table 4-3.
- 4.6.15 DMRB LA 104 recognises “*the approach to assigning significance of effect relies on reasoned argument, the professional judgement of competent experts and using effective consultation to ensure the advice and views of relevant stakeholders are taken into account.*”
- 4.6.16 Where relevant, individual environmental factors can set out variations in significance description requirements. Each chapter defines the approach taken to the assessment of significance. Where appropriate, topic chapters have adopted the general approach set out in DMRB LA 104 (see Table 4-3).
- 4.6.17 The evaluation of significance takes into account industry and professional guidance, codes of practice, policy objectives regulations or standards, advice

<sup>16</sup> Available at: <http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol11/section2/la104.pdf>

from statutory consultees and other stakeholders, as well as expert judgement of the EIA practitioners, based on specialist experience. For some topics, a simplified or quantitative approach is considered appropriate.

**Table 4-3 Significance Matrix**

		Magnitude of change				
		No change	Negligible	Minor	Moderate	Major
Environmental Value (Sensitivity)	Negligible	Neutral	Neutral	Neutral or slight	Neutral or slight	Slight
	Low	Neutral	Neutral or slight	Neutral or slight	Slight	Slight or moderate
	Medium	Neutral	Neutral or slight	Slight	Moderate	Moderate or Large
	High	Neutral	Slight	Slight or moderate	Moderate or Large	Large or Very Large
	Very High	Neutral	Slight	Moderate or Large	Large or Very Large	Very Large
	Very High	Neutral	Slight	Moderate or Large	Large or Very Large	Very Large

Based on Table 3.8.1 of LA 104

- 4.6.18 Where Table 4-3 includes two significance categories, evidence should be provided to support the reporting of a single significance category.
- 4.6.19 Slight, moderate, large or very large effects may be beneficial or adverse. Except where guidance requires otherwise, the significance of effect is described using the terms very large, large, moderate, slight and neutral. In terms of the EIA Regulations, 'significant' effects are generally those where the significance of the effect is 'moderate' or greater. Effects determined to be slight or neutral are deemed 'non-significant', and as such will not be reported in detail in the ES and will not require specific mitigation. The exception to this is where the combination of multiple slight effects has the potential to lead to a significant (i.e. moderate or above) cumulative effect.
- 4.6.20 Not all of the environmental topics will use the above criteria or approach. For example, some topics do not use a matrix-based approach but instead use numerical values to identify impacts (e.g. Noise and vibration) and some topics do not have agreed methods of assessment or scales of measurement for either value or sensitivity (e.g. Geology and soils). Therefore, each environmental topic specialist will use the information provided above, their topic specific guidance as well as their professional judgement to assess the significance of effects.
- 4.6.21 The assessment of the significance of environmental effects shall cover the following factors:
- the receptors/resources (natural and human) which would be affected and the pathways for such effects;
  - the geographic importance, sensitivity or value of receptors/resources;
  - the duration (long or short term); permanence (permanent or temporary) and changes in significance (increase or decrease);
  - reversibility - e.g. is the change reversible or irreversible, permanent or temporary;
  - environmental and health standards (e.g. local air quality standards) being threatened; and
  - feasibility and mechanisms for delivering mitigating measures, e.g. Is there evidence of the ability to legally deliver the environmental assumptions which are the basis for the assessment?

## 4.7 Design and Mitigation

- 4.7.1 One of the key requirements of an EIA is that measures are taken to avoid, reduce and, where possible, remedy significant adverse environmental effects. These are termed mitigation measures and their development is part of an iterative EIA process.
- 4.7.2 Environmental assessment and design shall incorporate mitigation measures using a hierarchical system as per Table 4-4.

**Table 4-4 Mitigation hierarchy**

Mitigation hierarchy	Description
1 avoidance and prevention	Design and mitigation measures to prevent the effect (e.g. alternative design options or avoidance of environmentally sensitive sites);
2 reduction	Where avoidance is not possible, then mitigation is used to lessen the magnitude or significance of effects;
3 remediation	Where it is not possible to avoid or reduce a significant adverse effect, these are measures to offset the effect.

- 4.7.3 Mitigation measures shall be developed in response to the findings of surveys, initial assessments and consultation. These mitigation measures shall be designed principally to address impacts whose occurrence, timing and location can be predicted in advance and are intrinsic to the design of the proposed scheme.
- 4.7.4 Environmental assessment shall report on the following categories of mitigation:
- embedded mitigation: project design principles adopted to avoid or prevent adverse environmental effects; and
  - essential mitigation: measures required to reduce and if possible offset likely significant adverse environmental effects, in support of the reported significance of effects in the environmental assessment.

### Embedded mitigation

- 4.7.5 The first preference in mitigating any impact is to seek engineering design measures to entirely avoid or eliminate the impact. Where this is not possible, the mitigation should seek to reduce the magnitude of the impact. Impacts can be avoided or reduced, for instance, through changes to the horizontal or vertical alignment of the proposed scheme, junction strategy or other aspects of the proposed scheme layout; or through changes in the methods and / or materials to be used in construction.
- 4.7.6 The proposed scheme assessed within this PEI Report includes a number of engineering design measures that have been designed to avoid or reduce significant adverse environmental effects arising, where practicable. Those measures forming part of the proposed scheme design are summarised within chapter 2. Such measures are therefore not proposed or reported in this PEI Report as mitigation.

### Essential mitigation

- 4.7.7 Where avoidance of an impact through engineering design measures is not possible, or is only partly effective, further mitigation measures may be required. Essential mitigation falls into three broad categories:

- Measures that do not remove an impact but make it less significant. A typical example on the proposed scheme includes planting trees to screen views of the road where it is visually intrusive.
- The like-for-like replacement of a feature that would be lost. For example, this includes the creation of hedgerows on the proposed scheme alignment to replace those that cannot be avoided.
- The provision of a beneficial effect that is related to the impact but is not a like-for-like replacement of the feature to be lost. A typical example would be the construction of a bridge to replace an existing culvert, allowing associated watercourse renaturalisation and improving the wildlife corridor function.

4.7.8 Mitigation measures can produce adverse as well as beneficial effects e.g. an environmental noise barrier can increase visual intrusion.

4.7.9 Measures identified during the EIA process to further prevent, reduce and, where possible, offset any adverse effects on the environment will be shown on Environmental Master Plans within the ES.

4.7.10 The essential mitigation measures identified in the topic chapters of the ES will be summarised in the Register of Environmental Actions and Commitments (REAC) in the Outline CEMP as part of the ES. They will also be included in the Environmental Masterplans and described in the relevant topic chapters of the ES.

4.7.11 Significance of an effect shall be reported after an assessment of the effectiveness of the design and mitigation measures (the residual effect). Assigning significance to an effect after an assessment of the effectiveness of the design allows for positive contribution of all mitigation that is effective, deliverable and committed.

### **Construction mitigation**

4.7.12 There are potential impacts to the environment that could occur as a result of the construction process including accidental occurrences during construction. The timing and location of these impacts cannot be accurately predicted at this stage. An example would include accidental spillages of fuels, oils or other chemicals.

4.7.13 The assessment will consider reasonably foreseeable construction impacts. The likelihood of occurrence and the severity of any such incidents can be reduced through good construction site management practices. To help ensure adequate consideration of risks identified during the EIA which would relate to the construction period, an outline Construction Environmental Management Plan (CEMP) will be prepared. This will set out how construction stage mitigation measures would be implemented to manage those risks and certain requirements for the contractors.

4.7.14 The Outline CEMP included in the ES will detail the roles and responsibilities, control measures, training and briefing procedures, risk assessments and monitoring systems to be employed during planning and construction for all relevant environmental topic areas.

4.7.15 Each PEI Report topic chapter describes measures identified to date to be adopted during construction to avoid and reduce environmental effects, such as pollution control measures.



## **Implementation and enforcement of mitigation**

- 4.7.16 Mitigation will be secured by way of Requirements in the DCO. The proposed scheme must comply with these requirements.
- 4.7.17 A CEMP will be implemented and is secured through a Requirement of the DCO. This will be approved in line with the Outline CEMP submitted with the DCO application as part of the Environmental Statement.
- 4.7.18 Contractors at detailed design and construction will be obliged to comply with the Requirements of the DCO.
- 4.7.19 As part of the DCO application, a Mitigation Route Map will be prepared to demonstrate that all necessary controls and mitigation for the project have been identified and secured. It will provide an audit trail of the controls and mitigation measures and will set out the way in which they will be translated into clear and enforceable controls.

## **4.8 Environmental Enhancement**

- 4.8.1 Enhancement is a measure that is over and above what is required to mitigate the adverse effects of a proposed scheme. Enhancement opportunities will be considered throughout the design development and shall be reported within the ES.
- 4.8.2 The following items may be relevant to the design and delivery of enhancement opportunities:
- national and local policy requirements;
  - policy and performance requirements of the Overseeing Organisation; and
  - project specific objectives.
- 4.8.3 Where essential mitigation is being delivered for other purposes, this offers an enhancement opportunity where it does not compromise the original objective of that land.

## **4.9 Monitoring**

- 4.9.1 Where the environmental assessment reported in the ES concludes that there are significant adverse environmental effects, projects must undertake proportionate monitoring of associated mitigation measures, in accordance with the EIA Directive.
- 4.9.2 Mitigation and monitoring measures shall be identified and developed through the design and environmental assessment process and initially documented in the ES.
- 4.9.3 Monitoring measures should be undertaken as required during construction, handover and through the operation and maintenance periods.

## **4.10 Major Accidents and Disasters**

- 4.10.1 This section of the PEI Report covers the methodology for assessing the potential vulnerability of the proposed scheme to major accidents and disaster (hereafter referred to as major events) and considering the potential for likely significant environmental effects arising from such an event. There is currently no DMRB guidance on how this assessment should be undertaken.

## Legal framework

- 4.10.2 The assessment of the vulnerability of the proposed scheme to major accidents and disasters is considered following changes to EU and UK legislation. The EIA Regulations 2017 require an assessment of *'the expected significant adverse effects of the development on the environment deriving from the vulnerability of the development to risks of major accidents and/or disasters which are relevant to the project concerned'*.
- 4.10.3 The proposed scope of the assessment in relation to major events will be in line with the EIA Regulations. The scope of the assessment will cover:
- Vulnerability of the project to risks of major events; and
  - Any consequential changes in the predicted effects of that project on environmental factors.

## Terminology

- 4.10.4 Major events shall include both man-made and naturally occurring events.
- 4.10.5 For the purposes of this assessment, a major accident is defined as an event that threatens immediate or delayed serious damage to human health, welfare and/or environment and requires the use of resources beyond those of the client or its contractors to manage.
- 4.10.6 A disaster is defined as a naturally occurring phenomenon such as an extreme weather event (e.g. storm, flood, temperature) or ground-related hazard events (e.g. subsidence, landslide, earthquake) with the potential to cause an event or situation that meets the definition of a major accident.
- 4.10.7 Vulnerability refers to 'exposure and resilience' of the proposed scheme to the risk of a major accident and/or natural disaster in the context of the 2014 EU EIA Directive. An identified, unplanned event, which is considered relevant to the proposed scheme and has the potential to be a major accident or natural disaster subject to assessment of its potential to result in significant adverse effect on an environmental receptor is referred as a risk event.

## Methodology

- 4.10.8 To address the requirements of the EIA Regulations, the factor of major accidents and disasters will be assessed as part of the ES. In considering the elements of vulnerability, professional judgement will be applied to develop scheme specific definitions of major events.
- 4.10.9 Major events that are relevant to and can affect a project, both man-made and naturally occurring, will be identified. Where major events are identified, the potential for any change in the assessed significance of the proposed scheme on relevant environmental topics will be described in qualitative terms and likely mitigation measures will be included as part of the assessment. The potential receptors of impacts resulting from major events are all reported in the relevant topic chapters of this report, and as such major events is not included as a standalone chapter. Relevant major events will, therefore, be reported in the project description section of the ES, whilst any consequences for receptors will be reported in the applicable topic chapters as appropriate.

4.10.10 With regards to the methodology, the assessment will assess the potential for significant effects (during construction and operation) of major accidents and disasters that:

- **Stage 1:** a long list of possible major events ('risks') will be developed. This list will draw upon a variety of sources, including the UK National Risk Register of Civil Emergencies<sup>17</sup>, the proposed scheme risk register and the proposed scheme design hazard assessment log;
- **Stage 2:** a screening exercise will be undertaken to review the long list of major events and to consider their relevance to the proposed scheme, and therefore whether they should be included on the project specific short list of events requiring further consideration; and
- **Stage 3:** where further design mitigation is unable to remove the potential interaction between a major event and a particular topic, the relevant ES chapter will identify the potential consequence for receptors covered by the topic and give a qualitative evaluation of the potential for the significance of the reported effect to be increased as a result of a major event.

4.10.11 A general guideline for screening is that risks can be screened out if:

- There is no source-pathway-receptor linkage.
- The receptor is not within scope, as defined through scoping.
- The consequence does not meet the criteria of 'serious damage' and therefore, the risk is not a potential major accident or disaster.
- The consequence and likelihood of the risk is high, such that it is considered unreasonable to the project therefore will be designed out or managed.

4.10.12 Where events identified during this process are not already being considered within existing chapters of the ES, they will continue to be reviewed with the design team to ensure the risks are understood and addressed through design as necessary.

### **Assessment on major events**

4.10.13 A long list of possible major events will be developed and included in in the ES. Major risk events to which the proposed scheme may be vulnerable during the construction phase and operation phase will be included.

4.10.14 The long list of risk events will be assessed to consider their relevance to the proposed scheme. Major risk events will be scoped in and short-listed and will be reported within the relevant chapters of the ES.

## **4.11 Consideration of Climate Change**

4.11.1 The PEI Report considers effects related to climate change as per the requirements of EU Directive 2014/52 and the 2017 EIA Regulations. Chapter 14 outlines the assessment of the effect of the scheme on climate and the vulnerability of the scheme to climate change. The combined effects of the proposed scheme and potential climate change on the receiving environment, resources, and community (the in-combination climate change impacts) are considered in for each topic chapter of the PEI Report.

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<sup>17</sup> National Risk Register (NRR) of Civil Emergencies – 2017 Edition available at <https://www.gov.uk/government/collections/national-risk-register-of-civil-emergencies>

- 4.11.2 Climate change projections have been embedded into the future baseline of the technical assessments. Current and future climate baselines are outlined in chapter 14 for key climate parameters, including winter and summer temperature and precipitation, using UK Climate Projections 2018 (UKCP18).
- 4.11.3 Climate change is considered in both the assessment of scheme effects and the design of mitigation and enhancement measures. This consideration is qualitative in the PEI Report, based on the future climate trends outlined in chapter 14. Where possible, a quantitative assessment will be integrated into the assessments for the ES.

## **4.12 Transboundary Effects**

- 4.12.1 Regulation 32 of The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 requires the consideration of any likely significant effects on the environment of another European Economic Area (EEA) State.
- 4.12.2 Guidance on the consideration of transboundary effects is provided in Planning Inspectorate's Advice Note Twelve: Development with significant transboundary impacts consultation<sup>18</sup>.
- 4.12.3 Having considered the nature and location of the proposed scheme, it is unlikely to have a significant effect either alone or cumulatively on the environment in other EEA states. For the avoidance of doubt, the ES details any such consideration and assessment.

## **4.13 Competent Expert Evidence**

- 4.13.1 The EIA Regulations require that the ES is prepared by 'competent experts'. The EIA is being undertaken by Arup on behalf of Highways England. Arup has been awarded the EIA Quality Mark from the Institute of Environmental Management and Assessment (IEMA), demonstrating competency in ES preparation. At the individual level, the EIA is being undertaken by competent experts with the relevant and appropriate experience in their respective topics.
- 4.13.2 The professional qualifications and experience of each of the EIA technical leads are summarised in appendix 1.1.

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<sup>18</sup> Planning Inspectorate (March 2018) Advice Note Twelve: Transboundary impacts and process, Version 5 available at <https://infrastructure.planninginspectorate.gov.uk/wp-content/uploads/2013/04/Advice-note-12v2.pdf>

## 5 Air Quality

### 5.1 Introduction

- 5.1.1 Air quality is a consideration in any development proposal involving significant changes in the nature and location of emissions of pollutants to air. The proposed scheme would change the flows on both existing roads and other roads in a wider surrounding area. This would result in changes to pollutant emissions from vehicle traffic on the affected roads and thus changes in pollutant concentrations at nearby receptors.
- 5.1.2 The scoping report determined that a 'detailed' level of assessment is required with regard to air quality and this level of assessment will be undertaken for the EIA and reported in the ES that will be submitted with the DCO application.
- 5.1.3 For this PEI Report assessment, a qualitative assessment has been undertaken to establish the potential construction and operational phase effects of the proposed scheme on local air quality based on the latest design fix.
- 5.1.4 The Environmental Assessment Report<sup>19</sup> contained detailed assessment results for operation of the preferred route and modelled impacts on areas beyond the proposed scheme extent. No updated traffic data is available following this assessment. Therefore, additional air quality modelling using the same traffic data would not provide new data in relation to air quality impacts from the scheme. While design changes may have occurred following preferred route announcement, these would not be expected to significantly alter traffic flows. Therefore, the preferred route assessment results can be relied upon for the assessment of impacts for this PEI Report chapter.
- 5.1.5 A review of the construction and operational air quality impacts has been undertaken following guidance in HA207/07<sup>20</sup> in order to feed into the outline CEMP to be submitted as part of the ES with the DCO application.

### 5.2 Legislative and Policy Framework

- 5.2.1 Details of relevant European, national and local legislation, policy and guidance have been provided in appendix 5.1.
- 5.2.2 Potential effects on air quality resulting from the proposed scheme have been assessed following the principles in relevant guidance outlined in DMRB HA207/07, associated Interim Advice Notes (IANs) and the Department for the Environment, Food and Rural Affairs' (Defra's) Local Air Quality Management Technical Guidance (LAQM TG.16)<sup>21</sup>. Relevant guidance documents used for the air quality assessment are listed below:
- HA207/07 Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3, Part 1, May 2007.
  - IAN 170/12 v3 Updated air quality advice on the assessment of future NO<sub>x</sub> and NO<sub>2</sub> projections for users for the DMRB Volume 11, Section 3, Part 1 Air Quality, November 2013<sup>22</sup>.

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<sup>19</sup> Mott MacDonald Sweco (February 2019) Environmental Assessment Report

<sup>20</sup> H. England, Design Manual For Roads and Bridges Volume 11, Section 3, Part 1 Air Quality, 2007.

<sup>21</sup> Defra, "Local Air Quality Management Technical Guidance LAQM TG.16," 2016.

<sup>22</sup> H. Agency, "Interim Advice Note 170/12v3 Updated air quality advice on the assessment of future NO<sub>x</sub> and NO<sub>2</sub> projections for users of DMRB Volume 11, Section 3 Part 1 'Air,'" 2013.

- IAN 174/13 Updated advice for evaluating significant local air quality effects for users of DMRB Volume 11, Section 3, Part 1 Air Quality (HA207/07), June 2013<sup>23</sup>.
- IAN 175/13 Updated advice on risk assessment related to compliance with the EU Directive on ambient air quality and on the production of Scheme Air Quality Action Plans for users of DMRB Volume 11, Section 3, Part 1 Air Quality (HA207/07), June 2013<sup>24</sup>.
- IAN 185/15 Updated traffic, air quality and noise advice on the assessment of link speeds and generation of vehicle data into 'speed-bands' for users of DMRB Volume 11, Section 3, Part 1 'Air Quality and Volume 11, January 2015<sup>25</sup>.
- Note on Highways England's Interim Alternative Long Term Annual Projection Factors (LTTE6) for Annual Mean NO<sub>2</sub> and NO<sub>x</sub> Concentrations between 2008 and 2030, draft, October 2013<sup>26</sup>.
- Defra's Local Air Quality Management Technical Guidance (LAQM TG.16)<sup>27</sup>.

## 5.3 Study Area

5.3.1 The air quality assessment comprises three sub-topics:

- construction dust assessment, which is related to the risk of dust nuisance and dust with potential to affect human health and ecosystems at a local level;
- local air quality, which relates to pollutants with potential to affect human health and ecosystems at a local level; and
- regional air quality, which relates to pollutants dispersing over a larger area, with potential to affect human health, ecosystems or climate change.

5.3.2 The study area for the assessment of local air quality has been defined following guidance contained in HA207/07. It comprises:

- all land within 200m of the centre line of the existing road;
- land within 200m of the centre line of the proposed scheme; and
- land within 200m of the centre line of any other 'affected roads'.

5.3.3 The Affected Road Network (ARN) for the purposes of a local air quality assessment is defined as those roads within a defined 'traffic reliability area' (TRA) (i.e. the area of the traffic model considered to provide reliable estimates of traffic when the base traffic model is compared to observed traffic) that meet any of the following traffic change criteria (based on the two-way flow on all roads). A road is in the ARN if one or more of the following criteria are true:

- road alignment will change by 5m or more;
- daily traffic flows will change by  $\geq 1,000$  AADT;
- Heavy Duty Vehicle (HDV) flows will change by  $\geq 200$  AADT;
- daily average speed will change by  $\geq 10$  kph; and
- peak hour speed will change by  $\geq 20$  kph.

<sup>23</sup> H. Agency, "Interim Advice Note 174/13 Updated advice for evaluating significant local air quality effects for users of DMRB Volume 11, Section 3, Part 1 'Air Quality (HA207/07)," 2013.

<sup>24</sup> H. Agency, "Interim Advice Note 175/13 Updated air quality advice on risk assessment related to compliance with the EU Directive on ambient air quality and on the production of Scheme Air Quality Action Plans for users of DMRB Volume 11, Section 3, Part 1 Air Quality (HA207/07)," 2013.

<sup>25</sup> H. England, "Interim Advice Note 185/15 Updated traffic, air quality and noise advice on the assessment of link speeds and generation of vehicle data into 'speed-bands' for," 2015.

<sup>26</sup> H. Agency, "Highways Agency (2013) Note on HA's Interim Alternative Long Term Annual Projection Factors (LTTE6) for Annual Mean NO<sub>2</sub> and NO<sub>x</sub> Concentrations Between 2008 and 2030.," 2013.

<sup>27</sup> Ibid

5.3.4 For the regional air quality assessment, the ARN is defined as those links in the TRA which meet any of the criteria below in the proposed scheme opening year or design year (+15 years):

- Daily traffic flows will change by 10% AADT or more;
- HDV flows will change by 10% AADT or more; and
- Daily average speed will change by 20km/hr or more.

5.3.5 Figure 5.1 shows the air quality study area.

5.3.6 The study area for this PEI Report is the ARN that was determined using existing traffic data. The ARN covers the following areas:

- A417 between Gloucester and Medbourne;
- M5 between Newtown and Bristol;
- A40 between Gloucester and Burford; and
- Local roads joining the highways outlined above.

It is possible that the ARN will change for the ES following updates and revisions to the traffic data as the proposed scheme develops.

## 5.4 Potential Impacts

### Construction Impacts

5.4.1 During construction, potential air quality effects arise from emissions of construction dust and particulate matter (PM). These emissions occur as a result of construction activities such as demolition, earthworks, construction and trackout. The quantities of each depend on the scale and intensity of the construction works. These effects will be assessed further in the ES.

### Operation Impacts

5.4.2 During the operational phase, potential air quality effects arise from emissions of pollutants from vehicles using the road network. Emissions from vehicle exhausts contain several pollutants, including oxides of nitrogen (NO<sub>x</sub>), carbon monoxide (CO), hydrocarbons, carbon dioxide (CO<sub>2</sub>) and particulate matter (PM). The quantities of each pollutant emitted depend on the type of vehicle, quantity and type of fuel used, engine size, speed of the vehicle and abatement equipment fitted. Once emitted, the pollutants are diluted and dispersed into the ambient air. Pollutant concentrations in the air can be measured or modelled, and then compared with air quality standards. These impacts are discussed in section 5.10.

### Potential Impacts Due to Climate Change

5.4.3 The PEI Report consider effects related to climate change as per the requirements of EU Directive 2014/52 and the 2017 EIA Regulations. The combined effects relating to air quality of the proposed scheme and potential climate change on receptors include the following:

- Changes in wind speed and direction could influence local pollutant levels. If there is increased channelling due to changes in wind directing this would increase annual average levels of pollutants at some receptors and decrease them at others. However, emissions from all sources are predicted to decrease over time and hence pollutant concentrations are likely to decrease.

## 5.5 Assessment Methodology

### Construction Dust Assessment

- 5.5.1 A qualitative assessment of the impacts of nuisance dust arising during construction has been undertaken, using guidance set out in paragraph 3.45 of DMRB HA207/07. Properties within 200m of dust producing activities have been identified and appropriate mitigation recommended where required.
- 5.5.2 Mitigation measures will be included in the outline CEMP for the scheme. The adoption of best practice measures will reduce the risk of significant adverse dust effects and statutory nuisance issues during the construction phase.

### PEI Report Air Quality Assessment

- 5.5.3 A detailed assessment has not been carried out in this PEI Report. Detailed assessment using dispersion modelling software will be included in the ES. The air quality assessment for this PEI Report consists of the following:
- A qualitative assessment of the potential impact the proposed scheme on the sensitive receptors identified in the Environmental Assessment Report.
- 5.5.4 The inputs for this assessment are:
- The ARN;
  - Receptor locations; and
  - Background concentrations.

### Traffic Data

- 5.5.5 Traffic data used in this PEI Report is the existing traffic data model used for the design of the proposed scheme. Traffic data provided represents the average conditions occurring in four specific time periods (AM peak, inter-peak, PM peak and off peak). For the time periods in Table 5-1 the following data parameters were provided:
- Traffic flow, defined as vehicles/hour;
  - Percentage heavy duty vehicles (HDV);
  - Vehicle speeds, in kilometres per hour (kph); and
  - Speed band information for use in calculation of emission factors in accordance with IAN 185/15.

**Table 5-1 Traffic Time Periods**

Traffic period	Time period
AM peak (AM)	3 hours (07.00 – 10.00)
Inter-peak (IP)	6 hours (10.00 – 16.00)
PM peak (PM)	3 hours (16.00 – 19.00)
Off peak (OP)	12 hours (19.00 – 07.00)

### Receptors

- 5.5.6 For the ES human and ecological receptors within 200m of the ARN will be identified and used in the air quality modelling. The Environmental Assessment



Report<sup>28</sup> identified receptors using the following criteria and then a subset used for discussion:

- Proximity to the ARN;
- Representativeness of the receptor of the maximum effects of the proposed scheme in that region; and
- At risk of exceeding the annual mean NO<sub>2</sub> Air Quality Objective (AQO).

5.5.7 All locations, referred to as 'receptors' are treated as being equally sensitive. The human health receptors identified in the Environmental Assessment Report<sup>29</sup> are detailed in Table 5-2. The locations are shown in figure 5.5

**Table 5-2 Human Health Receptors**

Receptor ID	Receptor location	X	Y
1	Air Balloon Cottages	393447	216120
2	Air Balloon Cottages	393464	216132
3	Crickley Hill	393104	215886
4	Crickley Court	392022	215849
5	Fernbank	392881	215806
6	Barrow Wake House	393511	215622
7	The Rise	394049	214120
8	Castle Hill	394545	213635
9	Lychett Cottage	394313	216391
10	Highgate Farm	395605	212642
11	Lyefield Court	396407	219832
12	Leckhampton Road	394788	219867
13	Chosen View	390454	216691
14	Wye Road	389845	216035
15	Abbey Way	402206	202609
16	Brockworth Road	389340	219105
17	Seven Springs	396573	216877
18	Corner Cottage	392592	214369
19	Fosse Farm	396926	210376
20	Woodbine Cottage	389637	221834
21	Calcutt Manor	411209	193319
22	Sunny Bank	402028	205209
23	The Noake	387793	217869
24	Sussex Gardens	387916	217397

### Designated Habitat Sites

5.5.8 To assess the impacts on ecosystems the study area was reviewed to identify Special Areas of Conservation (SAC), Special Protection Areas (SPA) and Sites of Special Scientific Interest (SSSI) within 200m of the ARN. Details of the

<sup>28</sup> Mott MacDonald Sweco (February 2019) Environmental Assessment Report

<sup>29</sup> Mott MacDonald Sweco (February 2019) Environmental Assessment Report

designated sites are in Table 5-3. All nine sites are shown in the ecological receptors drawing, figure 5.2.

**Table 5-3 Designated Habitats Used in the Assessment**

Site Name	Designation	Habitat
Crickley Hill and Barrow Wake	SSSI	Broad-leaved, mixed and yew woodland Calcareous grassland
Cotswold Commons and Beechwoods	SSSI	Broad-leaved, mixed and yew woodland Calcareous grassland
Cotswold Beechwood	SAC	Asperuulo-Fagetum beech forests Semi-natural dry grasslands and scrubland facies on calcareous substrates
Hucclecote Meadows	SSSI	Neutral grassland
North Meadows and Clattinger Farm	SAC	Lowland hay meadows
Lineover Wood	SSSI	Broad-leaved, mixed and yew woodland
Westwell Gorse	SSSI	<i>Carex filiformis</i>
Leckhampton Hill and Charlton Kings Common	SSSI	Broad-leaved, mixed and yew woodland Calcareous grassland
Bull Cross, the Firth and Juniper Hill	SSSI	Broad-leaved, mixed and yew woodland Calcareous grassland

5.5.9 Effects at ecological receptors will be assessed in detail in the ES. The ecological results have been reviewed in section 5.10.

### Background Concentrations

5.5.10 'Background' air quality is a concept used to enable assessment of the effects of particular emission sources without the need for all sources in the area to be considered explicitly. For the purpose of this assessment, the background air quality represents the contribution of all other relevant sources of air pollutants except those roads that will be specifically included in the air quality model. The pollution due to the modelled roads will be added to the background pollution concentrations.

5.5.11 The Defra air quality website<sup>30</sup> includes estimated background air pollution concentrations for NO<sub>x</sub>, NO<sub>2</sub>, PM<sub>10</sub> and PM<sub>2.5</sub>, for each 1km by 1km square covering England.

### Operational assessment criteria

5.5.12 Evaluation of the significance of the local air quality findings has been undertaken in accordance with IAN 174/13, based on the data available from the Environmental Assessment Report. The key criteria outlined in IAN 174/13 against which air quality should be considered are:

- Is there a risk that environmental standards will be breached?
- Is there a high probability of the effect occurring?
- Will there be a large change in environmental conditions?

<sup>30</sup> Defra, "Defra Background Maps," 2017. [Online]. Available: <http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html>. [Accessed November 2017].

- Will the effect continue for a long time?
- Will many people be affected?
- Is there a risk that protected sites, areas, or features will be affected?
- Will it be difficult to avoid, or reduce or repair or compensate for the effect?

5.5.13 The evaluation of the significance of nitrogen deposition results requires advice from an ecologist and therefore the significance of changes in pollutant concentrations and deposition rates at ecological designations will also be discussed in the ES.

5.5.14 To assess the magnitude of change at receptor locations, including ecological receptors, as a result of the proposed scheme, IAN 174/13 provides the criteria shown in Table 5-4. These are based on the view that while modelled results are considered reasonably accurate, there is still an element of residual uncertainty, hereafter referred to as Measure of Uncertainty (MoU). This is due to inherent uncertainty in air quality monitoring, modelling and the input data used in the assessment.

**Table 5-4 Magnitude of Change Criteria**

Magnitude of change in concentration ( $\mu\text{g}/\text{m}^3$ )	Value of change in annual average $\text{NO}_2$ and $\text{PM}_{10}$
Large (>4)	Greater than full MoU value of 10% of the AQO ( $4\mu\text{g}/\text{m}^3$ )
Medium (>2 - 4)	Greater than half the MoU ( $2\mu\text{g}/\text{m}^3$ ), but less than the full MoU ( $4\mu\text{g}/\text{m}^3$ ) of 10% of the AQO
Small (>0.4 - 2)	More than 1% of objective ( $0.4\mu\text{g}/\text{m}^3$ ) and less than half of the MoU i.e. 5% ( $2\mu\text{g}/\text{m}^3$ ). The full MoU is 10% of the AQO ( $4\mu\text{g}/\text{m}^3$ )
Imperceptible ( $\leq 0.4$ )	Less than or equal to 1% of AQO ( $0.4\mu\text{g}/\text{m}^3$ )

5.5.15 Where predicted annual mean  $\text{NO}_2$  concentrations are below the AQO or the magnitude of change is  $\leq 0.4\mu\text{g}/\text{m}^3$ , effects are likely to be imperceptible.

5.5.16 IAN 174/13 also provides guidelines to aid the interpretation of significance of public exposure. Table 5-5 shows the guideline criteria used in this assessment.

**Table 5-5 Guideline for Number of Properties Constituting a Significant Effect**

Magnitude of change in $\text{NO}_2$ ( $\mu\text{g}/\text{m}^3$ )	Number of receptors with:	
	Worsening of AQO already above objective or creation of a new exceedance	Improvement of an AQO already above objective or the removal of an existing exceedance
Large (>4)	1-10	1-10
Medium (>2 - 4)	10-30	10-30
Small ( $\leq 0.4$ - 2)	30-60	30-60

## 5.6 Baseline Conditions

5.6.1 In order to provide an assessment of the significance of any new development proposal (in terms of air quality), it is necessary to identify and understand the baseline air quality conditions in and around the study area. This provides a reference level against which any potential changes in air quality can be assessed. Since the baseline air quality is predicted to change in the future (mainly because vehicle emissions are changing), the baseline situation has also been predicted for the opening year. The Do-Minimum (DM) scenario is the

predicted baseline for the opening year and includes any other proposed schemes with a high level of certainty of being built.

5.6.2 Baseline air quality data has been gathered from the following sources for the air quality study area:

- Defra Air Quality Management Area (AQMA) website<sup>31</sup>
- Defra Pollution Climate Model (PCM) data for relevant years<sup>32</sup>
- Data from monitoring surveys carried out by Highways England and from local authority monitoring
- GIS locations of sensitive receptors (residential properties, schools, hospitals and care homes) from OS Address Base Plus mapping and
- GIS boundaries of designated ecological sites from Natural England<sup>33</sup>.

### Local Air Quality Management Summary

5.6.3 Comparing baseline conditions for relevant pollutants against the AQOs detailed in the UK Government's Air Quality Strategy (AQS)<sup>34</sup> and the EU limit values, the following has been concluded:

- National assessments<sup>35</sup> have demonstrated that there is no risk of carbon monoxide, 1,3-butadiene or benzene concentrations exceeding relevant UK air quality objectives and EU limit value thresholds due to emissions from traffic anywhere in the UK. As such, concentrations of these pollutants have not been modelled as it is unlikely these pollutants will be a cause for concern in terms of potential exceedances as a result of the proposed scheme.
- For particulate matter (PM<sub>10</sub> and PM<sub>2.5</sub>), there are no AQMAs designated for an exceedance of UK air quality objectives and EU limit value thresholds for particulate matter in the study area.
- Exceedances of the annual mean NO<sub>2</sub> air quality objective and EU limit value threshold of 40µg/m<sup>3</sup> have been identified in the air quality study area. On this basis, NO<sub>2</sub> is the focus of the air quality assessment for the proposed scheme.

### Air Quality Management Areas (AQMA)

5.6.4 There are eight AQMAs within 200m of the ARN. Sandwell Metropolitan Borough Council (SMBC), Birmingham City Council (BCC), Dudley Metropolitan Borough Council (DMBC), Oxford City Council (OCC), and Cheltenham Borough Council (CBC) have declared the whole of their respective local authority areas AQMAs. They were all declared for exceedances of the annual mean NO<sub>2</sub> objective. The BCC AQMA was also declared for exceedances of the 24-hour PM<sub>10</sub> objective.

5.6.5 Vale of White Horse District Council (VWHDC) declared the Botley AQMA for exceedances of the annual mean NO<sub>2</sub> objective.

5.6.6 Wychavon District Council (WDC) declared the Worcester Road AQMA for exceedances of the annual mean NO<sub>2</sub> objective.

5.6.7 Cotswold District Council (CDC) declared the Birdlip AQMA for exceedances of the annual mean NO<sub>2</sub> objective. The Birdlip AQMA lies inside the proposed

<sup>31</sup> Defra, "AQMAs interactive map," 2017. [Online]. Available: <https://uk-air.defra.gov.uk/aqma/maps>. [Accessed November 2017].

<sup>32</sup> Defra, "Air Quality Plan for nitrogen dioxide (NO<sub>2</sub>) in UK (2017): Zone Plans," 2017. [Online]. Available: <https://uk-air.defra.gov.uk/library/no2ten/2017-zone-plan-documents>. [Accessed November 2017].

<sup>33</sup> Defra, "MAGIC," [Online]. Available: <http://www.magic.gov.uk/>. [Accessed November 2017].

<sup>34</sup> Defra, The air quality strategy for England, Scotland, Wales and Northern Ireland, 2007.

<sup>35</sup> Ibid

scheme boundary of the proposed scheme and therefore will be the AQMA that is a key focus of this assessment for Air Balloon pub and residential houses opposite known as Air Balloon cottages.

5.6.8 Gloucester District Council (GDC), Stroud District Council (SDC) and Tewksbury District Council (TDC) have not declared AQMAs on the ARN.

5.6.9 The AQMAs are shown in figure 5.3. The AQMAs studied in the ES may change when new traffic data becomes available.

### **Monitoring Data**

5.6.10 Monitoring of air quality for NO<sub>2</sub> concentrations has been undertaken across the study area by Highways England. The location of monitoring points across the study area is shown in figure 5.4. Information from the monitoring has been used to establish baseline air quality conditions.

### **Local Authority Monitoring Data**

**CDC, GDC, SDC and TDC all have diffusion tube monitoring on the ARN. Details of the monitoring locations are in Table 5-6. The monitoring results for 2014-2017 are in**

5.6.11 Table 5-7 and are shown in figure 5.4. Monitoring results are not yet available for 2018. The only exceedances of the NO<sub>2</sub> annual mean objective were recorded at the Air Balloon roundabout. The highest exceedance was 61.5µg/m<sup>3</sup> in 2014, there were still exceedances in 2016.

**Table 5-6 Details of Local Authority Monitoring Locations**

Local authority and ID	Site Name	Site Classification	National Grid Reference	
			X	Y
Cotswold T11	Birdlip – Air Balloon	Kerbside	393446	216118
Cotswold T12	Birdlip – Air Balloon 2	Kerbside	393459	216124
Cotswold T13	Birdlip – Air Balloon 3	Kerbside	393459	216124
Cotswold T14	Birdlip – Air Balloon, Beer Garden B	Kerbside	393459	216091
Cotswold T16	Stow Lodge	Kerbside	403943	202961
Cotswold T8	Cirencester – London Road (Wagon/Horses)	Kerbside	402735	201962
Gloucester 6	35 Buscombe Gardens	Roadside	387670	217250
Gloucester 7	12 Caravan Site	Urban background	387250	216530
Stroud 3	Brookthorpe – North View	Roadside	383410	212570
Stroud 31	Upton St Leonards – 50 Woodland Green	Kerbside	386301	215294
Tewkesbury 14N	69 Sussex Gardens	Urban background	387915	217389
Tewkesbury 15N	Comus Bamforlong	Urban background	389714	221845
Tewkesbury 16N	15 Withybridge	Urban background	390461	225544
Tewkesbury 52N	43 Stocken Close	Roadside	387570	216935
Tewkesbury 54N	Woodside House - Crickley Hill	Urban centre	393106	215913

**Table 5-7 Local Authority Monitoring Results**

Local authority and ID	Site Name	Annual Mean NO <sub>2</sub> (µg/m <sup>3</sup> )			
		2014	2015	2016	2017
Cotswold T11	Birdlip – Air Balloon	<b>61.5</b>	<b>59.1</b>	<b>61.2</b>	n/a
Cotswold T12	Birdlip – Air Balloon 2	<b>40.3</b>	<b>40.5</b>	39.8	n/a
Cotswold T13	Birdlip – Air Balloon 3	<b>41.4</b>	39.4	39.2	n/a
Cotswold T14	Birdlip – Air Balloon, Beer Garden B	<b>43.3</b>	<b>40.5</b>	<b>40.4</b>	n/a
Cotswold T16	Stow Lodge	32.2	31.7	33.3	n/a
Cotswold T8	Cirencester – London Road (Wagon/Horses)	29.8	23.8	30.4	n/a
Gloucester 6	35 Buscombe Gardens	27.9	25.5	27.9	24.0
Gloucester 7	12 Caravan Site	22.6	20.4	22.7	19.0
Stroud 3	Brookthorpe – North View	25.1	25.9	27.6	21.7
Stroud 31	Upton St Leonards – 50 Woodland Green	22.9	24.6	27.0	21.4
Tewkesbury 14N	69 Sussex Gardens	26.3	25.4	26.8	24.9
Tewkesbury 15N	Comus Bamforlong	27.9	28.5	25.6	26.4
Tewkesbury 16N	15 Withybridge	27.8	26.5	29.0	26.0
Tewkesbury 52N	43 Stocken Close	25.5	25.1	26.2	25.9
Tewkesbury 54N	Woodside House - Crickley Hill			30.6	24.2

N/A: monitoring data for CDC in 2017 is not yet available.

### Scheme Specific Monitoring

- 5.6.12 Highways England carried out monitoring of NO<sub>2</sub> concentrations using diffusion tubes at 20 monitoring sites from January 2016 to June 2016.
- 5.6.13 The results were bias adjusted and annualised to 2016.
- 5.6.14 Most of the monitoring sites measured NO<sub>2</sub> concentration that was below the annual mean objective. The only monitoring site that was recorded to be exceeding the annual mean NO<sub>2</sub> objective was the house opposite the Air Balloon pub within the Birdlip AQMA. The concentration at this site was recorded as 41.7µg/m<sup>3</sup>. All other monitoring results apart from the three automatic monitors at the Air Balloon Pub are very low. The details of the monitoring locations are shown in Table 5-8. Results from the monitoring survey are in Table 5-9.

**Table 5-8 Scheme Specific Monitoring**

Site Name	Location	Site Classification	National Grid Reference	
			X	Y
A417AB_001_1215	Birdlip GL4 8JL	Roadside	393205	214125
A417AB_002_1215	Road off A417 towards GL4 8JX (Kennels - on lamp post with no lamp)	Roadside	393802	215431
A417AB_003_1215	The Willows, Near Crickley Hill opposite A417 to GL3 4UH (on tree)	Roadside	393030	215876
A417AB_004_1215	House opposite The Air Balloon Pub GL4 8JY (across from pub)	Roadside	393458	216121
A417AB_005_1215	A436 GL53 9QX (lay-by)	Roadside	394269	216375
A417AB_006_1215	Ullenwood Cottages, Greenway Lane GL53 9QT (cottages)	Roadside	394413	216847
A417AB_007_1215	B4070 Ridgeway Close GL4 8BN	Roadside	392618	214415
A417AB_008_1215	Shurdington Road near roundabout GL3 4PX (mast)	Roadside	390439	216678

Site Name	Location	Site Classification	National Grid Reference	
			X	Y
A417AB_009_1215	Shurdington Road (Henley Bank Lane) GL3 4PG	Roadside	390397	216488
A417AB_010_1215	62 Court Road GL3 (lamp post)	Roadside	389182	216837
A417AB_011_1215	End of Cedar Road GL3 4DW (lamp post)	Roadside	388598	217247
A417AB_012_1215	73 Sussex Gardens GL3 3ST (lamp post)	Roadside	387925	217384
A417AB_013_1215	13 Hucclecote Road GL3 3AE (lamp post - by Victoria Pub)	Roadside	388356	216802
A417AB_014_1215	Churchdown Lane GL3 3QJ (lamp post)	Roadside	387623	217636
A417AB_015_1215	14 Millfields GL3 3NH	Roadside	387454	217908
A417AB_016_1215	Hucclecote Road side of 177 Sussex Gardens GL3 3SS (lamp post)	Roadside	388124	216931
A417AB_017_1215	Shurdington Road GL51 4UA (lamp post near road)	Roadside	390599	216877
A417AB_018_1215	BKGD - Near Shab Hill GL4 8JX (Drive past Kennels (No.1), on sign post near corner)	Background	394270	215829
A417AB_019_1215	Dog Lane Sign GL4 8JX	Roadside	391469	216107
A417AB_020_1215	76 Mill Lane GL3 4UG (lamp post)	Roadside	390190	216546
A417AB_021a_1215	Automatic Monitor, The Air Balloon Pub GL4 8JY	Roadside	393431	216092
A417AB_021b_1215	Automatic Monitor, The Air Balloon Pub GL4 8JY (behind pub)	Roadside	393431	216092
A417AB_021c_1215	Automatic Monitor, The Air Balloon Pub GL4 8JY (behind pub)	Roadside	393431	216092
A417AB_022_1215	1 Oak Drive GL3 4OQ	Roadside	388908	217014

**Table 5-9 Scheme specific monitoring results**

Site Name	Location	2016 Annualised NO <sub>2</sub> (µg/m <sup>3</sup> )
A417AB_001_1215	Birdlip GL4 8JL	7.7
A417AB_002_1215	Road off A417 towards GL4 8JX (Kennels - on lamp post with no lamp)	8.3
A417AB_003_1215	The Willows, Near Crickley Hill opposite A417 to GL3 4UH (on tree)	29.1
A417AB_004_1215	House opposite The Air Balloon Pub GL4 8JY (across from pub)	<b>41.7</b>
A417AB_005_1215	A436 GL53 9QX (lay-by)	19.0
A417AB_006_1215	Ullenwood Cottages, Greenway Lane GL53 9QT (cottages)	9.3
A417AB_007_1215	B4070 Ridgeway Close GL4 8BN	16.9
A417AB_008_1215	Shurdington Road near roundabout GL3 4PX (mast)	18.7
A417AB_009_1215	Shurdington Road (Henley Bank Lane) GL3 4PG	11.4
A417AB_010_1215	62 Court Road GL3 (lamp post)	13.4
A417AB_011_1215	End of Cedar Road GL3 4DW (lamp post)	14.9
A417AB_012_1215	73 Sussex Gardens GL3 3ST (lamp post)	20.4
A417AB_013_1215	13 Hucclecote Road GL3 3AE (lamp post - by Victoria Pub)	19.4
A417AB_014_1215	Churchdown Lane GL3 3QJ (lamp post)	22.6
A417AB_015_1215	14 Millfields GL3 3NH	20.4
A417AB_016_1215	Hucclecote Road side of 177 Sussex Gardens GL3 3SS (lamp post)	18.0
A417AB_017_1215	Shurdington Road GL51 4UA (lamp post near road)	26.5
A417AB_018_1215	BKGD - Near Shab Hill GL4 8JX (Drive past Kennels (No.1), on sign post near corner)	7.3
A417AB_019_1215	Dog Lane Sign GL4 8JX	12.9



Site Name	Location	2016 Annualised NO <sub>2</sub> (µg/m <sup>3</sup> )
A417AB_020_1215	76 Mill Lane GL3 4UG (lamp post)	13.5
A417AB_021a_1215	Automatic Monitor, The Air Balloon Pub GL4 8JY	34.2
A417AB_021b_1215	Automatic Monitor, The Air Balloon Pub GL4 8JY (behind pub)	33.9
A417AB_021c_1215	Automatic Monitor, The Air Balloon Pub GL4 8JY (behind pub)	35.8
A417AB_022_1215	1 Oak Drive GL3 4OQ	12.1

### Defra PCM Modelling

5.6.15 Predicted roadside NO<sub>2</sub> concentrations were obtained from Defra's PCM model for the years 2015 and 2024. In the study area Defra PCM mapping indicates no exceedances in 2015 at road links in the ARN. In 2024 Defra PCM mapping indicates all links will still comply with EU limit values. The PCM links studied in the ES may change when updated traffic data is available.

## 5.7 Consultation

5.7.1 Discussion with Natural England and relevant local authorities will be carried out after submission of the PEI report. The purpose of these discussions will be to agree the methodology of the ES.

## 5.8 Assessment Assumptions and Limitations

5.8.1 The PEI Report assessment has been qualitative and is therefore inherently reliant on professional judgement. The potential air quality outcomes of the proposed scheme discussed in this PEI Report are based on an understanding of how traffic flows are expected to change as a result of the proposed scheme and how these changes in flows will change emissions from vehicles and ultimately pollutant concentrations at receptors. The existing traffic data is not expected to significantly change, however, the design will now have altered which could affect the predicted impacts. Detailed quantitative assessment, using updated traffic data, will be available in the ES.

5.8.2 Gaps and uncertainties for the PEI Report are listed in Table 5-10.

**Table 5-10 Gaps and Uncertainties**

Gaps and Uncertainties	Description
Traffic data	Existing traffic data and ARN from the design used in the Environmental Assessment Report has been used in this PEI Report to describe scheme impacts.

## 5.9 Design, Mitigation and Enhancement Measures

### Mitigation through engineering design

5.9.1 The proposed scheme design moves traffic away from local sensitive receptors. By moving traffic away from receptors, it allows a greater distance over which pollutants can disperse. No other design specific mitigation has been incorporated for air quality.

## Construction Mitigation

5.9.2 Best practice mitigation measures to reduce effects from construction dust will be incorporated into the proposed scheme outline CEMP which will be produced as part of the ES. These measures would typically include the following:

- Minimisation of areas to be stripped of vegetation.
- Dampening down of dust generating activities and materials, including site roads, during dry weather, in addition to site monitoring.
- As far as possible temporary roads should be hard surfaced to reduce dust generation.
- Road sweeping to be carried out on access roads and local roads to remove any material tracked out of the site.
- Management of stockpiled materials with the potential to generate dust by rolling, covering and/or revegetating as soon as appropriate.

## Operation Mitigation

5.9.3 On the basis that the proposed scheme will have a positive impact (due to relieving congestion and moving the road away from receptors) on local air quality concentrations, no specific mitigation or Air Quality Action Plans are likely to be required for the operation of the proposed scheme. However, should there be a requirement as a result of a significant air quality effects (as per Interim Advice Note (IAN) 174/13) or an EU Directive compliance risk (as per IAN 175/13), scheme specific mitigations will be identified.

## Enhancement

5.9.4 The opportunities for scheme enhancement would be explored as part of the EIA and reported in the ES.

## 5.10 Assessment of Effects

### Construction Effects

5.10.1 The construction phase is expected to last approximately three years and could affect local air quality through the generation and subsequent deposition of construction dust arising from construction activities and vehicle movements. Following the method in set out in paragraph 3.45 of DMRB HA207/07 properties within 200m of the proposed scheme have been identified. There are properties within 200m with the nearest properties located at the Air Balloon roundabout, Shab Hill Farm, Acorn House and Grove Farm. All properties within 200m will be treated equally with regards to sensitivity of the property.

5.10.2 Mitigation to reduce impacts to a negligible level will be included in the CEMP. With best practice mitigation measures in place the impacts are considered to be not significant.

## Operational Effects

### Affected Road Network

- 5.10.3 Following DMRB HA207/07 screening criteria, the ARN was identified in the Environmental Assessment Report<sup>36</sup> for the area around the proposed scheme for the 2024 opening year scenario. The 2024 ARN is shown in figure 5.1.

### Human health

- 5.10.4 The Environmental Assessment Report showed there were no predicted exceedances at any receptor in the future operational scenario. The predicted concentrations from the Environmental Assessment Report are provided in Table 5-11.
- 5.10.5 The highest predicted annual mean NO<sub>2</sub> concentration in the Do-Something scenario is predicted to occur at receptor 21, the concentration at this receptor increased by 1.1µg/m<sup>3</sup> to 24.5µg/m<sup>3</sup> in the Do-Something scenario from 23.4µg/m<sup>3</sup> in the Do-Minimum. This receptor is located approximately 7m away from the A419 close to Cricklade. This road would experience an increase of approximately 3,600 AADT and 300 HDVs as a result of the proposed scheme.
- 5.10.6 Receptor 3 is predicted to experience the greatest increase in annual mean NO<sub>2</sub> with a change of 4.1µg/m<sup>3</sup> from 10.5µg/m<sup>3</sup> in the Do-Minimum to 14.6µg/m<sup>3</sup> in the Do-Something scenario. The proposed scheme would move the A417 closer to receptor 3 and there would also be an increase of approximately 5,700 AADT on this stretch of the A417. However, the predicted annual mean NO<sub>2</sub> concentration in the Do-Something scenario would remain below the annual mean NO<sub>2</sub> objective of 40µg/m<sup>3</sup>.
- 5.10.7 The greatest reductions in annual mean NO<sub>2</sub> concentrations are predicted to occur at the Air Balloon Cottages which are both located in the Birdlip AQMA and are adjacent to the Air Balloon roundabout. The concentrations would reduce by 13.9µg/m<sup>3</sup> at receptor 1 to give a Do-Something concentration of 13.0µg/m<sup>3</sup> and by 13.4µg/m<sup>3</sup> at receptor 2 to give a Do-Something concentration of 12.3µg/m<sup>3</sup>. These reductions occur because the proposed scheme would move the A417 35m from where it is currently located and away from the receptors. The proposed scheme would also improve the traffic flow from light congestion to high speed on the A417 adjacent to these receptors due to the removal of the roundabout and other improvements.
- 5.10.8 The proposed scheme also removes one receptor at the Birdlip AQMA which helps remove receptors from an area of existing poor air quality. The proposed scheme removes the Air Balloon roundabout, improving the flow of traffic through the Birdlip AQMA and reducing impacts of emissions from queuing and slow-moving traffic in this area.
- 5.10.9 The results in Table 5-11 show an overall improvement in NO<sub>2</sub> concentrations at the assessed receptors where the existing concentrations exceed the air quality objectives. No new exceedances are created as a result of the scheme impacts.
- 5.10.10 These impacts will be re-assessed with updated traffic data for the ES.

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<sup>36</sup> Mott MacDonald Sweco (February 2019) Environmental Assessment Report

**Table 5-11 Annual Mean NO<sub>2</sub> Concentrations**

Receptor ID	Receptor location	NO <sub>2</sub> annual mean NO <sub>2</sub> (µg/m <sup>3</sup> )			
		2015 Base year	2024 DM	2024 DS	Change (DM to DS)
1	Air Balloon Cottages	45.4	26.9	13.0	-13.9
2	Air Balloon Cottages	42.3	25.7	12.3	-13.4
3	Crickley Hill	16.0	10.5	14.6	4.1
4	Crickley Court	23.1	14.5	14.4	-0.1
5	Fernbank	23.1	14.4	13.5	-0.9
6	Barrow Wake House	11.3	7.8	7.4	-0.4
7	The Rise	9.1	6.4	6.0	-0.4
8	Castle Hill	20.9	12.9	6.1	-6.8
9	Lychett Cottage	20.6	13.2	10.9	-2.3
10	Highgate Farm	10.3	7.1	7.1	0.0
11	Lyefield Court	28.9	19.8	16.5	-3.3
12	Leckhampton Road	25.6	17.2	19.3	2.1
13	Chosen View	21.6	15.2	15.1	-0.1
14	Wye Road	18.6	13.1	12.7	-0.4
15	Abbey Way	14.6	10.0	10.2	0.2
16	Brockworth Road	26.6	18.9	19.1	0.2
17	Seven Springs	14.3	9.4	8.3	-1.1
18	Corner Cottage	15.0	10.3	9.7	-0.6
19	Fosse Farm	17.5	11.5	12.7	1.2
20	Woodbine Cottage	32.9	23.8	24.2	0.4
21	Calcutt Manor	36.0	23.4	24.5	1.1
22	Sunny Bank	11.9	8.2	8.6	0.4
23	The Noake	17.3	12.4	12.4	0.0
24	Sussex Gardens	26.1	18.6	18.6	0.0

### Compliance risk assessment

- 5.10.11 The Stage 2 assessment identified there are no PCM links which are at risk of exceeding the EU limit value and no risk of delaying compliance.
- 5.10.12 These impacts will be re-assessed with updated traffic data for the ES.

### **Ecological effects**

- 5.10.13 The Stage 2 assessment modelled concentrations at the nine ecological sites listed in Table 5-3. The Hucclecote Meadows SSSI was the only designated site where the annual mean NO<sub>x</sub> concentration was predicted to exceed the critical level (30µg/m<sup>3</sup>). The concentration at this location was predicted to improve by 0.2µg/m<sup>3</sup> with the proposed scheme in operation. As there were no designated sites with predicted annual mean NO<sub>x</sub> concentrations above 30µg/m<sup>3</sup> and experiencing a change of greater than 0.4µg/m<sup>3</sup> no assessment of nitrogen deposition was required.
- 5.10.14 Large improvements were predicted to occur at Crickley Hill and Barrow Wake SSSI. NO<sub>x</sub> concentrations were predicted to significantly reduce at these locations as the A417 is moved away from these receptor locations and the congestion on the A417 is reduced from 'light congestion' to 'high speed'.
- 5.10.15 These impacts will be re-assessed with updated traffic data for the ES.

## Assessment of significance

- 5.10.16 The Environmental Assessment Report<sup>37</sup> predicted no exceedances of the air quality objectives at human receptors in the do-something scenario. This is not likely to change with the updated traffic data which will be used for the detailed assessment carried out for the ES.
- 5.10.17 The proposed scheme was not predicted to impact compliance with the EU limit value.
- 5.10.18 The significance of the proposed scheme has been determined following IAN 174/13 guidance. The results are presented in Table 5-12. These impacts will be re-assessed with updated traffic data for the ES.

**Table 5-12 Significance Criteria**

Key criteria questions	Yes/No	Evidence to support professional judgement
Is there a risk that environmental standards will be breached?	No	There are no receptors where predicted annual mean NO <sub>2</sub> concentrations are above the air quality objective of 40µg/m <sup>3</sup> in either the Do-Minimum or Do-Something scenario and experience a large, medium or small change in concentration. PCM model outputs indicate there are no links in the ARN exceeding EU Limit Values. There is a low risk of non-compliance with the Air Quality Directive (2008/50/EC).
Will there be a large change in environmental conditions?	Yes	There will be some large decreases in NO <sub>x</sub> concentrations at designated sites.
Will the effect continue for a long time?	No	Impacts are, at most, small in magnitude, indicating likely return to pre-scheme concentrations within a guideline of 6 years.
Will many people be affected?	No	There are no human health receptors predicted to have concentrations above the AQS objectives in the opening year.
Is there a risk that designated sites, areas, or features will be affected?	No	Opening year NO <sub>x</sub> concentrations are only predicted to be above the air quality objective of 30µg/m <sup>3</sup> at Hucclecote Meadows SSSI, this site experiences an imperceptible change in concentration as a result of the proposed scheme. There are also 2 areas of the Crickley Hill and Barrow Wake SSSI that reduce from an exceedance in the Do-Minimum scenario to a non-exceedance in the Do-Something scenario.
Will it be difficult to avoid, or reduce or repair or compensate for the effect?	N/A	No mitigation considered necessary since no significant effects predicted.
On balance is the overall effect significant?	<b>No</b>	

## 5.11 Monitoring

- 5.11.1 Monitoring was carried out in 2016 and will be used in the air quality modelling for the ES. The 2016 monitoring is considered to still be valid for use in the air quality assessment for the ES.

<sup>37</sup> Mott MacDonald Sweco (February 2019) Environmental Assessment Report

## 5.12 Summary

5.12.1 The proposed scheme impacts are predicted to be not significant based on existing traffic data which is not expected to significantly alter for the ES. Therefore, the following conclusions can be made.

5.12.2 Preliminary construction assessment:

- With the implementation of best practice mitigation measures to be included in the outline CEMP, no likely significant effects are predicted to occur.

5.12.3 Preliminary operational assessment:

- No significant impacts are predicted to occur at human receptors.
- Air quality is likely to be improved at the Birdlip AQMA and ecological receptors close to the realigned section of the A417.

5.12.4 The ES will re-assess significance based on the final design and updated traffic data.

### Further Work

5.12.5 A detailed level assessment of potential impacts on air quality during the construction and operational phases of the proposed scheme will be undertaken in accordance with the methodology set out DMRB Volume 11, Section 3, HA207/07 Air Quality, and in line with the requirements of the NPSNN.

5.12.6 The following will be carried out for the EIA:

- Revision of the traffic model to ensure traffic data used in the air quality assessment is consistent with the latest design freeze of the proposed scheme.
- Consultation with local authorities along the ARN and other relevant stakeholders will be carried out to agree the methodology of the air quality assessment.
- Assessment of particulate matter (PM<sub>10</sub>) impacts as a result of operation of the proposed scheme, and an assessment of human health impacts associated with increased PM<sub>2.5</sub> from the proposed scheme with reference to the modelled impact on PM<sub>10</sub>.
- Construction traffic impacts will be based on the same traffic change criteria used to define the ARN for the air quality assessment. A construction dust assessment will be carried out once information and data about construction compounds and processes is available for the ES.
- Locally designated and non-designated ecological sites will be included in the assessment.
- Monitoring requirements during construction and operation will be considered and addressed in the ES.

## 6 Cultural Heritage

### 6.1 Introduction

- 6.1.1 This chapter of the PEI Report provides information on cultural heritage assets which may be subject to effects arising from the proposed scheme as far as information is available at the time of writing. It assesses the likely significant effects of the proposed scheme in respect of those heritage assets which are within 1km of the proposed scheme.
- 6.1.2 The objectives of this assessment for PEI Report are to:
- identify, describe and characterise the cultural heritage environment within the vicinity of the proposed scheme;
  - assess the value of the cultural heritage environment within the vicinity of the proposed scheme;
  - identify and assess the magnitude the potential effects of the proposed scheme on the cultural heritage environment within the vicinity of the proposed scheme;
  - identify appropriate mitigation measures;
  - assess the magnitude of the mitigated effects of the proposed scheme with the mitigation measures in place; and
  - assess the significance of the residual effects of the proposed scheme.

### 6.2 Legislative and Policy Framework

6.2.1 The legislation presented below is relevant to the assessment of effects on the historic environment for the proposed scheme:

- Ancient Monuments and Archaeological Areas Act (AMAA) 1979; and
- Planning (Listed Buildings and Conservation Areas) (P(LBCA) Act 1990.

6.2.2 The AMAA Act largely relates to Scheduled Monuments and Section 61(12) defines sites that warrant protection due to their being of national importance as 'ancient monuments'. A monument is defined by the Act as:

*"any building, structure or work above or below the surface of the land, any cave or excavation; any site comprising the remains of any such building, structure or work or any cave or excavation; and any site comprising or comprising the remains of any vehicle, vessel or aircraft or other movable structure or part thereof".*

#### **National Policy Statement for National Networks**

6.2.3 The National Policy Statement for National Networks (NPSNN) sets out the need for and Government's policies to deliver development of Nationally Significant Infrastructure Projects (NSIPs) on the national road and rail networks in England. The policies for the conservation of the historic environment state that:

*"Those elements of the historic environment that hold value to this and future generations because of their historic, archaeological, architectural or artistic interest are called 'heritage assets'. Heritage assets may be buildings, monuments, sites, places, areas or landscapes. The sum of the heritage interests that a heritage asset holds, or its value, is referred to as its significance. Significance derives not only from a heritage asset's physical presence, but also*

*from its setting. Non-designated heritage assets of archaeological interest that are demonstrably of equivalent significance to Scheduled Monuments, should be considered subject to the policies for designated heritage assets. The absence of designation for such heritage assets does not indicate lower significance".*

#### 6.2.4 The NPS advises:

*"the Secretary of State should also consider the impacts on other non-designated heritage assets (as identified either through the development plan process by local authorities, including 'local listing', or through the nationally significant infrastructure project examination and decision making process) on the basis of clear evidence that the assets have a significance that merit consideration in that process, even though those assets are of lesser value than designated heritage assets".*

### **National Policy**

6.2.5 National Planning policies on the conservation of the historic environment are set out in the National Planning Policy Framework (NPPF) and should be adhered to in conjunction with NPS, where the NPS does not cover a specific issue. The NPPF was updated in 2019, replacing all previous Planning Policy Statements, including Planning Policy Statement 5 (PPS 5): Planning for the Historic Environment. Guidance to help practitioners implement this policy, including the legislative requirements that underpin it, is provided in Planning for the Historic Environment Practice Guide (June 2012) produced to support the previous PPS 5 (2010).

6.2.6 Non-designated heritage assets as well as those designated under the above legislation are given protection under the NPPF. Policies dealing with the conservation and enhancement of the historic environment is set out principally in Section 12 of the NPPF, which directs local planning authorities to set out:

*"a positive strategy for the conservation and enjoyment of the historic environment, including heritage assets most at risk through neglect, decay or other threats. In doing so, they should recognise that heritage assets are an irreplaceable resource and conserve them in a manner appropriate to their significance".*

6.2.7 Paragraph 131, states:

*"In determining planning applications, local planning authorities should take account of:*

- *the desirability of sustaining or enhancing the significance of heritage assets and putting them to viable uses consistent with their conservation; and*
- *the positive contribution that conservation of heritage assets can make to sustainable communities including their economic vitality; and the desirability of new development making a positive contribution to local character and distinctiveness".*

6.2.8 Paragraph 132, states:

*"Great weight should be given to the conservation of the significance of designated heritage assets and that harm to this significance (either through alteration or destruction of the asset, or through development within its setting) requires 'clear and convincing justification'. The harm or loss needs to be outweighed by the public benefits of the proposed development and substantial*



*harm to or loss of a grade II listed building; park or garden should be exceptional. Substantial harm to or loss of designated heritage assets of the highest significance, notably scheduled monuments, protected wreck sites, battlefields, grade I and II\* listed buildings, grade I and II\* registered parks and gardens, and world heritage sites, should be wholly exceptional".*

6.2.9 Paragraph 135, states:

*"The effect of an application on the significance of a non-designated heritage asset should be taken into account in determining the application. In weighing applications that affect directly or indirectly non-designated heritage assets, a balanced judgement will be required having regard to the scale of any harm or loss and the significance of the heritage asset."*

6.2.10 Paragraph 139, states:

*"Non-designated heritage assets of archaeological interest that are demonstrably of equivalent significance to scheduled monuments should be considered subject to the policies for designated heritage assets."*

### **Local Policy**

6.2.11 The western end of the proposed scheme lies within that area covered by the Gloucestershire, Cheltenham and Tewkesbury Joint Core Strategy (adopted December 2017). Policy SD8: Historic Environment, states:

- The built, natural and cultural heritage of Gloucester City, Cheltenham town, Tewkesbury town, smaller historic settlements and the wider countryside will continue to be valued and promoted for their important contribution to local identity, quality of life and the economy.
- Development should make a positive contribution to local character and distinctiveness, having regard to valued and distinctive elements of the historic environment.
- Designated and undesignated heritage assets and their settings will be conserved and enhanced as appropriate to their significance, and for their important contribution to local character, distinctiveness and sense of place. Consideration will also be given to the contribution made by heritage assets to supporting sustainable communities and the local economy. Development should aim to sustain and enhance the significance of heritage assets and put them to viable uses consistent with their conservation whilst improving accessibility where appropriate.
- Proposals that will secure the future conservation and maintenance of heritage assets and their settings that are at risk through neglect, decay or other threats will be encouraged. Proposals that will bring vacant or derelict heritage assets back into appropriate use will also be encouraged.
- Development proposals at Strategic Allocations must have regard to the findings and recommendations of the JCS Historic Environment Assessment (or any subsequent revision) demonstrating that the potential impacts on heritage assets and appropriate mitigation measures have been addressed.

### **Standards and Guidance**

6.2.12 In addition to compliance with the NPSNN and NPPF, this assessment for PEI Report has been compiled in accordance with professional standards and guidance. The standards and guidance which relate to this assessment are:

- ClfA, 2017, Standard and guidance for historic environment desk-based assessment;
- ClfA, 2014a, Code of Conduct;
- Highways Agency 208/07, Design Manual for Roads and Bridges, Volume 11, Section 3, Part 2;
- Historic England, 2015, Good Practice Advice in Planning (GPA2) Managing Significance in Decision - Taking in the Historic Environment - this advice note provides information to support the NPPF and Planning Practice Guidance (PPG), such as aiding in assessing the significance of heritage assets;
- Historic England, 2015, Good Practice Advice in Planning (GPA3) The Setting of Heritage Assets - this advice note sets out a staged approach for assessing the impact of a proposed development on the heritage significance of assets, due to changes in their setting;
- English Heritage, 2008, Conservation Principles, Policies and Guidance for the Sustainable Management of the Historic Environment - this document sets out the approach to making decisions and offering guidance about all aspects of England's historic environment;
- English Heritage, 2011, Seeing the History in the View, a Method for Assessing Heritage Significance within Views - this document presents a method for understanding and assessing heritage significance within views; and
- Department for Communities and Local Government, 2014, Planning Practice Guidance 18a: Conserving and enhancing the historic environment, Scoping and consultation.

## 6.3 Study Area

- 6.3.1 The study area considered in the assessment comprises a buffer that extends 1km from the proposed scheme boundary. All designated assets within this study area have been considered by the assessment. In addition, where designated assets, such as registered parks and gardens, straddle the limit of the study area, any designated heritage assets that are associated within them have also been included in the assessment.
- 6.3.2 The Zone of Theoretical Visibility (ZTV) is zone from which the proposed scheme is theoretically visible over 'bare earth.' The ZTV was not available at the time that the study area for the PEI report was confirmed or for use in the PEI Report. However the ES will include a review of assets that lie outside of the 1km study area but within the ZTV, to determine whether a significant effect would be likely to occur.
- 6.3.3 The ES will also consider assets for which changes in the noise environment may result in significant effects. As with the ZTV, the noise contours for the project were not available at the time the study area for the PEI report was being confirmed.
- 6.3.4 Data for non-designated heritage had not been collated and assessed at the time of writing. The final ES will consider non-designated heritage assets within 300m of the proposed scheme boundary. This smaller study area is consistent with DMRB methodology and is based upon professional judgement that non-designated assets are less likely to experience significant adverse effects as a result of changes to their settings beyond this distance. This does not preclude non-designated assets being of greater than local importance, for instance the

prehistoric enclosure of Peak Camp, or the shrunken medieval settlement at Stockwell. For further details of how the importance of assets will be determined please refer to see section 6.5, Table 6-1.

## 6.4 Potential Impacts

### Construction Impacts

- 6.4.1 Where the proposed scheme is contained within the existing A417 corridor and alongside areas of prior disturbance, the potential for the presence of as-yet unknown archaeological remains would have been previously removed. However, where the proposed scheme requires excavation below existing ground surface within areas of fields, including compound areas, possible remains may exist.
- 6.4.2 Construction activities may also result in impacts to palaeoenvironmental deposits.
- 6.4.3 Construction activity, including movements of plant, temporary lighting and temporary compounds, would take place within the wider setting of listed buildings and upstanding non-designated heritage assets within the study area. These works would be temporary and of limited duration.
- 6.4.4 Views from heritage assets towards permanent works such as new roads, cuttings, embankments and other structures are considered to be construction impacts for the purposes of the assessment. Likewise, removal of elements of the existing A417, such as lighting of junctions, are considered to be construction effects.

### Operation Impacts

- 6.4.5 Impacts on the historic environment during the operational phase may result from the use of the proposed scheme; this will include traffic noise, new lighting, and the visibility of moving vehicles on the road. There will be no physical impacts on below-ground archaeology during operation, as these will have occurred during the construction phase.
- 6.4.6 Noise and traffic models for the operation of the proposed scheme were not available for use in the PEI Report. These impacts will be considered in the ES.

## 6.5 Assessment Methodology

- 6.5.1 The DMRB provides a three-stage approach to assessment, determining the importance of the heritage asset, the magnitude of impact and the significance of effect. This approach is described in more detail in the following sections.

### Assessment of value

- 6.5.2 The assessment methodology for assessing effects is based on the principle that the environmental effects of the proposed scheme, in relation to a single heritage asset, should be determined by identifying the asset's value, assessing the magnitude of change the proposed scheme would have on the asset's significance (where significance is defined as the attributes that give the asset its importance) and then combining these two elements to identify the significance of effect. The following tables provide further detail on the process for assessing effects.

6.5.3 The importance or value of each heritage asset within the study area was determined according to the DMRB criteria set out in Table 6-1.

**Table 6-1 Importance/Value Criteria for Heritage Assets**

Criteria for establishing importance/value of heritage assets	
Value	Typical descriptors
Very High	Internationally important assets, including World Heritage Sites and nominated sites. Assets that can contribute significantly to acknowledged international research objectives.
High	Nationally important assets, including Scheduled Monuments, Grade I and II* Listed Buildings, Grade I and II* Registered Parks and Gardens, Registered Battlefields, Protected Wreck Sites. Grade II Listed Buildings. Assets that can contribute significantly to acknowledged national research objectives. Other listed buildings, which can be shown to have exceptional qualities in their fabric or historical associations not adequately reflected in the listing grade. Conservation areas containing very important buildings. Undesignated structures of clear national importance. Undesignated assets of schedulable quality and importance. Assets that can contribute significantly to acknowledged national research objectives.
Medium	Regionally important assets, including designated assets, Conservation Areas containing buildings that contribute significantly to its historic character, Grade II Registered Parks and Gardens, and non-designated assets. Designated or undesignated assets that contribute to regional research objectives.
Low	Local important assets, including Locally listed buildings. Historic (unlisted) buildings of modest quality in their fabric or historical association. Assets compromised by poor preservation and/ or poor survival of contextual associations. Assets of limited value, but with potential to contribute to local research objectives.
Negligible	Buildings of no architectural or historical note. Features with very little or no surviving archaeological interest.

### Magnitude of Impacts

6.5.4 The approach used to assess magnitude of impacts on heritage assets considers the change upon the receptor. This takes into account the severity of impact of the proposed scheme, together with the vulnerability of the receptor to change. The approach used is based on professional judgment and experience. It also reflects guidance on '*substantial harm*' and '*less than substantial harm*' in the NPPF and established methodologies in the DMRB. Table 6-2 summarises the types of impact and magnitude used in the assessment, adapted from DMRB.

**Table 6-2 Broad Criteria for Assessing the Magnitude of Change/Impact**

Magnitude of impact	Description and nature of change/impact
Major	Substantial harm to, or total loss of, an asset's significance as a result of changes to its physical form or setting. This would include for example, demolition, removal of physical attributes critical to an asset, loss of all archaeological interest or the transformation of an asset's setting in a way that fundamentally compromises its ability to be understood or

Magnitude of impact	Description and nature of change/impact
	appreciated. The scale of change would be such that it could result in a designated asset being undesignated or having its level of designation lowered.
Moderate	Less than substantial harm to an asset's significance as a result of changes to its physical form or setting. For example, physical alterations that remove or alter some elements of significance but do not substantially alter the overall significance of the asset; notable alterations to the setting of an asset that affect appreciation of it; or the unrecorded loss of archaeological interest.
Minor	Limited harm to an asset's significance as a result of changes to its physical form or setting (less than substantial harm) For example, physical changes that alter some elements of significance but do not noticeably alter the overall significance of the asset; and small small-scale alterations to the setting of an asset that hardly affect its significance.
Negligible/Neutral	No appreciable change to an asset's significance. Negligible change or no material change to the site or feature. No real change in our ability to understand and appreciate the resource and its historical context and setting.
No Change	No change.

### Significance of Effect

- 6.5.5 By combining the magnitude of impact (or change) and the importance of each heritage asset, an assessment has been made of the significance of effect, taking into account the possibility and nature of mitigation. The resultant effects may be either negative (adverse) or positive (beneficial) or neutral, depending on the nature of the impact.
- 6.5.6 In accordance with DMRB, significance of effect upon the heritage resource is assessed used the matrix in Table 6-3.
- 6.5.7 Where the matrix suggests more than one likely outcome, for instance slight or moderate, professional judgement has been used in conjunction with the descriptors in Table 6-4 to arrive at a robust conclusion.

**Table 6-3 Significance of Effect Matrix**

		<b>MAGNITUDE OF CHANGE</b>				
		<b>No Change</b>	<b>Negligible</b>	<b>Minor</b>	<b>Moderate</b>	<b>Major</b>
<b>ENVIRONMENTAL IMPORTANCE/ VALUE</b>	<b>Very High</b>	Neutral	Slight	Moderate or Large	Large or Very Large	Very Large
	<b>High</b>	Neutral	Slight	Moderate or Slight	Moderate or Large	Large or Very Large
	<b>Medium</b>	Neutral	Neutral or Slight	Slight	Moderate	Moderate or Large
	<b>Low</b>	Neutral	Neutral or Slight	Neutral or Slight	Slight	Slight or Moderate
	<b>Negligible</b>	Neutral	Neutral	Neutral or Slight	Neutral or Slight	Slight

**Evaluation of effect**

6.5.8 The significance of the effects on the heritage assets has been assessed using the approach defined in Table 6-4. Effects are defined on a nine-point scale (very large beneficial, large beneficial, moderate beneficial, slight beneficial, neutral, slight adverse, moderate adverse, large adverse or very large adverse).

**Table 6-4 Evaluation Criteria**

<b>Significance of effect</b>	<b>Effect</b>
Very Large Adverse	Partial or total loss of a site of Very High Importance.
Large Adverse	Result in the total, or almost total, loss of heritage assets. Be highly intrusive and would seriously damage the setting of the heritage resource such that its context is seriously compromised and can no longer be appreciated or understood. Be strongly at variance with the form scale and pattern of a heritage resource or conservation area. Be in serious conflict with government policy for the protection of the heritage resource.
Moderate Adverse	Be out of scale with or at odds with the scale pattern or form of the heritage resource or conservation area. Be intrusive in the setting (context) and adversely affect the appreciation and understanding of the resource. Result in loss of features such that their integrity of the heritage resource is compromised, but not destroyed. Be in conflict with local or regional policies for the protection of the heritage.

Significance of effect	Effect
Slight Adverse	<p>Have a detrimental impact on the context of a heritage feature such that its integrity is compromised and appreciation and understanding of it is diminished.</p> <p>Not fit perfectly with the form scale pattern and character of a heritage resource or conservation area.</p> <p>Be in conflict with local policies for the protection of the local character of the heritage resource.</p>
Neutral	<p>Maintain existing historic features in the townscape.</p> <p>Have no appreciable impacts either beneficial or adverse on any known or potential heritage assets.</p> <p>Result in a balance of beneficial and adverse impacts.</p> <p>Not result in severance or loss of integrity context or understanding within a historic landscape.</p> <p>Not be in conflict with and do not contribute to policies for the protection or enhancement of the heritage.</p>
Slight Beneficial	<p>Restore or enhance the sense of place of a heritage feature through good design and mitigation.</p> <p>Remove or mitigate visual intrusion (or other indirect impacts) into the context of heritage features such as that appreciation and understanding of them is improved.</p> <p>Not be in conflict with national regional or local policies for the protection of the heritage.</p> <p>Marginally enhance the integrity understanding and sense of place of a site or group of sites.</p>
Moderate Beneficial	<p>Provide potential for significant restoration of characteristic features or their setting through the removal, relocation or mitigation of existing damaging or discordant impacts on the heritage resource.</p> <p>Contribute to regional or local policies for the protection or enhancement of the heritage resource.</p> <p>Enhance the integrity, understanding and sense of place of a site or group.</p>
Large Beneficial	<p>Result in the removal, relocation or substantial mitigation of very damaging or discordant existing impacts (direct or indirect) on the heritage.</p> <p>Result in extensive restoration or enhancement of characteristic features or their setting.</p> <p>Form a major contribution to government policies for the protection or enhancement of the heritage resource.</p> <p>Remove or successfully mitigate existing visual intrusion such as that the integrity, understanding and sense of place of a site or group of sites is re-established.</p>
Very Large Beneficial	<p>As 'Large Beneficial' where the effect would be upon a site of Very High Importance</p>

6.5.9 Adverse effects of moderate significance or above represent a significant effect that require mitigation.

## 6.6 Baseline Conditions

6.6.1 This assessment has considered the known designated heritage assets within the proposed scheme footprint, inner study area and outer study area. Desk based historical research and consideration of non-designated assets had not been

completed at the time of writing. Approximate historical periods, as defined by Historic England<sup>38</sup>, are provided in Table 6-5.

**Table 6-5 Definition of Archaeological Time Periods**

Period name	Date range	Additional periods, where needed
Palaeolithic	500,000 – 10,000BC	
Mesolithic	10,000 – 4,000BC	
Neolithic	4,000 – 2,200BC	
Bronze age	2,200 – 700BC	
Iron age	700BC – AD43	
Romano-British	AD43 - 410	
Early medieval (Anglo-Saxon)	410 - 1066	
Medieval	1066 - 1540	
Post-medieval	1540 - 1901	Tudor - 1485 - 1603 Elizabethan - 1558 - 1603 Stuart - 1603 – 1714 (Jacobean 1603 – 1625) Hanoverian – 1714 –1837 (Georgian 1714– 1830) Victorian - 1837 - 1901
20th Century	1901 - 2000	
21st Century	2001 - 2100	

### Designated heritage assets

6.6.2 One designated asset lies within the proposed scheme boundary, but outside of the footprint of the proposed scheme. This is a group of three round barrows, known collectively as Emma's Grove (NHLE 1017079). This asset is located approximately 70m to the south of the proposed scheme at its closest point.

6.6.3 Nine scheduled monuments are present within the study area, beyond the proposed scheme boundary. These are:

- Coberley long barrow (NHLE 1002129);
- Brimpsfield Castle (NHLE 1003326);
- Brimpsfield Castle mound (NHLE 1003343);
- Crickley Hill camp (NHLE 1003586);
- Dryhill Roman villa (NHLE 1004848);
- Moat and fishpond at Bentham Manor (NHLE 1016764);
- Moated site and fishpond at Urrist Barn, 220m south west of Yew Tree Farm (NHLE 1017039);
- Crippets long barrow, 680m north east of Dryhill Farm (NHLE 1017040); and
- Two bowl barrows, known as Crippet's Wood round barrows, 560m and 590m north east of Dryhill Farm (NHLE1017041).



- 6.6.4 50 listed buildings are present outside of the proposed scheme boundary, but within the study area, which comprise:
- 2 Grade I listed buildings- Church of St Michael (NHLE 1088482) and Church of St Mary (NHLE 1091745);
  - 1 Grade II\* listed building- Dovecote circa 3 metres north of Bridge House (NHLE 1304753); and
  - 47 Grade II listed buildings.
- 6.6.5 One Registered Park and Garden is present within the study area, the Grade II\* Listed Cowley Manor.
- 6.6.6 Two conservation areas are present within the study area, Cowley and Brimpsfield.
- 6.6.7 These designated heritage assets are shown on figure 6.1 accompanying this PEI Report.

## 6.7 Consultation

- 6.7.1 Consultation has been undertaken with Historic England to inform the proposed scheme design, and engagement is ongoing as part of the design and EIA process.
- 6.7.2 The Scoping Opinion published in response to the Environmental Scoping Report included responses relating to Historic Environment. These have been considered and included, where appropriate, in this chapter.
- 6.7.3 A summary of the responses relevant to the Historic Environment assessment and the respective changes made to the scope of this chapter will be reported within the ES, which will accompany the DCO application.

## 6.8 Assessment Assumptions and Limitations

- 6.8.1 This assessment has been prepared based on the proposed scheme design information available at the time of compilation of this assessment. Table 6-6 identifies gaps and uncertainties for this PEI Report assessment.

**Table 6-6 Gaps and Uncertainties**

Gaps and Uncertainties	Description
Non-designated assets	Assessment of non-designated assets had not been completed at the time of writing but will be included in and inform the final assessment reported in the ES.
As-yet undiscovered archaeological remains	A non-intrusive archaeological investigation in the form of a geophysical survey is being undertaken for the proposed scheme boundary. This would be followed by a programme of trial trenching to determine the presence, extent, significance, and level of survival of buried heritage assets. The geophysical survey and trial trenching will inform the final assessment reported in the ES.
Visual and Noise effects	At the time of writing the ZTV and noise modelling had not been completed, and therefore preliminary assessments are based on effects considered likely to occur

## 6.9 Design, Mitigation and Enhancement Measures

### Construction Mitigation

- 6.9.1 Mitigation of construction impacts would take the form of measures to ameliorate direct impacts (physical damage), and indirect impacts (changes to setting that affect the significance of the assets).
- 6.9.2 'Preservation in situ' through engineering design (mitigation by design) will be considered, where practicable. However, it is likely that within the footprint of the proposed scheme there would be limited opportunities to achieve this.
- 6.9.3 Mitigation of direct impacts would take the form of 'preservation by record', that is, the investigation of archaeological remains prior to construction, and the analysis of artefacts and publication of results following the construction of the proposed scheme.
- 6.9.4 Preservation by record can involve a number of levels of detail, commensurate with the significance of the assets being impacted directly by the proposed scheme. As the significance of assets requiring completion becomes clearer, the type and location of mitigation required will be agreed with the Gloucestershire Council Archaeological Officer by means of a Written Scheme of Investigation (WSI)

### Operation Mitigation

- 6.9.5 Mitigation measures to reduce the harm on the setting and opportunities for enhancement in setting would be incorporated in the Landscape mitigation for the proposed scheme and designed in consultation with the County Archaeologist and Historic England. Such measures may include enhancement of existing views, screening, and facilitating or improving access to heritage assets.
- 6.9.6 No operational mitigation has been identified at the time of writing. Should impacts requiring mitigation be identified during the design process, this will be reported in the ES.

## 6.10 Assessment of Effects

- 6.10.1 As noted in Section 7.8, insufficient baseline data was available at the time of writing to enable a detailed impact assessment to be undertaken. The following surveys are undertaken or proposed to enable a full assessment to be made for the ES:
- Desk based assessment;
  - Historic Landscape Character (HLC) assessment;
  - Archaeological Watching Brief on geotechnical investigations;
  - Geophysical survey of the footprint of the proposed scheme; and
  - Targeted archaeological trial trenching to investigate the results of the geophysical survey.
- 6.10.2 The ES will report fully the impacts in the historic environment and include detailed descriptions of the settings of heritage assets. The assessment reported below is based on an initial review of heritage assets within the study area.

## Construction Effects

**Table 6-7 Scheduled Monuments (High Value)**

NHLE No.	Name	Distance from proposed scheme	Nature of Impact	Effect predicted
1002129	Coberley long barrow	1300m	Although the proposed scheme would not be visible or audible from the barrow, the proposed scheme would represent a modern alteration to the wider rural landscape within which the barrow sits. This wider rural setting, which contains a number of other prehistoric funerary monuments, provides context to the barrow, of which the concept of movement through the landscape is a key aspect. The proposed scheme would create a physical barrier in the landscape that would affect the ability to understand the barrow in its wider context, and as a consequence its significance would be affected.	Adverse
1003326	Brimpsfield Castle	920m	The proposed scheme will not be visible, noise levels likely to remain at current levels. The setting of the asset, which consists primarily of its interrelationship with its associated castle mound and the nearby settlement of Brimpsfield, would be unchanged.	Neutral
1003343	Brimpsfield Castle mound	500m	The proposed scheme will not be visible, noise levels likely to remain at current levels. The setting of the asset, which consists primarily of its interrelationship with the nearby castle and the settlement of Brimpsfield, would be unchanged.	Neutral
1003586	Crickley Hill camp	500m	Crickley Hill occupies a commanding position, from which the proposed scheme would be clearly visible in views of the rural landscape that contribute substantially to the significance of the asset. This setting includes a number of contemporary prehistoric funerary monuments and settlement sites. This setting plays a key role in understanding how people moved and lived within this landscape. The proposed scheme would create a physical barrier in the landscape that would affect the ability to understand Crickley Hill in its wider context, and as a consequence its significance would be affected.	Adverse
1004848	Dryhill Roman villa	150m	The proposed scheme would not be visible or audible from the asset, which exists as below-ground archaeological remains. While the asset does have a wider relationship to its landscape within which the proposed scheme would sit, this setting makes only a small contribution to its significance.	Neutral

NHLE No.	Name	Distance from proposed scheme	Nature of Impact	Effect predicted
1016764	Moat and fishpond at Bentham Manor	1000m	This asset's significant setting comprises its immediate relationship with the adjacent Manor. The proposed scheme would not be visible from the asset, and its significance would not be affected.	Neutral
1017039	Moated site and fishpond at Urrist Barn, 220m south west of Yew Tree Farm	1200m	This asset's significant setting comprises its immediate relationship with its surrounding fieldscape. The proposed scheme would not be visible from the asset, and its significance would not be affected.	Neutral
1017040	Crippets long barrow, 680m north east of Dryhill Farm	1200m	Although the proposed scheme would not be visible or audible from the barrow, the proposed scheme would represent a modern alteration to the wider rural landscape within which the barrow sits. This wider rural setting, which contains a number of other prehistoric funerary monuments, provides context to the barrow, of which the concept of movement through the landscape is a key aspect. The proposed scheme would create a physical barrier in the landscape that would affect the ability to understand the barrow in its wider context, and as a consequence its significance would be affected.	Adverse
1017041	Two bowl barrows, known as Crippet's Wood round barrows, 560m and 590m north east of Dryhill Farm	780m	Although the proposed scheme would not be visible or audible from the barrows, the proposed scheme would represent a modern alteration to the wider rural landscape within which these barrows sit. This wider rural setting, which contains a number of other prehistoric funerary monuments, provides context to the barrow, of which the concept of movement through the landscape is a key aspect. The proposed scheme would create a physical barrier in the landscape that would affect the ability to understand the barrows in their wider context, and as a consequence its significance would be affected.	Adverse
1017079	Three bowl barrows, known as Emma's Grove round barrows	50m	Passing 50m to the north of these barrows, the proposed scheme would substantially alter the immediate setting of these barrows. The proposed scheme would represent a modern alteration to the wider rural landscape within which these barrows sit. This wider rural setting, which contains a number of other prehistoric funerary monuments, provides context to the barrow, of which the concept of movement through the landscape is a key aspect. The proposed	Adverse

NHLE No.	Name	Distance from proposed scheme	Nature of Impact	Effect predicted
			scheme would create a physical barrier in the landscape that would affect the ability to understand the barrows in their wider context, and as a consequence their significance would be affected.	

**Table 6-8 Listed Buildings (High Value)**

NHLE No.	Name	Grade	Distance from Proposed Scheme	Nature of Impact	Effect predicted
1088481	Brimpsfield Park	II	710m	The proposed scheme will not be visible from the asset. The setting of the asset comprises its immediate relationship with other buildings in the settlement of Brimpsfield, and this setting would be unchanged.	Neutral
1088482	Church of St Michael	I	770m	The proposed scheme will not be visible from the asset. The setting of the asset comprises its immediate relationship with other buildings in the settlement of Brimpsfield, and this setting would be unchanged.	Neutral
1088483	Wilks monument in the churchyard approximately 9 metres south west of Church of St Michael	II	770m	The setting of this asset comprises its immediate relationship with the Church of St. Michael. This relationship would not be altered by the proposed scheme.	Neutral
1088484	Unidentified monument in the churchyard approximately 10 Metres south west of Church of St Michael	II	770m	The setting of this asset comprises its immediate relationship with the Church of St. Michael. This relationship would not be altered by the proposed scheme.	Neutral
1088485	Hayward monument in the churchyard approximately 12 metres south of Church of St Michael	II	770m	The setting of this asset comprises its immediate relationship with the Church of St. Michael. This relationship would not be altered by the proposed scheme.	Neutral

NHLE No.	Name	Grade	Distance from Proposed Scheme	Nature of Impact	Effect predicted
1088486	Winning family monument in the churchyard approximately 2 metres south of Church of St Michael	II	770m	The setting of this asset comprises its immediate relationship with the Church of St. Michael. This relationship would not be altered by the proposed scheme.	Neutral
1088487	Pear Tree Cottage	II	1050m	The proposed scheme will not be visible from the asset. The setting of the asset comprises its immediate relationship with other buildings in the settlement of Brimpsfield, and this setting would be unchanged.	Neutral
1088488	Brimpsfield House	II	1050m	The proposed scheme will not be visible from the asset. The setting of the asset comprises its immediate relationship with other buildings in the settlement of Brimpsfield, and this setting would be unchanged.	Neutral
1088489	Game house adjoining Brimpsfield House	II	1050m	The proposed scheme will not be visible. The setting of the asset comprises its immediate relationship with Brimpsfield House, and other buildings in the settlement of Brimpsfield, and this setting would be unchanged.	Neutral
1088492	Yew Tree Farmhouse	II	1100m	The proposed scheme will not be visible from the asset. The setting of the asset comprises its immediate relationship with other buildings in the settlement of Brimpsfield, and this setting would be unchanged.	Neutral
1091744	Black Horse Ridge	II	540m	The setting of this buildings consists of its immediate relationship with other historic buildings within the settlement of Birdlip. The proposed scheme will not be visible from the asset.	Neutral
1091745	Church of St Mary	I	1200m	The key setting of this asset consists of its role as a community focus for the adjacent settlement of Great Whitcombe. The proposed scheme will not be visible, and noise levels are likely to remain at current levels. The setting of the asset would be unchanged.	Neutral
1091746	Holbert family monument in the	II	1200m	The setting of this asset comprises its immediate relationship with the Church of St. Mary. This	Neutral

NHLE No.	Name	Grade	Distance from Proposed Scheme	Nature of Impact	Effect predicted
	churchyard of the Church of St Mary circa 10 metres east of the chancel			relationship would not be altered by the proposed scheme.	
1091750	The Keeper's Cottage	II	1250m	This asset lies within woodland, and this forms its setting. The proposed scheme would not be visible from the asset, and therefore its setting would be unchanged.	Neutral
1091758	Chandler's Farmhouse	II	280m	Noise and visual elements relating to construction activity will temporarily alter the setting of the asset.	Adverse (temporary)
1091759	The Cot	II	490m	The setting of this asset consists of the surrounding settlement of Little Whitcombe. The proposed scheme will not be visible. The setting of the asset would be unchanged.	Neutral
1091760	Little Witcombe House	II	480m	The setting of this asset consists of the surrounding settlement of Little Whitcombe. The proposed scheme will not be visible, and noise levels are likely to remain at current levels. The setting of the asset would be unchanged.	Neutral
1091761	Witcombe Court	II	280m	The setting of this asset consists of the surrounding settlement of Little Whitcombe. The proposed scheme will not be visible, and noise levels are likely to remain at current levels. The setting of the asset would be unchanged.	Neutral
1091773	Caretaker's Residence at the entrance to Ullenwood Manor	II	1,000m	The setting of the asset consists of its relationship with Ullenwood Manor. The proposed scheme will not be visible, and noise levels are likely to remain at current levels. The setting of the asset would be unchanged.	Neutral
1091775	Shab Hill Barn	II	50m	Although surrounded by trees, the rural setting of the asset would be altered by the proximity of the Shab Hill junction to the east and the physical alteration of the historic access to the asset to accommodate the provision of a new connecting road from Shab Hill junction to Birdlip.	Adverse

NHLE No.	Name	Grade	Distance from Proposed Scheme	Nature of Impact	Effect predicted
1091776	Kingshead House Restaurant	II	510m	The setting of this building consists of its immediate relationship with other historic buildings within the settlement of Birdlip. The proposed scheme will not be visible from the asset.	Neutral
1091787	Crickley Hill Farm	II	50m	Noise and visual elements relating to construction activity will temporarily alter the setting of the asset..	Adverse (temporary)
1091796	Church of St Peter	II	200m	Noise and visual elements relating to construction activity will temporarily alter the setting of the asset.	Adverse (temporary)
1091797	The Elms	II	900m	The setting of the asset consists of its relationship with its immediate rural surroundings. The proposed scheme will not be visible. The setting of the asset would be unchanged.	Neutral
1152474	Bentham Manor	II	900m	The setting of the asset consists of its relationship with its immediate rural surroundings. The proposed scheme will not be visible. The setting of the asset would be unchanged.	Neutral
1152477	Willow Farm	II	600m	The setting of the asset consists of its relationship with its immediate rural surroundings. The proposed scheme will not be visible. The setting of the asset would be unchanged.	Neutral
1152705	West Lodge	II	1000m	The setting of the asset consists of its relationship with Ullenwood Manor, now the National Star College. The proposed scheme will not be visible. The setting of the asset would be unchanged.	Neutral
1152733	Hill Barn	II	700m	The setting of the asset consists of its relationship with its immediate rural surroundings. The proposed scheme will not be visible. The setting of the asset would be unchanged.	Neutral
1152736	Milestone	II	700m	The setting of the milestone is its immediate relationship with the existing road. The milestone would remain in situ alongside the existing A417.	Neutral
1152813	Reeves family monument in the churchyard of the Church of St Mary, circa	II	1200m	The setting of this asset comprises its immediate relationship with the Church of St. Mary. This relationship would not be altered by the proposed scheme.	Neutral



NHLE No.	Name	Grade	Distance from Proposed Scheme	Nature of Impact	Effect predicted
	11 metres north west of the tower				
1152820	Tadleys	II	1200m	The setting of this asset consists of the surrounding settlement of Great Whitcombe. The proposed scheme will not be visible. The setting of the asset would be unchanged.	Neutral
1171399	Dog kennels and shed approximately 5 metres east of Brimpsfield House	II	1050m	The setting of this asset consists of its immediate relationship with Brimpsfield House. The proposed scheme will not be visible. The setting of the asset would be unchanged.	Neutral
1171422	The Old Malt House	II	1200m	The proposed scheme will not be visible from the asset. The setting of the asset comprises its immediate relationship with other buildings that form the settlement of Brimpsfield, and this setting would be unchanged.	Neutral
1248788	Unidentified monument in the churchyard approximately 9 1/2 metres west of Church of St Michael	II	770m	The setting of this asset comprises its immediate relationship with the Church of St. Michael. This relationship would not be altered by the proposed scheme.	Neutral
1277748	Unidentified monument in the Churchyard approximately 10 metres south west of Church of St Michael	II	770m	The setting of this asset comprises its immediate relationship with the Church of St. Michael. This relationship would not be altered by the proposed scheme.	Neutral
1304608	Cotswold Cottage	II	460m	The setting of this building consists of its immediate relationship with other historic buildings within the settlement of Birdlip. The proposed scheme will not be visible from the asset. The setting of the asset would be unchanged.	Neutral
1304609	The Lodge	II	540m	The setting of this building consists of its immediate relationship with other historic buildings within the settlement of Birdlip. The proposed scheme will not be visible from the asset. The setting of the asset would be unchanged.	Neutral

NHLE No.	Name	Grade	Distance from Proposed Scheme	Nature of Impact	Effect predicted
1304644	Greywalls	II	500m	The setting of this building consists of its immediate relationship with other historic buildings within the settlement of Birdlip. The proposed scheme will not be visible from the asset. The setting of the asset would be unchanged.	Neutral
1304753	Dovecote circa 3 metres north of Bridge House	II*	900m	The setting of this asset comprises its immediate relationship with Bridge House. This relationship would not be altered by the proposed scheme.	Neutral
1340107	Bridge House	II	900m	The setting of the asset consists of its relationship with its immediate rural surroundings and its associated dovecote. The proposed scheme will not be visible. The setting of the asset would be unchanged.	Neutral
1340126	Chestnut Cottage	II	500m	The setting of this asset consists of the surrounding settlement of Little Whitcombe. The proposed scheme will not be visible. The setting of the asset would be unchanged.	Neutral
1340127	The Retreat	II	370m	The setting of this asset consists of the surrounding settlement of Little Whitcombe. The proposed scheme will not be visible. The setting of the asset would be unchanged.	Neutral
1340132	Booker's	II	2000m	The setting of the asset consists of its relationship with its immediate rural surroundings. The proposed scheme will not be visible. The setting of the asset would be unchanged.	Neutral
1340133	Harding's Barn	II	470m	Noise and visual elements relating to construction activity will temporarily alter the setting of the asset.	Adverse
1340134	Birdlip House	II	540m	The setting of this building consists of its immediate relationship with other historic buildings within the settlement of Birdlip. The proposed scheme will not be visible from the asset. The setting of the asset would be unchanged.	Neutral
1340135	Pool House	II	450m	The setting of this building consists of its immediate relationship with other historic buildings within the settlement of Birdlip. The proposed scheme will not be visible from the asset. The setting of the asset would be unchanged.	Neutral

NHLE No.	Name	Grade	Distance from Proposed Scheme	Nature of Impact	Effect predicted
1341764	Unidentified monument in the churchyard approximately 9 metres west of Church of St Michael	II	770m	The setting of this asset comprises its immediate relationship with the Church of St. Michael. This relationship would not be altered by the proposed scheme.	Neutral
1341766	Golden Heart Inn	II	450m	The setting of the asset comprises its immediate relationship with the existing road. This relationship would not be altered by the proposed scheme.	Neutral
1391005	K6 Kiosk	II	1070m	The setting of the asset comprises its immediate relationship within the settlement of Brimpsfield, and this setting would be unchanged.	Neutral
1393852	Beverley Cottage	II	480m	The setting of this building consists of its immediate relationship with other historic buildings within the settlement of Birdlip. The proposed scheme will not be visible from the asset. The setting of the asset would be unchanged.	Neutral

### Registered Parks and Gardens

- 6.10.3 Cowley Manor lies to the east of the proposed scheme at a distance of 950m at its closest point. It is situated in a mid to late 19<sup>th</sup> century landscape park and formal garden with lakes and waterworks which is a Registered Park and Garden (RPG). The focus of the park is the Grade II\* Cowley Manor, the south western facing view from which is considered to be the principal view within the RPG; this is emphasised by an avenue of trees that extends south west from the Manor, for a distance of 1.4km, culminating at the summit of Bubb's Hill. At this point the view to the south west encompasses the existing A417 dual carriageway.
- 6.10.4 The RPG would be screened from the proposed scheme by topography and existing mature vegetation, and as such its setting would not alter as a result of either the construction or operation of the proposed scheme. This would result in a magnitude of change of No Change, and the resultant significance of effect on the RPG would therefore be Neutral.

### Conservation Areas

- 6.10.5 Cowley Conservation Area largely coincides with the area of Cowley Manor RPG, and therefore the effect upon it would be as described in 6.10.3.
- 6.10.6 Brimpsfield Conservation area lies approximately 750m to the south east of the proposed scheme at its closest point. The proposed scheme would not be visible from the Conservation Area, and noise levels would likely remain at current levels. This would result in a magnitude of change of no change, and the resultant significance of effect on the RPG would therefore be neutral.

### Buried Archaeological Remains

- 6.10.7 The study area has a very high potential to contain buried archaeological remains of at least medium value. The proposed scheme would remove any such remains that lie within its footprint, which would be a major magnitude of change. The significance of effect, once mitigation is taken into account, would likely be slight to moderate adverse, depending on the significance of assets affected. This reduction in effect accrues from the preservation of archaeological knowledge by record, and the dissemination of the results of archaeological investigation to the archaeological community and the public at-large.

### **Operation Effects**

- 6.10.8 Insufficient data was available at the time of writing to assess the operational effect of the proposed scheme of heritage assets. These effects will be fully considered in the environmental statement, in consultation with topic specialists for landscape and visual and noise, with reference to the final form of the proposed scheme.

## **6.11 Monitoring**

- 6.11.1 Monitoring will be required during construction to ensure that mitigation measures are applied as agreed with the consultees. No monitoring will be required during operation.

## **6.12 Summary**

### **Preliminary Construction Assessment**

- 6.12.1 During construction, impacts on buried archaeological deposits, if found, are considered to be direct and permanent. Depending on the value of the assets found, impacts are considered to range from slight to moderate. At this stage of assessment, the effects on buried archaeological deposits, if found, are considered to be significant adverse.
- 6.12.2 Construction impacts on scheduled monuments and listed buildings are considered to be indirect and temporary.
- 6.12.3 Following implementation of mitigation measures, the proposed scheme would result in significant adverse effects on the setting of the following Scheduled Monuments:
- Coberly Long Barrow;
  - Crickley Hill Camp;
  - Crippets Long Barrow;
  - Crippet's Wood Round Barrows (2No.); and
  - Emma's Grove Bowl Barrows (3No.).
- 6.12.4 The proposed scheme would also result in significant adverse effect on the setting of the Shab Hill Barn which is a Grade II listed building.

### **Preliminary Operation Assessment**

- 6.12.5 As stated in section 6.10.8. operational effects will be fully considered in the environmental statement.

**Further work**

- 6.12.6 A detailed level of assessment on the cultural heritage impacts during construction and operation of the proposed scheme will be undertaken in accordance with the methodology set out in the DMRB Volume 11, Section 3, Part 2, HA208/07 "Cultural Heritage". It will discuss the value of the heritage assets and their settings and their cultural heritage significance.
- 6.12.7 A cultural heritage desk study has been commissioned which will provide baseline data regarding non-designated assets for the ES.
- 6.12.8 A geophysical survey, to identify any potential buried archaeological remains within the proposed scheme boundary has been commissioned. The results will be analysed and incorporated into the ES and appropriate mitigation considered and recommended in consultation with Historic England and the County Archaeologist.
- 6.12.9 Where access is granted by landowners, and where practicable within programme constraints, archaeological trial trenching will be undertaken to ground-truth the results of the geophysical survey.
- 6.12.10 There will be consultation with Historic England and the County Archaeologist to ensure that all designated and non-designated assets surrounding the proposed scheme which constitute a sensitive receptor have been identified and assessed.
- 6.12.11 A review of the ZTV models developed for the Landscape and Visual Assessment will be undertaken to assist in the assessment of effects on cultural heritage sensitive receptors.
- 6.12.12 A programme of mitigation appropriate to the proposed scheme will be developed in consultation with Historic England and the County Archaeologist to reduce harm and to provide enhancements.
- 6.12.13 The ES will assess the potential impacts upon historic assets during the construction and operation of the proposed scheme. This will include consideration of the impact upon the setting of all heritage assets, including buried archaeological remains.
- 6.12.14 Monitoring to measure the success of any mitigation and enhancement measures will be considered as part of the EIA.

## 7 Landscape and Visual

### 7.1 Introduction

- 7.1.1 This PEI Report chapter on the Landscape and Visual Impact Assessment (LVIA) sets out the baseline conditions within the study area and the approach that will be used to undertake the LVIA, which will be reported in the Environmental Statement.
- 7.1.2 The Landscape and Visual PEI Report chapter will set out what work has been undertaken to date and what further work will be completed to prepare the LVIA.
- 7.1.3 Effects on landscape and visual receptors are closely related but are separately assessed, the former relating specifically to the landscape as a resource and its overall character and the latter relating to views and the visual amenity of people, i.e. users of Public Rights of Way (PRoW), the local road network, visitor attractions, visitors to the AONB and communities.
- 7.1.4 The Landscape Institute and Institute of Environmental Management and Assessment's Guidelines for Landscape and Visual Impact Assessment (GLVIA3) Third Edition state:
- Landscape as a resource: "*Landscape receptors, including the constituent elements of the landscape, its specific aesthetic or perceptual qualities and the character of the landscape in different areas*"; and
  - Visual Amenity: "*Visual receptors, that is, the people who will be affected by changes in views or visual amenity at different places.*"
- 7.1.5 The landscape baseline will identify landscape receptors within the study area including component characteristics of the receiving landscape and its overall character. The proposed scheme is situated within the Cotswolds AONB, therefore the character of the AONB, along with other designated landscapes, and relevant landscape character areas will be assessed as separate, individual receptors.
- 7.1.6 It is important to understand the inextricable link between the landscape and historic and ecological features which form an integral part of the overall character of the landscape. In this context, heritage and ecological features which influence or relate to the landscape are identified as key component characteristics of the landscape. Therefore, they are considered as part of the landscape character, rather than as individual landscape receptors. Reference will also be made to the separate PEI Report chapters for each of the interrelated topics where relevant.
- 7.1.7 The visual baseline will identify the visual resource affected by the proposed scheme and existing views to, across or from the scheme, and will identify visual receptors, such as people living in nearby communities, users of PRoW, Open Access Land (OAL), Country Parks and other recreational spaces, people travelling through the landscape on transport routes and people visiting the AONB or other publicly accessible areas (in addition to OAL, known as section 15 land) or features of interest, whose views or visual amenity might be affected by the proposed scheme.
- 7.1.8 This chapter should be read in conjunction with chapter 1 which includes the schemes vision and objectives, and with reference to chapter 2 which provides a full description of the proposed scheme.

- 7.1.9 This chapter should be read in conjunction with chapter 6 Cultural Heritage, particularly when reviewing viewpoint locations form heritage assets, chapter 8 Biodiversity, relating to the value of existing habitats and proposed landscape mitigation design and chapter 14 Climate for further information on the likely effects of climate change and how this may affect soft landscape planting, plant species selection and other relevant mitigation proposals.

## 7.2 Legislative and Policy Framework

### European Landscape Convention

- 7.2.1 The following paragraphs regarding the European Landscape Convention<sup>39</sup> are quoted from IEMA and the Landscape Institute's Guidance on Landscape and Visual Impact Assessment, 3rd Edition (2013)<sup>40</sup>:

*“The UK has signed and ratified the European Landscape Convention (ELC) since 2002, when the last edition of this guidance was published. The recognition that government has thus given to landscape matters raises the profile of this important area and emphasises the role that landscape can play as an integrating framework for many areas of policy. The ELC is designed to achieve improved approaches to the planning, management and protection of landscapes throughout Europe and to put people at the heart of this process.”*

### National Policy Statement for National Networks 2014

- 7.2.2 The National Policy Statement for National Networks (NPSNN) notes that where a development is subject to an Environmental Impact Assessment (EIA), an assessment of any likely significant landscape and visual impacts should be undertaken by the applicant within the EIA and described within the Environmental Statement (ES) (paragraph 5.144). The Applicant's assessment should consider any relevant national and local development policies, significant effects during construction and operation, and visibility and conspicuousness (paragraphs 5.146-148). Compliance with the respective duties in section 11A of the National Parks and Access to Countryside Act 1949 and section 85 of the Countryside and Rights of Way Act 2000 is required (paragraph 5.147). Paragraph 5.148 also states that significant road widening or the building of new roads in AONB should comply with the requirements set out in Defra's English national parks and the broads: UK government vision and circular 2010 or successor documents. Paragraph 5.149 of the NPSNN seeks careful design, having regard to the siting, operational and other constraints, in order to avoid or reduce landscape harm and to provide reasonable mitigation where possible and appropriate.
- 7.2.3 Great weight should be given to conserving landscape and scenic beauty nationally designated areas (National Parks, the Broads and AONBs). These areas have the highest status of protection in relation to landscape and scenic beauty. In decisions, the Secretary of State has a statutory duty to have regard to the statutory purposes which help ensure their continued protection. The Secretary of State should refuse development consent except in exceptional circumstances and where it can be demonstrated that it is in the public interest. For any significant road widening or the building of new roads in these areas,

<sup>39</sup> Council of Europe, "European Landscape Convention," Florence, 2000.

<sup>40</sup> The Landscape Institute / Institute of Environmental Management and Assessment (IEMA), Guidance on Landscape and Visual Impact Assessment, 3rd Edition, 2013.

compelling reasons for the new or enhanced capacity are required, and with any benefits outweighing the costs very significantly. The applicant should ensure that the project will be carried out to high environmental standards and where possible include measures to enhance other aspects of the environment. Where necessary, the Secretary of State should consider the imposition of appropriate requirements to ensure these standards are delivered (paragraphs 5.150-5.153).

7.2.4 The policies set out within the NPSNN will be address within the ES LVIA.

### **National Policy**

#### The National Planning Policy Framework (NPPF)<sup>41</sup>

7.2.5 The section on Strategic Policies refers to strategies for infrastructure such as transport and “*the conservation and enhancement of the natural, built and historic environment, including landscapes and green infrastructure, and planning measures to address climate change mitigation and adaptation.*” (paragraph 20).

7.2.6 Other relevant sections include:

Open Space and Recreation: “*access to a network of high-quality open spaces and opportunities for sport and physical activity is important for the health and well-being of communities.*” (paragraph 96)

Developments “*should protect and enhance public rights of way and access, including taking opportunities to provide better facilities for users, for example by adding links to existing rights of way networks including National Trails.*” (paragraph 98).

7.2.7 Chapter 8 Promoting Sustainable Transport notes that:

“*the environmental impacts of transport infrastructure should be identified and assessed including appropriate opportunities for avoiding and mitigating any adverse effects, and for net environmental gains*” and that “*opportunities to promote walking, cycling and public transport use are identified and pursued*” (paragraph 102).

7.2.8 With paragraph 104 going on to state that high quality walking and cycling networks should be provided for and that facilities such as cycle parking should be accommodated.

7.2.9 Chapter 8 also notes that the planning system should contribute to and enhance the natural, built and historic environment by protecting and enhancing valued landscapes, geological value and soils (paragraph 170), with great weight be given to conserving landscape and scenic beauty in AONBs and National Parks (paragraph 172).

7.2.10 However, the Framework does not contain specific policies for nationally significant infrastructure projects (paragraph 5). These are included within the NPSNN which, is detailed above. As with the NPSNN policies, the policies set out in the NPPF will also be addressed within the ES LVIA.

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<sup>41</sup> Department for Communities and Local Government, National Planning Policy Framework, February 2019



### A Green Future: Our 25 Year Plan to Improve the Environment

- 7.2.11 In 2018, the Government published their plans for creating a greener future and how they intend to improve the environment. The introduction states - landscape are goods in themselves and that broader landscapes are transformed by connecting habitats into larger corridors for wildlife.
- 7.2.12 Under the heading 'Our 25-year goals', the Government introduces their aims and goals, including:
- thriving plants and wildlife;
  - enhanced beauty, heritage and engagement with the natural environment; and
  - mitigating and adapting to climate change.
- 7.2.13 Chapters of relevance to the protection and enhancement of landscape in relation to the proposed A417 include chapter 1 and 2, with relevant sections lifted and commented on below.
- 7.2.14 Chapter 1: using and managing land sustainably introduces the principles of developments (including infrastructure schemes like the A417) providing 'environmental net gain', improving soil health, expand woodland cover and enhance existing woodland having a net positive impact and bringing wider environmental improvements by recognising the significant heritage value and irreplaceable character of ancient woodland and veteran trees and focusing on woodland to maximise its many benefits by increasing tree planting, creating new forests as part of the government's plan to plant 11 million trees.
- 7.2.15 Chapter 2: recovering nature and enhancing the beauty of landscapes, sets out their intention to protect and restore wildlife, and conserve and enhance the natural beauty of our landscapes by connecting wildlife sites or adding new wildlife habitats, in the region of 500,000 hectares. This landscape-scale approach to restore wildflower-rich grassland, meadows could include the A417 design intention to restore and enhance large areas of calcareous grassland, positively contributing to the Government's Nature Recovery Network, along with extensive woodland planting and providing better access for people to nature. Carbon capture is an additional benefits of planting trees positively contributing to improving the environment, and although this will not offset the impacts of the proposed scheme, they can help reduce them.
- 7.2.16 The Environmental Masterplan, including combined landscape, biodiversity and historic environment proposals will address and positively contribute to achieving environmental improvements as outlined within the Government's 25-year plan. Within the ES LVIA, commentary will be provided on how the goals listed above will be addressed during the design and assessment process.

### **Local Policy**

- 7.2.17 Local policy documents of relevance to the scheme include the adopted Cotswold Local Plan (2011 - 2031), the Gloucester Cheltenham Tewkesbury Joint Core Strategy 2011-2031 and the DRAFT Tewkesbury Borough Plan 2011-2031. Relevant policies will be commented on further in the ES LVIA.

### Gloucestershire County Council

- 7.2.18 The proposed scheme is situated within the Gloucestershire County boundary. Gloucestershire County Council is responsible for much of the area's

infrastructure, mineral working and associated development, and the disposal of waste. It does not set policy or consider domestic or infrastructure projects such as the proposed realignment of the A417 trunk road. Therefore, at the county level there are no relevant planning policies to consider.

Stroud District Council (Adopted November 2015)

- 7.2.19 The proposed scheme is situated outside of Stroud District Council; however, their boundary crosses within a small proportion of the wider 3km study area, south west of the scheme. This area is also situated within the Cotswolds AONB. Policies covering this area which include CP4 Place Making “*protecting and enhancing a sense of place with a locally inspired or distinctive character*” will be considered as part of its wider AONB context. Therefore, at the local level there are no relevant planning policies to consider.

Cotswold District Council Local Plan 2011-2031 (Adopted August 2018)

- 7.2.20 Relevant policies within Cotswolds District Council’s Local Plan include:

Policy EN4: The Wider Natural and Historic Landscape

*“1. Development will be permitted where it does not have a significant detrimental impact on the natural and historic landscape (including the tranquillity of the countryside) of Cotswold District or neighbouring areas.*

*“2. Proposals will take account of landscape and historic landscape character, visual quality and local distinctiveness. They will be expected to enhance, restore and better manage the natural and historic landscape, and any significant landscape features and elements, including key views, settlement patterns and heritage assets.”*

Policy EN5: Cotswolds Area of Outstanding Natural Beauty

*“1. In determining development proposals within the AONB or its setting, the conservation and enhancement of the natural beauty of the landscape, its character and special qualities will be given great weight.*

*“2. Major development will not be permitted within the AONB unless it satisfies the exceptions set out in national Policy and Guidance.”*

Policy EN6: Special Landscape Areas

*“Development within Special Landscape Areas will be permitted provided it does not have a significant detrimental impact upon the special character and key landscape qualities of the area including its tranquillity.”*

Tewkesbury Borough Council, Gloucester City Council and Cheltenham Borough Council Joint Core Strategy (Adopted December 2017)

- 7.2.21 The Joint Core Strategy is a partnership between Gloucester City Council, Cheltenham Borough Council and Tewkesbury Borough Council to deliver a co-ordinated strategic development plan. The Joint Core Strategy identifies larger strategic issues which impact all three authorities whilst each authority retains individual local plans which provide planning guidance on smaller and local development issues.

### *Joint Core Strategy*

7.2.22 Policies considered in this assessment are set out below and where appropriate relevant extracts have been included for ease of reference.

#### Policy SD4: Design Requirement

*“1. Context, Character and Sense of Place; New development should respond positively to, and respect the character of, the site and its surroundings, enhancing local distinctiveness, and...materials appropriate to the site and its setting. Design should establish a strong sense of place using streetscapes and buildings to create attractive and comfortable places to live and having appropriate regard to the historic environment.”*

#### Policy SD5: Green Belt

*“1. To ensure the Green Belt continues to serve its key functions, it will be protected from harmful development. Within its boundaries, development will be restricted to those limited types of development which are deemed appropriate by the NPPF, unless very special circumstances can be demonstrated. That is: ‘whether very special circumstances exist to outweigh the harm automatically caused to the Green Belt by virtue of the development being inappropriate and any other harm actually caused.’”*

#### Policy SD6: Landscape

*“1. Development will seek to protect landscape character for its own intrinsic beauty and for its benefit to economic, environmental and social well-being;*

*“2. Proposals will have regard to the local distinctiveness and historic character of the different landscapes in the JCS area, drawing, as appropriate, upon existing Landscape Character Assessments and the Landscape Character and Sensitivity Analysis. They will be required to demonstrate how the development will protect or enhance landscape character and avoid detrimental effects on types, patterns and features which make a significant contribution to the character, history and setting of a settlement or area.”*

#### Policy SD7: The Cotswolds Area of Outstanding Natural Beauty (AONB)

*“All development proposals in or within the setting of the Cotswolds AONB will be required to conserve and, where appropriate, enhance its landscape, scenic beauty, wildlife, cultural heritage and other special qualities. Proposals will be required to be consistent with the policies set out in the Cotswolds AONB Management Plan.”*

#### Policy SD14: Health and Environmental Quality

*“1. High-quality development should protect and seek to improve environmental quality. Development should not create or exacerbate conditions that could impact on human health or cause health inequality.*

*“2. New development must:*

*vi. Take into account the quality and versatility of any agricultural land affected by proposals, recognising that the best agricultural land is a finite resource;*

*vii. Have regard to any areas of tranquillity that are identified in adopted or emerging District plans and neighbourhood plans; and*

*viii. Avoid any adverse impact from artificial light on intrinsically dark landscapes.”*

#### Policy INF1: Transport Network

*“Developers should provide safe and accessible connections to the transport network to enable travel choice for residents and commuters. All proposals should ensure that:*

*ii. Connections are provided, where appropriate, to existing walking, cycling and passenger transport networks and should be designed to encourage maximum potential use; and*

*iii. All opportunities are identified and taken, where appropriate, to extend and/or modify existing walking, cycling and public transport networks and links, to ensure that credible travel choices are provided by sustainable modes.”*

#### Policy INF3: Green Infrastructure

*“1. The green infrastructure network of local and strategic importance will be conserved and enhanced, in order to deliver a series of multifunctional, linked green corridors across the JCS area by:*

- Improving the quantity and/or quality of assets;*
- Improving linkages between assets in a manner appropriate to the scale of development, and*
- Designing improvements in a way that supports the cohesive management of green infrastructure;*

*“2. Development proposals should consider and contribute positively towards green infrastructure, including the wider landscape context and strategic corridors between major assets and populations;*

*“3. Existing green infrastructure will be protected in a manner that reflects its contribution to ecosystem services (including biodiversity, landscape quality, the historic environment, public access, recreation and play) and the connectivity of the green infrastructure network. Development proposals that will have an impact on woodlands, hedges and trees will need to include a justification for why this impact cannot be avoided and should incorporate measures acceptable to the Local Planning Authority to mitigate the loss. Mitigation should be provided on-site or, where this is not possible, in the immediate environs of the site; and*

*“4. Where assets are created, retained or replaced within a scheme, they should be properly integrated into the design and contribute to local character and distinctiveness. Proposals should also make provisions for future maintenance of green infrastructure.”*

#### Draft Tewkesbury Borough Plan (2011-2031)

7.2.23 The Tewkesbury Borough Plan is still in the process of being adopted by Tewkesbury Borough Council. The draft version provides site options for future development and draft policies for those areas not covered by national guidance

or the Joint Core Strategy. Relevant draft policies for each topic are outlined below.

#### Policy ENV1 Special Landscape Areas

*“When assessing proposals for development that affect a Special Landscape Area particular attention will be accorded to the protection and enhancement of those features of the landscape character which are of local significance. Proposals must demonstrate that they do not adversely affect the quality of the natural and built environment, its visual attractiveness, wildlife and ecology, or detract from the quiet enjoyment of the countryside.”*

#### Policy ENV2 Landscape Protection Zones

*“Within these zones special protection is given to the ecology and visual amenity of the river environment. Development will not be permitted which:*

- 1. Has a detrimental visual or ecological effect on the character of the river banks or associated landscape setting of the Severn Vale;*
- 2. Has an adverse impact on the water environment.”*

#### Tewkesbury Borough Local Plan to 2011, adopted March 2006

- 7.2.24 Key objectives of the Local Plan are to promote sustainable development, conserve and enhance the built and natural heritage of the Borough and stimulate an approach to new development which: respects local environment conditions in the detailed siting and design; takes full account of local eco-systems and biodiversity; supports innovative design solutions consistent with sustainability objectives; and supports more efficient use of land.

#### **Supplementary and Further Guidance**

- 7.2.25 The documents referred to below set out key principles which will be reflected within the emerging design and will be further commented on within the ES.
- 7.2.26 Design and environmental guidance documents produced by Cotswold District Council listed below, provide development advice on working with regionally-appropriate building materials, public access and enjoyment of the countryside, promoting the landscape features and systems, protecting and enhancing the tranquillity and dark skies and enhancing landscape character through plant species and local provenance. The Cotswolds AONB Management Plan, provides detail on the landscape character of the designation, and details policies regarding its management.

#### Supplementary guidance

- Cotswolds AONB Management Plan 2018-2023;
- Conserving and Celebrating Cultural Capital in the Cotswolds AONB;
- Cotswolds Dark Skies and Artificial Light Position Statement (Adopted 2019);
- Cotswolds Tranquillity and Dark Skies;
- Cotswolds National Park Position Statement;
- Cotswolds Public Rights of Ways; and
- Cotswolds Tree Species and provenance.

- 7.2.27 A strategic approach produced by the Gloucestershire Nature Partnership outlines priorities to conserve and enhance the counties biodiversity for the benefit of the environment and people. This is echoed through Gloucestershire Wildlife Trust's Strategic Plan (2017-2022) and the National Trust's strategic vision.
- 7.2.28 The Strategic Vision 2019 -2022 produced by Gloucestershire County Council provides guidance on transport and infrastructure in relation "*to safeguarding the county's natural landscape and environment*". Key areas of focus include:
- *"Embedding green infrastructure into our thinking and planning for Gloucestershire's future development and regeneration; and*
  - *Planning and designing with health and wellbeing in mind;"*

#### Environment Strategy 2017 and Delivery Plan 2015-2020

- 7.2.29 The Highways England vision is for a strategic road network that works more harmoniously with its surroundings to deliver an improved environment. This includes investment to improve the appearance of the network and to protect and enhance the character and quality of the built and natural landscape. Key areas of focus include:
- addressing existing environmental problems and specifically reducing visual intrusion by revising existing landscape mitigation;
  - amending the design of roads to better address national, regional and local priorities; and
  - promoting schemes that are better integrated with the surrounding environment at a landscape scale, which also deliver associated ecosystem service benefits. This will be done in line with National Character Area profiles.

#### The road to good design 2018

- 7.2.30 The document sets out a vision, which aims to put people at the heart of Highways England's work, by designing an inclusive, resilient and sustainable road network. This road network should be appreciated for its usefulness but also its elegance, reflecting in its design the beauty of the natural, built and historic environment through which it passes, and enhancing it where possible.

#### Stakeholder design vision

- 7.2.31 Gloucestershire Wildlife Trust, National Trust, Natural England, Environmental Agency and Historic England presented the collaborative Landscape Vision for the A417 Missing Link Road Scheme. The presentation outlined the key issues and impacts from the old A417 road and recommended a series of improvement strategies for the proposed scheme.
- 7.2.32 Many of the proposed strategies were incorporated in the existing design through previous interactions with stakeholders. Those interventions which had not been considered, were reviewed and, where appropriate, incorporated into the design.

## **7.3 Study Area**

- 7.3.1 The study area for the PEI Report is 3km offset either side from the centreline of the proposed scheme. This has been informed by the Zone of Theoretical Visibility (ZTV) that has been produced for the Stage 2 design proposals, which indicates the extent of theoretical visibility of the proposed scheme.

- 7.3.2 Following consultation, the ZTV will be further refined for inclusion within the ES accompanying the DCO. This will be based on 2m Digital Surface Map (DSM) data, to identify areas from which the scheme would theoretically be visible. The DSM data reflects the 'surface' condition with heights data on a 2m grid, picking up existing features such as buildings and woodland. Small individual buildings, hedgerows and individual trees are not included in the model, but it should be noted that these features would provide additional local screening. Therefore, the ZTV shows the best representation in terms of the theoretical extent of visibility.
- 7.3.3 Two ZTVs were generated by computer software. The first places the Stage 2 design layout, minus landscape proposals, into the DSM and projects the theoretical extent of visibility of the proposed scheme from an average person's eye level at 1.75m. The second ZTV extends points 4.7m high above the layout of the proposed scheme to represent lorries and HGVs projecting a worst-case scenario for any vehicle or object likely to be using the scheme. In both scenarios, points are allocated along the layout at 2m intervals.
- 7.3.4 The desk-based assessment identified areas of higher ground along the escarpment including Leckhampton Hill (VP9), Crickley Hill (VP6), Barrow Wake (VP5) and The Peak (VP4). All of these areas are included within the Cotswolds AONB and are subject to a number of landscape and heritage designations including Open Access Land at Crickley Hill Country Park and the Cotswold Way National Trail which traverses the scarp. In addition, there are several scheduled monuments at Leckhampton Hill, Shurdington Hill, Crickley Hill, Copper's Hill and Barrow Wake. Additional areas of high ground, within the AONB include Brimpsfield (VP15) and Cowley Wood (VP12).
- 7.3.5 It is generally accepted that visual effect decreases with increased distance between the receptor and source of effect, IAN 135/10 states: "*the magnitude of any change would generally decrease with distance from its source, until a point is reached where there is no discernible change*". It may be possible that sensitive features lie beyond 3km; however, visual effects from this distance are unlikely to be significantly affected by the proposed scheme, so will not be assessed as part of the ES LVIA. The majority of features with the potential to receive significant effects lie within 1km of the scheme with a small number of features including Leckhampton Hill, Shurdington Hill, Cooper's Hill, Cowley Manor RGP and Miserden Park between 1km and 3km from the scheme. The core focus area for this assessment has therefore been set at 1km and a wider study area of up to 3km. Figure 7.2 shows the 1km Core Focus Area and the 3km Wider study area.
- 7.3.6 Using the ZTV, supported by field work, a selection of indicative viewpoints has been chosen for assessment. The locations of the selected representative viewpoints and the ZTV are shown on figure 7.1 Visibility and Indicative Viewpoints.
- 7.3.7 Once the viewpoint locations have been agreed with the statutory stakeholder, they will be visited to record the baseline photography. The viewpoint photographs will be presented in the ES.

## 7.4 Potential Impacts

### Sources of Landscape and Visual Effects

- 7.4.1 This section of the PEI Report sets out how the overall potential effect or residual effect of the proposed scheme, including the designed in mitigation and enhancements, will be reported within the ES LVIA.
- 7.4.2 At this stage of the assessment process, predicted effects and judgements have not been made. A full detailed assessment of likely effects of the proposed scheme will be assessed within the ES LVIA.

### Sources of Demolition and Construction Effects

- 7.4.3 Construction and demolition activities associated with this development would take place over a period of approximately 3 years (2021-2024).
- 7.4.4 To avoid double counting of effects, the assessment of landscape and visual construction effects identifies and assesses only temporary adverse effects which arise because of activities and elements that are unique to the construction phase.
- 7.4.5 For example, the permanent removal of built form or vegetation is assessed as part of the operational phase, but the works, such as the disruption caused by construction plant used during demolition and site clearance are assessed as part of the construction phase. A further example would be proposed landforms or building platforms, which are permanent features will be assessed as part of the operational phase, but the earthworks required to form them, including excavation, aggregate, earth movements and stock piling during the construction works, are assessed as construction effects.
- 7.4.6 As the scheme is gradually built throughout the construction phase, permanent effects would increasingly become part of the landscape and views. These effects are assessed as part of the operational phase. They include, for example, gradual introduction of transport infrastructure and the presence of the proposed built elements, such as the main structures up to completion.
- 7.4.7 Sources of construction effects on landscape and visual receptors include:
- temporary construction compounds with associated temporary lighting and fencing;
  - temporary haul roads;
  - stockpiling and storage of materials;
  - excavation and handling of materials;
  - on- and off-site construction traffic; and
  - on-site plant, such as:
    - demolition plant and excavators for site clearance;
    - articulated dump trucks, excavators up to 35T capacity, dozers and rollers for bulk earthworks;
    - cranes, telescopic boom lifts, piling rigs and telescopic forklifts for construction of structures; and
  - night time security lighting year-round, such as:



- isolated task lighting would be provided intermittently where required during the winter months only; or
- lighting of construction site compounds.

7.4.8 A description of the construction phase is provided in chapter 2 of this PEI Report.

7.4.9 The full assessment of landscape and visual construction effects will be reported within the ES, which will accompany the DCO application.

#### Sources of Operation Effects

7.4.10 The length of the proposed scheme is approximately 5.8 km. The proposals consist of a new dual carriageway between Brockworth bypass and Cowley roundabout, consisting partly of an online section along the existing alignment of the A417 south of Crickley Hill and partly via an offline section between the Air Balloon roundabout and Cowley junction. In addition to the dual carriageway, there will be a new route alignment for the A436 link road.

7.4.11 The new dual carriageway has a typical overall width of three lanes travelling east and south and two lanes traveling north and west. There would be three new grade-separated junctions at Shab Hill, as well as under- and over-bridges at Stockwell and Cowley.

7.4.12 Additional features include a requirement for retaining walls along the foot of Crickley Hill and along the cutting opposite Crickley Hill. Retaining wall design is being developed but these features will be up to a maximum of approximately 15m high (for Cold Slad Link retaining wall). A new large cutting slope will occur between Shab Hill junction and Crickley Hill and along the proposed scheme to the south of Crickley Hill (up to approximately 25m high). Cuttings and embankments will be required along the route to integrate the new road alignment.

7.4.13 Throughout the iterative design process, interventions have been made and integrated into the proposed scheme with the primary purpose of avoiding or reducing adverse effects at source and to make the proposed scheme fit better into its landscape setting. These measures are considered integral to the proposed scheme rather than as mitigation measures.

#### Sources of Landscape and Visual Operational Effects

7.4.14 Sources of landscape and visual effects are likely to occur because of the loss of or changes to existing landscape features or characteristics, feature or composition of a view, or the addition of new infrastructure or features within the landscape or view, including:

- the presence of the widened road, change of vertical and horizontal alignment south of Crickley Hill;
- altered road access arrangements to accommodate the new road infrastructure;
- the green bridge between Crickley Hill and Barrow Wake along elevated ground above the new A417 following the escarpment edge;

- the presence of replacement or enhancement vegetation, particularly along the southern side of the A417 between Brockworth bypass and Air Balloon roundabout;
- loss of the Hot Air Balloon public house and associated grounds;
- deep section of road cutting across the escarpment and through Shab Hill, creating exposed rock faces and retaining walls to accommodate six lanes of traffic;
- the realigned A436 between Shab Hill and Air Balloon roundabout;
- over bridges at Cowley and Stockwell;
- changes in the layout of the Cowley roundabout;
- upgrading of farm/property access tracks or points of egress;
- loss of trees and vegetation resulting in changes to landscape character and views;
- the presence of attenuation, cascade pond, filtration strips, bioswales drainage channels and culverts associated with the drainage proposals, particularly where these are typical engineered solutions e.g. regular shaped ponds, slope angle and location on steep gradients and any associated earthworks, retaining walls, culverts or other features;
- change of surfacing and additional proposed planting along the proposed detrunked section of the existing A417 between the minor road to Stockwell and Barrow Wake;
- changes to existing field pattern, including the removal, relocation or new field boundaries;
- new sections of drystone walling or hedgerow boundaries, planting of hedgerow trees or the change of land cover or agricultural practice as a result of the proposed landscape, heritage or ecological mitigation or enhancements; and
- changes to land cover from arable to rough/calcareous grassland or tree and woodland planting. Vegetation re-establishment will vary in timescale with calcareous grassland and scrub taking up to two to three years post construction, with trees taking approximately 15 years).

#### Sources of Likely Effects due to Climate Change

7.4.15 The PEI Report considers effects related to climate change as per the requirements of EU Directive 2014/52 and the 2017 EIA Regulations. The combined effects relating to landscape character, views and visual resource of the proposed development and potential climate change on receptors include the following:

- drier/drought conditions could lead to loss of vegetation and defoliation and receptors could become more vulnerable to stress. Could further disrupt views to and from the site;
- drought tolerant trees may become more prevalent (therefore also changing landscape character);
- wetlands may disappear (also dependent on elevation and spilt type) and certain soil types may be less readily available;
- hotter and wetter conditions could lead to an increase in pests and diseases, leading to loss of vegetation and defoliation making species more susceptible to external stress;

- increase in frequency and intensity of heavy rainfall events/ flooding could cause the loss of species in certain areas, because soils become water-saturated and can no longer support existing species;
- hotter and wetter conditions would lead to a longer growing season – increased rate of growth of vegetation. Could be a beneficial impact; and
- increased wind speed could impact the landscape through potential tree losses. Could further disrupt views to and from the site.

## 7.5 Assessment Methodology

7.5.1 The method for assessing landscape and visual effects in the ES will be based on the principles set out in the GLVIA3<sup>42</sup>, with reference also being made to, Design Manual for Roads and Bridges (DMRB) Volume 11<sup>43</sup> and Interim Advice Note 135/10<sup>44</sup>, as follows:

- the landscape of the 3km study area will be analysed and landscape receptors identified based on published landscape character assessments for the area and site visits;
- the extent of visibility will be established through the creation of a ZTV, refer to figure 7.1 Visibility and Viewpoints and 7.3 above;
- the visual baseline will be recorded in terms of the different groups of people (receptors) who may experience views of the proposed scheme and the nature of their existing views and visual amenity will be described;
- preliminary indicative viewpoints have been selected (including representative viewpoints, specific viewpoints and illustrative viewpoints);
- panoramic photography will be undertaken for each viewpoint, to record the extent of likely visibility of the proposed scheme as experienced by people at these locations;
- likely significant effects on landscape and visual resources will be identified; and
- the level (and significance) of landscape and visual effect will be judged, regarding how sensitive the resource or receptor (its susceptibility and value) and magnitude of effect (a combination of the scale of effect, geographical extent, duration and reversibility).

7.5.2 In addition to the GLVIA3, the ES LVIA will follow guidance set out in the following documents:

- Highways England (formerly Highways Agency), August 2008. The Design Manual for Roads and Bridges Volume 11: Section 2, Part 5, Assessment and Management of Environment Effects;
- Highways England (formerly Highways Agency), June 1993, updated August 1994. The Design Manual for Roads and Bridges Volume 11: Section 3, Part 5, Landscape Effects<sup>45</sup>;

<sup>42</sup> Landscape Institute and Institute of Environmental Management and Assessment (2013) Guidelines for Landscape and Visual Impact Assessment. 3rd Edition. Routledge. Paragraph 2.21.

<sup>43</sup> Highways England (1993, revised 1994) The Design Manual for Roads and Bridges Volume 11: Section 3, Part 5, Landscape Effects. Downloaded from <http://www.standardsforhighways.co.uk/ha/standards/dmr/vol11/section3/11s3p05.pdf>

<sup>44</sup> Highways England (2010). Interim Advice Note 135/10 Landscape and Visual Effects Assessment. Downloaded from <http://www.standardsforhighways.co.uk/ha/standards/ians/pdfs/ian135.pdf>

<sup>45</sup> Highways England (1993, revised 1994) The Design Manual for Roads and Bridges Volume 11: Section 3, Part 5, Landscape Effects. Downloaded from <http://www.standardsforhighways.co.uk/ha/standards/dmr/vol11/section3/11s3p05.pdf>

- Highways England (formerly Highways Agency), 2010. Interim Advice Note 135/10 Landscape and Visual Effects Assessment<sup>46</sup>;
- Highways England (formerly Highways Agency), 2015. Interim Advice Note 125/15 Environmental Assessment Update;
- Landscape Institute (2017) Visual representation of development proposals, Technical Guidance Note 02/17<sup>47</sup>;
- Landscape Institute. (2011). Photography and Photomontage in Landscape and Visual Impact Assessment, Landscape Institute Advice Note 01/11<sup>48</sup>;
- Landscape Institute (June 2018). Technical Guidance Note, Public Consultation Draft - Photography and photomontage in Landscape and Visual Impact Assessment<sup>49</sup>;
- Institution of Lighting Professionals. (2011). Institute of Lighting Professionals Guidance Notes for the Reduction of Obtrusive Light GN01:2011. 21; and
- Natural England (2014). An approach to Landscape Character Assessment.<sup>50</sup>

7.5.3 Where there are different approaches to undertaking the LVIA, between DMRB Volume 11, IAN 135/10 and GLVIA3, the preferred method will be described. In most cases GLVIA3 will take precedence as this approach uses descriptive narrative to provide transparency in the judgement process and follows a more up-to-date industry accepted approach.

7.5.4 The site location and LVIA study area is shown in figure 7.2: Landscape Designations. The Site Boundary includes the proposed scheme and encompasses all temporary and permanent works. The LVIA will focus on areas which are likely to experience significant effects, as set out in EIA Regulations – ‘*likely significant effects of the project on the environment*’ (Schedule 4 Part 1).

7.5.5 The study area includes the site and the wider landscape around it, up to 3km, which may be potentially influenced in a significant manner. A desk study review of sources of information will be undertaken to establish the baseline conditions of the study area. These include land use data and policies detailed in relevant documents, sources cited above, and the additional sources listed below:

- National Character Area 106 - Severn and Avon Vales;
- National Character Area 107 – Cotswolds;
- Gloucestershire Landscape Character Assessment;
- Gloucestershire Landscape Character Typology;
- Cotswolds AONB Character Assessment;
- Cotswolds AONB Landscape Strategy and Guidelines;
- The Landscape of the Cotswolds;
- Ordnance Survey – 1:50,000 and 1:25,000 scale maps;
- Google Earth Pro and Street View;
- Bing Maps; and
- GIS designation data sets.

<sup>46</sup> Highways England (2010). Interim Advice Note 135/10 Landscape and Visual Effects Assessment. Downloaded from <http://www.standardsforhighways.co.uk/ha/standards/ians/pdfs/ian135.pdf>

<sup>47</sup> Landscape Institute (March 2017). Technical Guidance Note 02/17 – Visual representation of development proposals. <https://landscapewpstorage01.blob.core.windows.net/www-landscapeinstitute-org/2016/01/02-17-Visual-Representation.pdf>

<sup>48</sup> Landscape Institute (March 2011). Advice Note 01/11. Photography and photomontage in landscape and visual impact assessment. (<https://landscapewpstorage01.blob.core.windows.net/www-landscapeinstitute-org/2019/01/LIPhotographyAdviceNote01-11.pdf>)

<sup>49</sup> Landscape Institute (June 2018). Technical Guidance Note, Public Consultation Draft - Photography and photomontage in Landscape and Visual Impact Assessment. <https://landscapewpstorage01.blob.core.windows.net/www-landscapeinstitute-org/2018/06/draft-tin-2018-XX-photography-photomontage-lvia.pdf>

<sup>50</sup> [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/691184/landscape-character-assessment.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/691184/landscape-character-assessment.pdf)

### Approach to Identification of Baseline Conditions

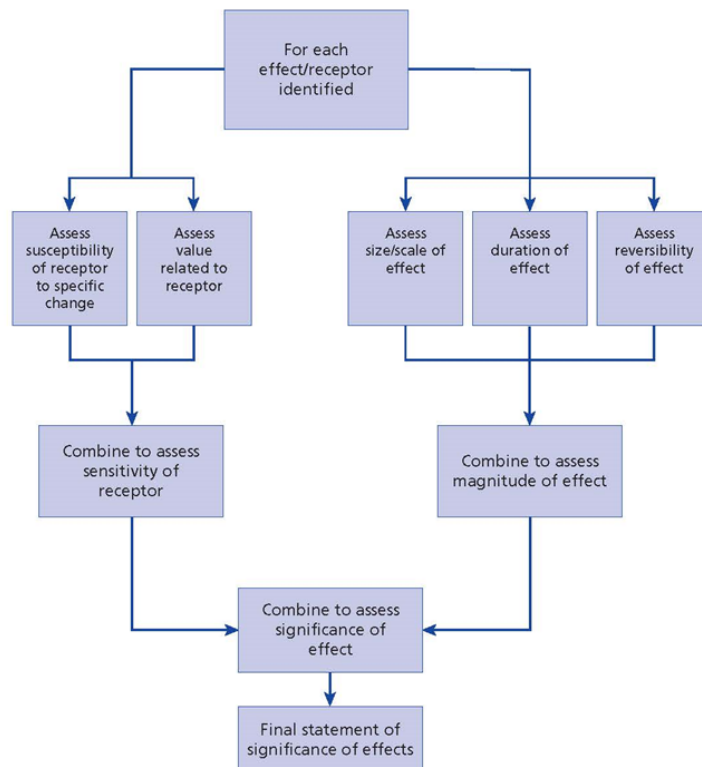
7.5.6 The following baseline studies have been carried out to inform the PEI Report:

- desk study and computer based visual analysis (ZTV as detailed above);
- initial field work to familiarise with the landscape and its character;
- preparation of figures including:
  - figure 7-1 Visibility and Indicative Viewpoints;
  - figure 7.2 Visibility (trucks) and Indicative Viewpoints;
  - figure 7.3 Designations;
  - figure 7.4 AONB Landscape Character Types;
  - figure 7.7 CPRE Dark Skies Mapping;
  - figure 7.8 Landscape Design Approach; and
  - figure 7.9 CPRE Tranquillity Mapping.
- the following additional figures will be prepared for the ES:
  - Landscape Features and Topography;
  - Photosheets; and
  - Environmental Masterplan.

### Assessment Criteria and Assignment of Significance

7.5.7 Typical criteria used in the assessment of receptors and effects is in accordance with a combination of GLVIA3 and IAN 135/10 Landscape and Visual Effects Assessment.

7.5.8 To provide judgments on the likely significance of effect on landscape and visual receptor requires consideration of the nature of the receptor (sensitivity) and the nature of the effect on those receptors (magnitude) as shown in the flow diagram.



- 7.5.9 As stated in GLVIA3, the nature of the landscape receptor, or their sensitivity, should be assessed in terms of their susceptibility to the type of change proposed and the value attached to each receptor.
- 7.5.10 GLVIA3 defines susceptibility as:  
*“the ability of the landscape receptor (whether it be the overall character or quality/condition of a particular type or area, or an individual element and/or feature, or a particular aesthetic and perceptual aspect) to accommodate the proposed scheme without undue consequences for the maintenance of the baseline situation and/or the achievement of landscape planning policies and strategies” (GLVIA3 paragraph 5.40).*
- 7.5.11 In this instance, the ES LVIA will focus on the receptors (landscape or visual) ability to accommodate large scale road infrastructure, including a multi lane dual carriageway, junctions, loss of existing landscape features including woodland and hedgerows, the A436 link road and associated features.
- 7.5.12 Judgements on susceptibility of receptors will be recorded as high, medium or low.
- 7.5.13 The second part of judging a receptors sensitivity is to determine its value. This will be done with reference to designation and the level of policy importance that they signify and the application of criteria that indicates value, such a landscape or scenic quality, conversation interest, recreational value, or perceptual and cultural associations.
- 7.5.14 Judgements on value will be recorded as of national, local or community value. As the site is situated within the Cotswolds AONB, it should be noted that whilst this landscape is designated at national level, and accorded the highest value, it does not mean that all parts of the AONB are of high quality/condition or that they have a high susceptibility to all types of change.
- 7.5.15 To report on the nature of effect, or magnitude, for each receptor (landscape or visual) judgements will be made in terms of the size and scale of effect, its geographical extent, duration and reversibility.
- 7.5.16 The size and scale of change will depend on the degree to which the landscape or visual receptor is changed by the proposed scheme, such as the removal or addition of new features within the landscape or view, and whether these are perceived as typical. The assessment of size and scale will be described as being imperceptible, small, medium or large.
- 7.5.17 To establish geographical extent, a judgement about how far ranging the effects will be made. These will be described as locally (small extent), wider area (medium extent) or widespread (large extent).
- 7.5.18 The duration will be reported as short term (0-3 years), medium term (3-15 years) and long term (over 15 years), refer to section Temporal Scope below.
- 7.5.19 Reversibility relates to whether the change is likely to be reversed, such as, for most construction effects could be recorded as ‘reversible’. Where through the replanting of vegetation or rebuilt stone wall, these may restore the landscape or view to something similar but would not be the same as the original could be recorded as ‘partially reversible’. Or the permanent presence or removal of built structures would be considered ‘not reversible’.

- 7.5.20 The susceptibility and value of each receptor to the proposed changes will then be combined with judgements on size and scale, geographical extent, duration and reversibility of effects to provide an overall judgement for each identified effect. This will involve making an informed professional assessment of the overall level of each effect, as set out in GLVIA3.
- 7.5.21 Levels of effect will be identified as either negligible, minor, moderate or major. For the ES LVIA, major and moderate effects will be judged to be significant. Any effect assessed to have a level of effect less than moderate is normally considered not to be significant.
- 7.5.22 Finally, the direction of effect will be determined in relation to the which the change is typical or whether it is deemed to fit with the baseline character or view, this judgement will be recorded as either positive, negative or neutral.

### **Temporal Scope**

- 7.5.23 The landscape and visual effects of the proposed scheme would vary through time. The assessment therefore considers the effects on landscape character and visual amenity arising over the life of the project, through its construction and operation:
- short-term temporary construction effects during the three-year construction phase, 2021 – 2024 (including any standard construction mitigation measures);
  - medium-term operational effects which would occur between completion in the winter of the first year of operation (2024) until the 15th year of operation (2039) before landscape mitigation would have established (without mitigation, but considering measures designed into the proposed scheme to reduce effects at source); and
  - long-term residual effects with mitigation from the 15th year after opening (2039), in accordance with GLVIA3 and IAN135/10<sup>51</sup>. This allows the assessment to take account of the mitigating effect of the proposed landscape mitigation once established.

### **Field Survey**

- 7.5.24 Field survey work will be carried out to record landscape character, the existing visual resource including the availability and opportunity to gain views towards the site. This work will include visits to site, viewpoint locations and designated landscape throughout the 3km study area to consider potential effects on landscape character and on views of the proposed scheme.
- 7.5.25 Field work and the first photographic survey work was undertaken in June 2019 at a time when the deciduous trees were in leaf. The screening effect of vegetation is most effective at this time of the year. Field work and photography will also be undertaken during the winter months whilst vegetation was out of leaf and visibility will be at its greatest.
- 7.5.26 The assessment is based on a worst-case scenario in terms of visibility, but also considers the more 'visually-contained' landscape during summer months.

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<sup>51</sup> Highways Agency, "IAN 135/10 Landscape and Visual Effects Assessment," 2010.

## Photography and Imaging

- 7.5.27 Once the viewpoint locations have been agreed with the statutory stakeholders, summer and winter photographic survey work will be carried out with reference to the emerging design. For this PEI Report no viewpoint photography has been undertaken to date but will be undertaken and will be carried out in accordance with best practise and current guidance (GLVA3 and LI Advice Note 01/11).

## Visualisations

- 7.5.28 Visualisations are a useful tool for assessment that can be used by the assessor to compare a digital representation of the proposed scheme with an actual view in the field. Presentation of visualisations includes a baseline photomontage displayed above the relevant visualisation and presented in an A3 format (height and length appropriate for each image, following the relevant guidance) to achieve a recommended viewing distance of 400mm.
- 7.5.29 Production of verified photomontages will be undertaken following the principles set out in the LI Advice Note 01/11. Verified photomontages will be based on baseline photography for selected viewpoint locations. These will aid the assessment of the visual effects of the proposed scheme, showing a three-dimensional (3D) model of the proposed scheme superimposed onto the baseline photographs. 3D models will be built using computer aided design software (CAD) with material finishes being assigned to the proposed scheme.

## 7.6 Baseline Conditions

- 7.6.1 A large amount of baseline work has been undertaken in relation to landscape character and visual amenity. This work will be used to inform the baseline of the PEI Report and subsequent LVIA chapter of the ES. The baseline will continue to be reviewed. Information relating to committed developments to inform the cumulative assessment, will be presented in the ES.

### Landscape Character

- 7.6.2 This section provides a description of landscape character (including individual landscape components) drawing on published studies and previous work. This will be supplemented and confirmed by undertaking sites visits.
- 7.6.3 Landscape character is defined as the “*distinct, recognisable and consistent pattern of elements in the landscape that makes one landscape different from another*”.<sup>52</sup> Landscape character type/area boundaries generally represent transitional zones and where the proposed scheme study area is located close to the boundary between character areas, the ‘key characteristics’ of adjacent areas will also be considered.
- 7.6.4 Landscape Character Assessments are a method of identifying and describing variations in the character of the landscape, and ‘*seek to identify and explain the unique combination of elements and features (characteristics) that make landscapes distinctive*’<sup>53</sup>. They can be carried out at several scales, from national (National Character Areas), to regional and local (Landscape Character Types or Areas).

<sup>52</sup> An Approach to Landscape Character Assessment (2014) Christine Tudor, Natural England.

<sup>53</sup> Natural England (2014). An Approach to Landscape Character Assessment, Christine Tudor, Natural England.



7.6.5 The principal sources of information about the landscape character of the study area are:

- National Landscape Character Assessment, Character Area 106 - Severn and Avon Vales, (Natural England);
- National Landscape Character Assessment, National Character Area 107 – Cotswolds, (Natural England);
- Cotswolds AONB Character Assessment;
- Cotswolds AONB Management Plan. Supporting guidance for the Cotswolds AONB Character Assessment;
- Cotswolds AONB Landscape Strategy & Guidelines. Supporting guidance for the Cotswolds AONB Landscape Character Assessment;
- Cotswolds Local Distinctiveness Guide. Supporting guidance for the Cotswolds AONB Landscape Character assessment;
- Gloucestershire County Council (2006) Gloucestershire Vales Landscape Character Assessment (LDA);
- Gloucestershire County Council (2002) Gloucestershire Landscape Character Typology. Supporting Guidance for the Gloucestershire Landscape Character Assessment; and
- Joint Core Strategy (2013) The Gloucester-Cheltenham-Tewkesbury Joint Core Strategy Landscape Characterisation Assessment & Sensitivity Analysis.

#### **National Character Areas (NCA's) 2012-14**

7.6.6 The description of the NCA's is included for context. The assessment of landscape character is carried out at a local scale in a proportional level of detail.

The proposed scheme is located within National Character Area (NCA) 107 Cotswolds with part of the 3km study area to the west situated within NCA 106 Severn Avon and Vales.

#### NCA 107 Cotswolds

7.6.7 A description of key relevant characteristics for NCA 107 Cotswolds (as defined by the Natural England National Character Area Profile and confirmed by field work) are:

- The Cotswolds is predominately an agricultural landscape characterised by a dramatic limestone scarp rising above the adjacent lowlands of the Severn and Avon Vales. The limestone geology has formed the scarp and dip slope of the landscape, which forms part of a transitional boundary between the two NCA's and has influenced drainage, vegetation, land use and settlement.
- The agricultural landscape is primarily located across the high wold and dip slope with permanent pasture along the steep slopes of the scarp and river valleys. Limestone Grassland flank these steep slopes of the scarp.
- Ancient Beech woods line the upper slopes of the scarp, with oak and ash woodlands more typical in the river valleys. Numerous plantations scatter the high wold and dip slope.
- There are large areas of common land, typically along the crest of the scarp which is important for unimproved calcareous grassland.
- There is a strong visual imprint of historic human activity in the landscape with Neolithic Barrows, Iron age hill forts and historic medieval fields patterns with ridge and furrow and later planned enclosures.

- The use of quarried limestone in the drystone walls and buildings brings a strong visual cohesion and harmony to the area, providing a distinct characteristic which has become internationally renowned.

7.6.8 In the profile for each NCA, Natural England sets out Statements of Environmental Opportunity. These help to bring together relevant information and offer suggestions where action can be best targeted to conserve and improve the natural environment. Statements of Environmental Opportunity for NCA 107 are:

- **“SEO 1:** *Protect and enhance the highly distinctive farmed landscape, retaining the balance between productive arable, pastoral and wooded elements and the open, expansive views particularly from the scarp, high wold and dip slope;*
- **“SEO 2:** *Safeguard and conserve the historic environment, cultural heritage and geodiversity that illustrate the history, evolution, foundations, land use and settlement of the Cotswolds landscape, and enable access to and interpretation of the relationship between natural processes and human influences; and*
- **“SEO 3:** *Protect, maintain and expand the distinctive character of the Cotswolds and the network of semi-natural and arable habitats, including limestone grassland, beech woods and wetlands along streams and rivers, to enhance water quality, strengthen ecological and landscape connectivity, support rare species and allow for adaptation to changes in climate.”<sup>54</sup>*

#### NCA 106 The Severn and Avon Vales

7.6.9 Key relevant characteristics (as defined by the Natural England National Character Area Profile and confirmed by field work) are:

*“A diverse range of flat and gently undulating landscapes strongly influenced and united by the Severn and Avon rivers which meet at Tewkesbury. Woodland is sparsely distributed across this landscape, but a well wooded impression is provided by frequent hedgerow trees, parkland and surviving traditional orchards. Small pasture fields and commons are prevalent in the west with a regular pattern of parliamentary enclosure in the east. Pasture and stock rearing predominate on the floodplain and on steeper slopes, with a mixture of livestock rearing, arable, market gardening and hop growing elsewhere. Along the main rivers, floodplain grazing marsh is prevalent. Fragments of unimproved calcareous grassland and acidic grasslands are also found. A strong historic time line is visible in the landscape, from the Roman influences centred at Gloucester, earthwork remains of medieval settlements and associated field systems.”*

7.6.10 Relevant Statements of Environmental Opportunity for NCA 106 are:

- **“SEO 2:** *Seek to safeguard and enhance this area’s distinctive patterns of field boundaries, ancient hedgerows, settlements, orchards, parkland, small woodlands, chases, commons and floodplain management with their strong links to past land use and settlement history, and for the benefits this will bring to soil erosion, soil quality and biodiversity; and*
- **“SEO 4:** *Protect geological exposures and maintain, restore and expand semi natural habitats throughout the agricultural landscape, linking them together to*

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<sup>54</sup> National Character Assessment: NCA Profile 107 Cotswolds available at: <http://publications.naturalengland.org.uk/publication/5900626?category=587130>

*create a coherent and resilient habitat network enabling ecosystems to adapt to climate change.”*

## **Regional Landscape Character Areas**

### Joint Core Strategy Landscape Characterisation Assessment and Sensitivity Analysis

- 7.6.11 A small part of the 3km study area is situated within the Gloucester Landscape Character K – Brockworth to Badgeworth and L – north Brockworth. These descriptions and the corresponding sensitivity areas are included for context. The assessment of landscape character is carried out at a local scale in a proportional level of detail.
- 7.6.12 Key relevant descriptions (as defined by the Joint Core Strategy and confirmed through field work) include:

#### K: Brockworth to Badgeworth

*“On a broad scale Chosen Hill encloses the area to the west, with the Cotswold AONB Escarpment, to the distant east. The undulating landform, synonymous with the A417 cutting, divides the area from Brockworth. Running north-south, the larger M5 corridor has minimal visual impact, as its route is predominantly lower than the surrounding landscape (becoming visible only in the north of the area) and landform gradually rises in the west, helping to unify the landscape through which it passes. Traffic noise has a significant impact in the immediate vicinity and across much, if not all, of the area. A single line of pylons cross the site diagonally, creating large industrial features at a local scale, and focal point from further afield. Scattered farmsteads are very typical of the area and offer a mix of building age and style from traditional to large and industrial (the latter can be a visual detractor at a local scale). Field pattern is quite regular with field size ranging from small to medium, with smaller fields generally being located around farms and settlement. The foot of Chosen Hill, west of the M5, offers a consistently medium to small field size, and has perhaps not, therefore, undergone the agricultural intensification evident in places east of the M5. Pasture is dominant within the area, but some arable land is evident, corresponding with larger field size. Field boundaries are usually low level, well maintained hedgerows with sporadically located mature deciduous trees. However, there are frequently taller, overgrown boundaries and bands of tree planting (including dense tree and scrub banks of the M5) which create the appearance of a heavily treed landscape in places. Small streams create small but steep valleys, which are often well vegetated and possibly of high wildlife value. Throughout the area pockets of traditional rural character exist, these are often located where built form and ridge and furrow offer time depth e.g. west of the M5, at Badgeworth, and around various farmsteads. A basic network of footpaths pass through the area, including a section of the Gloucestershire Way.”*

#### L: North Brockworth (south of the A417)

*“This gently undulating and predominantly arable landscape is bound by the A417 in the north, a major infrastructure confluence in the west and the residentially developed village of Brockworth to the south. The undulating topography and tree and scrub lined road network generally prevent views into the area north of the A417. This, in conjunction with the continuous proximity to residential*

*development, gives a notable degree of separation from the northerly landscape, which is otherwise similar in character. To the west the landscape becomes more fragmented by infrastructure, including bridges and embankments, and field size increases. A meandering brook follows the southern boundary, likely to be a biodiverse corridor important to wildlife. Central to the area are the historically significant Brockworth Church and Brockworth Court, around which ridge and furrow and well-established native hedgerows were observed. The M5 and A417 can be glimpsed and traffic noise is audible across the site.”*

- 7.6.13 Both Gloucester landscape character areas as described above in the Joint Core Strategy Landscape Characterisation Assessment and Sensitivity Analysis are characterised as medium sensitivity areas due to:
- *“Undulating landform creates visual containment at a local scale and visual associations can be made with surrounding AONB and Chosen Hill landform;*
  - *Tranquillity lost owing to the M5, A417 and A46;*
  - *Reasonable amenity value - long public footpaths (including link to Chosen Hill over the M5, and the Gloucestershire Way) but a limited number of circular walks;*
  - *Agricultural intensification and fragmentation by the A417 has degraded the rural landscape character has occurred but pockets of better retained landscape, and certain landscape features, have endured; and*
  - *Some landscape features have been retained including orchard, historic buildings, some mature trees”.*<sup>55</sup>

## **Local Landscape Character Areas**

### Gloucestershire Landscape Character Assessment

#### *Gloucestershire County Landscape Character Types and Areas*<sup>56</sup>

- 7.6.14 The landscape character of Gloucestershire county has been appraised in the Cotswolds AONB, Gloucestershire Vales, Forest of Dean and Stroud District Landscape Character Assessments. In order to keep the assessment proportional, only the landscape character Types (LCT's) and Landscape Character area's (LCA's) which will receive direct or indirect effects from the proposed scheme, as identified within the 3km study area will be appraised as part of this LVIA. These are outlined within the Cotswolds AONB and Gloucestershire Vales Landscape Character Assessments.
- 7.6.15 The Gloucestershire Vales Landscape Character Assessment is a combined LCA covering Tewkesbury District Council and areas of the Cotswold District Council which fall outside of the AONB. The Cotswolds Conservation Board have prepared their own Landscape Character Assessment covering the AONB.
- 7.6.16 The Forest of Dean and Stroud District Landscape Character Assessments have been scoped out at this stage as they will not receive any direct or indirect effects arising from the proposed scheme.

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<sup>55</sup> Joint Core Strategy Landscape Characterisation Assessment and Sensitivity Analysis available: [https://www.gloucester.gov.uk/media/1842/jcs\\_landscape\\_characterisation\\_assessment\\_and\\_sensitivity\\_analysis\\_septem.pdf](https://www.gloucester.gov.uk/media/1842/jcs_landscape_characterisation_assessment_and_sensitivity_analysis_septem.pdf)

<sup>56</sup> Landscape Character Assessment: Gloucestershire and Forest of Dean: County Scoping Study and County Typology, November 2002, Landscape Design Associates.

- 7.6.17 The Gloucestershire Vales LCA identifies a total of 38 landscape character types (LCT) which cover the whole of the Gloucestershire County. The proposed scheme crosses four LCT's from west to east. These are:
- LCT 18 Settled Unwooded Vale;
  - LCT 22 High Wold;
  - LCT 26 Escarpment; and
  - LCT 27 Secluded Valleys.
- 7.6.18 The landscape character types provide a generic understanding of the landscape as described as *“geology, landform, drainage patterns, vegetation and historical land use and settlement pattern.”*<sup>57</sup>
- 7.6.19 Alongside the LCT's, the Gloucestershire Vales Landscape Character Assessment identifies LCAs which describe unique and distinct geographical areas of a specific landscape type.
- 7.6.20 Within the 3km study area there is one LCA sited within the Settled Unwooded Vale (LCT18). The rest of the study area is sited within the AONB and appraised as part of the Cotswolds AONB Landscape Character Assessment. The LCT and LCAs which are sited within the study area are described as follows:

#### Landscape Character Type 18 Settled Unwooded Vale

- *“Soft gently undulating landform, with lower escarpment slopes forming a transitional area between the vale and escarpment;*
- *Cotswolds Escarpment defines the eastern limit of the Vale and provides a dramatic backdrop to vale settlements and landscapes;*
- *Mixed arable and pasture land use with occasional orchards;*
- *Well maintained hedgerows forming a strong landscape pattern;*
- *Limited woodland and ancient woodland cover;*
- *Quiet winding lanes linking villages, hamlets and farms at the foot of the escarpment;*
- *Varied mix of building materials, including use of brick, timber and stone, and slate and thatch roofing, but with Oolitic Limestone still prevalent within the vale villages in closer proximity to the Cotswolds Escarpment;*
- *Proliferation of modern ‘suburban’ building styles and materials;*
- *Major transport corridors through vale;*
- *Rural areas bordered by large urban and suburban areas and interspersed with commercial and industrial uses; and*
- *Widespread network of pylons and transmission lines.”*<sup>58</sup>

#### Landscape Character Area SV6B Vale of Gloucester

- *“The Vale of Gloucester is bounded by the principal urban areas of Gloucester, Cheltenham and Tewkesbury to the south west, south east and north respectively;*
- *To the east, the Vale is defined by the rising landform of the Cotswolds escarpment;*

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<sup>57</sup> Landscape Character Assessment: Gloucestershire Various Vales: County Scoping Study and County Typology, November 2002, Landscape Design Associates.

<sup>58</sup> Landscape Character Assessment: The Cotswolds Landscape Scoping Study and Typology (LDA, 2002) and Landscape Character Assessment: Gloucestershire Various Vales: County Scoping Study and County Typology, November 2002, Landscape Design Associates.

- *There is a diverse mixture of land uses in the Vale of Gloucester which combine to create a colourful and textured landscape;*
- *Agricultural land use in the vale includes both arable cultivation and pasture in a patchwork of fields that are large to medium in scale and predominantly regular in shape;*
- *In the wider vale landscape, low hedgerows with scattered hedgerow trees form the common boundary treatment. While these hedgerows are generally well maintained, some are becoming either gappy or overgrown;*
- *Woodland is not a characteristic feature of the Vale of Gloucester and is generally limited to few small copses; and*
- *Recreational resources in the character area include a number of rights of way, including the Gloucestershire Way long distance footpath which descends from the Cotswolds escarpment and crosses the vale.”<sup>59</sup>*

#### Cotswold District Council Landscape Character Assessment

- 7.6.21 The Cotswolds Conservation Board have prepared the Landscape Character Assessment covering the AONB. Areas within Cotswold District Council but outside the AONB are included as part of the Gloucestershire Vales Landscape Character Assessment. The proposed scheme is situated entirely within the Cotswolds AONB and so there are no additional LCA's as part of Cotswold district Council within the 3km study area.

#### Tewkesbury Borough Council Character Assessment

- 7.6.22 The Landscape Character Assessment which covers Tewkesbury Borough Council has been appraised as part of the Gloucestershire Vales Landscape Character Assessment. There is one LCA within Tewkesbury Borough Council and the 3km study area which is LCT 18 Settled Unwooded Valley and LCA SV6B Vale of Gloucester.

#### Cotswolds AONB Landscape Character Assessment

- 7.6.23 The Cotswolds AONB identifies five different LCTs along with seven LCA's within the 3km study area. The relevant character types are listed below along with their key characteristics:

##### LCT 2 Escarpment

- *“Steep exposed and elevated west facing scarp slope, partly cloaked in semi natural broadleaved woodland;*
- *generally poor soils and steep sloping relief of the escarpment not suited to arable farming, and primarily used for pasture or woodland;*
- *Limited areas of Registered Common Land on upper scarp slopes merging into the more extensive areas on the High Wold;*
- *Calcareous grasslands located on steeper scarp slopes;*
- *Summit of the scarp slope marked by dramatic linear beech hangers;*
- *Woodlands, hedgerows, scrub and isolated trees give the impression of a well treed landscape; and*
- *Small scale settlement generally confined to lower, shallower slopes of the escarpment, in sheltered locations, and adjacent to spring lines;*

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<sup>59</sup> Landscape Character Assessment: Gloucestershire Various Vales: County Scoping Study and County Typology, November 2002, Landscape Design Associates.

- LCA 2D Coopers Hill to Winchcombe
- *“This stretch of the escarpment forms a dramatic backdrop to the towns of Gloucester, Cheltenham and Bishop’s Cleeve and limits their eastward expansion;*
- *The height of the escarpment gradually increases in a northerly direction. Thus, at Cooper’s Hill it rises from 100 AOD to just over 200 m AOD;*
- *Large unenclosed areas of rough grassland on upper slopes and improved pasture in moderately sized hedged enclosures bordering the vale;*
- *Calcareous grassland located on steeper escarpment slopes, often found in close association with areas of ancient semi-natural broadleaved woodlands such as at Cold Slad and Barrow Wake;*
- *Large areas of ancient woodland between Cooper’s Hill and Birdlip; and*
- *Numerous archaeological sites border upper slopes such as at Crickley Hill.*

#### LCT 7 High Wold

- *“Broad, elevated, gently undulating plateau area dissected by a network of dry valleys with distinctive convex profile valley sides;*
- *Expansive long-distance views across the open plateau, and to distant hills beyond the Severn Vale;*
- *Elevated areas of plateau surrounded by deeply incised valleys;*
- *Predominantly arable land use with some improved pasture/grass leys, and very limited permanent pasture mainly confined to valley bottoms;*
- *Large scale, regular fields mainly enclosed by dry stone walls, together with*
- *Hedgerows with very occasional hedgerow trees, and post and wire fencing;*
- *Small to moderate size geometric farm woodlands, many comprising small coniferous and broadleaved plantations and shelterbelts, and plantations bordering roads;*
- *Settlement limited to small stone-built villages and hamlets, generally within valleys, and isolated farmsteads and individual dwellings;*
- *Network of mainly linear roads following ridge tops, and linking settlements;*
- *Evidence of long period of occupation of the land;*
- *Seasonal rotation of arable cropping patterns and improved grassland interrupts otherwise homogenous and simple land cover;*
- *Remnants of once more extensive commons survive on the fringes of the escarpment;*
- *Occasional active and disused limestone quarries located across the High Wold; and*
- *Use of locally quarried stone for both walls and houses, frequently constructed in distinctive local vernacular.*

#### LCA 7B Bisley Plateau

- *“A complex and convoluted form, extending across the upland plateau to the west and north of Stroud and as far north as Birdlip;*
- *The plateau projects extended ‘fingers’ of elevated and gently sloping land between a series of steep sided valleys;*
- *The plateau is detached from the main Cotswolds escarpment by the re-entrant strike valleys of Painswick and Slad;*
- *There are a number of higher ‘summit areas’ across the plateau, including 303m AOD south of Birdlip;*

- *The area has a distinctive open character and although there are a number of nucleated plateau top villages, notably Bisley, Whiteway, Brimpsfield and Birdlip, it is generally sparsely populated in character; and*
- *There is much evidence of former occupation of the area including a number of tumuli and long barrows.*

#### LCA 7C Cotswold High Wold Plateau

- *“The Cotswolds High Wold plateau comprises the largest section of the High Wold extending immediately east of the head of the Miserden Valley near Birdlip;*
- *The area embraces all the characteristics of the High Wold. Here, the influence of the underlying geology is particularly strongly expressed, from the dramatic, gently undulating, and expansive upland plateau landform, dissected by dry valleys, and light stony soil, through to the harmonious relationship between the network of limestone walls and buildings with their surroundings;*
- *The sense of scale and openness is particularly apparent, as well as the effects of an intensive managed agricultural landscape;*
- *Arable farming predominates although improved pastures grazed by cattle and sheep are also in evidence;*
- *Fields on the plateau tend to be large and geometric in shape;*
- *Boundaries are mainly dry stone walls and hedgerows, although hedge loss and dereliction of stretches of walls gives the landscape a neglected appearance in places;*
- *Woodland cover is not extensive and restricted to small deciduous plantations, walled corner copses and shelterbelts close to farms. Many of which planted at the time of the enclosures and are an integral part of the landscape;*
- *Few of the woodlands on the Cotswolds High Wold are ancient indicating a long history of clearance and farming;*
- *Within the managed agricultural landscape small areas of rough grassland are apparent, sometimes made more visible by beech plantations. These ‘islands’ mark the site of upstanding Neolithic long barrows and Bronze Age round barrows and are a significant feature of the Cotswolds High Wold;*
- *Settlement of the Cotswolds High Wold Plateau is sparse; and*
- *Telecommunication masts dominate some sections of the High Wold close to the escarpment edge. Particularly at Shab Hill north-east of Birdlip. The tall structures affect the perceived scale of the escarpment. Pylon lines are also intrusive features across this part of the High Wold.*

#### LCT 8 High Wold Valley

- *“Predominantly dry or ephemeral flow headwater valleys with generally broad valley form and shallow slope profiles;*
- *Incised valley form below heads of valleys with often steep, convoluted valley sides dissected by minor watercourses and distinctive convex profile at transition with the High Wold;*
- *Sections of pronounced valley form meanders with distinctive interlocking spurs, disproportionate to size of rivers and streams;*
- *Extensive areas of predominantly broadleaved woodland cloaking sections of the valley sides, particularly across the steeper sections;*
- *Areas of open pastoral farmland extend between the wooded slopes, and along valley bottoms, together with pockets of arable land, particularly on the shallower slopes;*



- *Pasture predominantly comprises improved grassland, together with occasional remnants of unimproved and calcareous grasslands;*
- *Intermittent stone-built villages occupying secluded locations in valley bottoms, often in association with a bridging point, and on valley sides;*
- *Occasional farmsteads and isolated buildings within the more open valley sections linking to farmed areas on the adjacent High Wold;*
- *Occasional private parklands and gardens associated with country houses;*
- *Limited road network within valleys, generally confined to a single valley bottom road, or routes that cross the valley; and*
- *Deeply incised and inaccessible wooded slopes extending across some valley sections.*

#### LCA 8A Toadsmoor, Holy Brook and Upper Frome Valleys

- *“In common with other High Wold valleys the Frome and its tributaries rise close to the escarpment, with a cluster of springs feeding into the Frome to the north of Brimpsfield, approximately 1.5 km (1 mile) east of the escarpment at Birdlip;*
- *Woodland cover is a notable feature of these valleys, and the Upper Frome together with its upper tributaries, have a particularly extensive cover of woodland throughout their courses;*
- *There are some notable areas of ancient woodland, eg east of Frampton Mansell to Pinbury Park within the Frome, and also within the Toadsmoor Valley. Intermittent areas of calcareous grassland also occur, the majority of which are designated as SSSIs;*
- *There is a notable absence of settlement or roads within the Upper Frome and Holy Brook valleys, imparting a strong sense of seclusion; and*
- *There are a number of parks within the Frome Valley the most notable being the Registered Garden of Misarden Park.*

#### LCA 8C Upper Churn Valley

- *“The general trend of the catchment is typical of the Dip-Slope valleys with a general north-west / south-east alignment;*
- *The upper reaches of the Churn from Colesbourne to Seven Springs is generally more open and with a gentler valley form profile than in the lower section of the valley;*
- *There is extensive pastoral land throughout the valley, interspersed with valley bottom woodland copses and riparian vegetation;*
- *The stone-built villages of Coberley and Cowley are notable settlements on the lower valley slopes; and*
- *Parklands and estate managed land is also a notable feature of the Upper Churn valley, notably to the east of Cowley Manor.*

#### LCT 10 High Wold Dip-Slope Valley

- *“Well-defined gentle concave valley form with intermittently very steep and indented valley sides dissected by minor watercourses, and distinctive convex profile at transition with the High Wold Dip-Slope;*
- *Intermittent areas of predominantly broadleaved and mixed woodland extend across sections of the valley sides, particularly across the steeper sections;*

- *Predominance of improved pastoral farmland extending between the wooded slopes, and along valley bottoms, together with pockets of arable land, particularly on the shallower slopes;*
- *Occasional remnants of unimproved and calcareous grasslands;*
- *Sheltered, visually contained and intimate valley systems;*
- *Intermittent stone-built villages occupy sheltered locations in valley bottoms, often in association with a bridging point;*
- *Farmsteads and individual buildings within the more open valley sections link to farmed areas on the adjacent High Wold Dip-Slope;*
- *Occasional private parklands within or adjacent to valleys influence character; and*
- *Road network generally confined to a single valley bottom road, together with principal and local cross valley routes.”*

#### LCA 10A Middle Churn Valley

- *“The valley form is still distinct, it assumes a progressively broader form with shallower slope profiles to the south of the character area;*
- *The land is predominantly under pasture, with occasional areas of arable, within a mosaic of regular and mainly medium-scale fields; and*
- *Woodland cover within the Middle Churn Valley is generally sparse. There is, however, an intermittent cover of small rectilinear broadleaved woodlands on the lower valley slopes and bottom, together with riparian vegetation, and a mosaic of hedgerows and hedgerow trees.”<sup>60</sup>*

#### LCT 18 Settled Unwooded Vale

- *“Soft gently undulating landform, with lower escarpment slopes forming a transitional area between the vale and escarpment;*
- *Cotswolds Escarpment defines the eastern limit of the Vale and provides a dramatic backdrop to vale settlements and landscapes;*
- *Mixed arable and pasture land use with occasional orchards;*
- *Well maintained hedgerows forming a strong landscape pattern;*
- *Limited woodland and ancient woodland cover;*
- *Quiet winding lanes linking villages, hamlets and farms at the foot of the escarpment;*
- *Varied mix of building materials, including use of brick, timber and stone, and slate and thatch roofing, but with Oolitic Limestone still prevalent within the vale villages in closer proximity to the Cotswolds Escarpment;*
- *Proliferation of modern ‘suburban’ building styles and materials;*
- *Major transport corridors through vale;*
- *Rural areas bordered by large urban and suburban areas and interspersed with commercial and industrial uses; and*
- *Widespread network of pylons and transmission lines.”<sup>61</sup>*

#### LCA18A Vale of Gloucester Fringe

- *“Within the boundary of the AONB, the area of land classified as Settled Unwooded Vale is limited, confined to a narrow section of the landscape type*

<sup>60</sup> Landscape Character Assessment: The Cotswolds Landscape Scoping Study and Typology (LDA, 2002)

<sup>61</sup> Landscape Character Assessment: The Cotswolds Landscape Scoping Study and Typology (LDA, 2002) and Landscape Character Assessment: Gloucestershire Various Vales: County Scoping Study and County Typology, November 2002, Landscape Design Associates.

*at the base of the escarpment, merging into the broad lowland Vale of Gloucester;*

- *The Settled Unwooded Vale within the AONB is underlain by Lias Group mudstones and sandstone, which in places are overlain by extensive areas of drift deposits creating a soft, gently undulating landscape;*
- *There is a regular patchwork of arable and pasture fields enclosed largely by neat hawthorn hedges and as such the agricultural landscape is typical of the wider vale;*
- *The type is characterised by a mosaic of improved grassland and arable land with small areas of neutral grassland;*
- *Woodland is largely absent although numerous small farm copses are conspicuous;*
- *Hedgerow and field oaks contribute significantly to local landscape character and help maintain the rural character of some areas by screening views to urban and suburban features;*
- *Stonewalls also create a number of field boundaries within the landscape type;*
- *The landscape is perceived as being more intimate and sheltered in close proximity to the escarpment; and*
- *The character of the Settled Unwooded Vale retains influences from neighbouring urban development. Such influences are often associated with the proliferation of masts and overhead transmission lines, and more subtly, from the effects of lighting.”<sup>62</sup>*

7.6.24 For the ES LVIA, Table 7-1 lists the LCT and LCAs which will be used to assess the likely effects of the proposed scheme on the landscape. The table outlines the seven Cotswolds AONB LCAs and one Gloucestershire LCA which cover the 3km study area.

**Table 7-1 Landscape Character Types and Related Landscape Character Areas**

<b>Cotswolds AONB Landscape Character Type</b>	<b>Cotswolds AONB Landscape Character Area</b>	<b>Source</b>	<b>Corresponding Gloucestershire Vales LCT</b>
LCT 2 Escarpment	LCA 2D Coopers Hill to Winchcombe	Cotswolds AONB Landscape Character Assessment	LCT 26 Escarpment
LCT 7 High Wold	LCA 7B Bisley Plateau	Cotswolds AONB Landscape Character Assessment	LCT 22 High Wold
	LCA 7C Cotswold High Wold Plateau	Cotswolds AONB Landscape Character Assessment	
LCT 8 High Wold Valley	LCA 8A Toadsmoor, Holy Brook and Upper Frome Valleys	Cotswolds AONB Landscape Character Assessment	LCT 27 Secluded Valleys
	LCA 8C Upper Churn Valley	Cotswolds AONB Landscape Character Assessment	LCT 27 Secluded Valleys

<sup>62</sup> Landscape Character Assessment: The Cotswolds Landscape Scoping Study and Typology (LDA, 2002)

Cotswolds AONB Landscape Character Type	Cotswolds AONB Landscape Character Area	Source	Corresponding Gloucestershire Vales LCT
LCT 10 High Wold Dip-Slope Valley	LCA 10A Middle Churn Valley	Cotswolds AONB Landscape Character Assessment	LCT 22 High Wold
LCT 18 Settled Unwooded Vale	LCA18A Vale of Gloucester Fringe	Cotswolds AONB Landscape Character Assessment	LCT 18 Settled Unwooded Vale
	SV6B Vale of Gloucester	Gloucestershire Various Vales Landscape Character Assessment	

### Nationally Designated Sites

- 7.6.25 There are several designations within the 3km study area. The proposed scheme is situated entirely within the Cotswolds AONB with a small section of the study area falling outside to the west. The Cotswolds AONB is characterised by the steep escarpment which runs north to south and is the largest continuous landform feature in lowland England<sup>63</sup>. The scarp also provides the setting for the Cotswold National Trail.
- 7.6.26 The proposed scheme climbs the escarpment closely following the existing alignment of the A417 through Crickley Hill and Barrows Wake. To the south of the proposed scheme along the scarp is Cotswold Commons and Beechwood. Further south on the High Wold is Bushley Muzzard at Brimpsfield and to the east of the proposed scheme is Cowley Manor a Grade II Registered Park and Garden (RPG). There are also several scheduled monuments dotted throughout the study area including Crickley Hill Camp, Emma's Grove, Brimpsfield Castle and mound, Coberley Long Barrow, Coberley Roman Villa, Cotswold Beechwoods, Bowl Barrow and Great Witcombe Roman Villa.
- 7.6.27 These designations reflect the conservation value of the region, and its rich heritage of human settlement.

#### Cotswolds AONB Management Plan 2018- 2023

- 7.6.28 The purposes of the AONB are to:
- “conserve and enhance the natural beauty of the Cotswolds AONB; and
  - increase the understanding and enjoyment of the special qualities of the Cotswolds AONB.”
- 7.6.29 The AONB’s Vision is to be “a distinctive, unique, accessible living landscape treasured for its diversity which is recognised by all for its wide open views, dry stone walls, intimate valleys, flower rich grasslands, ancient woodlands, dark skies, tranquillity, archaeology, historic and cultural heritage and distinctive Cotswold stone architecture.”

63 Cotswolds AONB. Available: <https://www.cotswoldsaonb.org.uk/our-landscape/geology/>

7.6.30 To achieve their Purpose and ‘Vision’ the AONB have set out several ‘Outcomes’ which cover key topics such as Landscape and Geology, Local Distinctiveness, Tranquillity, Dark Skies, and Access and Recreation, with associated policies. The relevant Policies are listed below:

- Policy CC1: Developing a Consistent, Coordinated and Landscape-led Approach Across the Cotswolds AONB;
- Policy CC2: Compliance with Section 85 of the Countryside and Rights of Way Act (the ‘Duty of Regard’);
- Policy CC3: Working in Partnership;
- Policy CC4: Natural and Cultural Capital and Ecosystem Services – Principles;
- Policy CC5: Soils;
- Policy CC6: Water;
- Policy CC7: Climate Change – Mitigation;
- Policy CC8: Climate Change – Adaptation;
- Policy CE1: Landscape;
- Policy CE2: Geology;
- Policy CE3: Local Distinctiveness;
- Policy CE4: Tranquillity;
- Policy CE5: Dark Skies;
- Policy CE6: Historic Environment and Cultural Heritage;
- Policy CE7: Biodiversity;
- Policy CE8: Rural Land Management;
- Policy CE9: Problem Species, Pests and Diseases;
- Policy CE10: Development and Transport – Principles;
- Policy CE11: Major Development;
- Policy UE2: Access and Recreation; and
- Policy UE3: Health and Well-being.

Cotswolds Conservation Board Local Distinctiveness and Landscape Change Report

7.6.31 This document supplements the AONB Landscape Character Assessment and guidance in providing additional understanding and guidance on the uniqueness and special qualities which contributes to the Cotswolds local distinctiveness, particularly in relation to Policy CE3: Local Distinctiveness.

7.6.32 The built environment in defining local distinctiveness can be categorised in terms of settlement, boundaries, and roofs and walls:

*“Boundaries of many types exist within the AONB, though dry stone walls and hedges predominate. Formally, it is important to distinguish between boundaries within settlement and those that subdivide the wider landscape, and to recognise the subtle stylistic variations that exist within types. Dry stone walls are only found where stone is close to the surface, and the distinctiveness of the landscape of the AONB stems from a subtle balance between walls and hedges, not the dominance of one or the other. Gates, stiles and other details are crucial to the special character of a boundary”.<sup>64</sup>*

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64 Local Distinctiveness and Landscape Change. (2003) Countryside Agency now Natural England

### Cotswolds AONB Position Statements

7.6.33 Design and environmental guidance documents produced by Cotswolds Conservation Board listed below, provide development advice on working with regionally-appropriate building materials, landscape features and systems, and plant species to conserve and enhance the special qualities of the AONB and maintain local distinctiveness.

7.6.34 Position statements:

- Cotswolds AONB National Park Position Statement;
- Cotswolds AONB Tree Species and Provenance;
- Cotswolds AONB Public Rights of Way;
- Cotswolds AONB Transport and Management of Roadside Verges;
- Cotswolds AONB Dark Skies and Artificial Light (Adopted March 2019); and
- Cotswolds AONB Tranquillity Position Statement (Adopted June 2019).

### Cotswolds AONB Landscape Strategy and Guidelines

7.6.35 The Cotswolds AONB published their Landscape Strategy and Guidelines document in June 2016 with the intention to help manage change in a sustainable and positive way. Strategies and guidelines are presented for each of the Landscape Character Areas located within the AONB, with potential forces of change identified for each LCT, with a description of the implications of these changes. Relevant chapters of the document include sections for LCT 2. Escarpment; LCT 7. High Wold; LCT 8 High Wold Valley; and LCT 18: Settled Unwooded Vale.

7.6.36 With relevant strategies including:

- major road construction and improvement schemes on escarpment slopes;
- road upgrading and improvements, especially of minor country roads, as a result of development or general improvement schemes;
- visitor pressure at escarpment vantage points and circular walks commencing from car park areas;
- loss of dry-stone walls due to abandonment, development of volunteer hedges, replacement with hedges or fences or removal to build/restore a wall elsewhere;
- loss of hedges characteristic of the Settled Unwooded Vale due to inappropriate management or ‘abandonment’;
- loss of traditional orchards in recent years;
- inappropriate woodland creation and planting of shelterbelts and farm copses; and
- creation of woodland.

7.6.37 The “*potential landscape implication*” of these and the proposed “*landscape strategies and guidelines*” will be fully reviewed as part of the ongoing landscape design and will be considered within the ES LVIA.

### **Historic Landscape Characterisation**

7.6.38 This description of the National Historic Landscape Characterisation (HLC) is included for context.

- 7.6.39 The proposed scheme is located within four Historic Landscape Character Areas (HLC) these are:
- Enclosed Agriculture: Typically Pre-Modern;
  - Enclosed Agriculture: Typically Modern;
  - Industry; and
  - Unimproved Land.
- 7.6.40 Gloucestershire County Council has carried out a more detailed assessment of the HLC to characterise the present landscape.<sup>65</sup> This identifies the visible evidence of the human processes which have formed the landscape through time to inform a wide range of planning, conservation and management-led initiatives and strategies.
- 7.6.41 There are 23 historic landscape types that cover the study area. The proposed scheme is situated within seven HLCs, these are:
- A1 Irregular enclosure reflecting former unenclosed cultivation patterns;
  - A4 Less regular organised enclosure partly reflecting former unenclosed cultivation patterns;
  - B1 Largely unenclosed pasture;
  - B4 Less regular organised enclosure of former unenclosed pasture;
  - C2 Early woodland cleared in the post-medieval period;
  - L1 Irregular enclosure. Former land use not identified; and
  - L3 Regular segmentation of less regular parallel boundaries; former land use not identified.
- 7.6.42 The following descriptions of each HLC have been included to provide historical and present land use context which contribute to the local distinctiveness of the Cotswolds AONB.

A1 Irregular enclosure reflecting former unenclosed cultivation patterns

- *“Small (generally between 1 and 7ha) irregular fields;*
- *Enclosures are piecemeal enclosure of earlier open fields. They are likely to owe their origin to gradual enclosure by local arrangement, generally from the 16th century and later (although this form of enclosure is known from at least the 13th century and as late as the 19th century); and*
- *Most common outside the area of the Cotswolds AONB, particularly in the area of the Severn Vale. Where found within the of the Cotswolds AONB, this type tends to be found on relatively steep ground, such as valley sides or the edges of the Cotswolds escarpment at the western edge of the Cotswolds AONB”.*

A4 Less regular organised enclosure partly reflecting former unenclosed cultivation patterns

- *“Typically, fairly large (between 6 and 14ha, although some are as small as 4ha);*
- *The enclosure pattern is generally regular and displays clear internal cohesion demonstrated by similar boundary type and numerous co-axial boundaries;*

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65 HISTORIC LANDSCAPE CHARACTERISATION Gloucestershire The Cotswolds Area of Outstanding Natural Beauty The Wye Valley Area of Outstanding Natural Beauty. Gloucestershire County Council. 2006

- *This enclosure pattern is likely to owe its origins to Non-parliamentary large-scale organised enclosure dating to the 18th and 19th centuries, which may have taken more account of former open-cultivation boundaries than parliamentary enclosure; and*
- *This Landscape Type is found throughout the Cotswolds AONB.”*

#### B1 Largely unenclosed pasture

- *“Areas of common with no internal enclosures, although occasional long boundaries, subdividing the areas of open pasture into large areas, or isolated discrete enclosures, are found within some areas categorised as B1. This Landscape Type generally survives as open grassland with some invasive scrub or isolated tree clumps;*
- *Found almost exclusively in the western part of the area of the Cotswolds AONB on areas of high ground, overlying a geology of Great Oolite limestone, at the top of the Cotswolds scarp; and*
- *These open commons are generally in the vicinity of former open fields which had been enclosed on a piecemeal basis. This lack of large-scale reorganisation of the countryside may have contributed to their preservation.”*

#### B4 Less regular organised enclosure of former unenclosed pasture

- *“Relatively large (generally between 6 and 14ha, although some were as small as 4ha) fields, clearly organised on a large scale and with a number of common boundaries and enclosures of similar size;*
- *The pattern of enclosure, however, was less regular than that categorised as B3. Fields were also larger than those categorised as B2;*
- *Occasional boundaries may echo open field divisions in the form of old strip field land or furlong boundaries (reversed S or irregular “dog leg” boundaries but this was not a determining characteristic of this type;*
- *This Landscape Type is interpreted as large-scale, organised enclosure of earlier long-term open pasture;*
- *The date of the enclosure is unknown, but likely to be the result of the large-scale landscape reorganisations of the 18th and 19th centuries, of which parliamentary enclosure was a part; and*
- *Some enclosures in this Landscape Type may owe their origins to parliamentary enclosure. In these instances, the irregular enclosure pattern may be the result of local variations influenced by topography. Where enclosures follow former open fields divisions, this may indicate that these survived as boundaries within areas of largely unenclosed pasture, or as significant landscape features, and were utilised during later enclosure.”*

#### C2 Early woodland cleared in the post-medieval period

- *“Early woodland known to have been cleared in the later post-medieval period.”*

#### L1 Irregular enclosure. Former land use not identified

- *“Small (generally 1 and 7ha) enclosures with either irregular or sinuous boundaries, although occasional straight boundaries;*
- *The enclosures tend to lack co-axial common boundaries, and boundary patterns and generally lack a sense of overall cohesion. This suggests that enclosure of these areas may have been undertaken on a piecemeal basis;*



- *Tend to be found on marginal slopes (particularly steep river valley sides at the western edge of the Cotswolds AONB); and*
- *This type may represent either piecemeal enclosure of marginal areas of unenclosed cultivation (A1s) or perhaps the enclosure of uncultivated waste (or woodland) at the edges of cultivated open fields.”*

### L3 Regular segmentation of less regular parallel boundaries; former land use not identified

- *“These areas consist of generally long thin areas of land, often on valley sides or sandwiched between different elements of the landscape (e.g. an area of woodland and a road), or different landscape types;*
- *These areas are now enclosed in a regular fashion generally consisting of straight, approximately parallel boundaries segmenting the area into roughly equal enclosures between 2 and 7ha;*
- *Likely to represent relatively recent enclosure of areas of waste or cleared woodland; and*
- *Some areas are found on valley sides at the western edge of the Cotswolds AONB.”*

### **Heritage Assets**

- 7.6.43 Heritage assets are key component characteristics within the landscape which are fundamental to the overall landscape character. The LVIA within the ES will assess heritage assets as part of its associated landscape character area to ensure that these are not double counted. For this reason, it is important that this chapter is read in conjunction with chapter 6 Cultural Heritage.
- 7.6.44 Heritage assets will also be considered as part of the visual assessment with consideration of views to and from key heritage assets. The following descriptions are to provide context.

### Registered Park and Garden

- 7.6.45 Cowley Manor is Grade II\* Listed for its mid to late C19 landscape park and formal garden with lakes and waterworks. Cowley Manor is open to the public as a hotel and has several PRoWs which cross through the Registered Park and Garden. Parts of the historic park and garden lies within 1km core study area and the setting of the historic park and garden may receive direct effects.

### Scheduled Monuments

- 7.6.46 There are several heritage assets including Scheduled Monuments within 1km of the proposed scheme. The following descriptions of Scheduled Monuments are to provide context.

### *Moat and Fishpond at Bentham Manor*

- 7.6.47 A medieval moat and fishpond consisting of wide ditches. They form a significant class of medieval monument and are important for the understanding of the distribution of wealth and status in the countryside. The moat and fishpond at Bentham Manor is publicly accessible from the local public right of way network. Due to the local historic interest and the proximity of the proposed scheme the setting of this Scheduled Monument may experience direct effects.

*Crickley Hill Camp*

- 7.6.48 A rich history of human relationship with the landscape since the early Neolithic period, this site has been excavated many times and is now considered to be of international importance. This site is experienced as part of Crickley Hill Country Park which is jointly owned by the National Trust and Gloucestershire Wildlife Trust. The Cotswold Way National Trail which runs through this heritage asset with a viewing point marked on 25k OS map highlighting this as a key tourist attraction. Due to the proximity of the proposed scheme, its international importance, a designated Country Park the Cotswold Way National Trail and a nationally publicised viewing spot, the setting of this heritage asset may experience direct effects from the proposed scheme.

*Emma's Grove*

- 7.6.49 Religious ritual and funerary these types of Scheduled Monuments are typically evident in the landscape as mounds. The three bowl barrows at Emma's Grove are experienced from the Gloucestershire Way long distance footpath which runs adjacent the Tumuli. Due to the proximity of the proposed scheme and the Gloucestershire Long Distance walking path the setting of the Tumuli may experience direct effects from the proposed scheme.

*Dryhill Roman Villa*

- 7.6.50 This site is experienced from Crickley Hill Country Park which is jointly owned by the National Trust and Gloucestershire Wildlife Trust. The Cotswold Way National Trail which runs adjacent this Scheduled Monument. Due to the proximity of the proposed scheme and its experience from a designated Country Park and the Cotswold Way National Trail the setting of this Scheduled Monument may experience direct effects from the proposed scheme.

*Crippet's Wood Round Barrows*

- 7.6.51 Religious ritual and funerary types of Scheduled Monument are typically evident in the landscape as mounds. The two bowl barrows are on private land but close to and experienced from the Cotswold Way National Trail. Due to the proximity of the proposed scheme and the Cotswold Way National Trail the setting of the Tumuli may experience direct effects from the proposed scheme.

*Brimpsfield Castle*

- 7.6.52 Likely to be of Norman origin as is the existing village, today the remains consist of a mound with an outer bank and ditch. Due to the proximity of the proposed scheme, the existing community and local PRow network, the setting of the Scheduled Monument may experience direct effects from the proposed scheme.

*Brimpsfield Mound*

- 7.6.53 Located to the east of Brimpsfield Castle the mound is on privately owned land and not publicly accessible and so will not be able to directly assess the setting of scheduled monument, however this mound is closely connected as part of the original Norman Castle at Brimpsfield with the existing Brimpsfield Community located on the site of the original castle. These types of Castles and mounds are particularly important for the study of Norman Britain and the development of the feudal system. Therefore, in its wider context the setting of this scheduled

monument will be experienced from Brimpsfield Village and due to the proximity of the proposed scheme is likely to receive direct effects.

- 7.6.54 Within the wider 3km study there are three Scheduled Monuments where the setting of these Scheduled Monuments are likely to experience indirect effects arising from the proposed scheme. There are:

*Crippet's Long Barrow*

- 7.6.55 Long barrows were constructed as earthen or drystone mounds with flanking ditches and acted as funerary monuments during the Early and Middle Neolithic periods (3400-2400 BC). They represent the burial places of Britain's early farming communities and, as such, are amongst the oldest field monuments surviving visibly in the present landscape. Although located separately, Crippet's long barrow is likely to be related to the tumuli at Crippet's Wood and is experienced from the Cotswold Way National Trail. Therefore, in its wider context the setting as part of the tumuli at Crippet's Wood it is likely to experience indirect effects from the proposed scheme.

*Leckhampton Camp and Tumulus*

- 7.6.56 The hillfort survives as an irregular shaped enclosure defined to the west by artificially enhanced scarps and on the remaining sides by a single rampart and ditch. To the east of the hillfort is a bowl barrow which survives as a circular mound. The setting of this monument is experienced from the Cotswold Way National Trail which runs through the monument and from the Cheltenham Circular Footpath Long Distance Path. Situated on the summit of the limestone plateau of the Cotswolds escarpment overlooking the valley and tributaries of the River Chelt although not a publicised viewpoint it is locally recognised. Due to the national trail the setting and experience of this monument is likely to receive indirect effects from the proposed scheme.

*Coberley Long Barrow*

- 7.6.57 Communal funerary dating to early Neolithic period. The setting of this monument is experienced from the Gloucestershire Way long distance footpath therefore the setting is likely to receive indirect effects arising from the proposed scheme.

- 7.6.58 Additional to these three Scheduled Monuments there are a further seven Scheduled Monuments located within the wider 3km study area which are experienced from the local road or public right of way network. For this reason, the setting and experience of these monuments are unlikely to receive any direct or indirect effect from the proposed scheme and have therefore been scoped out at this stage. These include:

- Moated site and fishpond at Urrist Barn;
- Coberley Roman Villa; A435 Road;
- Buck's head Round barrow;
- Manless Town medieval settlement and the buried remains of a Roman camp;
- Climperwell round barrows;
- West Tump long barrow; and
- Round barrow 830m north east of Combend Farm.

- 7.6.59 Further assessment will be carried out as part of the LVIA and scoped in or out as part of ongoing consultation with key stakeholders.

### *Conservation Areas and Listed Buildings*

- Cotswold District has 144 conservation areas. Elements such as the historic layout of roads, paths and boundaries are integral to the character and setting of conservation areas and their setting. This will be considered in this assessment as a key component as part of the overall character of the Landscape.

7.6.60 The setting of conservation areas will be also considered as part of the visual assessment with consideration of views to and from key Conservation Areas to assess the surroundings in which the Conservation Area is experienced.

7.6.61 There are three Conservation Areas within the 3km study area, these are:

- Brimpsfield Conservation Area;
- Coberley Conservation Area; and
- Cowley Conservation Area.

### *Brimpsfield Conservation Area*

7.6.62 Brimpsfield Conservation Area covers mostly the entire village, with the exception of modern housing estates to the south of the village built in the 1950's and 70's. The village is situated 1km from the proposed scheme. Built on the former site of Brimpsfield Castle, it occupies an elevated position above the 183m contour line.

*“Brimpsfield village stands 1.5 km. west of Ermin Street. The parish church, which had been built by the 12th century, stands a short distance north-east of the village and overlooks a valley containing the site of an early castle and Brimpsfield Park house. House platforms visible west of the churchyard in 1977 indicate that the village, or much of it, was displaced probably in the 12th century, when a second castle was built to the south. By the mid 13th century there was a priory adjoining the northern side of the churchyard. (fn. 34) The ruins of the later castle provided a quarry for buildings in the village, which lies along a street running from north to south with a lane leading westwards on the Knapp.”<sup>66</sup>*

### *Coberley Conservation Area*

7.6.63 Coberley Conservation Area covers the village of Coberley and an area further east which covers the Church and Coberley Court, situated approximately 2.5km from the proposed scheme.

*“Coberley church, situated east of a crossing of the Churn, had been built by the 12th century. Next to it stood the medieval manor-house, later incorporated in Coberley Court, which was demolished in 1790; the farm-house north of the church, which had also formed part of Coberley Court, was rebuilt soon afterwards. A house lower down the river was formerly a mill. Coberley village, the main settlement of the parish, grew up further north-west around a green, The village, which in 1838 contained only eight buildings, has remained small. The oldest surviving houses, including the rectory, date from the early 19th century.”<sup>67</sup>*

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<sup>66</sup> Institute of Historical Research. British History online available at: <https://www.british-history.ac.uk>

<sup>67</sup> *ibid*

### *Cowley Conservation Area*

- 7.6.64 Cowley Conservation Area covers the historic park and garden with the exclusion of Manor Farm, and the playing field south and west of the lane which cuts through the estate. A couple cottages and farm buildings to the north and west of Cowley Manor are included in the Conservation Area.

*“The settlement at Cowley is a small estate village dominated by Cowley Manor, a substantial 19th-century mansion beside the Churn. The church stands east of the house and in its grounds.”<sup>68</sup>*

### **National Trails, Long Distance Paths and Public Rights of Way (PRoW)**

- 7.6.65 Guidance documents produced by Cotswolds Conservation Board on Public Rights of Ways provide development advice on enhancing the PRoW network. The Cotswolds position statement states that:

*“The public rights of way network is the main way for residents and visitors to explore and enjoy the Cotswolds and is important to the area’s economy.”*

- 7.6.66 The proposed scheme will sever the Cotswold Way National Trail and Gloucestershire Way long distance footpath at/near the existing Air Balloon roundabout.

- 7.6.67 Where the proposed scheme severs and diverts (both temporarily or permanently) the PRoW network, a visual assessment will be carried out to assess both the severance and the diversion to give a true representation of the impact of the proposed scheme on the setting and experience of the PRoW network.

### Cotswold Way National Trail

- 7.6.68 The Cotswold Way National Trail is 102 miles long and runs for most of its length along the Cotswold escarpment. The proposed scheme will sever the trail at the Air Balloon roundabout and proposes to divert the trail over a new green bridge, connecting Crickley Hill to Barrow Wake following the line of the escarpment. The LVIA will assess the changes in setting and experience along the Cotswold Way National Trail where it will be severed and diverted.

### Gloucestershire Way long distance footpath

- 7.6.69 The Gloucestershire Way is a long-distance walking path that runs east to west through the Study Area. This long distance footpath will be severed near the Air Balloon roundabout and at a second point just east of Emma’s Grove tumuli, south of Ullen Wood. The diversion is proposed to cross over the new roundabout for the A436 and run adjacent to the parallel slip road and Ullen Wood. The LVIA will assess changes in the setting and experience along the Gloucestershire Way long distance footpath at the point of diversion at either end and along the proposed severed section. Where possible it will also assess the PRoW along the proposed diverted route, however there will be limitations and subject to landowner access to currently privately-owned land.

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<sup>68</sup> ibid

- 7.6.70 The Visual Assessment of the LVIA will assess likely effects on people using the Cotswold Way National Trail and Gloucestershire Way long distance footpath. The approach to this will be consulted on with key stakeholders.

#### PRoW

- 7.6.71 There is an extensive network of PRoW that traverse the site and the proposed scheme seeks to enhance the user experience of this network.

#### **Country Park**

- 7.6.72 Crickley Hill Country Park is jointly owned by National Trust and Gloucestershire Wildlife Trust and is designated for its archaeological interest and as a Site of Special Scientific Interest (SSSI) for its species rich grassland, scrub and semi-natural woodland, together with nationally important rock exposures. The proposed scheme runs just south of the Crickley Hill, approximately on the same alignment of the existing A417.

#### **Common Land, Open Access Land including section 15 land**

- 7.6.73 The following areas within the 3km Study Area are Registered Common Land made publicly accessible under the Countryside and Rights of Ways Act 2000 (CROW Act) and with the right to roam.

- Barrow Wake;
- Cold Slad;
- Brimpsfield Common;
- Leckhampton Hill;
- Bucklewood Common;
- Buckle Wood, Cranham Wood and Cranham Common;
- Buckholt Wood; and
- Brockworth Wood, Upton Wood and Coopers Hill.

#### **Other Recreational Spaces**

- 7.6.74 Ullen Wood (Ullenwood) Cricket ground is an open sports ground located by the existing Air Balloon roundabout.

#### **Site Surveys and Fieldwork**

- 7.6.75 Four site visits have been undertaken by Chartered Landscape Architects on 23 May, 24 May, 4 June and 28 June 2019. The focus of these walkovers was familiarisation of the site, identify viewpoint locations and visibility and ground truth information provided. In addition, visits were undertaken to gain an understanding of the proposed scheme in the context of the Landscape and to check viewpoint locations.

#### **Future Baseline**

- 7.6.76 As set out in chapter 4, the 'Do Minimum' and 'Do Something' scenarios have been set out, with the 'Do Minimum' scenario represents the future baseline with minimal interventions and without new infrastructure. Potential landscape and visual change for receptors in the future would not be noticeable i.e. tree and vegetation growth will not be extensive, landscape pattern or topography is unlikely to change and the receptor groups are unlikely to be different to those

whose identified in the baseline text above. Therefore the future baseline will remain the same as set out in above.

7.6.77 The EIA will assess the likely impacts of the proposed scheme at the following stages:

- the start of construction is late 2021;
- the whole scheme is operational from 2024; and
- the design year, 15 years after opening is 2039.

## 7.7 Consultation

7.7.1 The scope of the landscape and visual assessment was set out in the scoping report<sup>69</sup> for which a Scoping Opinion was provided by the Planning Inspectorate.

7.7.2 Consultation on the landscape design is ongoing and will continue as the proposed scheme develops. Key stakeholders including Gloucestershire Wildlife Trust, National Trust, Natural England, Environment Agency, Historic England and Cotswolds Conversation Board.

7.7.3 A meeting was held with Cotswolds Conservation Board and Highways England in July 2019 to discuss the most appropriate methodology that the ES LVIA should follow and to share thoughts on indicative viewpoint locations. A further meeting will take place to agree LVIA viewpoint locations.

## 7.8 Assessment Assumptions and Limitations

7.8.1 Limited field work has been carried out and there is an assumption on baseline information and viewpoints based on previous consultant guidance. Moving forward baseline information and viewpoint photography will be undertaken and during the Public Consultation process.

7.8.2 A full LVIA is yet to be carried out - once baseline information, methodology and viewpoint locations are confirmed with the stakeholders during consultation, the assessment of effects will be carried out.

7.8.3 Photography work has yet to be carried out, the scope of photography work will be confirmed and carried out as part of stakeholder consultation.

7.8.4 Photomontages will be prepared with verified photography has been carried out. This is normal practise as several aspects of the proposed scheme are not fixed. For example; the precise alignment of side roads, structures and junctions and proposed landscape design scheme.

7.8.5 The ZTV is a tool to aid assessment and shows the theoretical visibility of the proposed design (at the time of writing), including projections for vehicular movements (cars at 1.9m and lorries at 4.7m). Additional vertical structures such as gantries, lighting columns (not currently proposed) or signage have not been included in the projected ZTV because it is not known if these features will be present in the final design and if so where they will be located.

7.8.6 The co-ordination between landscape and related disciplines such as noise, heritage and biodiversity are ongoing and iterative. This will likely to lead to minor

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69 <https://infrastructure.planninginspectorate.gov.uk/projects/south-west/a417-missing-link/>

design changes to the proposed scheme and consequently necessary amendments to the assessment.

- 7.8.7 The landscape design approach is set out on figure 7.4 and shows the proposed landscape design approach including enhancement measures. These are a working draft and will be subject to changes throughout the consultation process and more detailed engineering and environmental design work.
- 7.8.8 It is assumed that permanent lighting will not form part of the proposed scheme, therefore, a night time landscape and visual assessment will not be carried out. If lighting is introduced to the proposed scheme, a night time assessment will be carried out.
- 7.8.9 An arboricultural survey and impact assessment will be used to inform assessments and will be submitted with the DCO application.
- 7.8.10 For the ES LVIA, It is assumed that annual tree and shrub height growth is assumed to be between approximately 0.3-0.5m per year, so that if a mix of mature and immature tree and shrub planting was implemented with mature trees planted at 5m tall and whips or transplants at 0.6m – 0.8m high, by year 15 the tree height will be between approximately 9.2m – 12m.
- 7.8.11 Gaps and uncertainties in the PEI Report are listed in Table 7-3.

**Table 7-2 Gaps and Uncertainties**

<b>Gaps and Uncertainties</b>	<b>Description</b>
Gaps in baseline information: need to confirm characteristics of the landscapes within the Study Area	Sufficient site visits or fieldwork have not yet undertaken to confirm the accuracy of the landscape baseline or establish the landscape character for the areas within the Study Area. Fieldwork will continue to be undertaken during the Public Consultation process.
Gaps in baseline information: need to identify and confirm visual receptors and suitable viewpoint locations to accurately record likely significant effects	Sufficient site visits or fieldwork have not yet undertaken to confirm the accuracy of the visual baseline. They have not undertaken sufficient stakeholder consultation to ensure all relevant receptors or viewpoints have been identified.
Gaps in baseline data.	AONB landscape character areas and types will be used to carry out the landscape assessment. Sufficient consultation with the Cotswolds Conservation Board to obtain the necessary datasets has not been undertaken and so for the purpose of this PEI Report the Gloucestershire Landscape Character Types only have been included within the Landscape Character figure 7.3. The Landscape Character figure will be updated as part of the ongoing stakeholder consultation process.
Limitations to PRoW diversions	It may not be possible to fully assess the diverted Public Rights of Ways including the Cotswold Way National Trail and the Gloucestershire Way long distance footpath where the diversion falls on private land, although representative views and viewpoints will be used in these cases.
Lack of consultation with stakeholders and the public	Consultation with the statutory consultees is ongoing.



## 7.9 Design, Mitigation and Enhancement Measures

### Construction Mitigation

7.9.1 Mitigation will be developed to avoid or reduce the potential construction impacts. This will seek to employ best-practice methods. As far as reasonably practicable, mitigation would include the following:

- ensuring the CEMP is supported by an arboricultural impact assessment in line with BS 5837:2012 to retain and protect trees during construction in accordance with the recommendations made;
- where screening earthworks such as false cuttings are proposed as part of the wider mitigation strategy, they would be constructed as early as is practicable to provide screening to the construction work;
- siting compounds and other construction facilities sympathetically within the landscape, via a comprehensive site selection process. Additionally, temporary construction buildings, fencing and facilities could be rendered in tonal colours to reflect the landscape as well as screened in part by solid hoardings;
- ensuring soil structures are protected where land would be used temporarily, such as for compounds, haul roads, re-grading areas, etc., so that when it is returned to the existing land use, it is in a suitable condition; and
- the establishment of advanced planting for softening filtering views of the construction phase, as well as part of the wider visual mitigation if land is not required for other construction activities.

### Mitigation through engineering design

7.9.2 The landscape design approach is set out on figure 7.8 and includes:

- the aspiration to integrate the Cowley and Shab Hill junctions into the landscape using a combination of woodland planting with landscape earthworks to help visually screen the road infrastructure;
- all earthworks to be soft engineered slopes to gently tie into existing topography, constructed from excavated materials. Grading out of embankments to allow the land to be returned to agricultural use;
- where practicable to do so, retaining structures would be designed to be sympathetic to the character of the Cotswolds AONB, using suitable facing materials such as local sourced materials to fit existing vernacular and exposed rock faces. Facings may also include areas for colonisation with local species to visually break up the surfaces;
- proposed green bridge linking Crickley Hill and Barrow Wake to provide benefits for users of the Cotswold Way National Trail and to link SSSI habitats previously severed by the existing A417;
- footpath link across the green bridge to be realigned keeping the Cotswold Way National Trail on the ridge. The pathway will form part of the Cotswold Way National Trail and would be designed to allow views out in places to the Cotswolds AONB landscape;
- Green bridge designed to cater for walkers and other users of the Cotswold Way National Trail along with quieter areas to facilitate wildlife corridors;
- Green bridge planting is to be developed but is likely to feature a mosaic of habitats including calcareous grassland, groundcover shrub and small tree/

scrub to support wildlife movement between Crickley Hill and Barrow Wake SSSIs;

- detrunked sections of the A417 are to be reduced to a 'purpose-designed' width for footpath, bridleway and cycle access. Former road to be resurfaced with locally appropriate toppings, such as crushed stone;
- linear tree planting to be extended across the demolished section of the existing A417 road to increase biodiversity and create additional wildlife habitat;
- levels of the old A417 alignment are to be rationalised in places through infilling using excavated materials to restore land to original grades;
- protect and retain existing trees and woodland;
- create a combination of new Cotswold drystone walling and hedgerows to field boundaries affected by the road infrastructure;
- new tree planting to take place across the wider site to complement the local character using local province and climate change resilient species. Planting will pick up on existing local features such as avenues, groves, coppices and hanging woodland;
- the introduction of new woodland blocks and/or hedgerow planting as appropriate will create new field boundaries that will provide visual screening of the road. New planting areas will link with existing woodland and hedgerows to unify and link habitats in the area;
- false cuttings to screen the road and help reduce visual impacts of traffic surrounding landscape by including soft engineered slopes (using excavated materials); and
- bridges and structures to be of high architectural quality, finished in locally source material and other materials suitable to the local vernacular.

7.9.3 The landscape design will incorporate the biodiversity and cultural heritage mitigation and enhancement proposals to create a coordinated coherent scheme.

7.9.4 All required mitigation will form part of the proposed design and will be considered when producing the ES LVIA.

7.9.5 Possible landscape, biodiversity and historic environment enhancement measures will be identified as part of the design submitted as part of the DCO application.

### **Operation Mitigation**

7.9.6 Towards the end of the construction period the CEMP will be refined into a Handover Environmental Management Plan (HEMP) which will contain essential environmental information needed by the body responsible for the future maintenance and operation of the soft estate and environmental mitigation measures

## **7.10 Assessment of Effects**

### **Landscape and Visual Receptors**

7.10.1 This PEI Report chapter identifies landscape and visual receptors within the study area, which may be affected by the proposed scheme. The types of receptors are described below:

### Landscape Receptors

7.10.2 The European Landscape Convention (ELC)<sup>70</sup> definition of “landscape” is:

*“... an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors.”*

7.10.3 Effects on the Landscape may arise where the proposed scheme modifies the characteristics of the area. It is important to place the proposed scheme in its context.

7.10.4 The loss or depletion of important landscape features can adversely affect the condition, and quality of the landscape as a resource as well as its overall character. Conversely, the addition of significant beneficial features can constitute an improvement to the landscape and its overall character.

7.10.5 Aspects of the landscape considered in the assessment that may be affected by the proposed scheme include:

- landscape elements comprising physical features such as trees and hedgerows, topography, water courses, landforms, boundaries, transport corridors and recreation routes. Effects on these elements may arise where valued features are lost, gained or substantially modified as a result of the proposed scheme;
- aesthetic and perceptual characteristics of the landscape such as scale, texture and complexity, openness, tranquillity and remoteness; historic and cultural aspects and darkness at night;
- the overall character of the landscape and settlements made up of the components and characteristics above; and
- the character and settings of any areas designated specifically for their landscape or townscape value (i.e. the Cotswolds AONB).

7.10.6 For the ES LVIA, effects on the landscape as a resource will be assessed and reported in terms of LCAs which will include the broader LCTs. Landscape receptors are defined as the character of potentially affected LCAs. The consideration of the AONB as a landscape designation will be assessed separately focusing on how the proposed scheme will affect the AONB’s special qualities.

7.10.7 LCA receptors and AONB special qualities have been determined using a combination of desktop study, information available from Gloucestershire Vales Landscape Character Assessment, Cotswolds AONB Landscape Character Assessment, Cotswolds AONB Management Plan and confirmed by field work carried out by landscape architects.

7.10.8 The landscape character receptors have been grouped into three categories:

- direct and indirect effects on physical components, characteristics and overall character of the local LCAs, within the 1km Core Focus Area;
- indirect effects on the characteristics and overall character of the LCAs and designated landscapes within the 3km Wider Study Area from which the proposed scheme may be perceived as part of the wider setting; and

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<sup>70</sup> Council of Europe, “European Landscape Convention,” Florence, 2000.

- direct and indirect effects on the special qualities of the Cotswolds AONB.

7.10.9 Table 7-4 summarises the landscape receptors including landscape character types and individual landscape components which have been identified as part of the baseline conditions. Landscape character types and key components will be considered and assessed within the LVIA as part of the overall LCA receptor.

**Table 7-3 Summary of Landscape Receptors**

<b>Receptor</b>	<b>Landscape Character Type (Considers geology, landform, drainage patterns, vegetation and historical land use and settlement pattern)</b>	<b>Key landscape components (Considers heritage and conservation assets)</b>
AONB LCA 2D Coopers Hill to Winchcombe	LCT 2 Escarpment	Crickley Hill Camp Crickley Hill Country Park Cooper's Hill Barrow Wake Leckhampton Camp and Tumulus High Brotheridge Camp, Buckholt Great Witcombe Roman Villa Cotswold Way National Trail Gloucestershire Way long distance footpath Common land and Open Access Land at Barrow Wake Dryhill Roman Villa Crippet's Wood barrows
AONB LCA 7B Bisley Plateau	LCT 7 High Wold	Brimpsfield Castle Brimpsfield Mound Brimpsfield Conservation Area
AONB LCA 7C Cotswold High Wold Plateau		Emma's Grove Gloucestershire Way long distance footpath
AONB LCA 8A Toadsmoor, Holy Brook and Upper Frome Valleys	LCT 8 High Wold Valley	
AONB LCA 8C Upper Churn Valley		Coberley Long Barrow Coberley Conservation Area Cowley Manor RPG Cowley Conservation Area
AONB LCA 10A Middle Churn Valley	LCT 10 High Wold Dip Slope Valley	
AONB LCA18A Vale of Gloucester Fringe	LCT 18 Settled Unwooded Vale	
GLCA SV6B Vale of Gloucester		Moat and fishpond at Bentham Manor

<b>Receptor</b>	<b>Landscape Character Type</b> <i>(Considers geology, landform, drainage patterns, vegetation and historical land use and settlement pattern)</i>	<b>Key landscape components</b> <i>(Considers heritage and conservation assets)</i>
Special Qualities of the Cotswolds AONB	N/A	<ul style="list-style-type: none"> <li>• the unifying character of the limestone geology – its visible presence in the landscape and use as a building material;</li> <li>• the Cotswold escarpment, including views from and to the AONB;</li> <li>• the high wolds – a large open, elevated predominately arable landscape with commons, ‘big’ skies and long-distance views;</li> <li>• river valleys, the majority forming the headwaters of the Thames, with high-quality water;</li> <li>• distinctive dry-stone walls;</li> <li>• internationally important flower-rich grasslands, particularly limestone grasslands;</li> <li>• internationally important ancient broadleaved woodland, particularly along the crest of the escarpment;</li> <li>• variations in the colour of the stone from one part of the AONB to another which add a vital element of local distinctiveness;</li> <li>• the tranquillity of the area, away from major sources of inappropriate noise, development, visual clutter and pollution;</li> <li>• extensive dark sky areas;</li> <li>• distinctive settlements, developed in the Cotswold vernacular, high architectural quality and integrity;</li> <li>• an accessible landscape for quiet recreation for both rural and urban users, with numerous walking and riding routes, including the Cotswolds Way National Trail;</li> <li>• significant archaeological, prehistoric and historic associations dating back 6,000 years, including Neolithic stone monuments, ancient drove roads, Iron Age forts, Roman villas, ridge and furrow fields, medieval wool churches and country estates and parks;</li> <li>• a vibrant heritage of cultural associations, including the Arts and Crafts movement of the 19th and 20th centuries, famous composers and authors and traditional events such as the Cotswolds Olympicks, cheese rolling and woolsack races.</li> </ul>

Visual Receptors

- visual receptors are people enjoying views from locations which it is possible to obtain views of the proposed scheme. Such locations include:
- private viewpoints, such as views from domestic residences or places of work; and
- public viewpoints such as roads or railway lines, PRow or other footpaths and areas of open space or recreational places with public access.

7.10.10 These views may be partial or full, glimpsed or direct. Impacts on the visual amenity of a receptor may arise where features intrude into or obstruct views, or where there is some other qualitative change to the view.

7.10.11 Types of viewpoints that can be selected for LVIA include:

- representative viewpoints, which represent the experience of different types of visual receptors;
- specific viewpoints, chosen because they are key, promoted viewpoints within the landscape; and
- illustrative viewpoints, to demonstrate a specific visual issue.

7.10.12 For the LIVA, most viewpoints will likely be representative viewpoints representing, for example, views from a community and a PRoW. It may also include specific viewpoints for views available from identified higher grounds along the escarpment, for example.

7.10.13 Table 7-5 summarises the indicative viewpoint selection and visual receptors.

**Table 7-4 Summary of Indicative Viewpoints and Visual Receptors**

Viewpoint	Visual Receptors	Grid Reference	Description and Location
VP 1	Specific view from Great Witcombe Roman Villa.	SO 89919 14490	Great Witcombe Roman Villa
VP2	Representative view of A46 road users.	SO 89574 15703	A46 Painswick Road
VP3	Representative view of Ermin Way road users and the communities at Little Witcombe and Great Witcombe.	SO 91151 15270	Birdlip Hill/Ermin Way
VP4	Specific view from the Peak representative of recreational users of the Cotswold Way National Trail and people enjoying the AONB.	SO 92228 15116	The Peak, Cotswold Way National Trail
VP5	Specific view from Barrow Wake representative of recreational users of the Cotswold Way National Trail and people enjoying the AONB.	SO 93106 15347	Barrow Wake, Cotswold Way National Trail
VP6	Representative view from Crickley Hill representative of recreational users of the Country Park, the Cotswold Way National Trail and people enjoying the AONB.	SO 92772 16010	Crickley Hill, Cotswold Way National Trail
VP7	Representative view of road users and recreational users of Crickley Hill Country Park.	SO 93594 16329	B4070/Leckhampton Hill
VP8	Representative view of recreational users of Cotswold Way National Trail, the visual amenity of Dryhill Roman Villa and Crippet's Wood barrows and people enjoying the AONB.	SO 93417 17002	Cotswold Way National Trail
VP9	Specific view from Devil's Chimney representative view of recreational users of Cotswold Way National Trail	SO 94602 17786	Leckhampton Hill, Cotswold Way National Trail

Viewpoint	Visual Receptors	Grid Reference	Description and Location
	and Cheltenham Circular Walk Long Distance Footpath. Also representative of the visual amenity of Leckhampton Camp and tumulus and people enjoying the AONB.		
VP10	Representative view of the community scattered around Shabb Hill and recreational users of Gloucestershire Long Distance Footpath.	SO 94096 15505	Rushwood Kennels, Gloucestershire Way
VP11	Representative view of recreational users of byway and people enjoying the AONB from elevated land.	SO 97489 15318	Hill Barn Byway
VP12	Representative view of road users, the community at Cowley and recreational users of the local Public Right of Way network.	SO 95028 14649	Minor Road, Cowley
VP13	Representative view of the community at Stockwell and recreational users of the local Public Right of Way network.	SO 94117 14303	Stockwell
VP14	Representative view of residential and recreational users of the public house and recreational users of the local Public Rights of Way network and community.	SO 94320 13724	The Golden Heart Inn, Nettleton
VP15	Representative view of Cowley Manor Registered Park and Garden.	SO 95184 13515	Cowley Wood, minor road
VP16	Representative view of the community at Brimpsfield and the visual amenity to and from the Scheduled Monument at Brimpsfield Castle and Brimpsfield Mound.	SO 94034 12936	Brimpsfield
VP17	Representative view of the existing A417 road users and recreational users of the Gloucester Beeches Bridleway.	SO 95786 12251	Gloucester Beeches Bridleway

### Effect Scoped Out

- 7.10.14 The LVIA will not assess the effects of the proposed scheme on any landscape or visual receptors located outside the 3km study area. No receptors outside of this area have been identified through the ZTV, however, final viewpoint locations will be consulted on with the statutory consultees and confirmed through discussions with the Technical Working Group/Strategic Stakeholder Panel.
- 7.10.15 It is notable that there is no right in planning law to a private view. This has been accepted by various appeal decisions determined by the Planning Inspectorate. Therefore, views from private properties will not form part of the ES LVIA.
- 7.10.16 Permanent lighting is not proposed therefore the LVIA is unlikely to include an assessment on permanent lighting, although there will be an assessment conducted if lighting were to be introduced during the design process. There will

likely be temporary construction lighting, which will be intermittently used throughout the construction phase for select operations in isolated locations only and the effects of these construction operations will be addressed in the LVIA.

## 7.11 Monitoring

- 7.11.1 Landscape design and mitigation proposals will be required to successfully mitigate the likely effects of the proposed scheme. These will be developed during the EIA process and will be illustrated in the Environmental Masterplans. It is essential that the proposed planting proposals establish well after planting and are monitored and maintained to ensure it thrives and grows to the desired extent, so that it becomes effective as mitigation design following construction.
- 7.11.2 An Outline Landscape and Ecology Management Plan will be developed and will set out a framework in which the successful establishment of these measures can be managed and ensured. This will form part of the Outline CEMP.

## 7.12 Summary

- 7.12.1 The PEI Report provides information on the landscape and visual baseline conditions in 2019. It sets out the methodology which the ES will follow to assess significant effects of the proposed scheme on landscape character, and views and the visual resources as experienced by people.

### Preliminary construction assessment

- Construction activities will have a likely significant **adverse** temporary effect on the study area and some of the special qualities of the Cotswolds AONB.
- A number of the AONB's special qualities will be significantly affected by the proposed scheme where the project boundary is located within the affected landscape character areas;
  - LCT 2 Escarpment;
  - LCT 7 High Wold;
  - LCT 8 High Wold Valley; and
- Construction activities will have a likely significant **adverse** temporary effect on the following visual receptors:
  - Recreational users on the Cotswolds Way National Trail, Gloucestershire Way long distance footpath and the Cheltenham Circular Walk long distance footpath, byways, bridleways and Public Rights of Way including at Coopers Hill, the Peak, Barrow Wake and Crickley Hill;
  - Visitors to the Cotswolds AONB and Crickley Hill Country Park, Leckhampton Camp, Coopers Hill, the Peak, Barrow Wake and Crickley Hill, Devil's Chimney, Dryhill Roman Villa, Crippet's Wood barrows and Cowley Manor Registered Park and Gardens;
  - Communities including Little Witcombe and Great Witcombe, Shab Hill, Cowley, Stockwell; and
  - Road users on the local minor road network around the proposed scheme, the A417, A436 and B4070.



### Preliminary operational assessment

- The operation of the proposed scheme will have a combination of likely significant **beneficial** and **adverse** permanent effects for character areas directly affected.
- A number of the AONB's special qualities will be significantly affected by the proposed scheme where the project boundary is located within the affected landscape character areas;
  - LCT 2 Escarpment;
  - LCT 7 High Wold;
  - LCT 8 High Wold Valley; and
  - LCT 18 Settled Unwooded Vale.
- As a result of the proposed development, there will likely be a mix of **adverse** and **beneficial** permanent effects with significant effects experienced by the following visual receptors:
  - Recreational users on the Cotswolds Way National Trail, Gloucestershire Way long distance footpath and the Cheltenham Circular Walk long distance footpath, byways, bridleways and Public Rights of Way including at Coopers Hill, the Peak, Barrow Wake and Crickley Hill;
  - Visitors to the Cotswolds AONB and Crickley Hill Country Park, Leckhampton Camp, Coopers Hill, the Peak, Barrow Wake and Crickley Hill, Devil's Chimney, Dryhill Roman Villa, Crippet's Wood barrows and Cowley Manor Registered Park and Gardens;
  - Communities including Little Witcombe and Great Witcombe, Shab Hill, Cowley, Stockwell; and
  - Road users on the local minor road network around the proposed scheme, the A417, A436 and B4070.

### Further Work

- 7.12.2 Thorough consultation will be undertaken with all relevant statutory and non-statutory consultees.
- 7.12.3 Further, field survey work will continue to confirm the baseline landscape conditions and existing visual resource. A site-specific landscape character assessment will be undertaken to inform the ES LVIA, along with a visual assessment following the methodology as set out above in section 8.6. The findings of which will be used to prepare a detailed LVIA, making judgements on the significance of effects that will occur because of the proposed scheme.
- 7.12.4 Viewpoint locations will be agreed with the statutory stakeholder. At each of these locations, summer and winter photography will be undertaken. A number of the viewpoints will be revisited to undertake verified viewpoint photography which will be used to prepare the visualisations/photomontages of the proposed scheme.
- 7.12.5 Cross over and collaborative work will be undertaken between the interrelated project disciplines, particularly between landscape, ecology/biodiversity, heritage, drainage and acoustics.
- 7.12.6 Findings of the field survey and assessment work will feed into the design, with the landscape design being finalised as part of this stage. This will include all proposed landscape mitigation and enhancements required to deliver a high-quality landscape led design solution.

## 8 Biodiversity

### 8.1 Introduction

- 8.1.1 This chapter of the PEI Report assesses the likely significant effects of the proposed scheme on the ecological resources within the study area and surrounding environments.
- 8.1.2 This chapter documents survey work undertaken in relation to designated sites, habitats and species to date. The chapter documents measures to mitigate and compensate any ecological effects. Within this chapter the value of receptors is reported and the residual effects subsequent to mitigation, arising from the construction and the operation of the proposed scheme are assessed in turn. Enhancement measures which go beyond mitigating effects are also identified.
- 8.1.3 In 2006, a Stage 2 assessment of a proposed scheme which partly covered the options currently being considered. The results of this Stage 2 Assessment were reported in '*A417 Cowley to Brockworth Bypass Improvement Scheme - Stage 2 Ecology and Nature Conservation Report*' (2006). Key findings of these surveys and report formed part of the desk study and are considered within this report. However, it is worth noting that ecological surveys are currently being updated.
- 8.1.4 The ecological resource of the study area was surveyed in detail with preliminary surveys commenced in 2017, to ensure a comprehensive ecological baseline for the assessment. Key findings from the report '*A417 Missing Link Environmental Impact Assessment Scoping Report*' (2019) are considered in this report.
- 8.1.5 The detailed ecological baseline reports will be reported within the appendices of the ES, which will accompany the DCO application.

### 8.2 Legislative and Policy Framework

- 8.2.1 A framework of international, European, national and local legislation and planning policy guidance exists to protect and conserve wildlife and habitats. The following relevant legislation exists to protect habitats and species of nature conservation importance:
- The Conservation of Habitats and Species Regulations 2017 (as amended) (the 'Habitat Regulations 2017') which transposes Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora ('the Habitats Directive') into UK law;
  - Ramsar Convention on Wetlands 1971;
  - The Birds Directive (Council Directive 2009/147/EC on the conservation of wild birds);
  - Wildlife and Countryside Act (WCA)1 1981 (as amended);
  - Natural Environment and Rural Communities (NERC) Act 2006;
  - The Countryside and Rights of Way Act 2000;
  - The Hedgerow Regulations 1997;
  - Eels (England and Wales) Regulations 2009; and
  - Protection of Badgers Act 1992.
- 8.2.2 These pieces of legislation include a number of offences relating to protected species and requirements for licences to allow construction works to proceed. In addition, the Habitats Regulations set out the requirement for the consideration of the potential effects of a project on European designated sites.

8.2.3 The legislation and policy relating to specific species are further detailed within the ecological baseline reports, which will be provided in a separate policy chapter.

### **National Policy**

8.2.4 Particular attention has been made to the planning policy and strategy documents listed below that are applicable to assessing the impacts to the ecological resources:

- National Policy Statement for National Networks (NPSNN): Road and Rail Infrastructure;
- National Planning Policy Framework (March 2012 amended 2019)
- UK-Post 2010 Biodiversity Framework (replaced the previous UK Biodiversity Action Plan) and
- Biodiversity 2020: A strategy for England's wildlife and ecosystem services (Natural England, 2011).

8.2.5 The Government recognises that for development of the national road networks to be sustainable these should be designed to reduce environmental impacts and in delivering this, applicants are expected to avoid and mitigate environmental impacts in line with the principles set out in the National Planning Policy Framework (NPPF) revised in 2019, and the Government's planning guidance. Applicants should also provide evidence that they have considered reasonable opportunities to deliver environmental benefits as part of schemes. The Government's detailed policy on environmental mitigations for developments is set out in chapter 5 of the National Policy Statement for National Networks (NPSNN).

8.2.6 Biodiversity is the variety of life in all its forms and encompasses all species of plants and animals and the complex ecosystems of which they are a part. Government policy for the natural environment is set out in the Natural Environment White Paper (NEWP). The NEWP sets out a vision of moving progressively from net biodiversity loss to net gain, by supporting healthy, well-functioning ecosystems and establishing more coherent ecological networks that are more resilient to current and future pressures.

8.2.7 Biodiversity policy within the UK has been revised through the publication of the UK Post-2010 Biodiversity Framework<sup>71</sup> which supersedes the UK Biodiversity Action Plans and covers the period from 2011 to 2020. A total of 65 Priority Habitats and 1150 Priority Species have been identified as the most in need of protection.

8.2.8 The UK list of priority species however remains an important reference source and has been used to draw up statutory lists of priority species in England as required under Section 41 of the Natural Environment and Rural Communities (NERC) Act 2006. A total of 56 habitats and 943 species of principal importance found in England are included in the S41 list. These habitats and species were identified as requiring action in the UK BAP and continue to be regarded as conservation policies in the subsequent UK post-2010 Biodiversity Framework.

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<sup>71</sup> JNCC (2012), UK post 2010 Biodiversity framework. <http://jncc.defra.gov.uk/page-6189>

## Local Policy

8.2.9 Consideration has been given to relevant section and policies relating to biodiversity, environment within the following resources:

- Cotswold District Local Plan 2001 – 2011 (adopted 2006) with particular focus on key policy 9 Biodiversity, geology and geomorphology<sup>72</sup>;
- Cotswold AONB Management Plan 2018-2023<sup>73</sup> – Policy CE7: Biodiversity;
- Gloucestershire Highways Biodiversity Guidance (2019);
- Gloucester City Plan (Sustainability Appraisal Summary (2012);
- Gloucester City Plan Sustainability Appraisal (2013);
- Gloucester, Cheltenham and Tewksbury Joint Core Strategy 2011 – 2031;
- Sustainability (Integrated) Appraisal (SA), incorporating Strategic; and
- Environmental Assessment (SEA)SA Adoption Statement 2017

## Guidance

8.2.10 A range of guidance documents are available for biodiversity, but the principal assessment sources include:

- The ecological assessment will be undertaken using the Guidance for Ecological Impact Assessment in the United Kingdom Third Edition (CIEEM, 2018) and;
- Highways England standards, including IAN Ecology and Nature Conservation: Criteria for Impact Assessment (IAN 130/10) which supplements the earlier Design Manual for Roads and Bridges (DMRB) chapter in volume 11, section 3, part 4 (dated 1993).

8.2.11 Guidance for specific species, groups and other ecological features is discussed in individual relevant sections or will be provided in the ecological baseline reports which will be provided in the ES.

## 8.3 Study Area

8.3.1 The ecology of the proposed scheme and surrounding area was surveyed primarily between 2017 and 2019 as part of a Preliminary Ecological Appraisal and in preparation for the Environmental Statement. Surveys are still ongoing and additional work is currently being undertaken. During this time several route options were considered. Historical surveys which partly covered the options that were under consideration were also carried out in 2006.

8.3.2 The study area varied for different species and ecological survey methods to ensure compliance with specific guidance for species, groups and habitats.

8.3.3 Study areas thus varied depending on time of survey and type of survey. The overall study area is shown on the Phase 1 Habitat Map provided in figure 8.3. Individual study areas for each species will be provided in the ES.

8.3.4 The maximum extent of the study area was determined by guidance, Zone of Influence (ZOI) and consultation with statutory bodies. For example, badger (*Meles meles*) were surveyed within at least 250 metres from the proposed

<sup>72</sup> Cotswolds District Council Website (accessed 18.06.19) <https://www.cotswold.gov.uk/residents/planning-building/wildlife-biodiversity/biodiversity-planning-policy/#>

<sup>73</sup> Cotswold AONB Management Plan (accessed 18.06.19) <https://www.cotswoldsaonb.org.uk/wp-content/uploads/2018/12/Management-Plan-2018-23.pdf>

scheme as per DMRB guidelines (Highway Agency 2001). Where there are any deviations from guidance these are described and justified within the assessment and ecological baseline reports, which will be provided in the ES.

- 8.3.5 The preferred route was announced in May 2019. As such, the study areas for some receptors may differ in 2019 and onwards in response to the route selection. However, the below areas are those that have been assessed to date (see Table 8-1).

**Table 8-1 Search Distances Used for the Assessment**

Site, habitat or species searched for (online and through field surveys)	Distance from proposed scheme
Internationally designated nature conservation sites, including Special Areas for Conservation (SAC), Special Protection Areas (SPA) and Ramsar Sites (in line with DMRB Volume 11, Section 4, Part 1 HD 44/09 'Assessment of Implications (of Highways and / or Roads Projects) on European sites (including Appropriate Assessment)).	2 km
SACs designated for bat populations in line with DMRB Volume 11, Section 4, Part 1 HD 44/09 'Assessment of Implications (of Highways and / or Roads Projects) on European sites (including Appropriate Assessment)'.	30 km
Internationally designated nature conservation sites which are linked hydrologically to watercourses potentially affected by the proposed scheme options.	30 km
Nationally and locally designated nature conservation sites, including National Nature Reserves (NNR), Site of Special Scientific Interest (SSSI), Local Nature Reserves (LNR), priority habitats, Local Wildlife Sites (LWS), ancient woodland and RSPB Reserves.	2 km
Records of protected species and notable species.	2 km
Preliminary ecological assessments including Extended Phase 1 habitat survey, Habitat Suitability Index (HSI) assessments of waterbodies for Great Crested Newts (GCN) <i>Triturus cristatus</i> , and badgers.	500m
Barn owl <i>Tyto alba</i> surveys.	1.5 km
Assessment of known/potential bat roosts.	100m
Surveys along watercourses for white-clawed crayfish <i>Austropotamobius pallipes</i> .	Within proposed scheme (Norman's Brook) and where indirect effects could occur (River Frome Upper Tributaries. 110m south-west of the proposed scheme at its closest point).
Water vole <i>Arvicola amphibius</i> , dormouse <i>Muscardinus avellanarius</i> , reptiles and wintering and breeding birds.	250 m
Surveys along watercourses for otter <i>Lutra lutra</i> where these watercourses are within 250m of the boundary of the proposed scheme, in accordance with DMRB Volume 10 Section 1 Part 9 'Nature Conservation Advice in Relation to Otters'.	2 km
Roads that are expected to be affected by the proposed scheme options for sites affected by changes in air quality with national or international designations for nature conservation.	200m

## 8.4 Potential Impacts

- 8.4.1 A highway scheme can impact biodiversity and nature conservation in a number of ways during both construction and operation of the proposed scheme.
- 8.4.2 The potential impacts to habitats and species may be permanent or temporary, and direct and indirect. The direct effects are of habitat loss and severance, species mortality through vehicle collisions, disturbance due to noise, habitat degradation due to changes in air quality, surface run-off and pollution events. Indirect effects may include displaced individuals on the occupancy of alternative habitat, including reduced foraging success, increased competition and predation, genetic isolation and inbreeding, which can lead to local extinctions. It is possible that there may be indirect effects of the proposed scheme due to hydrological changes affecting woodland and other areas of vegetation.

### Habitat loss

- 8.4.3 Habitats will be lost through the change of land use from countryside (predominantly farmland and some woodland) to highway. In particular, a small section of woodland at Emma's Grove (which supports a number of ancient woodland indicator species and is likely to be ancient in origin) may be permanently lost as the east of the site falls within the proposed scheme boundary. The western edge of Ullen Wood (ancient and semi-natural woodland) may also be lost during construction. However, it is expected that habitat loss within these woodlands will be minimal. Habitat loss within the highway boundary will be permanent, whereas some areas that will be used as access routes, compounds and borrow pits during construction will be temporary, with the habitat reinstated or in most cases enhanced post-construction.
- 8.4.4 Works are anticipated within Crickley Hill and Barrow Wake SSSI during the detrunking of the existing A417 road. Although these works are not expected to impact directly upon the SSSI grassland and woodland habitats around Barrow Wake, these works will be completed within the SSSI.
- 8.4.5 A green bridge is to be created over the A417 which is currently proposed to link Crickley Hill SSSI and Barrow Wake SSSI. The extent of the proposed scheme footprint associated with this is not currently understood but some habitat loss is expected including mature trees.
- 8.4.6 In general, habitat loss, including that which supports protected species, will be mitigated through creation of replacement habitat or enhancement of retained habitat.

### Habitat severance

- 8.4.7 Given that much of the proposed A417 proposed scheme will run through open countryside, the habitat severance between habitats and the populations of animals they support north and south of the road are likely to have significant effects on species populations in the area. The road is likely to sever existing wildlife corridors and foraging areas for wildlife.
- 8.4.8 Severance can lead to isolation both within and between populations and from specific resources vital for survival. The indirect effects of this could include reduced foraging success, increased competition, genetic isolation and inbreeding, which can lead to local extinctions.

- 8.4.9 The new road alignment could prove a barrier to species movements across the landscape. As such habitat severance, isolation and movements of species will be mitigated through the provision of multispecies crossings in the form of overbridges, underbridges or culverts with fencing to ensure their safe crossing and provide connectivity for wildlife between habitats severed by the proposed scheme thus reducing any isolation effects. A green bridge is also proposed which will provide a green link for species across the new A417 linking Crickley Hill and Barrow Wake SSSI (this SSSI comprises two sites; Crickley Hill to the north of the A417 and Barrow Wake Nature Reserve to the south).
- 8.4.10 Habitat severance will also occur during site clearance and construction, but these effects can be reduced through the sensitive construction programming, for example in bat sensitive areas the vegetation clearance and planting schedule can be tailored to ensure minimal time of bare ground / habitat severance during the bat active season between May to September. Such severance effects can be further reduced through dead hedging for example, which can provide temporary habitat connectivity within bat hot spots and commuting routes during sensitive bat activity periods.

#### **Habitat damage or degradation**

- 8.4.11 Habitats within or adjacent to the proposed scheme or those which are hydrologically connected aquatic habitats, are sensitive to effects from both construction and operation such as pollution events from fuel and chemical spills, from change in vehicle emissions, and from sediment run-off.
- 8.4.12 Whilst best practice construction and operation design techniques for pollution prevention and control will be used, there is always a risk during construction and operation from vehicles and the transporting of potentially polluting goods.
- 8.4.13 Crickley Hill and Barrow Wake SSSI, partly designated for calcareous grassland habitat, may be sensitive to elevated levels of airborne dust from the works and nitrogen deposition during both construction and operation of the road. Best practise control measures will be used to reduce this risk, and any changes in nitrogen deposition will be investigated. Crickley Hill and Barrow Wake SSSI fall within the proposed scheme boundary and are at particular risk of habitat damage.
- 8.4.14 Ullen Wood is also at risk of habitat damage or degradation as the proposed scheme boundary borders the entire western aspect of the wood, and crosses into the wood in the north-west. Ullen Wood is listed as an ancient woodland on Natural England's Ancient Woodland Inventory and is considered to be an irreplaceable habitat.
- 8.4.15 It is possible that works within Crickley Hill and Barrow Wake SSSI may impact upon local hydrology and indirectly affect woodland, especially beech woodland habitat and calcareous grassland habitat which are sensitive to drainage conditions. Likely impacts will be assessed, and avoidance or mitigation measures will be proposed. Further details will be discussed within chapter 13 Road Drainage and The Water Environment and any associated impacts on vegetation will be provided within the Biodiversity and Road Drainage and Water Environment chapters of the ES.
- 8.4.16 Elevated oxides of nitrogen (NOx) concentrations are generally considered to be the main threat to vegetation from vehicle emissions. More details on air quality

impacts are set out in chapter 5 Air Quality, and any associated impacts on vegetation will be provided within the Biodiversity and Air Quality chapters of the ES.

### **Disturbance**

- 8.4.17 Disturbance effects could have significant impacts on sensitive species. This could lead to abandonment of territory or of young, increased predation risk and use of critical energy reserves.
- 8.4.18 Disturbance resulting from lighting can also lead to significant effects on nocturnal species such as bats. The effect of road lighting is complex and varies for different species, but includes roost disturbance and abandonment, severance and loss of foraging and commuting habitats, and a decline in airborne invertebrate prey.

### **Species mortality**

- 8.4.19 Species mortality can occur during construction as well as operation of highways. Less mobile species, or animals that are hibernating or have young, are likely to be most vulnerable to direct mortality during vegetation clearance and construction.
- 8.4.20 The effects of individual mortality can lead to local extinctions once a population falls below a critical threshold. These effects are often greatest within longer-lived species, with greater parental investment and low annual reproduction, which struggle to recover from loss of family or population members.
- 8.4.21 Many animals are killed by vehicle collision on UK roads each year and this is likely to be the case for the proposed scheme in the absence of mitigation in the form of wildlife crossings either under or over the road.
- 8.4.22 Animals that are particularly susceptible and are at risk from collision are badger, otter and bats due to the severance of wildlife corridors, and birds, especially barn owl, due to the way in which they hunt.

### **Potential impacts due to climate change**

- 8.4.23 The PEI Report considers effects related to climate change as per the requirements of EU Directive 2014/52 and the 2017 EIA Regulations to assess In-Combination Climate Change Impacts. The combined effects relating to ecological impacts of the proposed development and potential climate change on receptors include the following:
- Drier and potentially drought-like conditions are a potential impact of global climate change leading to changes in hydrological and groundwater conditions. The limestone geology of the area means that the proposed scheme may have an increased risk of impact on water quantity in the headwaters of the River Frome if local hydrology is affected. There may be ground water effects as a result of the development which may affect the calcareous grasslands and woodland of Crickley Hill and Barrow Wake SSSI and potentially the Cotswolds Beechwood SAC woodlands, Bushley Muzzard SSSI wetlands and the River Frome KWS although it is too early to conclude this. Sites such as Bushley Muzzard SSSI are reliant on groundwater and the in-combination effects of climate change and potential ground water effects from the proposed scheme may have detrimental effects on nearby habitats



and wildlife. No mitigation for this has currently been outlined as the hydrological effects of the proposed scheme have not yet been fully assessed. These will be fully detailed in the ES.

- Increases in wind speed, temperature variations and rainfall patterns associated with climate change and the increase in extreme weather events such as storms have the potential to cause structural damage to, and even fell trees, as well as increase soil erosion. The loss of individual trees is detrimental from an ecological point of view and the loss of large numbers of trees can result in habitat degradation, habitat loss and habitat fragmentation and loss of connectivity. As habitat loss, including that of trees will occur as a result of the proposed scheme, the in-combination effect has the potential to result in large scale habitat degradation, habitat loss and loss of connectivity between habitats. In general, throughout the proposed scheme, habitat loss, including that which supports protected species, will be mitigated through creation of replacement habitat or enhancement of retained habitat. Overall, temperature changes are expected to be within the tolerance of local habitats and not to have a significant impact upon local habitats and species in the short term.
- Increases in rainfall and likelihood of flooding are potential hazard of climate change. This may have an effect of groundwater, waterbodies and protected species that live in or rely on them. Flooding and increases in water volume within rivers may affect riparian mammals and their behaviour. Destruction or change of riparian mammal habitat may cause an increase in species relocating to other habitats. The potential changes in water courses caused by the development may also contribute to this although it is too soon to say what the exact effects will be due to the lack of data. The design of the proposed scheme is currently being assessed and key areas for riparian mammals are being considered in order to ensure that potential crossing points such as culverts and underbridges can be adapted in order to be utilised by otters and other wildlife.

8.4.24 Potential changes in climatic conditions will be considered when proposing mitigation with regard to habitat creation and enhancements.

## 8.5 Assessment Methodology

### Desk study

8.5.1 A desk study was undertaken in 2017 to collate and review records of statutory and non-statutory designated sites, protected and notable species and notable habitats within two kilometres of proposed development. At the time of the desk study being carried out the final route option had not been decided and so the proposed development route included corridor route options 3, 21, 24, 29 and 30. This search area was extended to 30 kilometres for SACs where bats are a qualifying species. The desk study will be updated ahead of the DCO application.

8.5.2 The following organisations and resources were consulted to compile the desk study:

- Multi-Agency Geographic Information for the Countryside (MAGIC);
- Gloucestershire Centre for Environmental Records (GCER); and
- Additional records of habitat and protected and notable species data was provided by the National Trust (NT) and Gloucestershire Wildlife Trust (GWT)

for records around Crickley Hill and Barrow Wake SSSI (comprising Crickley Hill and Barrow Wake Nature Reserve).

### **Extended Phase 1 Habitat survey**

- 8.5.3 The Extended Phase 1 Habitat survey was carried out in May and June 2017. The broad habitat types were identified and mapped in accordance with the Handbook for Phase 1 Habitat Survey (JNCC, 2010<sup>74</sup>).
- 8.5.4 During the Phase 1 survey, features of potential significance to protected species were identified and recorded as Target Notes. These included habitats of potential significance or evidence of or potential for any protected or notable species.
- 8.5.5 Habitats within the Zol were classified according to JNCC habitat types. Where possible, plant species were identified to species level. The species lists were compiled and incorporated into the Phase 1 Habitat Survey map and Preliminary Ecological Appraisal report (2017<sup>75</sup>). The Phase 1 Habitat map can be found in figure 8.3.

### **Phase 2 Protected Species and Habitat Surveys**

- 8.5.6 Most protected species surveys are currently ongoing or have only just been completed at the time of writing the PEI Report. Therefore, most Phase 2 reports have not yet completed and therefore information on survey methodologies used or any particular limitations for each protected species survey or detailed habitat surveys have not been included at this time. However, a summary of interim results has been provided wherever possible. Full details will be provided in the ES once this information becomes available.

### **Assessment of Biodiversity Value and Significance Criteria**

- 8.5.7 This assessment methodology is based on that set out in the Highways Agency's DMRB Interim Advice Note (IAN) 130/10 Ecology and Nature Conservation: Criteria for Impact Assessment<sup>76</sup>. This advice note is supplementary to the advice provided in DMRB Volume 11, Section 3 Part 4 'Ecology and Nature Conservation'<sup>77</sup>, which continues to provide the framework for assessment of potential impacts of roads projects on nature conservation resources.

### **Valuation of Resources**

- 8.5.8 IAN 130/10 sets out a process for the valuation of resources including sites, habitats, species populations and assemblages of species, characterisation of predicted project impacts before and after mitigation and the subsequent assessment of significance of effects.

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<sup>74</sup> Joint Nature Conservation Committee, "Handbook for Phase I Habitat Survey: A technique for environmental audit," Peterborough, 2010.

<sup>75</sup> Mott MacDonald Sweco Joint Venture, "A417 Missing Link at Air Balloon, PCF1 Preliminary Ecological Appraisal", 2017.

<sup>76</sup> Highways Agency, "Design Manual for Roads and Bridges DMRB Interim Advice Note 130/10 Ecology and Nature Conservation: Criteria for Impact Assessment," 2010.

<sup>77</sup> Department of Transport, "DMRB Volume 11, Section 3 Part 4 'Ecology and Nature Conservation'," 1993.

- 8.5.9 The assessment methodology for ecological resources is supplemented where appropriate with guidance from the CIEEM Guidelines for Ecological Impact Assessment<sup>78</sup>.
- 8.5.10 The assessment process has also relied on professional judgement by individuals with sufficient relevant expertise, recognising project specific circumstances and decisions have been made through consultation with stakeholders including Natural England.
- 8.5.11 The value of nature conservation resources including sites, habitats, species populations and assemblages of species is assessed in accordance with DMRB IAN 130/10, as summarised in Table 8-2.

**Table 8-2 Resource Valuation**

<b>Resource Valuation</b>	<b>Typical Ecological Resources</b>
International or European Value	<p>Internationally designated sites e.g. Special Protection Areas (SPAs), SACs, or areas which meet the criteria, but which are not themselves designated.</p> <p>Resident, or regularly occurring, populations of species which may be considered at an International or European level<sup>79</sup> where:</p> <ul style="list-style-type: none"> <li>• the loss of these populations would adversely affect the conservation status or distribution of the species at this geographic scale; or</li> <li>• the population forms a critical part of a wider population at this scale; or</li> <li>• the species is at a critical phase of its life cycle at this scale.</li> </ul>
National Value	<p>Nationally designated sites e.g. SSSIs and National Nature Reserves (NNRs) or areas which meet the criteria, but which are not themselves designated. Areas of Ancient Woodland e.g. woodland listed within the Ancient Woodland Inventory, and HPis listed on Section 41 of the Natural Environment and Rural Communities Act 2006.</p> <p>Resident, or regularly occurring, populations of species which may be considered at an International, European, UK or National level where:</p> <ul style="list-style-type: none"> <li>• the loss of these populations would adversely affect the conservation status or distribution of the species at this scale; or</li> <li>• the population forms a critical part of a wider population at this scale; or</li> <li>• the species is at a critical phase of its life cycle at this scale.</li> </ul>
Regional Value	<p>Areas of key/HPis identified in the Regional BAP (where available); areas of key/HPI identified as being of Regional value in the appropriate Natural Area Profile (or equivalent); areas that have been identified by regional plans or strategies as areas for restoration or re-creation of HPis (for example, South West Nature Map); and areas of key/HPI listed within the Highways Agency's (now Highways England) BAP.</p> <p>Resident, or regularly occurring, populations of species which may be considered at an International, European, UK or National level and key/SPIs listed within the HABAP where:</p> <ul style="list-style-type: none"> <li>• the loss of these populations would adversely affect the conservation status or distribution of the species at this scale; or</li> <li>• the population forms a critical part of a wider population; or</li> <li>• the species is at a critical phase of its life cycle.</li> </ul>
County	<p>Sites designated in the county context (or considered worthy of such designation). Areas of key/HPis identified in the Local BAP; and areas of habitat identified in the appropriate Natural Area Profile (or equivalent).</p>

<sup>78</sup> Chartered Institute of Ecology and Environmental Management, "Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal, 2nd edition," Winchester, 2016.

<sup>79</sup> Such species include those listed within Council Directive 79/409/EEC on the conservation of wild birds or animal/plant species listed within Council Directive 92/43/EEC.

Resource Valuation	Typical Ecological Resources
	Resident, or regularly occurring, populations of species which may be considered at an International, European, UK or National level where: <ul style="list-style-type: none"> <li>• the loss of these populations would adversely affect the conservation status or distribution of the species across the County; or</li> <li>• the population forms a critical part of a wider population; or</li> <li>• the species is at a critical phase of its life cycle.</li> </ul>
Local Value	Designated sites including: Local Nature Reserves (LNRs) designated in the local context. Areas of habitat; or populations/communities of species considered to appreciably enrich the habitat resource within the local context (such as veteran trees), including features of value for migration, dispersal or genetic exchange.

Summarised from Table 1 of DMRB IAN 130/10 'Resource Valuation'

- 8.5.12 Any receptors that are considered to be of lower than local value have been assigned a less than local value; only receptors valued local or above will be taken forward for detailed assessment.
- 8.5.13 Bat receptors (bat roosts, bat commuting routes and bat foraging areas) have been valued in accordance with guidance on valuing bats in ecological impact assessment by Wray et al, (2010<sup>80</sup>).
- 8.5.14 The guidance categorises UK bat species according to rarity within geographical range (rarest/rarer/common). Roost value is described in a similar geographic frame of reference used in IAN 130/10 (International/National/Regional/County/District, Local or Parish) where for example, SAC sites where bats are qualifying features are valued as International value, maternity sites of rarest species are valued as National, maternity sites of rarer species are valued as Regional value and maternity sites of common species are valued as County value. Commuting routes and foraging areas are valued using a scoring system based on rarity of species, number of bats using feature for commuting/foraging, number of roosts nearby and the type and complexity of the linear feature/foraging habitat characteristics.
- 8.5.15 In circumstances where there are other factors influencing the value of the receptor not covered by the guidance, then professional judgement has overruled the guidance.
- 8.5.16 Where detailed assessment of specific receptors is considered appropriate, i.e. for those taken forward for detailed assessment, the potential project impacts on these receptors are described and characterised in detail in accordance with DMRB IAN 130/10. The project impacts are characterised firstly in the absence of mitigation and then with the proposed mitigation being taken into account as outlined in Table 2 of the guidance. The following terminology is used for the characterisation of impacts:
- Positive or negative impact;
  - Probability of occurring (certain, probable or unlikely);
  - Complexity (direct, indirect, cumulative);

<sup>80</sup> S. W. J. Wray, "Valuing Bats in Ecological Impact Assessment. CIEEM's," *Chartered Institute of Ecology and Environmental Management: In Practice*, pp. 23-25.

- Extent (area measures and percentage of total e.g. area of habitat/territory lost);
- Size (description of level of severity of influence (e.g. complete loss, number of animals affected));
- Reversibility (reversible or not reversible);
- Duration (permanent, or temporary in ecological terms); and
- Timing and frequency (important seasonal and/or life-cycle constraints and any relationship with frequency considered).

8.5.17 The CIEEM Guidelines for Ecological Impact Assessment<sup>81</sup> are used to guide the characterisation process. For example, in determining the complexity of the impact (whether it is direct or indirect, and the ZOI of that receptor will be considered). ZOI is explained in more detail under Section 9.3 (Study Area), however the maximum ZOI that will be applied to the assessment, including the cumulative assessment, for ecological receptors are provided in Table 8-3.

**Table 8-3 Maximum ZOI from the Proposed Scheme for Ecological Features**

Ecological Feature	Maximum ZOI from the proposed scheme
Internationally designated sites e.g. SACs and SPAs.	Two kilometres
Internationally designated sites for bats e.g. bat SACs.	30 kilometres
Nationally designated sites, including SSSIs and NNRs.	Two kilometres
Locally designated sites e.g. CWSs and CRVI sites.	Two kilometres
Species including otter, badger, bat, and reptile.	500 metres

8.5.18 The maximum ZOI for international sites designated for bats was established at 30 kilometres due to the potential for bats associated with these sites to use habitats within this radius. For other internationally designated sites as well as nationally and locally designated sites, two kilometres was selected as a maximum ZOI based on potential impacts. Regarding fauna, it is largely the behaviour of these species, including movement in the landscape, which determines the maximum ZOI.

### Assessment of Significance of Effects

8.5.19 The significance of effects, both adverse and beneficial, is determined by assessing the value of resources/receptors against any residual impact in accordance with DMRB IAN 130/10 (Neutral, Slight, Moderate, Large, Very Large), see Table 8-4. The assessment will continue to rely on professional judgement and guidance as provided within CIEEM Guidelines.

**Table 8-4 Significance of Effects**

Significance Category	Typical Descriptors of Effect (Nature Conservation)
Very Large	An impact on one or more receptor(s) of International, European, UK or National Value.
Large	An impact on one or more receptor(s) of Regional Value.
Moderate	An impact on one or more receptor(s) of County or Unitary Authority Area Value.

<sup>81</sup> Chartered Institute of Ecology and Environmental Management, "Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal, 2nd edition," Winchester, 2016.

Significance Category	Typical Descriptors of Effect (Nature Conservation)
Slight	An impact on one or more receptor(s) of Local Value.
Neutral	no significant impacts on key nature conservation receptors.

Source: DMRB 130/10

- 8.5.19 A significant effect is considered to be any impact of slight significance or above. Significant effects, or impacts which effect receptors protected under legislation, require consideration of avoidance, reduction or mitigation as defined within CIEEM Guidance.

## 8.6 Baseline Conditions

- 8.6.1 Desk study data for each habitat and protected species has been summarised here within each relevant sub-heading; which is followed by the field survey results. As stated above, protected species and specific habitat surveys were ongoing at the time of writing, and therefore detailed results are not available for inclusion in this PEI Report. Full details will be provided within the ES and interim results have been provided where possible.

### Designated Sites

#### Statutory Designations

- 8.6.2 Internationally important statutory designated sites include SPAs, SACs and Ramsar Sites. Nationally important statutory designations include SSSIs and NNRs, and locally important statutory designations are termed LNRs.
- 8.6.3 There is one internationally important site within the two kilometres search area: the Cotswold Beechwoods SAC which is located approximately 260m from the proposed scheme boundary. There is also one bat SAC within the 30km search area for such sites: the Wye Valley and Forest of Dean Bat Sites (SAC) is located approximately 22km west of the proposed scheme boundary.
- 8.6.4 There are five nationally designated SSSIs within the two kilometres search area. These are the Crickley Hill and Barrow Wake (SSSI) (comprising Crickley Hill and Barrow Wake Nature Reserve), Bushley Muzzard, Brimpsfield (SSSI), Knap House Quarry, Birdlip (SSSI), Cotswold Commons and Beechwoods (SSSI) and Leckhampton Hill and Charlton Kings Common SSSI. The closest SSSI is Crickley Hill and Barrow Wake SSSI which is within the proposed scheme boundary.
- 8.6.5 The full results from the statutory designated sites search are summarised in Table 8-5. The full details of the statutory designated sites search will be provided within the ES. Figure 8.1 shows the location of these sites in relation to the proposed scheme.
- 8.6.6 All measurements of distances of designated sites, habitats and protect species have been calculated from the proposed scheme boundary or are stated where different.

**Table 8-5 Statutory Designated Sites Within a Two Kilometre Search Area**

Site	Reasons for Designation	Distance from proposed scheme
Cotswold Beechwoods SAC	Cotswolds Beechwoods SAC is 82% broad-leaved deciduous woodland and represents the most westerly block of <i>Asperulo-Fagetum</i> beech forests in the UK. The woodland has a species rich flora with rare plants, including red helleborine <i>Cephalanthera rubra</i> , stinking hellebore <i>Helleborus foetidus</i> , narrow-lipped helleborine <i>Epipactis leptochila</i> and wood barley <i>Hordelymus europaeus</i> . The woods are structurally varied with some areas of remnant beech coppice and blocks of high forest. There is also a rich mollusc fauna here.	260m west
Wye Valley and Forest of Dean Bat Sites SAC	The Wye Valley and Forest of Dean Bat Sites SAC contains the greatest concentration of lesser horseshoe bat <i>Rhinolophus hipposideros</i> in the UK, with 26% of the national population present. The importance of the site lies in the excellent breeding population and most sites on the complex are maternity roosts. There is also a population of greater horseshoe bats <i>Rhinolophus ferrumequinum</i> present and the site contains the main maternity roost for bats in the area. The bats are believed to hibernate in many of the disused mines in the area.	22 km west
Crickley Hill and Barrow Wake SSSI (comprising Crickley Hill and Barrow Wake Nature Reserve)	Within the Cotswolds ANOB, the Crickley Hill and Barrow Wake SSSI comprises two sites; Crickley Hill and Barrow Wake Nature Reserve. Both of which are co-owned and managed by Gloucestershire Wildlife Trust and the National Trust). The site contains a range of habitats characteristic of the Cotswold limestone, including species rich grassland, scrub and semi-natural woodland, together with nationally important rock exposures. Several types of grassland are present and feature many calcicole herbs including clustered bellflower <i>Campanula glomerata</i> and chalk milkwort <i>Polygala calcarea</i> and several orchids, with the notable musk orchid <i>Herminium monorchis</i> locally frequent. The diversity of vegetation provides habitat for a variety of invertebrates including the marsh fritillary <i>Eurodryas aurinia</i> , the notable cistus forester moth <i>Adscita geryon</i> and the very local snail <i>Abide secale</i> .	Within
Knap House Quarry, Birdlip SSSI	Knap House Quarry, Birdlip SSSI consists of a disused quarry in woodland about 400 m north of the village of Birdlip. It provides important exposures of Middle Jurassic sediments belonging to the Aalenian and Bajocian Stages. These exposures are of national importance for the understanding of Middle Jurassic stratigraphy, palaeogeography and tectonics in Britain.	170m west
Bushley Muzzard, Brimpsfield SSSI	The Bushley Muzzard, Brimpsfield SSSI is one of a small number of marshes in the Cotswolds and is of particular importance for its species richness and uncommon plant species. Dominant plant species are jointed rush <i>Juncus articulatus</i> , hard rush <i>J. inflexus</i> and Yorkshire fog <i>Holcus lanatus</i> . There are eight species of sedge present, including the scarce yellow sedge <i>Carex lepidocarpa</i> . There are also a number of orchid species including early marsh orchid <i>Dactylorhiza incarnata</i> and hybrid marsh orchids <i>D. fuchsii</i> x <i>incarnata</i> and <i>D. fuchsii</i> x <i>pratensis</i> . Unimproved calcareous permanent pasture surrounds the marsh areas.	185m west
Cotswold Commons and Beechwoods SSSI	The importance of the Cotswold Commons and Beechwoods SSSI lies in the ancient beech woodlands which are among the most diverse and species-rich of their type. The canopy is dominated by beech <i>Fagus sylvatica</i> with an understory of holly <i>Ilex aquifolium</i> and yew <i>Taxus bacata</i> . The field layer consists mainly of bramble	260m west

Site	Reasons for Designation	Distance from proposed scheme
	<i>Rubus fruticosus</i> , dog's mercury <i>Mercurialis perennis</i> and ivy <i>Hedera helix</i> . A number of nationally rare plants also occur, including fingered sedge <i>Carex digitata</i> , wood barley <i>Hordeum europaeus</i> and stinking hellebore <i>Helleborus foetidus</i> . There are also areas of wet woodland, mixed conifer and broadleaved plantation and hazel <i>Corylus avellana</i> coppice as well as unimproved calcareous pastures. Several nationally rare terrestrial snails are present in the ancient woodland sites including <i>Ena montana</i> and <i>Phenocolimax major</i> . Some disused limestone mines within the notified area are used as winter roosts by several bat species.	
Leckhampton Hill and Charlton Kings Common SSSI	A range of habitats are present including unimproved calcareous grassland, scrub, woodland, scree slopes and cliff faces. The most important and extensive feature is the grassland. This mainly consists of a tall ungrazed sward dominated by tor-grass <i>Brachypodium pinnatum</i> and upright brome <i>Bromus erectus</i> with meadow oat-grass <i>Avenula pratensis</i> , sweet vernal-grass <i>Anthoxanthum odoratum</i> , and quaking grass <i>Briza media</i> . Herb species present include salad burnet <i>Sanguisorba minor</i> , common rock-rose <i>Helianthemum nummularium</i> and common bird's-foot-trefoil <i>Lotus corniculatus</i> . There is extensive scrub development over parts of the site. Two principal types of scrub may be distinguished: mixed broadleaf scrub dominated by hawthorn <i>Crataegus monogyna</i> with blackthorn <i>Prunus spinosa</i> and wild rose <i>Rosa sp.</i> ; and gorse scrub consisting of gorse <i>Ulex europaeus</i> with occasional pockets of ash <i>Fraxinus excelsior</i> regeneration.	1.65 km north-east

### Non-Statutory Designations

- 8.6.7 There are 18 non-statutory sites within the two kilometres search area. These are Local Wildlife Reserves (LWR), Key Wildlife Sites (KWS) and potential KWSs (Gloucestershire County Council and Gloucestershire Centre for Environmental Records refer to Local Wildlife Sites as Key Wildlife Sites and they will be referred to as such throughout this report).
- 8.6.8 The non-statutory sites are summarised in Table 8-6. Figure 8.2 shows the location of these sites in relation to the proposed scheme.

**Table 8-6 Non-Statutory Designated Sites Within a Two Kilometre Search Area**

Site	Reasons for designation	Distance from proposed scheme
Barrow Wake Gloucestershire Wildlife Trust Reserve LWR	A site containing herb-rich calcareous grassland where five species of orchid have been recorded.	Adjacent/within boundary
Crickley Hill Country Park Gloucestershire Wildlife Trust Reserve LWR	A large heterogeneous area of species-rich limestone grassland of varying slope and aspect, scrub and semi-natural woodland.	Adjacent/within boundary
Haroldstone Fields (Crickley Hill) Potential KSW	Mosaic neutral and calcareous grassland.	Adjacent/within boundary
Bushley Muzzard,	A site containing rough grassland, tall herbs, scrub, ponds, wetland and dead/veteran trees.	Adjacent/within boundary



Site	Reasons for designation	Distance from proposed scheme
Bentham, Dog Lane Fields Potential KSW		
Coldwell Bottom KWS	Contains calcareous semi-natural grassland.	Adjacent/within boundary
Ullen Woods KWS	Ancient semi-natural broad-leaved woodland sites larger than 2 ha.	Adjacent/within boundary
River Frome Mainstream and Tributaries KWS	Structural diversity with significant botanical and animal interest with a variety of bankside, emergent and aquatic vegetation. Riparian mammals and white-clawed crayfish are present.	20m south
Cowley and Wards Woods KWS	Ancient semi-natural broad-leaved woodland sites larger than 2 ha.	138m east
Hawcote Hill Wood KWS	Ancient semi-natural broad-leaved woodland sites larger than 2 ha.	250m south-west
Birdlip (Hawcote Hill) Conservation Road Verge	The verges are narrow banked with mixed hedgerows along about 250m, both sides of a minor road. Flora includes field scabious <i>Knautia arvensis</i> , wild basil <i>Clinopodium vulgare</i> , salad burnet <i>Sanguisorba minor</i> , restharrow <i>Ononis repens</i> & greater knapweed <i>Centaurea scabiosa</i> . Meadow crane's-bill <i>Geranium pratense</i> (criteria 4 species) is also abundant.	382m south
Poston, Syde and Ostrich Woods KWS	Ancient semi-natural broad-leaved woodland sites larger than 2 ha.	556m south-west
Little Bittomes KWS	A site of invertebrate interest.	577m west
Park Wood (Brimpsfield) KWS	Ancient semi-natural broad-leaved woodland sites larger than 2 ha.	596m south
Witcombe Reservoirs KWS	Contains lakes, reservoirs and gravel pits of importance, all of which are larger than 0.25 ha.	1 km south-west
Gorveridge Banks KWS	Contains unimproved and semi-natural grassland.	1.1 km south-west
Stonehill Valley KWS	Contains unimproved and semi-natural grassland.	1.4 km south-west
Orchard Meadow Potential KSW	An area of damp neutral grassland.	1.4 km south-west
Ostrich Bank Potential KSW	An area of herb rich calcareous grassland and scrubby calcareous grassland.	1.7 km south

8.6.9 Key Wildlife Sites include five Ancient Woodland Sites within 1 km of the proposed scheme boundary as shown in the table above. However, not all of these woodlands are recognised on Natural England's Ancient Woodland Inventory which may be due to the size threshold of 2 ha to be included. Ancient Woodland sites recognised on Natural England's Ancient Woodland Inventory within 1km are showing in Table 8-7.

**Table 8-7 Ancient Woodland within a one kilometre search area**

Site	Distance from proposed scheme boundary
Ullen Wood	The western tip of the woodland is within the proposed scheme boundary.
Cowley/Wards Woods	138m east
Witcombe and Buckle Wood	310m west

Site	Distance from proposed scheme boundary
Park Wood	596m south
Poston/Syde/Ostrich Woods	556m south-west

### Phase 1 Habitat Survey

- 8.6.9 Much of the proposed scheme passes through arable land, improved grassland, limited areas of unimproved and semi-improved calcareous grassland, areas of broadleaved woodland, scrub, scattered trees and tree lines, and species rich hedgerows.
- 8.6.10 All habitats surveyed within the ZoI are described below using information from the Preliminary Ecological Appraisal (2017)<sup>82</sup> and are indicated on the Phase 1 Habitat Map included in figure 8.3.

#### Semi-Natural Broadleaved Woodland

- 8.6.11 There are a number of areas of semi-natural broadleaved woodland within the study area, ranging from small copses such as Emma's Grove immediately to the east of the A417 by the Air Balloon roundabout, to large areas of continuous woodland, such as Whitcombe Wood which forms part of the Cotswolds Beechwoods SAC/SSSI to the west of the existing A417. A number of the woodlands within the study area are considered to be Ancient Semi-Natural Broadleaved Woodland including Hawcote Copse, Whitcombe Wood and Ullen Wood. Additionally, Emma's Grove, although not recorded in the Ancient Woodland Inventory, is notable for supporting a number of ancient woodland indicator species including herb Paris *Paris quadrifolia*, wild garlic *Allium ursinum*, pignut *Conopodium majus*, woodruff *Galium odoratum*, bluebell *Hyacinthoides non-scripta* and dog's mercury *Mercurialis perennis*. The majority of the woodlands are dominated by canopy trees, with less developed understorey, except around the woodland margins. Species present include ash *Fraxinus excelsior*, beech *Fagus sylvatica*, pedunculate oak *Quercus robur*, sycamore *Acer pseudoplatanus*, silver birch *Betula pendula*, hazel *Corylus avellana*, elder *Sambucus nigra*, hawthorn *Crataegus monogyna*, blackthorn *Prunus spinosa*, field maple *Acer campestre*, wayfaring tree *Viburnum lantana*, horse chesnut *Aesculus hippocastanum*, hornbeam *Carpinus betulus* wild privet *Ligustrum vulgare* and yew *Taxus baccata*.

#### Plantation Woodland

- 8.6.12 Plantation woodland is present within a number of areas throughout the study area. This includes an extensive area of plantation broadleaved woodland to the west of Barrow Wake comprising ash, wild cherry *Prunus avium*, pedunculate oak, field maple and lime *Tilia* species. A large area of mixed plantation woodland is present within the Clay Hill plantation, comprising a mix of ash, beech, guelder rose *Viburnum opulus*, hazel, hawthorn, blackthorn, lime, wild privet, gogwood *Cornus sanguinea*, Norway spruce *Picea abies*, cedar *sp.*, and Scot's pine *Pinus sylvestris*. Additional areas are covered with coniferous plantation woodland with species such as western red cedar *Thuja plicata*, European larch *Larix decidua* and spruce *Picea* species. Plantation woodland is present along the existing highways verge in a number of locations. These are generally composed of a

<sup>82</sup> Mott MacDonald Sweco Joint Venture, "A417 Missing Link at Air Balloon, PCF1 Preliminary Ecological Appraisal", 2017.

standard highways mix of species including hawthorn, hazel, whitebeam *Sorbus aria*, guelder rose, wayfaring tree, hawthorn, dogwood and field maple.

#### Scattered Broadleaved Trees

- 8.6.13 A number of scattered broadleaved trees are present in the study area, associated with defunct field boundaries, or areas of parkland landscape. A number of these trees are ancient supporting significant cavities, and both standing and fallen deadwood. Species present include ash and pedunculate oak.

#### Scrub

- 8.6.14 Areas of dense and scattered scrub are widespread, in particularly to the west of Barrow Wake SSSI where scrub is encroaching on areas of grassland. Such areas are generally being colonised by hawthorn, blackthorn, bramble *Rubus fruticosus* agg, traveller's joy *Clematis vitalba*, hogweed *Heracleum mantegazzianum* and various ruderal herbs including common nettle *Urtica dioica* and willowherbs *Epilobium* sp. The steep slopes at Barrow Wake SSSI are locally being encroached by scrub and scrub encroachment is present in a number of the less intensively managed fields throughout the study area.

#### Unimproved Calcareous Grassland

- 8.6.15 Areas of unimproved calcareous grassland are present within Crickley Hill and Barrow Wake SSSI (comprising Crickley Hill and Barrow Wake Nature Reserve) which includes species-rich grasslands dominated by calcareous species including tor-grass *Brachypodium pinnatum*, upright brome *Bromus erectus*, salad burnett *Sanguisorba minor*, yellow wort *Blackstonia perfoliate*, small scabious *Scabiosa columbaria*, clustered bellflower *Campanula glomerate*, chalk milkwort *Polygala calcarean*, carline thistle *Carlina vulgaris*, common rock rose *Helianthemum nummularium*, ladies bedstraw *Galium verum* and burnet saxifrage *Pimpinella saxifrage*. Orchid species are frequent including early-purple orchid *Orchis mascula* and bee orchid *Ophrys apifera* with the notable musk orchid *Herminium monorchis* locally frequent. The areas of unimproved grassland are all located within the boundaries of the SSSI.

#### Semi-improved Calcareous Grassland

- 8.6.16 Semi-improved calcareous grassland is present within a number of areas in the study area. These areas are species rich but less diverse than the unimproved grasslands. Upright brome is locally abundant in these areas, along with a mix of herbs typical of calcareous grassland habitats including ladies' bedstraw, yellow wort, common rock-rose and salad burnet. Common spotted orchid *Dactylorhiza fuchsia* and pyramidal orchid *Anacamptis pyramidalis* was recorded in a number of areas supporting this habitat. Locally frequent ant hills were present indicating lack of recent management of these areas of grassland. Additionally, areas of the existing highways verge are locally species rich with occasional calcareous indicators and a number of orchids including scattered common spotted and pyramidal orchids.

#### Semi-improved Species-Poor Grassland

- 8.6.17 Areas of semi-improved species poor grassland are frequent throughout the study area including areas of low intensity grazing, hay meadows and highways verges. These grasslands are typically dominated by grasses including false oat grass

*Arrhenatherum elatius*, sweet vernal *Anthoxanthum odoratum*, red fescue *festuca rubra*, Yorkshire fog *Holcus lanatus*, and cock's-foot *Dactylis glomerata*, together with scattered herbs including field wood rush *Luzula campestris*, common sorrel *Rumex acetosa*, cuckoo flower *Cardamine pratensis*, lesser celandine *Ficaria verna*, meadow vetchling *Lathyrus pratensis*, ribwort plantain *Plantago lanceolata*, selfheal *Prunella vulgaris*, barren strawberry *Potentilla sterilis*, creeping thistle *Cirsium arvense*, and crosswort *Galium cruciata*. Whilst these areas of grassland are generally of low diversity, small areas are locally herb rich.

#### Improved Grassland

- 8.6.18 A number of large fields of agriculturally improved grassland are present across the study area. These grasslands have a low diversity being typically dominated by perennial rye-grass *Lolium perenne*. These areas of grassland are largely sheep grazed pastures.

#### Marshy Grassland

- 8.6.19 Marshy grassland is rare within the study area due to the free draining nature of the local geology. A small number of areas of marshy grassland are present, notably within Bushley Muzzard, Brimpsfield SSSI where narrow areas of marshy grassland are present along spring lines with jointed rush *Juncus articulatus*, hard rush *Juncus inflexus* and eight species of sedge, including the scarce yellow sedge *Carex lepidocarpa*. There are a number of orchid species including early marsh orchid *Dactylorhiza incarnata* and hybrid marsh orchids *Dactylorhiza fuchsii x incarnata* and *Dactylorhiza fuchsii x pratermissa*. A second area of marshy grassland is present south of Shab Hill Farm with cuckoo flower *Cardamine pratensis*, soft rush *Juncus effusus*, common spotted orchid, willow herb, marsh thistle *Cirsium palustre*, and lesser celandine.

#### Hedgerows

- 8.6.20 Hedgerows are present throughout the study area, with the land to the west of Barrow Wake SSSI typically comprising more enclosed field systems and the area to the east of the A417 being more open and subject to more intensive agricultural management.
- 8.6.21 The hedgerows are generally dominated by hawthorn and blackthorn, with field maple and occasional standard trees including ash and pedunculate oak. A number of species-rich hedgerows are present with additional species such as hazel, wild privet, wayfaring tree, dog rose *Rosa canina*, and elder. The hedgerows range from heavily managed and regularly cut, to unmanaged.
- 8.6.22 Hedgerows are often associated with defunct dry-stone walls, where these features have been taken over by shrub and tree species. Some areas to the east of the A417 support intact drystone walls.
- 8.6.23 At least 22 intact species-rich hedgerows or species-rich hedgerows with trees are present throughout the study area as shown in the Phase 1 Habitat Survey Map. Several of these are within the scheme boundary of the proposed scheme and will be directly affected as a result of the proposed scheme.

### Standing Water

- 8.6.24 A total of 29 ponds have been identified as part of the 2017 Preliminary Ecological Appraisal (2017<sup>83</sup>) from Ordnance Survey Mapping within the study area along with numerous springs and wells. The majority of ponds and springs which were accessible were found to be dry at the time of survey. However, a number of ponds with standing water were identified with aquatic and emergent species including species such as mint *Mentha aquatica*, soft rush *Juncus effusus*, floating sweetgrass *Glyceria fluitans*, and Meadowsweet *Filipendula ulmaria*. Additional ponds were found since the 2017 Preliminary Ecological Appraisal, and have been reported upon under the great crested newt section.

### Running Water

- 8.6.25 The limestone geology of the area means that wet ditches and streams are sparse. There are a number of spring lines which were dry at the time of survey and appear to only be seasonally wet. A tributary of Norman's Brook is located within the woodland along the westbound A417 running from the Air Balloon roundabout towards Gloucester. This watercourse is spring fed and is heavily shaded by woodland throughout the length of the proposed scheme. The stream disappears under culverts in several places through the woodland.
- 8.6.26 A small tributary of the River Frome is located around Brimpsfield Park, associated with a number of ponds along the tributary.

### **Phase 2 surveys**

- 8.6.27 A number of Phase 2 surveys have been carried out during 2018 and 2019 and some are still underway at the time of writing this PEI Report. Although a number of reports are not available at this time, interim results have been provided, and full results along with methodologies and any limitations will be incorporated into the ES.

### **Habitats**

- 8.6.28 Hedgerow surveys to assess their importance in accordance with the Hedgerow Regulations (1997) were undertaken in June 2019. Of the 31 hedgerows surveyed in this study, 13 were deemed to be important under the Hedgerow Regulations 1997. Full results will be included in the ES.
- 8.6.29 Detailed botanical (National Vegetation Classification) surveys for woodlands and calcareous grasslands, as well as River Habitat Survey and tufa springs surveys are also being undertaken at the time of writing and full results will be included in the ES.

### **Bat surveys**

#### Desk study

- 8.6.30 The 2017 desk study identified the presence of seven species of bat within 2km of the study area including common pipistrelle *Pipistrellus pipistrellus*; whiskered/Brandt's bat *Myotis mystacinus / brandtii*; Natterer's bat *Myotis nattereri*; noctule *Nyctalus noctula*; brown long-eared *Plecotus auritus*; greater

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<sup>83</sup> Mott MacDonald Sweco Joint Venture, "A417 Missing Link at Air Balloon, PCF1 Preliminary Ecological Appraisal", 2017.

horseshoe *Rhinolophus ferrumequinum* and lesser horseshoe *Rhinolophus hipposideros*.

### Field Surveys Overview

- 8.6.31 Buildings and trees within 100m of options 12 and 30 were surveyed for their potential to support roosting bats in summer 2018. Emergence / re-entry surveys were conducted within 100m of the proposed scheme alignment for high potential buildings and trees (three visits), within 20m for moderate potential buildings and trees (two visits) and finally, where a low potential building was directly impacted by the proposed scheme (i.e. within the construction footprint, one visit). These surveys took place between June to October 2018 and some are still ongoing to account for the early part of the bat active season or where access was not possible.
- 8.6.32 Aerial inspections of trees using rope access, bat activity transect surveys and static monitoring also commenced in summer 2018 and are continuing in 2019.

### *Tree Surveys*

- 8.6.33 Ground level tree assessments were undertaken within 100m of options 12 and 30 in summer 2018. 37 trees were noted as having high potential, 74 trees with moderate potential and 86 trees with low potential. Tree climbing (aerial) surveys for bats are ongoing.
- 8.6.34 Trees 33 & 63 were identified as common pipistrelle day roosts, tree 63 was identified as a *Myotis* sp. day roost and tree 24 as a day roost for an unknown species. Surveys are ongoing and full results will be available at a later date and provided in the ES.

### *Building Surveys*

- 8.6.35 The 2006 Stage 2 assessment identified four bat roosts within buildings including the Air Balloon pub (pipistrelle *Pipistrellus* species); Barrow Wake House (brown long-eared); Crickley Hill Farmhouse (brown long-eared); and Pinewood (pipistrelle species). As a result of the 2018 building assessments, 21 buildings were noted as having high potential, 30 buildings with moderate roosting potential and 30 building with low bat roosting potential.
- 8.6.36 Dusk emergence and dawn re-entry surveys were undertaken between June and October 2018. 13 buildings were identified to have evidence of roosting bats as shown in Table 8-8 below. Surveys are ongoing and full results will be provided in the ES.

**Table 8-8 Bat Roosts within Buildings (Interim Results)**

<b>Roost Status</b>	<b>Building numbers</b>	<b>Species</b>
Confirmed day roost	9, 15, 21, 31 32, 33, 38, 44 60, 66, 68, 81 82, 84, 91, 16b, 8a and 8b	Common pipistrelle
Confirmed day roost	20, 21 and 32	<i>Myotis</i> sp.
Confirmed day roost	84 and 60b	Lesser horseshoe bat
Confirmed day roost	8a	Brown long-eared bat

Roost Status	Building numbers	Species
Confirmed maternity roost	80	Common pipistrelle
Confirmed night roost	14	<i>Myotis</i> sp.
Likely mating site	91	<i>Myotis</i> sp.

### *Hibernation Surveys*

- 8.6.36 Surveys were undertaken of buildings and other structures identified as suitable for hibernation roosts within 100m of options 12 and 30. The survey area was extended beyond the 100m buffer where highly suitable features had been highlighted, including caves around Birdlip and deep rock fissures along Crickley Hill. Surveys were undertaken between January and February 2019 (access in December 2018 not possible). Surveys included internal inspections where possible and deployment of static detectors for two-week periods in January and February 2019. Results confirmed lesser horseshoe bats hibernating in Crickley Hill rock fissures (numbers not known) and within the Birdlip Royal George Cave (maximum count of 13 lesser horseshoes – more bats likely to be present in inaccessible areas).

### *Bat Activity Transect Surveys*

- 8.6.37 Using the phase 1 habitat survey information collected in 2017 and aerial imagery, seven transect routes were designed to provide adequate coverage (where access allowed) to all suitable bat foraging and commuting habitat within 250m of the proposed scheme boundary. Dusk activity transect surveys commenced in June 2018 and continued monthly until October 2018. July transects were completed as dusk/dawn surveys within 24 hours. Ten species of bat were recorded in this time, including barbastelle, lesser horseshoe and greater horseshoe bats. Further transect surveys are being carried out in April and May 2019 to account for the early part of the bat activity season, and further into the summer for those where access was not possible in 2018. Transect route maps and detailed results will be included in the ES.

### *Automated Detector Surveys*

- 8.6.38 Three full spectrum Wildlife Acoustics SM4 automated detectors (referred to as static detectors) were installed for each of the 7 transects (21 static sites) and were deployed for five continuous days a month from June to October 2018. Eleven species of bat were recorded in this time, including barbastelle, Nathusius' pipistrelle *Pipistrellus nathusii*, lesser horseshoe and greater horseshoe bats. Static deployment will continue in April and May 2019 to cover the full UK bat active period, and further into the summer to account for some equipment failures in 2018. Full details of results will be included in the ES.
- 8.6.39 Further bat surveys in the form of bat trapping and radio tracking are being undertaken during the 2019 survey season and the full results will be included in the ES. At the time of writing, emerging results from the July 2019 bat trapping include the trapping and tracking of a male Bechstein's, a male barbastelle, a male lesser horseshoe and a lactating female lesser horseshoe.

### *Bat Crossing Point Surveys*

- 8.6.40 Bat crossing point surveys commenced in late June 2019 and are based on the standard guidance by J. Altringham & A. Berthoussen (2015) *WC1060 Development of a cost-effective method for monitoring the effectiveness of*

*mitigation for bats crossing linear transport infrastructure, which was adapted for pre-construction surveys. The basic survey consists of visual observations of bats at a mitigation site over a minimum of 60 min periods at dusk or dawn (this was extended to 90min for this proposed scheme due to the presence of barbastelle and other late emerging species such as horseshoes.*

- 8.6.41 Following a review of the data gathered during the 2018 bat activity transect surveys, nine bat crossing point locations were chosen along the proposed scheme alignment. A minimum of six surveys will be carried out at each of these locations between June and September 2019 and should be repeated at the same time each year before, during and after construction of the proposed scheme.

### **Badger survey**

#### Desk study

- 8.6.42 Five badger records were returned within 2km of the route options in the 2017 desk study.

#### Field surveys

- 8.6.43 Four main areas of badger activity and associated setts were identified during the 2006 WPS Stage 2 assessment, at Crickley Hill; Barrow Wake; Ullen Wood and Nettleton Bottom. During the 2017 Phase 1 survey, a single badger outlier sett was recorded.
- 8.6.44 Incidental findings of badger activity were recorded during the Stage 2 ecology surveys in 2018. Targeted badger walkover surveys were undertaken (where access allowed) during January and February 2019 within 500m of the route corridor of option 30. During these surveys, five active main setts, three active outlier setts, two disused subsidiary setts and two active subsidiary setts were identified. Badger bait marking surveys of the five active main setts were undertaken in March and April 2019. These surveys confirmed badger activity within the study area. Fresh latrines were found for each sett throughout the survey period. Full details of these surveys and results will be provided in the ES.

### **Bird surveys**

#### Desk study

- 8.6.45 The 2006 Stage 2 assessments identified a range of common breeding birds, nine Red List Species of High Conservation Concern and 14 Amber List Species of Medium Conservation Concern.
- 8.6.46 The 2017 desk study identified a range of breeding birds within the study area including a number of Red and Amber listed species of conservation concern and Schedule 1 species including barn owl.

#### Field Surveys

##### *Breeding Bird Survey*

- 8.6.47 Targeted breeding bird surveys within 250m of the proposed scheme boundary were carried out between April and June 2019. A total of six surveys were completed, in accordance with the Common Bird Census (CBC) and Royal



Society for the Protection of Birds (RSPB) survey guidance<sup>84</sup>. The arable fields and their margins were found to hold in places a high density of breeding territories of seed-eating species including skylark, linnet and yellowhammer. Woodlands and other areas with trees were found to hold species of conservation concern such as marsh tit, song thrush, mistle thrush and bullfinch. Full details of these surveys and results will be provided in the ES.

#### *Wintering bird Survey*

- 8.6.48 A total of five surveys were undertaken between October 2018 and February 2019 within 250m either side of the route corridor (option 30 and option 12). Key findings include Shab Hill area and arable land to the south-east. Surveys indicated good numbers of wintering birds including six yellowhammer (BTO Red List<sup>85</sup>), 167 common gull (BTO Amber List), 75 golden plover, 85 lapwing (BTO Red List), 375 fieldfare (BTO Red List) and 245 redwing (BTO Red List). Full details of these surveys and results will be provided in the ES.

#### *Barn owl survey*

- 8.6.49 Barn owl was confirmed to be present in the study area including breeding roosts in Ullen Wood and barn owl roosts recorded in two mature oaks in other areas of the site during the 2006 Stage 2 assessments.
- 8.6.50 Stage 1 & 2 habitat and potential nest identification surveys within 1.5km of the proposed scheme boundary were completed in May 2019. Large areas of suitable type 1 & 2 habitat were noted at Shab Hill, FlyUp bike park & Crickley Hill/Bentham area. Evidence of barn owl roosts was found at FlyUp bike park & Little Witcombe. Over 50 potential nest sites were noted across the scheme. Stage 3 nest verification surveys are underway at the time of writing (July and early August 2019) and full details will be provided in the ES.

### **Dormouse survey**

#### Desk study

- 8.6.51 No records of dormouse were returned in the 2017 desk study.

#### Field surveys

- 8.6.52 Suitable habitat for dormice is present at the site. Broadleaved woodland at the site generally have poor understorey which is not optimal for dormice, but the woodland margins provide diverse structure and species diversity providing more suitable habitat. A number of areas of mixed plantation woodland provide suitable habitat as well as a network of hedgerows providing valuable linking habitat to the wider landscape.
- 8.6.53 Habitat suitable for dormouse (identified during the Phase 1 Habitat survey and a desktop study) were subject to presence absence surveys using nest tubes during July to October 2018. Thirteen sites in total were surveyed, with 50 or more tubes deployed at each site. No dormice were identified during these surveys, however potential, but not confirmed dormouse nests were found at five

<sup>84</sup> Gilbert, G., Gibbons, D. W. and Evans, J. (1998) *Bird Monitoring Methods: A Manual of Techniques Used for Key UK Species*. The Royal Society for the Protection of Birds, Sandy, Bedfordshire.

<sup>85</sup> The British Ornithological Society (BTO) red, amber and green list provides information about the population status of birds in the UK, based on their conservation concern (for further details see <https://www.bto.org/our-science/publications/psob>)

sites. At the time of writing, all sites required further effort in 2019 to complete the survey programme in line with guidance. These surveys are ongoing, and full results will be included in the ES.

## Great Crested Newts

### Desk study

- 8.6.54 Four records of great crested newt were returned in the 2017 desk study, all of which are in the Bentham area approximately 500m north of the existing A417.

### Field surveys

- 8.6.55 The 2006 Stage 2 Assessment undertook detailed surveys of three ponds. No evidence of great crested newt (GCN) was identified during these surveys.
- 8.6.56 All ponds within 500m of the route options 12 and 30 were assessed for their potential to support GCN. Forty ponds were identified to require Habitat Suitability Index (HSI) surveys for GCN. HSI and eDNA surveys were undertaken during May to July 2018. Due to access, HSI surveys were undertaken at 35 of these ponds and from these, ten ponds (with a HSI score of 0.5 or more) were subject to eDNA surveys. Eight ponds returned a eDNA score of negative, whilst two ponds (Pond 15 and Pond 26a) returned a positive eDNA result. In addition, a known medium meta population of GCN are located within three ponds at Bentham Green Space to the north-west of the current A417. These ponds are over 500m from the proposed scheme boundary and have not been surveyed. Full details and maps of these results will be included in the ES.

## Reptile survey

### Desk study

- 8.6.57 The 2017 desk study returned records of common lizard, slow worm, adder *Vipera berus* and grass snake within 2km of the route options 12 and 30. The closest reptile record is showing as an adder approximately 93m north. Full details will be included within the survey reports to be appended to the ES.
- 8.6.58 Personal communications<sup>86</sup> with Gloucester Wildlife Trust indicate that adders are present within Crickley Hill SSSI.

### Field surveys

- 8.6.59 The 2006 Stage 2 Assessment identified populations of common lizard *Zootoca vivipara* and slow worm *Anguis fragilis* at two sites within the study area.
- 8.6.60 Twenty-two reptile surveys sites were identified within 100m of either side of the route options' corridor (option 30 and option 12) during the phase 1 habitat survey in 2017. Of the 22 sites assessed, seven were considered to be of high potential, 11 medium potential and three low potential to support reptiles. From this presence / absence reptile surveys (artificial refuge search) were conducted at all medium to high potential sites (18 in total) through June to October 2018.
- 8.6.61 Reptiles were identified at 17 of 18 sites surveyed. Species identified included adder, grass snake, slow worm and common lizard. From these 17 sites, 12 sites

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<sup>86</sup> Gareth Parry, Gloucester Wildlife Trust, 18<sup>th</sup> June 2019

require further surveys in 2019, so that 10 separate site visits are achieved. Where reptile populations are identified and are likely to be impacted by the proposed scheme, population estimate surveys are being completed, increasing the number of surveys undertaken on each positive site to 20. In addition, during the surveys, four sites were heavily mowed following the survey set up, resulting in them having unsuitable habitat to support reptiles during the survey period. Due to local records for adder and incidental sightings during the ecology surveys during 2018, seven adder survey sites were set up in March 2019 to gain a greater understanding of the adder population. The surveys at these sites are ongoing. Full details of the results will be included in the ES.

### **Otter survey**

#### Desk study

- 8.6.62 A single otter record from 2015 was identified in the 2017 desk study from a residential garden near Horsbere brook approximately 800m south-west of the site. Otters are also known to be present in the River Frome Catchment.

#### Field surveys

- 8.6.63 No signs of otter were identified during the 2006 Stage 2 assessment. Where access allowed, habitat suitability and field sign surveys for otter were undertaken within 2km of the proposed scheme options in 2018. An unnamed tributary of the River Frome; located in Brimpsfield Park, and Horsbere Brook; running through Little Witcombe, were surveyed in August and September 2018. Recent otter spraints were found in Brimpsfield Park. No evidence of otter was found along Horsbere Brook. Additional surveys were undertaken in 2019 and confirmed the presence of otters along the Upper Frome. No evidence of otter was recorded along any of the other watercourses. Full details of the results will be included in the ES.

### **Water Voles**

#### Desk study

- 8.6.64 No signs of water vole were identified during the 2006 Stage 2 assessment. No records of water vole were returned in the 2017 desk study.

#### Field survey

- 8.6.65 Where access allowed, habitat suitability and field sign surveys for water voles was undertaken along watercourses within 250m of options 30 and 12 in 2018. Possible but inconclusive evidence of water vole (outside of the 250m buffer) were found in Brimpsfield Park. Field surveys carried out in August 2018 and May 2019 recorded no evidence of water vole along Norman's Brook or the River Frome. Full details of the results will be included in the ES.

### **White-clawed crayfish**

#### Desk Study

- 8.6.66 The data search as part of this assessment returned records for white-clawed crayfish *Austropotamobius pallipes* in the upper catchment of the River Frome as well as within streams of the Cotswolds Beechwood SAC.

### Field survey

- 8.6.67 The phase 1 habitat survey conducted during 2017 assessed habitat suitability for White-clawed Crayfish (WCC) for all watercourses that bisected the options' route corridor. From this, presence / absence surveys for WCC were undertaken during October 2018 (hand searches and baited trapping) at Norman's Brook and in the River Frome Upper Tributaries. WCC were found to be absent at both watercourses during these surveys. Full details of results and those of any further surveys carried out will be included in the ES.

### **Other Invertebrates**

#### Field study

- 8.6.68 It is recognised that the ancient woodland habitat with veteran trees and calcareous grassland habitat provide excellent invertebrate habitat, including for Roman snails. Targeted terrestrial invertebrate surveys commenced in June 2019 and are currently being undertaken in key habitat locations which are considered to be affected by the proposed scheme.
- 8.6.69 With the exception of a white-clawed crayfish survey undertaken in October 2018, no other aquatic invertebrate surveys have been undertaken to date. Due to the potential for ecological effects on watercourses within or connected to the study area, aquatic invertebrate surveys are in the process of being commissioned. Full details of results will be included in the ES.

### **Future Baseline**

- 8.6.70 The ecological baseline conditions described above represent those which currently exist in the absence of the proposed scheme and at the time of writing. As stated in section 3 of the CIEEM guidelines<sup>87</sup>, potential changes in baseline conditions also need to be identified in order to assess impacts.
- 8.6.71 Based on the above information and current land use, the future baseline in the absence of the proposed scheme is unlikely to change significantly by 2039. Subtle changes are expected due to climate change, such as some movements of certain species and local population changes, however the overall habitats and species composition in the study area are expected to be broadly similar to that of the existing baseline.

## **8.7 Consultation**

- 8.7.1 Informal statutory and non-statutory consultations have been undertaken during the options selection stage.
- 8.7.2 Ecologists have been involved in discussion and Technical Working Groups (TWGs) regarding the shared Landscape vision for the proposed scheme and more detailed design with regard to the green bridge, infrastructure crossings and ecological networks with the Gloucestershire Wildlife Trust, the National Trust, the Environment Agency, Natural England and Historic England.

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<sup>87</sup> Chartered Institute of Ecology and Environmental Management, "Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal, 2nd edition," Winchester, 2016.

- 8.7.3 The first of a more formal biodiversity focussed TWG took place on the 2<sup>nd</sup> of July with two further TWG meetings planned for later in July and August 2019.
- 8.7.4 Further details on the ongoing consultation relating to biodiversity will be provided in the ES accompanying DCO application.

## 8.8 Assessment Assumptions and Limitations

- 8.8.1 The findings presented in this PEI Report chapter represent those available at the time writing and data collected to date.
- 8.8.2 Ecological surveys are limited by factors that affect the presence of plants and animals, such as the time of year, migration patterns and behaviour.
- 8.8.3 As stated in the PEI Report chapter, many of the specific Phase 2 species and habitat surveys are ongoing and detailed results therefore not included in this PEI Report. Specific limitations and assumptions will be provided in the associated baseline reports to be included within the ES.
- 8.8.4 Nevertheless, surveys undertaken to date were largely conducted at the optimal survey periods and using standard methodologies accepted by Natural England and other statutory bodies, with the main constraint to date being land access. The interim results of the ecological surveys carried out to date allow for some limited evaluation of nature conservation value. However, a full assessment of the significance of potential impacts that may arise from the proposal and consideration of appropriate mitigation measures will be further detailed in the ES.
- 8.8.5 Every effort will be made to ensure that the findings of the study present as accurate an interpretation as possible of the status of flora and fauna within the study area.
- 8.8.6 General gaps and uncertainties within this chapter are detailed within Table 8-9.

**Table 8-9 Gaps and Uncertainties**

Gaps and Uncertainties	Description
Most Phase 2 survey reports are in the process of being written up, and therefore details of methodologies, limitations, results or figures are not included in this PEI Report.	All baseline reports and their associated figures are in draft form and are subject to minor change. These changes, as well as the full baseline reports, will be detailed in the ES.
Certain Phase 2 species surveys are commencing or being completed in the 2019 survey season. These results will be available by Autumn 2019 and will be included in the ES.	<p>The final results including presence, absence or locations are not yet known for dormice, adder populations, confirmed barn owl roost sites, and confirmed bat roosts.</p> <p>Hedgerow surveys were completed very recently (late June 2019) to provide information on important hedgerows to be assessed in accordance with the Hedgerow Regulations 1992.</p> <p>Bat trapping and radio-tracking surveys will be completed by end of September 2019 and analysis of data by end of October 2019.</p> <p>Bat crossing point surveys commenced in late June 2019 and will be completed by end of September 2019 and analysis of data by end of October 2019.</p> <p>National Vegetation Classification (NVC) survey of grasslands is being undertaken in July /August 2019.</p>

Gaps and Uncertainties	Description
	<p>NVC survey of woodlands were completed very recently (late June 2019).</p> <p>Terrestrial and aquatic invertebrate surveys are being conducted during summer /autumn season 2019.</p> <p>Arboricultural Surveys are being carried out in summer 2019 to include a survey of veteran trees.</p> <p>Detailed results to inform the assessment will be included in the ES.</p>

## 8.9 Design, Mitigation and Enhancement Measures

### Mitigation through engineering design

- 8.9.1 The first preference in mitigating any impact is to seek engineering design measures to entirely avoid or eliminate the impact. Where this is not possible, the mitigation should seek to reduce the magnitude of the impact. Impacts can be avoided or reduced, for instance, through changes to the horizontal or vertical alignment of the proposed scheme, junction strategy or other aspects of the proposed scheme layout; or through changes in the methods and / or materials to be used in construction.
- 8.9.2 The proposed scheme assessed within this PEI Report at the current stage of the programme includes a number of engineering design measures that have been designed to avoid or reduce significant adverse environmental effects arising, where practical. These measures will form part of the proposed scheme design and will be summarised within chapter 2 The Project.
- 8.9.3 Based on the ecological data available to date, it is thought that through the design of the proposed scheme, as well as likely proposed mitigation and enhancement measures, the proposed scheme will be able to re-connect designated habitats previously severed by the original A417 alignment.
- 8.9.4 Habitat fragmentation and habitat loss is being mitigated where possible including with the provision of a green bridge to span the A417, with the aim to link Crickley Hill and Barrow Wake SSSI. The green bridge will include habitat planting, the detail of which will be informed by habitat and species survey in order to create suitable habitat connectivity for any notable or protected species associated with the SSSI such as invertebrates and reptiles but also bats and barn owls. The proposed location would provide maximum ecological benefit in reconnecting the SSSI habitat and providing a green link for wildlife. This location also requires a smaller construction footprint at each end of the bridge, minimising existing habitat loss. Several other overbridges such as those at Cowley Lane and Stockwell Lane will include minimum 2m wide grass verges on both and one side respectively in order to maintain habitat connectivity for many species within the currently arable landscape.
- 8.9.5 A detailed management plan would be developed as part of the outline CEMP to replace any habitats permanently lost as a result of the proposed scheme. This would seek to replace and enhance lost habitat and aim to provide an overall net gain in biodiversity as a result of the proposed scheme. The management plan may include the creation of diverse habitat corridors along the length of the proposed scheme. Biodiversity Units lost and gained will be calculated in

accordance with Highways England's current guidelines as part of the mitigation strategy to achieve a net biodiversity gain.

- 8.9.6 The loss of priority habitats including ancient woodland, deciduous woodland, hedgerows, ponds, species rich calcareous and neutral grassland and marshy grassland would be avoided where possible. The translocation of priority habitats would be considered, where appropriate. Where priority habitats would be lost, these would be recreated with new areas of habitats incorporated into the landscape design with additional habitat created to achieve a net gain in biodiversity. Retained priority habitats would be protected during construction by putting up screening barriers to protect habitats from dust and pollution
- 8.9.7 The use of culverts/mammal tunnels and pedestrian underbridges as wildlife crossing is being built into the design again to maintain connectivity for animal dispersal across the landscape and reduce wildlife use of the road, thus reducing animal fatalities. The final designs in terms of target species and locations of such structures is yet to be determined as they will be informed by the final survey results, but designs will follow industry guidance within the DMRB for species such as otters, bats and badgers.
- 8.9.8 Habitat creation will be designed to create new wildlife corridors and link existing but isolated areas of habitat such as small areas of woodland. All habitat planting and species selection will consider the potential effects of future climate change to ensure establishment and resilience in the longer term.
- 8.9.9 The existing A417 would be de-trunked as described in chapter 2. The opportunities for habitat connectivity for wildlife including bats, invertebrates, birds and reptiles are being explored.
- 8.9.10 The proposed scheme will not be lit which avoids potential impact to foraging and commuting bats and potential disturbance to roosting bats due to lighting, but this may not be the case for pedestrian underbridges. Potential impacts on bats from lighting will be mitigated through sensitive design of lighting.
- 8.9.11 Landscape planting can be designed to provide a buffer between lit working areas during construction, and light spill from headlights at night during operation of the proposed scheme. If temporary construction lighting is required during the bat activity season, at compound areas for example, or for health and safety requirements, this will consist of directional lighting designed to ensure no light spill over 0.5 Lux on to any identified commuting and foraging areas, as well as roosting habitats.
- 8.9.12 Through the mitigation and enhancement proposals, the proposed scheme is aiming for an increase in wildlife habitat quality and species of flora and fauna compared to the baseline. This aim supports Highways England's organisational biodiversity performance targets.

### **Construction Mitigation**

- 8.9.13 A detailed mitigation strategy is being developed to avoid or reduce the potential construction impacts. This strategy will seek to employ best-practice methods for dealing in particular with habitat loss, habitat severance, disturbance and species mortality.
- 8.9.14 There are potential impacts to the environment that could occur as a result of the construction process including accidental occurrences during construction. The

timing and location of these impacts cannot be accurately predicted at this stage. An example would include accidental spillages of fuels, oils or other chemicals.

- 8.9.15 As the occurrence of such impacts is not certain at this stage, they are better described as ‘risks’ rather than ‘impacts’. The likelihood of occurrence and the severity of any such incidents can be reduced through good construction site management practices. To help ensure adequate consideration of risks identified during the EIA which would relate to the construction period, an outline Construction Environmental Management Plan (CEMP) will be prepared. This will set out how construction stage mitigation measures would be implemented to manage those risks and certain requirements for the contractors.
- 8.9.16 The outline CEMP will detail the roles and responsibilities, control measures, training and briefing procedures, risk assessments and monitoring systems to be employed during planning and construction for all relevant environmental topic areas.
- 8.9.17 The CEMP will include site-specific methods, for example to reduce the risk of pollution by ensuring that all site activities in proximity to watercourses and waterbodies are controlled and are in accordance with relevant legislation and undertaken in compliance with the relevant Guidance for Pollution Prevention (GPPs) and industry best practice (GPP5<sup>88</sup>, CIRIA<sup>89</sup>). Additional measures such as silt busters or bales may be used to prevent silt or contaminants from being released into connecting watercourses.
- 8.9.18 It is anticipated that the effects of disturbance during construction would be mitigated through specific construction phase method statements that would address potential impacts on species. This could for instance include the removal of vegetation outside of the breeding bird season, sensitive timing of works near known bat roosts, and avoidance of works within 30m of active badger setts or providing alternative setts for badgers that are close to construction areas under licence.
- 8.9.19 Vegetation clearance should also take into account the life cycles of wildlife such as active seasons, breeding seasons and hibernation periods for species such as bats dormice, wild birds, great crested newts, reptiles, hedgehogs and badgers. Where possible, clearance of land should be tailored to avoid disturbance to wildlife at critical times (such as breeding). Wherever necessary, ecological supervision should be provided during clearance and construction work to advise on the best approaches to reduce disturbance to species.

### **Operation Mitigation**

- 8.9.20 Towards the end of the construction period the CEMP will be refined into a Handover Environmental Management Plan (HEMP) which will contain essential environmental information needed by the body responsible for the future maintenance and operation of the asset.
- 8.9.21 Replacement habitats would be implemented through planting works in the first season available following completion of construction works. Any opportunities for

<sup>88</sup> Natural Resources Wales (NRW), the Northern Ireland Environment Agency (NIEA), Scottish Environment Protection Agency (SEPA) (2018). Guidance for Pollution Prevention – Works or maintenance in or near water: GPP5 v1.2 Feb 2018.

<http://www.netregs.org.uk/media/1418/gpp-5-works-and-maintenance-in-or-near-water.pdf> (accessed 11/12/18)

<sup>89</sup> CIRIA (2018) CIRIA <http://www.ciria.org> (accessed 11/12/18)



early planting in areas that would not be affected during construction will be explored.

- 8.9.22 There are mitigation measures which can reduce the risk of wildlife collisions with vehicles such as hedgerow and tree planting along the proposed scheme to discourage species such as barn owl flying into the carriageway, and provisions of multispecies crossings and fencing to ensure their safe crossing of species.
- 8.9.23 Potential impacts on bats from lighting will be mitigated through sensitive design and planting in order to mitigate for lighting generated by night-time traffic and potentially spilling onto adjacent habitats/dark corridors.

### **Enhancement**

- 8.9.24 Enhancement is a measure that is over and above what is required to mitigate the adverse effects of a proposed scheme.
- 8.9.25 The NPSNN states that opportunities for building in biodiversity features should be maximised and the project should show how it has taken advantage of opportunities to conserve and enhance biodiversity. Therefore, enhancement measures for the proposed scheme would need to be implemented. Potential enhancement measures are likely to include additional replanting of native species-rich hedgerows and trees, additional planting of native broadleaved woodland, additional creation of species-rich calcareous grassland and the additional provision of nesting and roosting opportunities for bats and birds.
- 8.9.26 Opportunities for ecological enhancement in addition to the mitigation and compensation measures above which could be undertaken as part of the proposed scheme are outlined below. Opportunities are being developed and discussed with relevant stakeholders including National Trust, Natural England and GWT. Initial opportunities have been identified such as:
- downgrading retained sections of the existing A417;
  - removal of redundant sections of existing A417;
  - lowland calcareous grassland creation;
  - broadleaved woodland habitat creation; and
  - species-rich hedgerow planting.

## **8.10 Assessment of Effects**

- 8.10.1 The assessment of effects takes into account the potential impacts to each ecological receptor and the design, mitigation and enhancement measures to determine the significance of the effects.
- 8.10.2 Due to the lack of ecological baseline data at the time of writing, it is not possible to provide a detailed assessment of effects at this time. Instead, broad principles have been provided.
- 8.10.3 Within this section, the receptors within the study area are valued in accordance to DMRB IAN 130/10 which assigns a geographical value. This value can then be used to determine the significance of the potential impacts of the proposed scheme with design, mitigation and enhancement considered.
- 8.10.4 The effects have been separated into construction and operation effects.

## **Construction Effects**

### Designated Sites

#### *Statutory Designations*

- 8.10.5 Potential effects from construction activities, such as from dust deposition, pollution events or sediment run-off, to designated sites which are within relative close proximity and/or are hydrologically connected to the construction footprint will be mitigated through standard best-practice techniques and methods which will be determine and detailed with the Outline CEMP.
- 8.10.6 The potential effects from NOx emissions and nitrogen deposition during the construction phase are likely to be negligible as emissions from heavy goods vehicles and site equipment would be minimal and temporary.
- 8.10.7 A Habitat Regulations Assessment (HRA) will be undertaken due to the presence of internationally designated sites located within 2 and 30 kilometres of the proposed scheme, in accordance with DMRB HD 44/09. Consistency of information and avoidance of duplication will be ensured between the HRA process and within the Environmental Statement.

#### *Non-statutory Designations*

- 8.10.8 Several non-statutory designated sites will potentially be permanently and directly impacted as they fall, in part, within the construction footprint. Further information about these sites is currently being gathered as part of the ongoing ecological surveys and will be assessed in more detail in the ES.
- 8.10.9 Habitat creation which will provided along the entire route and designed to connect into existing habitats and wildlife corridors will mitigate loss of habitat. However, during construction before all landscape planting has been realised, there will be an adverse effect, which is likely to reduce in significance as planting is started throughout the proposed scheme, and once established could be of beneficial significance.

### Habitats

- 8.10.10 Appropriate measures will be implemented during construction as set out within the Outline CEMP to detail timing of works to avoid sensitive ecological periods, such as bird nesting (depending on location), stand-off distances/exclusion zones (for woodland and trees), and measures to avoid accidental pollution.
- 8.10.11 A detailed habitat mitigation strategy would be developed to replace any habitats permanently lost as a result of the proposed scheme. This strategy would replace and enhance lost habitat as a result of the proposed scheme. The strategy will include the creation of diverse habitat corridors along the length of the proposed scheme, providing links to offsite habitats.

### Protected Species

#### *Bats*

- 8.10.12 The construction works would result in the clearance of habitat including trees which could be used by roosting bats, and the demolition of buildings which could be used by roosting bats. Habitat clearance may also sever commuting routes

and fragment habitats, potentially having a significant impact on the local bat population. Lighting and noise disturbance during construction could also disturb roosting, commuting and foraging bats, potentially leading to roost abandonment. Surveys are ongoing to assess the status of the local bat population and the importance of local habitats affected by the proposed scheme. It is likely that most adverse impacts could be mitigated by standard mitigation such as the provision of alternative roost sites and control of construction lighting, noise and vibration.

- 8.10.13 However, in the absence of detailed survey results a significant impact is possible. If significant commuting routes for Annex II species were severed by the proposed scheme or if significant roosts, such as maternity or hibernation roosts of Annex II species, were directly impacted this could affect the integrity of a nationally significant population. It is probable that such significant impacts could be reduced and reversed in the long term with appropriate mitigation such as greened overbridges or underbridges at crossing points and new roost creation for lost roost sites.

#### *Badgers*

- 8.10.14 General construction activities within the proposed scheme boundary may result in temporary increased risk of mortality/injury to badger during works within and in proximity to known badger sett locations; and permanent loss of foraging habitat, such as scrub and grassland within known badger territories. A development licence would need to be obtained from Natural England which would include measures to protect badgers during construction and compensatory setts, where required. The implementation of appropriate protection measures would be set out within the Outline CEMP, which may include exclusion zones to construction activity, covering of trenches/voids overnight, installation of crossing points to maintain connectivity and reduce mortality risk, in order to safeguard badger during construction.

#### Irreplaceable habitats including Ancient Woodland and Veteran<sup>90</sup> Trees

- 8.10.15 The construction would remove a small part of Emma's Grove. This area is not included in the Ancient Woodland Inventory as it is under two hectares, however it supports a number of ancient woodland indicator species and is likely to be ancient in origin. To date access has not been permitted into this area of ancient woodland to survey the extent of habitat to be removed during construction. Until further surveys are undertaken, it is assumed that the area of woodland lost at Emma's Grove is ancient. Therefore, adverse effects are only probable at this stage of the assessment. The western edge of Ullen Wood (ancient and semi-natural woodland) may also be lost during construction. However, it is expected that habitat loss within this woodland will be minimal. The proposals would also result in the loss of one veteran tree, an apple tree within the grounds of the Air Balloon Pub. Therefore, a significant impact is likely on ancient woodland and veteran trees. During the final assessment, impacts to all trees including aged and veteran specimens will be considered, in line with the NPS.

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<sup>90</sup> For the purpose of this report, a veteran tree is defined as: "a tree that is of interest biologically, culturally or aesthetically because of its age, size or condition" (refer to the following link for further details: <http://publications.naturalengland.org.uk/file/113006>).

## Operation Effects

### Designated Sites

- 8.10.16 As stated above, a HRA will be undertaken due to the presence of internationally designated sites located within 2 and 30 kilometres of the proposed scheme, in accordance with DMRB HD 44/09.
- 8.10.17 One of the key potential effects from the construction of the proposed scheme relates to potential increase in visitor pressure on the Cotswold Beechwoods SAC. Visitor surveys are currently underway on the SAC and will aid in the assessment of such potential effects. The provision of a green bridge and other footpath routes will seek to disperse visitors rather than concentrate them in one point.
- 8.10.18 Habitat creation along the entire proposed scheme is expected to provide connectivity for species to access the new habitats of the proposed scheme and also to connect into existing habitats and wildlife corridors. Best practice drainage design would also be incorporated to reduce pollution.

### Habitats

- 8.10.19 The proposal to link Barrow Wake SSSI calcareous grasslands by de-trunking a section of the A417 would lead to a positive impact at operational stage.

### Protected Species

#### *Bats*

- 8.10.20 The footprint of the new road would result in the permanent loss of potential roost sites, and the loss of commuting and foraging habitat. Where the new road is constructed across significant bat commuting routes, there would be a significant risk of traffic collisions with commuting bats. The above impacts could have a significant impact on the local bat population, especially where any major roost sites are directly impacted or roost sites and foraging sites are severed by the new road, in particular roosts and commuting habitat used by Annex II species.
- 8.10.21 Artificial lighting generated by headlights of traffic at night could also have a significant impact on roosting, foraging and commuting bats, especially along the new offline section of road east of the Air Balloon roundabout, which will cross habitats that are currently in darkness at night. It is likely that most adverse impacts could be mitigated by standard mitigation such as the provision of alternative roost sites, provision of mitigation features to maintain connectivity and reduce traffic related mortality.
- 8.10.22 Habitat losses would be temporary as suitable replacement foraging habitat and roosting habitat would be created as part of the mitigation strategy. However, in the absence of detailed survey results a precautionary approach has been taken and a significant impact is possible. There is potential for significant effects on bats through the severance of commuting and foraging habitat, and risk of killing and injuring bats through collision with traffic. Further surveys needed to assess status of population and likely impacts.

*Badger*

8.10.23 There is an inherent increased potential risk of mortality through traffic collision, associated with badger crossing the carriageway. Crossing points will be installed (where required) to improve connectivity and reduce mortality risk. In addition, the installation of fencing and planting will assist in encouraging and channelling movement through underbridges.

## 8.11 Monitoring

8.11.1 At this stage it is not clear what monitoring may be required as ecological surveys are ongoing. However, the following potential monitoring is anticipated:

- Monitoring may be required during and post construction at identified crossing points for bats and along landscape scale transect for comparative analysis<sup>91</sup>;
- Monitoring may be required for habitat clearance to ensure no animals are harmed during the clearance and to ensure all retained vegetation are not damaged during the works;
- Reptile mitigation strategies, such as fencing, may also require monitoring throughout construction and post-construction, if required;
- Monitoring may also be required for otter and white-clawed crayfish presence during construction;
- If any European Protected Species licences are required for the proposed scheme such as for bats or dormice or development licences for badgers, monitoring of the species and any mitigation such as habitat creation will be necessary; and
- Habitat creation, habitat enhancement and compensatory habitat planting may be monitored, and maintenance regimes implemented, to ensure their establishment and intended functionality is being delivered. This may be with regard to habitat connectivity across green or grey/green bridges, woodland planting or new grassland creation.

8.11.2 Monitoring requirements could change as more data becomes available for analysis and during consultation. Any potential changes, including the requirement for monitoring and what form that monitoring will take, will be detailed in the ES.

## 8.12 Summary

8.12.1 A summary of the preliminary likely significant effects is presented below. This is based upon currently available information and professional judgement. However, these effects could change as the EIA progresses.

### Preliminary Construction Assessment

- Likely **adverse** effect on bats possible depending on outcome of ongoing surveys. Magnitude to be assessed at ES stage - Construction activities resulting in the clearance of habitat and demolition of buildings used by roosting bats; habitat clearance resulting in the severance of commuting routes and fragment habitats; lighting and noise disturbance during construction.

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<sup>91</sup> Berthinussen and Altringham, "WC1060 'Development of a cost-effective method for monitoring the effectiveness of mitigation for bats crossing linear transport infrastructure'," 2015.

- Likely **adverse** effect likely on ancient woodland and veteran trees due to irreplaceable habitat. Magnitude to be assessed at ES stage – construction activities resulting in the loss of ancient woodland at Ullen Wood and Emma's Grove, and loss of a veteran tree by Air Balloon roundabout.

### **Preliminary Operational Assessment**

- Likely **adverse** effect on bats possible depending on outcome of ongoing surveys. Magnitude to be assessed and reported in the ES – loss of roosting and foraging resources; inherent increased potential risk of mortality through traffic collision due to the widening of the carriageway and the offline section.
- Likely **adverse** effect likely due to the loss of irreplaceable habitat: loss of ancient woodland at Ullen Wood and Emma's Grove, and loss of a veteran tree by Air Balloon. Magnitude to be assessed and reported in the ES.
- **Beneficial** effect on a designated site and habitats, through the proposal to link Barrow Wake SSSI calcareous grasslands by de-trunking a section of the A417.
- **Beneficial** effects resulting from additional habitat creation and ecological connectivity associated with the green bridge.

### **Further Survey Work**

8.12.2 At the time of writing, a number of ecological surveys are continuing during the 2019 summer survey season. These include:

- Bat emergence survey of buildings and trees (May to August 2019);
- Bat crossing point surveys (six repeat surveys between June and September 2019);
- Bat trapping and radio racking surveys (two sessions; July and September 2019);
- Stage 3 barn owl nest verification surveys (July/August 2019)
- National Vegetation Classification Surveys for Woodlands and Grasslands (June to August 2019);
- Arboricultural Survey for veteran trees (summer 2019);
- Terrestrial invertebrate surveys (June to August 2019); and
- Aquatic invertebrates and tufa springs (summer/autumn 2019).

## 9 Geology and Soils

### 9.1 Introduction

- 9.1.1 This chapter of the PEI Report describes and characterises the baseline geological setting of the proposed scheme with respect to geology, geomorphology, designated sites, land stability, mineral resources, agricultural soils and land contamination (hereafter referred to as 'geology and soils' unless otherwise stated).
- 9.1.2 This chapters identifies and assesses the potential effects of the construction and operational phases of the proposed scheme with respect to geology and soils and is assessed in accordance with the DMRB volume 11, section 3, parts 6 and 11<sup>92</sup>.
- 9.1.3 This chapter sets out a baseline conceptual site model with respect to soil and groundwater contamination and identifies plausible contaminant linkages formed due to the construction and/or operational phases of the proposed scheme.
- 9.1.4 This chapter describes the assessment methodology, baseline conditions, potential significant effects, mitigation measures and the likely residual effects remaining after implementation of mitigation measures. Mitigation measures reduce the significance of potential adverse effects on geological resources or receptors of soil and/or groundwater contamination.
- 9.1.5 Chapter 11 on Material Assets and Waste describes the use of materials and the generation and management of waste. It also describes the suitability for reuse of soils.
- 9.1.6 Whilst this chapter describes the potential effects on groundwater and surface water quality in a context of land contamination, chapter 13 on Road Drainage and the Water Environment describes the potential effects on groundwater and surface water of drainage and discharge and potential effects on hydrogeology associated with the construction and operation of the proposed scheme.

### 9.2 Legislative and Policy Framework

#### Legislation

- 9.2.1 Geological sites of national importance are principally afforded protection under the Wildlife and Countryside Act 1981 (as amended) or the National Parks and Access to the Countryside Act 1949 by designation as Site of Special Scientific Interest (SSSI) or National Nature Reserve (NNR). In addition, the Joint Nature Conservation Committee (JNCC) have carried out a Geological Conservation Review (GCR) and Earth Science Conservation Review (ESCR) to identify the best and most representative earth science sites in Great Britain, with a view to their long-term conservation. Although GCR/ESCR identification does not itself give any statutory protection, many GCR/ESCR sites have been notified as SSSIs/ASSIs.
- 9.2.2 Environmental legislation and regulation provide separate drivers to manage contamination. The main legislative drivers for managing risks to human health and the environment from land contamination are:

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<sup>92</sup> Highways Agency, "Design Manual for Roads and Bridges: Volume 11 Section 3 Part 11, Geology and Soils," 1993.

- Part IIA of the Environmental Protection Act (1990);
- Contaminated Land Regulations (2012);
- Environment Act (1995); and
- Environmental Permitting Regulations (2016).

9.2.3 Under Part IIA of the Environmental Protection Act, sites are identified as 'contaminated land' if they are causing, or if there is a significant possibility of causing significant harm to human health or significant pollution of controlled waters (as defined by Section 104 of the Water Resources Act 1991).

9.2.4 In general terms, the legislation advocates the use of a risk assessment approach to assessing contamination and remedial requirements.

9.2.5 A list of additional key legislation and guidance considered within the assessment relating to contamination and the water environment include:

- Water Resources Act 1991 (Amendment) (England and Wales) Regulations 2009;
- EU Water Framework Directive (WFD) 2000/60/EC (as amended by supplementary directives and decisions);
- The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 which implement Water Framework Directive (2000/60/EC), and transpose aspects of the Groundwater Directive (2006/118/EEC) and the Priority Substances Directive (2008/105/EC);
- The Environmental Permitting Regulations 2016 (as amended in 2018 and 2019), which amend the Environmental Permitting (England and Wales) Regulations SI 2010/675. The 2010 regulations revoked the Groundwater Regulations (England and Wales) 2009, originally implemented in the Groundwater Directive;
- Groundwater Daughter Directive (GWDD) (2006/118/EC);
- Department for Environment Food and Rural Affairs (Defra) (2015) The Water Framework Directive (Standards & Classification) Directions (England and Wales);
- The Environmental Damage (Prevention and Remediation) Regulations 2009; and
- Flood and Water Management Act 2010.

9.2.6 The Geology and Soils chapter of this PEI Report documents the assessments carried out in line with the requirements of DMRB volume 11 section 3 part 11. This does not include the assessment of waste production, disposal or management, which are included in chapter 10.

### **National Policy**

9.2.7 The National Planning Policy Framework<sup>93</sup> and the Regional Planning Guidance for the South West (RPG 10)<sup>94</sup> provides general guidance and information with regard to development planning in England and the south-west region. It provides information on the planning objectives for the region and puts emphasis on the need for sustainable development in terms of the resources used, the maintenance of the environment, the economic use of land and consideration of

<sup>93</sup> Department for Communities and Local Government, "National Planning Policy Framework," 2012.

<sup>94</sup> Government Office for the South West, "Regional Planning Guidance for the South West (RPG 10)," 2001.



society in the general area. Within the policy, the importance for the restoration of derelict and contaminated land is stated.

9.2.8 In relation to conserving and enhancing the natural environment, the National Planning Policy Framework<sup>95</sup> states that impacts on geodiversity should be minimised by preventing harm to geological conservation interests. In the UK, geological sites are afforded consideration at a local level by designation, including:

- Geological Conservation Review (GCR) sites (England, Scotland, Wales);
- Geoparks;
- Regionally Important Geological and Geomorphological Sites (RIGS);
- Locally Important Geological and Geomorphological Sites (LIGS);
- Sites of Importance for Nature Conservation (SINC).

9.2.9 The National planning guidance sets out the principles of the planning system with respect to the development on unstable land and land affected by contamination. It places an emphasis on the requirement to understand the ground risks, and on the development of appropriate remediation to make ground hazards material considerations during the planning process.

9.2.10 The National Planning Policy Framework<sup>96</sup> paragraph 120 states:

*“Where a site is affected by contamination or land stability issues, responsibility for securing a safe development rests with the developer and/or landowner”.*

9.2.11 Relevant national and regional policy documents include:

- National Planning Policy Framework (NPPF), Department for Communities and Local Government (DCLG), March 2012<sup>97</sup>;
- Regional Planning Guidance for the South West (RPG 10), 2001<sup>98</sup>;
- National Policy Statement for National Networks (NPSNN), Department for Transport, 2014<sup>99</sup>; and
- Technical Guidance to the NPPF, DCLG, 2012<sup>100</sup>.

### Local Policy

9.2.12 The Cotswold District Local Plan<sup>101</sup> provides guidance for development planning within the Cotswolds AONB. It provides information on the spatial strategy and emphasises the value and sensitivity of geodiversity. It provides guidance on the protection of geodiversity in accordance with international, national and local status and recommends mitigation. Development should avoid adverse impact on existing features as a first principle and enable net gains by designing in opportunities for geological conservation alongside new development. The Local Plan states:

*“New development will, where appropriate, promote the protection, conservation and enhancement of the historic and natural environment by:*

<sup>95</sup> Department for Communities and Local Government, “National Planning Policy Framework,” 2012.

<sup>96</sup> Department for Communities and Local Government, “National Planning Policy Framework,” 2012.

<sup>97</sup> Department for Communities and Local Government, “National Planning Policy Framework,” 2012.

<sup>98</sup> Government Office for the South West, “Regional Planning Guidance for the South West (RPG 10),” 2001.

<sup>99</sup> Department for Transport, “National Policy Statement for National Networks,” 2014.

<sup>100</sup> Department for Communities and Local Government, “Technical Guidance to the National Planning Policy Framework,” 2012.

<sup>101</sup> Department for Communities and Local Government, “Technical Guidance to the National Planning Policy Framework,” 2012.

- *Ensuring the protection and enhancement of existing natural and historic environmental assets and their settings in proportion with the significance of the asset;*
- *Contributing to the provision and enhancement of multi-functional green infrastructure;*
- *Addressing climate change, habitat loss and fragmentation through creating new habitats and the better management of existing habitats;*
- *Seeking to improve air, soil and water quality where feasible; and*
- *Ensuring design standards that complement the character of the area and the sustainable use of the development.”*

9.2.13 The Cotswolds AONB Management Plan<sup>102</sup> highlighted the following special qualities of the Cotswolds (relevant to geology and soils):

- limestone geology – including its visible presence as natural outcrops, use as building material, and through the plant and animal communities it supports, e.g. internationally important flower-rich limestone grasslands and ancient broadleaved woodland;
- the Cotswold escarpment – including views to and from it;
- the High Wolds – a large open, elevated landscape with commons, ‘big’ skies and long-distance views; and
- river valleys – the majority forming the headwaters of the Thames, with high quality water.

9.2.14 Gloucestershire County Council is preparing an updated Minerals Local Plan for 2018 to 2032. Meanwhile the adopted Gloucestershire Minerals Local Plan (1997-2006)<sup>103</sup> continues to provide the local policy framework and guidance on safeguarding of mineral areas using Mineral Consultation Areas (MCAs). MCAs are defined to safeguard mineral resources and ensure non-mineral development is not located where it could affect or be affected by mineral-related development. Policy SE3 states that any consideration for non-mineral development must be viewed in the context of whether it is likely to permanently sterilise the affected mineral deposits.

9.2.15 The Gloucester, Cheltenham and Tewkesbury Joint Core Strategy (JCS)<sup>104</sup> (adopted in December 2017) presents a coordinated strategic development plan for 2011 to 2031 for the three authorities, including Tewkesbury Borough Council. The following policies are relevant to geology and soils:

- Policy SD6: new developments should seek to protect the character of the landscape. Proposals should have regard to the local distinctiveness and historic character of the different landscapes in the JCS area, considering the landscape and visual sensitivity of the area.
- Policy SD7: all development proposals in or within the Cotswolds AONB will be required to conserve and, where appropriate, enhance its landscape, scenic beauty, wildlife, cultural heritage and other special qualities, consistent with the policies set out in the Cotswolds AONB Management Plan<sup>105</sup>.
- Policy SD9: the biodiversity and geological resource of the JCS area should be conserved and enhanced on designated sites, ensuring that new

<sup>102</sup> Cotswolds Conservation Board, “Cotswolds Area of Outstanding Natural Beauty Management Plan 2018-2023,” 2018.

<sup>103</sup> Gloucestershire County Council, “Gloucestershire Minerals Local Plan,” 2003.

<sup>104</sup> Gloucester, Cheltenham and Tewkesbury Joint Core Strategy 2011-2031, 2017.

<sup>105</sup> Cotswolds Conservation Board, “Cotswolds Area of Outstanding Natural Beauty Management Plan 2018-2023,” 2018.

development within and surrounding such sites has no unacceptable adverse impacts. New development should be encouraged to contribute positively to biodiversity and geodiversity whilst linking with wider networks of green infrastructure. A Geodiversity Action Plan is likely to be developed for Gloucestershire that will provide more detailed advice on the conservation of geodiversity. Developers and local authorities should work with appropriate partner organisations including the Local Nature Partnership and Gloucestershire Geology Trust to deliver enhancements.

## Guidance

9.2.16 This PEI Report and the ES to follow is undertaken with due consideration of the following guidance:

- Geotechnics and Drainage, Earthworks, Managing Geotechnical Risks DMRB Volume 4, Section 1, Part 2 HD22/08<sup>106</sup>;
- Assessment and Management of Environmental Effects, DMRB Volume 11, Section 2, Part 5<sup>107</sup>;
- Geology and Soils, Environmental Assessment, Environmental Assessment Techniques, Highways Agency, DMRB Volume 11, Section 3, Part 11<sup>108</sup>;
- Contaminated Land Statutory Guidance, Department for Environment, Food and Rural Affairs (Defra), 2012<sup>109</sup>;
- Model Procedures for the Management of Land Contamination (CLR11) Defra and Environment Agency, 2004<sup>110</sup>; The guidance is currently under review and will be withdrawn by end of 2019 and replaced by the updated online guidance called 'Land contamination: risk management'<sup>111</sup>
- CIRIA R132: A Guide for Safe Working on Contaminated Sites<sup>112</sup>;
- CIRIA SP73: Roles and Responsibility in Site Investigations<sup>113</sup>;
- BS 5930: 2015: Code of Practice for Site Investigations<sup>114</sup>;
- BS 10175:2011 + A1 2013: Code of Practice for Investigation of Potentially Contaminated Sites<sup>115</sup>;
- Groundwater protection guidance<sup>116</sup>, including the Environment Agency's approach to groundwater protection<sup>117</sup>;
- CIRIA C552: Contaminated Land Risk Assessment, A guide to good practice<sup>118</sup>;
- CIRIA C681: Unexploded ordnance (UXO) A guide for the construction industry<sup>119</sup>;

<sup>106</sup> Highways Agency, "Design Manual for Roads and Bridges: Volume 4 Section 1 Part 2, Managing Geotechnical Risk, HD22/08," 2008.

<sup>107</sup> Highways Agency, "Design Manual for Roads and Bridges: Volume 11 Section 2 Part 5, Assessment and Management of Environmental Effects," 2008.

<sup>108</sup> Highways Agency, "Design Manual for Roads and Bridges: Volume 11 Section 3 Part 11, Geology and Soils," 1993.

<sup>109</sup> Department for Environment and Rural Affairs, "Contaminated Land Statutory Guidance," 2012.

<sup>110</sup> Department for Environment and Rural Affairs, "Contaminated Land Statutory Guidance," 2012.

<sup>111</sup> Environment Agency, Land contamination: risk management, <https://www.gov.uk/guidance/land-contamination-how-to-manage-the-risks>

<sup>112</sup> CIRIA, "R132: A Guide for Safe Working on Contaminated Sites," 1996.

<sup>113</sup> CIRIA, "SP73: Roles and Responsibility in Site Investigations," 1991.

<sup>114</sup> British Standards Institution, "BS 5930:2015 Code of practice for ground investigation," 2015.

<sup>115</sup> British Standards Institution, "BS 10175:2011+A1 2013 Code of practice for investigation of potentially contaminated sites," 2013.

<sup>116</sup> Department for Environment and Rural Affairs, "Groundwater Protection," 14 March 2017. [Online]. Available:

<https://www.gov.uk/government/collections/groundwater-protection>. [Accessed 17 June 2019].

<sup>117</sup> Environment Agency, "The Environment Agency's approach to groundwater protection," February 2018. [Online]. Available:

<https://www.gov.uk/government/publications/groundwater-protection-position-statements>. [Accessed 17 June 2019].

<sup>118</sup> CIRIA, "C552: Contaminated Land Risk Assessment, a guide to good practice," 2001.

<sup>119</sup> CIRIA, "C681: Unexploded ordnance (UXO) A guide for the construction industry," 2009.

- CIRIA C733: Asbestos in soil and made ground: a guide to understanding and managing risks<sup>120</sup>;
- CIRIA C765: Asbestos in soil and made ground: good practice site guide<sup>121</sup>;
- Eurocode 7 (BS EN 1997-1<sup>122</sup> & EN 1997-2<sup>123</sup>) and all relevant normative guidance;
- Planning Practice Guidance for land stability<sup>124</sup>; and
- Draft version of CIRIA RP940: Abandoned Mine Workings Manual<sup>125</sup>.

### 9.3 Study Area

- 9.3.1 The proposed scheme study area for all aspects of the Geology and Soils chapter comprises the maximum physical extent of the proposed scheme boundary plus a buffer zone of 500m (see figure 9.1). This distance is referenced in best practice documents, including Guidance for the Safe Development of Housing on Land Affected by Contamination: R&D Publication 66 (NHBC, 2008<sup>126</sup>), and is typically used at the hazard identification stage of an assessment.
- 9.3.2 As detailed in chapter 13, the proposed scheme study area has been increased to a minimum 1km for the assessment of the effects on water resources.
- 9.3.3 If there is a potential for features outside of this buffer zone to be impacted by, or constrain the proposed scheme, these will be included in the assessment and presented in the Environmental Statement.

### 9.4 Potential Impacts

#### Geology and geomorphology

- 9.4.1 The proposed scheme crosses an area of mapped relict landslide deposits and there is a potential for reactivation of ancient landslides within the study area, particularly around Brockworth bypass and Crickley Hill. In the area around the proposed Birdlip bypass at Shab Hill, the proposed scheme also crosses outcrops of Fuller's Earth Formation, which is known to be susceptible to landslips. A land stability plan, presenting the susceptibility of the ground to landsliding, is provided within figure 9.6.
- 9.4.2 In addition to the potential environmental impacts associated with reactivation of landslides, there is also the potential to impact on the distinctive geomorphology of the relict landslide deposits on the Cotswold escarpment and within the Churn valley. The proposed scheme will intrude into the landslide deposits, resulting in loss of these important geomorphological features.
- 9.4.3 Other important geomorphological features include Norman's Brook and the escarpment feature of the Crickley Hill and Barrows Wake SSSI. The proposed

<sup>120</sup> CIRIA, "C733: Asbestos in soil and made ground, a guide to understanding and managing risks (including Errata August 2014)," 2014.

<sup>121</sup> CIRIA, "C765: Asbestos in soil and made ground, good practice site guide," 2017.

<sup>122</sup> British Standards Institution, "Eurocode 7: Geotechnical design. General rules (+A1:2013) (incorporating corrigendum February 2009)," 2009.

<sup>123</sup> British Standards Institution, "Eurocode 7: Geotechnical design. Ground investigation and testing (including corrigendum June 2010)," 2010.

<sup>124</sup> Department for Communities and Local Government, "Planning practice guidance - land stability," 6 March 2014. [Online]. Available: <https://www.gov.uk/guidance/land-stability>. [Accessed 17 June 2019].

<sup>125</sup> CIRIA, "RP940: Abandoned mine workings," 2017.

<sup>126</sup> British Geological Survey, "Gloucester (Solid and Drift) Sheet 234, 1:50,000," 1975.

scheme will result in the realignment of the tributary of Norman's Brook, which may result in the permanent loss of the escarpment geomorphological feature.

- 9.4.4 Excavations for the main line and the proposed green bridge would increase the scale of the adverse impact on the Crickley Hill and Barrow Wake SSSI, which has nationally important geological features (see figure 9.6). Crickley Hill and Barrow Wake Site of Special Scientific Interest (SSSI), formerly known only as Crickley Hill and incorporates a small part of a former site known as Tuffleys Quarry, is located immediately adjacent to the proposed scheme. Crickley Hill is also a Geological Conservation Review (GCR) site and Regionally Important Geological Site (RIGS). Refer to paragraph 9.6.50 for further details. The current design has the potential lead to the loss of the lower part of the geological sequence which, whilst it is a small section, is a key element of the designated features of the SSSI.
- 9.4.5 No impacts are anticipated upon the Knap House Quarry or Cotswold Commons and Beechwoods SSSI. Knap House Quarry, formerly known as Birdlip Quarry, is a SSSI consisting of a disused quarry in woodland approximately 400m north of the village of Birdlip. The site has also been designated as a GCR site and RIGS. Refer to paragraph 9.6.51 for further details. Cotswold Commons and Beechwoods is designated as a SSSI, National Nature Reserve (NNR), and Special Area of Conservation (SAC). It contains ancient beech woodland and unimproved grassland and includes land around the villages of Sheepscombe and Cranham and along the top of the Cotswold escarpment between Painswick and Birdlip. The site is important for its species richness and grasslands. Refer to section 9.6.53 for further details.
- 9.4.6 Bushley Muzzard, formerly known as Watercombe Marsh, is a designated SSSI for its species richness and presence of several uncommon plants. This marshland may be adversely impacted by changes in groundwater levels or quality. This will be considered within the ES.
- 9.4.7 Rockfalls may be triggered during construction, either directly or indirectly by construction works, resulting in damage to ongoing works, or the existing A417. Additional consequences include health and safety risks to construction workers/road users.
- 9.4.8 Temporary or even permanent drainage may be required in areas of cutting, which may affect the supply of water to springs, streams and other surface water features such as bogs, marshes and ponds. This will be assessed in the ES. Consideration will also be given to the position of embankments with respect to the location of the springs and streams.

### **Mineral and Mining Resources**

- 9.4.9 Several old quarries and gravel pits are situated to the north of the A417, west of Air Balloon roundabout, and to the east of the A417, south and east of the roundabout (see figure 9.4). It is understood that historical quarrying of the Inferior Oolite took place across Crickley Hill and Leckhampton Hill. Further details can be found in paragraphs 9.6.33 to 9.6.36. The proposed scheme may impact the stability of these quarries if they have open pit faces.
- 9.4.10 There are no Mineral Infrastructure Safeguarded Sites near the proposed scheme, and therefore no potential impacts on these locally designated sites. The most recently worked quarry on Crickley Hill closed in 1963.

- 9.4.11 The proposed scheme falls within a Mineral Consultation Area (MCA), defined as: “*an area in which development is likely to affect or be affected by the winning and working of minerals other than coal*”<sup>127</sup>. The delineation of the MCA ensures that the Mineral Planning Authority (i.e. Gloucestershire County Council) is consulted before any planning applications are determined.
- 9.4.12 There is a potential for mining instability in Birdlip associated with limestone extraction. The extent of mining as interpreted by the British Geological Survey (BGS) is presented within figure 9.7.

### Soils

- 9.4.13 Potential effects upon soils within the study area will manifest as a result of the construction and presence of the proposed scheme, including the potential effects on agricultural land due to temporary and permanent land take requirements.
- 9.4.14 Other potential effects to soils that will be considered within this chapter include:
- soil erosion as a result of new road cuttings, leading to sediment loading of nearby surface water bodies (if contaminated, this could potentially be a significant negative effect); and
  - soil compaction and de-vegetation as a result of increased hardstanding cover, leading to a reduction in infiltration and increase in surface water runoff.

### Contaminated land

- 9.4.15 Potential effects of the construction and operation of the proposed scheme in relation to contaminated land may include:
- creation of new migratory pathways between potentially contaminated soils or shallow groundwater and underlying Principal and Secondary Aquifers, through ground disturbance such as piling activities or compromising geological formations currently acting as aquitards;
  - re-use of site won or imported contaminated materials in the construction;
  - creation of migratory pathways between potentially contaminated land and construction workers and neighbouring site users;
  - the migration of ground gas in association with historical landfill cells and potentially infilled quarries, and migration and accumulation of the gas in excavations, structures (drainage etc);
  - the introduction of contaminative materials, e.g. due to inappropriate storage and use of fuels, etc., or use of grout during treatment works, which may impact water resources. This will be considered within chapter 13 on Road Drainage and Water Environment;
  - contamination of controlled waters as a result of contaminated surface water runoff from the proposed development discharging into surface water bodies or groundwater. Water as a resource will be discussed within chapter 13 on Road Drainage and Water Environment; and
  - the removal or remediation of any areas of contaminated soils identified would potentially have a beneficial impact.
- 9.4.16 Any potential mitigation measures will be developed as the assessment is carried out and will be included in the proposed scheme design.

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<sup>127</sup> Gloucestershire County Council, “Gloucestershire Minerals Local Plan 1997 - 2006,” 2003.

- 9.4.17 It is assumed that potential effects on human health (e.g. construction and maintenance workers) will be mitigated through adherence to all relevant legislation and best practice; including the Construction (Design and Management) Regulations (CDM) 2015 and the Control of Substances Hazardous to Health Regulations (COSHH) 2002, as amended.

### Climate change

- 9.4.18 The PEI Report considers effects related to climate change as per the requirements of EU Directive 2014/52 and the 2017 EIA Regulations. The combined effects relating to geology and soils of the proposed development and potential climate change on receptors include the following:
- Increasing frequency and severity of precipitation and storms may accelerate erosion of engineered slopes. This may increase infiltration, making the slopes more susceptible to failure.
  - Increasing frequency and intensity of drought periods may result in surface cracking and the formation of infiltration pathways into slopes. This may lead to an accelerated porewater pressure response, making slopes more susceptible to failure.
  - Increasing repeated cycles of drying and rewetting may result in crack propagation, reducing slope stability by creating planes of weakness that may develop into shear zones.
  - Increasing frequency and intensity of drought periods may increase the frequency of shrink-swelling of the soils, leading to significant volume reductions and potential for differential settlement.
  - Increasing long spells of hot weather and wildfires may result in soils developing water repellence. This may reduce or temporarily impede water infiltration, leading to preferential flow and an increase in surface runoff.

## 9.5 Assessment Methodology

### Value of receptor

#### Approach to identification of baseline conditions

- 9.5.1 The identification of baseline conditions in relation to site geology, geomorphology, agricultural soils and land contamination is primarily based on desk study information included within the Preliminary Sources Study Report (PSSR)<sup>128</sup> prepared for the proposed scheme (included in appendix 9.2). Further pertinent information from previous investigations and studies of the site has been collated, as detailed in paragraph 9.5.2. The interpretation of this information is presented in the Baseline Conditions section 9.6.
- 9.5.2 Previous options phase studies have been undertaken for the proposed scheme. The following studies and reports were reviewed as key sources for the PSSR<sup>129</sup>:
- Amey (2014) Preliminary Sources Study Report;
  - WSP (2003) A417 Cowley to Brockworth bypass Improvement Preliminary Sources Study Report (HA GDMS Ref 18693);

<sup>128</sup> Mott MacDonald Sweco Joint Venture, "A417 Missing Link Preliminary Sources Study Report, HE551505-MMSJV-HGT-000-RP-CE-00001, P04," 2018.

<sup>129</sup> Mott MacDonald Sweco Joint Venture, "A417 Missing Link Preliminary Sources Study Report, HE551505-MMSJV-HGT-000-RP-CE-00001, P04," 2018.

- WSP (2004) A417 Cowley to Brockworth bypass Improvement Geomorphological Survey Report (HA GDMS Ref 18694);
- WSP (2002) A417 Crickley Hill Improvement Scheme Preliminary Sources Study (HA GDMS Ref 16772);
- A417 Crickley Hill Improvements – Geotechnical Investigations and Schemes for Road Widening on the northern Valley Side, report by Professor John Hutchinson (1991);
- Edward J Wilson & Associates (1988) Report on Geomorphological Survey at Crickley Hill (A417) (HA GDMS Ref 12609);
- Edward J Wilson & Associates (1990) Addendum to Geomorphological Survey at Crickley Hill (A417) (HA GDMS Ref 21576).

9.5.3 Extracts of the relevant historical geomorphological maps are provided within appendix 9.1.

9.5.4 The factual reports of previous ground investigations are listed in Table 9-7. The location of all historical and proposed ground investigation is presented within figure 9.3.

9.5.5 A review of the information contained within the 2018 PSSR<sup>130</sup> has been undertaken, and the existing information will be validated and updated in the ES, where appropriate. The scope of the baseline survey for specific topic areas is listed in Table 9-1.

**Table 9-1 Scope of Baseline Survey**

Topic	Reference
Geology and geomorphology	<ul style="list-style-type: none"> <li>• British Geological Survey (BGS) 1:50,000 scale geological map of Gloucester (Solid and Drift) Sheet 234<sup>131</sup>;</li> <li>• BGS 1:50,000 scale digital geological map, available on the 'Onshore GeoIndex' viewer<sup>132</sup>;</li> <li>• BGS 1:10,560 scale geological map of Gloucestershire Sheet SO91SW<sup>133</sup>;</li> <li>• BGS 1:10,560 scale geological map of Gloucestershire Sheet SO91NW<sup>134</sup>;</li> <li>• BGS Bristol and Gloucester regional geology guide, 3<sup>rd</sup> edition<sup>135</sup>;</li> <li>• Topographical survey;</li> <li>• Geology of the Cirencester district: memoir for 1:50,000 geological sheet 235<sup>136</sup>.</li> </ul>
Current and historical land use	<ul style="list-style-type: none"> <li>• Groundsure report (2019) for A417 Missing Link. Reference Arup_1 prepared July 2019.</li> <li>• Envirocheck report for Crickley Hill – A417. Reference 213224-1-1, prepared by Landmark Information Group (2002);</li> <li>• Groundsure EnviroSight: A417 Missing Link. Reference COGL14R011, prepared by Groundsure Environmental Intelligence Solutions (2014);</li> </ul>

<sup>130</sup> Mott MacDonald Sweco Joint Venture, "A417 Missing Link Preliminary Sources Study Report, HE551505-MMSJV-HGT-000-RP-CE-00001, P04," 2018.

<sup>131</sup> British Geological Survey, "Gloucester (Solid and Drift) Sheet 234, 1:50,000," 1975.

<sup>132</sup> British Geological Survey, "Onshore Geoindex," [Online]. Available: <http://mapapps2.bgs.ac.uk/geoindex/home.html>.

<sup>133</sup> Geological Survey of Great Britain, "Gloucestershire Sheet SO91SW, 1:10,560," 1975.

<sup>134</sup> Geological Survey of Great Britain, "Gloucestershire Sheet SO91NW, 1:10,560," 1975.

<sup>135</sup> G. W. Green, British Regional Geology: Bristol and Gloucester region, 3<sup>rd</sup> edition, 1992.

<sup>136</sup> M. G. Sumbler, A. J. M. Barron, A. N. Morigi, B. M. Cox, H. C. Ivimey-Cook, A. Horton, G. K. Lott, G. Warrington, I. T. Williamson, T. C. Pharaoh, A. Forster, D. K. Buckley and V. K. Robinson, Geology of the Cirencester district: memoir for 1:50,000 geological sheet 235 (England & Wales), 2000.



Topic	Reference
	<ul style="list-style-type: none"> <li>Results of a site walkover carried out in April 2017, reported in the PSSR<sup>137</sup>.</li> </ul>
Hydrology and hydrogeology	<ul style="list-style-type: none"> <li>Refer to chapter 13, Road Drainage and the Water Environment.</li> </ul>
Mining and mineral safeguarding	<ul style="list-style-type: none"> <li>Highways Agency Geotechnical Data Management System (HA GDMS);</li> <li>The Review of Mining Instability in Great Britain – South West Regional Report, prepared for the Department of the Environment;</li> <li>BGS 1:100,000 Mineral Resource map for Gloucestershire;</li> <li>Historical OS plans contained within the Groundsure report (to identify the presence of historical quarries).</li> </ul>
Land stability	<ul style="list-style-type: none"> <li>Results of a site walkover carried out in April 2017, reported in the 2018 PSSR<sup>138</sup>;</li> <li>Groundsure report (2019) for A417 Missing Link. Reference Arup_1 prepared July 2019.</li> <li>Envirocheck report for Crickley Hill – A417. Reference 213224-1-1, prepared by Landmark Information Group (2002);</li> <li>Groundsure Envirosight: A417 Missing Link. Reference COGL14R011, prepared by Groundsure Environmental Intelligence Solutions (2014);</li> <li>WSP (2003) Cowley to Brockworth bypass Improvement Geomorphological Survey Report (HA GDMS Ref 18694)<sup>139</sup>;</li> <li>A417 Crickley Hill Improvements – Geotechnical Investigations and Schemes for Road Widening on the northern Valley Side, report by Professor John Hutchinson (1991)<sup>140</sup>;</li> <li>Edward J Wilson &amp; Associates (1988) Report on Geomorphological Survey at Crickley Hill (A417) (HA GDMS Ref 12609)<sup>141</sup>;</li> <li>Edward J Wilson &amp; Associates (1990) Addendum to Geomorphological Survey at Crickley Hill (A417) (HA GDMS Ref 21576)<sup>142</sup>;</li> <li>Geomorphological Services Ltd (1988) Engineering Geomorphology of the A417 Stratton By-pass and the A417 north of Stratton to Birdlip Improvement<sup>143</sup>.</li> </ul>
Soil survey	<ul style="list-style-type: none"> <li>Natural England 1:250,000 Agricultural Land Classification Map South West Region (ALC006)</li> </ul>
Ground conditions (from ground investigations)	<ul style="list-style-type: none"> <li>Results of a site walkover carried out in April 2017, reported in the PSSR<sup>144</sup>;</li> <li>Groundsure report (2019) for A417 Missing Link. Reference Arup_1 prepared July 2019.</li> <li>Envirocheck report for Crickley Hill – A417. Reference 213224-1-1, prepared by Landmark Information Group (2002);</li> <li>Groundsure Envirosight: A417 Missing Link. Reference COGL14R011, prepared by Groundsure Environmental Intelligence Solutions (2014);</li> </ul>

<sup>137</sup> Mott MacDonald Sweco Joint Venture, "A417 Missing Link Preliminary Sources Study Report, HE551505-MMSJV-HGT-000-RP-CE-00001, P04," 2018.

<sup>138</sup> Mott MacDonald Sweco Joint Venture, "A417 Missing Link Preliminary Sources Study Report, HE551505-MMSJV-HGT-000-RP-CE-00001, P04," 2018.

<sup>139</sup> WSP, "Cowley to Brockworth Bypass Improvement Geomorphological Survey Report," 2003.

<sup>140</sup> J. N. Hutchinson, "A417 Crickley Hill Improvement: Geotechnical Investigations and Schemes for Road Widening on the northern Valley Side," 1991.

<sup>141</sup> Edward J Wilson & Associates, "Report on Geomorphological Survey at Crickley Hill (A417)," 1988.

<sup>142</sup> Edward J Wilson & Associates, "Addendum to Geomorphological Survey at Crickley Hill (A417)," 1990.

<sup>143</sup> Geomorphological Services Ltd, "Engineering Geomorphology of the A417 Stratton By-pass and the A417 north of Stratton to Birdlip Improvement," 1988.

<sup>144</sup> Mott MacDonald Sweco Joint Venture, "A417 Missing Link Preliminary Sources Study Report, HE551505-MMSJV-HGT-000-RP-CE-00001, P04," 2018.

Topic	Reference
	<ul style="list-style-type: none"> <li>• Information from historical ground investigations, listed in Table 9-7;</li> <li>• Historical borehole records available from BGS Onshore GeolIndex<sup>145</sup>.</li> </ul>
Consultation with statutory and non-statutory bodies and agencies	<ul style="list-style-type: none"> <li>• Natural England</li> <li>• National Trust</li> <li>• Environment Agency</li> <li>• Cotswold District Council</li> <li>• Gloucestershire County Council</li> <li>• Cotswolds Conservation Board</li> </ul>

#### Ground investigation survey methodology

- 9.5.6 At the time of writing, the Phase 1 round investigation had been undertaken, however a factual report was not available and therefore this data was not used to inform this assessment. The Phase 2A and Phase 2B intrusive ground investigations are currently underway in line with best practice current at the time of the investigation. The most recent investigation in 2009 by Geotechnical Engineering was carried out in accordance with BS EN 1997-2 Eurocode 7<sup>146</sup> and BS5930 Code of Practice for Site Investigations. Soil and rock samples were recovered and sent to suitably accredited laboratories for chemical and/or geotechnical testing.
- 9.5.7 The exact details of the methodology employed by the ground investigation contractors are described within the ground investigation contractor's factual report.

#### Baseline assessment methodology

- 9.5.8 The assessment of baseline conditions is based on the scope of baseline studies presented in Table 9-1. Geology and soil features that have potential to be impacted by the proposed scheme have been identified. This information has also informed the baseline information associated with land stability, agricultural soils and land contamination.

The baseline Land Contamination Conceptual Site Model is based on the information reviewed as part of the baseline study preparation, detailed in Table 9-1. It presents the identified potential pollution linkages, i.e. the presence of sources of contamination, receptors (both human and environmental) and pathways through which the contamination could have a detrimental impact on these receptors, as listed in

<sup>145</sup> British Geological Survey, "Onshore Geolindex," [Online]. Available: <http://mapapps2.bgs.ac.uk/geoindex/home.html>.

<sup>146</sup> British Standards Institution, "Eurocode 7: Geotechnical design. Ground investigation and testing (including corrigendum June 2010)," 2010.

9.5.9 Table 9-2.

**Table 9-2 Potential Sources of Contamination, Sensitive Receptors, and Potential Contaminative Pathways Identified to Inform EIA**

Potential sources of contamination	Potential pathways for contamination	Sensitive receptors
<ul style="list-style-type: none"> <li>• Historical industrial/commercial activities;</li> <li>• Current industrial/commercial activities;</li> <li>• Possible or known areas of made ground;</li> <li>• Locations of pollution incidents or licensed discharges; and</li> <li>• Past and present environmental permits, processes, and licenses.</li> </ul>	<ul style="list-style-type: none"> <li>• Ingestion, inhalation, or dermal contact with soils/dust originating from sources of contamination;</li> <li>• Inhalation of ground gasses/hydrocarbon vapours originating from sources of contamination; and</li> <li>• Leaching and migration of contamination.</li> </ul>	<ul style="list-style-type: none"> <li>• Sensitive human receptors;</li> <li>• Controlled waters that may be affected by contaminants; and</li> <li>• Ecological receptors that may be affected by contaminants.</li> </ul>

#### Methodology for assessment of construction impacts

- 9.5.10 The assessment of the construction impacts on geology and soils has been carried out through consideration of baseline conditions in the context of the extent of proposed earthworks and construction activities. A description of the proposed scheme is presented in chapter 2 The Project.
- 9.5.11 For the assessment the following construction activities are considered:
- construction of cuttings;
  - construction of earth embankments;
  - construction of structures;
  - construction of drainage features.
- 9.5.12 The methodology for assessing the construction impacts on the geology and soils is in accordance with the procedure outlined in volume 11 of DMRB (section 3 part 11, Geology and Soils).
- 9.5.13 The methodology for assessing the construction impacts on agricultural land is in accordance with the procedure described in volume 11 of DMRB, section 3 part 6, Land Use.
- 9.5.14 A review of the baseline data identifies and refines the extent of potentially contaminated land within the study area, the need for further focussed assessment has been considered where existing or suspected contamination may be affected by the route, i.e. by creating or altering pollutant linkages between sources and sensitive receptors.
- 9.5.15 For the assessment of construction impacts the Conceptual Site Model (CSM) has been revised to include new pollution linkages introduced during the construction phase. The revised CSM has been used to establish the risks posed and the potential need for further assessment.
- 9.5.16 Those contamination sources identified fully outside of the study area have been scoped out and therefore require no further assessment.

- 9.5.17 Further detailed description of the methodology for assessing potential effects can be found in appendix 9.4.

Methodology for assessment of operational impacts

- 9.5.18 The assessment of the operational impacts on geology and soils will be carried out through consideration of baseline conditions in the context of the operational activities. Assessment of any new pollution linkages will be undertaken in line with the processes detailed in appendix 9.4.
- 9.5.19 The assessment will be based on all soils that are suitable for reuse being retained on site for reuse within the proposed scheme, and measures being taken to establish acceptable reuse criteria and procedures for the proposed scheme to ensure that suitability of material for reuse can be demonstrated and verified. For this approach, a discovery strategy would be developed to enable unforeseen ground conditions to be addressed if or when encountered. This approach is in line with the Specification for Highway Works, Series 600 – Earthworks that is applicable for the proposed scheme, and standard practice for earthworks. Inter-relationships with chapter 10 on Material Assets and Waste would be captured relating to soil re-use.

**Magnitude of impacts**

- 9.5.20 The significance and magnitude of impacts will be assessed by attributing an environmental value or sensitivity to each receptor impacted, in combination with the magnitude of impact that would occur to it. The sensitivity of each receptor will be assessed based on Table 9-3, and the magnitude of impact in accordance with Table 9-4.

**Table 9-3 Criteria and DMRB Definitions of Sensitivity or Value**

Value (sensitivity)	Typical descriptors
Very high	<p><b>Geology and geomorphology:</b> Sites of very high rarity and very high international, national and regional geological/geomorphological importance with no potential for replacement (e.g. designated sites of national importance, including SSSI and SAC).</p> <p><b>Mineral resources:</b> Active quarries and mining activities of national importance.</p> <p><b>Agricultural land:</b> Over 20ha of best and most versatile (BMV) agricultural land (Grades 1 to 3a) required for land take.</p> <p><b>Controlled waters (aquifers/surface water):</b> Groundwater with a high quality and rarity on a regional or national scale with limited potential for substitution (e.g. principal aquifer providing potable water to a large population). Surface water with a European Community (EC) Designated Salmonid/Cyprinid fishery Water Framework Directive (WFD) Class 'High' Site protected/designated under EC or UK wildlife legislation (SAC, SPA, SSSI, WPZ, Ramsar Site, salmonid water)/species protected by EC legislation.</p> <p><b>Land contamination:</b> Human health (high sensitivity land use scenario, e.g. residential with plant uptake).</p>

Value (sensitivity)	Typical descriptors
High	<p><b>Geology and geomorphology:</b> Sites of medium national and high regional geological/geomorphological importance with limited potential for replacement (e.g. currently non-designated GCR site, regionally important site).</p> <p><b>Mineral resources:</b> Active quarries and mining activities of regional or local importance.</p> <p><b>Agricultural land:</b> Not applicable.</p> <p><b>Controlled waters (aquifers/surface water):</b> Groundwater and surface water with a high quality and rarity on a local scale with limited potential for substitution, or attribute with a medium quality or rarity on a regional or national scale with limited potential for substitution (e.g. principal aquifer providing potable water to a small population and/or large resource potential). WFD Class 'Good' Major Cyprinid Fishery Species protected under EU or UK habitat Legislation.</p> <p><b>Land contamination:</b> Sensitive receptor, which is the reason for SSSI designation. Human health (Lower sensitivity land use scenario e.g. public open space, commercial, industrial).</p>
Medium	<p><b>Geology and geomorphology:</b> Sites of low regional and high local geological/geomorphological importance with some potential for replacement (e.g. allocated RIGS or recommended RIGS).</p> <p><b>Mineral resources:</b> Not applicable.</p> <p><b>Agricultural land:</b> Not applicable.</p> <p><b>Controlled waters (aquifers / surface water):</b> Groundwater and surface water with a medium quality and rarity on a local scale with limited potential for substitution, or attribute with a low quality and rarity on a regional or national scale with limited potential for substitution (e.g. secondary aquifer unit supporting abstraction for agricultural or industrial use and/or moderate resource potential). WFD Class 'Moderate'.</p> <p><b>Land contamination:</b> Receptor that is of regional importance.</p>
Low	<p><b>Geology and geomorphology:</b> Sites of local geological/geomorphological importance with potential for replacement (e.g. non-designated exposures/former quarries and mining activities).</p> <p><b>Mineral resources:</b> Former quarries and mining activities.</p> <p><b>Agricultural land:</b> Not applicable.</p>

Value (sensitivity)	Typical descriptors
	<p><b>Controlled waters (aquifers/surface water):</b> Groundwater with a low quality and rarity on a local scale with limited potential for substitution (e.g. non-aquifer unit that does not afford protection to underlying water bearing units). WFD Class 'Poor'.</p> <p><b>Land contamination:</b> Human health (low sensitivity land use scenario, e.g. highway construction). Receptor of local importance.</p>
Very low	<p><b>Geology and geomorphology:</b> Sites of little local geological/geomorphological interest.</p> <p><b>Mineral resources:</b> Not applicable.</p> <p><b>Agricultural land:</b> Not applicable.</p> <p><b>Controlled waters (aquifers/surface water):</b> Not applicable.</p> <p><b>Land contamination:</b> Receptor with low importance or rarity.</p>

Table 9-4 Criteria and DMRB Definitions of Magnitude of Impact

Magnitude of impact	Typical criteria descriptors
Major	<p><b>Geology and geomorphology:</b></p> <ul style="list-style-type: none"> <li>• The proposals are very damaging to the geological environment of the area. (Adverse)</li> <li>• May result in loss or damage to areas designated as being of regional or national geological/geomorphological interest. (Adverse)</li> <li>• Severe damage to key characteristics, features or elements. (Adverse)</li> <li>• Impacts cannot be mitigated (e.g. destruction of a designated site). (Adverse)</li> <li>• Extensive restoration or enhancement. (Beneficial)</li> </ul> <p><b>Controlled waters (aquifers/surface water):</b></p> <ul style="list-style-type: none"> <li>• Reduction of water quality rendering groundwater or surface water unfit to drink and/or substantial adverse impact on groundwater dependent environmental receptors. (Adverse)</li> </ul> <p><b>Land contamination:</b></p> <ul style="list-style-type: none"> <li>• Major effect upon receptor. Severe or irreversible effect on human health. (Adverse)</li> <li>• Temporary severe or irreversible effect on ground/surface water quality. (Adverse)</li> </ul> <p><b>Mineral resources:</b></p> <ul style="list-style-type: none"> <li>• Damage to the soils resource of the area. Loss of resource and/or quality and integrity of resource. (Adverse)</li> <li>• Large scale or major improvement of resource quality. (Beneficial)</li> </ul> <p><b>Agricultural land:</b> Temporary or permanent land take required for over 20ha of BMV agricultural land (Grades 1 to 3a). (Adverse)</p>

Magnitude of impact	Typical criteria descriptors
Moderate	<p><b>Geology and geomorphology:</b></p> <ul style="list-style-type: none"> <li>• The proposals may adversely affect the existing geological/hydrogeological conditions at the site but would not result in the loss of, or damage to, areas designated as being of regional or national geological interest. (Adverse)</li> <li>• Partial loss of/damage to key characteristics, features or elements. (Adverse)</li> <li>• Some mitigation may be possible but would not prevent scarring of the geological environment, as some features of interest would be lost or partly destroyed. (Adverse)</li> <li>• Benefit to, or addition of, key characteristics, features or elements. (Beneficial)</li> </ul> <p><b>Controlled waters (aquifers/surface water):</b></p> <ul style="list-style-type: none"> <li>• Reduced reliability of supply at a groundwater/surface water abstraction source. (Adverse)</li> </ul> <p><b>Land contamination:</b></p> <ul style="list-style-type: none"> <li>• Moderate effect upon receptor. Long-term or short-term moderate effect on human health. (Adverse)</li> <li>• Moderate effect on ground/surface water quality, reversible with time. (Adverse)</li> </ul> <p><b>Mineral resources:</b></p> <ul style="list-style-type: none"> <li>• The proposals may adversely affect the existing soils resource at the site. Loss of resource, but not adversely affecting the integrity. (Adverse)</li> </ul>
Minor	<p><b>Geology and geomorphology:</b></p> <ul style="list-style-type: none"> <li>• The proposals would not affect areas with regional or national geological interest, but may result in the loss of, or damage to, areas of local geological interest. (Adverse)</li> <li>• Cannot be completely mitigated but opportunities exist for the replacement of lost or damaged areas, which may be of similar local geological interest. (Adverse)</li> <li>• Minor benefit to, or addition of, one (or more) key characteristics, features or elements (Beneficial).</li> </ul> <p><b>Controlled waters (aquifers/surface water):</b></p> <ul style="list-style-type: none"> <li>• Marginal reduced reliability of supply at a groundwater/surface water abstraction source. (Adverse)</li> </ul> <p><b>Land contamination:</b></p> <ul style="list-style-type: none"> <li>• Non-permanent health effects to human health, but can be prevented by means such as personal protective clothing etc. (Adverse)</li> <li>• Slight effect on ground/surface water quality, reversible with time. (Adverse)</li> </ul> <p><b>Mineral resources:</b></p> <ul style="list-style-type: none"> <li>• The proposals would not affect areas with soils resource but may result in the loss of, or damage to, areas of local soils resource interest. (Adverse)</li> <li>• Cannot be completely mitigated but opportunities exist for the replacement of lost or damaged areas, which may be of similar local soils interest. (Adverse)</li> </ul>
Negligible	<p><b>Geology and geomorphology:</b></p> <ul style="list-style-type: none"> <li>• The proposals would result in very minor loss or damage to local areas of geological interest, such that mitigation is not considered practical. (Adverse)</li> <li>• Very minor loss or detrimental alteration to one (or more) characteristics, features or elements. (Adverse)</li> <li>• Very minor benefit to, or positive addition of, one (or more) characteristics, features or elements (Beneficial).</li> </ul> <p><b>Controlled waters (aquifers / surface water):</b></p> <ul style="list-style-type: none"> <li>• Non-measurable change to quality, level and flow. (Adverse)</li> </ul> <p><b>Land contamination:</b></p>



Magnitude of impact	Typical criteria descriptors
	<ul style="list-style-type: none"> <li>• No discernible change or impact on attribute of sufficient magnitude to affect use /integrity, e.g. soil contaminants present, but risk assessment suggests negligible low risk to human health. (Adverse)</li> </ul> <p><b>Mineral resources:</b></p> <ul style="list-style-type: none"> <li>• The proposals would result in very minor loss or damage to local areas of soils resource, such that mitigation is not considered practical. (Adverse)</li> </ul>
<b>No change</b>	<ul style="list-style-type: none"> <li>• No loss or alteration of characteristics, features or elements.</li> <li>• No observable impact in either direction.</li> </ul>

### Assessment of significance

9.5.21 The assessment of significance for negative (adverse) and positive (beneficial) effects is based on consideration of the value/sensitivity of a receptor (Table 9-3) combined with the magnitude of impact (Table 9-4). The significance of an impact will then be assessed by considering the combination of both the sensitivity of the receptor in combination with the magnitude of impact in accordance with Table 4-3 in chapter 4.

## 9.6 Baseline Conditions

### Topography and geomorphology

- 9.6.1 The findings of the Preliminary Sources Study Report (PSSR)<sup>147</sup> have been used to describe the topography and geomorphology. Figure 9.1 presents a digital elevation model (DEM) derived from the recent LiDAR survey.
- 9.6.2 Geomorphological mapping has previously been undertaken by WSP in 2003, and E J Wilson in 1988. The results of the field studies are presented in the WSP (2003) PSSR<sup>148</sup>, WSP (2003) Geomorphological Survey Report<sup>149</sup>, and the E J Wilson (1988) Geomorphological Survey Report<sup>150</sup>. Hutchinson (1991)<sup>151</sup> provided additional commentary on the geomorphology of Crickley Hill. Key plans and drawings from these reports are reproduced in appendix 9.1.
- 9.6.3 The north-west-south-east trending Cotswold escarpment dominates the regional landscape, formed by the more competent Jurassic limestones of the Inferior Oolite Group overlying the weaker, more easily eroded mudstones of the Lias Group. The proposed scheme study area comprises an asymmetrical valley adjacent to Crickley Hill, where the northern slopes are steeper than the southern slopes. The existing A417 runs along the axis of this valley. Above the escarpment the landscape comprises an extensive plateau that follows the dip of the underlying limestone (2-5° to the east or south-east).
- 9.6.4 Norman's Brook is a stream that runs from east to west down Crickley Hill. Several springs and areas of marshy ground have been identified on the slopes below the escarpment, which drain into Norman's Brook. A small stream was also noted above the escarpment, immediately south of Birdlip junction (possibly the

<sup>147</sup> Mott MacDonald Sweco Joint Venture, "A417 Missing Link Preliminary Sources Study Report, HE551505-MMSJV-HGT-000-RP-CE-00001, P04," 2018.

<sup>148</sup> WSP, "A417 Crickley Hill Improvement: Preliminary Sources Study," 2002.

<sup>149</sup> WSP, "Cowley to Brockworth Bypass Improvement Geomorphological Survey Report," 2003.

<sup>150</sup> Edward J Wilson & Associates, "Report on Geomorphological Survey at Crickley Hill (A417)," 1988.

<sup>151</sup> J. N. Hutchinson, "A417 Crickley Hill Improvement: Geotechnical Investigations and Schemes for Road Widening on the northern Valley Side," 1991.

Churn valley). Hutchinson (1991) recorded an area of artesian water at the base of the southern slope, adjacent to Norman's Brook<sup>152</sup>.

- 9.6.5 A flat-bottom valley was recorded in the vicinity of Nettleton Bottom, which is likely to have been formed by the flow of water. The area was noted to be waterlogged during the WSP walkover in 2002<sup>153</sup>, suggesting a high-water table.
- 9.6.6 Evidence of mass movement, such as landslides, cambering, gulls, valley bulging, and solifluction are present in the proposed scheme study area. Hutchinson (1991) concluded that the landslide on Crickley Hill was only marginally stable, and identified a number of small localised landslides, thought to be on reactivated relict shear surfaces, on the northern slope<sup>154</sup>.

### **Published geological information**

- 9.6.7 This section describes the published geology based on a review of geological maps and existing geological publications, listed in Table 9-1. The published geology is presented in figure 9.2.

#### Artificial ground

- 9.6.8 The available BGS mapping does not indicate areas of artificial ground within the proposed scheme study area. However E J Wilson (1988)<sup>155</sup> indicates the presence of 'filled ground' at Grove Farm part way up Crickley Hill.

#### Superficial deposits

- 9.6.9 Superficial deposits are largely absent in the proposed scheme study area. There is a small area of Cheltenham Sand and Gravel underlying the western part of the proposed scheme study area, near the junction between the existing A417 and A46, and in between Little and Great Witcombe, approximately 1.5km west of the village of Birdlip.

#### Mass movement deposits

- 9.6.10 Mass movement deposits, also known as colluvium, is mapped across the Cotswold escarpment, including Crickley Hill. BGS mapping also indicates localised 'landslide deposits' in the relatively shallow valleys on the dip slope, e.g. the Churn valley near Shab Hill Farm, and the Frome valley near Stockwell – Nettleton.
- 9.6.11 The colluvium is typically composed of a random assortment of the underlying parent geology within a matrix of largely cohesive material, but the nature of these deposits can vary. On the upper slopes of the escarpment, the colluvium is anticipated to comprise coarser material derived from the Inferior Oolite Group, whereas the lower slopes are expected to be predominantly composed of reworked cohesive material from the Lias Group. The shallow valleys on the dip slope are expected to be composed of reworked Fuller's Earth Formation, with limited coarse material derived from the Great Oolite Group. The maximum thickness of the colluvium is estimated to be over 20m.

<sup>152</sup> J. N. Hutchinson, "A417 Crickley Hill Improvement: Geotechnical Investigations and Schemes for Road Widening on the northern Valley Side," 1991.

<sup>153</sup> WSP, "A417 Crickley Hill Improvement: Preliminary Sources Study," 2002.

<sup>154</sup> J. N. Hutchinson, "A417 Crickley Hill Improvement: Geotechnical Investigations and Schemes for Road Widening on the northern Valley Side," 1991.

<sup>155</sup> E. J. Wilson & Associates, "Report on Geomorphological Survey at Crickley Hill (A417)", 1988.

- 9.6.12 It is inferred that the colluvium in this area was formed due to periglacial or paraglacial processes, or a combination of the two<sup>156</sup>. Periglacial processes, involving successive freeze-thaw cycles, may have resulted in landsliding along the scarp over time. Paraglacial processes, such as the rapid thawing of permafrost, would have released substantial quantities of water into the soils at the front of the scarp. Instabilities formed during periglacial periods may have been reactivated during the paraglacial phase.
- 9.6.13 The WSP (2002) report identified several potential rotational failures immediately below the escarpment and inferred a vertical displacement of around 20m to 30m. E J Wilson (1988) reported a number of shallow shear surfaces in the area, which may indicate the presence of active slip surfaces. The shear surfaces were inferred to be no more than marginally stable.

#### Cambering and gulls

- 9.6.14 Cambering relates to the collapse and downhill displacement of competent strata where they overlie incompetent strata at outcrop. In the study area, this phenomenon is prevalent where the limestones of the Inferior Oolite and Great Oolite groups overlie the mudstones of the Lias Group or Fuller's Earth Formation, such as the escarpment around Crickley Hill and Barrow Wake. This phenomenon may also have occurred locally at Shab Hill. This will be confirmed during upcoming investigations.
- 9.6.15 Evidence of cambering in the underlying bedrock is usually indicated by the presence of gulls, which are widened joints or fault structures developed subparallel to the slope contour. At the ground surface, gulls may be observed as step-like features or linear depressions. Gulls are anticipated to be present within the Inferior Oolite Group close to the top of the escarpment.

#### Bedrock geology

- 9.6.16 The regional geology of the Cotswolds is characterised by an alternating sequence of limestones and mudstones deposited in a shallow marine environment during the Jurassic period, around 200 to 145 million years ago (Ma).
- 9.6.17 The proposed scheme alignment is predominantly underlain by rocks of the Jurassic Lias Group, Inferior Oolite Group, and Great Oolite Group. The western part of the proposed scheme study area is underlain by the Lias Group, but the bedrock is largely buried under a cover of ancient mass movement deposits (or 'colluvium'). The Inferior Oolite Group overlies the Lias Group in the Crickley Hill area. The Great Oolite Group, which in turn overlies the Inferior Oolite Group, outcrops near Shab Hill Farm.
- 9.6.18 The stratigraphy is summarised in appendix 9.5 from youngest to oldest.

#### Structural geology

- 9.6.19 The regional dip of the strata is shown to be between 2° and 5° to the south-east and east, but this may vary locally.
- 9.6.20 Two north-west-south-east trending normal faults have been inferred in the vicinity, namely the Shab Hill Barn and Shab Hill faults. The Shab Hill Fault is

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<sup>156</sup> WSP, "A417 Crickley Hill Improvement: Preliminary Sources Study," 2002.

shown to downthrow to the south-west, whereas the Shab Hill Barn Fault downthrows to the north-east. The downthrow of the Shab Hill Fault is estimated to be between 10m and 24m, while the Shab Hill Barn Fault is thought to downthrow around 10m to 13m. The opposing dips of the faults have resulted in the formation of a downthrown 'graben' in between the two faults, where the Great Oolite Group is shown to outcrop.

- 9.6.21 It is inferred that the faults may be associated with late Jurassic – early Cretaceous extension, during the further development of the Wessex Basin. This suggests that faulting occurred after the deposition of the Great Oolite Group, and all bedrock strata present beneath the proposed scheme alignment were affected by faulting. There are also indications of movement during the mid-Jurassic, but its evidence may have been obscured by cambering effects<sup>157</sup>.
- 9.6.22 Hutchinson (1991) suggested that the actual location of the Shab Hill Barn Fault may be approximately 170m to the north-east of the inferred location shown on the existing geological maps<sup>158</sup>. It is assumed that the Shab Hill Barn Fault lies further north of the cutting from Air Balloon roundabout to Barrow Wake, as WSP did not identify any indications of faulting in or around the cutting during their walkover in 2003<sup>159</sup>.

### Site history

- 9.6.23 The site history has been interpreted through a review of historical Ordnance Survey mapping and presented in the PSSR<sup>160</sup>.
- 9.6.24 The area has historically undergone very little development, aside from the construction of a radio communication station complex in Birdlip circa 1940s. It is understood that a local historian has published an account of the development, but this was not available for review at the time of writing. The proposed scheme would pass through the radio station. Although it is not anticipated that the radio station would significantly impact the proposed works, further information should be acquired to eliminate any residual risks.
- 9.6.25 Records of a road along approximately the same route up Crickley Hill as the present day A417 exist from around 1777. It was converted into a two-lane road in the early 1960s. Remedial works have been undertaken over the years after slope failures on the existing A417 up Crickley Hill<sup>161</sup>. Significant upgrades and modifications to the existing A417 are listed below:
- 1966: improvement of A417 up Crickley Hill (increased to three lanes, curves and gradients reduced);
  - 1988: construction of Birdlip bypass;
  - 1996: construction of Brockworth bypass; and
  - 2000: construction of the north of Stratton to Nettleton improvements.

<sup>157</sup> M. G. Sumbler, A. J. M. Barron, A. N. Morigi, B. M. Cox, H. C. Ivimey-Cook, A. Horton, G. K. Lott, G. Warrington, I. T. Williamson, T. C. Pharaoh, A. Forster, D. K. Buckley and V. K. Robinson, *Geology of the Cirencester district: memoir for 1:50,000 geological sheet 235 (England & Wales)*, 2000.

<sup>158</sup> J. N. Hutchinson, "A417 Crickley Hill Improvement: Geotechnical Investigations and Schemes for Road Widening on the northern Valley Side," 1991.

<sup>159</sup> WSP, "Cowley to Brockworth Bypass Improvement Geomorphological Survey Report," 2003.

<sup>160</sup> Mott MacDonald Sweco Joint Venture, "A417 Missing Link Preliminary Sources Study Report, HE551505-MMSJV-HGT-000-RP-CE-00001, P04," 2018.

<sup>161</sup> J. N. Hutchinson, "A417 Crickley Hill Improvement: Geotechnical Investigations and Schemes for Road Widening on the northern Valley Side," 1991.

- 9.6.26 During the construction of Birdlip bypass, an infilled gull (at NGR SO 9332 1575) led to local stability issues. It is thought that its position may follow the line of the Shab Hill Barn Fault. The issue was corrected using a short, piled retaining wall.
- 9.6.27 Earlier landslide scarps on Crickley Hill have been inferred from historical mapping between 1900 and 1920. Changes in the scarp lines north of the existing A417 showed a retreat in the rear scarp by about 10m. This may have been caused by retrogressive landsliding, or as a result of quarrying. A new 20m-long scarp was noted running parallel to the A417, approximately 10m north-north-west of its northern edge, which may have been due to landsliding<sup>162</sup>.
- 9.6.28 In 1968, during the execution of remedial works and following an excessively wet autumn and winter, a landslide developed in a cut on the north side of the improvement line, extending about 80m along the road cutting, and up to 45m in width<sup>163</sup>. This occurred in an area where quarry waste had been tipped in the past. The slip surface is understood to have emerged above the road, in the toe or face of the cutting, and did not interfere with the existing carriageway. Stabilisation measures, comprising 5 no. rock-filled counterfort drains, up to 4.6m deep and approximately 1m wide, were installed immediately to discharge water into a toe drain carried under the carriageway to the stream.
- 9.6.29 In February 1972, an inspection was carried out on a landslip just above a house (known as 'Crickley'). It was found that the slip was caused by excavations at the rear of the house, which extended 1.8-2.4m into the hillside, and produced a 0.9-1.2m-high face, retained by a block wall. The slip resulted in the collapse of the wall and cracks in the southern verges of Cold Slad Lane<sup>164</sup>.
- 9.6.30 In 1988, a fresh 30-40cm scar was reported at the rear of the most north-easterly counterfort drain, which may have been due to slope movement or settlement within the drain. An area of fresh slip scars and fallen trees was also observed in between Dog Lane and Cold Slad Lane, based on aerial photographs from June 1982<sup>165</sup>.
- 9.6.31 Most recently, CCTV masts were erected mid-slope and at the top of Crickley Hill around 2009.

### **Unexploded ordnance (UXO)**

- 9.6.32 Based on the findings of the pre-desk study UXO assessment, included in the 2018 PSSR<sup>166</sup>, the UXO risk is low. During the Second World War, a radio station and transmitter site was located on Shab Hill, and a military hospital was situated in Ullenwood, approximately 1.5km north-east of Air Balloon roundabout. However, there were no readily available records of any previous bombing in the area.

<sup>162</sup> Mott MacDonald Sweco Joint Venture, "A417 Missing Link Preliminary Sources Study Report, HE551505-MMSJV-HGT-000-RP-CE-00001, P04," 2018.

<sup>163</sup> Mott MacDonald Sweco Joint Venture, "A417 Missing Link Preliminary Sources Study Report, HE551505-MMSJV-HGT-000-RP-CE-00001, P04," 2018.

<sup>164</sup> Mott MacDonald Sweco Joint Venture, "A417 Missing Link Preliminary Sources Study Report, HE551505-MMSJV-HGT-000-RP-CE-00001, P04," 2018.

<sup>165</sup> Edward J Wilson & Associates, "Report on Geomorphological Survey at Crickley Hill (A417)," 1988.

<sup>166</sup> Mott MacDonald Sweco Joint Venture, "A417 Missing Link Preliminary Sources Study Report, HE551505-MMSJV-HGT-000-RP-CE-00001, P04," 2018.

## Mining and mineral resources

- 9.6.33 The Cotswolds is a main source area of Jurassic limestone in Gloucestershire. It is an important resource for aggregate, building stone, and is processed to produce agricultural lime, mortar, and for use in other industrial applications<sup>167</sup>.
- 9.6.34 Quarrying of the Inferior Oolite limestone was a major local activity since the late 16<sup>th</sup> century to around the mid-1920s, particularly at Crickley Hill and Leckhampton Hill. Limekilns and quarries were developed to the south-east of the existing A417 around the late 19<sup>th</sup> century, the latter on either side of Birdlip bypass. The most recently worked quarry on Crickley Hill closed in 1963.
- 9.6.35 Leckhampton Hill was a major source of ‘Cotswold Stone’, where the best stone was used for carving for interior use, while the bulk of the lower quality stone was used for roads and lime production. The Cleeve Cloud Member of the Birdlip Limestone Formation, which consists of a thick succession of massive uniform oolite, strongly current bedded with very little fossil content, was by far the most important unit used for building stone in the Cotswolds, being the most widely used and versatile of the Cotswold Limestones.
- 9.6.36 The site falls outside the Coal Authority reporting area, however the Review of Mining Instability in Great Britain – South West Regional Report, indicates that there is a potential for mining instability in Birdlip, associated with rock commodity (limestone). This area is also shown to have a ‘Likely’ hazard from underground mining by the BGS non-coal mining areas of Great Britain database, related to a ‘Limestone – Bath Stone’ commodity (see figure 9.7). Further details of underground mining in the Birdlip area are unavailable, though a cave on the escarpment by the Royal George Hotel in Birdlip is known to have had its entrance ‘modified by miners’, and a passage enlarged by stone extraction<sup>168</sup>.

## Agricultural land

- 9.6.37 Agriculture is the main land use within the areas surrounding the proposed scheme. Figure 9.5 shows the agricultural land classifications across the proposed scheme.
- 9.6.38 The Agricultural Land Classification (ALC) system provides a framework for classifying land according to the extent to which its physical or chemical characteristics impose long-term limitations on agricultural use. This offers a useful way of considering the sensitivity of receptors, sharing a five-point scale (with Grade 1 being of a very high sensitivity and Grade 5 negligible sensitivity).
- 9.6.39 The principal physical factors influencing agricultural production are climate, site and soil. These factors together with interactions between them form the basis for classifying land into one of five grades; Grade 1 land being of excellent quality and Grade 5 land of very poor quality. Grade 3, which constitutes about half of the agricultural land in England and Wales, is now divided into two subgrades designated 3a and 3b.
- 9.6.40 An initial review of the agricultural land quality within the scheme boundary of the proposed scheme has been undertaken for the purposes of PEI Report. The

<sup>167</sup> A. J. Benham, D. J. Harrison, A. J. Bloodworth, D. G. Cameron, N. A. Spencer, D. J. Evans, G. K. Lott and D. E. Highley, “Mineral Resource Information in Support of National, Regional and Local Planning. Gloucestershire (comprising Gloucestershire and South Gloucestershire). British Geological Survey Commissioned Report, CR/05/105N,” 2006.

<sup>168</sup> Mott MacDonald Sweco Joint Venture, “A417 Missing Link Preliminary Sources Study Report, HE551505-MMSJV-HGT-000-RP-CE-00001, P04,” 2018.

current proposed scheme, as shown in Table 9-5 requires both temporary and permanent land take, as well as land for wider mitigation as part of the proposed scheme. There are likely to be areas of mitigation and enhancement for example with potential landscape, ecological and public rights of way (PRoW) works, which will also be included within the scheme boundary as either temporary or permanent land take.

**Table 9-5 ALC Data Scheme Wide**

Works	ALC Grade	Area (ha)
Permanent Works	Grade 3	129
Permanent Works	Grade 4	68
Temporary Works	Grade 3	19.5
Temporary Works	Grade 4	3.3
<b>TOTAL AGRICULTURAL LAND AFFECTED*</b>	<b>ALL</b>	<b>219.8</b>

*\*Note: these are preliminary figures only and will change as the proposed scheme is developed further and the Order Limits are amended accordingly.*

9.6.41 This data is being reviewed and updated as necessary for the ES.

9.6.42 Given the amount of Grade 3 agricultural land through which the proposed scheme passes, Highways England are in the process of commissioning a full Agricultural Land and Soil Resources Report. This report will provide detailed soil analysis and confirm which areas of the proposed scheme are proposed on land which would be considered to be best and most versatile (BMV) (Grades 1 to 3a).

9.6.43 A full Agricultural Land Impact Assessment (AIA) will also be completed and appended to the ES.

### Hydrology and hydrogeology

9.6.44 A full review of the hydrological and hydrogeological baseline conditions is presented in chapter 13, Road Drainage and the Water Environment. A summary is provided.

9.6.45 The groundwater regime of the study area is complex. The Great Oolite Group (excluding the Fuller's Earth Formation) and Inferior Oolite Group are classified as Principal Aquifers, separated by the less permeable Fuller's Earth Formation. The Lias Group is classified as a Secondary (undifferentiated) Aquifer. The Bridport Sand Formation (the uppermost formation in the Lias) is considered to be in hydraulic continuity with the Inferior Oolite aquifer. However, the hydrogeological properties are complicated by faulting and the layered and cambered nature of the limestone.

9.6.46 The Cotswold escarpment forms a surface water divide between the Thames and Severn catchments. The regional groundwater flow of the Thames catchment is towards the south-east, where the Great and Inferior Oolite aquifers drain to the River Churn and its tributaries. For the Severn catchment, the Great and Inferior Oolite and Lias aquifers drain to the River Frome and its tributaries. Where the Fuller's Earth overlies the Inferior Oolite, the latter becomes confined.

9.6.47 The superficial deposits overlying the Lias Group at the base of the escarpment in the west is classified as a Secondary A aquifer. Locally, the granular colluvium may contain perched groundwater, which may leak to or receive leakage from the

underlying bedrock aquifers depending on relative groundwater heads and may support spring and seepage flow. However, the flow pathways are complicated by the bedrock cambering and the disturbed nature of the colluvium.

- 9.6.48 Springs from the face of the escarpment generally occur locally at the contact between the more impermeable strata in the Upper Lias and the Inferior Oolite Group or Bridport Sand Formation. Norman's Brook is an ephemeral stream connected to the River Severn and rises from springs on the escarpment. Additional spring-fed streams flow into Witcombe Reservoir, which in turn discharges to Norman's Brook upstream of Brockworth, close to the A417/A46 junction.

### Ground hazards

- 9.6.49 The geological risks potentially affecting the proposed scheme, as defined by the BGS, are listed in Table 9-6 and presented within figures 9.6 to 9.8.

**Table 9-6 Potential Ground Hazards Affecting the Proposed Scheme**

Hazard	Figure	Hazard Level
Collapsible ground	N/A	Very low to negligible.
Compressible ground	N/A	Negligible
Ground dissolution	Figure 9.9	The plateau area, very low (soluble rocks are present within the ground and few dissolution features are likely to be present) On the escarpment and Outcrops of Fuller's Earth, negligible (rocks not prone to dissolution).
Land stability	Figure 9.7	On the escarpment and within the head of the Churn Valley (at Shab Hill), high (slope instability problems almost certainly present and may be active) to moderate (slope instability problems are probably present or have occurred in the past). For the remaining areas, negligible to very low (slope instability problems not thought to occur).
Running sand	N/A	Very low to negligible.
Shrinking or swelling clay	Figure 9.8	Majority of the site is negligible (non-plastic). Outcrops of Fuller's Earth and Charmouth Mudstone Formation correspond with low (medium plasticity).

### Geologically designated sites

- 9.6.50 Crickley Hill and Barrow Wake SSSI (also GCR and RIGS) is designated partly due to the rock exposures along the southern slopes of Crickley Hill, comprising Lower and Middle Jurassic rocks, from the Upper Lias through to the Birdlip Limestone Formation (formerly Lower Inferior Oolite); the site exhibits the best sections in the Cotswolds of the Crickley Member (formerly known as Pea Grit) and overlying coral bed (now the Scottsquar Member). The lowest part of the exposed sequence of bedrock is one of the very few to show the basal Leckhampton Member (formerly Scissum Beds), which overlies the Lias Group.
- 9.6.51 Knap House Quarry SSSI (also GCR and RIGS) contains important exposures of Middle Jurassic sediments, and the best illustration of the effects of tectonic uplift in between the deposition of the Birdlip Limestone Formation and the Salperton Limestone Formation (formerly Upper Inferior Oolite). The Aston Limestone Formation (formerly Middle Inferior Oolite) is absent in this location, and the



Birdlip Limestone Formation is overlain unconformably by the Salperton Limestone Formation.

- 9.6.52 Bushley Muzzard, formerly known as Watercombe Marsh, is a designated SSSI for its species richness and presence of several uncommon plants.
- 9.6.53 Cotswold Commons and Beechwoods SSSI (also NNR and SAC) contains woodlands considered to be amongst the most diverse and species-rich of their type. The grasslands typify the unimproved calcareous pastures for which the Cotswolds area is famous. Some disused limestone mines exist in the area, which are known to be used as winter roosts by several bat species.

### **Environmental setting**

- 9.6.54 A review of the current industrial land uses in the Groundsure report<sup>169</sup> indicates that no fuel stations are present within 1km of the proposed scheme. Numerous tanks have been noted throughout the study area, little information is provided in the Groundsure entries for these, however, review of the current OS mapping and aerial imagery indicates that many, if not all of these are likely to be in relation to agricultural irrigation, private water supply, or livestock/farm use. Birdlip Radio Station with associated masts used for telecommunications and an electrical substation are present adjacent to the proposed scheme at approximate chainage 3+050. A features plan is presented within figure 9.4.
- 9.6.55 Review of the historical land uses listed in the Groundsure report indicate that most of the features within the study area relate to unspecified old quarries and pits, many of which have since been infilled. An old lime kiln is noted adjacent to the north of the proposed scheme at approximate chainage 1+200.
- 9.6.56 Review of records of Environment Agency Recorded Pollution Incidents indicate that a total of seven incidents have occurred within the study area. One is located to the west of the proposed scheme relating to an atmospheric pollutant, however no impact was recorded. Three lie along the existing A417 alignment in close proximity to Air Balloon roundabout (approximate chainage 2+000). These relate to oils and fuels, smoke, and inert materials and waste, however, only the inert materials and waste have recorded an impact to land (category 3). A pollution incident relating to oils and fuel occurred north of Air Balloon roundabout, though no impact was recorded. Two pollution incidents occurred to the south of the proposed scheme along the B4070; one for oils and fuels with no recorded impact, the other for inert materials and wastes classified as a category 3 minor impact.
- 9.6.57 There are 8 No Licenced Discharge Consents noted within the study area. Seven consents relate to sewage discharge of treated effluent. A single consent relates to domestic soakaway drainage at the Air Balloon public house.
- 9.6.58 Review of Part A2 and Part B Local Authority Pollution Prevention Controls indicates that none are present within 500m of the proposed scheme.
- 9.6.59 The Groundsure report indicates the presence of six individual landfill cells associated with Crickley Lodge, north of the alignment at approximate chainages 0+600 to 1+000. These cells were used for the disposal of inert waste however no further information is given as to the types of materials disposed.

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<sup>169</sup> Groundsure, "Groundsure Report for A417," 2019.

- 9.6.60 Review of Designated Environmentally Sensitive Sites indicates that the proposed scheme is situated in an area of significant sensitivity. The proposed scheme in its entirety lies within an Area of Natural Beauty and is in a Nitrate Sensitive Area. Ullen Wood ancient woodland lies to the east of Air Balloon roundabout. The north of the proposed scheme above the existing A417 alignment lies within the Gloucester Green Belt and includes Crickley Hill and Barrow Wake Site of Special Scientific Interest (SSSI). A site sensitivity plan is presented as figure 9.6.
- 9.6.61 Mining records included within the Groundsure report indicate that Birdlip Quarry (chainage 4+860 to 5+100) was mined for Limestone (Bath Stone). There are no records of coal mining areas within the proposed scheme.
- 9.6.62 Review of the records of surface water, groundwater and potable water abstractions within 1km of the proposed scheme indicates that all abstractions are historical.
- 9.6.63 The Groundsure report indicates the presence of a Source Protection Zone (SPZ) 3 to the east of the proposed scheme. This is further discussed in chapter 13 on Road Drainage and the Water Environment.

### Ground investigations

- 9.6.64 Several ground investigations have been undertaken within the study area, as listed in Table 9-7. A summary of the scope of work will be provided in the ES as part of the DCO application. The factual results from the ground investigation, including exploratory hole logs, in-situ and laboratory test results, are included within the respective factual reports.

**Table 9-7 Previous Ground Investigations**

Date	Source	Report (including HA GDMS Reference)	Scope of investigation
April 1981	Gloucester County Council Materials Laboratory	Report on Brockworth bypass Preliminary Soil Survey (HA GDMS Ref 21588)	1 no. cable percussion borehole 9 no. hand auger holes
1983	Gloucester County Council Materials Laboratory	Birdlip bypass Soil Survey (HA GDMS Ref 12606)	13 no. cable percussion boreholes 16 no. machine excavated trial pits 1 no. machine excavated slit trench 6 no. permeability (soakaway) tests
December 1988	Gloucester County Council Materials Laboratory / Edward Wilson and Associates (for trial pits)	Preliminary Site Investigation Factual Report – A417 Crickley Hill Widening Proposals (HA GDMS Ref 12609)	11 no. cable percussion boreholes 4 no. 'Minute man' auger holes 14 no. trial pits 10 no. California Bearing Ratio (CBR) tests
March 1989	Foundation Exploration Services Ltd	A417 north of Stratton to Birdlip Improvement – Factual Report on Site Investigation (HA GDMS Ref 12600)	In the Nettleton area: 8 no. cable percussion boreholes 5 no. machine excavated trial pits

Date	Source	Report (including HA GDMS Reference)	Scope of investigation
			(more ground investigation undertaken towards Stratton)
October 1989	Fugro McClelland Ltd	A417 Crickley Hill Improvements – Soil Investigation Static Cone Penetration (within HA GDMS Ref 18693)	93 no. Dutch Cone Probe Holes at 72 no. locations
1989 – 1990	Gloucester County Council Materials Laboratory/Fugro McClelland Ltd	Survey Interim Factual Report – A417 Crickley Hill Improvement (HA GDMS Ref 21573)	4 no. cored boreholes 5 no. cable percussion boreholes
January 1991	Exploration Associates	A417 north of Stratton to Birdlip – Factual Report on Ground Investigations (HA GDMS Ref 12601)	In the Nettleton area: 41 no. trial pits 33 no. boreholes (more ground investigation undertaken towards Stratton)
1991	Exploration Associates	A417 Brockworth bypass (within HA GDMS Ref 17619)	73 no. boreholes 94 no. trial pits
April 2002	WSP/Geotechnical Engineering Ltd	A417 Grove Farm Access – Crickley Hill (HA GDMS Ref 21571)	3 no. cored boreholes (Geotechnical Engineering) 7 no. window sampling holes (WSP)
July 2009	Geotechnical Engineering Ltd	A417/A419 between M5 J11A and M4 J15 CCTV masts (HA GDMS ref 23973)	9 no. dynamically sampled and cored boreholes (using a Pioneer rig) 9 no. dynamic ‘pre-boreholes’ 1m away from each borehole

9.6.65 Figure 9.3 shows the positions of the exploratory holes from previous ground investigations as well as the positions of proposed ground investigations.

### Ground conditions

9.6.66 The baseline ground conditions within the proposed scheme study area have been determined through a review of available published geological information and previous ground investigation information.

9.6.67 The ground conditions are summarised in Table 9-8 to Table 9-10 for Brockworth bypass, Crickley Hill, and Birdlip bypass, based on the 2018 PSSR<sup>170</sup>. It should be noted that these summaries are only valid along the existing A417 route areas and not necessarily representative of the proposed scheme alignment.

9.6.68 Further ground investigation is ongoing, and the tables below will be updated in the ES following a review of all existing ground investigation information.

**Table 9-8 Summary of Ground Conditions at Brockworth Bypass**

<sup>170</sup> Mott MacDonald Sweco Joint Venture, “A417 Missing Link Preliminary Sources Study Report, HE551505-MMSJV-HGT-000-RP-CE-00001, P04,” 2018.

Stratum	Typical description	Approx. level of base of stratum (mOD)	Estimated thickness (m)
Topsoil	Gravelly sandy CLAY or sandy clayey GRAVEL of limestone with frequent rootlets.	+92 to +104	< 0.5
Made ground	Firm silty CLAY with occasional gravel of limestone and brick fragments.	+129	0.3 – 1.0
Colluvium	Soft to firm gravelly CLAY/sandy fine to coarse GRAVEL with frequent cobbles of limestone.	+123 to +172	3.5 – 11.0
Lias Group	Firm to stiff thinly laminated closely fissured sheared sandy silty CLAY with occasional gravel of mudstone and limestone/thinly to thickly laminated silty very weak to weak MUDSTONE in silty clay matrix.	+77 to +98	> 16.0 (not proven)

**Table 9-9 Summary of Ground Conditions at Crickley Hill**

Stratum	Typical description	Approx. level of base of stratum (mOD)	Estimated thickness (m)
Topsoil	Soft organic clay/turf.	+165 to +266	< 1.0
Made ground	Firm sandy CLAY/medium dense clayey sandy GRAVEL of limestone with occasional ash, clinker and brick fragments.	+152 to +236	0.5 – 4.0
Alluvium	Firm to stiff slightly sandy CLAY	+244 to +248	< 2.5
Colluvium	Soft to stiff silty CLAY with frequent gravel, cobbles and boulders of limestone.	+142 to +257	4.5 – 16.0
Great Oolite Group (Undiff.)	Slightly weathered LIMESTONE / moderately to highly weathered thinly laminated MUDSTONE/moderately weathered calcareous SANDSTONE/very stiff thinly laminated sandy silty CLAY.	+242	14.0
Fuller's Earth Formation	Moderately weathered very closely fissured SILTSTONE/slightly weathered LIMESTONE/thinly to thickly laminated calcareous MUDSTONE.	+241 to +279	1.5 – 8.0
Inferior Oolite Group	Oolitic LIMESTONE, recovered as: dense sandy clayey fine to coarse GRAVEL and COBBLES.	+183 to +231	> 6.0 (not proven)
Lias Group	Firm to stiff sandy SILT/CLAY/ massive LIMESTONE/ MUDSTONE.	+135 to +197	> 12.0 (not proven)

**Table 9-10 Summary of Ground Conditions at Birdlip Bypass**

Stratum	Typical description	Approx. level of base of stratum (mOD)	Estimated thickness (m)
Topsoil	Clay/gravel.	+253 to +297	< 0.5
Made ground	Compacted well-graded/clayey limestone gravel fill.	+249 to +297	0.5 – 5.5
Fuller's Earth Formation	Firm to stiff silty CLAY with thinly bedded limestone bands and inclusions of calcareous siltstone.	+281 to +284	5.0 – 7.0
Inferior Oolite Group	Firm sandy gravelly silty CLAY/Oolitic LIMESTONE.	< +246 to +295	> 7.0 (not proven)

### Made ground

- 9.6.69 The site is generally agricultural land, with rare sightings of made ground. Previous ground investigations have encountered made ground in areas close to the existing A417 alignment, near access roads or embankments. Previous geomorphological studies indicated the presence of 'filled ground' at Grove Farm<sup>171</sup>. Details of the made ground encountered have been summarised in appendix 9.3.
- 9.6.70 There is no existing ground investigation information to the east and south-east of Crickley Hill and Barrow Wake, but it is anticipated that any made ground encountered in this area would not be of significant thickness and extent given the site history.
- 9.6.71 It is understood that historical infilled quarries may be present in the area, but the backfill materials used are unknown. Birdlip Quarry is understood to be partially infilled, and fly tipped material is known to be present.

### **Groundwater levels**

- 9.6.72 Details on available information on groundwater levels are presented in chapter 13 on Road Drainage and the Water Environment. A summary on groundwater levels is provided.
- 9.6.73 Groundwater levels within the Great and Inferior Oolite aquifers may vary by several of metres annually due to the low storage of the aquifers and rapid transmission of recharge through the unsaturated zone, making the aquifers very responsive to recharge events.
- 9.6.74 Groundwater monitoring in the vicinity of Air Balloon indicates the saturated zone within the Inferior Oolite is very thin (3-3.5m) with groundwater level at approximately 31.5m bgl to 32.0m bgl.
- 9.6.75 The saturated thickness of the Bridport Sand was between 2.8 and 5.2m near the Barrow Wake car park and 1.9m thick at Star College (north of Shab Hill Fault) during groundwater monitoring. Groundwater levels at Barrow Wake were recorded at 39.3m bgl and 36.8m bgl, while levels at Star College were up to 22.1m bgl.

### **Hydraulic conductivity**

- 9.6.76 Details on available information on hydraulic conductivity are presented in chapter 13 on Road Drainage and the Water Environment. A summary on permeability is provided.
- 9.6.77 The Great and Inferior Oolite aquifers are well cemented, resulting in low intergranular permeability and low storage. Groundwater flow is largely through secondary fractures and fissures, which can be enhanced by dissolution. It is likely that fracture density, and therefore groundwater flow, increases towards the edge of the escarpment due to cambering of the limestone. The Fuller's Earth Formation acts as an aquitard between the Great Oolite and Inferior Oolite, with localised leakage likely to occur where it thins, fractures, or becomes faulted.

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<sup>171</sup> Edward J Wilson & Associates, "Report on Geomorphological Survey at Crickley Hill (A417)," 1988.

### **Conceptual site model**

- 9.6.78 The following paragraphs detail the Conceptual Site Model (CSM) for the existing baseline conditions. The CSM presents the potential existing sources, pathways, and receptors (potential existing pollution linkages) identified from the review of the baseline conditions within the study area. It identifies potential current impacts from contamination in the baseline conditions.
- 9.6.79 The potential sources of contamination identified during review of the baseline conditions are presented and discussed in appendix 9.6. For the purpose of the CSM those sources listed as on site relate to locations within the redline boundary. Sources identified outside this area but within the boundaries of the study area are deemed to be off site sources.
- 9.6.80 Further information and discussion on the potential receptors and pathways identified during review of the baseline conditions are also presented in appendix 9.6.
- 9.6.81 Table 9-11 presents the plausible pollutant linkages present in the baseline setting for the proposed scheme.

**Table 9-11 Baseline Source-Pathway-Receptor Linkages**

Sources	Pathways	Receptors	Comments
<p><b>On Site</b></p> <p><b>Made ground:</b></p> <ul style="list-style-type: none"> <li>Existing road infrastructure</li> <li>Made ground identified during previous ground investigations</li> </ul> <p><b>Infilled quarries:</b></p> <ul style="list-style-type: none"> <li>Unknown backfill with potential contamination.</li> </ul> <p><b>Current or historical activities:</b></p> <ul style="list-style-type: none"> <li>Possible contamination associated with operation of A417 and other roads crossing the proposed scheme alignment.</li> <li>Land use – electrical masts, agricultural, etc.</li> <li>Previous pollution incidents (recorded and un-recorded).</li> </ul> <p><b>Off Site</b></p> <p><b>Made ground:</b></p> <ul style="list-style-type: none"> <li>Possible made ground associated with the existing road infrastructure crossing the proposed scheme alignment.</li> <li>Possible made ground associated with private developments, farm land.</li> </ul> <p><b>Historical landfill/Backfilled quarries:</b></p> <ul style="list-style-type: none"> <li>Crickley Lodge historical landfill used for the disposal of inert waste.</li> <li>Backfilled quarries – unknown backfill with potential contamination</li> </ul> <p><b>Current or historical activities</b></p> <ul style="list-style-type: none"> <li>Possible contamination associated with operation of A417 and other roads/highways crossing the Scheme alignment.</li> <li>Land use – horticulture, agriculture, substations etc.</li> <li>Previous pollution incidents (recorded and un-recorded).</li> <li>Soakaway drainage as possible contamination pathways.</li> </ul>	<p><b>Human Health</b></p> <ul style="list-style-type: none"> <li>Ingestion of soil and dust</li> <li>Inhalation of soil and dust</li> <li>Inhalation of gasses and volatile organic contamination</li> <li>Dermal contact with soils, dust.</li> </ul> <p><b>Controlled Waters</b></p> <ul style="list-style-type: none"> <li>Leaching of contaminants, vertical and horizontal migration within the subsurface.</li> <li>Direct discharge into ground.</li> </ul>	<p><b>Human Health</b></p> <ul style="list-style-type: none"> <li>Maintenance workers on highways or other land that crosses the proposed scheme alignment.</li> </ul> <p><b>Controlled Waters</b></p> <ul style="list-style-type: none"> <li>Groundwater beneath the proposed scheme alignment (Principal Aquifers)</li> <li>Surface water features</li> <li>Water abstractions</li> </ul>	<p><b>Human Health</b></p> <ul style="list-style-type: none"> <li>Made ground or backfilled workings, and potential current contaminative processes are considered likely to be present in locations in the study area. Maintenance workers on existing highways may be directly exposed to potentially contaminated made ground.</li> </ul> <p><b>Controlled Waters</b></p> <ul style="list-style-type: none"> <li>Direct release into groundwater is considered unlikely, however migration of contaminants from spills/leaks or via leaching of soil based contamination is considered plausible.</li> <li>Any migrating landfill leachates would be likely to flow down-gradient towards the proposed scheme, and the works associated with the proposed scheme may therefore intercept potentially contaminated groundwaters.</li> <li>Given the distance from the proposed scheme to surface water features it is considered plausible that direct releases will impact. Indirect migration of contamination may also be considered plausible.</li> <li>Source protection zones related to abstractions exist encroaching the study area to the east.</li> </ul>

## 9.7 Consultation

- 9.7.1 The Scoping Opinion published in response to the Environmental Scoping Report and included responses relating to Geology and Soils. These have been considered and included, where appropriate, in this chapter.
- 9.7.2 A summary of the responses relevant to the Geology and Soils assessment and the respective changes made to the scope of this chapter will be reported within the ES, which will accompany the DCO application.

## 9.8 Assessment Assumptions and Limitations

### Introduction

- 9.8.1 This section presents the assumptions used in this PEI Report assessment. The limitations are presented in Table 9-12 to identify gaps in the baseline information and uncertainties for the assessment. The assessment will be updated following further investigation and incorporated in the ES.

### Assumptions

- 9.8.2 It is assumed that sufficient due diligence on the existing information has been carried out. The available ground investigation information is considered sufficient at preliminary design stage and to inform the Environmental Impact Assessment. The ongoing Phase 2A and 2B ground investigation will be reviewed to fill in any data gaps and inform the ES.
- 9.8.3 In terms of assessing the quality of farmland, an independent review of Agricultural Land Classification (ALC) for the Order limits will be undertaken with an Agricultural land and soil resources report. That assessment of the likely effects will rely on the accuracy of those datasets and information as provided by third parties.
- 9.8.4 In areas of land which would be temporarily acquired, soils would be managed in accordance with DEFRA (2009) 'Construction Code of Practice for the Sustainable Use of Soils on Construction Sites' with Highways England and its contractor discussing and agreeing with the Council how agricultural land will be restored at the end of construction.
- 9.8.5 It is assumed that measures would be put in place during the construction of the proposed scheme to control potential pollution incidents caused by accidental leaks and spills of fuels and oils stored and used on site for construction plant and machinery. A Construction Environmental Management Plan (CEMP) typically controls this. Adherence to the CEMP will mitigate the risk to identified receptors, however, to reinforce requirements, particular measures are outlined within section 9.9 Design, Mitigation and Enhancement Measures.
- 9.8.6 It is assumed that prior to completion of construction, the areas adjacent to the proposed scheme used for access, egress and other associated construction works are to be reinstated with turf and topsoil in keeping with the original land use.
- 9.8.7 The re-use of site won or imported materials to the proposed scheme will be managed by a verification system applied via the Specification for Highway Earthworks Series 600, and only materials found suitable for use would be acceptable for construction works.



9.8.8 Professional judgement has been applied where necessary in assignment of sensitivity and magnitude of effects in line with definitions provided in Table 9-3 and Table 9-4.

9.8.9 The assessment of pollution release as a result of operational or construction activities and potential impacts on hydrogeology are covered in chapter 13 on Road Drainage and the Water Environment.

### Limitations

**Table 9-12 Gaps and Uncertainties**

Gaps and Uncertainties	Description
Gaps in ground investigation	There is limited ground investigation information in the Crickley Hill area, and there is no existing ground investigation information for the proposed alignment to the south-east of Birdlip. These areas will be investigated as part of the ongoing Phase 2A and Phase 2B ground investigation.
Interpretation of ground conditions	Uncertainty in levels and thickness of strata reported in Table 9-8 to Table 9-10, based on 2018 PSSR. The ground conditions and ground model will be further developed upon receipt of further information from the ongoing ground investigation. Reliance will then be placed on the accompanying Geotechnical Interpretative Report.
Land stability	The existing slopes are known to be marginally stable, with the potential for reactivation during widening of existing carriageways. Geomorphological mapping has previously been carried out for earlier scheme studies. Further monitoring and assessment are required to verify previous findings and characterise the hazard to inform requirements for mitigation relevant to the proposed scheme.
Groundwater	The groundwater regime in the area is known to be complex and poorly understood. There is insufficient information on groundwater to assess its effects on construction and vice versa. Further discussed in chapter 13.
Faulting	The location and nature of the Shab Hill Barn and Shab Hill Faults are unconfirmed. Past walkover surveys and intrusive investigations have failed to identify evidence of faulting at the mapped locations. Faulting may result in increased bedrock fracturing, which may impact rock cuttings and hydrogeological conditions. Further investigation is required to locate the faults and determine faulted displacements.
Rock properties	The strength and rock mass properties of the material in which the deep cutting will be excavated is unknown. If extensive highly weathered (weak) rock is encountered, significant retaining measures/cutting design may be required, leading to additional cost/land requirements. If strong massive rock is encountered, it is likely that blasting may be required to excavate the deep cutting. Rock strength and rock mass properties will be assessed as part of the ongoing ground investigation.
Cavities, gulls, caves and fissures	Uncertainty in the presence and extents of these features, associated with faulting, cambering, and dissolution, known to be present towards the top of the escarpment. These features may present a risk to cutting stability by promoting slope failure or localised ground collapse. Further investigation, including mapping and geophysical surveys, is recommended to identify these features.
Mining	There is a potential for mining instability in the area north of Birdlip, associated with past limestone mining. Further investigation, which may include geophysical surveys, is recommended to identify underground cavities.

## 9.9 Design, Mitigation and Enhancement Measures

9.9.1 This section provides a description of the inherent design, mitigation and enhancement strategy for the proposed scheme. It describes measures relied upon within the assessment and discusses the assumed development of these mitigation measures.

### Mitigation through engineering design

9.9.2 There are no design, mitigation and enhancement measures considered for pre-assessment over and above the standard engineering design processes that have been carried out and will continue in accordance with DMRB HD22/08 Managing Geotechnical Risk<sup>172</sup>. This includes a Preliminary Sources Study Report, ground investigations, and geotechnical interpretive reporting. It also includes appropriate geotechnical design of embankments, cuttings, structures and pavements.

9.9.3 Development of preliminary design shall be informed by further ground investigation and geomorphological mapping. Where possible the scope of the ground investigation has been developed in anticipation of the requirement to mitigate or reduce certain potential effects on the geology and soils, i.e. the potential for instability of existing slopes.

9.9.4 Temporary works shall be appropriately designed, this will ensure mitigation of potential effects on the geology and soils during construction.

### Construction Mitigation

9.9.5 The potential for instability of existing slopes and proposed cut slopes shall be mitigated during construction through monitoring of existing movement markers, existing and proposed inclinometers, and remote sensing tools.

9.9.6 The information used to produce the baseline assessment indicates potential areas of contamination may be present across the proposed scheme study area. Intrusive ground investigations and analysis of contaminated land and groundwater has been relatively limited to date and as such some risks remain unquantified. Mitigation measures can be adopted to limit the impact of these potential risks without further assessment, however, it is considered prudent to undertake further intrusive investigations in order determine the level of risk and therefore the scope of required mitigation measures. Nevertheless, the following section outlines the design, mitigation and enhancement measures incorporated into the proposed scheme pre-assessment.

9.9.7 Construction activities will be undertaken on site in line with current best practice and guidance as detailed in Section 9.9 and in accordance with a Construction Environmental Management Plan (CEMP). Construction-related receptors and sources would be managed to negate their impact on the environment.

9.9.8 As a minimum or outline scope the CEMP will include:

- Dust control measures during the works, wheel washers for offsite movements, construction of appropriate temporary transport networks within the construction area, covering of loads during on site transport.

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<sup>172</sup> Highways Agency, "Design Manual for Roads and Bridges: Volume 4 Section 1 Part 2, Managing Geotechnical Risk, HD22/08," 2008.

- Health and safety training, guidance notes and signs and suitable welfare facilities. Promotion of good hygiene practices implemented for the duration of the works with no smoking, eating, or drinking in the locale of excavations in potentially contaminated areas.
- A watching brief by a suitably qualified and experienced person should be undertaken for the duration of site works in areas of potential contaminated land or groundwater.
- The use of protective clothing and equipment; appropriate Personal Protective Equipment (PPE) provided to all construction workers. The assessment of risks to construction workers and the provision of appropriate PPE would be the responsibility of the contractor involved in the works.
- An Action Plan for safely dealing with unexpected contamination should be developed. This will include provisions to appoint a suitably qualified and experienced contaminated land practitioner to provide a watching brief and supervisory role should unexpected contamination be encountered. This role shall include assessment of the risks to the construction works and workers. In addition, measures shall be identified to minimise the spread or release of contamination by suitably storing contaminated materials and appropriate waste disposal procedures.
- Management of construction related waters and agreement and permitting with the Environment Agency with regards to release to controlled waters or Service providers in relation to discharge existing drainage/sewerage infrastructure.
- Environmental monitoring throughout the construction period to ensure environmentally sound working practises are being adopted and adhered to.
- If piling or any ground improvement is undertaken, provision for additional task related risk assessments to evaluate the risk to the environment and provide mitigation measures e.g. Foundation Works Risk Assessments for piling if undertaken.

9.9.9 In addition to the guidance provided in section 9.9 and the outline CEMP, the management of materials, including handling, re-use and removal from site, should be undertaken in accordance with an agreed Material Management Plan (MMP) for the proposed scheme. This will provide a framework via which potentially contaminated soils can be managed safely to limit the risk to identified receptors during both the construction phase and during the operational lifetime of the proposed scheme.

### **Operation Mitigation**

- 9.9.10 No operational mitigation is required as the completed and operational proposed scheme is not expected to result in adverse impacts on geology and soils.
- 9.9.11 It is assumed that operational maintenance of the proposed scheme would be undertaken in accordance with best practice guidance and legislation and therefore the risk to maintenance workers would be reduced to an acceptable level or negated.

### **Enhancement**

- 9.9.12 There are limited opportunities for additional enhancement in relation to geology and soils for the proposed scheme given the nature of the development. However, the presence of geological SSSIs near the proposed scheme may

present an opportunity for the provision of improvements to areas of these sites should they be impacted in any way.

- 9.9.13 These improvements would be designed to be visible and accessible for the interpretation or enjoyment of geological formations for which Crickley Hill and Barrow Wake SSSI is designated.
- 9.9.14 In particular, there may be an opportunity to enhance the existing geological exposures in Crickley Hill and Barrow Wake SSSI or create new geological exposures within the proposed cuttings.

## 9.10 Assessment of Effects

- 9.10.1 This section presents a preliminary assessment of potential effects resulting from and during construction of the proposed scheme on the geology and geomorphology, soils and land contamination. The effects on water resources, hydrogeology and flooding are considered in chapter 13, Road Drainage and Water Environment.
- 9.10.2 A full Agricultural Land Classification (ALC) Survey will be completed in support of the ES. This survey will qualify the quality of the agricultural land through which the proposed scheme passes (in particular distinguishing if areas of Grade 3 land are Grade 3a or 3b) and quantify the proposed scheme's land take both temporarily and permanently, describing any agreed mitigation.
- 9.10.3 An Agricultural Impact Assessment (AIA) will also be completed and appended to the ES. This assessment will consider the impact of the proposed scheme on land use and assesses impacts on individual farm units (plots) forming part of a farm holding, taking into account agricultural land quality and the likely impact on its functionality in terms of severance and access. A summary of the full assessment for temporary and permanent land take will be provided in this section of the ES.

### Construction Effects

#### Geology and geomorphology

- 9.10.4 There is a potential for intrusion to SSSI or geologically designated sites, or important geomorphological features identified within the study area, for example the Cotswold escarpment and Crickley Hill and Barrow Wake SSSI, due to land take and disturbance during construction. The proposed green bridge is expected to extend within the SSSI boundary and across the escarpment line to the south of the A417. Mitigation measures, such as limiting excavations through the SSSI area, creating new geological exposures within proposed cuttings, or enhancing existing geological exposures, would be incorporated in the design.
- 9.10.5 Construction work may result in the reactivation of ancient landslides on the Cotswold escarpment or within the landslide-prone deposits of the Fuller's Earth Formation in the Churn Valley, or rockfalls from the Inferior Oolite Group. This may cause damage to ongoing works or the existing A417 and may pose health and safety risks to construction workers and road users. The ground disturbance may also result in surface water contamination, leading to a potential pollution incident. Further investigations will be undertaken to characterise the slope deposits and current slope condition. Monitoring of the existing slopes should be undertaken throughout design and construction.

- 9.10.6 The presence of gulls within the Inferior Oolite Group may be associated with widened fissures and subsurface cavities or dissolution features, which may impact the stability of cuttings, foundation integrity, and road pavements. These may be managed by the contractor in the CEMP.
- 9.10.7 Construction over previously mined areas north of Birdlip may accelerate natural rates of subsidence or collapse of shallow underground mine workings. Subsurface voids may potentially propagate to the ground surface. The extents of the mined areas should be investigated, and potential remedial measures, such as grouting or bridging, considered to infill any subsurface cavities.
- 9.10.8 Consolidation and differential settlement of soils due to the applied load of embankment materials may occur in upper layers of weathered bedrock, or where cohesive materials are present, e.g. localised areas of alluvium or made ground. This can be mitigated by the removal of any compressible material encountered during construction and replacement with competent material.
- 9.10.9 There is a potential for the sterilisation of mineral resource, such as the limestone from the Inferior Oolite Group. However, no mineral safeguarding sites or active quarries are present within the study area, and access to the vast majority of limestone resources in the region would not be affected.

#### Agricultural land

- 9.10.10 The proposed scheme construction would lead to the temporary loss of agricultural land for construction compounds, haul roads and other works areas.
- 9.10.11 As part of the ES, the outline CEMP will detail mitigation measures to ensure the effect of this temporary land take is minimised. For example, this will detail measures to see the land returned to its former use and interventions to maintain quality of soils through correct storage.
- 9.10.12 Given the temporary and short-term nature of the construction phase, and with appropriate mitigation, it is not considered that the construction phase of the proposed scheme is likely to lead to any long-term residual effects on agricultural land.
- 9.10.13 Severance during construction would be minimised through careful siting of construction compounds and lay down areas and careful planning of construction activities through consultation with the landowners and mitigated in places by new temporary and permanent accesses. The construction stage is therefore not anticipated to lead to any significant effects on land holdings in terms of ongoing access or severance issues.
- 9.10.14 Alongside the above potential effects on agricultural land and the individual plots during construction, there are several potential wider effects that could arise during to construction activities. These are considered below:
- Crop loss associated with temporary land take can be reduced by giving advanced warning to enable farmers to plan and consideration of field drainage impacts during the design phase.
  - Certain farming activities could be affected by increased construction traffic on the local roads and traffic management measures such as temporary lights/diversions. Silage making for example can be constrained by timeliness as it requires uninterrupted flow of activity. Similarly, unrestricted access to

- fields is crucial during certain times of the year (e.g. harvesting) and activities can be disrupted should the transport chain between farm and field be cut off.
- In areas of land which would be temporarily acquired, soils would be managed in accordance with DEFRA (2009) 'Construction Code of Practice for the Sustainable Use of Soils on Construction Sites' whilst a Soils Management Plan will be prepared and followed, which will include details of how agricultural land will be restored at the end of construction.
  - Nuisance from noise, dust and visual impacts due to movement of construction vehicles will be mitigated through considerate construction management including the use of screening (temporary or permanent).
  - In extreme circumstances construction activities can cause disruption that could have an adverse impact on livestock or crops. For example, significant construction noise could affect livestock and significant dust and pollution generation could contaminate crops. Although with best practice construction methods this is considered unlikely, the ES will consider this further and suggest appropriate controls where possible (e.g. frequent use of watering to suppress dust during adverse conditions).

### Contaminated land

- 9.10.15 The construction of the proposed scheme will introduce new receptors to potential contamination arising from the possible sources as identified in the baseline CSM summarised in Table 9-11.
- 9.10.16 The review of the identified potential sources, receptors, and pathways and the plausible pollution linkages allows for the assessment of likely impacts of land contamination on the existing baseline conditions during the construction phase.
- 9.10.17 In addition to the sources, receptors and pathways identified during the baseline assessment, Tables 9-13, Table 9-14 and Table 9-15 identify sources, receptors and pathways which may be introduced during the construction phase.

**Table 9-13 Potential Sources of Contamination During Construction Phase**

Potential source (on site)	Potential contaminants
Areas of unexpected/unknown contamination along the proposed scheme.	Metals, hydrocarbons, asbestos, herbicides in soils and groundwater, ground gas
Site won or off site derived fill materials used in the proposed scheme.	Metals, hydrocarbons, asbestos, ground gas.
Dust generated during construction from areas of made ground, infilled quarries, other contamination (unexpected/unknown)	Metals, hydrocarbons, asbestos.
Contaminated groundwater encountered during groundworks	Heavy metals, hydrocarbons.

**Table 9-14 Potential Receptors During Construction Phase**

Receptors	Description
<b>Human:</b>	
Construction workers 16 years of age upwards.	Short-term duration for exposure during proposed works.

**Table 9-15 Potential Pathways During Construction Phase**

Pathway	Description
<b>Human Health:</b>	
Ingestion of soil and dust	<p>Direct contact between construction workers and exposed soils and possibly groundwater on the proposed scheme.</p> <p>Mobilisation of dust from soils on the proposed scheme may impact nearby residents, workers, and recreational users of the study area.</p> <p>Assessment of dust generation impact is covered in chapter 5 on Air Quality. However, assessment of the impact of potentially contaminated dust on humans is provided in this chapter.</p>
Inhalation of soil dust	
Inhalation of gases and volatile organic contamination	
Dermal contact with soils and dust	
<b>Controlled Waters:</b>	
Mobilisation of contaminants during the works	<p>Construction activities can introduce additional pathways between groundwater and surface water features via excavations, piling, pumping, etc. Pumping to ground or other receptors.</p>
Direct/indirect discharge	
Increased leachate generation	<p>Greater exposure of soils in excavations and earthworks to rainwater infiltration leading to increase leaching of potential contaminants.</p>

9.10.18 The other baseline source-pathway-receptor scenarios identified for nearby residents and workers, and recreational users, including existing users of the A417 or other roads in the proposed scheme study area, would not be significantly altered during the construction phase. As in the baseline assessment, the pathways between potential sources and receptors are not considered plausible, and as such potential linkages are not present.

9.10.19 The possible impact on maintenance workers would not significantly change from the baseline scenario during the construction phase. A plausible pollutant linkage still exists between maintenance workers and potential sources in relation to existing highways.

9.10.20 Table 9-16 presents the plausible pollutant linkages present during the construction phase for the proposed scheme in addition to the baseline conditions. This includes a new potential pollutant linkage to construction workers, and new sources and pathways in which construction workers and controlled waters may be impacted by construction phase activities.

**Table 9-16 Source-Pathway-Receptor Linkages During Construction Phase**

Sources	Pathways	Receptors	Comments
<p><b>On Site</b></p> <p><b>Made ground:</b></p> <ul style="list-style-type: none"> <li>Existing road infrastructure</li> <li>Made ground identified during previous ground investigations</li> </ul> <p><b>Infilled quarries</b></p> <ul style="list-style-type: none"> <li>Backfilled Birdlip Quarry – unknown backfill with potential contamination.</li> </ul> <p><b>Current or historical activities</b></p> <ul style="list-style-type: none"> <li>Possible contamination associated with operation of A417 and other roads crossing the proposed scheme alignment.</li> <li>Land use – Agriculture, Radio Masts, Electricity Substations.</li> <li>Previous pollution incidents (recorded and un-recorded).</li> </ul> <p><b>Construction Phase:</b></p> <ul style="list-style-type: none"> <li>Unexpected contamination</li> <li>Site won or imported soils</li> <li>Dust from exposed soils</li> <li>Contaminated groundwater encountered during the works</li> </ul>	<p><b>Human Health</b></p> <ul style="list-style-type: none"> <li>Ingestion of soil and dust</li> <li>Inhalation of soil and dust</li> <li>Inhalation of gasses and volatile organic contamination</li> <li>Dermal contact with soils, dust.</li> </ul>	<p><b>Human Health</b></p> <ul style="list-style-type: none"> <li>Maintenance workers on highways or other land that crosses the proposed scheme alignment.</li> </ul> <p><b>Construction Phase:</b></p> <ul style="list-style-type: none"> <li>Nearby residents and workers</li> <li>Construction workers</li> </ul>	<p><b>Human Health</b></p> <p>Made ground, mining waste or backfilled workings, and potential current contaminative processes are considered likely to be present in locations in the study area. Maintenance workers on existing highways may be directly exposed to potential contaminated made ground.</p> <p><b>Construction Phase:</b></p> <p><i>Nearby residents and workers may be impacted by dermal, ingestion and inhalation routes via dust generated during the construction works.</i></p> <p><i>Construction workers involved in the Scheme may come into direct contact with contaminated soils and made ground along the scheme. Significant levels of contamination are not expected based on the baseline information; however, there is a possibility of encountering unexpected contamination along the scheme. Similarly, they may be impacted by contact with contaminated groundwater in excavations or cuttings.</i></p>
<p><b>Off Site</b></p> <p><b>Made ground:</b></p> <ul style="list-style-type: none"> <li>Possible made ground associated with the existing road infrastructure crossing the proposed scheme alignment.</li> </ul>	<p><b>Controlled Waters</b></p> <ul style="list-style-type: none"> <li>Leaching of contaminants, vertical and horizontal migration within the subsurface.</li> <li>Direct discharge into surface waters via run off or from</li> </ul>	<p><b>Controlled Waters</b></p> <ul style="list-style-type: none"> <li>Groundwater beneath the proposed scheme alignment (Principal Aquifers)</li> <li>Surface water features</li> </ul>	<p><b>Controlled Waters</b></p> <p>Migration of contaminants from spills or leaks or via leaching of soil-based contamination is considered plausible.</p> <p>Surface water features are present within the proposed scheme, direct discharge of contamination possible as is indirect migration of contamination.</p>



Sources	Pathways	Receptors	Comments
<ul style="list-style-type: none"> <li>Possible made ground associated with private developments, farm land.</li> </ul> <p><b>Historical landfill</b></p> <ul style="list-style-type: none"> <li>Crickley Lodge historic landfill (six individual cells) used for the disposal of inert waste.</li> </ul> <p><b>Current or historical activities</b></p> <ul style="list-style-type: none"> <li>Possible contamination associated with operation of A417 and other highways crossing the proposed scheme alignment.</li> <li>Land use – Agriculture, substations etc</li> <li>Previous pollution incidents (recorded and un-recorded).</li> <li>Soakaway drainage as possible contamination pathways.</li> </ul>	<p>groundwater seepage/springs.</p>	<ul style="list-style-type: none"> <li>Water Abstractions</li> </ul>	<p>Source protection zones related to abstractions exist to the east of the proposed scheme. These are considered likely to be impacted by any contamination present.</p> <p><b>Construction Phase:</b></p> <p><i>Direct release of construction related contaminants (fuels etc) into the groundwater is considered possible. It is considered that this will be assessed in chapter 13, Road Drainage and Water Environment.</i></p> <p><i>Increased surface water run-off from potentially contaminated soils and impact on surface water receptors. It is considered that this will be assessed in chapter 13, Road Drainage and Water Environment.</i></p> <p><i>Mobilisation of contamination as a result of excavations, piling and directly discharged into ground or surface water features as part of dewatering.</i></p>

## Operational Effects

### General

- 9.10.21 The EIA scoping report<sup>173</sup> stated that the completed and operational scheme is not expected to result in any impacts on geology and geomorphology, soils, and contaminated land. As the ES progresses, the design development will be considered. If it is considered that there are any potential operational effects relevant to geology and soils, these will be assessed as part of the ES.
- 9.10.22 The assessment of the soils adjacent to the proposed scheme to be affected by spray or air borne pollutants has been assessed within chapter 5, Air Quality.

### Agricultural land

- 9.10.23 The proposed scheme would lead to the permanent loss of agricultural land through the construction of the mainline carriageway. The ES will explore in full the extent of this loss and the potential effects on the farm holdings which will experience loss of land and potential severance issues.
- 9.10.24 Potential severance effects during operation have been considered as part of the design development and the proposed scheme includes a number of new private means of access and new overbridges in order to mitigate potential severance effects.
- 9.10.25 In addition, where necessary, Highways England would seek to mitigate adverse effects through negotiation with land owners. A land owner would receive compensation should voluntary agreement not be reached, in line with the compensation code.
- 9.10.26 Overall, given the current scheme design and the steps that have been or will be taken by Highway's England to avoid complete severance of land with no access, it is not considered that the proposed scheme would lead to any significant severance effects during operation.
- 9.10.27 Further assessment and development of mitigation measures will be undertaken as part of the ES and through the completion of the following surveys, assessments and management plans:
- Agricultural Land Classification Survey; and
  - Agricultural Impact Assessment.

## 9.11 Monitoring

- 9.11.1 This section summarises the possible monitoring required to inform the mitigation of effects considered to be of adverse significance.
- 9.11.2 Monitoring of the existing slopes would be required throughout the design and construction phases to assess the potential for landslide reactivation, rockfall, or presence of gulls and associated features on the Cotswold escarpment. Movement sensors, inclinometers, and extensometers have and are continuing to be installed on the existing slopes. Remote sensing tools and surface geophysics will be used to supplement the data obtained from the installations. This

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<sup>173</sup> Mott MacDonald Sweco JV, "A417 Missing Link Environmental Impact Assessment Scoping Report," 2019.

monitoring will provide input to the hazard assessment and development of mitigation measures to be incorporated in the engineering design.

9.11.3 Monitoring of possible remedial/stabilisation measures may be required if the further investigation confirms the presence of gulls, subsurface features, or shallow mine workings beneath the proposed scheme alignment. The updated assessment and description of monitoring will be included within the ES.

9.11.4 Additional ground investigation, including groundwater level monitoring, will be carried out as part of the development of the engineering design. Groundwater monitoring should also be undertaken during and post-piling. Further details are included in chapter 13, Road Drainage and the Water Environment.

## 9.12 Summary

### Summary of preliminary assessment

9.12.1 Preliminary construction assessment:

- Construction of the proposed scheme may result in permanent **adverse** or beneficial effect on the SSSI or geologically designated sites, including the distinctive geomorphology of the Cotswold escarpment, Crickley Hill and Barrow Wake SSSI, and the Churn Valley. There is an opportunity to enhance existing geological exposures or create new exposures within the proposed cuttings. During the design phase, excavations could be limited through the SSSI, Cotswold escarpment, and Churn Valley. Existing slopes should be monitored throughout design and construction phases. Further investigation is ongoing to characterise the slope deposits and assess current slope conditions.
- With mitigation measures in place, no significant **adverse** effects related to contaminated land are considered likely during the construction phase.
- At this stage it is uncertain how much and of what quality agricultural land would be required for the proposed scheme. Should over 20ha of agricultural land classified as BMV (Grades 1 to 3a) be required for the proposed scheme during construction, the magnitude of impact would be very high, leading to a significant **adverse** effect. To help determine this likely effect within the ES, it is intended that an Agricultural Land Classification survey and associated Agricultural Land and Soil Resources Report will be undertaken by an appropriate specialist.

9.12.2 Preliminary operational assessment:

- No significant effects on geology and geomorphology, and contaminated land are considered likely during the operation of the proposed scheme. If any potential effects are identified during design development, these will be assessed as part of the ES.
- Given that mitigation is likely to be available to avoid complete severance of land with no access, it is not anticipated that the proposed scheme would lead to any significant severance effects on agricultural land during operation. The likely effects on farm holdings will be considered further within chapter 12, Population and Human Health as part of its consideration of likely effects on land and property. To help determine the likely effects within the ES, it is intended that an Agricultural Impact Assessment is undertaken by an appropriate specialist.

### **Further Work**

- 9.12.3 At this stage the preliminary information used for this chapter is based mostly on the June 2019 Design Fix 2, described in chapter 2. Further EIA work is currently being undertaken to confirm the scale and significance of predicted environmental impacts arising from the proposed scheme design. The final EIA work will be reported within the ES, which will accompany the DCO application.
- 9.12.4 Further intrusive investigations are ongoing to provide supplementary information on the ground conditions across the proposed scheme. An interpretation of the findings will be presented in a Geotechnical Interpretative Report (GIR). Information obtained from these investigations, including the results of supplementary soils and groundwater chemical analysis will be utilised to further define the assessment of baseline conditions as part of the ongoing EIA work. Further definition of the baseline conditions will allow greater accuracy in the assessment of potential risks during and after construction.
- 9.12.5 Further investigation of the potential for instability of existing slopes and location of inferred faults is proposed to be undertaken during 2019. This work will initially involve a walkover survey to verify previous findings and fill in current gaps in knowledge. It will also include aerial photography interpretation, other remote sensing techniques, geomorphological mapping and geophysical investigations.

## 10 Material Assets and Waste

### 10.1 Introduction

- 10.1.1 This chapter provides an assessment of the likely significance of environmental effects from use of material resources and the generation and management of waste resulting from the proposed scheme.
- 10.1.2 Material assets and waste are defined as comprising:
- the provision and use of material resources, including primary, secondary, recycled and manufactured materials; and
  - the generation and management of waste.
- 10.1.3 It should be noted that effects of the proposed scheme in terms of geology and soils, and the potential for land contamination, have been addressed in chapter 9 of this PEI Report and the effects on climate change have been addressed in chapter 14.
- 10.1.4 The assessment presented in this chapter focuses on the construction phase of the proposed scheme as this is where potential significant effects of materials and waste are more likely to arise.
- 10.1.5 The effects associated with the operational phase of the proposed scheme are unlikely to be significant. As such, and as agreed through the scoping opinion, operational effects, in terms of resource use and waste generation, have been scoped out of this assessment.
- 10.1.6 It is considered that the potential exists for significant environmental effects from the use of materials and generation of waste. Given the scale of the development and the large quantity of materials likely to be required, a detailed level of assessment will be undertaken in accordance with the DMRB guidance.

### 10.2 Legislative and Policy Framework

#### Legislation

##### Environmental Impact Assessment Directive 2014/52/EU

- 10.2.1 The Environmental Impact Assessment (EIA) Directive 2014/52/EU provides the overarching legislative framework for undertaking environmental impact assessments for public and private projects.
- 10.2.2 Article 3 of the EIA Directive requires the EIA to identify, describe and assess in an appropriate manner the direct and indirect significant effects of a project on a number of factors including material assets (in light of each individual case).

##### EU Waste Framework Directive 2008/98/EC

- 10.2.3 The EU Waste Framework Directive 2008/98/EC provides the overarching legislative framework for the collection, transport, recovery and disposal of waste, and includes a common definition of waste, as provided in paragraph 10.1.13. It sets out measures to protect the environment and human health by preventing or reducing the adverse effects of the generation and management of waste, and by improving the efficiency of resource use, and reducing the overall impact.

10.2.4 The Directive also mandates the Waste Hierarchy<sup>174</sup> (Table 10-1) which requires that where waste is unavoidable, products and materials should, subject to regulatory controls, be used again, for the same or a different purpose (re-use). Otherwise, resources should be recovered from waste through recycling. Value can also be recovered by generating energy from waste but only if none of the above offer an appropriate alternative solution.

**Table 10-1 The Waste Hierarchy**

Stages	Includes
Prevention	Using less material in design and manufacture. Keeping products for longer; re use. Using less hazardous material.
Preparing for re-use	Checking, cleaning, repairing, refurbishing, whole items or spare parts.
Recycling	Turning waste into a new substance or product. Includes composting if it meets quality protocols.
Other recovery	Includes anaerobic digestion, incineration with energy recovery, gasification and pyrolysis which produce energy (fuels, heat and power) and materials from waste; some backfilling operations.
Disposal	Landfill and incineration without energy recovery.

#### EU Landfill Directive 1999/31/EC

10.2.5 The EU Landfill Directive 1999/31/EC<sup>5</sup> sets stringent requirements for the landfilling of wastes. The Directive aims to prevent or reduce negative effects on the environment from the landfilling of waste, as far as is practicably possible, and introduces stringent technical requirements for waste and landfills as a disposal option through:

- setting minimum standards for the location, design, construction and operation of landfills;
- setting targets for the diversion of Biodegradable Municipal Waste from landfill; Controlling the nature of waste accepted for landfill.; and
- defining the different categories of waste (hazardous waste, non-hazardous waste and inert waste) and applies to all landfills, defined as waste disposal sites for the deposit of waste onto or into land.

10.2.6 The requirements of the Directive were transposed into national legislation through the Landfill (England and Wales) Regulations 2002 (as amended) and subsequently re-transposed as part of the Environmental Permitting (England and Wales) Regulations 2016 (as amended).

#### **National Policy**

#### The Waste (England and Wales) (Amendment) Regulations 2011 (as amended)

10.2.7 Directive 2008/98/EC has now been transposed in England by the Waste (England and Wales) Regulations 2011 (S.I. 2011 No. 988) (as amended)<sup>175</sup>. In

<sup>174</sup> Department for Environment Food and Rural Affairs. (2013). Waste Management Plan for England Post Adoption Statement. December 2013. Accessed on 12 October 2014 from

[https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/265543/pb14101-wastemanagepost-adopt-20131212.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/265543/pb14101-wastemanagepost-adopt-20131212.pdf)

<sup>175</sup> The Waste (England and Wales) (Amendment) Regulations 2014. Accessed online at:

[https://www.legislation.gov.uk/uk/si/2014/656/pdfs/uk/si\\_20140656\\_en.pdf](https://www.legislation.gov.uk/uk/si/2014/656/pdfs/uk/si_20140656_en.pdf)

addition to the above, the following legislation relating to material resources and waste management will also be taken into account:

- The Controlled Waste (England and Wales) Regulations 2012; and
- The Hazardous Waste (England and Wales) Regulations 2005.

10.2.8 Primary legislative instruments exist in the UK on waste which enact a wide range of secondary legislation that governs the storage, collection, treatment and disposal of waste. These are listed below:

- The Environmental Permitting (England and Wales) Regulations 2016;
- Environmental Protection Act 1990;
- The Environment Act 1995;
- The Finance Act 1996;
- Waste Minimisation Act 1998;
- The Waste and Emissions Trading Act 2003; and
- The Clean Neighbourhoods and Environment Act 2005.

#### National Policy Statement for National Networks (NPSNN) 2014

10.2.9 The NPSNN<sup>176</sup> requires that evidence of appropriate mitigation measures (incorporating engineering plans on configuration and layout and use of materials) during both design and construction needs to be presented together with the arrangements for managing any wastes that are produced. It specifically states at paragraph 5.42 that:

*'The applicant should set out the arrangements that are proposed for managing any waste produced. The arrangements described should include information on the proposed waste recovery and disposal system for all waste generated by the development. The applicant should seek to minimise the volume of waste produced and the volume of waste sent for disposal unless it can be demonstrated that the alternative is the best overall environmental outcome.'*

10.2.10 The NPSNN identifies that the Government policy on waste is intended to protect the environment, and human health, by producing less and using it as a resource wherever possible. Where this is not possible, the NPSNN identifies that waste management regulation ensures waste is disposed of in a way that is least damaging to the environment and to human health and that the waste hierarchy is utilised. This includes consideration of the ability for the waste from the development to be dealt with appropriately by waste infrastructure, without having an adverse effect on the capacity of existing waste management facilities to deal with other waste arisings in the area.

#### National Planning Policy for Waste 2014

10.2.11 The National Planning Policy for Waste<sup>177</sup> sets out the detailed waste planning policies for England and has been considered in conjunction with the NPPF, the National Waste Management Plan for England<sup>178</sup> and National Policy Statements for Waste Water<sup>179</sup> and Hazardous Waste<sup>180</sup>.

<sup>176</sup> 6 Department for Transport, 2014. National Policy Statement for National Networks

<sup>177</sup> Department for Communities and Local Government, October 2014. National Planning Policy for Waste

<sup>178</sup> Department for Environment Food & Rural Affairs, 2013. Waste Management Plan for England

<sup>179</sup> HM Government, 2012. National Policy Statement for Waste Water

<sup>180</sup> Department for Environment Food & Rural Affairs, 2013. National Policy Statement for Hazardous Waste

### National Planning Policy Framework 2018

10.2.12 The National Planning Policy Framework (NPPF) sets out the Government's planning policies for England. It does not contain specific materials or waste management policies; however, the framework includes reference to waste management by advocating that waste minimisation forms part of the environmental role of achieving sustainable development.

### Waste Prevention Programme for England 2013

10.2.13 The Waste Prevention Programme is a requirement of the revised Waste Framework Directive (2008/98/EC). The Waste Prevention Programme<sup>181</sup> sets out the roles and actions for government and others to reduce the amount of waste produced in England.

### Environmental Protection Act 1990

10.2.14 The Environmental Protection Act (EPA) defines the fundamental structure and authority for waste management and control of emissions into the environment. It outlines:

- the definition of controlled waste;
- the requirements of the duty of care in respect of waste and transferral of waste;
- the requirements for permits and authorisations; and
- waste collection and waste disposal authorities and their roles.

### The Landfill (England and Wales) Regulations 2002 (as amended)

10.2.15 The Landfill (England and Wales) Regulations 2002 (as amended) require that landfill sites are classified into one of three categories, dependent on the chemical composition of the material. These are hazardous, non-hazardous, and inert. Prior to disposal, all waste must be pre-treated, and waste producers must apply the waste hierarchy in the management of their wastes. If excavated materials are in accordance with the Waste Acceptance Criteria (WAC) testing and Soil Guideline Values (SGVs), then a number of re-use and recycling opportunities exist.

### The Waste Prevention Programme for England 2013

10.2.16 The development of a Waste Prevention Programme<sup>182</sup> is a requirement of the revised Waste Framework Directive (2008/98/EC) and takes forward a commitment in the Government Review of Waste Policy in England 2011<sup>183</sup>. The programme sets a number of objectives to help people and organisations make the most of opportunities to save money by reducing waste.

### The Waste Management Plan for England, 2013

10.2.17 Defra published the National Waste Management Plan for England in July 2013<sup>184</sup>. The plan outlines the waste hierarchy as a guide to sustainable waste management.

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<sup>181</sup> Department for Environment, Food & Rural Affairs, 2013. Waste Prevention Programme for England

<sup>182</sup> Department for Environment, Food & Rural Affairs, 2013. Waste Prevention Programme for England

<sup>183</sup> Department for Environment, Food & Rural Affairs, 2011. Government Review of Waste Policy in England

<sup>184</sup> Department for Environment Food & Rural Affairs, 2013. Waste Management Plan for England



- 10.2.18 The Waste Management Plan for England sets out the Government's ambition to work towards a more sustainable and efficient approach to resource use and management. Positive planning plays a pivotal role in delivering England's waste ambitions through ensuring the re-use, recovery or disposal of waste is undertaken without endangering human health or harming the environment and delivering sustainable development and resource efficiency through all schemes.
- 10.2.19 The plan evaluates how it would support implementation of the objectives and provisions of the revised Waste Framework Directive. It identifies the UK's commitment and success in not only meeting but exceeding its target under the Waste Framework Directive of recovering at least 70% by weight of construction and demolition waste by 2020.

### **Local Policy**

#### Cotswold District Local Plan (2011 – 2031)

- 10.2.20 The Cotswold District Local Plan was formally adopted on 3<sup>rd</sup> August 2018 and sets out the policies and proposals to meet the challenges facing the area over the period 2011-2031.

#### Gloucestershire Minerals Local Plan (1997 – 2006)

- 10.2.21 The Gloucestershire Minerals Local Plan was adopted in April 2003 and provides a plan for the area, with detailed policies to control and guide all future mineral development in the County. A review of the Plan is underway to develop a new plan for the period 2018 – 2032 which has been submitted to the Secretary of State for examination by an appointed planning inspector. Policies in the Emerging Minerals Local Plan of relevance to the proposed scheme are outlined below:

*“SR01 – Maximising the use of secondary and recycled aggregates:*

*Non-mineral developments should use secondary and recycled aggregates in preference to primary aggregates wherever possible and practicable to do so.*

*Major non-mineral developments should maximise the use of secondary and recycled aggregates including building products made from these materials and demonstrate this through supporting evidence.”*

#### Gloucestershire Waste Core Strategy (2012 – 2027)

- 10.2.22 The Waste Core Strategy was adopted in November 2012 and forms part of the local development plan for Gloucestershire, replacing the Gloucestershire Waste Local Plan (2002 – 2012). The Strategy explains how the County Council and its partners will address the issue of planning for waste management in Gloucestershire. Appendix 1 of the Strategy sets out the policies from the Waste Local Plan which have been replaced by the Strategy, and those which have been discarded.
- 10.2.23 Policies of relevance to the proposed scheme are outlined below.

- *“WCS2 – Waste Reduction:*

*All development will be expected to incorporate the principles of waste minimisation and re-use. Planning applications for ‘major’ development must be supported by a statement setting out how any waste arising during the*

*demolition, construction, and subsequent occupation for the development will be minimised and managed.”*

- “WCS4 – Inert Waste Recycling and Recovery:

*In order to help reduce the impact of landfill and achieve the requirements of the Waste Framework Directive (2008) the Council will aim to divert around 85,000 tonnes/year of inert waste from landfill through recycling and recovery operations.”*

- “WCS9 – Hazardous Waste:

*In the interest of moving the management of hazardous waste up the waste hierarchy, proposals for the recycling and recovery of hazardous waste will be supported in principle, where it can be demonstrated that the proposal is ‘environmentally acceptable’ and complies with other relevant development plan policies.”*

### Cotswolds Area of Outstanding Natural Beauty (AONB) Management Plan 2018-2023

- 10.2.24 The Cotswolds AONB Management Plan is a non-statutory plan, which sets out the vision, outcomes and policies for the management of the Cotswolds AONB (‘the AONB’) for the period 2018-2023.
- 10.2.25 The Plan recognises that the movement of waste in and around the AONB has the potential to impact on the local road network, local communities and roadside verges and promotes the reduction of waste in accordance with the waste hierarchy (Policy CE13 Waste management).

### **Guidance**

- 10.2.26 The assessment of the environmental effects associated with the use of material resources and the generation and management of waste resulting from the construction of the proposed scheme has been undertaken in accordance with interim guidance provided from Highways England.
- 10.2.27 At the time of writing Highways England introduced new DMRB, LA 110 Material assets and waste<sup>185</sup>. This will be followed as part of the EIA and reported in the ES.
- 10.2.28 Reference has also been made to the following guidance relating to material resources and wastes:
- LA105 Introduction to Environmental Assessment<sup>186</sup>; and
  - Definition of Waste: Development Industry Code of Practice, Version 2 (Contaminated Land: Applications in Real Environments (CL:AIRE))<sup>187</sup>.

<sup>185</sup> <http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol11/section3/LA%20110%20Material%20assets%20and%20waste-web.pdf>

<sup>186</sup> Highways England, 2019. LA 101 Introduction to environmental assessment

<sup>187</sup> Contaminated Land: Applications in Real Environments (CL:AIRE), 2011. The Definition of Waste: Development Industry Code of Practice Version 2

### Highways England Sustainable Development Strategy (2017)

10.2.29 The Highways England Sustainable Development Strategy<sup>188</sup> sets out Highways England's approach and priorities for sustainable development to their key stakeholders. The strategy outlines several ambitions relating to Financial Capital (climate change adaptation), Human Capital (sustainability leadership), Natural Capital (carbon management), Social Capital (responsible sourcing), and Manufactured Capital (circular economy). Of these ambitions, the following are of relevance to this assessment:

- *“We will more actively manage our carbon emissions: we will examine and focus on business areas where efficiencies can be achieved through reducing fuel, energy and raw material consumption, and all waste generation”.*
- *“We will increase our knowledge of where our goods and materials are sourced from...Ensuring we responsibly source resources is essential, as their production and handling can have local, national and global impacts – on human and social health and also on the environment and climate change”.*
- *“We will push towards a circular approach to our management of resources: minimising our demand for primary resources extracted from the ground and maximise the reuse of the resources already in use on the network. Reutilising them in as high a value function as possible”.*

## 10.3 Study Area

- 10.3.1 There is currently no industry guidance available for defining the study area to be used for material assets and waste assessments. As a result, the study area has been determined through professional judgement based on an understanding of the proposed scheme, encompassing the extent of potential effects. The assessment will use two geographically different study areas to examine the use of material resources and the generation and management of waste.
- 10.3.2 The first study area is based on the area of the works within the DCO site boundary of the proposed scheme, as this constitutes the area within which construction materials would be consumed (used, re-used and recycled) and waste would be generated.
- 10.3.3 The second study area covers an area sufficient to identify feasible sources and availability of construction materials typically required for motorway and all-purpose trunk roads projects, and suitable waste infrastructure that could accept arisings of waste generated by the proposed scheme. The second study area is focused on Gloucestershire, recognising that surrounding counties may need to be considered as necessary. The proximity principle will be taken into account alongside the value for money principle.
- 10.3.4 Based on the guidance, it is outside the scope of the assessment to assess the indirect environmental effects associated with the extraction of raw materials from their original source and the manufacture of products which occur off-site. This stage of a material's life cycle is likely to have already been subjected to an environmental assessment. These effects are therefore not addressed in this chapter. It is also outside the scope of this chapter to undertake an assessment of greenhouse gas emissions associated with the use and transportation of

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<sup>188</sup> Highways England, 2017. Sustainable development strategy: our approach. [online] Accessed 14/06/2019

materials. Chapter 14 includes an assessment of carbon emissions associated with the construction and operation of the proposed scheme.

## 10.4 Potential Impacts

### Construction Impacts

- 10.4.1 For material resource use, the potential environmental effects are associated with the sourcing and transportation of primary raw materials, the sourcing of secondary products and their subsequent transport and use during construction. There are also potential environmental effects associated with the site won material, such as the requirement to transport, store and possibly process any materials during construction.
- 10.4.2 For waste materials, the potential environmental effects are associated with the production, movement, transport, processing and disposal of arisings from site to alternative sites or landfill during construction. The proposed scheme has the potential to generate large amounts of Construction, Demolition and Excavation (CDE) waste which may affect the capacity of Gloucestershire and the wider regions' waste management infrastructure.

### Climate change

- 10.4.3 The PEI Report considers effects related to climate change as per the requirements of EU Directive 2014/52 and the 2017 EIA Regulations. The combined effects relating to material resources for the proposed scheme and potential climate change on receptors includes the risk of contamination through increased heavy rainfall events and flooding which may result in a reduced capacity at both non-hazardous waste landfill facilities and hazardous waste landfill facilities. The increase in frequency of extreme weather events may result in a reduction in quality of available material resources and therefore further reduce capacity at waste landfill facilities.

### *Operation Impacts*

- 10.4.4 Significant effects are considered unlikely during the operation of the proposed scheme, from both the use of material resources and the generation and management of waste. As such, operational impacts have been scoped out of the assessment, in accordance with the scoping opinion.

## 10.5 Assessment Methodology

- 10.5.1 This section sets out the methods that have been employed to undertake the material resource and waste assessment, with reference to published standards, guidelines and best practice.
- 10.5.2 The assessment of the environmental effects associated with the use of material resources and the generation and management of waste resulting from the construction of the proposed scheme has been undertaken in accordance with guidance provided within LA 110.
- 10.5.3 This guidance document, alongside the use of professional judgement and emerging best practice, will be used to assess environmental value, magnitude of impact and the significance of environmental effects from the use of material resources.

## Identification of Baseline

- 10.5.4 The existing baseline conditions have been identified as the receptors which have the potential to be impacted by the proposed scheme. This includes the source of materials required for the construction of the proposed scheme, and waste management facilities which may be used for the treatment or disposal of waste. The baseline conditions have been informed by desk-based studies and information from ground investigations, including (but not limited to) data from:
- The Environment Agency;
  - Defra;
  - Gloucestershire County Council; and
  - local development policies and topic papers.
- 10.5.5 To identify the baseline conditions, data has also been collected from Highways England and members of the design team on the materials which are likely to be used during each stage of the proposed scheme, and the waste that is likely to arise.

## Assessment of Construction Impacts

- 10.5.6 For the purposes of assessing the effects associated with materials use and waste, the Detailed Assessment that will be presented in the ES is a quantitative exercise which identifies the following:
- the types and quantities of materials required for the project;
  - details of the source/origin of materials, site-won materials to replace virgin materials, materials from secondary/recycled sources or virgin/non-renewable sources;
  - the cut and fill balance;
  - the types and quantities of forecast waste arisings from the project, including the identification of any forecast hazardous wastes;
  - surplus materials and waste falling under regulatory controls;
  - waste that requires storage on site prior to re-use, recycling or disposal;
  - waste to be pre-treated on site for re-use within the project;
  - wastes requiring treatment and/or disposal off site;
  - the impacts that would arise from the issues identified in relation to materials and waste;
  - the impacts on capacity of waste management infrastructure;
  - a conclusion about the magnitude and nature of the impacts; and
  - the identification of measures to mitigate the identified impacts.

## Assessment Criteria

- 10.5.7 LA 110 guidance has been used to inform the significance criteria for the proposed scheme, alongside professional judgement.
- 10.5.8 The effects on material resources shall be assessed in accordance with Table 10-2. A sense check will be undertaken using professional judgment to ensure that the significance of criteria as determined in the matrix is in broad accordance with the definitions outlined in Table 10-2.

**Table 10-2 Description of Significance of Effects**

Significance category	Description
Neutral	<p>Material Assets</p> <ul style="list-style-type: none"> <li>No reduction or alteration in the availability of material assets at a regional scale (relating to the resources the project has used).</li> </ul> <p>Waste</p> <ul style="list-style-type: none"> <li>No reduction or alteration in the capacity of waste infrastructure at a regional scale.</li> </ul>
Slight	<p>Material Assets</p> <ul style="list-style-type: none"> <li>Requires ≤50% of primary materials to be sourced nationally (with other primary materials sourced at a lower geographic scale); and</li> <li>comprises re-used/recycled aggregate (alternative materials) above the higher of the relevant regional or national percentage target (refer to appendix 2).</li> </ul> <p>Waste</p> <ul style="list-style-type: none"> <li>≤1% reduction or alteration in the regional capacity of waste infrastructure; and</li> <li>waste infrastructure has sufficient capacity to accommodate waste from a project, without compromising integrity of the receiving infrastructure (design life or capacity) within the region.</li> </ul>
Moderate	<p>Material Assets</p> <ul style="list-style-type: none"> <li>&gt;50% of primary materials to be sourced nationally (with other primary materials sourced at a lower geographic scale); and</li> <li>comprises re-used/recycled aggregate (alternative materials) below the lower of the relevant regional or national percentage target (refer to appendix 2).</li> </ul> <p>Waste</p> <ul style="list-style-type: none"> <li>&gt;1% reduction or alteration in the regional capacity of waste infrastructure as a result of accommodating waste from a project.</li> <li>1-50% of project waste requires disposal outside of the region.</li> </ul>
Large	<p>Material Assets</p> <ul style="list-style-type: none"> <li>&gt;50% of primary materials to be sourced internationally;</li> <li>sterilises ≥1 mineral safeguarding site and/or peat resource; and</li> <li>comprises no re-used/recycled aggregate (alternative materials).</li> </ul> <p>Waste</p> <ul style="list-style-type: none"> <li>&gt;1% reduction or alteration in the regional capacity of waste infrastructure as a result of accommodating waste from a project; and</li> <li>&gt;50% of project waste requires disposal outside of the region.</li> </ul>
Very large	<p>Material Assets</p> <ul style="list-style-type: none"> <li>No criteria: use criteria for large category.</li> </ul> <p>Waste</p> <ul style="list-style-type: none"> <li>&gt;1% reduction or alteration in national capacity of waste infrastructure, as a result of accommodating waste from a project; or</li> <li>the project would require new (permanent) waste infrastructure to be constructed to accommodate waste.</li> </ul>
<p><i>Table notes:</i></p> <ul style="list-style-type: none"> <li>'Region' means the local authority/authorities comprising the second study area.</li> <li>'Primary materials': Materials that are from a non-renewable source (also referred to as 'virgin' materials.).</li> <li>'Peat resource': existing or potential peat extraction sites.</li> </ul>	

10.5.9 Significance of effects on material assets and waste shall be reported in accordance with the criteria in Table 10-3.

**Table 10-3 Significance criteria for material assets & waste**

Significance	Description
Not significant	Material assets category description met for neutral, slight or moderate effect.  Waste category description met for neutral or slight effect.
Significant (one or more criteria met)	Material assets category description met for large effect.  Waste category description met for moderate, large or very large effect.
<i>NOTE: Where projects have a material surplus, re-use / recycling of material can be achieved by use on other sites in line with sustainability principles and the CL:AIRE Definition of Waste Code of Practice ISBN 978-1-905046-23-2 [Ref 1.1].</i>	

## 10.6 Baseline Conditions

- 10.6.1 The baseline environment is comprised of receptors which have been identified based on the likely impacts set out in LA 110.
- 10.6.2 The proposed scheme would require both primary raw materials, such as stone and soil, and manufactured construction materials such as concrete, asphalt and steel.
- 10.6.3 The manufactured construction materials would be sourced from established suppliers who regularly provide materials for similar sized projects. The suppliers have not yet been determined, but the contractor would ensure that they are suppliers with adequate resources to meet the quantitative needs of the proposed scheme, without having a negative influence on their resources. Where possible, materials would be provided from local sources in accordance with the proximity principle, although the contractor would work to ensure a balance with the value for money principle. The sensitivity of the manufactured material sources is thus considered to be low.
- 10.6.4 The sensitivity of the raw material sources has been determined through the availability of minerals in the second study area (with a focus on Gloucestershire).
- 10.6.5 In addition, information for the UK<sup>189</sup> has also been provided as a national comparison. This information has been determined through a desk study using readily available resources, including from the Minerals Products Association, International Steel Statistics Bureau, and Gloucestershire County Council.
- 10.6.6 Table 10-4 outlines the UK demand, in terms of sales, of minerals and mineral products in 2016, and 2018 for steel.

<sup>189</sup> Where information is not available for the UK due to the differing governing authorities for England, Wales and Scotland, England has been used to provide the national comparison.

**Table 10-4 Materials Demand in the UK**

Mineral	UK demand (year)
Aggregates of which: <ul style="list-style-type: none"> <li>Crushed rock</li> <li>Sand and gravel – land won</li> <li>Sand and gravel – marine won</li> <li>Recycled and secondary</li> </ul>	247 million tonnes (2016) <sup>190</sup> : <ul style="list-style-type: none"> <li>113.9 million tonnes</li> <li>48.6 million tonnes</li> <li>14.1 million tonnes</li> <li>70.5 million tonnes</li> </ul>
Cementitious (including imports) of which: <ul style="list-style-type: none"> <li>Cement (including imports)</li> <li>Other cementitious materials (fly ash, ground clay bricks (GCBs))</li> </ul>	15 million tonnes (2016): <ul style="list-style-type: none"> <li>12 million tonnes</li> <li>3 million tonnes</li> </ul>
Ready-mixed concrete	56.1 million tonnes (2016)
Concrete products	25.8 million tonnes (2016)
Asphalt	25.2 million tonnes (2016)
Dimension stone	1 million tonnes (2016)
Steel	10.72 million tonnes (2018) <sup>191</sup>

- 10.6.7 At a regional level, Table 10-5 outlines the most recent publicly available information on the aggregate sales and reserves in Gloucestershire (for 2016). Aggregates produced across Gloucestershire include crushed rock from Carboniferous and Jurassic limestone, sand and gravel mostly made up of sharp sand with small amounts of soft sand, and recycled aggregates from construction, demolition and excavation wastes.
- 10.6.8 The landbank for crushed rock across Gloucestershire, at the end of 2016, was 24.32 million tonnes, which indicates that reserves may be available to meet projected demand for just under 17 years according to analysis undertaken by Gloucestershire County Council. For sand and gravel the landbank, at the end of 2016, was 4.41 million tonnes, with the remaining length of this landbank being close to six years.
- 10.6.9 Therefore, in regard to the trend in the amount of remaining permitted reserves, in Gloucestershire, these continue to be in decline and now equate to an overall fall of 15% from 2012.

<sup>190</sup> Minerals Products Association (2016) The Mineral Products Industry at a Glance: 2016 Edition [online] available at: [http://www.mineralproducts.org/documents/Mineral\\_Products\\_Industry\\_At\\_A\\_Glance\\_2016.pdf](http://www.mineralproducts.org/documents/Mineral_Products_Industry_At_A_Glance_2016.pdf) (last accessed June 2019)

<sup>191</sup> International Steel Statistics Bureau (2017) Steel Demand [online] available at: <http://issb.co.uk/news/news/uk.html> (last accessed June 2019)



**Table 10-5 Materials Demand in Gloucestershire for 2016192**

Aggregate	Sales (million tonnes)	Average 10-year sales (million tonnes per annum)	Average 3-year sales (million tonnes per annum)	LAA rate per year (million tonnes)	Reserve (million tonnes)	Landbank (remaining years)	Theoretical capacity (million tonnes per annum)
All land-won sand and gravel	0.701mt	0.742mtpa	0.573mtpa	0.742mt	4.41mt	5.94 years	Up to 1.22mtpa
Crushed rock	1.652mt	1.452mtpa	1.540mtpa	1.452mt	24.32mt	16.75 years	Up to 2.33mtpa
Recycled / secondary aggregates	0.139mt	-	-	0.139mt*	-	-	-

10.6.10 The sensitivity of off-site raw material resources in Gloucestershire is considered to be medium due to the declining trend in available materials.

#### Material resources (on-site)

##### *Mineral safeguarding areas and peat resources*

10.6.11 There is a Mineral Resource Area (MRA) for sandstone and limestone, as identified on the policies (proposals) map for the existing Minerals Local Plan<sup>193</sup>. This MRA is located within the footprint (the first study area) of the proposed scheme. Changes proposed under the Emerging Minerals Local Plan have been documented and include a Minerals Safeguarding Area for sandstone and limestone within the footprint of the proposed scheme.

10.6.12 The designation of Minerals Safeguarding Areas aims to ensure that non-minerals development doesn't needlessly prevent the future extraction of mineral resources which are of local and national importance.

10.6.13 As such, the sensitivity of on-site material resources is considered to be high.

#### **Generation and management of waste**

10.6.14 The most recent information available relating to current waste generation and operational waste facilities in Gloucestershire has been gathered to provide the baseline for this assessment. As stated above, information for the UK<sup>194</sup> has also been provided as a national comparison. Information on the current waste arisings, and the waste management facilities have been determined through a desk-top study, using a number of readily available resources, in particular data from the Environment Agency, Defra and Gloucestershire County Council.

<sup>192</sup> Gloucestershire County Council (2017) The Sixth Local Aggregates Assessment for Gloucestershire [online] available at: <https://www.gloucestershire.gov.uk/media/18811/publication-draft-6th-laa-2016-update.pdf> (last accessed June 2019)

<sup>193</sup> Gloucestershire County Council (2018) Policies (Proposals) Map [online] available at: <https://www.gloucestershire.gov.uk/planning-and-environment/planning-policy/policies-proposals-map/> (last accessed June 2019)

<sup>194</sup> Where information is not available for the UK due to the differing governing authorities for England, Wales and Scotland, England has been used to provide the national comparison.

### Waste generation

10.6.15 The latest data from the Environment Agency<sup>195</sup> as shown in Table 10-6 indicates that Gloucestershire produced over 2.5 million tonnes of waste in 2017. England produced over 210 million tonnes of waste in 2017, which was managed in 9,264 permitted waste facilities.

**Table 10-6 Waste Management by Type in 2017**

Site type	Gloucestershire (tonnes)	England (tonnes)
Landfill	619,000	45,419,000
Transfer	417,000	46,129,000
Treatment (excluding metal recycling sector)	716,000	78,147,000
Metal recovery	176,000	15,697,000
Incinerated	0	12,992,000
Use of waste	20,000	168,000
Land disposal	561,000	13,555,000
<b>Total</b>	<b>2,509,000</b>	<b>212,107,000</b>

10.6.16 With respect to construction and demolition waste, Table 10-7 sets out the latest information for Gloucestershire and England, taken from the latest Environment Agency data. These figures indicate that a total of 1.236 million tonnes of construction and demolition waste was managed or disposed of under permits during 2017.

**Table 10-7 Construction and Demolition Waste Management by Type in 2017**

Site type	Gloucestershire (tonnes)	England (tonnes)
Landfill	291,000	29,680,000
Transfer	159,000	15,270,000
Treatment (excluding metal recycling sector)	179,000	25,820,000
Metal recovery	26,000	2,216,000
Use of waste	20,000	82,000
On/In Land (Recovery)	561,000	11,951,000
<b>Total</b>	<b>1,236,000</b>	<b>85,019,000</b>

10.6.17 Regarding construction and demolition hazardous waste, Table 10-8 below outlines the quantities managed and deposited in Gloucestershire, in 2017, as taken from the Environment Agency data.

**Table 10-8 Hazardous Waste Managed and Deposited in 2017**

Hazardous waste	Gloucestershire (tonnes)	England (tonnes)
Managed	240	604,200
Deposited in Landfill	4,820	392,900
<b>Total</b>	<b>5,060</b>	<b>997,100</b>

<sup>195</sup> Environment Agency (2018) Waste Management for England 2017 [online] available at: <https://www.gov.uk/government/publications/waste-management-data-for-england> (last accessed June 2019)

### *Potential hazardous waste arisings*

10.6.18 Sources of contamination have been considered within the proposed scheme boundary. There are no authorised or historic landfills within the study area. However, as indicated in chapter 9 there may be potential contamination risks from general highways use and agricultural land use. For more information on the potential contamination risks see chapter 9.

### Waste management facilities

- 10.6.19 The most recent data from Gloucestershire County Council on the capacity of their waste management facilities is outlined in their adopted Waste Core Strategy<sup>196</sup> from 2012, along with the associated evidence base documents that informed the strategy, with data relating to the period 2008 – 2010. Consultation with Gloucestershire County Council is ongoing to determine whether there is any more recent data available.
- 10.6.20 The Waste Core Strategy identifies four operational landfills in Gloucestershire; three non-hazardous sites (Hempsted in Gloucester, and Wingmoor Farm West and Wingmoor Farm East near Bishop's Cleeve, Tewkesbury Borough), and one hazardous site (Wingmoor Farm East near Bishop's Cleeve, Tewkesbury Borough). The remaining capacity, recorded in March 2009, for non-hazardous waste, was 6,029,500m<sup>3</sup> which equates to at least 10-13 years input, and for hazardous waste was 1,206,200m<sup>3</sup> which equates to 22 years input.
- 10.6.21 In addition to permitted construction and demolition waste management sites, inert material is also managed on sites that have an Environment Agency environmental permit exemption. These exempt sites generally comprise land restoration activities such as restoring mineral voids, engineering / landscaping schemes and for beneficial improvements to land. These sites are an important part of the provision of the capacity for managing inert materials. Although small tonnages of waste from other waste streams (e.g. biodegradable waste) may be managed at locations with an exemption, the largest tonnage of exempt activities is likely to involve construction and demolition material.
- 10.6.22 In 2007, there were 2,139 exempt sites, listed by the Environment Agency, in Gloucestershire, and it was estimated that there was around 1.25 million m<sup>3</sup> of capacity in the County<sup>197</sup>. These sites are often short-lived, and therefore should be identified upon commencement of construction.
- 10.6.23 In regard to recovery and recycling facilities, there are 29 permanent permitted inert waste recycling and recovery facilities in Gloucestershire<sup>198</sup>. These manage construction and demolition waste, through transfer, treatment, crushing and screening, and storage.
- 10.6.24 The capacity for construction and demolition waste management through permitted facilities in Gloucestershire, in 2010, was estimated to be 504,000 tonnes per annum<sup>199</sup>.
- 10.6.25 The sensitivity of off-site waste management infrastructure is considered to be low.

<sup>196</sup> Gloucestershire County Council, 2012. Waste Core Strategy.

<sup>197</sup> [https://www.gloucestershire.gov.uk/media/8107/technical\\_evidence\\_paper\\_wcs-a\\_data\\_-2010\\_update-43159.pdf](https://www.gloucestershire.gov.uk/media/8107/technical_evidence_paper_wcs-a_data_-2010_update-43159.pdf)

<sup>198</sup> [https://www.gloucestershire.gov.uk/media/8107/technical\\_evidence\\_paper\\_wcs-a\\_data\\_-2010\\_update-43159.pdf](https://www.gloucestershire.gov.uk/media/8107/technical_evidence_paper_wcs-a_data_-2010_update-43159.pdf)

<sup>199</sup> [https://www.gloucestershire.gov.uk/media/8107/technical\\_evidence\\_paper\\_wcs-a\\_data\\_-2010\\_update-43159.pdf](https://www.gloucestershire.gov.uk/media/8107/technical_evidence_paper_wcs-a_data_-2010_update-43159.pdf)

## 10.7 Consultation

- 10.7.1 Consultation with Gloucestershire County Council is ongoing to determine whether the Council holds any updated information on the capacity of waste management facilities in the region. The ES will be updated with this information.

## 10.8 Assessment Assumptions and Limitations

- 10.8.1 The baseline information has been based on publicly available information at this stage. Consultation will be undertaken with Gloucestershire County Council to obtain the most recent information held on the capacity of waste management infrastructure to inform the ES.
- 10.8.2 Given the early stages of design, estimates relating to the quantity of secondary materials required are not available nor are there estimates available relating to the quantity of waste arisings anticipated. As such, a qualitative assessment has been carried out at this stage, limited to identifying activities that are likely to require significant quantities of materials, or are likely to produce significant quantities of waste.
- 10.8.3 Indicative cut and fill volumes for the proposed scheme are provided in Table 10-12. These volumes have been estimated based on the latest design information available and are likely to change as the design of the proposed scheme evolves. Therefore, the estimated cut and fill volumes will be reviewed and updated to inform the assessment for the ES. An overview of the gaps and uncertainties is provided in Table 10-9.

**Table 10-9 Gaps and Uncertainties**

Gaps and Uncertainties	Description
Confirmation of types and quantities of materials required for the proposed scheme and estimated waste arisings.	To be developed pending further ground investigation.
Earthworks strategy including management of excess material.	To be developed as part of the EIA. Potential opportunity for reuse on local projects.
Off-site material sources and suppliers.	To be confirmed by the contractor at detailed design stage.
Measures for transporting materials and waste to and from site including any access or haul roads.	To be confirmed by the contractor at detailed design stage.
Measures incorporated into the design to ensure sustainable use of resources and minimisation of waste arisings.	A Construction Environmental Management Plan (CEMP), and this CEMP will include a Site Waste Management Plan. Proposals for the handling of waste material will be in accordance with the CLAIRE Definition of Waste Code of Practice.
Whether any invasive species would need to be removed from site.	An Outline Invasive Species Management Plan will be produced as part of the Outline CEMP.

## 10.9 Design, Mitigation and Enhancement Measures

### Mitigation through engineering design

- 10.9.1 The earthworks process allows for the materials which will be excavated on site to be re-used at areas of the site where materials are required. This reduces the amount of material that is required from off-site sources. Initial estimations show that a large surplus of material would arise through the earthworks. Work is

ongoing to determine how much of this material can be re-used on site through for example retaining walls and other structures and discussions are ongoing to determine whether some of the material could be re-used off-site on other projects within the region. It may also be possible to reuse the local stone from the earthworks for the creation of dry-stone walls, in keeping with the character of the local environment. The final ES will provide further information.

### Construction Mitigation

- 10.9.2 It would likely be necessary to remove some unsuitable and excess materials from site which may result on impacts on waste management infrastructure and the local road network. A Site Waste Management Plan would be produced as part of the Outline CEMP accompanying ES. This will detail the estimated quantities of waste material and the opportunities for reuse, recycling, recovery or disposal.
- 10.9.3 In order to limit the quantity of material that may be required to be disposed of to landfill thereby reducing impacts on local waste management infrastructure, the materials would be sorted/processed and where necessary treated (through for example, sorting and drying onsite) and the materials disposed of or reused as appropriate for the particular waste stream. The pre-treatment of waste material prior to disposal is a requirement of the waste regulations. By minimising the quantity of materials to be disposed of offsite the associated Heavy Goods Vehicles (HGV) movements would also be reduced thereby reducing impacts on the local road network.
- 10.9.4 Table 10-10 sets out the proposed mitigation measures associated with each project activity.

**Table 10-10 Proposed Mitigation Measures**

<b>Project Activity</b>	<b>Potential impacts associated with material resource use/waste management</b>	<b>Description of mitigation measures</b>	<b>How the measures would be implemented, measured and monitored</b>
Site clearance	Waste disposal	Reuse on site where possible. Recycle/recovery opportunities.	The CEMP will include a Site Waste Management Plan and Materials Management Plan to implement, measure and monitor waste. Material to be reused on site where possible. Any excess materials to be sorted and where practical disposed of to local recycling facilities.
Earthworks	Use of primary resources Waste disposal	Reuse of site won materials in earthworks. Reuse of site won materials off-site on other local projects. Limit disposal and movements.	Design to maximise the earthworks balance. The CEMP will include a Site Waste Management Plan to implement, measure and monitor waste.
Pavement planning	Waste disposal	Reuse as sub base in footpaths. Reuse in pavement	Design to maximise the earthworks balance.

Project Activity	Potential impacts associated with material resource use/waste management	Description of mitigation measures	How the measures would be implemented, measured and monitored
		construction. Reuse elsewhere.	The CEMP will include a Site Waste Management Plan to implement, measure and monitor waste.

## 10.10 Assessment of Effects

10.10.1 This section assesses the potential effects of the materials used and waste generated during construction of the proposed scheme.

### Construction Effects

#### Use of material resources

10.10.2 A variety of different materials would be required for the construction phase of the proposed scheme. The proposed scheme has been designed to reduce the quantity of imported construction materials, as well as reduce the quantities of waste taken off site by reusing or recycling the available existing materials along the proposed scheme.

10.10.3 The types of materials required for the construction and operational phase of the proposed scheme are listed in Table 10-13 and are based on the Design Fix 2 information.

10.10.4 There would be a net import of secondary construction materials required for the proposed scheme, which could potentially have an effect on material sources. The contractor would work to ensure that materials are imported from established local or regional suppliers who regularly provide materials for commercial projects. The quantities of the common construction materials required is not yet available however would be relatively large in the context of the material suppliers. This will be assessed as part of the ES.

**Table 10-11 Material Resources Required**

Project Activity	Material resources required for the project	Quantities of material resources required	Additional information on material resources
Cut and fill	General fill, including earth embankments (mainline and side roads).	Not available at this stage.	Sourced from material won on site.
Landscaping	Topsoil required for new verges and earthworks.	Not available at this stage.	Likely to be a reuse of site won material.
Installation of pavement	Type 1 sub-base Base Binder Surface course	Not available at this stage.	Potential to reuse site won materials. If not suitable, material would be sourced from local quarries due to programme requirements (within 15 miles radius).
Installation of manufactured products	Drainage, kerbs, traffic signs, lighting, safety barriers etc.	Various quantities relative to road length and necessary safety measures.	Sourced from local suppliers.

Project Activity	Material resources required for the project	Quantities of material resources required	Additional information on material resources
Structures	Concrete, including pre-cast structures.	Various quantities relative to road length and necessary safety measures.	Local batching plants. Majority of precast factories in the UK are situated in the Midlands.
	Steel	Various quantities relative to road length and necessary safety measures.	Likely to be sourced from a national supplier. Closest availability would be Somerset/South Wales.
Total balance of materials		Not available at this stage.	

10.10.5 Modelling is ongoing to determine the final earthworks estimations. Preliminary earthworks estimations are set out in Table 10-12. This includes earthworks at Shab Hill junction but at this stage does not take into account that material would be re-used for retaining walls and other structures. In particular, opportunities exist to re-use material for the restoration of the detrunked existing carriageway, and this will be considered in the earthworks estimations in the ES.

10.10.6 Whilst the current calculations predict an excess of 837,332 m<sup>3</sup> of primary raw material associated with the construction of the proposed scheme, this is a worst-case calculation and it is anticipated that the final surplus will be closer to the region of 750,000m<sup>3</sup>. Due to the excess of material, it is anticipated that raw material required from offsite sources will be minimal and therefore the impact on these sources is unlikely to be significant. This will be assessed as part of the ES.

**Table 10-12 Earthworks Estimates**

Segment	Cut (m <sup>3</sup> )	Fill (m <sup>3</sup> )	Net (m <sup>3</sup> )
1 – Mainline Chainage CH 0 - 900	14,266.10	85,677.49	-71,411.39
2 – Mainline Chainage CH 900 - 2420	616,907.00	64,141.97	552,765.03
3 – Mainline Chainage CH 2420 - 4040	396,751.49	441,301.20	-44,549.71
4 – Mainline Chainage CH 4040 - 5850	192,207.70	51,156.20	141,051.50
5 – Overbridge over B4070 (South) Excluding Structure	26,782.05	7,497.89	19,284.16
6 – A436 Mainline Chainage CH 0 - 1050	247,563.77	7,371.27	240,192.50
<b>TOTAL</b>	<b>1,494,478.11</b>	<b>657,146.02</b>	<b>837,332.09</b>

#### Use of material sources (on-site)

10.10.7 The earthworks required for the new road and bridges would involve cutting into existing topography.

10.10.8 The primary material gained from the excavation works is considered to be of high importance as there are regional proposals in place to safeguard the material. Further assessment is ongoing and will be documented as part of the

final ES to identify the suitability of the primary won material for reuse. For the purposes of the assessment at this stage, it has been assumed that the material would be suitable for reuse. The sensitivity of the material resources on-site is considered to be high due to its location in a proposed Minerals Safeguarding Area, however the site is situated within an AONB and as such it is unlikely that the primary material would ever be quarried. The impact on the availability of these minerals is therefore not considered to be significant. This will be assessed as part of the ES.

#### Estimated waste arisings

10.10.9 The types of waste arisings associated with the construction phase of the proposed scheme are listed in Table 10-13.

**Table 10-13 Estimated Waste Arisings**

<b>Project Activity</b>	<b>Waste arisings from the project</b>	<b>Quantities of waste arisings</b>	<b>Additional information on waste arisings</b>
Site remediation/ preparation/ earthworks	Vegetation surface strip and trees. Existing traffic signs, lighting columns and foundations, safety barriers and kerbs.	Not available at this stage.	Likely to be a combination of reuse on site, local recycling facilities, disposal at an inert or non-hazardous landfill site.
Demolition	Bridge, house and road demolition including supports, rails, voids.	Not available at this stage.	Some material may be suitable for reuse on site. The remaining would likely be managed through a combination of local recycling facilities, disposal at an inert or non-hazardous landfill site.
Site construction	Surface planning's.	Not available at this stage.	Likely to be a combination of reuse on site, local recycling facilities, disposal at an inert or non-hazardous landfill site.
	Site won material (hazardous).	Not available at this stage.	Any hazardous material would be taken to a licensed waste management facility.
Total mixed C&D waste	Not available at this stage.		
Total mixed hazardous C&D waste	Not available at this stage.		

10.10.10 Site clearance works would include the clearance of existing trees, safety barriers, concrete kerbs, lighting columns and traffic signs. The materials would be segregated and appropriately recycled on site or disposed of at an appropriate waste handling facility. Several existing structures would require demolition. Materials that may be won during the demolition works, and which may potentially be reused, are set out below:

- bituminous pavement material;
- aggregate sub-base;
- fill and landscaping material;
- reinforced concrete and concrete;
- masonry and brickwork; and
- reinforcement and structural steelwork.



- 10.10.11 Where possible, demolition materials proposed for reuse would be appropriately processed to meet specification requirements.
- 10.10.12 Earthworks estimates predict an excess of 837,332m<sup>3</sup> of earthwork material. This figure will be more accurately calculated once ground investigation and detailed design information is available. The intention is to reuse as much material as possible on site, however there is a potential that some material would need to be removed to offsite material or waste management facilities.
- 10.10.13 The amount of waste likely to arise throughout the construction of the proposed scheme is yet to be confirmed, however it is assumed that there would be limited material taken off site and as such is not considered to be significant.

## 10.11 Monitoring

- 10.11.1 Procedures would be adopted by the contractor during construction to control the use of materials and further reduce the impact. This will be documented in the Outline CEMP which will include an Outline Site Waste Management Plan (SWMP) that will detail the estimated quantities of waste material and the opportunities for reuse, recycling, recovery or disposal. Materials would be responsibly sourced (i.e. must have a certified provenance, traceability and sustainability) where possible, in order to reduce the impact on the highways network and material resources. Responsible sourcing is defined in BS8902 – Responsible sourcing sector certification schemes for construction projects – Specification as:

*“the management of sustainable development in the provision or procurement of a product”.*

- 10.11.2 Where sustainable development is further defined as:

*“an enduring, balanced approach to economic activity, environmental responsibility and social progress”.*

- 10.11.3 In order to comply with responsible sourcing principles, the contractor would, for example:

- refer to standard BES 6001 - The Responsible Sourcing of Construction Products; and
- ensure suppliers are certified by the Forest Stewardship Council (FSC) or Programme for the Endorsement of Forest Certification (PEFC).

## 10.12 Summary of Preliminary Assessment

- 10.12.1 The likely significance of environmental effects from the use of material resources, and the generation and management of waste resulting from the construction and operation of the proposed scheme, are summarised in this section.
- 10.12.2 Where materials excavated on site are initially unable to meet the re-use criteria they would either be treated to make them suitable for use or, as a last resort, disposed of off-site as waste. Effective treatment would be in the form of drying out of materials which is unlikely to need a licence and would offset the need for imported material resources and reduce the requirements for disposal.

- 10.12.3 During the construction phase, standard best construction practice would be adopted. The Outline CEMP will be provided as part of the final ES and set out the controls for material storage.
- 10.12.4 This approach for managing materials is consistent with the waste hierarchy defined in the Waste Framework Directive (Directive 2008/98/EC). Adopting the waste hierarchy would significantly reduce the amount of material requiring offsite disposal and hence reduce potential impacts relating to movement of materials both on to and off the site.
- 10.12.5 A detailed strategy will be developed, in accordance with the waste management hierarchy, and set out in a SWMP as part of the Outline CEMP, with an aim to reduce the amount of material that would need to be disposed of off-site, and to avoid landfill use, instead aiming for the materials to be reused on other sites.

#### Preliminary construction assessment

- No significant impacts are anticipated during construction.

#### Preliminary operation assessment

- No significant impacts are anticipated during operation.

#### **Further Work**

- 10.12.6 The information presented is preliminary and is based on the proposed scheme design, as described in chapter 2. A list of missing information has been provided in Table 10-9. Further EIA work is currently being undertaken to confirm the scale and significance of environmental impacts arising from the proposed scheme design. The final EIA will be reported within the ES, which will accompany the DCO application.

# 11 Noise and Vibration

## 11.1 Introduction

- 11.1.1 This chapter of the PEI Report describes the findings of the noise and vibration assessment of the scheme, during construction and operation.
- 11.1.2 A description is given of the baseline noise climate, assessment methodology, results and conclusions for the ‘Detailed’ assessment approach as described in DMRB HD 213/11<sup>200</sup>.

## 11.2 Legislative and Policy Framework

### Legislation

#### EIA Regulations (Town and Country Planning (Environmental Impact Assessment) Regulations 2017)

- 11.2.1 The EIA Regulations<sup>201</sup> enact the amended EU directive<sup>202</sup> “on the assessment of the effects of certain public and private projects on the environment” and sets out the assessment requirements for certain types of planning applications in England. The Regulations describe the types of project subject to a formal Environmental Impact Assessment to support the planning application, and how the process of assessment, consulting, mitigation and decision-making should be carried out.

#### The Environmental Noise (England) (Amendment) Regulations 2018

- 11.2.2 These Regulations implement EC Directive 2002/49/EC<sup>203</sup> (Environmental Noise Directive), on the assessment and management of environmental noise in England. Specifically, the Regulations enact the EC requirements for Noise Action Planning to promote good health and good quality of life (wellbeing) through the effective management of noise. The latest 2018 amendment to the Regulations provides for new common noise assessment methods for five-yearly Action Plans.

#### Land Compensation Act

- 11.2.3 The Land Compensation Act<sup>204</sup> Part 1 entitles property or land owners to apply for compensation if the value of their property goes down because of pollution or disturbance from the use of a new or altered road<sup>205</sup>.

#### Noise Insulation Regulations

- 11.2.4 The Noise Insulation Regulations (NIR)<sup>206</sup> define the conditions under which dwellings are eligible for noise insulation to control internal noise levels. The conditions relate to the level of traffic noise at the façade, the increase in noise

<sup>200</sup> THE HIGHWAYS AGENCY, TRANSPORT SCOTLAND, WELSH ASSEMBLY, DRD (2011), Design Manual for Roads and Bridges Volume 11, Section 3, Part 7, HD 213/11 – Revision 1, TSO

<sup>201</sup> TSO, (2017) Town and Country Planning (Environmental Impact Assessment) Regulations 2017

<sup>202</sup> European Union Directive (2014), Directive 2014/52/EU of The European Parliament and of The Council, on the assessment of the effects of certain public and private projects on the environment.

<sup>203</sup> EUROPEAN COMMISSION, Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise - Declaration by the Commission in the Conciliation Committee on the Directive relating to the assessment and management of environmental noise, EC, 2002.

<sup>204</sup> HMSO (1973), Land Compensation Act, HMSO

<sup>205</sup> <https://www.gov.uk/compensation-road-property-value>

<sup>206</sup> HMSO (1988), Noise Insulation (Amendment) Regulations, HMSO

levels as a result of the highway, and the contribution of the new or altered project to the noise level received at the façade. In summary, noise insulation qualification criteria require that:

- the façade noise threshold of 68dB<sub>L<sub>pA</sub>10,18h</sub> is met or exceeded;
- there must be a noise increase of at least 1dB(A) compared to the prevailing noise level immediately before the works to construct or improve the highway were begun;
- the noise caused by traffic on new or altered roads makes an effective contribution of at least 1dB(A); and
- the property is 300m or less from the nearest point on the carriageway of a highway to which the Regulations apply.

## National Policy

11.2.5 The Government's noise policy is set out in the Noise Policy Statement for England (NPSE)<sup>207</sup>. In legislative and policy terms, noise is taken to include vibration.

11.2.6 Government noise policy sets three aims, which are to be met within the context of the government policy on sustainable development:

- to avoid significant adverse impacts on health and quality of life;
- to mitigate and reduce adverse impacts on health and quality of life; and
- where possible, contribute to the improvement of health and quality of life.

11.2.7 The same three aims are also reflected in:

- National Planning Policy Framework (NPPF)<sup>208</sup>;
- Planning Practice Guidance – Noise (PPG-Noise)<sup>209</sup>; and
- the National Policy Statement for National Networks (NPSNN)<sup>210</sup> (Department for Transport (DfT), 2014).

11.2.8 PPG-Noise provides guidance on the application of Government noise policy. PPG-Noise notes that unacceptable adverse effects on health and quality of life due to noise exposure (set at a level higher than significant adverse impacts on health and quality of life) should be 'prevented'<sup>211</sup>.

11.2.9 NPSNN states that excessive noise can impact on the '*...use and enjoyment of areas of value (such as quiet places) and areas with high landscape quality*'. Further to this, paragraph 5.188 of the NPS notes that the degree of noise impact will depend on the:

- '*proximity of the proposed development to quiet places and other areas that are particularly valued for their tranquillity*<sup>212</sup>, acoustic environment or

<sup>207</sup> Department for Environment Food and Rural Affairs (2010), Noise Policy Statement for England (NPSE)

<sup>208</sup> Revised, Department for Communities and Local Government (2018), National Planning Policy Framework, <http://www.communities.gov.uk/publications/planningandbuilding/nppf>

<sup>209</sup> Department for Communities & Local Government (2014), Planning Practice Guidance – Noise, <http://planningguidance.communities.gov.uk/blog/guidance/noise/noise-guidance/>

<sup>210</sup> Department for Transport (2014), National Policy Statement for National Networks (NPSNN)

<sup>211</sup> PPG-N defines an unacceptable adverse effect as 'noticeable and very disruptive', with outcomes described as 'Extensive and regular changes in behaviour and/or an inability to mitigate effect of noise leading to psychological stress or physiological effects, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory'.

<sup>212</sup> Άλσο, παραγραφή 180(β) οφ της ΝΠΠΦ ηας α ρεθυρεμεντ το: □ιδεντιψμ ανδ προτεχτ τρανθυιλ αρεασ ωηιχη ηαπε ρεμαινεδ ρελατιω ελμ υνδιστυρβεδ βμ νοισε ανδ αρε πριζεδ φορ τηειρ ρεχρεατιοναλ ανδ αμενιτμ παλυε φορ τηισ ρεασον.□

*landscape quality such as National Parks, the Broads or Areas of Outstanding Natural Beauty*; and

- *‘the proximity of the proposed development to designated sites where noise may have an adverse impact on the special features of interest, protected species or other wildlife.’*

11.2.10 Paragraph 5.194 of the NPS also requires that:

*‘The project should demonstrate good design through optimisation of scheme layout to reduce noise emissions and, where possible, the use of landscaping, bunds or noise barriers to reduce noise transmission.’*

11.2.11 Thresholds for identifying adverse effect levels in terms of Government noise policy<sup>213</sup> are not clearly defined numerically in any published Government document. Rather they are to be established specifically for each scheme and context and may include some professional judgement depending on the local circumstances or specific receptor. The values adopted for this assessment, unless a justified variation was made for an individual receptor, were established through consultation with Highways England. These thresholds are discussed later in this chapter (paragraph 11.5.43).

11.2.12 The general thresholds adopted to identify noise policy adverse effect levels have been applied following the precedent set on recent major infrastructure schemes.

11.2.13 With regard to AONBs and National Parks, DEFRA’s 25-year plan<sup>214</sup> (2018) states:

*‘Over the next 25 years, we must significantly cut all forms of pollution and ease the pressure on the environment. We must ensure that noise and light pollution are managed effectively.’*

11.2.14 In addition to Government noise policy, the scope and methodology for this assessment has also taken account of relevant guidance, particularly DMRB HD213/11 as described in Table 11-1.

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<sup>213</sup> Adverse effects, significant adverse effects and unacceptable adverse effects on health and quality of life

<sup>214</sup> Department for Environment Food and Rural Affairs (2018), A Green Future: Our 25 Year Plan to Improve the Environment [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/693158/25-year-environment-plan.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/693158/25-year-environment-plan.pdf)

## Local Policy

11.2.15 Table 11-1 sets out local policy requirements and key considerations for residential communities and the AONB.

**Table 11-1 Local Planning and Environmental Policies and Strategies**

Local policy document	Extract relevant to noise and vibration assessment
<p>Adopted Cotswold Local Plan (2011-2031)  <a href="https://www.cotswold.gov.uk/media/1621895/Cotswold-District-Local-Plan-2011-2031-Adopted-3-August-2018-Web-Version.pdf">https://www.cotswold.gov.uk/media/1621895/Cotswold-District-Local-Plan-2011-2031-Adopted-3-August-2018-Web-Version.pdf</a></p>	<p>Policy EN15 Pollution and Contaminated Land  <i>'1. Development will be permitted that will not result in unacceptable risk to public health or safety, the natural environment or the amenity of existing land uses through:</i>  <i>a. pollution of the air, land, surface water, or ground water sources; and/or,</i>  <i>b. generation of noise or light levels (pollution), or other disturbance such as spillage, flicker, vibration, dust or smell.'</i>            Clause 10.15.5 under EN15: <i>'Noise should not give rise to significant adverse impacts on health and quality of life. Acceptable noise levels will vary according to the source, receptor and time, and the policy is not intended to unduly restrict existing established businesses which may need to develop.'</i></p>
<p>Gloucester, Cheltenham and Tewkesbury Joint Core Strategy (2011-2031)  <a href="https://www.jointcorestrategy.org/">https://www.jointcorestrategy.org/</a></p>	<p>Policy SD4: Design Requirements  <i>'iii. Amenity and space;</i>  <i>New development should enhance comfort, convenience and enjoyment through assessment of the opportunities for light, privacy and external space, and the avoidance or mitigation of potential disturbances, including visual intrusion, noise, smell and pollution.'</i></p>
<p>Draft Tewkesbury Borough Plan (2011-2031)  <a href="https://minutes.tewkesbury.gov.uk/documents/s23896/Borough%20Plan%20Document.pdf">https://minutes.tewkesbury.gov.uk/documents/s23896/Borough%20Plan%20Document.pdf</a></p>	<p>Policy ENV1 Special Landscape Areas  <i>'Proposals must demonstrate that they do not adversely affect the quality of the natural and built environment, its visual attractiveness, wildlife and ecology, or detract from the quiet enjoyment of the countryside.'</i></p>
<p>Cotswolds AONB Management Plan (2018-2023)  <a href="https://www.cotswold.gov.uk/media/1547669/N5027-Cotswolds-AONB-management-plan-2013-18-adopted-pre-publication.pdf">https://www.cotswold.gov.uk/media/1547669/N5027-Cotswolds-AONB-management-plan-2013-18-adopted-pre-publication.pdf</a></p>	<p>Outcome 6 (Tranquillity):  <i>'The tranquillity of the Cotswolds AONB will have been conserved and enhanced, with fewer areas being affected by noise pollution and other aural and visual disturbance.'</i></p> <p>Policy CE4: Tranquillity  <i>'1. Proposals that are likely to impact on the tranquillity of the Cotswolds AONB should have regard to this tranquillity, by seeking to (i) avoid and (ii) reduce noise pollution and other aural and visual disturbance.</i>  <i>2. Measures should be taken to enhance the tranquillity of the Cotswolds AONB by (i) removing and (ii) reducing existing sources of noise pollution and other aural and visual disturbance.'</i></p>

Local policy document	Extract relevant to noise and vibration assessment
	<i>'Policy CE4 has an emphasis on noise. This incorporates issues such as significant increases in traffic in the towns, villages and smaller settlements of the AONB, including increased traffic arising from developments outside of the AONB.'</i>
<p>Cotswolds AONB Position Statements  <a href="https://www.cotswoldsaonb.org.uk/our-landscape/position-statements-2/">https://www.cotswoldsaonb.org.uk/our-landscape/position-statements-2/</a></p> <p>Position Statement (2019) on Dark Skies &amp; Artificial Light:  <a href="https://www.cotswoldsaonb.org.uk/wp-content/uploads/2019/03/Cotswolds-Dark-Skies-Artificial-Light-Position-Statement.pdf">https://www.cotswoldsaonb.org.uk/wp-content/uploads/2019/03/Cotswolds-Dark-Skies-Artificial-Light-Position-Statement.pdf</a></p> <p>Position Statement (2016) on Development in the setting of the Cotswolds AONB:  <a href="https://www.cotswoldsaonb.org.uk/wp-content/uploads/2017/08/setting-position-statement-2016-adopted-with-minor-changes-30616-1.pdf">https://www.cotswoldsaonb.org.uk/wp-content/uploads/2017/08/setting-position-statement-2016-adopted-with-minor-changes-30616-1.pdf</a></p>	<p>Position Statement (2019) on Dark Skies &amp; Artificial Light UK Government Policy and National and Local Planning Policies</p> <p>The Position Statement cites the Government's Rural White Paper published in 2003 which observed that:</p> <p><i>"It is not just its physical features which give the countryside its unique character; there are also less tangible features such as ... dark skies and remoteness from the visible impact of civilisation."</i></p> <p><i>The White Paper went on to state that: "Increased measures will be taken to promote tranquillity". Influences on tranquillity in the countryside identified in the White Paper included light pollution.'</i></p> <p>Position Statement (2016) on Development in the setting of the Cotswolds AONB.</p>
<p>Position Statement (2015) on Public Rights of Way: <a href="https://www.cotswoldsaonb.org.uk/wp-content/uploads/2017/08/public-rights-of-way.pdf">https://www.cotswoldsaonb.org.uk/wp-content/uploads/2017/08/public-rights-of-way.pdf</a></p>	<p><i>'Development proposals that affect views into and out of the AONB need to be carefully assessed to ensure that they conserve and enhance the natural beauty and landscape character of the AONB.'</i></p> <p><i>'The level of harm from any proposal does [...] have to be considered and expressed in terms of: (i) harm directly to land in the designated AONB itself which is the significant issue and (ii) [...] harm to land outside the designated AONB that is viewed in the context or backdrop of the AONB.'</i></p> <p>Position Statement (2015) on Public Rights of Way</p> <p><i>'Highway Authorities have a duty to have regard to the purposes of AONB designation and all the councils have endorsed the Cotswolds AONB Management Plan.'</i></p> <p><i>'Highway authorities also have a duty to prepare a Rights of Way Improvement Plan (ROWIP). The ROWIP, some of which are now part of the authorities' Local Transport Plan, must consider what the current and likely future needs of the public are, and present proposals for how the authority will improve the network to meet those needs.'</i></p> <p><i>'The public rights of way network is the main way for residents and visitors to explore and enjoy the Cotswolds and is important to the area's economy. The Board therefore expects to see a safe, pleasant, well maintained, clearly waymarked and better-connected PROW network available for all, making the</i></p>

Local policy document	Extract relevant to noise and vibration assessment
	<i>Cotswolds AONB a place for positive, high quality experiences. An adequate network is needed for walkers, cyclists (on- and off-road), horseriders and carriage drivers.'</i>
<p>Cotswolds Conservation Board Position Statement – Tranquillity (2019)</p> <p><a href="https://www.cotswoldsaonb.org.uk/wp-content/uploads/2019/06/Tranquillity-Position-Statement-FINAL-June-2019.pdf">https://www.cotswoldsaonb.org.uk/wp-content/uploads/2019/06/Tranquillity-Position-Statement-FINAL-June-2019.pdf</a></p>	<p>The Position Statement makes multiple recommendations to preserve and enhance tranquillity in the Cotswolds AONB. Tranquillity is defined, in part, as <i>'a state of calm and quietude'</i> that is <i>'free from man-made noise'</i>. Tranquillity is <i>'one of the features of the Cotswolds that makes the area so outstanding that it is in the nation's interest to safeguard it.'</i> The Statement notes that tranquillity is the basis for the enjoyment of other special qualities in the AONB and cites survey evidence that tranquillity ranks number 1 as the quality people value in the countryside.</p> <p>The Position Statement expands the Cotswolds AONB Management Plan 2018-202, Policy CE4 (Tranquillity), which states that proposals impacting on tranquillity should <i>'(i) avoid and (ii) reduce noise pollution and other aural and visual disturbance'</i>, as well as enhance the tranquillity of the AONB by <i>'(i) removing and (ii) reducing existing sources of noise pollution'</i>.</p> <p>With regard to highway noise, the recommendation aligns closely with the Government's Noise Policy Statement (NPS) for England and associated policy documents<sup>215</sup>:</p> <p><i>'The Board recommends that Highways England and other highways authorities should ensure that highway schemes within the Cotswolds AONB support the aims of the Noise Policy Statement (NPS) for England:</i></p> <ul style="list-style-type: none"> <li>• <i>To avoid significant adverse noise effects</i></li> <li>• <i>To mitigate and reduce adverse noise effects</i></li> <li>• <i>To improve the noise environment where possible'</i></li> </ul> <p>Additionally, a recommendation is made about noise levels on minor roads since significant noise levels can be generated by higher traffic levels and/or larger, noisier vehicles such as HGVs (heavy goods vehicles):</p> <p><i>'The Board recommends that proposals that have the potential to affect the tranquillity of minor roads should assess baseline and anticipated noise levels on such roads.'</i></p>

<sup>215</sup> See paragraph 11.2.7 of this chapter.



## Guidance

### DMRB – Environmental Assessment, Volume 11, Section 3, Part 7

- 11.2.16 The DMRB is the guidance and standard for the design of a new road or improvements to an existing road. Volume 11 section 3 part 7: HD 213/11 Revision 1 sets out the method for assessing noise and vibration associated with road traffic. HD 213/11 provides guidance on the selection of the scheme assessment area and the relevant assessment years. The assessment presented in this PEI Report has been based upon these procedures. Paragraph A1.13 notes that assessment should consider designated areas such as AONB.

### Calculation of Road Traffic Noise

- 11.2.17 HD 213/11 requires that road traffic noise is calculated under the method described in Calculation of Road Traffic Noise<sup>216</sup> (CRTN). This describes a procedure for determining the level of noise from the highway based upon the traffic flow parameters, road surface, propagation distance, screening, intervening ground cover and topographical features between the highway and receptor. This is the accepted methodology to quantify traffic noise levels for use with highway noise assessment procedures.

### BS 5228-1:2009+A1:2014 and BS 5228-2 Code of Practice for noise and vibration on construction and open sites

- 11.2.18 BS 5228<sup>217</sup> provides guidance on the assessment and control of noise and vibration from construction operations. The Standard contains detailed information on noise reduction measures and promotes the 'best practicable means' approach to control noise and vibration to reduce the impact on residents and construction workers. A methodology for predicting construction noise is included. The Standard also provides criteria for vibration disturbance to people.

### BS 7385-2 Evaluation and measurement for vibration in buildings – Guide to damage levels from groundborne vibration

- 11.2.19 BS 7385-2<sup>218</sup> provides criteria for the effects of vibration upon buildings.

### BS ISO 4866: 2010 Mechanical vibration and shock – Vibration of fixed structures – Guidelines for the measurement of vibrations and evaluation of their effects on structures

- 11.2.20 BS ISO 4866<sup>219</sup> provides damage categories methodologies for the measurement and effects of vibration upon buildings. BS 8233: 2014 Guidance on sound insulation and noise reduction for buildings.

<sup>216</sup> DEPARTMENT OF TRANSPORT WELSH OFFICE (1988), Calculation of Road Traffic Noise, HMSO

<sup>217</sup> BRITISH STANDARDS INSTITUTION (2014) BS 5228-1:2009+A1:2014 and BS 5228-2:2009+A1:2014 Code of Practice for Noise and Vibration Control on Open Construction Sites

<sup>218</sup> BRITISH STANDARDS INSTITUTION (1993) BS 7385-2 *Evaluation and measurement for vibration in buildings – Guide to damage levels from groundborne vibration*, British Standards Institution

<sup>219</sup> BRITISH STANDARDS INSTITUTION (2010) BS ISO 4866: 2010, Mechanical vibration and shock – Vibration of fixed structures – Guidelines for the measurement of vibrations and evaluation of their effects on structures, British Standards Institution

- 11.2.21 BS 8233<sup>220</sup> provides advice for the control of noise in and around buildings and guidance criteria for noise levels inside new buildings.

## 11.3 Study Area

- 11.3.1 The determination of the operational assessment study area has been based on the HD 213/11 guidance. For the 'Detailed' level of assessment used for this study, HD 213/11 requires that a quantitative noise impact study is made for all noise sensitive properties within 600m of the scheme. Also, sections of existing roads within 1 km of the scheme that are predicted to be subject to a change in noise level of more than 1dB(A) as a result of the scheme at the 'baseline' year (or 3dB(A) in the 'future' year), are also assessed<sup>221</sup> within a 600m calculation area. The terms 'baseline' and 'future' years are used in HD 213/11 for the noise assessment. These are defined as follows in paragraph 3.8 of the guidance:

*'For an assessment of permanent noise and vibration impacts, the baseline year is taken as the opening year of the road project' ... 'The future assessment year for operation is typically the 15<sup>th</sup> year after the opening year of the road project, but in some circumstances this may occur before the 15<sup>th</sup> year. For example, inspection of the traffic model outputs may highlight that the greatest traffic flows do not occur in the 15<sup>th</sup> year.'*

- 11.3.2 Existing roads subject to a change of 1dB(A) or more were identified by forecast traffic changes arising from the scheme. HD 213/11 notes that a change in noise level of 1dB(A) is associated with an increase in flow by at least 25% or decrease by 20% in the scheme opening year. The area for which these detailed quantitative calculations are made is defined as the calculation area (HD 213/11).
- 11.3.3 DMRB HD 213/11 requires consideration of potential noise impacts on existing roads outside the study area<sup>222</sup>, where traffic increases are forecast to be greater than 25% in the short-term. These are described as 'affected' links. This assessment will be carried as part of the ES but has not been included in this PEI Report.
- 11.3.4 The study area for the construction assessment comprises noise-sensitive properties within approximately 300m from the proposed works, although receptors at greater distances will be considered in some cases where it is considered there could be adverse effects on sensitive locations. BS 5228 notes that the prediction results should be treated with caution at distances greater than this (as the prediction results may be less reliable).

## 11.4 Potential Impacts

### Construction Impacts

- 11.4.1 The construction works would include a major area of cutting excavation in the northern part of the scheme which is likely to be the area of most prolonged works. There are three areas of proposed junction works including a grade-separated junction at Shab Hill. Away from the major cutting and junctions, the new or improved carriageway works would progress more rapidly along the

<sup>220</sup> British standards institution (2014) BS 8233 Guidance on sound insulation and noise reduction for buildings, British Standards Institution

<sup>221</sup> The more sensitive test is the 1dB change in the baseline year.

<sup>222</sup> i.e. 1km from the scheme, including existing routes that are being bypassed or improved.

scheme, and hence would be alongside any one receptor location for a shorter period. The Environmental Assessment Report<sup>223</sup> from the options scheme stage indicated that significant adverse effects are not expected to occur, but this was subject to more detailed assessment as the design progressed. The potential for effects at the area of the major cutting is considered to be an area where potential impacts are most likely, and this will be the area of focus for this PEI Report based upon the available scheme information prior to the ES.

### Operation Impacts

- 11.4.2 Operational noise impacts would be greatest where the proposed scheme would be closer to nearby noise sensitive receptors than the existing highway. Where the distance between the highway and receptor is halved (or even closer), there is the potential for significant adverse effects. Minor changes in alignment, particularly where the receptors are some distance from the existing highway, would be less likely to result in impacts as the proportionate change in distance would be small. Conversely, there are locations where the scheme would be substantially further from receptors such that there is the potential for significant beneficial effects. The Environmental Assessment Report<sup>224</sup> assessed that there would be adverse noise effects at some residential properties close to the realigned scheme. However, it was assessed that there that there would be more beneficial noise effects overall because of those residential areas that would be further from the realigned scheme.

## 11.5 Assessment Methodology

### Value of receptor

- 11.5.1 In addition to residential receptors, the guidance for noise assessment in HD 213/11 identifies a range of non-residential properties as noise sensitive, which should also be considered in the assessment. These include hospitals, schools, community facilities and designated areas<sup>225</sup> including cultural heritage assets and public rights of way. HD 213/11 does not specifically assign levels of sensitivity to different types of receptor. However, sensitivity has been considered in the assessment based on common practice for noise assessment. Therefore, residential receptors, hospitals and schools are considered high sensitivity (with regard to noise and vibration). Community facilities maybe high or medium sensitivity depending on their specific use. This also applies to other non-residential sensitive receptors such as footpaths and outdoor amenity areas, where each case must be assessed according to its use.

### Magnitude of impacts

#### Construction noise

- 11.5.2 The noise assessment from the construction of the scheme has been determined using BS 5228–1:2009+A1:2014. This standard provides information on the prevention and control of construction noise and includes a procedure for predicting construction noise. Calculations of noise levels at selected receptors have been based on typical noise levels for construction processes (mainly taken

<sup>223</sup> Mott MacDonald Sweco (February 2019) Environmental Assessment Report

<sup>224</sup> Mott MacDonald Sweco (February 2019) Environmental Assessment Report

<sup>225</sup> (e.g. AONB, National Park, SSI SAC, SPA, SSSI, SM).

from BS 5228). Calculations also take account of propagation distance, details of the intervening ground cover, topography and screening.

- 11.5.3 Temporary impacts from construction noise may be caused, for example, by construction activities associated with site clearance, earthworks and laying of pavements.
- 11.5.4 The assessments have been undertaken at locations that may be representative of several dwellings or other sensitive receptors. For groups of properties, receptors are chosen to be representative of the worst-case (most exposed) location in the group of properties. Where a receptor has multiple uses the assessment has been made based on the most sensitive use. For the PEI Report, the assessment has focused on the most intensive areas of construction work as described in section 11.8 (Assessment Assumptions and Limitations). A more detailed assessment will be carried out in the ES.
- 11.5.5 Construction noise levels have been predicted as the logarithmic average over a calendar month as an  $L_{Aeq,T}$ . The predictions consider the variation in the programme and the working area for the period assessed. The assessment results present the range of monthly noise levels for a specified assessment location.
- 11.5.6 The predictions are presented as façade levels relating to a position 1m from the building, or as a free-field<sup>226</sup> level for sensitive receptors in open spaces such as country parks or outdoor amenity areas. The assessment considers monthly noise levels, but construction noise levels would vary day-to-day. Highest daily levels may sometimes be around 5dB(A) higher than the monthly level but would also be substantially lower on other days in that month.
- 11.5.7 Many of the construction processes would move progressively along the line of route. For these processes, noise levels have been considered for the worst-case month, i.e. when the process is closest to the receptor.

#### Construction vibration

- 11.5.8 Ground-borne vibration during the construction of the proposed scheme may potentially arise due to the use of percussive rock-breaking machinery and compaction plant. The PEI Report will focus on the major areas of work; other processes will also be considered when a more detailed assessment is carried out for the ES. Impacts at sensitive receptors will be dependent on their proximity to the works and the intervening screening and ground conditions.
- 11.5.9 The effects in terms of people's response are expected to be governed mainly by the type of activities undertaken and their associated noise emission, although public liaison and prior notice of potential impacts are also important factors. Effects in terms of cosmetic or structural damage to buildings may also be a factor to consider where buildings are exposed to levels of vibration much higher than the lowest perceptible levels.
- 11.5.10 BS 5228–2:2009+A1:2014 provides a methodology for predicting typical levels of vibration from certain types of construction activities, based on case study data and empirical models. This will be used in the ES to consider the likelihood that vibration from the works may exceed the thresholds for perception and

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<sup>226</sup> Free Field: An external sound field in which no significant sound reflections occur (apart from the ground).

disturbance. For the PEI Report, detailed information on construction plant that would generate vibration is limited, but an assessment of the likelihood of vibration effects has been made based on the most intensive types of plant machinery that would be used.

### Operational noise

- 11.5.11 Geographical Information Systems (GIS) have been used to construct a three-dimensional noise model of the prescribed calculation area for the proposed scheme. The model includes highways, terrain data, buildings and other structures that might screen or reflect noise, and types of ground cover.
- 11.5.12 For each road link in the model, data on traffic flow, speed<sup>227</sup>, proportion of heavy goods vehicles (HGVs) and road surface type were obtained for inclusion into the model. Once the data were complete and the inputs checked, noise level calculations were carried out according to the CRTN methodology. Traffic noise levels were calculated across a grid of receptor positions over the calculation area, and contours of noise level exposure were established. Additional calculations were also conducted at specific assessment locations to represent noise sensitive receptors (e.g. residential properties). The study area and calculation area according to HD 213/11 are defined in paragraph 11.3.1 and PEI Report figure 11.1.
- 11.5.13 The traffic data used in the model were those forecasted under the 'Do-Something' and 'Do-Minimum' scenarios<sup>228</sup> in the baseline year<sup>229</sup> 2024 and those in the future assessment year. The assessment year is the year of maximum projected traffic flow within 15 years of opening – in this case, the design year (2039). The traffic modelling approach and data verification will be described in the Transport Report which will be submitted as part of the DCO.
- 11.5.14 The noise prediction model was used to calculate noise levels within the noise calculation area, at a height of 4m above local ground, in terms of the free-field  $L_{A10,18h}$  index in accordance with CRTN methodology, as required by HD 213/11.
- 11.5.15 The  $L_{A10,18h}$  index represents the arithmetic mean of all the hourly values of  $L_{A10}$  during the period between the hours of 06:00 and 24:00. The CRTN procedure is based upon empirical noise data assuming the wind blowing from the source to receptor (i.e. worst-case wind direction). The CRTN prediction therefore assumes an adverse wind component to represent a typical worst-case scenario. The additional advice given in HD 213/11 has been adopted regarding CRTN procedures. These include revisions to vehicle classification, traffic data and corrections due to road surface.
- 11.5.16 For the purposes of this assessment, the  $L_{A10,18h}$  results are converted to the corresponding  $L_{Aeq}$  scale for daytime noise, i.e.  $L_{Aeq,16h}$  (see Glossary in appendix 11.1). This provides a direct comparison with the quantitative  $L_{Aeq}$  criteria described later for assessing significance with respect to the Government's noise policy (NPSE). The  $L_{Aeq,16h}$  scale has also been adopted for traffic noise

<sup>227</sup> The traffic speeds for the assessment were determined for each section of highway following the procedure given in Interim Advice Note 185/15 which provides supplementary advice to users of DMRB Volume 11, SECTION 3, PART 1 (HA207/07) and PART 7 (HD213/11). The note provides advice on the assessment of link speeds and generation of speed-bands for use with scheme noise assessments.

<sup>228</sup> DMRB terms for assessment scenarios, i.e. 'Do-Something' being with scheme and 'Do-Minimum' being without-scheme.

<sup>229</sup> HD 213/11 Para 3.6 notes that: 'For an assessment of permanent noise and vibration impacts, the baseline year is taken as the opening year of the road project.'

assessment as part of the government's WebTAG methodology for environmental impact assessment, which will be undertaken alongside the ES.

- 11.5.17 As part of the procedure for a Detailed Assessment, HD 213/11 requires that the magnitude of the noise impact is reported using a scale of magnitude to describe the increase or decrease in noise level associated with the proposed scheme. The magnitude scale is described in more detail in the section on assessment criteria (from paragraph 11.5.55).
- 11.5.18 The assessment has considered short-term and long-term noise impacts as described in DMRB HD213/11. This assessment has focused primarily on the long-term change (i.e. with-scheme 2039 (Do-Something) vs without-scheme 2024 (Do-Minimum), as this is the likely worst-case considering traffic growth and represents the permanent effect of the scheme. The Do-Minimum 'future assessment' year (i.e. design year) was also considered to determine whether any effects identified are as a consequence of traffic growth.
- 11.5.19 In addition, traffic noise nuisance reporting tables are also stipulated in HD 213/11 for a Detailed assessment. The noise nuisance level is presented in percentage bands relating to the change in percentage of people 'bothered' by the noise change. For the Do-Minimum scenario, the change in 'steady state' nuisance between the baseline and future years is reported. For the Do-Something scenario, it is the highest increase in nuisance that occurs between the baseline and future assessment years for each dwelling that is reported (or the least beneficial reduction in noise) in accordance with HD 213/11 methodology.
- 11.5.20 Eligibility for sound insulation measures under the Noise Insulation Regulations 1975 (as amended 1988) will be considered in the ES.

#### Operational night-time noise

- 11.5.21 The HD 213/11 Detailed Assessment also requires night-time noise is also assessed. The  $L_{\text{night}}$  descriptor is used to represent the noise level at dwellings between the hours of 23:00 and 07:00. Method 3 from the Transport Research Laboratory (TRL) report PR/SE/451/02<sup>230</sup> was used for predicting  $L_{\text{night}}$  noise levels. Method 3 uses daily traffic flow data converting predicted daytime noise levels ( $L_{A10,18h}$ ) to night-time noise levels. This method was considered appropriate as there was nothing atypical in the proportionate traffic flow volumes for this route between daytime and night-time.
- 11.5.22 The assessment of impact magnitude for night-time noise follows the same method as that for daytime.

#### Operational vibration

- 11.5.23 DMRB HD213/11 requires that the effects of vibration are considered where appropriate. In the case of groundborne vibration, the likelihood of perceptible vibration being caused is particularly dependent upon the smoothness of the road surface. Research has shown that wayside vibration is only caused by heavy vehicles travelling at speed over large discontinuities in the road surface.

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<sup>230</sup> Abbott, PG & Nelson PM (2002), PR/SE/451/02, Converting the UK traffic noise index  $L_{A10,18h}$  to EU noise indices for noise mapping, TRL

11.5.24 It is a requirement of new highway construction specification that the surface would be smooth and free from any discontinuities of this magnitude (25mm). Paragraph A5.26 of DMRB HD213/11 states that:

*“Such vibrations are unlikely to be important when considering disturbance from new roads and an assessment will only be necessary in exceptional circumstances.”*

11.5.25 No such exceptional circumstances, such as vibration-sensitive laboratories or other facilities requiring very low vibration environments have been identified near the scheme as part of the baseline receptor studies for the PEI Report. Hence no impacts or effects from groundborne vibration from traffic are predicted.

11.5.26 DMRB HD213/11 covers the potential for airborne noise from heavy goods vehicles to cause vibration nuisance close to main roads. As an indication of the scale of impact, paragraph A6.21 of HD213/11 states that:

*“For a given level of noise exposure the percentage of people bothered very much or quite a lot by vibration is 10% lower than the corresponding figure for noise nuisance.”*

11.5.27 It also notes that airborne vibration is expected to affect a very small percentage of people at exposure levels below 58dB<sub>LA10,18hr</sub> and the significance of any change in airborne traffic vibration can be considered proportional to the significance of changes in traffic noise. The assessment of airborne vibration can therefore be considered included within the assessment of airborne noise.

### **Assessment scenarios**

11.5.28 The assessment scenarios were those specified in HD 213/11 for the ‘baseline’ and ‘future’ years.

11.5.29 In this case the future year is 15 years after opening, i.e. the scheme design year (2039). These traffic data were included in the noise model to produce predictions for the following scenarios:

- Do-Minimum (without the scheme) ‘baseline’ year at completion of scheme construction (2024);
- Do-Minimum (without the scheme) ‘future’ year (design year) (2039);
- Do-Something (with the scheme) ‘baseline’ year at the completion of scheme construction (2024); and
- Do-Something (with the scheme) ‘future’ year (design year) (2039).

### **Assessment of significance**

#### Approach to assessment of effects – all sources and receptors

11.5.30 The method for identifying likely significant effects of noise and vibration from construction and operation of the scheme, as required by the EIA Regulations, draws on best practice from other major infrastructure projects, and is aligned with DMRB HD213/11 and Government noise policy.

11.5.31 Taking Government noise policy (Defra 2010) and PPG-Noise (DCLG, 2014) together, they are based on the premise that once noise becomes perceptible, the effect on people in dwellings and other receptors used by people (for example schools and hospitals) increases as the total level of noise increases.

Government policy and practice guidance defines four levels of effect on health and quality of life in increasing severity:

- no effect;
- adverse effect;
- significant adverse effect; and
- unacceptable adverse effect.

11.5.32 It follows from Government noise policy NPSE, PPG-Noise and NPSNN that thresholds should be set to define the onset of the following levels of effect:

- Lowest Observed Adverse Effect Levels (LOAEL) to identify the onset of adverse impact on health and quality of life;
- Significant Observed Adverse Effect Levels (SOAEL) to identify the onset of significant impacts on health and quality of life.

11.5.33 These thresholds must be identified to achieve the Government policy aims to 'avoid significant adverse impacts on health and quality of life; to mitigate and reduce adverse impacts on health and quality of life; and, where possible, contribute to the improvement of health and quality of life'.

11.5.34 In an explanatory note, NPSE states: 'It is not possible to have a single objective noise-based measure that defines SOAEL that is applicable to all sources of noise in all situations. Consequently, the SOAEL is likely to be different for different noise sources, for different receptors and at different times.'. The Policy notes that these thresholds should reflect the nature of the noise source, the sensitivity of the receptor and the local context. Assessment criteria for this study are defined in a later section (from paragraph 11.5.43).

#### Significant adverse effects on health and quality of life

11.5.35 The EIA Regulations require the identification of 'likely significant effects'. Where the calculated noise or vibration indicates a significant adverse impact on health and quality of life (i.e. the noise level exceeds the relevant SOAEL threshold – criteria defined in Table 11-3 to Table 11-7), then this is assessed as a likely 'significant observed adverse effect' at each receptor. For example, such noise levels would disrupt activities indoors, as described in the assessment framework given in PPG-Noise.

#### Adverse effects on health and quality of life

11.5.36 In line with best practice, DMRB HD213/11 and previous projects, this assessment also identifies likely 'significant adverse effects'. This describes effects that are an adverse impact on health and quality of life and are significant in the EIA, but which are not significant in terms of Government noise policy (paragraph 11.5.32). Specifically, this describes a situation when the construction or operational noise is greater than the relevant LOAEL but is less than the SOAEL (see Table 11-3 to Table 11-7).

11.5.37 In this case, the basis for assessing a likely significant effect is the change in noise caused by the scheme, with consideration of other factors such as the existing level of noise exposure. With regard to PPG-Noise, such likely significant effects relate, for example, to a change in the "acoustic character" of an area due to a noise increase or decrease as a result of the scheme.



11.5.38 Table 11-2 summarises how noise levels in terms of Government noise policy and change in noise levels (in terms of DMRB HD213/11) have been used to identify likely significant effects.

11.5.39 In considering whether the level of effect is significant in EIA terms, the assessment criteria described in paragraph 11.5.61 are also considered.

#### Types of receptor, direct and indirect effects

11.5.40 The assessment approach considers a range of receptors and effects:

- residential receptors: direct effects – exceeding the SOAEL;
- residential receptors: direct effects – between LOAEL and SOAEL;
- non-residential receptors: direct effects;
- all above receptors: indirect effects - i.e. those effects not resulting directly from the scheme itself, such as changes in noise on existing roads due to construction traffic, or additional traffic on existing roads due to operation of the scheme.

11.5.41 Regarding indirect effects - the assessment has considered likely noise or vibration effects from temporary or permanent changes in traffic on existing roads caused by the proposed scheme. As for direct effects, the assessment of indirect effects is based on evaluating the likely change in noise or vibration levels at receptors alongside each road, based on the anticipated change in traffic type and numbers.

11.5.42 The criteria used to assess the significance of the above effects for different receptor types and noise exposure levels are described in the section “Assessment Criteria”.

**Table 11-2 Noise and Vibration Assessment Approach to Address both the EIA and Government Policy Requirements**

	Perception	Government policy		EIA		Mitigation		
		Effect	Action	Assessment	Effect	Project	Receptor	
Increasing level of noise or vibration ↓	Not noticeable	No observed effect	No specific measures required	Special cases	<u>No adverse effect</u>	Special cases	None	
	Noticeable and not intrusive	No observed adverse effect	No specific measures required					
	Lowest observed adverse effect level – LOAEL							
	Noticeable and intrusive	Observed adverse effect	Mitigate and reduce to a minimum	Noise level change as indicator of impact/effect magnitude + contextual significance criteria	Change or absolute level may cause <u>adverse effect</u> on acoustic character. May be considered significant in EIA terms	Maximise mitigation as far as sustainable	None	
	Significant observed adverse effect level – SOAEL							
	Noticeable and disruptive	Significant observed adverse effect	Avoid	Exceeding SOAEL is a significant effect	<u>Significant adverse effect</u>	Maximise mitigation as far as sustainable. Prevent UAELs where possible	Noise insulation	
Noticeable and very disruptive	Unacceptable adverse effect	Prevent	Exceeding UAEL is a significant effect	Potentially re-house where noise is from the scheme				

Assessment criteria

11.5.43 Assessment criteria have been established that respond to the requirements of:

- Government policy set out in NPSE, NPPF, NPSNN and PPG- Noise;
- DMRB HD213/11;
- relevant regulations, guidance and standards; and
- best practice as set by previous relevant projects.

*Construction noise assessment criteria*

11.5.44 Potential adverse effect thresholds in Government policy terms have been established based upon the ABC Method described in BS5228-1:2009+A1:2014. These thresholds, described in Table 11-3, have been used to establish assessment criteria for monthly average construction noise levels. The numerical thresholds for the ABC method are defined in Table 11-4. These criteria have been used to derive LOAEL and SOAEL thresholds for this assessment.

**Table 11-3 LOAEL and SOAEL Thresholds for Construction Noise at all Receptors in Terms of Government Policy**

Time period	LOAEL	SOAEL	Notes
Day (0700-1900 weekday and 0700-1200 Saturdays)	Exceeds existing $L_{Aeq,T}$ noise level	Threshold level determined as per BS 5228-1 section E3.2 (see Table 11- 4 below)	LOAEL is set at a level where construction noise becomes the dominant source.  SOAEL is set where construction noise exceeds BS5228 thresholds (see Table 11- 4).  Existing noise level shall be determined based on ambient noise monitoring, noise model prediction or estimation based on published noise level datasets (for example Defra Noise Mapping <sup>231</sup> )
Night (2300-0700)	Exceeds existing $L_{Aeq,T}$ noise level	Threshold level determined as per BS 5228-1 section E3.2	
Evening and weekends (time periods not covered above)	Exceeds existing $L_{Aeq,T}$ noise level	Threshold level determined as per BS 5228:2009 + A2014 section E3.2	

11.5.45 The threshold of potential adverse effect described in BS5228-1:2009+A1:2014 according to the ABC method is evaluated in accordance with Table 11-4

**Table 11-4 Threshold of Potential Significant Effect at Dwellings According to ABC Method – from BS 5228–1:2009 + A1:2014**

Assessment category and threshold value period	Threshold value, dB(A)		
	Category A	Category B	Category C
Night-time (23:00 – 07:00)	45	50	55
Daytime (07:00 – 19:00) and Saturdays (07:00 – 13:00)	65	70	75
Other: Weekday evenings (19:00 – 23:00) Saturdays (13:00 – 23:00) Sundays (07:00 – 23:00)	55	60	65

Category A: threshold value to use when ambient noise levels (rounded to the nearest 5dB) are less than these values  
Category B: threshold value to use when ambient noise levels (rounded to the nearest 5dB) are the same as Category A values  
Category C: threshold value to use when ambient noise levels (rounded to the nearest 5dB) are higher than Category A values.

11.5.46 The ABC method described in BS5228-1:2009+A1:2014 determines the adverse impact threshold at a dwelling using the existing ambient noise level, rounded to the nearest 5dB. This is then used to determine the assessment category: A, B or C, which defines the adverse noise impact threshold. The predicted construction noise level is then compared to the appropriate noise impact threshold level. If the  $L_{Aeq}$  construction noise level exceeds the appropriate noise impact threshold level shown in Table 11-4, then an adverse impact with the potential to cause a significant effect is identified.

<sup>231</sup> <https://www.gov.uk/government/publications/open-data-strategic-noise-mapping>

- 11.5.47 For example, for a site exposed to an existing ambient noise level of 68dB(A), this would be rounded to 70dB(A). An ambient level of 70dB(A) is higher than the Category A value of 65dB(A), therefore the Category C value of 75dB(A) would apply as a threshold for potential significant effect.
- 11.5.48 Having established if there is a potentially significant effect using the ABC method, the final assessment of significance is made using professional judgement. This is evaluated by considering various other factors described at the end of this section (paragraph 11.5.63) such as the expected duration of the activity.
- 11.5.49 For non-residential receptors, significant effects would be evaluated on a receptor-by-receptor basis, using established noise impact criteria for the type of receptor and professional judgement based on the factors described at the end of this section (paragraph 11.5.65).

### Construction vibration assessment criteria

- 11.5.50 BS 5228–2:2009+A1:2014 indicates that the threshold of perception in residential environments corresponds with a peak particle velocity (PPV) of 0.3mm/s. The Standard also states that a complaint is likely where levels occur above 1.0mm/s PPV at residential properties but this exposure can be tolerated if prior warning and explanation has been given to residents. Levels of vibration of 10mm/s PPV and above are likely to be intolerable for any more than a very brief exposure to this level.
- 11.5.51 BS 5228-2:2009+A1:2014, section B2, states that PPV vibration levels are considered to be an appropriate vibration parameter to be used when considering construction vibration, and the Standard provides guidance upon the ‘instantaneous’ human response to vibration in buildings in terms of overall vibration velocity levels (Table 11-5)<sup>232</sup>. These criteria have been used to derive LOAEL and SOAEL thresholds for this assessment.
- 11.5.52 The overall significance of the effect is assessed using professional judgement by considering not only the criteria described above but also other factors, such as the duration of exposure and the characteristics of the source.

**Table 11-5 LOAEL and SOAEL Thresholds of Likely Effects of Vibration for Building Occupants Derived from BS 5228-2:2009+A1:2014**

Time period	LOAEL	SOAEL	Notes
All time periods	0.3mm.s <sup>-1</sup> PPV	1.0mm.s <sup>-1</sup> PPV	LOAEL is set at the lowest level at which vibration may be perceptible in residential environments. SOAEL is set where levels can be tolerated with prior warning (ref BS5228:2).

- 11.5.53 Risk of damage to buildings from groundborne vibration is assessed using the criteria in Table 11-6. The criteria are derived from British Standard BS7385, part

<sup>232</sup> BS 5228-2 notes in Table B.1: ‘The values are provided to give an initial indication of potential effects, and where these values are routinely measured or expected then an assessment in accordance with BS 6472-1 or -2, and/or other available guidance, might be appropriate to determine whether the time varying exposure is likely to give rise to any degree of adverse comment.’ Consideration has been given to other guidance with regard to time varying exposure where appropriate – the BS 6472 guidance makes use of the ‘Vibration Dose Value’ metric (VDV).

2 'Evaluation and measurement for vibration in buildings – Guide to damage levels from groundborne vibration' (BSI, 1993). This ensures there is no risk of the lowest damage category ('cosmetic') being exceeded, as defined in BS ISO 4866:2010 *Mechanical vibration and shock – Vibration of fixed structures – Guidelines for the measurement of vibrations and evaluation of their effects on structures* (BSI, 2010). However, effects in terms of even cosmetic damage to buildings would occur only for vibration exposures much higher than the lowest perceptible levels.

**Table 11-6 Vibration Impact Criteria for Buildings (conservative criteria below which there is no risk of cosmetic damage)**

Category of building	Peak particle velocity <sup>1</sup> (mm.s <sup>-1</sup> )	
	Transient <sup>2</sup> vibration	Continuous <sup>3</sup> vibration
Potentially vulnerable building	6	3
Structurally sound buildings	12	6
Notes:		
<sup>1</sup> At the building foundation		
<sup>2</sup> Transient relative to building response e.g. from percussive piling		
<sup>3</sup> Continuous relative to building response e.g. from vibratory piling, vibrating rollers		

#### *Operational noise assessment criteria*

11.5.54 Adverse effect levels have been set in accordance with Government noise policy (NPPF, NPSE, and PPG-Noise) and with regard to the guidance from the World Health Organization (Guidelines for Community Noise<sup>233</sup>; and WHO Night Noise Guidelines for Europe<sup>234</sup>, the Noise Insulation Regulations 1975 (as amended), and best practice from other projects. These criteria have been used to derive LOAEL and SOAEL thresholds for this assessment.

**Table 11-7 LOAEL and SOAEL Thresholds of Likely Effects of Operational Noise at all Receptors in Terms of Government Policy**

Time period	LOAEL	SOAEL	Notes
Day (06:00-24:00)	55dB <sub>LA10,18h</sub> (façade)  50dB <sub>LAeq,16h</sub> (free-field)	68dB <sub>LA10,18h</sub> (façade)  63dB <sub>LAeq,16h</sub> (free-field)	The daytime LOAEL is based on the onset of moderate community annoyance, and the daytime SOAEL is based on the onset of cardiovascular health effects (ref. WHO Guidelines for Community Noise) and the Noise Insulation Regulation Threshold. The slightly lower Noise Insulation Threshold should be used for consistency with other parts of the DMRB methodology.
Night	40dB <sub>LAeq,8hr</sub> L <sub>night,outside</sub> (free-field)	55dB <sub>LAeq,8hr</sub> L <sub>night,outside</sub> (free-field)	The night time LOAEL is defined using the WHO Night Noise Guidelines, and the night time SOAEL is equivalent to the levels above which cardio vascular health effects become the major public health concern (ref. WHO Night Noise Guidelines).

<sup>233</sup> WORLD HEALTH ORGANISATION (1999), Guidelines for Community Noise, World Health Organization

<sup>234</sup> WORLD HEALTH ORGANISATION (2009), Night Noise Guidelines for Europe, WHO, Bonn: WHO, regional Office for Europe, 2007

11.5.55 The magnitude of the impact and effect caused by long-term change in noise levels attributable to the proposed scheme, where the overall 'end state' (i.e. operational noise level of the completed scheme), is between the lowest and the significant observed adverse effect levels, (i.e. between the LOAEL and SOAEL) is evaluated in accordance with Table 11-8.

11.5.56 DMRB, HD213/11 provides a basis for evaluating the magnitude of the impact and effect caused by noise change both in the short term and long term. This assessment has focused primarily on the long-term, permanent change as this is the likely worst-case considering traffic growth. This is also consistent with DMRB, HD213/11 that notes:

*"In terms of permanent impacts... In the long-term, a 3dB(A) change is considered perceptible. Such increases in noise should be mitigated if possible".*

11.5.57 The focus on long-term effects also relates to the evidence that underpins DMRB, HD213/11. This evidence shows that the reported sensitivity to small changes in noise levels (less than 3dB(A)) may be influenced by factors other than noise at the time a new road opens<sup>235</sup>.

**Table 11-8 Classification of Magnitude of Noise Impact in the Long Term Under DMRB HD 213/11, Where the 'End-State' of Overall Exposure is Between LOAEL and SOAEL**

Noise change [dB(A)]	Magnitude of impact in the long-term
0	No change
0.1 – 2.9	Negligible
3.0 – 4.9	Minor
5.0 – 9.9	Moderate
10.0 +	Major

11.5.58 Where the overall exposure is greater than the relevant significant observed adverse effect level (SOAEL), then there is increasing risk of likely health effects associated with long-term (permanent) exposure.

11.5.59 Some areas in the scheme noise study area already have a designated status as being exposed to high levels of road traffic noise, i.e. Noise Important Areas recognised by Defra<sup>236</sup> – see figure 11.1. It is considered appropriate to give greater weight to noise change where the existing baseline noise level is already high, i.e. in excess of the relevant SOAEL. This is to reflect the consideration of health effects. In these situations, the magnitude of the impact and effect caused by change in noise levels attributable to the scheme is shown in Table 11-9. DMRB HD 213/11 also assigns these impact levels to noise changes in the short-term; it should be noted that relative to Table 11-8 above, the equivalent impact descriptors are assigned to smaller noise changes, hence the impact scale is more sensitive.

<sup>235</sup> Paragraph A5.4, DMRB, HD 213/11 Revision 1

<sup>236</sup> DEFRA (2016), Noise Action Planning Important Areas Round 2 England, (<https://data.gov.uk/dataset/fc786717-3756-4fd1-9c7d-c082331e40e4/noise-action-planning-important-areas-round-2-england>)

**Table 11-9 Classification of Magnitude of Noise Impact Under DMRB HD 213/11 in the Short Term Where the ‘End-State’ of Overall Exposure Between LOAEL and SOAEL, or Where the Baseline Noise Level is Greater than SOAEL**

Noise change [dB(A)]	Magnitude of impact
0	No change
0.1 – 0.9	Negligible
1.0 – 2.9	Minor
3.0 – 4.9	Moderate
5.0 +	Major

11.5.60 An impact of 3dB(A) or greater is taken as an indicator of a potential significant effect for noise exposures between the LOAEL and SOAEL in either the short or long term. The magnitude of impact and effect is evaluated using Table 11-9 or Table 11-8 respectively according to whether the impact is short term or long-term. For example, a 3dB(A) change in the short term is described as a moderate impact, whereas a 3dB(A) change in long term is described as a minor impact.

11.5.61 For areas exposed to higher noise levels (above SOAEL), a smaller impact (1dB(A) or greater) is taken as an indicator of potential significance with the magnitude of impact and effect being evaluated using Table 11-9. The final assessment is based upon the indicated potential significance, as described above, and consideration of additional factors described at the end of this section (paragraph 11.5.63).

11.5.62 For non-residential buildings, the assessment considers the noise and vibration exposure at each receptor based on the above criteria and the receptor's generic sensitivity. Table 11-10 and paragraph 11.5.66 summarise the additional assessment criteria used for assessment on a likely worst-case basis.

**Table 11-10 Noise Impact Screening Criteria at Non-Residential Receptors (Construction and Operation)**

Description	Impact (screening) criterion		Outcome	Reference
	Day 0700-2300	Night 2300-0700		
Places of meeting for religious worship; courts; cinemas; lecture theatres; museums; and small auditoria or community halls	50dB <sub>L<sub>Aeq,T</sub></sub> and a change >3dB(A)	--	disturbance	BS8233: 2014, EFAs Acoustics Performance Standards <sup>1</sup> ,
Schools; colleges; hospitals*; hotels*; and libraries	50dB <sub>L<sub>Aeq,T</sub></sub> and a change >3dB(A)	*45dB <sub>L<sub>Aeq,T</sub></sub> <sup>3</sup> and a change >3 dB(A)	disturbance and sleep disturbance*	HTM08-01 <sup>2</sup> , WHO guidelines
Offices	55dB <sub>L<sub>Aeq,T</sub></sub> <sup>4</sup> and a change >3dB(A)	--	disturbance	BS 8233

Notes:

<sup>1</sup> Based on an internal level of 35dB<sub>L<sub>Aeq,T</sub></sub> consistent with Education Funding Agency (EFA) (2012) and BS8233 (BSI, 2014). Equivalent external level assumes 15dB(A) for a partially open window

<sup>2</sup> Department of Health (2013)

<sup>3</sup> Based on an internal level of 30dB<sub>L<sub>Aeq,T</sub></sub> consistent with BS8233, WHO guidelines. Equivalent external level assuming 15dB(A) for a partially open window.

<sup>4</sup> Based on an internal level of 40dB<sub>L<sub>Aeq,T</sub></sub> consistent with BS8233 and BCO (British Council for Offices, 2014) guidelines. Equivalent external level assuming 15dB(A) attenuation for a partially open window.

## **Additional factors considered in determining significance of noise and vibration effects**

### Residential receptors

- 11.5.63 In considering whether the level of effect is significant in EIA terms, the following criteria have been considered:
- the change in noise levels (and resulting noise effect on receptors);
  - for operational noise, if the change in noise level is near the top or bottom of the DMRB HD 213/11 impact magnitude range;
  - the level of noise exposure once the scheme is in operation, particularly if above SOAEL;
  - for operational noise, the relationship difference between short-term and long-term changes;
  - acoustic context in respect of the level and character of the existing noise environment;
  - any unique features of the source or receiving environment in the local area;
  - circumstances of receptor – e.g. whether sensitive façades are exposed to noise impact;
  - combined exposure to noise and vibration;
  - for construction, the duration of the adverse or beneficial effect; and
  - the effectiveness of mitigation measures that are provided.
- 11.5.64 The results used to inform the significance decisions reported in the operational assessment is presented in Table 11-13. Numerical noise level results for all receptors in the long term (the permanent impact) are shown in appendix 11.3, i.e. absolute noise levels for the Do Minimum and Do Something scenarios and the change in noise levels.

### Non-residential receptors

- 11.5.65 Medical buildings, educational buildings, community facilities, buildings having specific noise and vibration sensitive resources, and outdoor amenity areas (with consideration of the AONB) are called non-residential sensitive receptors in this assessment.
- 11.5.66 Assessment of the level of effect of noise or vibration on a non-residential receptor should consider the above criteria, in addition to the following factors:
- the overall noise level and the change in noise level (from the baseline) due to the scheme;
  - the receptor's generic sensitivity to noise or vibration, which is dependent on the use of the receptor;
  - the receptor's unique or specific sensitivity to noise or vibration. For example, in the case of a school, the location, construction and layout of the site. This would include matters such as whether the most sensitive parts of the school are closest to and face the scheme or are further from and on the opposite side of a building to the scheme; and the sound insulation performance of the building; and
  - designated sites – the proportion of the resource affected by noise impact.
- 11.5.67 Unique features that could influence the assessment of effects from noise and vibration at non-residential receptors would include areas where the baseline noise level is subjectively very quiet. This refers to areas substantially less than



50dB<sub>L<sub>Aeq</sub></sub> daytime) and /or 40dB<sub>L<sub>Aeq</sub></sub> night-time and the existing environment is characterised by little or no appreciable man-made sound sources. Such environments are considered rare in the national context and hence it is considered a unique feature.

## 11.6 Baseline Conditions

- 11.6.1 Noise or vibration sensitive locations have been identified for inclusion in the assessment across the study area (see figure 11.1). Baseline noise survey locations will be agreed with Gloucestershire County Council, Tewkesbury District Council and Cotswold District Council. Surveys will be carried out at sufficient locations to represent noise sensitive areas alongside the scheme. The noise survey will be performed in accordance with the 'Shortened measurement procedure', described in paragraph 43 of CRTN (survey procedures and locations are described in appendix 11.2). These surveys were not completed at the time of producing this PEI Report, but the results will be included within the ES accompanying the DCO application.
- 11.6.2 It is assumed that local noise conditions would not change substantively between the survey period and the commencement of proposed works.
- 11.6.3 The baseline noise conditions (i.e. Do-Minimum) for the operational traffic assessment have been determined by the CRTN noise prediction model for a forecast traffic scenario of 2024. This has provided a detailed coverage of noise levels across the entire calculation area.
- 11.6.4 HD 213/11 states that prediction is the preferred approach for establishing the Do-Minimum baseline noise conditions, which are then directly comparable with the noise levels predicted in the same way for the Do-Something future assessment year.
- 11.6.5 The predicted traffic noise level contours for the baseline year (i.e. Do-Minimum 2024 for the noise assessment) are also shown so the relative baseline noise exposures of the different sensitive receptors can be seen. Noise Important Areas (NIA) are shown to identify dwellings in areas of relatively high noise exposure recognised by Defra.
- 11.6.6 The following sections summarise the sensitive receptor locations across the scheme area, the locations are described using the chainage references for the scheme alignment. The following sections should be read with reference to figure 11.1.

### **Bentham to Air Balloon Roundabout – 0+000.000 to 2+100.000**

- 11.6.7 At the western extent of the scheme corridor, the improved highway would follow the existing alignment along the Brockworth bypass. The study area for the noise assessment extends beyond the western end of the scheme to include dwellings in Witcombe to the southwest and a recently established housing development to the northwest near to the Bentham Country Club. There are also scattered dwellings which lie either side of the highway within approximately 50-150m.
- 11.6.8 Moving east from 1+500.000 to 2+100.000, the scheme alignment ascends towards Air Balloon roundabout. Crickley Hill Country Park lies approximately 700m to the west of the Air balloon roundabout where the hillside rises steeply from the highway, approximately 60m above the existing A417. The Cotswold Way runs on the top of this escarpment and approximately parallel with the A417

highway. The peak of Crickley Hill is approximately in line with 1+500.000. At this point the Cotswold Way is located approximately 160m to the NW of the A417. Figure 11.1 shows that existing noise levels are in the range 62.5-65.0dB LAeq,16hr along this section of the footpath. As the Cotswold Way continues toward Air Balloon roundabout, it descends progressively lower and closer to the scheme. The boundary of the Country Park is close to the existing highway alignment. At 2+000.000 the Cotswold Way is around 10m from the existing highway. Figure 11.1 shows that existing noise levels are in the range 72.5-75.0dB LAeq,16hr along this section of the footpath. The Park is used by the public as an outdoor amenity destination; there are popular footpaths through the woodland and grassland areas. There are picnics areas and there is a visitor centre. The Park also has SSSI and SM<sup>237</sup> designations (Crickley Hill Camp). To the south of the highway the ground also rises steeply on approach to the roundabout with a residential property approximately 100m from the highway.

- 11.6.9 There are four Noise Important Areas identified on this section at residential locations close to the highway, as shown on figure 11.1 (NIAs 3906, 3907, 3908 and 13915).

### **Air Balloon Roundabout to Cowley Junction– existing alignment**

- 11.6.10 From the Air Balloon roundabout, the existing A417 runs south to the east side of Birdlip (approx. 250m away) with the Cotswold Way footpath running along the top of the escarpment with the Barrow Wake viewpoint beside the road. Just to the east of the A417 on the Gloucestershire Way is Emma's Grove (Round Barrows and SM cultural heritage asset). There are scattered dwellings at various locations within approximately 50-150m from the highway between the Air Balloon and Cowley junction roundabouts. The Peak, a Neolithic enclosure and heritage asset (although not a designated SM), is northwest of Birdlip approximately 900m west of the existing A417. Stockwell is approximately 400m northeast of the existing A417 with a network of footpaths on either side of the highway.
- 11.6.11 There is one Noise Important Areas identified on this section at a residential location approximately 350 northwest of the Cowley junction, as shown on figure 11.1 (NIA 3905).

### **Air Balloon roundabout to Cowley junction– proposed re-alignment – 2+100.000 to 5+760.000**

- 11.6.12 The scheme corridor would continue east of the Air Balloon roundabout (2+150.000), turning southeast between Birdlip Radio Station and Rushwood Kennels and Cattery (3+000.000). There are few dwellings within 200m of the proposed scheme on this section. The Gloucestershire Way footpath is presently aligned northwest to southeast in this locality and would be crossed by the proposed scheme corridor (2+750.000). Therefore, this path would be realigned to pass around the new Air Balloon roundabout and then follow the top of the new A417 cut line beside the realigned A436, until joining back up with the existing path just north of Rushwood Kennels. Currently, this point on the footpath is approximately 700m from the existing A417 alignment, hence noise levels are between 40.0 and 45.0dB LAeq,16hr for much of this section. Moving southeast, the proposed scheme corridor passes approximately 300m north of Stockwell through open grassland with no dwellings within several hundred metres towards the point

<sup>237</sup> Site of Special Scientific Interest, Scheduled Monument and cultural heritage asset.

where it would reconnect with the existing A417 at Cowley junction. Existing noise levels around the various footpaths in this area range from 42.5 to 50.0dB L<sub>Aeq,16hr</sub> between 3+000.000 and 5+000.000, and gradually increasing to 55dB L<sub>Aeq,16hr</sub> at the closest footpath to Cowley roundabout.

- 11.6.13 There is a Noise Important Area identified on this section of the study area at residential locations close to the highway on the A436, north-east of the scheme, as shown on figure 11.1 (NIA 13196) – Laurel Cottage (The Grove and Crendon House are close by but are not within the NIA area).

## 11.7 Consultation

- 11.7.1 A request has been made to Gloucestershire County Council, Tewkesbury District Council, and Cotswold District Council to consult on the methodology and any noise and vibration sensitivities within the study area. This process will continue as part of the ES stage. The Planning Inspectorate (PINS) were consulted during the scoping stage and provided an opinion<sup>238</sup>. The PINS responses have been considered and included, where appropriate, in this chapter.
- 11.7.2 The PINS Scoping Opinion noted the requirement to comply with the relevant guidance and planning policy in relation noise and vibration assessment. PINS highlighted the need to consider cultural heritage assets and Special Areas of Conservation within the AONB. Also, in combination effects with respect to 'effects to landscape and tranquillity' should be considered, and the combined effects 'to the settings of cultural heritage assets'.

## 11.8 Assessment Assumptions and Limitations

### Construction

- 11.8.1 Detailed construction information was not available at the time of the construction noise and vibration assessment. For the PEI Report, the assessment of construction noise and vibration has focussed on the area of deep cutting between approximate chainages 1+800.000 to 2+800.000 This is where the potentially most intensive work will be carried out for the longest duration, and there is more certainty as to the types of process, relative to more complex construction activities such as junction structures. Appropriate assumptions have been made as to the type and number of construction plant and the intensity and duration of the construction processes for the major cutting. These data have been taken from similar highway construction works where construction method data was available. The assumptions are shown in appendix 11.2 and are considered suitable to represent the types of works and associated impacts for the assessment of this extensive construction process.
- 11.8.2 It is likely that a number of short-term activities would be required to be undertaken during extended working hours and sometimes at night. These primarily relate to works to, or on existing transport corridors (such as safety-critical aspects of junction or bridge works) to reduce the impact on existing roads. From the information available at the time of the assessment, the potential

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<sup>238</sup> <https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/TR010056/TR010056-000046-TR010056%20-%20Scoping%20Opinion.pdf>

for effects from these activities would be limited given the short duration of such works.

11.8.3 When further construction methodology details are available, for other parts of the scheme works, this will be assessed in ES.

**Operation**

11.8.4 Road traffic flows and speeds used in the assessment were provided by the project traffic engineers for all the assessment scenarios listed in paragraph 11.5.29.

11.8.5 Low noise surface would be laid on all new and altered roads in the scheme. It is assumed that, low noise surface is already laid in Do-Minimum baseline year (2024).

11.8.6 Any landscape mitigation included in the option 30 scheme design has been incorporated in the scheme design for the PEI Report. Other than that, no additional landscape earthworks are currently included for the purposes of the noise modelling and assessment. Chapter 7 of the PEI Report describes measures being considered for the ES to reduce visual and landscape impact.

11.8.7 However, engineering earthworks features are included in the noise modelling as part of the design to achieve the vertical alignment for the proposed scheme. Landscaping features which also may provide noise mitigation will be included as part of the scheme design for the ES.

11.8.8 It is assumed that noise insulation would be offered if and where future noise levels exceed the noise level trigger value of 68dB<sub>L<sub>pA10,18hr</sub></sub> (façade) and the other requirements referred to in the Noise Insulation Regulations 1975 (as amended) (NIR). Confirmation of qualification for noise insulation would be made by the responsible authority before the scheme comes into operation, based on built information in accordance with the NIR.

**Assessment and Baseline Gaps**

The following gaps in baseline and assessment information have been identified for the PEI Report.

**Table 11-11 Gaps and Uncertainties**

Gaps and Uncertainties	Description
Construction information	Detailed construction information will not be available until scheme contractors have developed a full construction method statement. However, the current construction method assumptions are considered to be representative of the most intensive works occurring for the longest duration that are likely to impact surrounding receptors. More comprehensive assessment of construction noise and vibration for all areas of the works will be carried out for the ES accompanying the DCO application.
Baseline noise survey	At the point of producing this PEI Report, it was not possible to complete the baseline noise survey to include the data in this assessment. When the data is available, it will be used to provide indicative information to validate the predicted results which will be presented in the ES. As noted in paragraph 11.6.4, HD 213/11 states that the preferred approach for establishing baseline noise conditions is to use predicted data across the calculation area, hence it has been

Gaps and Uncertainties	Description
	possible to carry out the operational assessment in the absence of the survey data at this assessment stage. Similarly, the baseline noise level at receptors where construction noise has been predicted has been taken from the baseline traffic noise prediction data.
Scheme related noise impacts from existing roads outside the study area	DMRB HD 213/11 requires consideration of potential noise impacts alongside existing roads outside the study area, where traffic increases are forecast to be greater than 25% in the short-term. These are described as 'affected' links. This assessment will be carried as part of the ES but has not been included in this PEI Report.
Impacts on ecological receptors	The effects of noise and vibration on ecological receptors have not been included in this PEI Report but will be considered as part of the ES. This is a requirement of the NPSNN.

## 11.9 Design, Mitigation and Enhancement Measures

### Construction Mitigation

- 11.9.1 The construction noise and vibration assessment assume that the works would be undertaken following the principles and processes set out in the Outline CEMP to be provided with the ES.
- 11.9.2 Best Practicable Means (BPM) is assumed as incorporated mitigation to control construction noise in the form of low noise emission plant and processes (as specified in BS 5228 Annex B - Noise sources, remedies and their effectiveness).
- 11.9.3 BPM would include noise and vibration control at source - for example:
- the selection of quiet and low vibration equipment, review of construction programme and methodology to consider quieter methods (including non-vibratory compaction plant, where required), location of equipment on site, control of working hours (to be set out in the Outline CEMP), the provision of acoustic enclosures and the use of less intrusive alarms, such as broadband vehicle reversing warnings; and
  - screening - for example local screening of equipment, perimeter hoarding or the use of temporary stockpiles.
- 11.9.4 If situations arise where despite the implementation of BPM, the noise exposure exceeds the criteria that will be defined in the Outline CEMP, the main contractors may offer:
- noise insulation; or ultimately
  - temporary re-housing.
- 11.9.5 As set out in section 11.10 of this chapter, further mitigation could be detailed as required in the Outline CEMP following dialogue with local authorities.

### Operation Mitigation

- 11.9.6 Incorporated noise mitigation is envisaged to avoid significant observed adverse effects from the scheme, reduce as far as sustainable other likely significant adverse effects from the scheme and reduce existing and future significant observed adverse effects. This will be included in the ES and integrated with the landscape and visual mitigation.

11.9.7 To ensure that additional mitigation is practicable and sustainable, the provision has been subject to the following tests:

- consideration of noise benefit compared to cost of the mitigation;
- engineering practicability;
- other environmental effects potentially caused by the mitigation (for example landscape or visual effects); and
- stakeholder engagement and consultation responses.

11.9.8 As noted in paragraph 11.8.6, the PEI Report noise model includes any landscaping/ visual mitigation proposed for the option 30 design.

11.9.9 As noted, a low noise surface would be also incorporated as part of the scheme.

### **Enhancement**

11.9.10 Where possible, enhanced mitigation would be developed during detailed design of the scheme which would be over and above what is required to mitigate the adverse effects of a scheme.

## **11.10 Assessment of Effects**

11.10.1 The assessment approach for construction and operation considers a range of receptors and effects as described in Table 11-2. The following assessment sections are divided as follows:

- Residential receptors: direct and indirect effects exceeding the SOAEL;
- Residential receptors: direct and indirect effects between the LOAEL and SOAEL; and
- Non-residential receptors: direct and indirect effects.

### **Construction Effects**

#### Noise

11.10.2 For the PEI Report, the assessment of construction noise and vibration has focussed on the area of deep cutting between approximate chainages 1+800 to 2+800. This is likely to be where the most intensive work will be carried out for the longest duration, i.e. topsoil strip and earthworks cut and fill, and surface levelling prior to pavement laying. This includes haul road traffic to access the works to move materials. Likely construction machinery and activities for the deep cutting would include excavators, bulldozers, rock breakers, stone crushing and movement of materials. The assumptions regarding plant machinery and the proportion of the day the various machines would operate are shown in appendix 11.2.

11.10.3 Table 11-2 shows the predicted construction noise levels at each receptor location selected for the assessment for the range of processes described in the previous paragraph. The selected receptor locations for the construction assessment for these works are shown in figure 11.1. The second column of the table identifies the daytime potential significance thresholds respectively based on the BS5228 ABC method ascribed in paragraph 11.5.44. The appropriate ABC method assessment category (and therefore the SOAEL) for each location has been determined from the predicted ambient noise level at the façade (taken from the baseline traffic noise level prediction for 2024).

**Table 11-12 Daytime Construction Noise Assessment at Residential and Non-Residential Locations**

Location (see figure 11.1)	SOAEL – ABC method dB(A) threshold, day (BS 5228)	Range of predicted monthly daytime construction noise levels* dBL <sub>Aeq, day</sub>
R1 Crendon House (and four other properties in this area)	70	55 – 60
R2 Fernbank	75	58 – 64
R3 Crickley Ridge	70	66 – 77
R4 Air Balloon Cottages	75	84 – 86
R5 Birdlip Radio Station, non-residential	65	66 – 76
R6 Rushwood Kennels, dwelling and non-residential uses	65	66 – 73
R7 Stockwell Farm Barn (and eight other properties in this area)	65	58 – 60
R8 Chestnut Cottage (and two other properties in this area)	65	57 – 58
R9 Crickley Hill Access Road (and footpath), non-residential	65	66 – 71 <sup>+</sup>
R10 Gloucestershire Way footpath, non-residential	65	67 – 73 <sup>+</sup>
R11 Gloucestershire Way ('Muddy Path'), non-residential	65	53 – 48 <sup>+</sup>

\* Noise level includes correction for façade acoustic reflection (i.e. noise level at 1m from façade), excluding footpath locations, which are assumed to be in free-field conditions (denoted by \*). Where the cell text is grey/italic, the range of predicted noise levels are below the LOAEL. Where the text is in bold font, the highest predicted value exceeds the ABC potential significance threshold and therefore exceeds the SOAEL for construction noise (Table 11-4).

### *Residential receptors: effects exceeding the SOAEL*

11.10.4 The ABC potential significance threshold and therefore the SOAEL would be exceeded during some months of the construction at the following construction assessment receptors:

- R3 Crickley Ridge;
- R4 Air Balloon Cottages;
- R6 Rushwood Kennels (residential accommodation).

11.10.5 The construction activities resulting in the highest noise levels are generally the earthworks (i.e. 'cut and fill' works). The noise levels would vary according to the location of the works relative to the receptors, but the period of these works would be approximately 18 months. The noise levels shown represent the worst-case situation when the works are closest to the receptors.

11.10.6 The greatest exceedance of the ABC threshold and therefore the SOAEL is at receptor R4 Air Balloon Cottages some 50m from the edge of the construction works with a predicted construction noise level of up to 11dB(A) above the SOAEL.

11.10.7 Noise predictions at receptor R3 Crickley Ridge are up to 7dB(A) above the SOAEL. This receptor is some 70m from the works.

11.10.8 Noise predictions at receptor R6 Rushwood Kennels (and residential accommodation) are up to 8dB(A) above the SOAEL. This receptor is some 210m from the works.

- 11.10.9 The predicted noise levels are above the SOAEL in some months for the receptors listed in paragraph 11.10.4 which is an indication of a likely significant observed adverse effect. The duration and the rate of progression of the works have been considered within the assessment and on this basis, these receptors are assessed as being subject to temporary significant observed adverse effects above the SOAEL, and are also considered significant adverse effects in EIA terms (see Table 11-2 for definition of these types of effect).
- 11.10.10 Specific mitigation, including eligibility for noise insulation, will be included, where relevant, in the Outline CEMP to be developed for the ES.

Residential receptors: direct effects between LOAEL and SOAEL

- 11.10.11 In locations where construction noise levels would be between the LOAEL and SOAEL, these noise changes may be considered an adverse effect on the acoustic character of the area and hence be perceived as a change in the quality of life (see Table 11-2).
- 11.10.12 The construction noise levels are predicted to exceed the LOAEL (existing ambient noise level) in some months, but not exceed the SOAEL at the following receptors:
- R7 Stockwell Farm Barn (also Stockwell Farm, Stockwell Cottage, No.1 – 4 Stockwell Cottages, Stockwell Farm and The Rise);
  - R8 Chestnut Cottage (also Hillbarn Cottage and Hill Barn).
- 11.10.13 The construction noise levels are below the ABC noise level threshold and although these are adverse effects (refer to Table 11-2 and Table 11-3), these effects are assessed as not significant in EIA terms.

Non-residential receptors: effects

- 11.10.14 Receptor R5 Birdlip Radio Station is a facility located some 280m from the construction works. The predicted construction noise levels would exceed the SOAEL by up to 11dB(A) (defined by the ABC threshold - as described in Table 11-3) in some months. The predicted construction noise levels would also exceed the existing ambient noise, and therefore exceed the LOAEL in some months. It is assumed that any listening or studio facilities would be within the core of the building and well sound-insulated (this will be reviewed further for the ES). Hence normally-glazed office accommodation on the façades of the building would potentially be more likely to be adversely impacted. Assuming a 26dB(A) external/internal noise reduction for windows comprised of a typical closed standard thermal double glazing with non-acoustically rated trickle ventilation, construction noise levels inside would be 36-47dBL<sub>Aeq, day</sub>. This would, therefore, in some months, slightly exceed the BS8233 guidance lower limit of 45dBL<sub>Aeq, T</sub> for an open plan office area on the side of the building closest to the construction works. The baseline indicates an existing ambient noise level of 44dBL<sub>Aeq, day</sub> outside which would result in noise levels inside to be well within the BS8233 guidance limit assuming the same loss of 26dB(A). Given the impact level of the construction works and the estimated noise ingress, the likely effects at this receptor are assessed as temporary significant.
- 11.10.15 Receptor R6 the Rushwood Kennels & Cattery (and residential accommodation) are located some 210m from the construction works. It is noted that the construction works could result in noise impacts with regard to animals boarding



at the facility, and this will be considered in the ES. However, a temporary significant effect has already been assessed at this location due to the residential use here.

- 11.10.16 Receptor R9 along the Crickley Hill Access Road and footpath is located some 230m from the works, approximately midway between the bottom of the access road and the car park at the top. This is in 'The Scrubbs' area with footpaths rising up the escarpment to the Country Park and the selected location represents an average distance for these amenity uses on this side of the hill. This location is predicted to experience monthly construction noise levels of 66-71dB<sub>L<sub>Aeq, day</sub></sub>. These levels are predicted to exceed the SOAEL by up to 6dB(A) and will, therefore, also exceed the LOAEL (existing ambient noise level) by approximately 10dB(A). The value of this area as an amenity receptor is particularly high within the AONB, although the baseline noise levels are not uniquely quiet given the existing highways close-by. Given the level of noise increase and the proportion of the footpaths and hillside that are affected, this is assessed as a temporary significant effect.
- 11.10.17 Receptor R10 along the Gloucestershire Way footpath is located some 190m from the construction works to the east of the existing A417 and would be subject to predicted monthly construction noise levels of 65-69dB<sub>L<sub>Aeq, day</sub></sub>. These levels are predicted to exceed the SOAEL by up to 8dB(A) and will, therefore, exceed the LOAEL (existing ambient noise level) by approximately 20dB(A).
- 11.10.18 Receptor R11 Gloucestershire Way (Muddy Path) is located some 1030m from the works, approximately 700m east of R6 Rushwood Kennels. The construction noise levels are predicted to exceed the LOAEL (existing ambient noise level) in some months, but not exceed the SOAEL. The levels are predicted to exceed the LOAEL by up to 17dB(A).
- 11.10.19 This section of the footpath described above for R10 and R11 is considered in this assessment to be a unique feature (see assessment criteria – paragraph 11.5.67) given the relatively low baseline noise levels and therefore the sensitivity of this section of the footpath. The magnitude of impact and the proportion of the footpath affected by perceptible noise increase from construction is assessed as a temporary significant effect. This relates to the section of the Gloucestershire Way between the Air Balloon roundabout and Coberley to the east.

### Vibration

- 11.10.20 As already discussed in section 12.10.2, the assessment of construction vibration is similarly focussed upon the deep cutting works between 1+800 to 2+800, where the highest vibration levels are expected to be generated by rock-breaking activities undertaken by percussive devices attached to heavy excavators, potentially over a prolonged period of up to 18 months.
- 11.10.21 The vibration assessment has been undertaken at the exact same receptor locations as used in the construction noise section.
- 11.10.22 The vibration parameter peak particle velocity (PPV) has been used throughout to evaluate the likely impact upon both human perception and building damage criteria. Due to the limited information available at this time on the proposed construction methodology, the PPV has been adopted as the most representative metric to indicate worst-case vibration levels from 'instantaneous' activities to

which both human perception and potential building damage can be effectively quantified.

- 11.10.23 The PPV levels describe the ‘instantaneous’ vibration levels that might be experienced during the activity (rather than averaged exposure across the whole day during periods when the machinery is both on and off). The worst-case (closest) predicted vibration levels during rock-breaking activities, would result in just two residential properties subject to a PPV level just above  $1\text{mms}^{-1}$ . These are represented by receptor location R4, Air Balloon Cottages which would be subject to PPVs of up to  $1.3\text{mms}^{-1}$ . These levels are well below the  $6.0\text{mms}^{-1}$  criteria given in Table 11-6, above which there might be a possibility of cosmetic damage within a structurally sound building. The BS5228 Standard states that a complaint is likely where levels occur above  $1.0\text{mm/s}$  PPV at residential properties but this exposure can be tolerated if prior warning and explanation has been given to residents.
- 11.10.24 The vibration levels at these receptors will be assessed by the contractor when more detailed information is available, at which time more accurate predictions and assessment of potential vibration effects can be undertaken. Those levels that are still found to exceed the SOAEL threshold values in Table 11-5, which have been identified in the above section, would be assessed based upon the likely duration above the SOAEL level, and if deemed necessary would then be controlled accordingly. This is assessed as a temporary significant effect. Based upon this PEI Report assessment, there would be no properties that would experience vibration levels which might exceed the building damage criteria given in Table 11-6.
- 11.10.25 Where other potential, but shorter-term construction vibration processes are identified during the more detailed ES assessment, i.e. pavement works, junction infrastructure and associated earthworks involving use of vibratory compactors as an example, then suitable control measures to reduce vibration effects will be explored and set out in the Outline CEMP.

### Operation Effects

- 11.10.26 Daytime and night-time traffic noise levels within the study area have been predicted and are assessed in terms of:
- Government Policy (NPSE) - for receptors exceeding the SOAEL; and
  - Environmental Impact Assessment significance - for receptors between the LOAEL and SOAEL.
- 11.10.27 Table 11-13 below summarizes the assessment of the significant effects for daytime and night-time resulting from the operational scheme.
- 11.10.28 Figure 11.2 shows the long-term noise level contours, and figure 11.3 shows the noise difference contours (i.e. the changes in noise) resulting from the operational scheme in 2039. These figures should be referred to for the following assessment description. Appendix 11.3 provides tabulated noise level results and indicates associated impacts.
- 11.10.29 Firstly, the overall noise impacts are summarised separately for each of the three scheme sections, west to south, as previously described under baseline conditions (section 11.6), i.e.:
- Bentham to Air Balloon roundabout – 0+000.000 to 2+100.000;

- Air Balloon roundabout to Cowley junction– existing alignment;
- Air Balloon roundabout to Cowley junction– proposed re-alignment – 2+100.000 to 5+760.000.

11.10.30 Following these summaries, paragraphs 11.10.38 to 11.10.56 quantify the numbers of receptors affected above the SOAEL threshold, and the numbers affected between the LOAEL and SOAEL thresholds for the whole scheme.

Bentham to Air Balloon roundabout – 0+000.000 to 2+100.000

11.10.31 On this section, the proposed scheme would be aligned with the existing A417. As shown in figure 11.3 (noise change contour map), traffic noise levels immediately around the highway would be increased on the southern side. At Witcombe, noise levels would be subject to negligible change (i.e. less than 1dB(A) increase or decrease). Larger noise increases would affect a number of isolated dwellings and commercial premises on the southern side alongside the highway. Further from the road, figure 11.3 shows noise increases between 1 to 3dB(A) would occur at distances up to approximately 500m at some locations.

11.10.32 On the north side of the scheme, beneficial noise reductions (i.e. greater than 3dB(A)) would occur over much of the escarpment ascending to Crickely Hill and the wider area of the Country Park, including Crickley Hill Camp (SM). Between chainages 1+200.000 and 2+250.000 within 100m from the scheme, parts of the Country Park at the bottom of the hill would be subject to noise reductions of between 5 and 10dB(A) due to the scheme realignment, the removal of the existing A417 immediately south of the Air Balloon roundabout down to Cowley junction. Residential properties on the northern side would generally be subject to negligible noise reductions except for Air Balloon Cottages near the roundabout where larger noise reductions would occur.

Air Balloon roundabout to Cowley junction– existing alignment

11.10.33 On the northern part of this section (north of the B4070), there would be substantial noise reductions either side of the removed A417 existing alignment (i.e. between 5 and 10dB(A) reductions approximately 100m either side of the removed highway). South of the B4070, noise reductions up to 10dB(A) would occur on the east side of Birdlip, with reductions up to 5dB(A) further towards the centre of village.

11.10.34 Southeast of Birdlip towards Cowley junction, substantial noise reductions, greater than 10dB(A) would also occur at a group of residential properties at Hawcote Hill. Similar noise reductions would occur at scattered dwellings closer to Cowley junction.

Air Balloon roundabout to Cowley junction– proposed re-alignment – 2+100.000 to 5+760.000

11.10.35 North of Shab Hill junction with the proposed extension to the B4070, noise level increases greater than 10dB(A) would occur up to several hundred metres either side of the proposed scheme away from existing roads. There are few properties on this section. These noise increases would affect Birdlip Radio Station, Rushwood Kennels and Cattery (including residential accommodation), and part of the Gloucestershire Way where it crosses the scheme.

- 11.10.36 South of Shab Hill junction, the extent of the 10dB(A) increase either side of the scheme would be slightly narrower towards Cowley, partly because the scheme would be in shallow cutting towards the southern end. The noise increase would affect a number of footpaths (see figure 11-3) both crossing and aligned parallel to the scheme, including areas of 10dB(A) increase. The community at Stockwell, to the southwest of the proposed scheme at chainage 4+000.000 would be affected by noise increases of between 3 to 5dB(A).
- 11.10.37 The village of Cowley is some 1300m to the east of the proposed scheme. The topography is such that there would be no direct line of sight towards the scheme from the village itself. This area is outside of the DMRB HD 213/11 study area and noise increases are expected to be negligible from the scheme at this distance. This will be reviewed in more detail for the ES.

#### Assessment of significant effects

- 11.10.38 Table 11-13 summarises areas alongside the scheme where significant effects are assessed. The text following the table describes further detail on the types of effect (in the long term) as well as effects in NIAs and on non-residential locations (e.g. footpaths in the AONB).

**Table 11-13 Significant Environmental Effects (Residential)**

Receptor	Conclusion of significance of environmental effect	Direct/indirect effect	Justification of significance conclusion
Crickley Court Crickley Hill, Witcombe, Gloucester, GL3 4UF. – NIA 3906	Significant	Direct	Adverse effect above the SOAEL in the short term and long term (note that a significant effect is assessed for a smaller noise change when noise exposure above SOAEL)  (See operational criteria in Table 11-9, potential significance criteria described in paragraph 11.5.61, and additional factors considered in determining significance in paragraph 11.5.63.)
Fernbank Crickley Hill, Witcombe, Gloucester, GL3 4UQ. – NIA 3907	Significant	Direct	Adverse effect above the SOAEL in the short term and long term
Pinewood Crickley Hill, Witcombe, Gloucester, GL3 4UH. – NIA 3908	Significant	Direct	Adverse effect above the SOAEL in the short term and long term
Grove Lodge Crickley Hill, Witcombe, Gloucester, GL3 4UH.	Significant	Direct	Adverse effect above the SOAEL in the short term and long term
Stockwell Cottage , Stockwell, Birdlip, Gloucester, GL4 8JZ.	Significant	Direct	Adverse effect in the short term and long term
Stockwell Barn, Stockwell, Birdlip, Gloucestershire, GL4 8JZ.	Significant	Direct	Adverse effect above the SOAEL in the short term and long term
The Rise, Stockwell, Birdlip, Gloucestershire, GL4 8JZ.	Significant	Direct	Adverse effect in the short term, and the long term

<b>Receptor</b>	<b>Conclusion of significance of environmental effect</b>	<b>Direct/indirect effect</b>	<b>Justification of significance conclusion</b>
Rushwood Kennels, Shab Hill, Birdlip, Gloucestershire, GL4 8JX.	Significant	Direct	Adverse effect in the short term and long term
Shab Hill Barn, Shab Hill, Birdlip, Gloucestershire, GL4 8JX.	Significant	Direct	Adverse effect in the short term and long term
Shab Hill Farm, Shab Hill, Birdlip, Gloucestershire, GL4 8JX.	Significant	Direct	Adverse effect in the short term, and the long term
No. 1 Air Balloon Cottages, Crickley Hill, Birdlip, Gloucestershire, GL4 8JY.	Significant	Direct	Beneficial effect above the SOAEL in the short term and long term
No. 2 Air Balloon Cottages, Crickley Hill, Birdlip, Gloucestershire, GL4 8JY.	Significant	Direct	Beneficial effect above the SOAEL in the short term and long term
Black Horse Ridge Stroud Road, Birdlip, Gloucestershire, GL4 8JN.	Significant	Indirect	Beneficial effect in the short term and long term (reducing below the SOAEL)
Leaside, Nettleton, Birdlip, Gloucestershire, GL4 8LA.	Significant	Direct	Beneficial effect in the short term and long term (reducing below the SOAEL)
The Old Pyke House, Cirencester Road, Birdlip, Gloucestershire, GL4 8JL.	Significant	Direct	Beneficial effect in the short term and long term
Castle Hill, Birdlip, Gloucestershire, GL4 8LA.	Significant	Direct	Beneficial effect in the short term, and long term
Purdey House, Hawcote Hill, Cirencester Road, Birdlip, Gloucestershire, GL4 8JL.	Significant	Direct	Beneficial effect in the short term, and long term
Highclere, Cirencester Road, Birdlip, Gloucestershire, GL4 8JL.	Significant	Direct	Beneficial effect in the short term and long term
Welwyn, Cirencester Road, Birdlip, Gloucestershire, GL4 8JL.	Significant	Direct	Beneficial effect in the short term and long term
Hawcote House, Hawcote Hill, Cirencester Road, Birdlip, Gloucestershire, GL4 8JL.	Significant	Direct	Beneficial effect in the short term and long term
Rose Cottage, Cirencester Road, Birdlip, Gloucestershire, GL4 8JL.	Significant	Direct	Beneficial effect in the short term and long term
Woodside, Nettleton, Birdlip, Gloucestershire, GL4 8LA.	Significant	Direct	Beneficial effect in the short term and long term
The Cottage Catchbar, Cirencester Road, Birdlip, Gloucestershire, GL4 8JL.	Significant	Direct	Beneficial effect in the short term and long term
Birdlip View, Cirencester Road, Birdlip, Gloucestershire, GL4 8JL.	Significant	Direct	Beneficial effect in the short term and long term
Hillcot, Cirencester Road, Birdlip, Gloucestershire, GL4 8JL.	Significant	Direct	Beneficial effect in the short term and long term

Receptor	Conclusion of significance of environmental effect	Direct/indirect effect	Justification of significance conclusion
Barrow Wake House, Shab Hill, Birdlip, Gloucestershire, GL4 8JX.	Significant	Direct	Beneficial effect in the short term and long term
Crickley Ridge, Crickley Hill, Birdlip, Gloucestershire, GL4 8JY.	Significant	Direct	Beneficial effect in the short term and long term
<ul style="list-style-type: none"> <li>Significant Adverse: 10 dwellings</li> <li>Significant Beneficial: 17 dwellings</li> <li>Not Significant Effects: 240 dwellings</li> <li>Negligible Effects (above SOAEL): 4 dwellings</li> </ul>			

*Residential receptors: effects exceeding the SOAEL*

- 11.10.39 Table 11-13 shows that there are four dwellings (which are already above the SOAEL) on this section of the scheme predicted to experience direct effects from increased noise levels higher than the relevant significant observed adverse level (SOAEL as described in Table 11-2 and criteria defined in Table 11-7). This refers to a direct effect where there is at least a 1dB(A) impact as a result of the scheme in the future year (2039), rather than effects from non-scheme roads. These properties are Fernbank, Crickley Court Cottages, Pinewood and Grove Lodge located west of the Air Balloon roundabout alongside the scheme. These are minor adverse impacts (other than Pinewood which is a moderate impact) assessed as a direct likely significant observed adverse effect.
- 11.10.40 The noise level information (appendix 11.3) shows that four dwellings would already exceed the SOAEL in the absence of the scheme. These are Beechwood, Cottage-On-Ridge, Half Acre and Laurel Cottage. For these dwellings there is negligible noise change, hence no adverse or beneficial effect.
- 11.10.41 There are four locations currently exceeding the SOAEL where the noise levels would reduce as a result of the scheme (as shown in the noise difference contours – figure 11.3). For two of these properties (Black Horse Ridge and Leaside), noise levels would reduce such that the noise exposure would fall below the SOAEL with the scheme in operation. This large reduction is assessed as a minor beneficial impact at Black Horse Ridge and a major beneficial impact at Leaside. Two dwellings (Air Balloon Cottages), would remain above the SOAEL, but the reduction would be a major beneficial impact. All these noise reductions would be direct likely significant beneficial effects in the future year.

*Residential receptors: effects between LOAEL and SOAEL*

- 11.10.42 Table 11-13 shows the properties identified as having predicted noise impacts between the LOAEL and SOAEL. The assessment is based upon the change in noise caused by the scheme, with consideration of other factors such as the existing level of noise exposure (see Methodology paragraph 11.5.63). There are six dwellings that will have a likely significant adverse effect in the long term: Rushwood Kennels (residential accommodation), Stockwell Cottage, Stockwell Barn, The Rise, Shab Hill Barn and Shab Hill Farm. The level of impact would range from minor to major impact. These dwellings are all located near the

proposed new alignment south of the Air Balloon roundabout. Full details of these effects are shown in Table 11-13.

- 11.10.43 There are thirteen dwellings subject to likely significant beneficial direct effects between the LOAEL and SOAEL. These are The Old Pyke House, Castle Hill Cottage, Hawcote House, Purdey House, Highclere, Welwyn, Rose Cottage, Woodside, The Cottage Catchbar, Birdlip View, Hilcot, Barrow Wake House, and Crickley Ridge. The level of impact would range from minor to major impact. These dwellings are all located near the existing alignment south of the Air Balloon roundabout where the existing highway would be removed.

*Non-residential sensitive receptors: effects*

- 11.10.44 Several non-residential receptors in Birdlip will be subject to noise reductions as a result of the removal of the existing A417 close to the village. These are, Birdlip Primary School, Birdlip Village Hall, and St Marys Church. As can be seen from figure 11.3, these are all subject to substantial noise reductions which are assessed as likely significant beneficial effects (see non-residential assessment criteria in paragraphs 11.5.66 - 11.5.67). Further south at Brimpsfield near Cowley junction, the Church of St Michael would be subject to a small increase in noise of approximately 1dB(A) which is assessed as not significant.
- 11.10.45 Around chainage 1+600.000 towards the Air Balloon roundabout, the new highway alignment would move southwards from its existing position. Between chainages 1+200.000 and 2+250.000, within 100m from the scheme, parts of the Country Park at the bottom of the hill would be subject to noise reductions of between 5 and 10dB(A).
- 11.10.46 These noise reductions in 'The Scrubbs' area and footpaths<sup>239</sup> on the escarpment rising up to the Country Park would result in a perceptible reduction in traffic noise exposure in this outdoor amenity area. The Park is also designated as an SSSI and a SM. As well as cultural heritage assets, Crickley Hill includes popular footpaths within the area of noise impact, including the Gloucestershire Way, Cotswold Way, and Gustav Holst Way. The magnitude and spatial extent of the noise reductions across this designated site is assessed as a likely significant beneficial effect (see non-residential assessment criteria in paragraphs 11.5.66 - 11.5.67).
- 11.10.47 South of the Air Balloon roundabout, the removal of the existing highway would result in noise reductions of between 5 and 10dB(A) approximately 100m either side of the removed highway (including Emma's Grove – SM). The Cotswold Way, on the section of the footpath between Air Balloon roundabout and Barrow Wake view point (shown on figure 11.3), would be subject to noise reductions of between 5 and 10dB(A) or more. These noise reductions for this section of the footpath are assessed as a likely significant beneficial effect. Further west, The Peak (Neolithic enclosure, heritage asset) would be subject to noise change of less than 1dB(A).
- 11.10.48 Further south, the section of footpath from just north of Birdlip, running east across the removed road and turning south to Parson's Pitch (800m in length – see figure 11.3) would be subject to noise reductions of between 5 and 10dB(A)

<sup>239</sup> Most footpaths discussed in this assessment of non-residential receptors are identified in figures 12.1 to 12.3.

or more. These noise reductions for this section of the footpath are assessed as a likely significant beneficial effect.

- 11.10.49 South of Birdlip, footpaths in the following areas would be subject to noise reductions of between 1 and over 10dB(A): Beechwoods SSSI, Hawcote Hill, Hawcote Copse, Birtlan Grove, Brimpsfield SSSI. However, given the proportions of these footpaths that are affected, these noise benefits are assessed as not significant.
- 11.10.50 To the east of the Air Balloon roundabout, the new alignment would result in noise increases around the proposed scheme. This would impact upon the Gloucestershire Way crossing this area of land where baseline noise levels range from 60dB<sub>L<sub>Aeq,16hr</sub></sub> or above close to the east side of the existing alignment (see figure 11.1); and as quiet as 35dB<sub>L<sub>Aeq,16hr</sub></sub> (below LOAEL) in the lower-lying area of the proposed scheme corridor furthest from existing roads. This section of the footpath is considered in this assessment to be a unique feature (see assessment criteria – paragraph 11.5.67) given the relatively low baseline noise levels and therefore the sensitivity of this section of the footpath within the AONB. The magnitude of impact and the proportion of the footpath affected by perceptible noise increases is assessed as a likely significant adverse effect on the section of the Gloucestershire Way<sup>240</sup> between the Air Balloon roundabout and Coberley to the east.
- 11.10.51 Further south, there is a footpath on the east side of Barrow Wake which runs southeast to join with the lane just north of Stockwell (see figure 11.3). At the Stockwell end of this footpath link, the easternmost 400m section would be affected by clearly perceptible noise increases of more than 3dB(A). However, the northwestern kilometre of this footpath link would be subject to smaller noise increase or reductions. Given the relatively small length of this footpath adversely affected as a proportion of the whole link, this is assessed as not significant.
- 11.10.52 On the east side of the lane through Stockwell there are three footpaths connecting to the lane (immediately north of Stockwell). Two of these are aligned to the southeast to join a lane approximately one kilometre to the southeast. The northernmost of these footpaths would align closely with the proposed scheme along most of the length of this link and will therefore be subject to noise increases of approximately 10dB(A). The southernmost footpath would be adversely affected for a relatively large proportion of its length. The third footpath in this area runs from the lane north of Stockwell towards Green Hatch Farm to the northeast where it re-joins the same lane. This footpath link would cross the proposed scheme and noise levels would be increased by 3dB(A) or more along the whole length of this link. These sections of footpath are considered in this assessment to be unique features given the relatively low baseline noise levels and therefore the sensitivity of these footpaths within the AONB. This is assessed as a likely significant adverse effect for these footpath links.

### *Noise Important Areas*

- 11.10.53 There are six NIAs that lie within the A417 study area. All these areas represent properties which are currently exposed to noise levels above the SOAEL. Of

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<sup>240</sup> The Gloucestershire Way would be realigned at the western end of this section described in paragraph 11.10.50. The assessment takes this realignment into account.



these, NIA 13915 (No.1 and 2 Air Balloon Cottages), and NIA 3905 (Castle Hill Cottage) will be subject to likely significant beneficial effects.

- 11.10.54 Without mitigation, NIA 3906 (Crickley Court Cottages), NIA 3907 (Fernbank), NIA 3908 (Pinewood), would be subject to likely significant adverse effects. NIA 13196 (Laurel Cottage) would be subject to a negligible noise increase. No noise mitigation has been included for the PEI Report, but this will be reviewed with landscape/visual specialists and incorporated for the ES as appropriate to address these potential effects.

#### Operational ground-borne vibration assessment

- 11.10.55 No operational ground-borne vibration impacts are expected. This is because, in accordance with highway construction standards, the surface of the proposed pavement alterations would be smooth with no surface irregularities, which could generate significant levels of ground-borne vibration. It is a standard requirement under the specification for new highways that the new road surfaces would be free of significant discontinuities.
- 11.10.56 The size of irregularities necessary to cause perceptible ground-borne vibration is only expected in 'exceptional circumstances'. It is not considered that any such exceptional circumstances would arise during operation of the proposed scheme.

### **11.11 Monitoring**

- 11.11.1 The prediction and assessment methodologies set out in section 11.5 of this chapter would be used to support the verification of the effectiveness of any mitigation measures<sup>241</sup>. Monitoring of the effectiveness would be carried out as part of Highways England's Project Evaluation procedures, which evaluates how highway schemes are delivered and would highlight any issues with meeting the accepted design.
- 11.11.2 Where access is required onto private land for monitoring purposes, prior consultation would be undertaken with the occupier and appropriate arrangements would be made to enable the monitoring to be undertaken.
- 11.11.3 Highways England has a duty under Regulation 6 of the NIR to assess noise levels following the opening of the scheme to traffic. The purpose of this is to establish the buildings which previously did not qualify for an original offer of carrying out or making a grant in respect of carrying out noise insulation work, but which would have become eligible by increased traffic flow. Assessments would be carried out in accordance with the obligations set out in the NIR.

### **11.12 Summary**

- 11.12.1 Construction and operational traffic noise have been assessed in terms of Government Policy (for dwellings potentially exceeding the SOAEL), and Environmental Impact Assessment significance (between the LOAEL and SOAEL). These different types of effect are explained in Table 11-2.

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<sup>241</sup> As noted, incorporated noise mitigation is envisaged although not included as part of the PEI Report. This will be reviewed in the ES and integrated with the landscape and visual mitigation.

### **Preliminary Construction Assessment**

- 11.12.2 Construction noise and vibration has been assessed from the available construction information at the time of PEI Report. The assessment assumes that the works would be undertaken following the principles, controls and processes set out in the Outline CEMP to be provided with the ES.
- 11.12.3 The principal activities considered within the PEI Report with the potential to cause noise and vibration effects are limited to the the area of deep cutting between approximate chainages 1+800 to 2+800. This is likely to be where the most intensive work will be carried out for the longest duration, i.e. topsoil strip and earthworks cut and fill (including haul roads), and surface levelling prior to pavement laying.
- 11.12.4 Temporary significant construction noise effects have been assessed at three residential locations (all construction receptors shown in figure 11.1). These are direct effects above the SOAEL threshold, as described in Government Policy (see Table 11-3). These locations are:
- R3 Crickley Ridge;
  - R4 Air Balloon Cottages; and
  - R6 Rushwood Kennels (residential accommodation).
- 11.12.5 The results are shown in Table 11-12.
- 11.12.6 Likely noise impacts are also assessed as direct temporary significant effects at three non-residential receptors, two of which represent public footpaths close to the proposed scheme within the AONB:
- Receptor R5 Birdlip Radio Station;
  - Receptor R9 Crickley Hill Access Road and footpath; and
  - R10 and R11 Gloucestershire Way between the Air Balloon roundabout and Coberley to the east.
- 11.12.7 Construction vibration effects have been assessed as direct temporary significant at two dwellings, but subject to further review in the ES when more information is available. Suitable mitigation protocols will be defined in the Outline CEMP.
- 11.12.8 This construction noise and vibration assessment will be further developed for the ES. This will include more detailed construction methodology information regarding processes and programme.

### **Preliminary Operational Assessment**

- 11.12.9 Incorporated mitigation is envisaged to avoid significant noise effects from the scheme, and to reduce, as far as practicable (and sustainable), other likely adverse effects from the proposed scheme. This will be developed as part of the ES.
- 11.12.10 Operational noise effects were identified for individual dwellings in the future assessment year (2039). The effects are associated with a noise change of 1dB(A) or more where existing noise levels exceed the SOAEL, i.e. a significant observable adverse effect in Government Policy terms (see Table 11-1).
- 11.12.11 Specifically, these are Fernbank, Crickely Court, Pinewood and Grove Lodge, all located west of the Air Balloon roundabout alongside the proposed scheme.

- 11.12.12 Four residential locations in the study area would already exceed the SOAEL in the absence of the scheme. For two of these properties (Black Horse Ridge and Leaside), noise levels would reduce such that the noise exposure would fall below the SOAEL with the scheme in operation. Two of these properties (Air Balloon Cottages), would remain above the SOAEL, but the reduction would result in a beneficial impact. All these reductions are assessed as direct permanent likely significant beneficial effects in the future year.
- 11.12.13 There are six dwellings assessed as being subject to direct, likely significant adverse effects in 2039 between the LOAEL and SOAEL (see Table 11-2). These are Rushwood Kennels (residential accommodation), Stockwell Cottage, Stockwell Barn, The Rise, Shab Hill Barn and Shab Hill Farm. These are assessed as direct permanent likely significant adverse effects. These dwellings are all located near the proposed new alignment south of the Air Balloon roundabout.
- 11.12.14 There are thirteen dwellings subject to likely significant beneficial effects between the LOAEL and SOAEL. These are The Old Pyke House, Castle Hill Cottage, Hawcote House, Purdey House, Highclere, Welwyn, Rose Cottage, Woodside, The Cottage Catchbar, Birdlip View, Hilcot, Barrow Wake House, and Crickley Ridge. These dwellings are all located near the existing alignment south of the Air Balloon roundabout where the existing highway would be removed.
- 11.12.15 These direct and indirect noise changes are reflected in the HD 213/11 noise impact tables shown in appendix 11.3 and the associated noise nuisance tables.
- 11.12.16 For non-residential sensitive receptors, several receptors have been identified to represent key, sensitive locations within the AONB that would be most affected by the scheme proposal.
- 11.12.17 At Crickley Hill Country Park, 'The Scrubbs' area and footpaths on the escarpment rising up to the Country Park would be subject to perceptible reductions in traffic noise exposure, particularly at the lower part of the hill closer to the removed section of highway. The magnitude and spatial extent of the noise reduction across this part of the County Park (designated site - SSSI, SAM) and footpaths here is assessed as a direct permanent likely significant beneficial effect.
- 11.12.18 South of the Air Balloon roundabout the removal of the existing highway would result in noise reductions in this area and along the Cotswold Way. The section of the footpath between Air Balloon roundabout and Barrow Wake view point, would be subject to a direct permanent likely significant beneficial effect. Further south, the section of footpath from just north of Birdlip, running east across the removed road and turning south to Parson's Pitch would also be subject to a direct permanent likely significant beneficial effect.
- 11.12.19 To the east of the Air Balloon roundabout, the new alignment would result in noise increases around the proposed scheme. The noise increase is assessed as a direct permanent likely significant adverse effect on the section of the Gloucestershire Way between the Air Balloon roundabout and Coberley to the east. This section of the footpath is considered in this assessment to be a unique feature given the relatively low baseline noise levels and therefore the sensitivity of this section of the footpath within the AONB.
- 11.12.20 On the east side of the lane through Stockwell there are three footpaths connected to the lane (immediately north of Stockwell). All these footpath links

run for approximately one kilometre to the east. These footpath links are assessed as unique features in this part of the AONB where baseline noise levels are low and are assessed as being subject to a direct permanent likely significant adverse effect.

### **Further Work**

- 11.12.21 It has been noted in section 11.8 that certain information was not available for the PEI Report, hence there is further work that will be carried out for inclusion in the ES. This will include the results of the baseline noise measurement survey which will provide supplementary information for the baseline assessment.
- 11.12.22 Where necessary, assumptions have been made with the advice of the scheme design engineers regarding aspects of the construction process. When scheme contractors have developed a full construction method statement and more detailed information on programme, the assessment of construction noise and vibration will be reviewed and updated.
- 11.12.23 DMRB HD 213/11 requires consideration of potential noise impacts on existing roads outside the study area, where these are affected by traffic flow changes above a specified threshold. This assessment will be carried as part of the ES but has not been included in this PEI Report.
- 11.12.24 The NPSNN requires that the effects on ecological receptors are considered and this will be included across the Biodiversity and Noise & Vibration chapters of the ES.

## 12 Population and Human Health

### 12.1 Introduction

12.1.1 This chapter of the PEI Report provides an overview of the potential construction and operational effects of the proposed scheme on population and human health.

12.1.2 In order to assist the reader and due to the broad scope of the population and human health topic, this chapter is structured under the following impact areas (receptor groups)<sup>242</sup>:

- **All Travellers** – including potential effects on vehicle travellers, walkers, cyclists and horse-riders.
- **Communities** – including potential effects on employment, existing settlements, access to services/green space, community safety and residential amenity.
- **Land and Property** – including potential effects on land and property to be used or acquired, allocated development land, tourism and recreation receptors and commercial business receptors.
- **Human Health** – potential effects on human health determinants which are identified as relevant to the proposed scheme.

12.1.3 The PEI Report provides preliminary information based on the development of the proposed scheme to date and data gathered at this point, which will be provided in full and final form within the ES.

12.1.4 Information gaps at PEI Report stage will be addressed in the ES and more specific mitigation and enhancement measures will be developed/considered.

### 12.2 Legislative and Policy Framework

12.2.1 This section of this chapter presents the legislation and policy of most relevance to the assessment and includes a summary of how the assessment has responded to the relevant policy requirements as set out below.

12.2.2 This section does not provide a review of the legislation and policy support for the proposed scheme itself. That will be addressed within a separate Planning Statement that will accompany the application for a DCO.

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<sup>242</sup> Taking into account the relevant Design Manual for Roads and Bridges (DMRB) guidance where there is an appropriate approach

**Table 12-1 Legislation and Policy**

Relevant document	Application to the proposed scheme
Countryside and Rights of Way Act 2000	The Act provides a new right of public access on foot to areas of open land. The Act also provides safeguards which consider the needs of landowners and occupiers, and of other interests, including wildlife. The Act improves the rights of way legislation by encouraging the creation of new routes and clarifying uncertainties about existing rights.
National Policy Statement for National Networks (NPSNN) (December 2014)	<p>The Government's vision and strategic objectives for national networks set out in the NPSNN includes '<i>supporting a prosperous and competitive economy</i>', and specifically: Networks with the capacity and connectivity to support national and local economic activity and facilitate growth and create jobs; and Networks which join up our communities and link effectively to each other. Paragraph 3.3 requires that '<i>reasonable opportunities to deliver environmental and social benefits as part of proposed schemes</i>' should be considered and that environmental and social impacts should be mitigated in line with the principles set out in the National Planning Policy Framework (NPPF) and the Government's planning guidance.</p> <p>The NPS recognises that roads have the potential to affect the health, wellbeing and quality of life of the population. Direct health effects are recognised in relation to traffic, noise, vibration, air quality and emissions, light pollution, community severance, dust, odour, polluting water, hazardous waste and pests. Indirect effects are identified as potentially resulting from changes to access to key public services, local transport, opportunities for cycling and walking or the use of open space for recreation and physical activity.</p> <p>Measures to avoid, reduce or compensate for adverse health impacts should be identified as appropriate and the assessment should consider cumulative impacts on health that arise as a result of different impacts affecting people simultaneously.</p>
Road Investment Strategy: 2015 – 2020 (2014)	The Strategy includes the A417 'Missing Link' as a project to be developed for the next road period.
Revised National Planning Policy Framework (2018)	The NPPF seeks a transport system in favour of sustainable modes and which gives choice to people on how they travel, while recognising that opportunities to maximise sustainable transport solutions will vary from urban to rural areas. The draft revised policy on transport retains the priority on reducing the need to travel and policies in favour of sustainable transport modes.
National Planning Practice Guidance (PPG) (2014)	The Guidance states that existing open space should be taken into account when considering development proposals.
Government White Paper: Healthy Lives, Healthy People (2010)	The white paper outlines the Government's commitment to helping people live longer, healthier and more fulfilling lives, while improving the health of the poorest, fastest.
Highways England Cycling Strategy	The Cycling Strategy sets out how the planned roads improvements programme will provide integrated schemes which improve cycling facilities, contributing towards the development of an integrated, safe, comprehensive and high-quality cycling network.
Highways England Accessibility Strategy	The vision for accessibility focuses on supporting road users' journeys, including pedestrians, cyclists, equestrians, those with disabilities and other vulnerable users, while delivering longer-term benefits for communities and users alike. It aims to address the barriers that roads can sometimes create, help expand people's travel choices, enhance and improve network facilities, and make every day journeys as easy as possible.

Relevant document	Application to the proposed scheme
Joint Core Strategy (2017) and Gloucester Local Plan (1983) – saved policies	<p>The Joint Core Strategy (JCS) was adopted by Gloucester City Council, Cheltenham Borough Council, and Tewkesbury Borough Council as a co-ordinated strategic development plan up to 2031. The relevant policies include:</p> <ul style="list-style-type: none"> <li>• Policy SD1: Employment – Except Retail Development;</li> <li>• Policy SD2: Retail and City/Town Centres;</li> <li>• Policy SD10: Residential Development;</li> <li>• Policy SD14: Health and Environmental Quality;</li> <li>• Policy INF1: Transport Network; and</li> <li>• Policy INF4: Social and Community Infrastructure.</li> </ul> <p>They are now taking forward a review and an Issues and Options consultation took place between November 2018 and January 2019. Further information will be made available in due course.</p> <p>None of the policies from the 1983 Local Plan are considered relevant. The A417 Air Balloon (Missing Link) proposed scheme is identified as a key priority through the JCS infrastructure delivery plan.</p>
Second Stage Deposit City of Gloucester Local Plan (2002)	<p>As the Second Stage Deposit is not an adopted plan, the policies contained within it could not be superseded by the adoption of the Joint Core Strategy. The relevant policies that are considered to be a material consideration and have significant weight in the decision-making process: Policy BE.2 Views and Skyline and Policy E.4 Protecting Employment Land.</p>
Local Transport Plan (LTP) for Gloucestershire 2015	<p>The Local Transport Plan's overarching objectives are to:</p> <ul style="list-style-type: none"> <li>• support sustainable economic growth;</li> <li>• enable community connectivity;</li> <li>• conserve the environment; and</li> <li>• Improve community health and wellbeing.</li> </ul> <p>Expected outcomes include improved network resilience, journey time reliability, a thriving economy, financial stability, reduced isolation and better active travel. Formal consultation will take place in the spring of 2020 where all stakeholders will have an opportunity to provide feedback on a reviewed Local Transport Plan.</p>
Strategic Economic Plan (SEP) and Gloucestershire Economic Growth Capital Investment Pipeline (CIP) 2018	<p>The SEP for Gloucestershire outlines how the ambition is to grow the local economy by an average of 4.8% GVA per annum by 2022. The SEP Update 2018 identifies the A417 as the 'Missing Link' and a weakness as a capacity constraint within the region. The Highways England Missing Link project is identified as a part of the required transport infrastructure to deliver the SEP.</p> <p>The CIP is a strategy central to the Local Enterprise Partnership GFirst. It is reviewed, refreshed and updated on a regular basis, to take account of emerging economic investment, strategic infrastructure requirements, resource needs and potential funding opportunities.</p>

Relevant document	Application to the proposed scheme
Cotswolds AONB Management Plan 2018-2023	<p>The purposes of the AONB are to: “<i>conserve and enhance the natural beauty of the Cotswolds AONB; and increase the understanding and enjoyment of the special qualities of the Cotswolds AONB.</i>”</p> <p>The AONB’s Vision is to be “<i>a distinctive, unique, accessible living landscape treasured for its diversity which is recognised by all for its wide-open views, dry stone walls, intimate valleys, flower rich grasslands, ancient woodlands, dark skies, tranquillity, archaeology, historic and cultural heritage and distinctive Cotswold stone architecture.</i>” To achieve their Purpose and ‘Vision’ the AONB have set out a number of ‘Outcomes’ which cover key topics such as Landscape and Geology, Local Distinctiveness, Tranquillity, Dark Skies, and Access and Recreation, with associated policies. The relevant Policies for this chapter are listed below:</p> <ul style="list-style-type: none"> <li>• Policy UE2: Access and Recreation - Of specific relevance to this assessment, Policy UE2 seeks to ensure that a safe, accessible, waymarked and connected PRow network is maintained, enhanced and promoted across the AONB. The policy also has similar aims for common land and other open access land and seeks that where appropriate more such land is provided.</li> <li>• Policy UE3: Health and Well-being - Of specific relevance to this assessment, Policy UE3 seeks to ensure that opportunities to improve health and well-being in the AONB are created, improved and promoted. This includes the provision of walking, cycling and riding routes where appropriate.</li> </ul>

## 12.3 Study Area

- 12.3.1 The study area for each impact area has been defined through consideration of the potential effects on key receptor groups as described above and the area over which an effect is likely to be experienced. This has been informed through both consideration of direct effects which will largely be limited to the extent of the proposed scheme, and indirect effects which could be experienced over a wider area.
- 12.3.2 It should be noted that the relevant Design Manual for Roads and Bridges (DMRB) guidance does not specify a standard study area for the assessment of effects on all travellers but refers to a requirement to identify existing and proposed Public Rights of Way (PRow) which may be affected. No other adopted guidance exists which would specify study areas for the receptors considered within the chapter. As such, all study areas have been defined based on professional judgement, best practice and in agreement with stakeholders as set out within the EIA Scoping Report<sup>243</sup>.
- 12.3.3 For ‘All Travellers’, an appropriate study area has been agreed comprising a 250m extent from the proposed scheme’s centre line for indirect effects. This area aims to capture the potential impacts on drivers, severance and amenity. PEI Report figure 12.1 – Study Area shows the 250m extent in the proposed scheme’s context. Direct effects are considered for the existing A417 Missing Link and routes interacting with (passing through) the proposed scheme boundary

<sup>243</sup> Environmental Scoping Report, May 2019 <https://infrastructure.planninginspectorate.gov.uk/wp-content/uploads/projects/TR010056/TR010056-000009-A417%20-%20Scoping%20Report.pdf>



(Order limits) as has been identified for construction and operation (those which would be directly impacted by access changes).

- 12.3.4 For 'Communities', potential indirect and amenity effects on people, access to services/green space and community safety receptors within 250m of the proposed scheme or where they are effected by benefits/disbenefits as a result of traffic changes on the local road network have been considered. This study area is considered appropriate to capture the local receptors that would most likely experience any result of changes in travel conditions and amenity along the existing A417 Missing Link and proposed scheme, both during construction and operation. Direct effects are considered for the receptors situated within the Order limits (those which would be directly affected in terms of their operation).
- 12.3.5 For 'Land and Property', potential indirect effects on land and property to be used or acquired to accommodate the proposed scheme, allocated land, tourism and recreation facilities and commercial business receptors within 250m of the proposed scheme or where they are affected by benefits/disbenefits as a result of traffic changes on the local road network have been considered. This study area is considered appropriate to capture the local and regional nature and scale of receptors that would most likely experience benefits or dis-benefits to their temporary and/or continued use because of changes in travel conditions and amenity along the existing A417 and proposed scheme, both during construction and operation. Direct effects are considered for the receptors situated within the proposed Order limits (those which would see their function or capacity directly affected).
- 12.3.6 For 'Human Health' the study area of the assessment varies dependent upon the different health determinants being assessed and the receptors they have an impact on. For example, air quality receptors will be considered within 200m of the proposed scheme (to align with the air assessments), whilst for noise this is 600m. However, general consideration of health effects covers the population that lives within the wards through which the proposed scheme passes. Therefore, the majority of data has been obtained at the level of wards that surround the proposed scheme. Where data is not available at this local level, data has been used from the wider Gloucestershire area.
- 12.3.7 Wards that have been included in the assessment are those in which the proposed scheme sits; this includes Badgeworth ward to the west (in Tewkesbury District) and Ermin ward (Cotswold District) to the east. Figure 12.1 shows the boundaries of these wards. Badgeworth ward actually extends much further north (following the M5 to just beyond Cheltenham) than is relevant for the health assessment. However, due to the way that data is collected, it is necessary to use health data covering this whole area.
- 12.3.8 In summary, the study areas considered for each of the impact areas that are taken into account within this chapter are summarised in Table 12-2.

**Table 12-2 Study Areas**

<b>Impact Area</b>	<b>Study area for Indirect or Amenity Effects</b>	<b>Study area for Direct Effects</b>
<b>All Travellers</b>	Existing and proposed routes located within 250m of the alignment of the Order limits.	The existing A417 Missing Link and existing and proposed routes passing within the Order limits, both during construction and operation, required for the proposed A417 scheme.
<b>Communities</b>	Receptors located within 250m of the proposed scheme or where they are affected by benefits/disbenefits as a result of traffic changes on the local road network have been considered.	Receptors located within the Order limits, both temporary and permanent, required for the proposed scheme.
<b>Land and Property</b>	Receptors located within 250m of the proposed scheme or where they are affected by benefits/disbenefits as a result of traffic changes on the local road network have been considered.	Receptors located within the Order limits, both temporary and permanent, required for the proposed scheme.
<b>Human Health</b>	Receptors within 200m of the proposed scheme, the local wards of Ermin, Badgeworth or within the larger District area of Tewkesbury.	Receptors within 200m of the proposed scheme, the local wards of Ermin, Badgeworth or within the larger District area of Tewkesbury.

## 12.4 Potential Impacts

- 12.4.1 The proposed scheme is described in PEI Report chapter 2 and is the scheme that has been assessed taking into account design, mitigation and enhancement measures.
- 12.4.2 This section of the chapter considers the potential impacts from the proposed scheme on the broad receptor groups identified above. The subsequent baseline and assessment sections of this chapter then consider the current context within the study area in respect of potential effects on the receptor groups identified.
- 12.4.3 In considering amenity effects on receptors, the assessment relies upon the information presented within other relevant chapters of this PEI Report to provide an 'in combination' assessment of the potential noise and vibration, air quality and visual impacts (PEI Report chapters 12, 6 and 8 respectively) that may result in a wider amenity effect on population and human health. The assessment of amenity effects will be completed in full as part of the ES as the technical content of these other chapters is finalised.
- 12.4.4 In considering the significance of potential effects on receptors, consideration has been given to design, mitigation and enhancement measures associated with the scheme as described in Section 12.9.

### All travellers

- 12.4.5 This includes an assessment of potential impacts arising from the scheme on vehicle travellers, walkers, cyclists and horse-riders (WCHs) as follows:
- construction and operational related effects on drivers' views from the road;
  - construction and operational related effects on driver stress;
  - potential effects on bus travellers during both construction and operation;

- potential effects on WCHs during construction including severance of key routes, any diversions required and associated impacts in relation to journey length and amenity; and
- potential effects on WCHs during operation including any severance or diversions to key routes and the potential for enhancements to the WCH network due to new overbridges and underbridges. Consideration has also been given to journey length effects and amenity impacts.

## **Communities**

12.4.6 This includes an assessment of potential impacts on a number of broad receptor groups, including employment, existing settlements, access to services/green space, community safety and amenity as follows:

- potential construction employment opportunities which could be generated by the proposed scheme and the associated local economic benefits;
- potential indirect or induced effects associated with the construction project and construction workforce in the local area (e.g. supply chain and spend in the local area);
- potential construction and operational effects on settlements, including access and potential severance effects;
- potential construction and operational effects in relation to access to services/green space; and
- potential effects on community safety, human health and amenity within local communities during both construction and operation.

## **Land and property**

12.4.7 This includes potential impacts on land and property to be used or acquired, allocated development land, tourism and recreation receptors and commercial business receptors as follows:

- construction and operational effects on commercial property and business receptors;
- construction and operational effects on agricultural receptors/farm holdings;
- potential effects on allocated land/future development land;
- construction and operational effects on tourism and recreational facilities within the vicinity of the proposed scheme, including direct effects on the receptor as well as indirect effects associated with any impacts on users of the receptors (e.g. amenity/perceived effects); and
- potential effects on other land (e.g. open space land) during both construction and operation.

## **Human Health**

12.4.8 This includes an assessment of impacts during construction and operation on identified relevant human health determinants which include:

- social capital;
- community safety;
- healthcare services and other community facilities;
- transport availability and connectivity;
- access to open space and nature;
- air quality;

- noise environment;
- visual amenity;
- climate change; and
- access to employment and training.

## 12.5 Assessment Methodology

### Assessment Methodology for Population Effects

- 12.5.1 The significance of an environmental effect is a function of the ‘value’ of the receptor and the ‘magnitude’ or ‘scale’ of the impact, which are considered further below.
- 12.5.2 There is no definitive guidance on significance criteria for the assessment of effects on ‘Population Health’. As such, the assessment methodology draws from published guidance where appropriate, and existing industry accepted practice where no guidance exists.
- 12.5.3 For example, certain elements of the assessment methodology have been developed in accordance with the following DMRB guidance, where this provides an appropriate approach:
- volume 11, section 2, LA 104 Environmental Assessment and Monitoring;
  - volume 11, section 3, part 6 – Land Use;
  - volume 11, section 3, part 8 – Pedestrians, Equestrians, Cyclists and Community Effects; and
  - volume 11, section 3, part 9 – Vehicle Travellers.
- 12.5.4 Where receptors cannot be assessed within this guidance, a bespoke methodology has been developed and utilised, using professional judgement and best practice where necessary, which is explained below where appropriate.

#### Value of Receptor

- 12.5.5 The value or sensitivity of a receptor relates to the scope for the receptor to overcome an effect. For example, a tourism receptor that is small in scale, typically attracts regional visitors and that could easily move elsewhere (such as a campsite) would have a lower sensitivity than a facility that is large in scale, typically attracts national visitors and which could not move elsewhere (such as a World Heritage Site).
- 12.5.6 Sensitivity is also a key dimension to the assessment of indirect and amenity effects. This can be illustrated by considering an adverse visual effect on two different receptors<sup>244</sup>. For a tourism business the visual effect could have a negative effect on activity, whereas for a distribution company the effect would not be expected to affect business activity. As such, the sensitivity for the amenity assessment is essentially a binary choice; either a resource is sensitive to amenity effects or it is not.
- 12.5.7 Where appropriate, sensitivities have been applied with reference to DMRB and IEMA guidance criteria<sup>245</sup>. Where no specific guidance for the assessment exists,

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<sup>244</sup> When considering indirect amenity, the assessment does not include individual residential properties unless they have a business function which is considered to have an amenity value (e.g. B&B accommodation).

<sup>245</sup> DMRB Volume 11, Section 3, Part 8 and Part 9

criteria has been defined using professional judgement and knowledge of the context and potential effects.

12.5.8 Receptor sensitivity is applied as per Table 12-3.

**Table 12-3 Receptor Sensitivity**

Receptor Sensitivity	Criteria
<b>Very High</b>	Very high importance and rarity, international scale and very limited potential for substitution.
<b>High</b>	High importance and rarity, national scale, and limited potential for substitution.
<b>Medium</b>	High or medium importance and rarity, regional scale, limited potential for substitution.
<b>Low</b>	Low or medium importance and rarity, local scale.
<b>Negligible</b>	Very low importance and rarity, local scale.

#### Magnitude of Impact

- 12.5.9 The magnitude of an effect represents its severity. Key factors to be considered when assessing magnitude include the extent (e.g. scale of impact, or number of groups and/or individuals or businesses affected) and the value of the resource. For example, an effect involving the permanent closure of a PRoW without substitution or re-provision would have a higher magnitude than a permanent closure with a new and appropriate diversion.
- 12.5.10 Only those receptors deemed to be situated within the Order limits are expected to experience direct effects. This approach helps ensure that potential direct construction effects (e.g. where receptors interact with construction access routes and construction compounds) and potential direct operational effects (e.g. where a receptor interacts with the proposed scheme alignment) are considered.
- 12.5.11 The approach is considered suitable for assessing both direct effects (where the proposed scheme directly encroaches on a resource) and other effects such as severance/isolation (where the proposed scheme effects access to a resource). However, a different approach is taken when considering indirect amenity effects on a resource/receptor.
- 12.5.12 For receptors situated outside of the Order limits, much of the assessment explores potential indirect and amenity effects, including impacts on access and ongoing use of a receptor. An indirect amenity effect relates to the experience users have when using a resource for its intended function. For example, a hotel renowned for its views and gardens would have a positive amenity value. The amenity value of a resource may be affected by a combination of factors including changes in air quality, noise and vibration and visual impacts.
- 12.5.13 Magnitude of impact for population effects is applied as per Table 12-4 for both direct and indirect and amenity effects:

**Table 12-4 Magnitude of Impact for Population Effects**

<b>Magnitude of Impact</b>	<b>Typical criteria descriptions for direct effects</b>	<b>Typical criteria descriptions for indirect and amenity effects</b>
<b>Major</b>	Loss of resource and/or quality and integrity of resource; severe damage to key characteristics, features or elements (Adverse).	Two or more residual significant effects are identified where both are major in nature.
	Large scale or major improvement of resource quality; extensive restoration or enhancement; major improvement of attribute quality (Beneficial).	
<b>Moderate</b>	Loss of resource, but not adversely affecting the integrity; partial loss of/damage to key characteristics, features or elements (Adverse).	Two residual significant effects are identified with one being major in nature.
	Benefit to, or addition of, key characteristics, features or elements; improvement of attribute quality (Beneficial).	
<b>Minor</b>	Some measurable change in attributes, quality or vulnerability; minor loss of, or alteration to, one (maybe more) key characteristics, features or elements (Adverse).	Two residual significant effects are identified with both being moderate or less in nature.
	Minor benefit to, or addition of, one (maybe more) key characteristics, features or elements; some beneficial impact on attribute or a reduced risk of negative impact occurring (Beneficial).	
<b>Negligible</b>	Very minor loss or detrimental alteration to one or more characteristics, features or elements (Adverse).	One residual or no significant effects identified.
	Very minor benefit to or positive addition of one or more characteristics, features or elements (Beneficial).	
<b>No Change</b>	No loss or alteration of characteristics, features or elements; No observable impact in either direction.	No residual effects identified.

### Assessment of Significance

12.5.14 The significance of effects is a function of the magnitude of the impact and the sensitivity of the receptor.

12.5.15 Given the broad nature of this chapter and the lack of definitive guidance on assessing many of the potential impacts, the evaluation of significance takes into account the justifications provided for attributing sensitivity and magnitude. This often utilises professional judgement in reaching a conclusion about significance.

12.5.16 The significance of impacts has been applied as per Table 12-5.

**Table 12-5 Significance of Impacts for Population Effects**

		<b>Magnitude of Change</b>				
<b>Environmental Value (Sensitivity)</b>		<b>No change</b>	<b>Negligible</b>	<b>Minor</b>	<b>Moderate</b>	<b>Major</b>
	<b>Negligible</b>	Neutral	Neutral	Neutral or slight	Neutral or slight	Slight
	<b>Low</b>	Neutral	Neutral or slight	Neutral or slight	Slight	Slight or moderate
	<b>Medium</b>	Neutral	Neutral slight	Slight	Moderate	Moderate or Large
	<b>High</b>	Neutral	Slight	Slight or moderate	Moderate or Large	Large or Very Large
	<b>Very High</b>	Neutral	Slight	Moderate or Large	Large or Very Large	Very Large

12.5.17 For the purposes of this PEI Report and as we progress the ES, significant effects are those where significance is deemed to be ‘moderate’ or greater, overall.

12.5.18 It is important to note that the assessment of effects and the associated decision making as to whether an effect is significant or not, takes into account design, mitigation and enhancement measures where identified. Such measures are considered in section 12.9 and as part of the assessment of effects.

### **Assessment Methodology for Human Health Effects**

12.5.19 The assessment of human health is a multidisciplinary process designed to identify and assess the potential health outcomes (both adverse and beneficial) of a proposed project, plan or programme and to deliver evidence-based recommendations that optimise health gains and reduce or remove potential negative impacts or inequalities.

12.5.20 This section sets out the scope of the human health assessment and the specific methodology that has been followed including the study population (including vulnerable and disadvantaged groups), information and data sources that were consulted, assessment criteria and assessment outcomes.

12.5.21 There is no statutory guidance for assessing the wider effects of projects on human health. There are, however, some well-established ‘toolkits’ and guides available for health assessment, including:

- Institute of Environmental Management and Assessment, 2017: Health in Environmental Assessment, a primer for a proportionate approach;
- NHS London Healthy Urban Development Unit (HUDU), 2017. Healthy Urban Planning Checklist and Rapid Health Impact Assessment Tool;
- Wales Health Impact Assessment Support Unit (WHIASU); HIA, A Practical Guide;
- National Mental Wellbeing Impact Assessment Development Unit 2011: Mental Wellbeing Impact Assessment Toolkit;
- Health Scotland et al, 2007: Health Impact Assessment for Transport: A Guide; and
- Ben Cave Associates, (2009); A review package for Health Impact Assessment reports of development projects.

12.5.22 The assessment approach has been qualitative except where informed by quantitative findings from the EIA. The assessment has been informed by and builds on the analysis of the EIA (air quality, noise, socio-economic, etc.).

#### Baseline data gathering

12.5.23 Baseline data has been collated from a range of sources to provide an overview of: the existing population; existing health profile; socioeconomic conditions in the local community; and the local physical environment.

12.5.24 This gathering of baseline data has been coordinated with other workstreams within the EIA such as socioeconomic assessment and the air and noise assessments.

12.5.25 The data reviewed has included, but has not been limited to:

- Public Health England publications such as Cotswold Health Profile, 2018<sup>246</sup> and Tewkesbury Health Profile 2018<sup>247</sup>;
- Gloucestershire Health and Wellbeing Board website<sup>248</sup>;
- Nomis Labour Market Statistics<sup>249</sup>; and
- Office for National Statistics, Census 2011 data<sup>250</sup>.

#### Determinants of human health

12.5.26 Health and well-being, or 'health outcomes' can be influenced by environmental, social, economic and fixed factors, which are collectively known as '*health determinants*'.

12.5.27 The key determinants of health can be characterised as:

- pre-determined factors such as age, genetic make-up and gender are fixed and strongly influence a person's health status;
- social and economic circumstances such as poverty, unemployment and other forms of social exclusion strongly influence health, and improving them can significantly improve health;
- how the environment in which people live, work and play is managed - its air quality, built environment, water quality – can damage health, or provide opportunities for health improvement;
- lifestyle factors such as physical activity, smoking, diet, alcohol consumption and sexual behaviour, can have significant impacts on health; and
- accessibility of services such as the National Health Service (NHS), education, social services, transport (especially public transport) and leisure facilities influence the health of the population.

12.5.28 Of these, only the pre-determined factors are unlikely to be influenced changes to the environment. This health assessment therefore considers all relevant health determinants other than the pre-determined factors.

12.5.29 Health determinants listed in Table 12-6, have been used for the identification of health impacts relevant to construction and/or operation of the proposed scheme.

<sup>246</sup> Public Health England, Cotswold District, Local Authority Health Profile 2018. Available at <https://fingertips.phe.org.uk/profile/health-profiles>

<sup>247</sup> Public Health England, Tewkesbury Health Profile, 2018. Available at <https://fingertips.phe.org.uk/profile/health-profiles>

<sup>248</sup> <https://www.gloucestershire.gov.uk/council-and-democracy/gloucestershire-health-and-wellbeing-board/>

<sup>249</sup> <https://www.nomisweb.co.uk/>

<sup>250</sup> <https://www.ons.gov.uk/help/localstatistics>



Related issues which are considered against each of these determinants are also listed. These health determinants have been identified based on reference to the guidance documents listed in Section 13.4 together an appreciation of the proposed scheme and study area.

**Table 12-6 Health Determinants Relevant to the Proposed Scheme**

Health determinant	Related Issues
<b>Lifestyle/social and community determinants</b>	
Social capital cohesion	Mental health and wellbeing Sense of place and views
Community safety	Crime Safety
Healthcare services and other community facilities	Equitable access Facilities that promote health and wellbeing
Transport and connectivity	Congestion Provision for active travel Equitable access
Open space and nature	Opportunities for exercise Equitable access
<b>Environmental determinants</b>	
Air quality	Changes in local environmental conditions
Noise environment	
Visual amenity	
Climate change	Changes in temperatures Changes in rainfall Changes in seasonal averages
<b>Economic determinants</b>	
Employment and Economy	Access to work, training and education

Definition of community (in relation to human health)

- 12.5.30 This health assessment has considered the health and well-being status and current health issues of all people within the local community. However, vulnerable and/or disadvantaged groups can often experience health impacts more acutely than other groups within communities and are therefore more sensitive.
- 12.5.31 The Wales Health Impact Assessment Support Unity (WHIASU) has developed a guide to identifying vulnerable groups for the purpose of health assessments. This has been used to identify which vulnerable groups within the local population should be identified as having high relevance to the proposed scheme and therefore considered in more detail in the assessment.
- 12.5.32 In addition to this people with protected characteristics, as defined by the Equality Act 2010 have been considered. Protected characteristics include age, disability, gender reassignment, marriage or civil partnership, pregnancy and maternity, race, religion and sex.
- 12.5.33 Based on the WHIASU guidance, Table 12-7 identifies which groups are considered to have high relevance to the proposed scheme and which are therefore considered in more detail in the assessment. The identification of these

vulnerable groups is based on a review of the population profile of the local communities within the wards listed above (see appendix 12.1 for the relevant community health and wellbeing profile). A short justification for what relevance has been given to each vulnerable group is also provided in Table 12-7.

12.5.34 The WHIASU vulnerable group checklist systematically considers inequalities and the impacts on a range of vulnerable groups within the population and assesses the extent and distribution of them. These groups can, for example, include older people, children and young people, those who suffer from chronic conditions, or those who are geographically isolated.

**Table 12-7 Vulnerable and Disadvantaged Groups and their Relevance to the Assessment**

<b>Vulnerable and disadvantaged groups</b>	<b>Relevance to assessment (high/medium/low)</b>	<b>Reason for assigned relevance in the context of the proposed scheme</b>
<b>Age related groups:</b>		
Children and young people	Medium	The percentage of under 16-year olds in study area (14.7%) is below that of the national average (19.1).
Older people	High	The percentage of over 65-year olds in the study area (24.9%) is higher than the national average (18%).
<b>Income related groups:</b>		
People on low income	Low	Economic deprivation in the study area is significantly better than the national average (although there are still pockets of deprivation).
Economically inactive	Low	Economic inactivity in the study area is approximately 5% lower than the national average (25.6% compared to 30.1% England).
Unemployed/workless	Low	The percentage of people in the study area who are unemployed (Job seekers allowance claimants) (0.4%) or are long term (>1 year) unemployed (0%) is significantly lower than the national average (1.9% and 3.6% respectively).
People who are unable to work due to ill health.	Medium	Within Badgeworth ward there are significantly more people with limiting long term illness (21.3%) than the national average (17.6%) but there is no significant difference in Ermin ward (16.4%).
<b>Other vulnerable groups and groups with protected characteristics (as defined by the Equality Act 2010):</b>		
People with physical or learning disabilities /difficulties	High	There is a college within 250m of the proposed scheme that caters for people with physical and learning disabilities (National Star Independent College)
Refugee groups/ asylum seekers	Low	No statistics for the study area specifically, but the ethnicity and language indicators show that 96% of the population are British and only 0.2% do not speak English well or at all. The road is unlikely to have a differential or disproportionate health impact.
Travellers	Low	There are no traveller sites affected by the proposed scheme
Single parent families	Low	A road would not have a differential or disproportionate health effect on single parents.

Vulnerable and disadvantaged groups	Relevance to assessment (high/medium/low)	Reason for assigned relevance in the context of the proposed scheme
Lesbian and gay and transgender people	Low	A road would not have a differential or disproportionate health effect on LGBT people.
Black and minority ethnic groups	Low	1.45% BME within the study area compared to 14.6% nationally. A road is unlikely to have a differential or disproportionate health effect on BME people.
Religious groups	Low	There is only one place of worship within 250m of the proposed scheme (Saint John Chrysostom Orthodox Church) and the study area has very little religious diversity with 0.85% of the population being Muslim, Hindu, Buddhist or Jewish and 71% being Christian. In this instance, the proposed scheme is unlikely to have a health effect on religious groups.
<b>Geographical groups:</b>		
People living in areas known to exhibit poor economic and/or health indicators	Low	The study area is not within an area that is economically deprived or showing ill health
People living in isolated/over-populated areas	Medium	The study area is not over-populated but does have some isolated properties along the route
People unable to access services and facilities	Low	The communities within the study area are not in areas that are likely to have access issues

### Literature review – linking health outcomes to health impacts

12.5.35 A literature review was undertaken to establish the evidence for links between the health determinants and potential health outcomes. The literature review for each of the health determinants is included in appendix 12.1.

12.5.36 Several types of literature have been used to inform the health assessment including research reports as well as literature reviews and primary research studies. Using available literature, including previous health studies and recent research, an evidence base has been collated to identify links between the selected determinants and health impacts. Key reference material has included:

- government health policies, programmes and strategies;
- previous health assessments for masterplans; and
- public health reports and research papers from a range of sources, including:
  - Public Health England;
  - WHO;
  - National Institute for Health and Care Excellence (NICE);
  - Health Development Agency (HDA).

### Assessing human health effects

12.5.37 There is no established or widely accepted framework for assessing the 'significance' of human health effects related to a development proposal. The health significance of an environmental impact is typically a function of the 'magnitude' and 'duration' of the change to health determinants, the extent of the population exposed to this change and the sensitivity of the people (receptors or population) who will experience the effect.

12.5.38 Assessment is made as to whether the effect on health determinants is:

- Direct or indirect;
- Positive or negative; and
- Permanent or temporary.

12.5.39 This approach permits the assessment to provide a relative scale of effects in order to give a sense of the importance of the potential human health effects.

12.5.40 The criteria that have been used in order to define significance of effects are set out in Table 12-8.

**Table 12-8 Impact Significance Matrix**

Significance level	Criteria
<p>Major +++/--</p> <p>(positive or negative)</p>	<p>Human health effects are categorised as a major positive if they prevent deaths/prolong lives, reduce/prevent the occurrence of acute or chronic diseases or significantly enhance mental wellbeing would be a major positive.</p> <p>Human health effects are categorised as a major negative if they could lead directly to deaths, acute or chronic diseases or mental ill health.</p> <p>The exposures tend to be of high intensity and/or long duration and/or over a wide geographical area and/or likely to affect a large number of people (e.g. over 500) and/or sensitive groups e.g. children/older people.</p> <p>They can affect either or both physical and mental health and either directly or through the wider determinants of health and wellbeing.</p> <p>They can be temporary or permanent in nature.</p> <p>These effects can be important local, district, regional and national considerations.</p> <p>Mitigation measures and detailed design work can reduce the level of negative effect though residual effects are likely to remain.</p>
<p>Moderate ++/--</p> <p>(positive or negative)</p>	<p>Human health effects are categorised as a moderate positive if they enhance mental wellbeing significantly and/or reduce exacerbations to existing illness and reduce the occurrence of acute or chronic diseases.</p> <p>Human health effects are categorised as a moderate negative if the effects are long-term nuisance impacts, such as smell and noise, or may lead to exacerbations of existing illness. The negative impacts may be nuisance/quality of life impacts which may affect physical and mental health either directly or through the wider determinants of health.</p> <p>The exposures tend to be of moderate intensity and/or over a relatively localised area and/or of intermittent duration and/or likely to affect a moderate-large number of people e.g. between 100-500 or so and/or sensitive groups.</p> <p>The cumulative effect of a set of moderate effects can lead to a major effect.</p> <p>These effects can be important local, district and regional considerations.</p>

Significance level	Criteria
	Mitigation measures and detailed design work can reduce and in some cases remove the negative effects and enhance the positive effects, although residual effects are likely to remain.
Minor/Mild +/- (positive or negative)	<p>Human health effects are categorised as minor/mild and either, positive or negative, if they are generally lower level quality of life or wellbeing impacts. Increases or reductions in noise, odour, visual amenity, are examples of such effects.</p> <p>The exposures tend to be of low intensity and/or short/intermittent duration and/or over a small area and/or affect a small number of people e.g. less than 100 or so.</p> <p>They can be permanent or temporary in nature.</p> <p>These effects can be important local considerations.</p> <p>Mitigation measures and detailed design work can reduce the negative and enhance the positive effects such that there are only some residual effects remaining.</p>
Neutral/No Effect (~)	No human health effect or effects within the bounds of normal/accepted variation.

## 12.6 Baseline Conditions

12.6.1 The baseline conditions for the scheme at the time of this PEI Report are presented below under the key impact areas.

### All Travellers

12.6.2 The baseline for all travellers is divided between vehicle travellers (car and bus users) and walkers, cyclists and horse-riders (WCH).

12.6.3 PEI Report figure 12.2 shows Public Rights of Way (PRoW) and local WCH routes.

### Vehicle travellers

12.6.4 The A417 forms a key link between Gloucester and Swindon that helps connect the West Midlands to London and the South of England. The road is used daily by more than 34,000 vehicles.

12.6.5 The current section of the A417 Missing Link causes many problems for road users who live and work in the area. Congestion can be frequent and unpredictable with users diverting onto local roads. Poor visibility and the single lane nature of this section of the A417 also means that incidents are frequent and can be serious.

12.6.6 Most of the A417 is dual-carriageway but the section which forms the basis of the proposed scheme, known as the Missing Link, is a single-carriageway section over a stretch of five and a half kilometres between the Brockworth bypass and

Cowley roundabout. In addition to its single carriageway nature the section of the A417 also has the Air Balloon roundabout at its centre which adds to current problems in terms of restricted flow of traffic and congestion/delays.

- 12.6.7 The current problems are known to lead to motorists leaving the A417 and diverting onto local roads which can cause problems for communities in the surrounding areas.
- 12.6.8 Poor visibility and challenging gradients also contribute to the disproportionately high number of serious or fatal incidents that are seen along this section of the A417.
- 12.6.9 The proposed scheme to upgrade this section of the A417 to dual-carriageway is considered to be critical to solve the current problems, as well as unlocking Gloucestershire's potential for growth, supporting the JCS plans for growth in the number of homes and jobs in the region.
- 12.6.10 There are no railway stations within 5km of this section of the A417 with the closest station being Cheltenham Spa Railway Station, approximately 5 miles north.
- 12.6.11 The railway line between Swindon and Gloucester/Cheltenham, known as the 'Golden Valley Line', provides a public transport option for people travelling on this corridor. Direct rail services are available between Swindon and Gloucester and Cheltenham Spa. These services generally operate with one service per hour in each direction, with journey times from Swindon of around 55 minutes to Gloucester and 70 minutes to Cheltenham Spa. The line is also used by direct services operating between Gloucester/Cheltenham and London Paddington.
- 12.6.12 Cheltenham Spa railway station is situated on the main line between Birmingham and Bristol, with journey times of 45 minutes and 100 minutes to each city respectively. Trains between Cheltenham and Gloucester themselves are frequent, with four services an hour in each direction throughout most of the day. Journey times vary but are usually around 10 minutes.
- 12.6.13 There are direct bus services linking Swindon, Cirencester and Cheltenham, but not Gloucester and Swindon. The Swindon to Cheltenham (via Cirencester) services generally operates with an hourly frequency, with total journey times of approaching two hours.
- 12.6.14 Views from the road, defined by DMRB as the '*extent to which travellers, including drivers, are exposed to different types of scenery through which a route passes*', is a consideration of the effect on vehicle travellers. The main current views from the road will be summarised as part of the ES chapter in line with terminology from relevant DMRB guidance<sup>251</sup>:
- 12.6.15 In addition to views from the road, driver stress forms another key consideration of this assessment. According to DMRB, driver stress has three main components: frustration, fear of potential incidents, and uncertainty.
- 12.6.16 The identified transport related problems set out in PEI Report chapter 2 explain how the current A417 between the Brockworth bypass and Cowley roundabout restricts the flow of traffic causing pollution and congestion. Delays of 20 minutes or more are not unusual. This results in some motorists diverting onto local roads

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<sup>251</sup> DMRB Volume 11, Section 3, Part 9

to avoid tailbacks, causing difficulties for neighbouring communities. Poor visibility and challenging gradients also mean that a disproportionately high number of incidents are seen along this stretch of road.

- 12.6.17 As a consequence of the high traffic flows and steep gradients, even minor incidents cause considerable disruption and delay. Observations and feedback from earlier public engagement exercises indicate that Heavy Goods Vehicles (HGV's) regularly break down in congested stop-start traffic on the steep hill.
- 12.6.18 Such capacity and resilience issues exacerbate adverse travel conditions, particularly at peak times, which will impact adversely on driver stress. Incidents and fear of incidents can add to driver stress and the high volumes of traffic, poor forward visibility and challenging gradients also contribute towards a particularly poor safety record on the existing single-carriageway section of the A417.
- 12.6.19 Relevant traffic and accident data has been collected, which shows that in the five years to the end of April 2018, there were 49 Personal Injury Accidents (PIAs) on this stretch of the A417, resulting in:
- 10 fatalities;
  - 18 seriously injured casualties; and
  - 61 slight casualties.
- 12.6.20 The casualty rates observed on the A417 are significantly higher than the national average for single-carriageway roads, particularly for fatal and serious casualties. This is shown in Table 12-9 which provides a comparison of the observed number of casualties against a national average equivalent. The national average number of casualties shown in the table are based on the same number of observed incidents (49) but assuming national average casualty rates.

**Table 12-9 Casualty Rates per PIA by Severity – Local and National Comparison**

	Total PIAs	Casualties			
		Fatal	Serious	Slight	Total
Observations (May 13 - Apr 18)	49	10	18	61	89
National Average	49	1	10	64	75

- 12.6.21 Taking the available data into account and acknowledging the more anecdotal data provided as a result of the consultation process with the public and other stakeholders, it is understood that:
- current conditions result in congestion that forms a bottleneck, preventing reliable journeys, particularly during peak periods;
  - the local road network is known to be used by vehicles avoiding traffic on the A417 when there are delays, causing congestion and pollution; and
  - there is limited space for safe overtaking and for vehicles turning off the A417 resulting in a poor accident record.
- 12.6.22 There is also the potential for a road scheme to have a beneficial impact by relieving existing severance. DMRB volume 11 section 3 part 8 provides guidance on the relief of severance, resulting from a scheme, through the reduction of

vehicle traffic. Table 12-10 shows categories of relief from severance by reduction in existing traffic levels<sup>252</sup> for rural areas, being appropriate for the study area.

**Table 12-10 Categorising the Level of Relief from Severance**

	Minor	Moderate	Substantial
Rural Area	60-75% <sup>253</sup>	75-90% <sup>254</sup>	90% <sup>255</sup>

Walkers, Cyclists and Horse-riders (WCH)

12.6.23 PRow mapping data has been provided by Gloucestershire County Council and has been taken to represent the definitive record of PRow in the study area. The mapping is being checked and updated as necessary in collaboration with Gloucestershire County Council for the purposes of the preparation of the ES.

12.6.24 PRow potentially affected by the proposed scheme were identified through examination of this data and site walkover work undertaken by the consultant team. In addition to the definitive PRow network a number of local routes have been identified through both site work (e.g. reviewing existing routes), review of the National Cycle Network (NCN) map and through workshops and consultation events that have highlighted a number of routes used and valued by local people and user groups (e.g. walking and cycling groups).

12.6.25 Walking, Cycling and Horse-Riding surveys were undertaken at 31 locations along the proposed scheme. These locations included a mixture of PRow and side roads. The survey locations are described in Table 12-11 and shown in PEI Report figure 12.2. These surveys were conducted for one weekend day in the school summer holidays with 14-hour (6am to 8pm) video surveys conducted on Saturday 2<sup>nd</sup> September 2017. Surveys at sites 8, 11 and 14 were undertaken on Sunday 10<sup>th</sup> September 2017 due to access issues. The need for further surveys to inform the ES is being considered in collaboration with Gloucestershire County Council and user groups.

**Table 12-11 Walking, Cycling and Horse-Riding Survey Locations**

Survey Location	Grid Reference	Closest Settlement	Survey Location Description	Survey Result
1	90673, 16948	Brockworth	Footpath on south side of A46 on the approach to the A417 grade separated junction.	- 16 Pedestrians - 24 joggers - 14 Cyclists on footpath - 161 cyclists on road
2	90401, 16667	Brockworth	Cycleway on north side of A46 on the approach to the A417 grade separated junction.	- 99 cyclists on road
3	91404, 15929	Witcombe	Bridleway/access road to Leisure Lakes Bikes Flyup A417.	- 16 pedestrians - 1 jogger - 78 cyclists on road

<sup>252</sup> Relief of severance is not significant where traffic flows are already relatively low; the guidelines do not apply to roads with an existing Annual Average Daily Traffic (AADT) flow of fewer than 8,000 vehicles. However, where particularly vulnerable user groups are relieved from severance the description may need to be amended.

<sup>253</sup> Where the existing road is passing through a village or on the perimeter of built up area.

<sup>254</sup> Where the existing road substantially bisects a village or small town this figure may be halved.

<sup>255</sup> Where the existing road substantially bisects a village or small town this figure may be reduced to 60%.



Survey Location	Grid Reference	Closest Settlement	Survey Location Description	Survey Result
4	91897, 15867	Witcombe	Dog Lane.	- 6 pedestrians - 1 wheelchair user - 6 joggers - 18 cyclists - 5 equestrians
5	91417, 15286	Witcombe	Green lane, near Witcombe.	- 10 pedestrians
6	93439, 16114	Ullenwood	Footway on north side of A417, west of Air Balloon roundabout.	- 5 pedestrians - 3 joggers - 6 cyclists on footpath - 1 cyclist on road
7	93453, 16157	Ullenwood	Cotswold Way, north of the Air Balloon roundabout.	- 36 pedestrians - 12 joggers - 4 cyclists
8	93010, 16306	Ullenwood	Cotswold Way, near Shurdington.	- 337 pedestrians - 2 wheelchair users - 3 joggers - 1 equestrian
9	93541, 16179	Ullenwood	Footway on north side of A436 east of the Air Balloon roundabout.	- 4 pedestrians - 1 jogger - 2 cyclists on footpath - 27 cyclists on road
10	93488, 16110	Ullenwood	Footway on west side of A417, outside Air Balloon public house.	- 31 pedestrians - 13 joggers - 10 cyclists
11	93424, 15983	Stockwell	Gloucestershire Way, east of the A417 .	- 14 pedestrians
12	93335, 15817	Witcombe	Footway on west side of A417 adjacent to bus stop.	- 31 pedestrians - 7 joggers - 14 cyclists on footpath - 26 cyclists on road
13	93977, 15576	Stockwell	Gloucestershire Way, east of the A417, where it crosses access road.	- 14 pedestrians - 1 jogger
14	93145, 15401	Witcombe	Footway adjacent to Barrow Wake look out car park.	- 18 pedestrians - 14 joggers - 16 cyclists
15	93218, 15219	Stockwell	Underbridge beneath A417 (access to Barrow Wake look out).	- 19 pedestrians - 5 joggers - 35 cyclists
16	92669, 15135	Witcombe	Known Bridleway which runs parallel to the Cotswold way, at the bottom of the valley.	- 8 pedestrians - 1 cyclist
17	92431, 14542	Witcombe	The Point where the Cotswold Way crosses Ermin Way to the West of Birdlip.	- 36 pedestrians - 4 joggers - 1 cyclist
18	92178, 14105	Great Witcombe	Cotswold Way to the south- west of Birdlip.	- 33 pedestrians - 10 joggers - 8 cyclists

Survey Location	Grid Reference	Closest Settlement	Survey Location Description	Survey Result
19	94517, 14731	Stockwell	Unnamed road, north of Stockwell.	- 3 pedestrians - 2 joggers - 21 cyclists - 2 equestrians
20	94813, 13915	Stockwell	Unnamed road, east of Stockwell.	- 13 pedestrians - 1 jogger - 28 cyclists
21	93531, 13460	Brimpsfield	Footpath, south of the A417.	- 0
22	94252, 13536	Brimpsfield	Footpath, south of the A417.	- 10 pedestrians
23	94954, 13198	Cockleford	Underbridge beneath the A417.	- 8 pedestrians - 1 jogger - 28 cyclists
24	94303, 13742	Brimpsfield	Uncontrolled crossing point of the A417 connecting footpaths adj The Golden Heart Inn.	- 0
25	933141	Birdlip	Uncontrolled crossing point of the A417 connecting footpaths.	- 2 pedestrians
26	93680, 14629	Stockwell	Junction of footpaths, near Stockwell.	- 11 pedestrians - 1 jogger - 2 cyclists
27	93091, 14492	Birdlip	Uncontrolled crossing point of the A417 connecting footpaths.	- 2 pedestrians
28	92997, 15860	Witcombe	Uncontrolled crossing point of the A417 connecting footpaths.	- 6 pedestrians - 2 joggers - 6 cyclists on footpath
29	92662, 15705	Witcombe	Uncontrolled crossing point of the A417 connecting footpaths.	- 2 pedestrians - 2 joggers - 8 cyclists on footpath
30	90918, 16436	Bentham	Footbridge over A417.	- 4 pedestrians - 2 joggers - 10 cyclists - 7 equestrians
31	93312, 14076	Birdlip	Gated road/cycleway connecting Birdlip with A417.	- 1 pedestrian - 15 cyclists on footpath - 3 cyclists on road

- 12.6.26 A total of 1,472 pedestrians, cyclists or horse-riders were observed throughout the sites, with users recorded. In summary, the surveys showed:
- 16 locations where flows were higher than 28 users per day (i.e. an average of 2 per hour); and
  - Five sites where WCH flows were highest, including:
    - Site 1: Footpath on south side of the A46 on the approach to the A417 grade separated junction;
    - Site 2: Cycleway on north side of the A46 on the approach to the A417 grade separated junction;
    - Site 3: Bridleway / access road to Leisure Lakes Bikes Flyup 417;
    - Site 8: Cotswold Way, near Shurdington; and
    - Site 12: Footpath on west side of A417 adjacent to bus stop.
- 12.6.27 The results of the site surveys have helped inform an appraisal of the value of PRoW and local routes. In turn, this has helped inform the proposed approach to assessment of those routes during construction and operation in relation to the proposed scheme.
- 12.6.28 Consultation has been undertaken and is ongoing to help develop the preferred route and its opportunities in relation to walkers, cyclists and horse-riders. This to date has involved engagement with relevant stakeholders to help collect evidence and discuss options.
- 12.6.29 PRoW that intersect with the proposed scheme and are therefore affected by works are shown on PEI Report figure 12.2 - Public Rights of Way and Local Routes and they are summarised in Table 12-12.
- 12.6.30 In total, the scheme has the potential to effect 24 PRoW as follows:
- 1 National Trail;
  - 1 long distance path;
  - 4 bridleways;
  - 15 footpaths; and
  - 3 restricted byway.
- 12.6.31 A site visit was undertaken on Tuesday 18<sup>th</sup> June 2019 in order to visit and review each of the PRoW identified as being potentially impacted by the scheme. Taking the findings of the site visit and the category of PRoW into account, each PRoW has been assigned a sensitivity value accordingly.
- 12.6.32 The assumed sensitives are subject to discussion and will be agreed with Gloucestershire County Council and it is intended that this will be recorded in a Statement of Common Ground in due course.

**Table 12-12 Existing PRoW that Interact with the Proposed Scheme**

<b>PRoW</b>	<b>Location</b>	<b>Site Visit Notes</b>	<b>Sensitivity</b>
Cotswolds Way National Trail	Bath to Chipping Campden	Widely promoted and well maintained. Difficult crossing at Air Balloon.	High
Gloucestershire Way Long Distance Path	Chepstow to Tewkesbury	Well signed/promoted. Difficult crossing at A417 to Air Balloon.	Medium
Badgeworth bridleway 125	West to east, Cirencester Road to south of A417	Surfaced path along access to 417 Bike Park.	Low
Badgeworth footpath 77	Links north-south from Badgeworth bridleway 125	Footpath across field which appears maintained with style to join BR125.	Low
Badgeworth footpath 74	Links north-south from Badgeworth bridleway 125	Appeared overgrown and unmaintained.	Low
Badgeworth footpath 80	Links end of Badgeworth bridleway 125 north-south to Badgeworth footpath 81	Footpath through Bike Park with style to join BR125.	Low
Badgeworth footpath 126	Links Badgeworth bridleway 125 east-west through Crickley Hill Farm	Surfaced path along access to 417 Bike Park.	Low
Badgeworth footpath 84	Links Badgeworth footpath 126 to A417	Path inaccessible north towards A417 but accessible south through Bike Park.	Low
Badgeworth bridleway 127	Links Badgeworth footpath 90 to Dog Lane	Surfaced and maintained. Joins to footpath along north side of A417.	Low
Badgeworth footpath 90	Links A417 to Haroldstone House north-south	Accessible/well maintained. Style to A417.	Low
Badgeworth footpath 86	Links A417 to Badgeworth bridleway 87 north-south	Overgrown/unmaintained – direct access onto A417.	Low
Badgeworth bridleway 87	Links A417 to Grove Farm north-south	Limited signage – assumed to run along access to Grove Farm and direct onto A417.	Low
Badgeworth footpath 89	Links Badgeworth bridleway 87 to Cotswold Way and A417 east-west		Low
Coberley footpath 51	Links Air balloon roundabout to Devil's Table east-west	Good quality/maintained path providing links to Cotswold Way and Country Park.	Low
Coberley bridleway 117	Links Air balloon roundabout through Crickley Hill Country Park east-west	Good quality/maintained.	Low
Coberley restricted byway 12	Links Air balloon roundabout through Crickley Hill Country Park east-west	Accessed off BR117.	Low
Coberley footpath 16	Part of Gloucestershire Way	Maintained, clear path through fields.	Medium
Cowley footpath 1	Part of Gloucestershire Way	Maintained but steep to A417 where crossing required but difficult.	Medium

PRoW	Location	Site Visit Notes	Sensitivity
Cowley footpath 3	Part of Gloucestershire Way	Runs along access to Kennels – signed and maintained.	Medium
Cowley footpath 7	Links Shab Hill Farm via track to Cowley footpath 44	Footpath through field connecting to small lane.	Low
Cowley footpath 44	Links north of Stockwell Farm to A417 east-west	Gated access, signed and clear route through field.	Low
Cowley restricted byway 36	Connects Stockwell Farm to Cowley restricted byway 27 east-west	Signed but no clear route through field.	Low
Cowley restricted byway 26	Provides east-west link and connection into RB36	Signed path with signs of recent use.	
Cowley footpath 22	Connects Stockwell Farm to Cowley bridleway 45 east-west	Runs along farm access road – signed and maintained.	Low

12.6.33 When significance of effects is considered, a temporary impact during construction is considered to have a reduced impact to that of a permanent effect during operation. For example, any local management of a route during construction with low sensitivity, which will have a negligible magnitude, would likely result in a neutral effect rather than a slight adverse given its temporary nature.

### Communities

12.6.34 This section presents the baseline in relation to the main communities located within the study area and the socio-economic and health profile of the local population.

12.6.35 PEI Report figure 12.3 shows the community features located along and adjacent to the A417 proposed scheme.

#### Settlements, access to services/green space

12.6.36 The main villages located along the existing A417 Missing Link are described below with reference to the settlement hierarchy provided by Policy SD2 - Retail and City / Town Centres of the Gloucester, Cheltenham and Tewkesbury Joint Core Strategy 2011-2031.

12.6.37 The A417 Missing Link serves low numbers of residential properties and businesses in a predominantly rural location at and around:

- Brockworth (west);
- Whitcome (west);
- Little Whitcombe (west);
- Bentham (west);
- Birdlip (south);
- Ullenwood (north-east);
- Stockwell (south-east); and
- Brimpsfield (south-east).

12.6.38 Brockworth is the largest of the settlements in the area, situated around 4.5km to the east of the Air Balloon roundabout. This is the key settlement for the local

area in terms of services and facilities it provides. These include a nursery, primary school, sports facilities and a number of public houses.

- 12.6.39 North Brockworth is identified as a Strategic Allocation within the Gloucester, Cheltenham and Tewkesbury Joint Core Strategy (2017) and is a key location to help meet the strategic need for approximately 35,175 new homes within the JCS area over the period to 2031. The allocation itself is for circa 1,500 new homes and 3 hectares of employment land, leading to substantial population increase near the scheme.
- 12.6.40 With the exception of Brockworth, which is considered to be of medium sensitivity, the remaining settlements within the vicinity of the proposed scheme are local in scale and primarily form village or rural settlements with some key tourism and recreation facilities and local facilities (e.g. village hall). These settlements are therefore considered to be of low sensitivity.
- 12.6.41 Key settlements and facilities are shown on PEI Report figure 12.3 - Community Facilities, Business and Tourism Receptors.
- 12.6.42 Further afield are the larger settlements of Cheltenham (approx. 6.8km to the north), Gloucester (approx. 10km to the east) and Stroud (approx. 13.5km to the south).
- 12.6.43 When considering key population trends, it is important to consider the region as well as the local area given the important connectivity function of the A417. Details are provided below and in summary:
- at the time of the 2011 Census, Gloucestershire had a population of 596,984;
  - the county's older population grew faster than the national trends and the county had a proportionately larger older population than national averages;
  - in 2011, there were 353,000 cars or vans belonging to the county's population, up 44,300 (14.3%) from 2001;
  - the proportion of people reliant on a car to access work increased between 2001 and 2011;
  - economic activity rates showed 473,000 usual residents aged between 16-74, of these, 72.4% were economically active;
  - the county's economic base revolved around service industries with particularly high employment in the public sector, wholesale and retailing;
  - more recent data suggests that the population in Gloucestershire was approximately 623,100 in 2016 and will continue to rise by a further 44,300 between 2016 and 2026; and
  - this growth continues earlier trends and suggests further growth in the older population within the county.
- 12.6.44 When considering the socio-economic profile of the local area, the proposed scheme lies within both Tewkesbury Borough Council and Cotswold District Council. Data from these local authorities has therefore been gathered, alongside data for the following wards which have been selected to represent the study area as those through which the A417 Missing Link interacts:
- Badgeworth (Tewkesbury);
  - Ermin (Cotswold); and
  - Churn Valley (Cotswold).

12.6.45 At the time of the 2011 census, the study area had approximately 5,887 usual residents with approximately 36% of these residing within Tewkesbury to the west of the proposed scheme and 63% residing within Cotswold's to the east of the proposed scheme. The population within the study area in 2011 equated to around 4% of the population of Tewkesbury and Cotswolds.

#### Age structure

12.6.46 The age structure of the study area is largely similar to that of the wider Tewkesbury Cotswold and Gloucestershire areas. Slight differences can be seen with a slightly lower proportion of people aged between 0 and 15 and slightly higher proportion of people aged 65+.

**Table 12-13 Broad Age Structure**

Broad Age Group	Study Area	Tewkesbury	Cotswold	Gloucestershire
0-15	16%	18%	17%	18%
16-64	62%	62%	61%	63%
65+	22%	20%	22%	19%

#### Ethnicity

12.6.47 Gloucestershire is less ethnically diverse than much of the rest of the UK having 96% white compared to 85.3% across England. In the 2011 census the following ethnic groups were identified, compared with the regional and England statistics. The ethnic diversity at the relevant ward level is also similar to the Gloucestershire statistics.

**Table 12-14 Ethnic Diversity, 2011, (Total and %)**

	Ermin ward	Badgeworth ward	Gloucestershire	England
<b>Black and minority ethnic (BME) population</b>	43 (1.7%)	26 (1.2%)	27,337 (4.6%)	7,731,314 (14.6%)
<b>Population whose ethnicity is not 'White UK'</b>	132 (5.2%)	85 (4%)	50,385 (8.4%)	10,733,220 (20.2%)
<b>Population who cannot speak English well or at all</b>	9 (0.4%)	1 (0%)	3,419 (0.6%)	843,845 (1.7%)

Source: ONS Census, 2011

#### Religion

12.6.48 The 2011 census identified the breakdown shown in Table 12-15 of religion within the study area compared to the national picture. It shows more people within the study areas are Christian than the national average, and there are significantly fewer people of Hindu, Muslim and Sikh faith than there are nationally. This reflects the reduced ethnic diversity of the study area compared to the national figures.

**Table 12-15 Religion, 2011, (%)**

	<b>Ermin ward</b>	<b>Badgeworth ward</b>	<b>Gloucestershire</b>	<b>England</b>
<b>Christian</b>	71.5%	70.2%	63.5%	59%
<b>Buddhist</b>	0.1%	0.0%	0.2%	0.5%
<b>Hindu</b>	0.2%	0.2%	0.3%	2%
<b>Jewish</b>	0.4%	0.0%	0.1%	0.5%
<b>Muslim</b>	0.2%	0.1%	0.2%	5%
<b>Sikh</b>	0.0%	0.0%	0.0%	0.8%
<b>Other</b>	0.4%	0.4%	0.5%	0.43%
<b>No religion</b>	20.6%	21.8%	26.7%	24.74%
<b>Religion not stated</b>	6.7%	7.3%	7.5%	7.18%

### Travel to work

- 12.6.49 Data in relation to method of travel to work suggests the majority of people travel by car or van (62%) which is comparable to the Gloucestershire average (61%). Within Tewkesbury and Cotswolds, a slightly higher proportion of people work from home (16% compared to 13% in Gloucestershire) and slightly less people commute on foot (9% compared to 11% in Gloucestershire). Approximately 3% of people were recorded as cycling to work.
- 12.6.50 Within Tewkesbury and Cotswolds, the majority of people travel less than 20km to work with the highest proportions travelling less than 2km (16%), between 5km and 10km (16%) and between 10km and 20km (15%). The reliance on the car for these journeys is clear from the data in Table 12-9.

### Community facilities

- 12.6.51 There are a number of community facilities and services within the study area immediately surrounding the proposed scheme. These are summarised in Table 12-16.
- 12.6.52 Where facilities are considered to be local in scale they are considered to be of low sensitivity, except where the potential for substitution is limited (e.g. churches). Where a facility has a wider draw (e.g. a college facility) the sensitivity is considered to be medium.



**Table 12-16 Community Facilities and Services**

Receptor	Approximate Proximity	Main Activity	Sensitivity
Saint John Chrysostom Orthodox Church	200m	Place of Worship	Medium
Birdlip Primary School	200m	Education	Low
National Star	250m	Education (further education, training, personal development and residential services for people with physical and learning disabilities and acquired brain injuries)	Medium
Birdlip Village Hall	230m	Community Facility	Low

### Employment & Skills

12.6.53 Data from the 2011 Census shows that 72.4% of those aged 16-74 were classed as economically active within Gloucestershire with 3.3% classed as unemployed. Data for the wards through which the scheme passes shows a slightly lower activity rate (69.2%), with a range within the wards of between 66.1% and 74.3%. However, unemployment within the study area is lower when compared to Gloucestershire with 2.0% classed as unemployed.

12.6.54 In 2011, 29.9% of the population in Gloucestershire aged 16+ were qualified to Level 4 or above. This includes degree (for example BA, BSc) or Higher Degree (for example MA, PhD, PGCE) or equivalent. This is lower than the study area as a whole with 37.7% on average achieving these qualification levels within the wards through which the scheme passes.

12.6.55 The data in Table 12-17 is taken from the Business Register and Employment Survey (2017) and shows the proportion of employment by broad industrial category. This data is presented for the Gloucestershire Area, Tewkesbury and Cotswold District Council areas and the Lower Super Output Area (LSOAs) through which the proposed scheme passes, representing the study area in this instance.

**Table 12-17 Employment by Industry (%)**

Broad Industrial Category	Study Area	Tewkesbury	Cotswold	Gloucestershire
<b>Agriculture, forestry &amp; fishing*</b>	0.7	0.8	3.0	1.0
<b>Mining, quarrying &amp; utilities</b>	0.2	1.1	1.4	1.6
<b>Manufacturing</b>	8.8	20.0	7.1	11.9
<b>Construction</b>	9.1	7.8	5.4	5.6
<b>Motor trades</b>	0.8	1.8	1.9	1.7
<b>Wholesale</b>	8.2	4.4	4.8	3.8
<b>Retail</b>	2.6	5.6	10.7	9.8
<b>Transport &amp; storage</b>	1.6	3.9	1.9	2.8
<b>Accommodation &amp; food services</b>	8.8	6.7	14.3	9.1
<b>Information &amp; communication</b>	5.9	3.9	4.8	4.5
<b>Financial &amp; insurance</b>	10.3	4.4	4.2	3.8

Broad Industrial Category	Study Area	Tewkesbury	Cotswold	Gloucestershire
Property	2.1	1.0	2.4	1.6
Professional, scientific * technical	6.8	10.0	9.5	8.0
Business administration & support services	7.1	6.7	6.0	7.3
Public administration & defence	4.8	2.8	1.4	2.8
Education	4.7	5.6	8.3	8.7
Health	12.1	10.0	7.1	12.9
Arts, entertainment, recreation & other services	3.5	2.8	5.4	3.8

\* Note – figures exclude farm agriculture (SIC subclass 01000)

12.6.56 The BRES data shows that employment within the study area is greatest in the following broad industrial categories:

- health – 12%;
- financial & insurance – 10.3%;
- construction – 9.1%;
- manufacturing – 8.8%; and
- accommodation & food services – 8.8%.

12.6.57 This broadly compares to data for Gloucestershire as a whole with the exception of the construction industry where employment is higher within the study area (9.1% when compared to 5.6%). Given the limited reliance local people have on the construction industry for employment, the sensitivity is considered to be low to medium.

#### Community safety

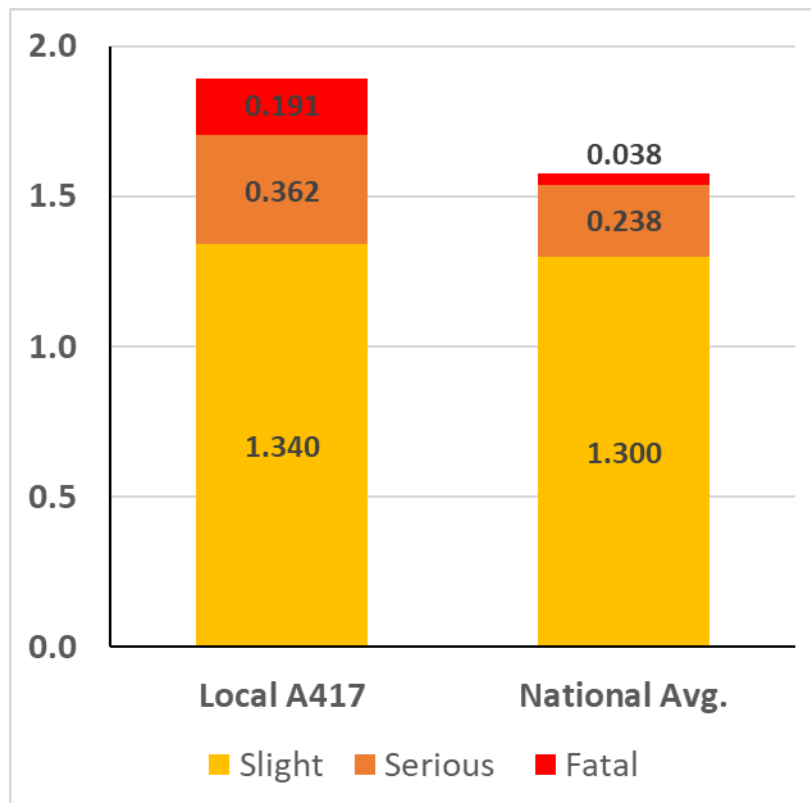
12.6.58 Relevant to this proposed transport scheme is the safety of people taking into account incidents involving vehicles, walkers, cyclists and horse-riders. Within the period May 2013 to April 2018 records indicate that, within the scheme area, there were a total of 49 Personal Injury Accidents (PIAs) on the single carriageway section of the A417 between Brockworth bypass and Cowley roundabout, resulting in:

- 10 fatalities;
- 18 seriously injured casualties; and
- a further 61 slight casualties.

12.6.59 In terms of collisions involving walkers, cyclists and horse-riders over the same period, records show:

- 0 PIAs involved horse-riders;
- 6 PIAs involving cyclists, of which 5 were classed as slight injuries and one as a serious injury; and
- 3 PIAs involving pedestrians, of which two resulted in fatalities.

12.6.60 When assessing the incident rates on the existing A417 against the national average for similar roads (single-carriageway), the data shows that rates are significantly higher, particularly for fatal and serious casualties as shown in the following graph.



12.6.61 Overall the sensitivity is considered to be moderate to take into account the incident rates along the A417.

### Human health

#### Personal well-being

12.6.62 Self-reported wellbeing status of people within the UK is now measured by the Office of National Statistics. Both nationally and in Gloucestershire, life satisfaction has increased, although only marginally.

12.6.63 In 2017/18 the self-reported personal well-being status of people in Gloucestershire showed that overall life satisfaction is good.

12.6.64 Table 12-18 below shows the average life satisfaction ratings where 10 is the most satisfied for Gloucestershire and England over a number of years.

**Table 12-18 Personal Well-Being – Self Reported, 2011-2018<sup>256</sup>**

Average (mean) ratings							
	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18
<b>Life satisfaction</b>							
England	7.41	7.44	7.50	7.60	7.64	7.68	7.68
Gloucestershire	7.54	7.60	7.60	7.62	7.70	7.73	7.79
<b>Worthwhile</b>							
England	7.66	7.69	7.74	7.82	7.83	7.86	7.88
Gloucestershire	7.75	7.79	7.86	7.81	7.85	7.83	7.88
<b>Happiness</b>							
England	7.29	7.29	7.38	7.46	7.47	7.51	7.52
Gloucestershire	7.32	7.29	7.49	7.48	7.38	7.39	7.43
<b>Anxiety</b>							
England	3.14	3.04	2.93	2.86	2.87	2.91	2.9
Gloucestershire	2.95	2.91	2.90	2.85	2.91	2.81	2.81

### Long-term human health conditions

- 12.6.65 Self-reported health status was measured in the 2011 census and within the study area 18.6% of the population reported having a limiting long-term illness or disability. This compares to the national rate of 17.6%.
- 12.6.66 47.6% of the population within Gloucestershire reported having very good health, whilst 12.7% reported having fair health, 3.5% reported having bad health and 1% reported having very bad health.
- 12.6.67 In Gloucestershire 61.5% of adults are classified as overweight or obese. This is similar to the national proportion of 62%.
- 12.6.68 The level of adult obesity is not significantly different to the national average of 62%.

### Child health

- 12.6.69 Child health appears to be slightly better than the national average with fewer children in Year 6 (age 10-11), being classified as obese (17.8% (1,102) of children), better than the average for England of 20.1%<sup>257</sup>, although still at a level of concern.
- 12.6.70 The rate of alcohol specific hospital stays among those under 18 was 31.5<sup>258</sup>, slightly better than the average for England (32.9).

<sup>256</sup> ONS, Personal well-being estimates ( <https://www.ons.gov.uk/peoplepopulationandcommunity/wellbeing/datasets/headlineestimatesofpersonalwellbeing>)

<sup>257</sup> Public Health England. Gloucestershire Health Profile 2017/8

<sup>258</sup> Rate per 100,000 population

### Life expectancy

12.6.71 Life expectancy for the Cotswold is 81.7 for men and 85 for women (compared to 79.6 nationally). In Tewkesbury life expectancy is 81.4 for men and 84.8 for women.

### Carers

12.6.72 In Gloucestershire in 2011, 10.5% of people undertook unpaid care every week compared. Of these, 2% provided unpaid care for 50+ hours per week and 1% provided between 20-49 hours of unpaid care<sup>259</sup>.

### Deprivation

12.6.73 Deprivation is measured by Lower Super Output Area (LSOA) rather than by ward. The Indices of Multiple Deprivation 2015 data show that Gloucestershire is now ranked 124 out of 152 local district authority areas for deprivation (where 1 is having the highest proportion of the population living in the most deprived neighbourhoods).

12.6.74 The areas that cover the wards adjacent to the proposed scheme are not in the most deprived areas within the county. However, 14.6% of children within the study area was living in poverty in 2015. Whilst this is significantly better the 19.9% of childhood poverty nationally, it still represents 49 children within the study areas living in income deprived households. For older people (60+), this rises to 118 people within the study area living in a pension credit household. Again, this is significantly better than the national proportion of older people living in poverty.

### Air quality

12.6.75 There are currently eight AQMAs within 200m of the Affected Road Network (study area for air quality assessment). Sandwell Metropolitan Borough Council (SMBC), Birmingham City Council (BCC), Dudley Metropolitan Borough Council (DMBC), Oxford City Council (OCC), and Cheltenham Borough Council (CBC) have declared the whole of their respective local authority areas AQMAs. They were all declared for exceedances of the annual mean NO<sub>2</sub> objective. The BCC AQMA is also declared for exceedances of the 24-hour PM<sub>10</sub> objective.

12.6.76 Vale of White Horse District Council (VWHDC) declared the Botley AQMA for exceedances of the annual mean NO<sub>2</sub> objective.

12.6.77 Wychavon District Council (WDC) declared the Worcester Road AQMA for exceedances of the annual mean NO<sub>2</sub> objective.

12.6.78 Cotswold District Council (CDC) declared the Birdlip AQMA for exceedances of the annual mean NO<sub>2</sub> objective. The Birdlip AQMA is within the boundary of the proposed scheme and is therefore the focus AQMA for the air quality assessment in chapter 5 of the PEI Report which at this stage has only been qualitative.

### Noise

12.6.79 Full details of noise and vibration baseline is set out in PEI Report chapter 11; Baseline noise surveys have not yet been undertaken for the proposed scheme.

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<sup>259</sup> ONS, 2011 – Census at a glance

However, there are Noise Important Areas (NIA) within the study area which are areas that have been identified as being areas where noise is an existing issue – usually for residential receptors. These are shown on figure 12.1 and include:

- Bentham to Air Balloon roundabout - 0+000.000 to 2+100.000 (NIAs 3906, 3907, 3908 and 13915);
- Air Balloon roundabout to Cowley junction– existing alignment (NIA 3905); and
- Air Balloon roundabout to Cowley junction– proposed re-alignment – 2+100.000 to 5+760.000 (NIA 13196).

### Emergency Hospital Admissions

12.6.80 Emergency hospital admissions are hospital admissions that occur unexpectedly and urgently. Nationally, data is collected to measure admissions from coronary heart disease, stroke, heart attack and chronic obstructive pulmonary disease which can be used as an indicator for the general health of a population in terms of fitness and heart health. For the wards of Badgeworth and Ermin, emergency hospital admissions are below the national average with Standardised Admission Rates (SAR) of 79.7 for all causes (against 100 SAR nationally).

### **Land and Property**

12.6.81 This section presents the baseline in relation to the main commercial/business, agricultural, tourism and recreational land and properties located within the study area.

12.6.82 PEI Report figure 12.3 shows the commercial properties/businesses, tourism and recreational facilities located along the A417 Missing Link.

### Commercial Property/Businesses

12.6.83 Through the desk based and site work completed to date, a total of 13 commercial properties/businesses have been identified along the A417 Missing Link, as described in Table 12-19 in order of proximity from the existing road. These exclude tourism and recreation properties/businesses, which are considered separately in the following sections of the baseline.

12.6.84 Commercial properties/businesses that are local in nature are considered to have a low sensitivity, whereas those with a regional scale or limited potential for substitution are considered to be of a medium sensitivity.

**Table 12-19 Commercial Property / Businesses**

Receptor	Approximate Proximity	Main Activity	Sensitivity
Galtec	240m	Civil Engineering / groundwork contractors	Low
Bentham Lane Poultry Unit	250m	Farm	Medium
Witcombe Supplies	100m	Catering	Low
Pipeline Logistics	150m	Contractor	Low
Crickley Hill Tractors	50m	Tractor dealer	Low
Countryside Mobility	200m	Mobility equipment	Low
Rushwood Kennels & Cattery	100m	Kennels and Cattery	Low

Receptor	Approximate Proximity	Main Activity	Sensitivity
McCarthy Taylor Systems	100m	Software	Medium
First Dance Discos	30m	Mobile disco	Low
Cotswold Way Sign Post	220m	Cafe	Low
Clavel & Hind	40m	Brewery	Low
Watercombe Farm	150m	Farm	Medium
Stockwell Farm	220m	Farm	Medium

12.6.85 Further information will be included within the ES in relation to the exact number of land holdings that the proposed scheme impacts upon, following further scheme refinement. This will inform the assessment of effects on farm holdings and individual farm businesses.

12.6.86 Effects on agricultural land and soils are presented within PEI Report chapter 9 Geology and Soils.

#### Tourism and recreation

12.6.87 Gloucestershire's tourism and recreational sector is of high importance to the local and regional economy.

12.6.88 In determining the number of jobs supported by the visitor economy, there are two broad approaches. The first is to estimate the number of jobs supported by visitor spend or turnover, and the second is to consider which Standard Industrial Classification of Economic Activities (SIC) codes are applicable to tourism and use Office for National Statistics (ONS) data to determine actual direct jobs. Neither method is an exact estimate, as using spend or turnover is not counting direct jobs, whereas using ONS data does not count indirect jobs that may be supported by spend in sectors outside of the SIC codes selected, nor does it allow for the calculation of indirect jobs being supported.

12.6.89 Using the ONS data, a selection of SIC codes have been chosen as providing the closest fit in terms of the visitor economy, as identified in Standard industrial classification of economic (SIC codes). The SIC codes utilised in this definition are presented in PEI Report appendix 12.2 – SIC Codes.

12.6.90 This approach suggests that there were estimated to be 31,000 direct jobs in the Gloucestershire visitor economy related SIC codes in 2017. Within the Mid-Level Super Output Areas (MSOAs) through which the proposed scheme passes, approximately 800 direct jobs were supported within the sector. This suggests the wards through which the proposed scheme passes support approximately 2.5% of direct jobs within Gloucestershire's visitor economy.

**Table 12-20 Jobs in the Visitor Economy**

SIC Code/Broad Sector	Gloucestershire	Relevant MSOAs
Accommodation	6,150	290
Food & Drink	19,250	420
Transport & Travel	1,450	10
Culture, Attractions, Entertainment, Other	3,795	55
TOTAL (Rounded)	30,645 (31,000)*	775 (800)*



**\* The level of rounding varies by estimate.**

The location of the key tourism and recreation receptors within the study area are shown on PEI Report figure 12.3 - Community Facilities, Business and Tourism Receptors and summarised in Table 12-21 in order of proximity to the existing A417.

**Table 12-21 Tourism and Recreation Receptors**

Receptor	Approximate Proximity	Main Activities	Sensitivity
<b>Accommodation</b>			
Field View Lane	200m	Lodging.	Low
Royal George Hotel	250m	Hotel and Inn with 34 rooms. Also caters for weddings, special occasions and meetings.	Low
Crickley Court Cottages	30m	Two self-catering cottages providing 7 beds for up to 10 guests.	Low
Star Glamping	250m	Glamping site.	Low
The Barn	150m	6-bedroom homestay.	Low
<b>Eateries / Venues</b>			
Air Balloon Pub	0m	Pub and Restaurant	Low
Golden Heart Inn	250m	16 <sup>th</sup> Century Country Inn Barn available for private dining, meetings / special events.	Low
<b>Recreation / Visitor Attractions</b>			
Bentham Country Club	250m	5-A-Side football and sports courts.	Medium
Birdlip & Brimpsfield Cricket Club	200m	Cricket Club.	Low
Crickley Hill Country Park	250m	Country Park with visitor centre, café and waymarked trails.	Medium
Costwold Hills Golf Club / Ullenwood Manor Golf Course / Star Golf	250m	Golf course with club house.	Medium
Flyup 417 Bike Park	50m	Mountain bike park with various trails, café and bike shop.	Medium

12.6.91 The approach to clarifying the sensitivity of tourism and recreation receptors will be discussed and agreed with Gloucestershire County Council through progression to ES. This process considers the nature of the asset, degree of permanence and ability to relocate, as well as location. Visitor numbers where available have also helped inform the exercise. For the purposes of this assessment, there are no assets of international nature and of corresponding a high sensitivity, whilst the more regional assets such as Crickley Hill Country Park are of a medium sensitivity, with all others are considered to be of a low sensitivity.

12.6.92 The tourism and recreation receptors identified above broadly reflects the tourism related employment, with a focus on employment within the accommodation and food and drink sectors within the wards through which the proposed scheme passes. However, the data also indicates that the local facilities as identified above form only a small part of the wider Gloucestershire visitor economy (contributing around 2.5% of jobs).

- 12.6.93 In terms of tourism trips, data from Visit Britain<sup>260</sup> suggests that on average, between 2015 and 2017, approximately 1.57 million trips were taken each year to Gloucestershire, equating to 3.8 million nights per year and an annual value of £266 million. At the more local level, data for the Cotswolds suggests 389,000 trips per year over the same period, equating to 1.05 million nights and an annual value of £87 million. For Tewkesbury, the data suggests 160,000 trips per year, equating to 317,000 nights and an annual value of approximately £20 million.
- 12.6.94 As with most locations in the UK, tourism is highly seasonal, and data collected shows that the months of July and August are those when visitors are most likely to visit. This brings with it associated pressure on key infrastructure (e.g. roads) and tourism facilities/attractions.
- 12.6.95 Given the largely rural nature of the area and the location of many of the attractions, there is a reliance on the private car being used for travel to tourism destinations and attractions.
- 12.6.96 Data on accommodation establishments, rooms and bedspaces have been gathered from Gloucestershire, Tewkesbury and Cotswold Districts from the Visit Britain Accommodation Stock Audit (2016)<sup>261</sup>. The data shows a good mix of accommodation stock with slightly more establishments in the serviced accommodation sector within Tewkesbury and Gloucestershire as a whole (hotels, guesthouses, inns and bed & breakfast accommodation). Outside of the serviced accommodation sector, the establishments on offer are focussed on holiday dwellings with a small number of campsites and other collective accommodation, as shown in Table 12-22.
- 12.6.97 The below tables provide the latest room and bedspace data for Cotswolds and Tewkesbury as the districts through which the proposed scheme passes, as well as for the wider Gloucestershire county.

**Table 12-22 Accommodation Establishments, 2016**

Accommodation Type	Cotswold	Tewkesbury	Gloucestershire
Serviced Accommodation (Hotels and Similar)	202	68	638
Non-Serviced (Total)	208	42	473
- Holiday Dwellings	202	39	443
- Tourist Campsites	4	3	20
- Other Collective Accommodation	2	0	10
<b>Total (Serviced and Non-Serviced)</b>	<b>410</b>	<b>110</b>	<b>1,111</b>

<sup>260</sup> Visit Britain – Destination Volume and Value Data - [https://www.visitbritain.org/sites/default/files/vb-corporate/Documents-Library/documents/England-documents/local\\_authorities\\_spreadsheet\\_2015-2017.xlsx](https://www.visitbritain.org/sites/default/files/vb-corporate/Documents-Library/documents/England-documents/local_authorities_spreadsheet_2015-2017.xlsx)

<sup>261</sup> [https://www.visitbritain.org/sites/default/files/vb-corporate/Documents-Library/documents/England-documents/final\\_districts\\_in\\_england\\_2016\\_final.xlsx](https://www.visitbritain.org/sites/default/files/vb-corporate/Documents-Library/documents/England-documents/final_districts_in_england_2016_final.xlsx)

**Table 12-23 Accommodation by Rooms, 2016**

Accommodation Type	Cotswold	Tewkesbury	Gloucestershire
Serviced Accommodation (Hotels and Similar)	2,065	1,359	11,733
Non-Serviced (Total)	1,829	676	7,147
- Holiday Dwellings	369	56	808
- Tourist Campsites	1,311	620	4,085
- Other Collective Accommodation	149	0	2,254
<b>Total (Serviced and Non-Serviced)</b>	<b>3,894</b>	<b>2,035</b>	<b>18,880</b>

**Table 12-24 Accommodation by Bedspaces, 2016**

Accommodation Type	Cotswold	Tewkesbury	Gloucestershire
Serviced Accommodation (Hotels and Similar)	4,487	3,192	26,856
Non-Serviced (Total)	3,100	1,057	13,734
- Holiday Dwellings	1,837	257	3,791
- Tourist Campsites	990	800	7,295
- Other Collective Accommodation	273	0	2,648
<b>Total (Serviced and Non-Serviced)</b>	<b>7,587</b>	<b>4,249</b>	<b>40,590</b>

12.6.98 The data shows that bedspace provision within Cotswold and Tewkesbury makes up approximately 30% of total bedspaces within the wider County. The latest annual occupancy data from Visit Britain<sup>262</sup> reflects seasonal variations, with room occupancy peaking at 82% in July 2018 with lowest room occupancy in January. Average occupancy rates in England over the 12 months was 78%. Reflecting the prominence of the tourism sector within Gloucestershire, the study area for the proposed scheme contains a number of tourism and recreational facilities which rely on the A417 for access.

#### Allocated/Future Development Land

12.6.99 The Joint Core Strategy (JCS) contains a strategic allocation, known as North Brockworth which is located to the west of the proposed scheme to the south of the existing A417. Policy SA1 of the JCS<sup>263</sup> identifies the site for the provision of circa 1,500 new homes and 3 hectares of employment land. Although located in close proximity, the allocation would not be directly affected by the proposed scheme. There are no wider development allocations within the JCS or any of the Local Plans that would be directly affected by the proposed scheme.

<sup>262</sup> [https://www.visitbritain.org/sites/default/files/vb-corporate/Documents-Library/documents/England-documents/annual\\_ukos\\_2018\\_final\\_summary\\_report.pdf](https://www.visitbritain.org/sites/default/files/vb-corporate/Documents-Library/documents/England-documents/annual_ukos_2018_final_summary_report.pdf)

<sup>263</sup> Gloucester, Cheltenham and Tewkesbury Joint Core Strategy 2011-2031 (Adopted Dec 2017)

12.6.100 At the time of writing this PEI Report there were no known current pending planning applications within the Order limits of the proposed scheme or within proximity to the proposed scheme.

#### Other land uses

12.6.101 There are no other land uses such as allotments or playgrounds located along the length of the proposed scheme.

12.6.102 As shown in PEI Report figure 12.4 - Open Access Land, there is an area of Common Land in the vicinity of Barrow Wake. This land usually has the right to roam over it and is more generally referred to as 'Access Land' under the Countryside and Rights of Way Act 2000 (CROW Act).

## **12.7 Consultation**

12.7.1 A significant amount of engagement has been undertaken, in particular with stakeholders with an interest in WCH. This has helped inform decision making on the proposed scheme to date.

12.7.2 Ongoing engagement and planned consultation will continue to inform development and design work. Further details will be provided within the ES which will accompany the DCO application.

12.7.3 A summary of engagement undertaken to date and that planned is provided in appendix 12.3 - Summary of Consultation.

## **12.8 Assessment Assumptions and Limitations**

12.8.1 This PEI Report provides preliminary information based on the development of the proposed scheme to date and the data gathered at this point in time. Some of the information gathered will be supplemented and provided in full and final form within the ES.

12.8.2 The PEI Report is intended to inform consultation responses and a more detailed assessment of the identified direct effects and potential indirect amenity effects on identified sensitive receptors will be undertaken at the Environmental Statement (ES) stage, drawing on the further assessment work of other disciplines.

12.8.3 Information gaps at the PEI Report stage, for example construction employment data, will be addressed as part of the ES. More specific mitigation measures will also be considered at the ES stage.

#### **General matters**

12.8.4 As far as practicable, agreement has been made with the relevant officers of the local authority, Gloucestershire County Council, in the approach taken to this initial assessment and consultation will continue as the PEI Report progresses to an ES.

12.8.5 It should be noted that DMRB guidance does not specify a standard study area for the assessment of effects on some impact areas (e.g. all travellers). As such, appropriate study areas have been defined based on professional judgement, best practice and in agreement with stakeholders including Gloucestershire Council.

- 12.8.6 The assessment relies, in part, on data provided by third parties (e.g. Gloucestershire Council) which are the most up to date, available at the time of the assessment.
- 12.8.7 As the proposed scheme progresses to EIA stage, a check will be undertaken to ensure that there has been no significant changes or limitations in the datasets used as the basis for this PEI Report. Where necessary, datasets will be updated in advance of the publication of the ES.
- 12.8.8 To avoid double counting of effects, the assessment identifies and assesses only temporary construction effects that arise as a result of activities and elements that are unique to the construction phase, separate from the post construction phase when the road would be operational. For example, the permanent removal of built form or vegetation is assessed as part of the operational phase, but the works, such as disruption caused by construction plant used during demolition and site clearance, are assessed as part of the construction phase.
- 12.8.9 The assessment of impacts on the identified facilities/receptors has been based on a desktop and site verification exercise, taking into account the promoted use and function of the identified facilities/receptors in the study area (e.g. tourism and recreation assets). Given the majority of potential impacts are likely to be indirect (with receptors outside of the proposed scheme's Order limits), the assessment often focuses on indirect and amenity effects on the operation and accessibility of existing facilities during both construction and operation of the proposed scheme.
- 12.8.10 Amenity has been assessed using, and relies upon, the assessments of other competent experts. These include the results of the relevant assessments into potential noise and vibration, landscape and visual, and air quality effects. As such, the assumptions and limitations that those experts rely are shared as part of this assessment and given the preliminary nature of this PEI Report, many amenity effects have not been quantified at this stage. A full assessment of indirect amenity effects will however be undertaken as part of the EIA process as the assessment progresses to the ES and will at that point include findings of other assessments.

### **All travellers**

- 12.8.11 The impacts on traffic flows and travel conditions rely on the outputs of the traffic model.
- 12.8.12 Accident data relies upon the accuracy of police records and is limited to Personal Injury Accidents (PIAs), which is the only data set used to evidence collision rates. The accident data will not take into account other types of incident including shunts and vehicle breakdowns, which do not form part of the police statistics.

### **Communities**

- 12.8.13 Socio-economic baseline data has largely been based on outputs from the 2011 Census, which despite being around 8 years old at the time of this assessment, provides the most full and reliable dataset.
- 12.8.14 Information on community facilities has been primarily obtained from desk-based research alongside site-based review. Should the situation on the ground have changed since the assessment (e.g. new facilities opening), this will not be reflected within the assessment.

12.8.15 The information contained within the ES and other project documents has been used to characterise the study area and identify impacts on human health determinants. The approach to the assessment of health impacts is generally qualitative, identifying likely positive and negative impacts based on the relationships between determinants and health outcomes identified within the literature reviewed.

### **Land and Property**

12.8.16 A review of commercial property and businesses has been informed by a desktop exercise and site visit to the study area, to help identify receptors. The list may not be exhaustive.

12.8.17 Landownership information has been collected using land registry data is updated by the project team on an ongoing basis based on information gathered from site visits, land owner discussions etc. This PEI Report chapter has utilised the information available at the time as assessment and will be updated as part of the ES process.

12.8.18 A review of the farm holdings, their plots and areas affected by the proposed scheme either permanently and temporarily will be undertaken in full as part of the ES. This will utilise land registry data and will also be informed by landowner questionnaires. Land registry data has only been sourced within the Order limits and as such the full extent of farm holdings is unknown and has not been shared by landowners largely for commercial reasons. As such, the percentage of land take, either temporarily or permanently, is a proportion of that land take compared to the farm holding plots directly affected by the proposed scheme only. To help understand the potential impact of the proposed scheme on a farm holding, landowner discussions and consultation is ongoing and will facilitated the opportunity for concerns to be shared.

12.8.19 The assessment has not taken into account the commercial operation or viability of businesses beyond where there is a direct impact, in which case it has been assumed that Highways England would seek to discuss and agree mitigation through negotiation where the direct impact is unavoidable, in accordance with their relevant Compensation Code and discussions with the District Valuer.

12.8.20 Following a desktop review and site visit to the study area, the identified tourism and recreation receptors have been discussed and agreed with Gloucestershire County Council, focusing on the most relevant facilities for the assessment. The list may not be exhaustive.

12.8.21 Effects on property prices have not been considered as part of the assessment, given they are not planning matters within the scope of considerations for the DCO application. Again, where necessary mitigation for adverse land and property impacts cannot be identified or achieved, Highways England may seek to discuss and agree mitigation through negotiation where an impact is unavoidable, in accordance with their relevant Compensation Code and discussions with the District Valuer.

### **Human Health**

12.8.22 Literature and baseline data used in the study has been limited to readily available public and published sources. The information contained within each of

the topic chapters of the PEI Report and other project documents has been used to characterise the study area and identify impacts on health determinants.

- 12.8.23 The approach to the assessment of health impacts is generally qualitative, identifying likely positive and negative impacts based on the relationships between determinants and health outcomes identified within the literature reviewed.

## 12.9 Design, Mitigation and Enhancement Measures

### Engineering design

- 12.9.1 The proposed scheme and its junctions at PEI Report stage have been designed to appropriate standards (Design Manual for Roads and Bridges), to allow safe access to existing facilities and services. For example, existing crossings and access arrangements interacting with the existing A417 will largely be provided with appropriate diversions or replacement infrastructure as part of the proposed scheme. This includes new junctions and overbridges. As the proposed scheme continues to develop, and on the basis of public/stakeholder feedback through formal consultation, it is likely that the engineering design will continue to evolve.
- 12.9.2 Where overriding landscape or design constraints do not cause restrictions, the views from the road would not be obstructed by new structure(s), and open views of the surrounding countryside would be retained.
- 12.9.3 Use of best practice construction methods during construction will reduce disruption to users of facilities within the facility of the proposed scheme.

### Construction mitigation

- 12.9.4 A Construction Environmental Management Plan (CEMP) will provide a complete list of outline mitigation measures to be taken into account as part of the construction of the proposed scheme Outline CEMP. A draft CEMP will be submitted alongside the final ES and will include a Public Rights of Way Management Plan for the proposed scheme.
- 12.9.5 When work is required that affects the existing A417 and its side roads, a series of traffic and WCH route management measures will be implemented and these will be provided in further detail as part of the ES and associated management plans.
- 12.9.6 Any diversion routes would be clearly marked and signed during these periods and adequate notices would be given to road users and local residents via press notices and local newsletter distributions to be agreed with Gloucester County Council as appropriate, thereby helping mitigate impacts associated with driver uncertainty.
- 12.9.7 Where the construction works would affect access to existing tourism receptors, temporary alternative access arrangements would be provided in agreement with the receptor.
- 12.9.8 Where access is affected to private properties and businesses, temporary alternative access would be provided as appropriate, to be agreed with the land owner and/or tenant(s) as necessary.

- 12.9.9 Necessary access arrangements during construction will be detailed in a Traffic Management Plan to be prepared and submitted alongside the final ES.
- 12.9.10 Land required for construction compounds would be returned to its original use and condition as per before the works. The majority of that land will be agricultural use. As such, crop loss will aim to be reduced by giving advanced warning to enable farmers to plan ahead and consideration of field drainage impacts during the design phase.
- 12.9.11 Severance during construction will be reduced through careful siting of construction compounds and lay down areas and careful planning of construction activities through consultation with the landowners and mitigated in places by new temporary and permanent accesses.
- 12.9.12 Potential indirect amenity effects relating to noise, dust and visual impacts associated with the movement of construction vehicles and construction works would be mitigated through considerate construction management including the use of screening (temporary or permanent), which will be outlined in further detail in the outline Construction Environmental Management Plan (CEMP) to be submitted in support of the Environmental Statement with the DCO application.
- 12.9.13 Direct effects on existing receptors would be mitigated by compensation through land negotiations with Highways England as appropriate.

### **Operation mitigation**

- 12.9.14 Landscape mitigation measures will be detailed through the Landscape Assessment as part of the ES. (chapter 7). Such measures are likely to consist of landscape planting, principally designed with the intention of mitigating negative effects and benefiting nature conservation and biodiversity, landscape integration and visual amenity. These will be considered as part of the amenity assessment within the final ES when details are fully defined/known.
- 12.9.15 Landscaping mitigation would also serve to contribute to noise mitigation measures which will be detailed in the noise and vibration assessment as part of the ES (chapter 11). Such measures will form an important consideration where potential negative effects to sensitive receptors, for example tourism facilities are established.
- 12.9.16 The need for additional signage beyond typical highway signage, for example to tourism assets, will be discussed with Highways England and Gloucester County Council as the assessment process continues.
- 12.9.17 Once operational, the most obvious human health benefits relate to the improved air quality and the potential for enhanced active travel and/or recreational opportunities along the current A417. These opportunities should be planned in consultation with local residents to create access and recreational opportunities that would bring improved health outcomes for these communities.

### **Enhancement**

- 12.9.18 There are opportunities to enhance the options for local communities to access open spaces and to utilise well designed and integrated active travel options such as cycle paths that connect existing residential areas to each other. These will be explored in more detail, along with any further identified enhancement measures for inclusion within the ES, accompanying the DCO application.



## 12.10 Assessment of Effects – All Travellers

This preliminary assessment seeks to set out the types of potential effects which are likely to be felt by vehicle travellers and WCH during both construction and operation of the proposed scheme. The PEI Report assessment is based on the information and proposed scheme design to date and provides a high-level assessment of potential effects on the identified broad receptor categories. Further detail will be provided in the ES.

### Vehicle travellers

#### Views from the road during construction

- 12.10.1 In relation to views from the road, DMRB, volume 11, section 3, part 9 advises that there are four categories which should be used in assessing travellers' ability to see the surrounding landscape, including:
- no view – road in deep cutting or contained by earth bunds, environmental barriers or adjacent structures;
  - restricted view – frequent cuttings or structures blocking the view;
  - intermittent view – road generally at ground level but with shallow cuttings or barriers at intervals; and
  - open view – view extending over many miles, or only restricted by existing landscape features.
- 12.10.2 Sources of construction effects on views from the road include:
- temporary construction compounds;
  - stockpiling and storage of materials;
  - excavation and handling of materials;
  - on and off-site construction traffic; and
  - on-site plant.
- 12.10.3 In addition to the construction of new stretches of dual carriageway, there would be construction compounds, with locations to be determined.
- 12.10.4 During construction, effects on views from the road are likely to be short-term and temporary, with a negligible change.
- 12.10.5 The ES will outline where additional mitigation is proposed in relation to drivers' views from the road during the construction phase beyond best practice techniques which will be described in the CEMP. However, Highways England and its contractors will aim to ensure views are not obstructed during construction and where practicable open views of the surrounding countryside would be retained during operation.
- 12.10.6 Overall at this stage of the assessment, it is not considered that the proposed scheme will generate any significant effects on views from the road during construction.

#### Views from the road during operation

- 12.10.7 During operation, the potential effects on views from the road are largely influenced by proposed mitigation (e.g. replacement of any vegetation removed during construction).

12.10.8 The ES will explore further the potential effects on views from the road, utilising findings and proposed landscape mitigation as this is developed.

12.10.9 With mitigation in place, and from previous experience, it is likely the view from the proposed scheme will be comparable to the existing situation and therefore the potential for significant effects is low.

#### Driver stress during construction

12.10.10 DMRB guidance states that on account of available evidence, the use of finely graded assessments of driver stress is not appropriate. In line with this advice, a three-point descriptive scale has been applied as follows:

- low (minor);
- moderate; and
- high (major).

12.10.11 At this PEI Report stage, it is anticipated that the majority of the construction of the proposed scheme would take place offline, which would reduce impacts on road users of the existing A417 and side roads. Some sections would involve online works with interfaces between the proposed scheme and existing roads, for example at the junctions.

12.10.12 During construction, traffic management measures including limited temporary diversions and speed limits where works interface with existing roads could result in minor delays and frustration and increased fear of accidents. There would also be additional construction traffic, largely HGVs and construction machinery, which are typically slower moving vehicles.

12.10.13 As part of the ES, an outline CEMP and Traffic Management Plan will be developed and will set out best practice mitigation measures such as safety measures, short diversions and working outside of peak traffic periods where practicable (e.g. large deliveries limited to off-peak periods). With such mitigation measures, it is not anticipated that effects during construction would result in significant effects on driver stress.

#### Driver stress during operation

12.10.14 The proposed scheme will be designed in accordance with Highways England's and the Department for Transport's (DfT) standards for road signing and it is therefore assumed that route uncertainty would not be a contributing factor to driver stress once the proposed scheme is operational. The ES will include full details of forecast peak traffic flows, journey time savings and forecast accident rates within the proposed scheme in place.

12.10.15 The assessment of driver stress at this PEI Report stage therefore focusses on potential changes to driver frustration and fear of potential accidents caused by changes to traffic flows and vehicle speeds. It is anticipated that the proposed scheme will bring beneficial effects to these forecasts, resulting in reduced fear of accidents, delays and overall improved travel conditions along the effected section of the A417. On this basis, it is likely that the proposed scheme will bring slight beneficial effects on driver stress during operation.

Bus travellers during construction

12.10.16 During the construction phase, the proposed scheme has the potential to temporarily effect bus travellers in terms of both access to bus stops and bus routes, particularly during any on-line works.

12.10.17 During the ES and as part of the proposed Traffic Management Plan, consultation will be held with bus operators and mitigation proposed in relation to the provision of advance travel information for passengers and effective traffic management. Any replacement temporary bus stops that may need to be provided would be clearly signposted for the general public.

12.10.18 With mitigation in place it is not anticipated that the proposed scheme will lead to any significant effects on bus travellers.

Bus travellers during operation

12.10.19 During operation it is assumed that services would return to normal, utilising the new A417 and its junctions where necessary to best service existing routes.

12.10.20 Improved conditions on this section of the A417 could bring slight benefits to bus travellers and this will be explored further as part of the ES.

Walkers, Cyclists and Horse-riders (WCH)

12.10.21 The assessment of effects on WCH considers direct effects on the routes where they are crossed by the proposed scheme and/or affected during construction (e.g. used in full or in part as construction accesses or crossed by construction routes). The assessment also considers indirect amenity effects on users of the routes, particularly where they run parallel to the proposed development. When considering indirect amenity effects, the assessment has been completed in the context of the current baseline.

12.10.22 The proposed scheme includes a number of structures and proposals that either ensure continued access for WCH or bring improvements in terms of current accessibility / severance, as follows:

- Green Bridge – as described in PEI Report chapter 2, a Green Bridge is proposed to provide benefits in terms of landscape, wildlife and PRoW. At this PEI Report stage it is proposed that the bridge will link/divert the Cotswold Way National Trail, enhancing the visitor experience of this important long-distance route, keeping visitors on the ridge instead of directing them alongside traffic movements (e.g. Air Balloon roundabout), bringing a significant improvement on the existing situation.
- diversion of Cowley footpaths 1, 16 and 3 which form part of the promoted Gloucestershire Way in a northerly direction along the alignment of the new side road, crossing the new roundabout junction at Air Balloon to connect into the existing alignment and link to the Green Bridge.
- Cowley Lane overbridge – This proposed bridge over the new A417 will provide access from Stockwell over to Cawley Lane minor road and on to Cowley. The bridge will include provision for WCHs.
- Stockwell Farm overbridge – This proposed bridge over the new A417 will primarily provide a farm access track from Stockwell Farm in an east-west direction. The bridge will include provision for WCHs.

12.10.23 In addition, opportunities are currently being explored in relation to the potential for WCH provision along the alignment of the existing A417 following de-trunking works. Further detail on this opportunity will be presented and assessed as part of the ES and following formal consultation and engagement with stakeholders.

12.10.24 Alongside the development of the ES and full assessment, a PRow Management Plan will be produced in order to demonstrate a planned approach to the management of PRow during the construction and operation of the proposed development, ensuring public safety while minimising disruption to users.

12.10.25 We will seek to agree a hierarchy of mitigation through consultation with Gloucestershire County Council which seeks to manage closures where possible (e.g. managed crossing and/or early re-provision) retaining rights of way as per current routes and seeking to reduce the effect on users. At this stage of the project we consider that this hierarchy would include:

- use of signage where PRow can remain open, but users need to be warned of the presence of construction vehicles (local management);
- implementation of short, temporary closures where local works might affect safety of users (local closures);
- closure of/extinguishment of a PRow following the early implementation of an alternative/new route (e.g. via a new overbridge/underbridge) (early re-provision);
- closure of/extinguishment of a PRow without re-provision (e.g. where works sequencing will not provide a new crossing in advance on the carriageway works) and/or permanent extinguishment of a PRow (full closure); and
- provision of new crossings/routes as part of the proposed scheme (new routes).

12.10.26 Each of these measures will be described in further detail within the PRow Management Plan and the ES.

12.10.27 Permanent closures without substitute would only be proposed in the following circumstances:

- where the value of the route is not sufficient to justify re-provision or diversion as part of the proposed development (for example a short length of PRow at its terminus); and
- where the proposed scheme and the mitigation proposals divert a route, rendering part of the current route no longer accessible.

12.10.28 All potential diversions and proposed new routes will be shown on a set of Access, Rights of Way and Public Rights of Navigation Plans and the DCO application would provide the necessary powers to stop up PRows and implement diversions/new routes as submitted if necessary.

#### Walkers, Cyclists and Horse-riders during construction

12.10.29 A number of potential effects are likely during construction given the linear nature of the proposed scheme and the construction activities required. However, through the future PRow Management Plan, it is Highways England's intention to keep the majority of PRow's open via local management, early re-provision and/or use of short-term, temporary closures in order to balance the risks to the public against the potential disruption that removing such a risk would cause.

- 12.10.30 It has been assumed that pre-commencement condition surveys/inspections will be undertaken on any PRow to be used by construction vehicles. Regular inspections on any installed temporary diversions or alternative routes will also be undertaken with any short-term damage repaired where necessary.
- 12.10.31 It is also assumed that during construction, Highways England or its Contractor will also provide a Public Liaison Officer and/or operate a Community Relations team with contact details to be provided on relevant signage located along the PRow network (for example, giving notice of temporary closures/diversions). Concerns around condition can therefore be flagged through this procedure and Highways England will explore any short-term reinstatement work where necessary. Any concerns raised will be shared with Gloucestershire County Council PRow Officers for discussion when appropriate.
- 12.10.32 At this PEI Report stage and based on the current proposed scheme design, it is anticipated that the following routes may experience effects as they interact with proposed construction:
- The Cotswold Way;
  - The Gloucestershire Way;
  - fifteen Footpaths across the proposed scheme;
  - four Bridleways across the proposed scheme; and
  - three Restricted Byways across the proposed scheme.
- 12.10.33 During the final assessment and ES production, further work will be undertaken in order to confirm the extent of the potential effects, mitigation, early re-provision of routes and wider management in order to reduce potential effects on the PRow network.
- 12.10.34 It is anticipated that with the implementation of management and appropriate mitigation measures there will be slight adverse effects on WCHs during construction of the proposed scheme.

#### Walkers, Cyclists and Horse-riders during operation

- 12.10.35 During operation, the proposed scheme includes several new structures and proposals that aim to mitigate or enhance the WCH provision across the study area, as summarised above and described in detail in PEI Report chapter 2.
- 12.10.36 For the purposes of this PEI Report, the following assumptions have been made in relation to mitigation, management and re-provision:
- surfaces would be restored/be as per existing post construction. Suitable surfaces for different types and classification of routes will be provided, taking into account relevant guidance, for example from the British Horse Society<sup>264</sup>. For multipurpose routes (e.g. routes providing private means of access and a bridleway) details of surfaces and access restrictions features (e.g. demountable bollards) will be agreed with the landowner and/or third party responsible for maintenance and/or use of that surface and/or route. Details and specifications for substituted and new PRow, including scale, surface materials, access features and signage will be agreed at detailed design between Highways England, its contractor and Gloucestershire County Council;

<sup>264</sup> <http://www.bhs.org.uk/~media/bhs/files/pdf-documents/access-leaflets/surfaces.ashx?la=en>

- Highways England and its contractor will provide appropriate signage for re-provided and new PRoW in agreement with Gloucestershire County Council; and
- where the proposed scheme severs local routes, the provision of alternative routes/diversions will ensure that access across the A417 proposed scheme is maintained at key points during operation.

12.10.37 In addition to the new provision through crossing points/new routes, the opportunity in relation to reclassification of the existing A417 and the associated significant reduction in traffic flows would also facilitate and allow improved conditions for walkers, cyclists and horse-riders.

12.10.38 The potential for WCH provision along this alignment and the associated reduction in severance may encourage increased travel by active modes, with further benefits to physical activity.

12.10.39 Detailed discussions will be held with Gloucestershire County Council in relation to the PRoW Management Plan and proposed new provision, ensuring the classifications of substituted and new PRoW will be discussed and agreed prior to the finalisation of the ES.

12.10.40 Gloucestershire County Council would then update their Definitive Maps as necessary, following notification of completion of works by Highways England and its contractor.

12.10.41 Given the proposed crossing points and mitigation outlined and with appropriate management and agreement which will be achieved through the PRoW Management Plan, this PEI Report considers that the proposed scheme has the potential to bring long-term beneficial effects to WCH and the route network during operation which could be significant.

#### Amenity effects

12.10.42 In assessing the potential for specific indirect amenity effects, consideration will be given to conclusions drawn elsewhere in the Environmental Statement, including Landscape - PEI Report chapter 7, Noise and vibration - PEI Report chapter 12 and Air quality - PEI Report chapter 5.

12.10.43 A Traffic Management Plan and Outline CEMP will be prepared in support of the DCO application. It will explain the issues and proposed measures to help ensure any potential adverse impacts during construction are reduced or avoided where possible.

12.10.44 Where PRoW or local routes run in close proximity to construction compounds or activities, best practice mitigation (e.g. screening) would help reduce any adverse amenity impacts. The wider assessment topics will identify mitigation where potential significant effects are assessed. Overall it is considered there would be a slight adverse impact on users' amenity during construction with effects likely to be greater where routes pass close to construction activity.

12.10.45 Given the sensitivity of WCH routes to amenity changes is typically low and given the proposals during operation to redirect key WCH routes as part of the proposed scheme (e.g. Green Bridge), it is considered that there is likely to be minimal or negligible impacts on the amenity of WCHs arising from the operation of the proposed scheme. This will be explored further as part of the ES.

## 12.11 Assessment of Effects – Communities

12.11.1 This preliminary assessment seeks to set out the types of potential effects which are likely to impact on settlements, their residents and the local economy during both construction and operation of the proposed scheme. The PEI Report assessment is based on the information and proposed scheme design to date and provides a high-level assessment of potential effects on the identified broad receptor categories. Further detail will be provided in the ES.

### **Settlements, access to services/green space**

#### Settlements, access to services/green space during construction

- 12.11.2 Highways England have tried to avoid direct effects on settlements and residential properties through scheme design. However, one property, Woodside House at Crickley Hill, would be directly affected by the proposed scheme as it stands at PEI Report stage. This effect is unavoidable given the properties current proximity to the A417 and the proposed alignment. Highways England are currently in active negotiation with the property owner with a view of reaching a voluntary agreement. This property owner would receive compensation should voluntary agreement not be reached, in line with the compensation code.
- 12.11.3 No other residential properties or settlements are directly affected by the proposed scheme.
- 12.11.4 There are a limited number of settlements along the proposed scheme which rely on the A417 for direct access and the majority of planned works are to be undertaken off-line in an area which is further from the main settlements when compared to the existing A417. However, it is recognised that a combination of construction effects could lead to potential effects on access to services and green space (e.g. footpath closures, increased construction traffic on the road network etc.).
- 12.11.5 During construction, the character of the settlements located along/adjacent to the A417 such as Birdlip, Brimpsfield and Witcombe could be affected by the construction activities including the presence of compounds, earthworks and machinery. Noise effects would be temporary and at their worst in close proximity to the proposed scheme alignment. However, the current A417 does not pass directly through any of these settlements and therefore potential effects are considered to be avoidable with appropriate management measures. For example, traffic management will help prevent impacts on these communities by restricting construction traffic to certain routes and nuisance can generally be limited through considerate construction management including the use of screening (temporary or permanent), which will be outlined in further detail in the Outline CEMP.
- 12.11.6 With mitigation in place and given the location of the communities within the surrounding areas, it is not considered that the proposed scheme would lead to any significant effects on settlements, access to service and green space during construction.

#### Settlements, access to services/green space during operation

- 12.11.7 During operation of the proposed scheme it is anticipated that there would be an overall reduction in the number of vehicles passing through settlements/communities within the areas surrounding the A417. This primarily

relates to the proposed scheme addressing issues around resilience of the A417, leading to less congestion and associated use of local roads during these times. In turn, some residential receptors will experience improved air and noise impacts from the new alignment, where some properties will see a deterioration due to proximity.

- 12.11.8 As such, reduced delays and improved travel conditions and journey times as a result of the proposed scheme are likely to contribute positively to accessibility to communities, facilities and services during operation, with overbridges and underbridges provided as part of the proposed A417 in order to facilitate greater connectivity across the proposed scheme.
- 12.11.9 At PEI Report stage, it is not anticipated that there would be any significant effects on settlements, access to services/green space during operation of the proposed scheme, with likely slight beneficial effects given the minor benefits to accessibility and reduction in traffic on local roads during peak periods/time of congestion on the A417.

## **Employment**

### Employment during construction

- 12.11.10 During construction the proposed scheme is expected to bring a number of potential effects to the local and regional economies.
- 12.11.11 The ES will include details in relation to anticipated employment generated by the proposed scheme. Experience from similar schemes suggests that resource requirements would remain fairly constant over the construction programme with slightly lower demand during mobilisation (first six months) and project handover/commissioning (final three months).
- 12.11.12 The ES will also include information on how the proposed scheme could benefit skills development locally through working with local colleges and apprenticeship schemes.
- 12.11.13 Given the geographic location of the proposed scheme and the type/volume of construction skills required, it is anticipated that a proportion of the construction workforce will be 'imported' into the area and therefore made up of workers travelling from outside the area and staying locally. The ES will provide further detail/assumptions in relation to the likely proportions.
- 12.11.14 This brings both potential beneficial and negative impacts for the local economy and the accommodation sector with the presence of non-local staff within the workforce leading to demand for accommodation within the study area.
- 12.11.15 Consideration of the potential impact of this accommodation demand on the local accommodation stock would be considered as part of the ES and when construction workforce numbers have been confirmed.
- 12.11.16 As identified in the baseline, the settlements immediately adjacent to the proposed scheme have a good supply of serviced and non-serviced accommodation and would likely be able to accommodate the workforce demand during off-peak times when occupancy rates are lower. This could bring beneficial effects to the local accommodation sector during the construction programme, bringing additional trade at their quietest times of the year.



- 12.11.17 However, during the peak tourist season, when occupancy rates are generally higher, the additional requirements for long-term accommodation could place increased pressure on providers.
- 12.11.18 Although this will be explored in detail as part of the ES, the baseline identifies that the provision locally is only a small proportion of the wider bedspace provision in Gloucestershire and taking that into account, there should generally be sufficient accommodation to service the workforce in addition to tourists and other visitors (including private trips) within the wider area during construction. During peak tourism periods, Highways England would consider instructing or directing their workforce to stay in accommodation outside of the study area where there is capacity during those peaks, with suitable travel arrangements as appropriate and if necessary.
- 12.11.19 If required, Highways England would discuss and agree suitable instructions/directions with Gloucestershire County Council as appropriate.
- 12.11.20 In addition to the potential accommodation demand, the non-local workers would also bring new spend into the local economy which would bring benefits to businesses such as restaurants and convenience retailers. The ES will consider in more detail this wider beneficial effect using the Construction Industry Joint Council: Working Rule Agreement, which covers over 500,000 workers within the UK construction industry and incorporates a subsistence (lodging) allowance of £36 per night<sup>265</sup>. This will be used to represent additional spending within the local economy which would not occur without the proposed development.
- 12.11.21 At this PEI Report stage of assessment and given the above likely effects, it is considered that the construction phase of the proposed scheme could bring overall positive effects to employment within the local and regional economy. These benefits will be quantified as far as possible within the ES but it is considered they are unlikely to be significant.

#### Employment during operation

- 12.11.22 There would be limited employment benefit as a result of the proposed scheme during its operation, beyond typical maintenance arrangements. However, benefits of the proposed scheme could continue to be experienced by the local labour force as a result of skills and training learned from working on or as part of the supply chain servicing the proposed scheme's construction.
- 12.11.23 Highways England and its contractor will discuss initiatives where legacy benefits could be realised and achieved, for example with targeted recruitment and training as well as apprenticeships utilising partnership arrangements with local educational institutions.
- 12.11.24 As a result, assuming that there would be local construction worker and training benefits, as well as supply chain service benefits (with associated multiplier effects) there could be minor positive impacts within the local and regional economy during operation of the proposed scheme.
- 12.11.25 Improved transport conditions with the proposed scheme in place would be likely to improve opportunities for employment, for example the proposed scheme is

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<sup>265</sup> UCATT, Construction Industry Joint Council: Working Rule Agreement. Available online at: <https://www.ucatt.org.uk/cijc-construction-industry-joint-council-working-rule-agreement> [accessed May 2017]

identified as a key enabler to the Joint Core Strategy. This is likely to lead to slight beneficial residual effects for the regional economy.

## **Community safety**

### Community safety during construction

- 12.11.26 During the construction phase, potential community safety impacts largely relate to construction vehicles and works compounds. For example, there would be increased HGV movements along the existing A417 and local road network.
- 12.11.27 As part of the ES, the Outline CEMP would outline mitigation measures to help ensure the safety of the local community during works. For example, clear signage and best practice techniques would be applied. When work is required online, a series of traffic management measures will be implemented including single way working of traffic in each direction maintained at all times. It is likely that other measures such as a mandatory 40mph speed limit would also be imposed where construction occurs in the vicinity of the existing A417.

Although the construction could therefore lead to a level of adverse effects to community safety, with mitigation in place, it is considered that such effects can be reduced and would not be significant.

### Community safety during operation

- 12.11.28 As set out in the baseline, the section of the A417 over which the proposed scheme passes has higher than average collision rates when compared to national averages. Initial traffic modelling suggests that accident rates on the proposed scheme would be lower, largely as a result of the safe and modern design standards of the new road. The fear of incidents would also therefore be reduced.
- 12.11.29 Furthermore, initial average forecast peak period traffic flows on local roads near the A417 as a result of the proposed scheme, show a reduction. That would result in the local roads experiencing, on average, less traffic. Those conditions would be favourable to community severance, the movement of people, and safety.
- 12.11.30 As part of the ES, findings of the traffic modelling would be incorporated into this section. However, based on initial forecasts it is considered that the proposed scheme could bring slight community safety benefits.

## **Human Health**

- 12.11.31 PEI Report appendix 12.1 provides the Health Assessment for the proposed scheme, which considers impacts during construction and operation.
- 12.11.32 The Health Assessment considers a wide range of vulnerable people and groups with protected characteristics (as defined by the Equality Act 2010) along with the wider community.
- 12.11.33 A summary of the full assessment is provided below in relation to people living and working in the adjoining wards to the proposed scheme, which is of most relevance to the study area identified for the assessment of health.

### Health during construction

- 12.11.1 Adverse effects have been identified for people relating to noise and landscape and visual amenity. In terms of noise, minor, short-term adverse health effects are

considered likely for those people living close to the new offline section of the proposed scheme. It is considered that the temporary nature of the construction will mitigate the otherwise significant adverse noise effects that would lead to potentially significant adverse health outcomes.

12.11.2 The construction period is likely to affect the sense of tranquillity and calm in the existing landscape and the construction activities will result in changes to the existing landscape. As the construction stage is only short-term, it is considered that any adverse health outcomes would also be short-term and minor.

12.11.3 Neutral health effects have been identified for:

- social capital;
- community safety;
- access to healthcare services and other community facilities;
- transport and connectivity;
- access to open space and nature;
- air quality; and
- climate change.

12.11.4 Minor, short-term, beneficial health outcomes are identified in relation to employment and economy although these effects would be widely dispersed across the study area (and more likely much further beyond).

12.11.5 The assessment does not identify any significant health effects associated with the proposed scheme during construction.

#### Health during operation

12.11.6 During operation, the proposed scheme is assessed as likely to have predominantly beneficial health effects. Moderate beneficial health effects (i.e. significant effects) have been identified in relation to air quality during operation of the proposed scheme. This is based on the predicted improvements in air quality around the existing AQMA (around the Air Balloon junction) and also on the movement of the road further from the residential area of Birdlip and Ullenwood.

12.11.7 Children, older people and those who are in poor health in particular will benefit from improvements in air quality in these specific areas as well as generally across the whole of the study areas.

12.11.8 Minor beneficial health effects have been identified in relation to:

- community safety;
- transport and connectivity;
- open Space and nature;
- climate change; and
- employment and economy

12.11.9 Mixed neutral and positive effects have been identified for:

- social capital cohesion; and
- noise.

12.11.10 Neutral effects have been identified for access to healthcare services and other community facilities and in relation to landscape and visual amenity effects.

- 12.11.11 These beneficial effects would primarily be a result of the improved road network, reduced congestion and faster journey times. Once completed, access to open space and active travel would also be improved, which bring health benefits to those people who make use of the new and improved assets.
- 12.11.12 The assessment of health has also helped inform an assessment of amenity effects, which is considered below.

### **Residential amenity**

- 12.11.13 In assessing the potential for specific indirect amenity effects, the ES would give consideration to conclusions drawn in other assessment chapters, for example Landscape, Noise and vibration and Air quality.

#### Residential amenity during construction

- 12.11.14 A Construction Environment Management Plan and Construction Traffic Management Plan will be prepared as part of the ES and submitted in support of the DCO application. These documents will explain the issues and proposed measures to help ensure any potential adverse impacts during construction are reduced or avoided where possible.
- 12.11.15 Where existing settlements and facilities are situated within close proximity to construction compounds or activities, best practice mitigation (e.g. screening) would help reduce any adverse amenity impacts.
- 12.11.16 The ES will consider locations at which significant landscape, noise and air quality effects have been identified and in applying the methodology outlined in Section 13.6 draw conclusions in relation to overall residential amenity.
- 12.11.17 Given previous experiences, although it is acknowledged that the scheme may lead to potential amenity effects, suitable mitigation measures should help to reduce these to an acceptable level, particularly as the majority of planned works are off-line and away from the main settlements.

#### Residential amenity during operation

- 12.11.18 As with the construction phase, the ES will draw conclusions from other assessment topics in order to assess overall amenity in line with the methodology at 13.6. This assessment will include visual impacts to properties or sensitive businesses, noise impacts and air quality impacts.

## **12.12 Assessment of Effects – Land and Property**

### **Commercial Property and Businesses**

#### Commercial property and business during construction

- 12.12.1 The design of the proposed scheme has avoided where possible direct impacts on commercial property and businesses, with the exception of farm holdings where land is required and where the construction of the proposed scheme would lead to an unavoidable impact including the loss of one business, the Air Balloon public house. Highways England are currently in active negotiation with the business and property owners with a view of reaching a voluntary agreement. The owners would receive compensation should voluntary agreement not be reached, in line with the compensation code.

- 12.12.2 No other commercial property or business would experience a direct impact as a result the construction of the proposed scheme.
- 12.12.3 Access arrangements would be maintained during construction to all identified commercial property and businesses. Through proposed scheme design, appropriate access would continue to be provided.
- 12.12.4 The proposed scheme therefore has the potential to lead to significant effects on those businesses that are lost (in part or in full). For other businesses and commercial property during construction there could be short-term impacts as a result of disruption and diversions. Such effects are likely to be experienced most by those situated in closest proximity to the A417, and which rely on the road network for the movement of goods and people.
- 12.12.5 Best practice construction techniques would be used to help reduce and avoid where practicable any likely adverse impacts. Details will be provided within the Construction Environment Management Plan as part of the ES.

#### Commercial property and businesses during operation

- 12.12.6 The commercial properties and businesses identified within the study area are not considered to be particularly sensitive to amenity changes, which are more relevant to tourism facilities and certain sensitive businesses that rely on these surroundings. However, there would be unavoidable loss of land associated with farm holdings where land is required to accommodate the proposed scheme. The amount and likely effect of loss of land associated with farm holdings will be considered further in the ES.
- 12.12.7 Overall, it is considered that the proposed scheme once operational would bring accessibility benefits to many of the existing businesses situated along and near to the A417 by virtue of improved transport conditions.
- 12.12.8 The proposed scheme seeks to maintain direct access where this is currently provided (e.g. Crickley Hill Tractors and Stockwell Farm) and would likely lead to accessibility benefits for others in terms of new crossing provision in the form of junctions and overbridges, as well as general improvements in travel conditions on this section of the A417.
- 12.12.9 As such, it is considered that the proposed scheme has the potential to bring slight beneficial impacts for commercial properties and businesses during operation, with no likely significant effects.

### **Tourism and Recreation**

#### Tourism and recreation during construction

- 12.12.10 As part of the proposed scheme's construction, there would be one direct and unavoidable effect on the Air Balloon public house which serves tourists/visitors as well as the local population. This has the potential to lead to a significant adverse effect as the facility will be lost without replacement.
- 12.12.11 There would likely be further indirect effects on the remainder of the tourism/recreation facilities identified within the study area. Such indirect effects are likely to relate to accessibility and diversions and wider amenity effects as a result of construction.

- 12.12.12A Traffic Management plan would identify the key areas where the works impact on the existing A417 traffic flow with solutions to phase the construction works in such a way as to reduce the disruption and impact on the travelling public.
- 12.12.13A CEMP and Traffic Management Plan will be produced in support of the ES and will include proposed mitigation measures to help reduce any potential adverse impacts during construction. With good design which ensures ongoing access to facilities, and with mitigation measures to be defined within the CEMP and Traffic Management Plan, it is not anticipated that construction will lead to any significant effects on tourism/recreation facilities, over and above the direct effect on the Air Balloon public house.

#### Tourism and recreation during operation

- 12.12.14 Once the proposed scheme is completed and operational, access to the identified tourism and recreation receptors would be maintained and improvements in travel conditions by virtue of the proposed scheme would improve accessibility in the study area and beyond. This would be particularly beneficial at peak times during summer months when congestion is often experienced, which could help remove a perceived barrier to tourism and accessibility to facilities and services with associated wider economic benefits. Overall, the proposed scheme could therefore lead to slight benefits in terms of accessibility.
- 12.12.15 In addition to the above indirect effects, the ES will also consider potential for specific indirect amenity effects, again drawing on the findings of other assessment chapters. Given the overarching objective of the proposed scheme to bring landscape enhancements, there could be some beneficial effects in terms of visual impacts from key receptors.

#### **Allocated/Future Development Land**

- 12.12.16 The baseline has not identified any development allocations within the order limits or within close proximity to the proposed scheme, although the strategic allocation of North Brockworth is located to the west of the proposed scheme.
- 12.12.17 Specifically, in relation to the strategic allocation, and given its distance from the proposed scheme, it is not envisaged that the site would be affected during the construction phase.
- 12.12.18 The proposed scheme once operational would bring accessibility benefits to the wider area by virtue of improved transport conditions. This section of the A417 has been identified within the evidence base to the Joint Core Strategy as a key infrastructure constraint to facilitate strategic growth.
- 12.12.19 Once operational therefore the proposed scheme would provide infrastructure improvements which are required to facilitate growth within Gloucestershire.

#### **Other land**

##### Other land during construction

- 12.12.20 When considering other land that is potentially affected by the proposed scheme, the assessment focusses on an area of common land located immediately west of the existing A417 in the vicinity of Barrow Wake, as shown on PEI Report figure 12.4 – Open Access Land.

12.12.21 Given the proximity of the current A417 there is potential for this area of land to be affected during de-trunking works.

Other land during operation

12.12.22 There is potential that a small area of the northern section of the common land would be lost due to the mainline construction of the proposed scheme.

12.12.23 In seeking to mitigate the loss of open space land, the proposed scheme will identify an area of replacement land.

**12.13 Assessment of Effects – Human Health**

12.13.1 The assessment of effects considers each of the determinants of health, identified in Table 12-6 (using significance levels as set out in Table 12-8). Findings from the literature review are firstly set out, followed by an assessment of how, as a result of the proposed scheme, the determinants of health are likely to affect the health outcomes of the population within the study area. Where relevant, assessment outcomes from other PEI Report topic assessments have been used as a basis for the assessment on health.

12.13.2 Additional consideration is given to the different groups of people within the population (see Table 12-7) whom may experience the impact in a differential or disproportionate way. Where it is identified that health outcomes for these groups may be more affected by the proposed scheme, this is identified, along with the reasons why.

12.13.3 Health assessments consider how health outcomes of populations within the study area are likely to be affected by a development proposal. Focus is therefore made on local communities rather than visitors to the area, although visitors are considered where appropriate.

12.13.4 Table 12-25 is a summary matrix of the health outcomes identified for the proposed scheme during construction and operation. The justification for these assessments is given in more detail in the discussions below.

**Table 12-25 Summary Assessment of Human Health Outcomes**

Key: Red = adverse effect (-)   Amber = neutral (~) or mixed   Green = positive effect (+) Minor (+) or (-)   Moderate (++) or (--)   Major (+++) or (---)		
Health Determinant	Construction	Operation
Social capital cohesion	~	- / +
Community safety	~	+
Healthcare services and other community facilities	~	~
Transport and connectivity	~	+
Open space and nature	~	+

Air	~	++
Noise	-	-/+
Landscape and visual amenity	-	~
Climate change	~	+
Employment and economy	+	+

**Social capital and social cohesion**

Construction phase effects

- 12.13.5 Figure 12.5 identifies all the residential properties that are within the study area. During construction there is a need to demolish the Air Balloon Pub and a residential property on the A417, west of the Air Balloon roundabout. For the people who frequent the pub and live in the residential property, the construction phase will lead to a loss of place and a need to create a new sense of place somewhere else. There will also be a loss of a social gathering place through the loss of the pub. This effect on the health determinant of social cohesion is considered to result in a long term, adverse, minor effect on the residents and those who frequent the pub. However, at the community population this is not considered to have an effect.
- 12.13.6 Visitors to the National Trust Crickley Hill Country Park experience long distance views across the AONB and would be able to see all the construction activities associated with the construction of the A417. It is assumed that visitors would only see construction activities within a very short time period of their visit to the site and therefore are unlikely to experience any adverse health outcomes as a result of changes to views.

Operation phase effects

- 12.13.7 The relocation of the A417 east of the existing route will change the landscape in this area and therefore affect views and the sense of place experienced by the local communities. This is particularly the case for Stockwell Farm, The Barn (holiday let), Rushwood Kennels and Cattery, and Cowley for whom the A417 will be in closer proximity. The loss of tranquillity and the introduction of a physical barrier is likely to affect the social cohesion of the local area which is considered to lead to long term, minor adverse health effects.
- 12.13.8 Contrary to this, the local community that is closer to the existing A417 which will become redundant are likely to experience beneficial changes to sense of place as the road becomes significantly quieter and more amenable to walking, cycling and horse-riding. These activities and increased tranquillity are considered likely to lead to long-term, medium beneficial health outcomes for the community in close proximity, such as in Birdlip and individual properties along the existing A417.



## **Community safety**

### Construction phase effects

- 12.13.9 It is not considered that the construction phase of the proposed scheme would influence the crime rates within the local communities and therefore no health effect in this regard are anticipated.
- 12.13.10 During the construction phase, community safety issues would relate to the potential for increased incidents as a result of temporary HGV movement, and construction traffic. A Traffic Management Plan would be prepared by the contractor and agreed with Gloucestershire County Council. This would include details of how construction traffic would reach the site on the local road network.
- 12.13.11 A CEMP will also be prepared which would outline mitigation measures to help ensure the safety of the local community during works. For example, clear signage and best practice techniques would be applied. When work is required online, a series of traffic management measures will be implemented. This is likely to include single way working of traffic in each direction, maintained at all times. A mandatory 40mph speed limit would be imposed where construction occurs in the vicinity of the existing A417.
- 12.13.12 As such, the health effect as a result of changes to community safety during works is considered to be temporary, minor adverse depending on the proximity of communities to construction works. With mitigation in place, it is considered there would be a neutral health effect.

### Operational phase effects

- 12.13.13 It is not considered that the operational phase of the proposed scheme would influence the crime rates within the local communities and therefore no effect in this regard is predicted.
- 12.13.14 The accident rates observed on the existing A417 are significantly higher than the national average for single-carriageway roads, particularly for fatal and serious casualties. In summary, in the five years to the end of April 2018, there were 49 Personal Injury Accidents (PIAs) on this stretch of the A417, resulting in:
- 10 fatalities;
  - 18 seriously injured casualties; and
  - 61 slight casualties.
- 12.13.15 For the new section of dual carriageway the accident rate is predicted to be reduced, largely as a result of the safe and modern design standard of the new road. The fear of incidents would therefore be reduced.
- 12.13.16 Furthermore, the average forecast peak period traffic flows on local roads near the A417 as a result of the proposed scheme, show a reduction. That would result in the local roads experiencing, on average, less traffic. Those conditions would be favourable to community severance, the movement of people, and safety which would be particularly beneficial to children and older people who are more vulnerable in higher volume traffic.
- 12.13.17 As such, there would be minor community safety benefits as a result of the proposed scheme which would result in a long term, minor beneficial health effect.

## **Healthcare services and other community facilities**

### Construction effects

- 12.13.18 Physical access to healthcare services will not be affected by the proposed scheme during the construction phase, i.e. people will still be able to reach these services. The construction workers are also unlikely to increase pressure on the services since many of them are likely to stay registered with their own local practices (if working from outside the region) or already be registered locally if they themselves are from the local area. Any unforeseen accident and emergency requirements requiring local services are likely to result in negligible effects given the limited nature and duration associated with that demand.
- 12.13.19 The loss of Air Balloon pub is not likely to have an adverse effect on the health of the local community as there are other options for eating out and socialising. For example, there is the Golden Heart Inn on the existing A417, 2.1 miles south of Air Balloon and a Beefeater approximately 3 miles away in Little Witcombe (east of A417). It is therefore considered that this would be a neutral health effect.
- 12.13.20 During construction access to healthcare, leisure and tourism facilities would be affected as a result of the temporary disruption from construction activities. However, it is not considered that this disruption would result in any health effects as people will still be able to access these facilities during the construction period with limited disturbance.
- 12.13.21 There are likely to be short term and temporary increased journey time unreliability when traffic management measures are required during construction. That could increase driver stress albeit the impact on health is likely to be neutral.
- 12.13.22 Overall it is considered that the construction phase of the proposed scheme would result in a neutral health effect for those within the study area as a result of any impacts on health care or other community facilities.

### Operation effects

- 12.13.23 Once the proposed scheme has been completed it is likely that ease of access to healthcare services and other social infrastructure will be improved due to the reduced amount of travel time/reduced congestion that the A417 Missing Link will offer. This, therefore, would result in minor positive health effects, particularly for those whose access to social infrastructure is more geographically limited to the study area, e.g. children/young people, older people and those in poor health. However, this is unlikely to make a large difference to the local communities which are relatively sparse and not likely to be directly affected by the proposed scheme.
- 12.13.24 Overall it is considered that there would be a neutral health effect within the study area with regards to access to healthcare and other social infrastructure.

## **Transport and connectivity**

### Construction phase effects

- 12.13.25 During the construction phase accessibility to public transport will not be affected significantly as services will still run. Where diversions are required, this is not predicted to affect the overall provision of the service and would not result in any health effects.

12.13.26 In total the proposed scheme has the potential to affect 20 Public Rights of Way (PRoW) which are shown on PEI Report figure 12.2. These include:

- one National Trail;
- one long distance path;
- four bridleways;
- fifteen footpaths; and
- two restricted byways.

12.13.27 During construction there will be a number of impacts on these PRoW, such as diversions and disruption which will affect options available for active travel. Highways England intends to keep the majority of PRoW's open via local management, early re-provision and/or use of short-term, temporary closures in order to balance the risks to the public against the potential disruption that removing such a risk would cause. In addition, a PRoW Management Plan will be prepared during the EIA detailing how effects on PRoW will be managed during construction.

12.13.28 In all cases, it is likely that realignment or diversion of local routes is proposed, utilising new side roads, overbridges and junctions where possible to maintain access for users. This will enable local communities to maintain access to active transport options during the construction phase, albeit if inconvenienced for a short period. These options will be developed further for the EIA.

12.13.29 Any health effects resulting from impacts on PRoW during the construction phase are considered to have a neutral effect on health.

#### Operational phase effects

12.13.30 Once the proposed scheme is fully operational, active travel facilities for walking, cycling and horse-riding will have been improved and new routes proposed. In particular, the existing A417 south of Air Balloon roundabout will be substantially quieter once the new dual carriageway is open (being used for access only for 12 properties) and therefore provide a safer and more pleasant route for walking and cycling, in particular for residents of Birdlip. In addition, there are opportunities for improving the pedestrian facilities at the proposed roundabout linking the A417 link road with the A436, where it is proposed the Gloucestershire Way would be diverted to join the Cotswold Way National Trail.

12.13.31 It is considered that the changes to the A417 would not increase or decrease the number of active travel journeys which are for the purpose of commuting. This is because whilst the A417 Missing Link project would improve journey times/experience for motor vehicles, travel distances are generally longer than would be appropriate for active commuting. The A417 Missing Link is also not providing a 'link' between destinations but rather a link between two sections of the same road. There is therefore no particular incentive for people to use active travel to move from one destination to another along this section of the A417.

12.13.32 However, opportunities have been identified for improving PRoW options around the proposed A417 which would provide better and safer links across the new A417, therefore opening up route options to more people (in particular vulnerable users such as children and older people). Whilst many of these users may not be from within the local communities considered in this health assessment, it is likely that local people would utilise the PRoW network more once the connectivity and safety issues are resolved.

12.13.33As a result of the proposed scheme it is not considered that active commuting would increase. However, in relation to recreational use, by local communities it is considered that this would increase therefore resulting in a long term, minor, positive health impact.

### **Open space and nature**

#### Construction phase effects

12.13.34As discussed in the assessment of Transport and Connectivity effects (previous section) there will be a variety of effects on the local Public Rights of Way (PRoW) ranging from complete closure and re-provision/redirection to temporary diversions. These will be managed (via a PRoW Management Plan) to help ensure public safety and reduce disruption to users. It is Highway England's intention to keep the majority of PRoW open via local management, early re-provision and/or use of short-term, temporary closures.

12.13.35In all cases, realignment or diversion of these local routes is proposed, utilising new side roads, overbridges and junctions where possible to maintain access for users. This will enable local communities to maintain access for recreation within the affected area.

12.13.36Access to open space will be maintained throughout construction and therefore no health effect is anticipated in relation to access to green space and nature during the construction phase. However, the quality of that access is likely to be adversely affected due to the proximity of the construction activities (and associated noise and general disturbance). Due to the rural nature of the local area, there are other options in close proximity which could be used during construction.

#### Operation phase effects

12.13.37Based on the Walking, Cycling and Horse-riding Assessment Report that was prepared for the proposed scheme in 2017, there are a number of opportunities that have been identified for improving the PRoW facilities within the study area.

12.13.38As a result of the improvements it is anticipated that health effects would be long term, beneficial and minor assuming that more people would choose to use the facilities as a result of improvements made. It is considered that those people who are less able to travel longer distances to benefit from access to open spaces are most likely to benefit from these improvements, including young people, economically inactive, unemployed and those living in isolated areas.

### **Air quality**

#### Construction phase effects

12.13.39During construction, potential air quality effects relate to effects arising from fugitive dust emissions due to earthworks, trackout and general construction activity associated with the proposed scheme. During these activities the contractor would be following a Construction Environmental Management Plan (CEMP) which sets out how environmental impacts should be mitigated during construction. The air quality assessment that was undertaken for the PEI Report has scoped construction air quality impact assessment out of the assessment. There is therefore no assessment of changes to air quality during construction.

12.13.40 It is not considered that there would be any air quality changes during construction that would affect human health.

#### Operation phase effects

12.13.41 The proposed scheme provides a duelled off-line section of road which allows for faster and less congested journeys along the A417. The proposed scheme will have a less steep angle from the top of the Crickley Ridge to Cowley. The new route will move traffic away from Birdlip and closer to Shab Hill and remove the Air Balloon roundabout.

12.13.42 The routing of the proposed scheme removes the Air Balloon roundabout and diverts traffic away from the AQMA that is currently in place for three receptors at the roundabout for the Air Balloon pub and the properties known as Air Balloon Cottages. This, in addition to less congestion on the road should provide an improvement in air quality by moving the emissions source further away from the receptors in that area.

12.13.43 These predicted improvements in air quality around these locations is likely to result in moderate, long term, positive health effects for those people in residential properties within the study area. Birdlip in particular will benefit from traffic being moved further away, as will residential properties in Ullenwood. Children, older people and those who are in poor health in particular will benefit from improvements in air quality in these areas.

### **Noise**

#### Construction phase effects

12.13.44 The construction works would include a major area of cutting excavation in the northern part of the proposed scheme which is likely to be the area of most prolonged works. There are three areas of proposed junction works including a grade-separated junction at Shab Hill. Away from the major cutting and junctions, the new or improved carriageway works would progress more rapidly along the proposed scheme, and hence would be alongside any one receptor location for a shorter period.

12.13.45 The construction activities resulting in the highest noise levels are generally the earthworks (i.e. 'cut and fill' works). The noise levels would vary according to the location of the works relative to the receptors, but the period of these works would be approximately 18 months.

12.13.46 During construction it is likely that some receptors along the proposed scheme would experience noise levels that exceed SOAEL<sup>266</sup> threshold limits set (by Government guidance). This would not be for the full duration of works, but rather during some months. These receptors (Rx) include:

- R3 (Crickley Ridge);
- R4 (Air Balloon Cottages);
- R5 (Birdlip Radio station);
- R6 (Rushwood Kennels);
- R9 (Crickley Hill - footpath); and

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<sup>266</sup> SOAEL – this is Significant Observed Adverse Effect Levels and identifies the onset of significant impacts on health and quality of life.

- R10 (Gloucestershire Way - footpath).

12.13.47 It is also predicted that the following receptors would experience noise levels that exceed LOAEL<sup>267</sup> threshold limits for some of the construction period:

- R7 (Stockwell Farm Barn);
- R8 (Chestnut Cottage); and
- R11 (Cally Hill – footpath).

12.13.48 The noise assessment concludes that these noise increases at these receptors during the construction phase would result in short-term, significant adverse effects. From a health perspective, this is likely to result in short term physiological stress for those people living in the residential properties at these identified receptor locations. Due to the relatively short period of noise exposure at this level, and the fact that residents would be fully cognisant to the fact that it will be short term only, it is considered that there would be a minor adverse health effect as a result of noise during construction.

#### Operation phase effects

12.13.49 Along the section between Bentham and Air Balloon roundabout the proposed scheme would be aligned with the existing A417. The noise assessment predicts that traffic noise levels immediately around the highway would be negligibly increased (by less than 1dB) on the southern side affecting a number of isolated dwellings and commercial premises.

12.13.50 The new section of the A417 will take traffic further from the majority of residential properties along the existing alignment, especially at Birdlip which would reduce noise levels at these locations. The opposite would be the case at Stockwell Farm, The Barn (holiday let), Rushwood Kennels and Cattery and at McCarthy Taylor Systems (business) although this has not yet been quantified. From a community health perspective, the reduced noise levels at Birdlip, which represents the most populated residential area within the study area of the noise assessment, is likely to result in a medium, long-term beneficial health effect. At the isolated properties close to the new alignment, the health effect is likely to be minor, long-term adverse health effect.

### **Landscape and visual amenity**

#### Construction phase effects

12.13.51 The landscape chapter of the PEI Report (chapter 7) identifies the sources of effects on landscape and visual receptors during construction as:

- temporary construction compounds with associated lighting and fencing;
- temporary haul roads;
- stockpiling and storage of materials;
- excavation and handling of materials;
- on- and off-site construction traffic; and
- on-site plant, such as:
  - chainsaws and excavators for site clearance;
  - demolition plant and excavators for site clearance;

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<sup>267</sup> LOAEL – this is Lowest Observed Adverse Effect Levels and daytime LOAEL is based on the onset of moderate community annoyance. Night time LOAEL is defined using the WHO Night Noise Guidelines

- articulated dump trucks, excavators up to 35T capacity, dozers and rollers for bulk earthworks;
- cranes, telescopic boom lifts, piling rigs and telescopic forklifts for construction of structures; and
- night time security lighting year-round; and
- isolated task lighting which would be provided intermittently where required during the winter months only.

12.13.52 Construction activities would take place over a period of approximately 3 years (2021-2024) and is considered temporary. The construction period is likely to impact on the sense of tranquillity and calm in the existing landscape and the construction activities themselves will result in changes to the existing landscape. The impacts of these changes have not yet been fully assessed, but from a health perspective, it is likely to result in short-term, minor adverse health effects due to the loss existing landscape attributes within the study area.

#### Operational phase effects

12.13.53 The landscape chapter of the PEI Report (chapter 7) identifies the sources of landscape and visual effects during operation as:

- the presence of the widened road width change of vertical and horizontal alignment south of Crickley Hill;
- altered road access arrangements to accommodate the new road infrastructure;
- the green bridge between Crickley Hill and Barrow Wake along elevated ground above the new A417 following the escarpment edge;
- the presence of replacement or enhancement vegetation, particularly along the southern side of the A417 between Brockworth bypass and Air Balloon roundabout;
- loss of the Hot Air Balloon public house and associated grounds;
- deep section of road cutting across the escarpment and through Shab Hill, creating exposed rock faces and retaining walls to accommodate six lanes of traffic;
- the realigned A436 between Shab Hill and Air Balloon roundabout;
- over bridges at Cowley and Stockwell;
- changes in the layout of the Cowley roundabout;
- upgrading of farm/property access tracks or points of egress;
- loss of trees and vegetation, or new woodland, tree, scrub, shrub or grassland planting as part of the proposed landscape mitigation design and enhancement measures;
- the presence of attenuation, cascade pond, filtration strips, bioswales drainage channels and culverts associated with the drainage proposals, particularly where these are typical engineered solutions e.g. regular shaped ponds, slope angle and location on steep gradients and any associated earthworks, retaining walls, culverts or other features;
- change of surfacing and additional proposed planting along the proposed detrunked section of the existing A417 between the minor road to Stockwell and Barrow Wake;
- changes to existing field pattern, including the removal, relocation or new field boundaries. New sections of drystone walling or hedgerow boundaries,

planting of hedgerow trees or the change of land cover or agricultural practice as a result of proposed landscape, heritage or ecological mitigation or enhancements; and

- additional tree and woodland planting across the site or the change of land cover from arable to rough/calcareous grassland. Vegetation re-establishment will vary in timescale with calcareous grassland and scrub (taking up to two to three years post construction).

12.13.54 Once the proposed scheme is operational, it is considered that the section that will be contained within a cutting will have no effect on the health and wellbeing outcomes related to landscape and visual amenity. This is because it will not be possible to see the road within views that look across the cutting and therefore will not have any effect.

12.13.55 Where the route passing through new areas of the landscape, this is likely to result in a loss of visual amenity in these areas. However, due to the decommissioning of the existing A417 and the improved visual amenity that will result in this section of the route, the effect of changes to landscape and visual amenity across the entirety of the proposed scheme can be considered, on balance, to have a neutral health effect.

## **Climate change**

### Construction phase effects

12.13.56 The carbon assessment within the Climate chapter of the PEI Report (chapter 14) has calculated that the carbon emissions from the construction of the proposed scheme are estimated to be 9,830.67tCO<sub>2</sub>. The Climate Change Resilience assessment within the same PEI Report chapter concludes that no significant climate change resilience effects during the construction stage have been identified. This is based on design mitigation being included such as geotechnical and drainage design and construction management practices such as those included within the Construction Environmental Management Plan (CEMP) being followed in the event of extreme weather events.

12.13.57 No health effects are therefore likely to result from climate change effects during the construction phase.

### Operational phase effects

12.13.58 The A417 provides an important transport link for the south-west and is a crucial part of the strategic road network in the region. The proposed scheme is expected to increase the resilience of transport systems in Gloucestershire to a range of hazards, including climatic hazards and climate change, and hence provide benefit for the overall resilience of the region.

12.13.59 This increased resilience is likely to result in long-term, minor beneficial health effects as local communities will remain connected to the wider areas even during times of extreme weather, for activities such as work, recreation and access to healthcare as needed.

## **Employment and economy**

### Construction phase effects

12.13.60 During construction it is anticipated that employment will be generated that would remain fairly constant over the construction programme. Given the location of the



proposed scheme, it is anticipated that a proportion of the construction workforce will be 'imported' into the area and therefore made up of workers travelling from outside the area and staying locally.

- 12.13.61 Due to the geographic location of the proposed scheme and the type/volume of construction skills required, it is anticipated that a large proportion of the construction workforce will be 'imported' into the area and therefore made up of workers travelling from outside the area and staying locally.
- 12.13.62 As the majority of the workforce will be from outside the local area, the health benefits associated with employment will be dissipated beyond the local communities. However, in addition to the direct employment there is also likely to be some induced employment within the tourism sector which is likely to provide some of the accommodation needed to house the workforce which would be travelling into the area for the work.
- 12.13.63 New spend within the local economy by these workers is also likely to benefit local businesses. This is likely to be relatively small when compared to the overall tourism spend in Gloucestershire, but nonetheless is not an insignificant level of spend in the local area, with a minor beneficial health effect expected during construction.
- 12.13.64 For those who are unemployed or economically inactive, there may be opportunities for accessing training related to construction employment. At this stage it is not known how many people would benefit and therefore it is not possible to quantify the magnitude of this effect although should people within the local communities' benefit, this would result in a short-term, minor beneficial health effect.
- 12.13.65 Whilst there will be some employment benefits in the local area as a result of induced spend, it is considered that the overall construction phase health related benefits would be short term, minor beneficial. This is based on the wide area across which direct employment benefits are likely to be felt and the relatively low levels of induced employment likely to result from the proposed scheme's construction phase.

#### Operational phase effects

- 12.13.66 During operation the proposed scheme would not result in any direct employment benefits beyond typical maintenance arrangements. However, two of the scheme objectives are to '*support economic growth*' and to '*improve connectivity and community cohesion*'.
- 12.13.67 Whilst it is difficult to measure the success of these objectives, if (when) met, they will all contribute to a stronger employment market that will benefit the health of the whole community. As such, it is predicted that the proposed scheme would result in long term, minor beneficial health effects.

## **12.14 Monitoring**

- 12.14.1 No monitoring measures have been identified at this stage but will be developed from the full assessment and included within the ES.

## 12.15 Summary

12.15.1 This PEI Report assessment has considered:

- **All Travellers** – including potential effects on vehicle travellers, walkers, cyclists and horse-riders;
- **Communities** – including potential effects on employment, existing settlements, access to services/green space, community safety and residential amenity;
- **Land and Property** – including potential effects on land and property to be used or acquired, allocated land, tourism and recreation receptors and commercial business receptors; and
- **Human Health** - identifying at potential effects on relevant health determinants.

12.15.2 It is considered that the proposed scheme complements the relevant legislative and policy framework by supporting economic development through improved access to jobs and services and improved journey time reliability.

12.15.3 Preliminary Construction Assessment:

- construction of the proposed scheme has the potential to bring significant **adverse** effects on one business and one residential property.

12.15.4 Preliminary Operational Assessment:

- operation of the proposed scheme would have likely significant **beneficial** effects on connectivity and amenity for users of the PRow network; and
- operation of the proposed scheme would have likely significant **beneficial** health effects in relation to air quality.

12.15.5 Further assessment and development of mitigation measures will be undertaken as part of the ES and through the completion of the following surveys, assessments and management plans:

- Public Rights of Way Management Plan;
- Outline Construction Environmental Management Plan; and
- Construction Traffic Management Plan.

## 13 Road Drainage and the Water Environment

### 13.1 Introduction

- 13.1.1 This chapter of the PEI Report sets out the preliminary assessment of potential impacts on the water environment that may arise from the proposed scheme. For the purposes of this chapter, the water environment is considered to comprise:
- surface water features within the study area;
  - groundwater contained within aquifer units that underlie the study area;
  - other water bodies or water dependent features that may potentially be affected; and
  - the aspects of potable water supply where they directly depend on water resources (e.g. private wells etc).
- 13.1.2 The chapter describes the baseline conditions of the existing water environment in the study area and the methodology used to assess potential impacts during the construction and operational phases of the proposed scheme, before presenting the preliminary results of these assessments and any further mitigation measures or monitoring deemed necessary.
- 13.1.3 The assessment considers the potential effects on the quality and quantity of surface and ground waters, geomorphology and flood risk that may result from construction activities, the operational road drainage and accidental spillages.
- 13.1.4 The Water Framework Directive (WFD) assessment and Flood Risk Assessment (FRA) will be reported within the ES.
- 13.1.5 Any associated effects on ecology are considered in chapter 8 Biodiversity, although ecological proxy indicators of water quality may be considered in assessment of effects in the ES chapter. Effects on ground conditions and water quality arising from existing land contamination are considered in the chapter 9 Geology and Soils.

### 13.2 Legislative and Policy Framework

#### European Legislation

##### Water Framework Directive (WFD) 2000/60/EC

- 13.2.1 The WFD provides a framework for the protection of inland surface waters (rivers and lakes), transitional waters (estuaries), coastal waters and groundwater. The WFD requires Member States to establish river basin districts (RBDs), and to prepare, implement and review a River Basin Management Plan (RBMP) for each RBD every six years. The current period from 2015-21 is Cycle 2 of these RBMPs.

##### Groundwater Daughter Directive (GDD) 2006/118/EC

- 13.2.2 The GDD establishes a regime which sets groundwater quality standards and introduces measures to prevent or limit inputs of pollutants into groundwater, clarifying some objectives of the WFD. Amended by Directive 2014/80/EU to clarify groundwater information to be provided to the European Commission. Member States must provide information on groundwater bodies classified as

being at risk and threshold values for the respective pollutants and indicators established.

#### Floods Directive 2007/60/EC

- 13.2.3 The Floods Directive requires Member States to: assess if watercourses and coastlines are at risk from flooding; map flood extents, assets and humans at risk in these areas; and to take adequate and coordinated measures to reduce this flood risk. The Directive requires that flood risk management plans be prepared, implemented and reviewed every six years for each river basin district, in coordination with RBMPs prepared under the WFD.

#### Habitats Directive 92/43/EEC & Birds Directive 2009/147/EC

- 13.2.4 The Habitats Directive and Birds Directive ensure the conservation of a range of rare or threatened species. They establish the European Union (EU) wide Natura 2000 ecological network of protected areas to safeguard against potentially damaging developments.

#### Priority Substances Directive 2013/39/EU

- 13.2.5 The Priority Substances Directive amends WFD 2000/60/EC and the Environmental Quality Standards Directive (2008/105/EC) by updating the list of priority substances that would apply to WFD assessment.

#### Urban Wastewater Treatment Directive 91/271/EEC (as amended) (UWWT Directive (consolidated))

- 13.2.6 This Directive concerns the collection, treatment and discharge of urban waste water and the treatment and discharge of waste water from certain industrial sectors. The objective of the Directive is to protect the environment from the adverse effects of the above-mentioned waste water discharges.

### **National Legislation**

#### Environmental Protection Act 1990

- 13.2.7 The Act makes provision to control pollution arising from industrial and other processes for waste management.

#### Water Industry Act 1991

- 13.2.8 The Water Industry Act relates to water supply and the provision of wastewater services in England and Wales.

#### Land Drainage Act 1991 (as amended)

- 13.2.9 The Land Drainage Act 1991 requires that a watercourse be maintained by its owner. The Act provides functions to internal drainage boards and local authorities to manage watercourses and provide consenting powers for proposed works to watercourses associated with development.

#### Water Resources Act (England and Wales) 1991 (Amended 2009)

- 13.2.10 The Water Resources Act 1991 (WRA) (as amended) sets out the responsibilities of the Environment Agency (EA) in relation to water pollution, resource management, flood defence, fisheries, and navigation.

### Environment Act 1995

- 13.2.11 The Environment Act sets new standards for environmental management, such as requiring national strategies for air quality and waste. It also deals with the establishment of the EA.

### Water Act 2003

- 13.2.12 The Water Act 2003 amends the Water Resources Act 1991 and the Water Industry Act 1991 to make provision with respect to compensation under Section 61 of the Water Resources Act 1991.

### Water Resources (Abstraction and Impounding) Regulations 2006

- 13.2.13 These Regulations contain provisions relating to the licensing of abstraction and impounding of water in England and Wales in the light of amendments made by the Water Act 2003 to the Water Resources Act 1991. The 2006 regulations have been updated by the Water Abstraction and Impounding (Exemptions) Regulations 2017.

### The Water Abstraction and Impounding (Exemptions) Regulations 2017

- 13.2.14 These Regulations contain circumstances where water abstractions and impounding works are exempt from licensing requirements.

### Flood Risk Regulations 2009

- 13.2.15 The Flood Risk Regulations 2009 transpose the EC Floods Directive (2008/60/EC) on the assessment and management of flood risk into domestic law in England and Wales and implement its provisions. The regulations designate a Local Lead Flood Authority (LLFA) and impose duties on the EA and Lead Local Flood Authorities to prepare a number of documents including:

- Preliminary Flood Risk Assessments;
- flood hazard and flood risk maps; and
- Flood Risk Management Plans.

### The Water Supply (Water Quality) Regulations 2018

- 13.2.16 These Regulations provide the framework for drinking water quality in England in respect of public supplies provided by water companies and licensed water suppliers. The Drinking Water Inspectorate, acting on behalf of the Secretary of State, enforces the legislation.

### Flood and Water Management Act 2010

- 13.2.17 The Act makes provision for water, including provision about the management of risks in connection with flooding and coastal erosion.

### The Environmental Damage (Prevention and Remediation) (England) Regulations 2015

- 13.2.18 These regulations are based on the 'polluter pays' principle and impose obligations on operators of economic activities requiring them to prevent, limit or remediate environmental damage. They apply to damage to protected species, natural habitats, sites of special scientific interest (SSSIs), water and land and implement Directive 2004/35/EC, on environmental liability.

The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015

- 13.2.19 The WFD Directions present the updated environmental standards to be used in the second cycle of the WFD (2000/60/EC) river basin management planning process in England and Wales. Environmental standards help assess risks to ecological quality of the water environment.

The Groundwater (Water Framework Directive) (England) Direction 2016

- 13.2.20 The direction sets out instructions to the EA on obligations to protect groundwater, including requirements to monitor and set thresholds for pollutants, add new pollutants to the monitoring list and change the information reported to the European Commission.

The Environmental Permitting Regulations 2016 (SI 2010/675) (as amended in 2018 and 2019)

- 13.2.21 The Environmental Permitting (England and Wales) Regulations SI 2010/675 were amended in order to extend the requirement for an environmental permit to flood risk activities, in addition to polluting activities included under the previous regulations. The permitting requirements for flood risk activities allow the EA (as regulator for England) to concentrate on higher risk activities. The 2010 regulations revoked the 2009 Groundwater Regulations, which originally implemented the Groundwater Directive.

The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017

- 13.2.22 The WFD has been transposed into the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017. WFD is delivered in England and Wales through a framework of RBMPs. England and Wales are divided into 11 RBDs, each comprising smaller management units known as water bodies, including all river, lake, groundwater, coastal and transitional waters located within that RBD.

**National Policy**

National Policy Statement for National Networks (NPSNN)

- 13.2.23 This sets out the need and governmental policies for nationally significant rail and road projects for England. Sections 5.90 to 5.115 set out how flood risk impacts should be considered, whilst sections 5.219 to 5.231 cover the assessment of impacts to water quality and resources.

The National Planning Policy Framework 2019

- 13.2.24 This provides a framework within which local people and their accountable councils can produce their own distinctive local and neighbourhood plans. Section 14, titled "*Meeting the challenge of climate change, flooding and coastal change*" relates to flooding. The policy states that development should be directed away from areas at highest risk of flooding (both existing and predicted), however, where necessary, the development must be safe, for the lifetime of the development, without increasing flood risk elsewhere.

## Regional Policy

### Cycle 2 River Basin Management Plans (RBMPs) 2015-2021

- 13.2.25 The proposed scheme spans the boundary between two RBDs, the Severn and the Thames. These plans provide a framework for protecting and enhancing the benefits provided by the water environment. They also inform decisions on land use planning. Cycle 3 RBMPs are currently being prepared for introduction in 2021.

### Flood Risk Management Plans (FRMPs) 2015-2021

- 13.2.26 The proposed scheme spans the boundary between two RBDs, the Severn and the Thames. The FRMPs set out how organisations, stakeholders and communities will work together to manage flood risk.

## Local Policy, Strategy and Evidence

### Gloucestershire Local Flood Risk Management Strategy 2014

- 13.2.27 Sets out how Gloucestershire Council and its partner authorities intend to work together to manage flood risk from all sources. This strategy is supported by a live action plan which is reported on annually. This Local Flood Risk Management Strategy has been adopted to guide the development of policy and programmes across Gloucestershire Council's operations and in its work with other organisations, communities and stakeholders.

### Level 1 Strategic Flood Risk Assessment (SFRA) for Gloucestershire 2008

- 13.2.28 A tool for planning authorities to identify and evaluate flood risk in their area with the aim of directing development to the areas of lowest risk of flooding valid until 2026.

### Gloucestershire SuDS Design and Maintenance Guide 2015

- 13.2.29 The guide sets out Gloucestershire LLFA's approach to sustainable drainage and aims to aid developers incorporate sustainable drainage systems (SuDS) into their plans. Gloucestershire Council takes a proactive approach to encourage the use of SuDS for the management of surface water.

### Gloucestershire County Council: Flood Risk Assessment Guidance Note (March 2015)

- 13.2.30 The guidance note is for Local Planning Authorities on Development and Flood Risk. The note details the main flood risk that should be considered and how climate change should be accounted for. The approach to management of surface water is detailed including description of how SuDS can manage surface water run-off. Further considerations detailed include disposal to public sewer, designing for exceedance and developments that are part of a larger proposal.

### Cotswold District Local Plan (2011-2031)

- 13.2.31 The local plan sets out a number of policies with respect to the built, natural and historic environment, placing emphasis on promotion the protection, conservation and enhancement of the natural environment. Policy EN1 particularly seeks to improve '*water quality where feasible*'; whereas Policy EN4 directly links with the

Cotswolds AONB Management Plan (2013-2018) and highlights the special qualities of the Cotswolds including river valleys forming headwaters of the Thames.

- 13.2.32 Development will not be permitted if it results in unacceptable risk to the natural environment including pollution of surface, or groundwater sources (Policy EN15). This policy also places requirements on the landowner/developer to undertake necessary remedial works on affected sites.
- 13.2.33 Policy EN14 – Managing Flood Risk. The policy states that development must avoid areas at risk of flooding in accordance with a risk-based sequential approach that takes account of all flooding sources. Minimising flood risk and providing resilience will be achieved by applying the sequential test; or requiring a SFRA. In addition, the design of development should account for flood risk management and climate change with SuDS. Developers could be required to fund flood management and/or mitigation measures and maintenance.
- 13.2.34 Policy INF8 – Water Management Infrastructure. The policy states that proposals should consider the impact on off-site water and wastewater infrastructure and make improvements where required. Additionally, proposals should not result in the deterioration of water quality and demand management measures should be implemented. SuDS should be incorporated where appropriate and pollution of groundwater sources should be avoided. The policy specifies further requirements for proposals in Source Protection Zone (SPZ) 1.

Gloucester, Cheltenham and Tewkesbury, Joint Core Strategy 2011-2031

- 13.2.35 The Joint Core Strategy (JCS) is a partnership between Gloucester City Council, Cheltenham Borough Council, and Tewkesbury Borough Council. It presents a joint and coordinated strategic development plan up for 2011 to 2031 for the three authorities. It was adopted in December 2017. The plan strives for conservation, management and enhancement of the natural environment, and to maximise the opportunities to use land to manage flood water. Specifically, Policy SD14: Health and Environmental Quality, states that a new development must not result in unacceptable levels of water pollution with respect to national and EU limit values.
- 13.2.36 Policy INF2 - Flood Risk Management. The policy states development must accord with the sequential approach and increase risk of safety to occupier, community or wider environment. For strategic sites, the cumulative impact of development on flood risk in relation to existing settlements, communities and allocated sites must be assessed and mitigated. The policy sets out the requirements to minimise the risk of flooding and provide resilience to flooding while accounting for climate change.

Tewkesbury Borough Plan 2011-2031, Draft policies and site options for public consultation (Feb 2015)

- 13.2.37 Consultation of the proposed draft policies closed in October 2018, however no final document has been published. The Tewkesbury Borough Plan, section K Landscape, Biodiversity and Nature, Policy ENV3 is aligned with the National Planning Policy and the JCS with respect to protection of designated sites.
- 13.2.38 Section J – Flooding: The document states that development proposals will be relying on National Planning Policy Framework paragraphs 100, 101, 102, 103 and 104. The Joint Core Strategy – Policy INF3 should also be adhered to.



## Cotswolds Area of Outstanding Natural Beauty (AONB) Management Plan 2018-2023

- 13.2.39 Sets out the vision, outcomes and policies for the management of the Cotswolds AONB in order to conserve and enhance the natural beauty of the Cotswolds AONB and increase the understanding and enjoyment of the special qualities of the AONB.
- 13.2.40 Policy CC6 – Water. The policy states water resources should be carefully managed and conserved to: improve water quality; ensure adequate aquifer recharge; ensure adequate river flows; and contribute to natural flood management systems, including sustainable drainage.

### **Guidance**

- 13.2.41 The assessment methodology is based upon the Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3, Part 10: LA113 Road Drainage and the Water Environment (August 2019), subsequently referred to as LA113.
- 13.2.42 Due reference has been made to GOV.UK guidance for preventing pollution<sup>268</sup>, working on or near water<sup>269</sup> and for managing water on land<sup>270</sup>.
- 13.2.43 CIRIA guidance used for the assessment includes:
- Control of Water Pollution from Construction Sites – Guide to Good Practice (SP156);
  - Control of Water Pollution from Construction Sites – Guidance for Consultants and Contractors (C532);
  - Control of Water Pollution from Linear Construction Projects – Technical Guidance (C648);
  - Control of Water Pollution from Linear Construction Projects – Site guide (C649);
  - Environmental good practice on site (C692);
  - Groundwater control: design and practice (second edition) (C750);
  - The SuDS Manual (C753); and
  - Guidance on the construction of SuDS (C768).

## **13.3 Study Area**

- 13.3.1 The study area is based on the 'source-pathway-receptor' pollutant linkage principle, as recommended by LA113.
- 13.3.2 For direct effects on surface waters, the study area includes the geographical extent of the full scope of the works and all surface water features within 1km where features have hydrological connectivity to the proposed scheme.
- 13.3.3 For groundwater, the study area includes the geographical extent of the full scope of the works and all groundwater features within 1km of the proposed scheme.

<sup>268</sup> The Environment Agency, "Pollution prevention for businesses," 12 07 2016. [Online]. Available: <https://www.gov.uk/guidance/pollution-prevention-for-businesses>. [Accessed 07 2019].

<sup>269</sup> The Environment Agency, "Check if you need permission to do work on a river, flood defence or sea defence," 2017. [Online]. Available: <https://www.gov.uk/permission-work-on-river-flood-sea-defence>. [Accessed 07 2019].

<sup>270</sup> The Environment Agency, "Manage water on land: guidance for land managers," 19 02 2015. [Online]. Available: <https://www.gov.uk/guidance/manage-water-on-land-guidance-for-land-managers>. [Accessed 07 2019].

13.3.4 The Planning Inspectorate (PINS) scoping opinion report<sup>271</sup> and meetings with the EA have highlighted the need to extend the study area beyond the 1km buffer. Extension of the study area beyond the 1km buffer is necessary to capture potential impacts to receptors beyond the standard study area. This is particularly important where dewatering is likely to impact receptors upstream and downstream of the study area where underlying geology may result in groundwater connectivity across a wider area. A risk-based approach will be taken to the extension of the study area based on assessment of impact pathways and this will be kept under review as understanding of complex interactions evolves.

## 13.4 Potential Impacts

13.4.1 The proposed scheme has the potential to impact the water environment during construction and operation. The below listed impacts represent possible impacts that will be considered during the assessment and are based on ongoing consultation with the regulators, the designers and professional judgment.

### Construction

13.4.2 During construction, the main effects to surface water features and groundwater features could arise from:

- Increased pollution risks from mobilised suspended solids and spillage of fuels or other harmful substances that may migrate to surface water and groundwater receptors;
- Impacts to the hydromorphological and ecological quality of watercourses associated with works within or in close proximity to watercourses, including physical change to the watercourses and longer-term changes associated with sediment deposition;
- Impacts to local land drainage structures, that may alter existing drainage patterns within catchments and provide potential pathways for pollution; and
- Impacts on local hydrogeology and groundwater resources. Changes to groundwater levels, flows and quality arising from construction activities, primarily dewatering; earthworks and intrusive investigation works creating new flow paths for groundwater.

### Dewatering

13.4.3 Dewatering during earthworks, particularly where the excavation of deep cuttings intersects the saturated aquifer, could locally reduce groundwater levels and divert flow. Dewatering zone of influence may extend into the outer area of SPZ 3 for the Baunton abstraction.

13.4.4 These construction activities may lead to a reduction or cessation of spring flow and baseflow supplying watercourses, as well as adversely impacting on groundwater resources/abstractions.

13.4.5 Dewatering to allow stabilisation of the landslip material on Crickley Hill could significantly affect flow to springs rising from the escarpment, although the water would be returned to Norman's Brook tributary at the toe of the landslip.

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<sup>271</sup> The Planning Inspectorate (June 2019) Scoping Opinion: Proposed A417 Missing Link, Case reference: TR010056

- 13.4.6 A reduction of groundwater levels may cause settlement in soft cohesive deposits.

Earthworks and intrusive investigation work creating new flow paths

- 13.4.7 Ground investigation boreholes and deep cuttings may create pathways through relatively low permeability formations, such as the Fuller's Earth, and connect the Great and Inferior Oolite. Cuttings that intercept faults zones which act as a flow barrier, may connect previously disconnected strata and groundwater bodies with dissimilar qualities. New flow pathways for pollution may also be created, allowing polluted waters to enter water bodies not previously impacted by pollution. However, leakage through relatively low permeability formations via faulting is noted throughout the region. There may be localised impacts upon water quality within the aquifers.

Earthworks and below ground structures

- 13.4.8 Structures and temporary works in place to facilitate construction may cause local changes to groundwater flow, vertical downward pathways for pollution and mounding of groundwater on the up-gradient side of the structure. This could impact on springs, watercourses, groundwater dependent habitats and abstractions, where flow could be reduced or temporarily ceased.
- 13.4.9 Temporary measures put in place to facilitate the construction of earthworks, retaining walls and piled foundations may redistribute groundwater flow paths or cause groundwater mounding. This could create or reactivate springs and induce groundwater flooding, that would have the potential to impact upon the capacity of the temporary construction drainage system.
- 13.4.10 Stockpiling of construction materials and excavated spoil may contaminate or pollute groundwaters if they are not stored correctly. These contaminants and pollutants may include fuels, hazardous substances and suspended solids. This has the potential to impact the water quality of the aquifer, springs, watercourses, abstractions and groundwater dependent habitats. The flashy response of the limestone aquifers may exacerbate the extent of pollution and make it hard to contain. This is a concern within the Baunton SPZ3.
- 13.4.11 Dewatering of trenches and voids preparing for construction works can also drawdown the shallow groundwater table should the water table be intercepted. This risk will depend on the time of year as flows and levels will vary in an aquifer of this nature. This water may also be connected to spring systems which feed into local watercourse baseflows.
- 13.4.12 Wet concrete and grout into the fissures of the Inferior Oolite Group have the potential to impact upon groundwater quality due to its inherently high pH and the potential to migrate. This would impact upon the water quality of the aquifer, springs, watercourse base flows and groundwater dependent habitats.
- 13.4.13 Removal of topsoil or hardstanding and exposure of underlying soils to increased rainwater infiltration may result in pollutants leaching into the underlying groundwater.

New drainage systems

- 13.4.14 Construction works may reduce the rate of recharge to aquifers where the water is captured in relative to where it is discharged. This is likely to impact the flow of

springs, watercourses, groundwater abstractions and groundwater dependent habitats.

13.4.15 Drainage for construction works may also distribute contaminants and pollutants to other parts of the aquifer and create an accumulation of these substances where soakaway basins are used.

13.4.16 Intensive rainfall may reactivate springs flows to cuttings or in dry valleys leading to drainage system overload and consequently result in flooding.

#### Works around watercourses

13.4.17 Physical change to watercourses and longer-term changes associated with sediment deposition are likely to have impacts on the hydromorphological and ecological quality of watercourses.

13.4.18 The realignment of Norman's Brook will result in the loss of geological features including tufa formations, which are also of ecological importance in the area, and locally change the groundwater regime that feeds springs and baseflow in the vicinity.

13.4.19 These works will also result in the loss of geomorphological features and habitat niches within the channel, although there may be opportunities to deliver enhancement through the realigned channel.

13.4.20 Working in, on or adjacent to watercourses may affect surface water quality through the accidental discharge of sediments or chemicals, including hydrocarbons. There may also be impacts to channel form through plant movements and operations. All works close to watercourses should be carefully designed and supervised.

#### **Operation**

13.4.21 During operation, the most significant effects to surface water features, groundwater features and flood risk could arise from:

- polluted surface water runoff containing silts and hydrocarbons that may migrate or be discharged to surface water features or groundwater resources via the proposed highway drainage system, including from spillages;
- permanent impact to the hydromorphological and ecological quality of water features associated with works within or in close proximity to water features;
- permanent impacts to catchment hydrology and hydrogeology caused by the introduction of a barrier to natural overland flow e.g. introduction of embankments and changes to natural catchment dynamics associated with the proposed highway drainage system;
- permanent impacts to catchment hydrology and hydrogeology caused by impact to natural groundwater springs or groundwater flow associated with proposed road cuttings that could affect baseflow to watercourses and groundwater resources;
- increased rates and volumes of surface water runoff from an increase in impermeable area or changes to the existing drainage regime leading to a potential increase in flood risk;
- increased flood risk to the proposed scheme and to people and property elsewhere caused by crossing of watercourses thus affecting flood flow conveyance;

- change in the rate of recharge of aquifers due to change in ground surface cover and introduction of new drainage systems; and
- reduced dilution and/or dispersion of consented discharges to groundwater and treated sewage effluent due to reduced or redirected groundwater flow paths.

13.4.22 There is limited information regarding the existing road drainage arrangements and water treatment provision. The proposed scheme may provide an opportunity to provide betterment.

#### Impact of cuttings and embankments on groundwater flows and flow paths

13.4.23 Excavation of the Air Balloon cutting may redirect groundwater flows in the Inferior Oolite. This is primarily a concern during and after recharge events as most of the cutting is expected to be excavated in the unsaturated zone. These temporary groundwater flows during recharge events may be directed to the cutting, which would act as a drainage line in the area and impact upon the water balance between the groundwater catchments. This could impact upon water resource availability for springs and baseflow.

13.4.24 Deep cuttings and deep foundations such as piling may create pathways through relatively low permeability formations, such as the Fuller's Earth, and connect the Great and Inferior Oolite aquifers. Cuttings or deep foundations that intercept faults zones which act as a flow barrier, may connect previously disconnected strata and groundwater bodies with dissimilar qualities. New flow paths for pollution may also be created and allow polluted waters to enter water bodies not previously impacted by pollution. However, leakage through relatively low permeability formations via faulting is noted throughout the region, so the impact of any new flow paths that may be created is expected to be not significant on a regional scale. There may be localised impacts upon the water quality within the aquifers.

13.4.25 Shallow cuttings associated with the Shab Hill junction could impact upon groundwater flows in the Great and Inferior Oolite aquifers.

13.4.26 The Shab Hill junction is located within a dry valley and a number of ephemeral springs discharge seasonally into this valley, which could impact flows to Coldwell Bottom and the River Churn if they are intercepted by the proposed scheme.

#### Earthworks, retaining walls and piling creating a barrier to flow

13.4.27 Construction of deep cutting at the Air Balloon and associated retaining walls could intercept shallow spring systems and cut off their flow pathways making them dry overtime. The below ground works may locally intercept a significant, or even the full thickness of the saturated aquifer, potentially locally impacting the catchment area of the Norman's Brook tributary and the Churn River.

13.4.28 No structures foundation design has been undertaken at this stage, however it is anticipated that the proposed structures would be founded on deep piled foundations. This kind of foundations would require a pile cap, a shallow concrete structure placed at or near ground level, providing protection to the inserted piles. Such below ground structures (e.g. if a continuous piled wall is constructed) can act as both barriers to shallow groundwater flow and provide more vertical downward pathways for perched/shallow groundwater flow into the deeper aquifer. Contamination migration as a result of the proposed scheme is

considered in chapter 10 Geology and Soils. As a result, the springs which are connected to more saturated aquifer could be influenced from a reduction in flow or cease to flow completely; discharges via soakaways could lead to direct pollution of a strategically important aquifer underlying the proposed road scheme.

- 13.4.29 Underground structures or retaining walls would require drainage provisions to relieve hydrostatic pressure. These would intercept groundwater seepages into the cuttings, as discussed in sections below.
- 13.4.30 Embankments could create a barrier for surface water and springs currently recharging to the surface watercourses and redirection of flows to a different catchment, ultimately reducing catchment areas of the Churn and the Frome Rivers, and changing the flow regime within these surface water bodies. This may also have consequential effects for aquatic ecology.
- 13.4.31 Construction of the embankment supporting the road widening along the Crickley Hill would result in the Norman's Brook tributary diversion, potentially into a watercourse elevated in relation to the current watercourse alignment. This may result in springs currently issuing into the watercourse infiltrating the proposed constructed embankment and consequently reducing flows within the watercourse.
- 13.4.32 Groundwater infiltrating earthworks structures may cause instability issues. Precipitation of calcium carbonate into any engineering drainage designed to intercept groundwater may result in fouling of the matrix and subsequent reduction in hydraulic conductivity, resulting in potential impacts on stability also localised flooding.
- 13.4.33 Changes in flow paths within the aquifers may reduce flow to groundwater receptors, resulting in the partial or total loss of springs and depletion of existing watercourses. This may impact surface water flows in watercourses and have consequential effects for aquatic ecology. Conversely, this may lead to the creation of new springs and/or groundwater flooding due to groundwater mounding up-gradient of the structure.

#### Changes to ground surface cover

- 13.4.34 New areas of hardstanding and associated drainage systems may increase the rate of run off and reduce the rate of recharge. This is likely to impact the flow of springs, watercourses, groundwater abstractions and groundwater dependent habitats.

#### Groundwater seepage into cuttings

- 13.4.35 Seepage into cuttings may create a localised reduction of groundwater levels, leading to a reduction or cessation of local spring flow. This may result in the depletion of existing watercourses and loss of water supply to groundwater receptors, including springs, watercourses and abstractions.
- 13.4.36 Seepage into a deep cutting at Air Balloon Junction may reduce groundwater flows towards Coldwell Bottom and the River Churn. This may impact surface water flows in watercourses and have consequential effects for aquatic ecology.
- 13.4.37 Localised settlement may occur where affected water levels are within shallow cohesive deposits.

### Cutting drainage

- 13.4.38 The creation of a drain may divert water from one surface water catchment to another (between local surface water catchments within the Severn catchment, and between the Severn and Thames catchments). This interruption of flow may lead to a reduction or loss of water supply to abstractions, springs and watercourses and potential loss of habitat (which may be permanent). The loss of water from one catchment to another, potentially affecting resources availability further down-gradient in the confined aquifers.
- 13.4.39 A change in the groundwater flow regime and flood flow pathway may impact on receptors (properties and environmental) near to Flood Zones 2 and 3, and Bushley Muzzard SSSI, located just north of Flood Zones 2 and 3 for the River Frome.

### Road drainage

- 13.4.40 Road drainage charge of routine runoff to outfall, or soakaway if required, may cause a long-term degradation of water quality. Discharge of runoff during accidental spills, or collisions, or with elevated suspended solids concentrations, may have a significant impact on water quality.
- 13.4.41 The pollution of surface watercourses may result in the pollution of environmental receptors and the potential loss of aquatic habitat. This may, in turn, result in impacts on the amenity and economic value of surface water bodies.
- 13.4.42 An increase in the rate and volume of surface water runoff to surface watercourses may impact on properties and aquatic environments near to flood zones.
- 13.4.43 A reduction of recharge to the underlying aquifer may result in a reduction or loss of water supply to abstractions, springs, watercourses, and wetland, and the potential loss of aquatic habitat (which may be permanent).
- 13.4.44 The loss of groundwater flow, due to cuttings and subsurface structures, may reduce the dilution potential of aquifers receiving discharge via soakaway. This may impact on aquatic environments dependent on groundwater supply.

### Unanticipated storm event/excessive rainfall

- 13.4.45 High rates of infiltration to groundwater may result in the reactivation of springs and / or excessive watercourse flow leading to excess flow into cuttings, and the drainage system being overwhelmed. This could also apply to the road drainage system.
- 13.4.46 Uncontrolled discharge of surface drainage may lead to flooding, and flow and water quality effects on environmental receptors, properties and abstractions

### Alteration of ground elevations

- 13.4.47 Alteration of ground elevations and changes in surface water flood flow pathways may result in the overloading of drainage systems and / or surface watercourses. This may impact on flood-sensitive receptors near to overloaded systems.

### Culverting/structures within watercourses

- 13.4.48 A change in the flood flow pathway may impact on properties and aquatic environments close to flood zones. In particular, the realignment of the Norman's Brook tributary may result in flooding further upstream and downstream without appropriate mitigation to attenuate flows.
- 13.4.49 An interruption of flow in the watercourse may result in a reduction or loss of water supply to downstream receptors, including abstractions, rivers and wetland, and the potential loss of aquatic habitat (which may be permanent).
- 13.4.50 Polluted surface water runoff containing silts and hydrocarbons that may migrate or be discharged to surface water features or groundwater resources via the proposed highway drainage system.

## **13.5 Assessment Methodology**

- 13.5.1 The assessment methodology follows the guidance set out in Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3, Part 10 LA 113 Road drainage and the water environment (August 2019). This includes the following assessments:
- Routine runoff and surface water quality
  - Groundwater level and flow
  - Groundwater dependent terrestrial ecosystems (GWDTE)
  - Groundwater quality and routine runoff
  - Groundwater quality and routine runoff
  - Spillage and water quality
  - Hydromorphological assessment
  - Flood risk
- 13.5.2 The groundwater assessments will also take into account the Environment Agency guidance for Dewatering Abstractions (SC040020 SR1 and SR2).

### **Significance of Effects**

- 13.5.3 For each of the relevant water attributes the significance of the potential impacts shall be reported. The importance of the attribute shall be assigned based on the quality indicators and measures in Table 13-1 and the criteria in Table 13-1 (using the typical examples as a gauge).



**Table 13-1 Criteria for estimating the importance of water environment attributes (adapted from LA113 Table 3.70)**

Importance	Typical Criteria	Typical examples	
Very High	Nationally significant attribute of high importance	Surface water	Watercourse having a WFD classification shown in a RBMP and $Q_{95} \geq 1.0$ m <sup>3</sup> /s. Site protected/designated under EC or UK legislation (SAC, SPA, SSSI, Ramsar site, salmonid water)/Species protected by EC legislation Ecology and Nature Conservation*
		Groundwater	Principal aquifer providing a regionally important resource and/or supporting a site protected under EC and UK legislation Ecology and Nature Conservation* Groundwater locally supports GWDTE SPZ1
		Flood risk	Essential infrastructure or highly vulnerable development
High	Locally significant attribute of high importance	Surface water	Watercourse having a WFD classification shown in a RBMP and $Q_{95} < 1.0$ m <sup>3</sup> /s. Species protected under EC or UK legislation Ecology and Nature Conservation*
		Groundwater	Principal aquifer providing locally important resource or supporting a river ecosystem. Groundwater supports a GWDTE SPZ2
		Flood risk	More vulnerable development
Medium	Of moderate quality and rarity	Surface water	Watercourses not having a WFD classification shown in a RBMP and $Q_{95} > 0.001$ m <sup>3</sup> /s.
		Groundwater	Aquifer providing water for agricultural or industrial use with limited connection to surface water. SPZ3
		Flood risk	Less vulnerable development
Low	Lower quality	Surface water	Watercourses not having a WFD classification shown in a RBMP and $Q_{95} \leq 0.001$ m <sup>3</sup> /s.
		Groundwater	Unproductive strata
		Flood risk	Water compatible development

\* Highways England. Ecology and Nature Conservation, 'DMRB, Volume 11, Section 3, Part 4: Ecology and Nature Conservation

13.5.4 The magnitude of the impact shall be assigned based on the criteria in Table 13.2 using the typical examples as a gauge.

**Table 13-2 Estimating the magnitude of an impact on an attribute (adapted from LA 113, Table 3.71)**

Magnitude	Criteria	Typical Example	
Major Adverse	Results in loss of attribute and / or quality and integrity of the attribute	Surface water	<p>Failure of both acute-soluble and chronic-sediment related pollutants in HEWRAT and compliance failure with EQS values.</p> <p>Calculated risk of pollution from a spillage <math>\geq 2\%</math> annually (spillage assessment).</p> <p>Loss or extensive change to a fishery.</p> <p>Loss of regionally important public water supply.</p> <p>Loss or extensive change to a designated nature conservation site.</p> <p>Reduction in water body WFD classification.</p>
		Ground water	<p>Loss of, or extensive change to, an aquifer.</p> <p>Loss of regionally important water supply.</p> <p>Potential high risk of pollution to groundwater from routine runoff - risk score <math>&gt;250</math> (Groundwater quality and runoff assessment).</p> <p>Calculated risk of pollution from spillages <math>\geq 2\%</math> annually (Spillage assessment).</p> <p>Loss of, or extensive change to GWDTE or baseflow contribution to protected surface water bodies.</p> <p>Reduction in water body WFD classification.</p> <p>Loss or significant damage to major structures through subsidence or similar effects.</p>
		Flood risk	Increase in peak flood level ( $> 100\text{mm}$ ).
Moderate Adverse	Results in effect on integrity of attribute, or loss of part of attribute	Surface water	<p>Failure of both acute-soluble and chronic-sediment related pollutants in HEWRAT but compliance with EQS values.</p> <p>Calculated risk of pollution from spillages <math>\geq 1\%</math> annually and <math>&lt; 2\%</math> annually.</p> <p>Partial loss in productivity of a fishery.</p> <p>Degradation of regionally important public water supply or loss of major commercial/ industrial/ agricultural supplies.</p> <p>Contribution to reduction in water body WFD classification.</p>
		Ground water	<p>Partial loss or change to an aquifer.</p> <p>Degradation of regionally important public water supply or loss of significant commercial/ industrial/ agricultural supplies.</p> <p>Potential medium risk of pollution to groundwater from routine runoff - risk score 150-250.</p> <p>Calculated risk of pollution from spillages <math>\geq 1\%</math> annually and <math>&lt; 2\%</math> annually.</p>

Magnitude	Criteria	Typical Example	
			<p>Partial loss of the integrity of GWDTE. Contribution to reduction in water body WFD classification. Damage to major structures through subsidence or similar effects or loss of minor structures.</p>
		Flood risk	Increase in peak flood level (> 50mm).
Minor Adverse	Results in some measurable change in attribute's quality or vulnerability	Surface water	<p>Failure of either acute soluble or chronic sediment related pollutants in HEWRAT. Calculated risk of pollution from spillages <math>\geq 0.5\%</math> annually and <math>&lt; 1\%</math> annually. Minor effects on water supplies.</p>
		Ground water	<p>Potential low risk of pollution to groundwater from routine runoff - risk score <math>&lt; 150</math> Calculated risk of pollution from spillages <math>\geq 0.5\%</math> annually and <math>&lt; 1\%</math> annually Minor effects on an aquifer, GWDTEs, abstractions and structures</p>
		Flood risk	Increase in peak flood level (> 10mm)
Negligible	Results in effect on attribute, but of insufficient magnitude to affect the use or integrity	Surface water	<p>No risk identified by HEWRAT (pass both acute-soluble and chronic-sediment related pollutants). Risk of pollution from spillages <math>&lt; 0.5\%</math>. Negligible change in peak flood level (1% annual probability event) <math>&lt; \pm 10\text{mm}</math>.</p>
		Ground water	<p>No measurable impact upon an aquifer and/or groundwater receptors and risk of pollution from spillages <math>&lt; 0.5\%</math>.</p>
		Flood risk	Negligible change to peak flood level ( $\leq \pm 10\text{mm}$ ).
Minor Beneficial	Results in some beneficial effect on attribute or a reduced risk of negative effect occurring	Surface water	<p>HEWRAT assessment of either acute soluble or chronic-sediment related pollutants becomes pass from an existing site where the baseline was a fail condition. Calculated reduction in existing spillage risk by 50% or more (when existing spillage risk is <math>&lt; 1\%</math> annually).</p>
		Ground water	<p>Calculated reduction in existing spillage risk by 50% or more to an aquifer (when existing spillage risk <math>&lt; 1\%</math> annually). Reduction of groundwater hazards to existing structures. Reductions in waterlogging and groundwater flooding.</p>
		Flood risk	Creation of flood storage and decrease in peak flood level (> 10mm).
		Surface water	HEWRAT assessment of both acute-soluble and

Magnitude	Criteria	Typical Example	
Moderate Beneficial	Results in moderate improvement of attribute quality		<p>chronic-sediment related pollutants becomes pass from an existing site where the baseline was a fail condition.</p> <p>Calculated reduction in existing spillage by 50% or more (when existing spillage risk &gt;1% annually).</p> <p>Contribution to improvement in water body WFD classification.</p>
		Ground water	<p>Calculated reduction in existing spillage risk by 50% or more (when existing spillage risk is &gt;1% annually).</p> <p>Contribution to improvement in water body WFD classification.</p> <p>Improvement in water body catchment abstraction management Strategy (CAMS) (or equivalent) classification.</p> <p>Support to significant improvements in damaged GWDTE.</p>
		Flood risk	Creation of flood storage and decrease in peak flood level1 (>50mm).
Major Beneficial	Results in major improvement of attribute quality	Surface water	<p>Significant improvement to a fishery / designated nature conservation site.</p> <p>Removal of existing polluting discharge or removing the likelihood of polluting discharges occurring.</p> <p>Removal of existing polluting discharge, or removing the likelihood of polluting discharges occurring to a watercourse.</p> <p>Improvement in water body WFD classification.</p>
		Ground water	<p>Removal of existing polluting discharge to an aquifer or removing the likelihood of polluting discharges occurring.</p> <p>Recharge of an aquifer.</p> <p>Improvement in water body WFD classification.</p>
		Flood risk	Creation of flood storage and decrease in peak flood level (> 1 00mm).
No change		No loss or alteration of characteristics, features or elements; no observable impact in either direction.	

13.5.5 Once the importance of each attribute and the magnitude of the potential impact upon it are established, the significance of the potential impact shall be determined in accordance with LA 104 Environmental assessment and monitoring.

### Construction Impacts

13.5.6 An assessment of construction phase impacts shall be undertaken. LA 113 recommends an assessment of construction phase impacts should use the advice

given in CIRIA Report C648<sup>272</sup> Control of Water Pollution from Linear Construction Projects, on potential impacts arising during the construction phase and the assessment and mitigation of these risks.

- 13.5.7 The potential impacts of construction on surface water or sediment runoff, water quality, flood risk and groundwater quality or levels will be assessed based on the planned construction methods and sequencing. Where construction methods are not available, standard construction practices will be assumed. Cumulative impacts as a result of construction phasing will also be assessed.
- 13.5.8 Where measures to reduce construction impacts are considered standard practice, they will be included in an Outline CEMP which will be reported within the ES that will accompany the DCO application. For the purposes of the impact assessment it will be assumed that they will be implemented correctly. Measures beyond standard practice are typically considered to be mitigation and will be identified as such in the chapter.

### **Operational Impacts**

- 13.5.9 The assessment of the potential impacts during operation will cover five key aspects of the water environment:
- Routine runoff and surface water quality
  - Groundwater level and flow
  - Groundwater dependent terrestrial ecosystems (GWDTE)
  - Groundwater quality and routine runoff
  - Spillage and water quality
  - Hydromorphological assessment
  - Flood risk
  - Water Framework Directive (WFD) assessment

- 13.5.10 The proposed assessment approach for each aspect is detailed in the following sections. All assessments follow a source – pathway – receptor approach.

#### Route Runoff and Surface Water Quality

- 13.5.11 A simple assessment of the potential impacts of routine runoff on surface water quality will be undertaken using the Highways England Water Risk Assessment Tool (HEWRAT) to determine whether the risk is acceptable.
- 13.5.12 The assessment will be made using professional judgement and experience and is focussed on locations where the proposed route physically interacts with watercourses (for example proposed culverts or realignments) or where sediment loading from the proposed drainage system may occur.
- 13.5.13 The following modelling of the surface waters is proposed:
- microdrainage hydrological modelling - to provide a measure of pipe size<sup>273</sup> and attenuation;
  - TuFlow model will identify areas susceptible to surface water flow paths/flooding; and

<sup>272</sup> CIRIA, 2006. Murname, E., Heap, A. and Swain, A.. CIRIA Report C648, 'Control of Water Pollution from Linear Construction Sites (Technical Guidance)'

<sup>273</sup> All pipe sizes will adhere to the DMRB standard.

- modelling of the rainfall return period events with allowance for climate change.

13.5.14 These models will be used to manage surface waters and design suitable drainage system and mitigation measures including design of channel diversions.

#### Groundwater

13.5.15 The assessment of potential effects resulting from the proposed scheme operation considers the interaction of the baseline conditions presented in the hydrogeological conceptual model with the proposed scheme, particularly focusing on specific elements of the proposed scheme (detailed in chapter 2 The Project) as follows:

- Crickley Hill embankment and Norman's Brook diversion;
- Air Balloon cutting;
- Shab Hill junction; and
- Shallow cuttings and embankments between Shab Hill junction and Cowley junction.

13.5.16 Information from the water features survey has been incorporated into a conceptual model of the proposed scheme to identify key features that pose a risk to groundwater resources.

13.5.17 It has been acknowledged by the Environment Agency that a full numerical model is difficult given the complex hydrogeological regime in the study area. The groundwater assessment will instead focus on developing conceptual models at selected design elements of the proposed scheme to understand the hydrogeological regime.

#### *Groundwater Level and Flow*

13.5.18 A simple assessment shall be undertaken following the procedures set out in Appendix A Groundwater Levels and Flow of LA 113, which follows a stepped approach.

- Step 1 Establish regional groundwater body status.
- Step 2 Develop a conceptual model for the surrounding area.
- Step 3 Based on the conceptual model, identify all potential features which are susceptible to groundwater level and flow impacts

#### *Groundwater Dependent Terrestrial Ecosystems*

13.5.19 A simple assessment shall be undertaken following the procedures set out in Appendix B Groundwater Dependent Terrestrial Ecosystems (GWDTE) of LA 113, which follows a stepped, risk based approach which depends upon establishing linkages between potential impacts from the proposed scheme on the hydrological and hydrogeological regime and the GWDTE.

13.5.20 A site specific conceptual hydrogeological model will provide an overview of the interactions between groundwater, surface water and to identify potential linkages between potential impacts from the road (during construction or operation) and GWDTE. Groundwater flow paths, groundwater levels and the proximity of the GWDTE should be taken into account in the conceptual hydrogeological model.

### *Groundwater quality and routine runoff*

- 13.5.21 A simple assessment shall be undertaken using Appendix C Groundwater Quality and Run Off of LA 113, which provides a methodology to determine the risk of impact on groundwater quality from routine runoff. The method is based on the 'source-pathway-receptor' pollutant linkage principle.
- 13.5.22 For there to be a risk of impact to groundwater quality, a source, pathway and receptor all must be present to create a pollutant linkage or create a linkage based on natural processes. In the context of road drainage, the source is the road runoff with any pollutants it contains. The pathways are the processes which may modify the pollutants during transmission through the discharge system and unsaturated zone. The receptor is the groundwater.

### Spillage and water quality

- 13.5.23 A spillage assessment will be undertaken using Appendix D Spillage Assessment from LA 113. Using the spillage assessment method, for the risk of a serious pollution incident to be acceptable the calculated annual probability of such an incident shall not be greater than 1%. Using the spillage assessment method, for the risk of a serious pollution incident to be acceptable the calculated annual probability shall not be greater than 0.5% where spillage has the potential to affect a SSSI, SPZ, protected area, drinking water supply or commercial activity abstracting from the watercourse.
- 13.5.24 The risk is assessed initially without any mitigation measures. If mitigation measures are needed to reduce the probability, a reduction factor is applied, depending on the type of mitigation used.

### Hydromorphological assessment

- 13.5.25 A simple hydromorphological assessment shall be undertaken to determine whether the degree of hydromorphological change is acceptable.
- 13.5.26 The appropriate method of assessment to measure hydromorphological change shall be determined by a competent expert on a site specific basis. Guidance in Appendix E Hydromorphological Assessment of LA 113 shall be followed.

### Flood Risk

- 13.5.27 A standalone FRA for the proposed scheme will be carried out and included within the ES which will accompany the DCO application.
- 13.5.28 It will include details of the methodology used to assess the risk of flooding from pluvial, fluvial and groundwater sources as a result of the proposed scheme. The approach will be agreed with Highways England (as the Highway Authority), Gloucestershire County Council (GCC) (as the Lead Local Flood Authority) and the EA (as Lead Authority for main rivers).
- 13.5.29 The FRA shall use the latest published climate change allowances.

### Water Framework Directive (WFD) Assessment

- 13.5.30 A standalone WFD assessment for the proposed scheme will be included within the ES which will accompany the DCO application and the assessment methodology will be described there.

- 13.5.31 The WFD quality and quantity elements identified through scoping as being at potential risk of impact from the proposed scheme shall be assessed in a WFD assessment.
- 13.5.32 The WFD assessment shall identify how the proposed scheme has the potential to affect each of the water body's quality/quantity elements and whether it could lead to non-compliance with the WFD. The results of the other assessments in this chapter may be used to inform the WFD assessment.
- 13.5.33 For water bodies that have the potential to be impacted by the proposed scheme, the effect of the proposed scheme on any mitigation measures identified within the relevant River Basin Management Plan (RBMP) shall be assessed.

## 13.6 Baseline Conditions

### Baseline Methodology

- 13.6.1 The baseline describes the existing condition of surface waters, groundwater and flood risk within the study area. The value of each water feature identified has been determined based on the attributes and indicators of quality listed in LA 113, Table 3.69 Water features: attributes and indicators of quality.
- 13.6.2 The following data sources were used to compile the baseline conditions in the subsequent sections:
- A417 Missing Link EIA Scoping Report;
  - Observations from water features survey (March 2018 to April 2019);
  - Observations from a site walkover on 16th November 2017;
  - Environment Agency Catchment Data Explorer<sup>274</sup>;
  - Severn and Thames River Basin Management Plans (2015);
  - Existing highway drainage plans;
  - National River Flow Archive<sup>275</sup>;
  - Natural England, MAGIC<sup>276</sup>;
  - Ordnance Survey (OS) mapping (including topography);
  - British Geological Survey (BGS) mapping<sup>277</sup>;
  - Envirocheck report;
  - Information from historic and recent ground investigations;
  - EA flood risk mapping<sup>278</sup>;
  - EA Water Quality Archive<sup>279</sup>;
  - Water feature report;
  - Rainfall intensity data;
  - NVC woodland report;
  - Groundwater levels and sampling;
  - Level 1 Flood Risk Assessment Norman's Brook Area;

<sup>274</sup> The Environment Agency, "Catchment Data Explorer," 16 01 2019. [Online]. Available: <http://environment.data.gov.uk/catchment-planning/>. [Accessed 07/2019].

<sup>275</sup> Centre for Ecology and Hydrology, "National River Flow Archive," 10/2017. [Online]. Available:

<http://nrfa.ceh.ac.uk/data/station/meanflow/64001>. [Accessed 10 2017]. <http://nrfa.ceh.ac.uk/data/station/meanflow/64001>

<sup>276</sup> MAGIC, Interactive mapping at your fingertips, 07 2019. [Online]. Available: <http://www.magic.gov.uk/>. [Accessed 07/2019].

<sup>277</sup> British Geological Survey, "Geology of Britain viewer," 2019. [Online]. Available:

<http://mapapps.bgs.ac.uk/geologyofbritain/home.html> [Accessed 07/2019].

<sup>278</sup> gov.uk, "Flood map for planning," 2017. [Online]. Available: <https://flood-map-for-planning.service.gov.uk/>. [Accessed 10/2017].

<sup>279</sup> EA, 2019. Water Quality Archive. [Online]. Available at: <https://environment.data.gov.uk/water-quality/view/sampling-point/TH-PUTE0282> (Accessed: 19/07/19)



- Preliminary Groundwater Report 2019<sup>280</sup>;
- Maurice L., Barron A. J. M., Lewis M. A. & Robins N. S., 2008. Maurice L., Barron A. J. M., Lewis M. A. & Robins N. S. (2008). The geology and hydrogeology of the Jurassic limestones in the Stroud-Cirencester area with particular reference to the position of the groundwater divide<sup>281</sup>; and
- Neumann, I, Brown, S., Smedley, P. & Besien, T, 2003. Baseline Report Series: 7. The Great and Inferior Oolite of the Cotswolds District<sup>282</sup>.

13.6.3 Relevant information, from the sources listed in Section 13.6.2, will also be incorporated into a hydrogeological baseline conceptual model of the proposed scheme, in addition to the following information:

- Published geological and hydrogeological information, including British Geological Survey Reports; and
- Site specific intrusive ground investigations, where available, including exploratory holes, groundwater monitoring surveys and permeability testing;

13.6.4 This information will be supplemented by a comprehensive programme of surface water and groundwater monitoring, outlined in section 13.11.

13.6.5 The conceptual model will help to identify key features that pose a risk to groundwater resources or groundwater dependent features and allow better understanding of hydraulic links with surface and groundwater features, especially on the escarpment.

### **Water Feature Survey**

13.6.6 A water features survey was completed between April 2018 and March 2019, which included five rounds of surveys<sup>283</sup>. The surveys were conducted within the study area and at some locations beyond the study area as it was developed prior to option 30 becoming the preferred alignment. It is anticipated that locations outside the study area were identified due to their potential hydraulic connectivity to features within the study area that may be impacted. The water features survey does not clarify why these locations were selected.

13.6.7 310 surface water and groundwater features were surveyed, including, but not limited to, watercourses, groundwater springs, wet flushes (boggy ground), seepages, road drainage pipes, ponds and groundwater abstractions. Most locations were only visited once during the survey period. 45 sites were selected for flow gauge monitoring of watercourses and some groundwater springs, with the majority of these features being gauged twice<sup>284</sup>.

13.6.8 The water features within the study area demonstrate that a number of surface water features which rely on groundwater sources from the Great and Inferior Oolite aquifers, superficial and perched aquifers and their separation with less permeable Lias Group mudstones and the Fullers Earth Formation mudstone.

<sup>280</sup> Mott MacDonald Sweco Joint Venture, 2019, Preliminary Groundwater Report, Doc No. HE551505-MMSJV-HGT-000-RP-CE-00004

<sup>281</sup> Maurice L., Barron A. J. M., Lewis M. A. & Robins N. S. (2008). The geology and hydrogeology of the Jurassic limestones in the Stroud-Cirencester area with particular reference to the position of the groundwater divide, British Geological Survey Commissioned Report, CR/08/146.

<sup>282</sup> Neumann, I, Brown, S., Smedley, P. & Besien, T, 2003. Baseline Report Series: 7. The Great and Inferior Oolite of the Cotswolds District, British Geological Survey Commissioned Report No. CR/03/202c

<sup>283</sup> Mott Macdonald Sweco JV, 2019, Water features survey, Report reference not available

<sup>284</sup> Mott Macdonald Sweco JV, 2019, A417 "Missing Link" Road Scheme, A417 Stream Flow Gauging Report, Document Reference HE551505-MMSJV-EWE-000-SU-LV-00007

13.6.9 Spring discharges, wet flushes (boggy ground) and seepages, are mainly found on the escarpment but also within the Upper Cotswold Plateau valleys where some valleys are seasonally dry and others have spring perennial and ephemeral spring flows which can also support wetland environments, including Bushley Muzzard SSSI. This SSSI is an area of marshland that has the potential to be impacted by changes in groundwater levels / quality and drainage related to the proposed scheme.

### Site Investigations

13.6.10 Several site investigations have been completed for the proposed scheme including survey of water features, geotechnical ground investigation and a surface water tracer test.

13.6.11 Details regarding historic site investigations are included in chapter 9 Geology and Soils.

### Ground Investigations

13.6.12 The Phase 1 ground investigation was completed by Geotechnical Engineering Ltd between January and February 2019<sup>285</sup>. The scope of works included eight boreholes with standpipe installations in each. The boreholes were positioned in four locations, where two boreholes were drilled approximately 10m apart in each location, monitoring different aquifers. Groundwater monitoring is currently on-going at these installations. A summary of the Phase 1 ground investigation is presented in Table 13-3.

**Table 13-3 Summary of Phase 1 Ground Investigation Monitoring Installations**

Location	Borehole	Response zone	Response zone lithology
National Star College	DS/RC408	20.0 – 24.0mbgl 212.5 – 208.5mAOD	Lias Group (Bridport Sand)
	OH407	6.0 – 15.5mbgl 225.75 – 216.25mAOD	Inferior Oolite Group
Air Balloon Public House	DS/RC406	20.5 – 35.0mbgl 218.15 – 203.65mAOD	Inferior Oolite Group (Birdlip Limestone)
	OH405	11.0 – 18.0mbgl 228.5 – 221.5mAOD	Inferior Oolite Group
Barrow Wake	DS/RC419	36.0 – 42.0mbgl 232.9 – 226.9mAOD	Lias Group (Bridport Sand)
	DS/RC404	23.0 – 34.0mbgl 246.0 – 235.0mAOD	Inferior Oolite (Birdlip Limestone)
Roman Road	DS/RC415	25.5 – 50.0mbgl 261.7 – 237.2mAOD	Inferior Oolite (Salperton, Aston and Birdlip Limestone formations)
	OH416	3.0 – 5.0mbgl 283.85 – 281.85mAOD	Weathered Fuller's Earth

13.6.13 The Phase 2 ground investigation is currently underway and is being delivered in two stages, Phase 2A and Phase 2B. The scope of the Phase 2A ground investigation is planned to be completed before the end of October 2019. The Phase 2B scope is currently under development and yet to be submitted to HE for approval.

<sup>285</sup> Geotechnical Engineering Ltd, 2019. HE551505 A417 Missing Link Ground Investigation, Factual Report on Ground Investigation, Report Reference 34888

- 13.6.14 Phase 2A includes the installation of 52 groundwater monitoring boreholes, that will be included in the Environmental Statement groundwater conceptual model. The proposed in-situ testing and monitoring of these boreholes includes:
- 14 diver data loggers for continuous groundwater level monitoring;
  - 8 packer tests; and
  - 7 permeability tests.
- 13.6.15 Groundwater monitoring of the 8 Phase 1 boreholes commenced in February 2019, where continuous monitoring results are available on a monthly basis. Monitoring of the Phase 2A boreholes constructed early in the ground investigation programme commenced at the end of May 2019. As the ground investigation progresses, new monitoring boreholes are becoming available to incorporate into the conceptual groundwater model of the site.
- 13.6.16 The Phase 1 boreholes were constructed when option 12 was still under consideration and are spatially distributed to incorporate option 12 and option 30 (the proposed scheme). The Phase 2A monitoring boreholes completed to date are located in the vicinity of the Norman's Brook tributary and the Fly Up bike park, where land access has been granted. The ground investigation programme is restricted by land access agreements with private land owners and the availability of borehole installations may not linearly progress along the alignment.
- 13.6.17 By December 2019, 10 months of groundwater monitoring data will be available from the Phase 1 boreholes and up to 6 months of data from the Phase 2A boreholes. Due to the challenges faced by the current Phase 2A ground investigation programme and parallel development of the ES, discussions with the EA have highlighted the need for flexibility regarding the monitoring data available at the time of ES submission in March 2020. This flexibility encompasses the spatial distribution and temporal duration of monitoring data and the relative risk of design elements to the water environment given the preliminary monitoring results.
- 13.6.18 At the commencement of the examination period in 2020, more than one year of monitoring data is expected to be available across the proposed scheme. As more monitoring data becomes available, on-going management during the planning and construction phases will allow for revisions to be made to the outline CEMP and Requirements in the DCO. These revisions will allow for flexibility to update potential impacts and risks to the water environment.

### **Surface Water**

- 13.6.19 The Cotswold escarpment forms a surface water divide between the River Severn catchment and the River Thames catchment (to the east and south-east of the divide). To the west of the divide, the land within the proposed scheme drains to the River Severn and its tributaries, including Norman's Brook, Horsbere Brook and the River Frome. To the east and south-east, the land within the proposed scheme drains to the River Churn, a tributary of the Thames.
- 13.6.20 Horsbere Brook, Norman's Brook, the River Frome and the River Churn are classed by the EA as ordinary watercourses within the study area.

- 13.6.21 The proposed scheme is located within one kilometre of Flood Zones 2 and 3 for the River Frome and Horsbere Brook at the eastern and western extents of the proposed scheme respectively<sup>286</sup>.
- 13.6.22 At the Birdlip junction, the proposed scheme crosses an area of 'High' surface water flood risk<sup>287</sup> that appears to coincide with the head of a dry valley and may be associated with an ephemeral watercourse or springs within the dry valley. An area of 'Low' surface water flood risk is recorded to the north-east of the proposed scheme at the A436 and Ullenwood Manor Road crossroads and is associated with a tributary of the River Churn. An area of 'Low' to 'Medium' surface water flood risk is identified to the north of the proposed scheme area near Crickley Hill Country Park access road. Areas of 'Low' to high surface water flood risk coincide with Norman's brook tributary flowing down Crickley Hill, to the south of the existing road. The level of surface water flood risk increases to 'High' risk towards Crickley Hill Farm.

### Tracer Test

- 13.6.23 A tracer test was conducted to the watercourse located along the southern toe of Crickley Hill, below the existing road, using tracer dye on the 6th March 2019<sup>288</sup>. The test was completed to ascertain where the watercourse flowed to. The tracer confirmed that the tributary is hydraulically connected to Norman's Brook rather than Horsbere Brook, as indicated in WFD water body delineation, via a culvert network.

### **WFD Status**

- 13.6.24 The WFD surface water bodies in the Severn Vale Management Catchment include Norman's Brook - source to confluence Hatherley Brook (No. GB109054032780)<sup>289</sup> within the Cheltenham Hatherley and Norman's Brook Operational Catchment, Horsbere Brook - source to confluence River Severn (No. GB109054032760)<sup>290</sup> within the Gloucester Tributary Operational Catchment and Frome - source to Ebley Mill (No. GB109054032470)<sup>91</sup> within the Frome and Cam Operational Catchment.
- 13.6.25 The WFD surface water body in the Cotswolds Management Catchment is the Churn (source to Perrots Brook) (No. GB106039029810), located within the Thames Upper Operational Catchment.
- 13.6.26 The Cycle 2 (2016) status for these surface water bodies are as follows:
- Norman's Brook – source to confluence Hatherley Brook: Ecological status of 'Poor', chemical status of 'Good', and overall status of 'Poor';
  - Horsbere Brook – source to confluence River Severn: Ecological status of 'Moderate', chemical status of 'Good', and overall status of 'Moderate';
  - Frome – source to Ebley Mill: Ecological status of 'Good', chemical status of 'Good', and overall status of 'Good'; and

<sup>286</sup> Environment Agency (2019) Flood Map for Planning [online] available at: <https://flood-map-forplanning.service.gov.uk/> (last accessed January 2019).

<sup>287</sup> Environment Agency (2019) Long Term Flood Risk [online] available at: <https://flood-warninginformation.service.gov.uk/long-term-flood-risk/map> (last accessed January 2019)

<sup>288</sup> MMSJV (2019) A417 "Missing Link" Road Scheme, A417 Tracer Test, HE551505-MMSJV-EWE-000-RP-LX-00003

<sup>289</sup> Environment Agency (2019) Environment Agency Catchment Data Explorer [online] available at <https://environment.data.gov.uk/catchment-planning/> (last accessed January 2019)

<sup>290</sup> Environment Agency (2019) Environment Agency Catchment Data Explorer [online] available at <https://environment.data.gov.uk/catchment-planning/> (last accessed January 2019)

- Churn – source to Perrots Brook: Ecological status of ‘Moderate’, chemical status of ‘Good’, and overall status of ‘Moderate’.

- 13.6.27 HADDMS<sup>291</sup> identifies five priority outfalls within the study area. Three of these were classed as moderate priority (category C status), one as low priority (category D status) and one as risk addressed. HADDMS notes that the medium priority outfall south of the Air Balloon roundabout and the low priority outfall may be soakaways.
- 13.6.28 Bushley Muzzard SSSI is species-rich wet grassland supplied by localised springs and seepages. It is located downgradient of the southern end of the proposed scheme.
- 13.6.29 Cotswold Commons and Beechwoods SSSI and Cotswold Beechwoods SAC includes areas of vegetation dependent high groundwater levels on springs and seepage that are associated with some nationally rare invertebrate species. These protected areas extend from the south-east of Birdlip to High Brotheridge, and includes springs supplying Horsbere Brook.
- 13.6.30 Witcombe Reservoirs, at the foot of the escarpment, is primarily supplied by spring-fed watercourses. It discharges to Horsbere Brook. There are a number of small ponds in the area that may be partially groundwater dependent or fed by springs.
- 13.6.31 There are ten relevant EA Water Quality sampling points as shown on the EA’s online Water Quality Archive<sup>292</sup>, which are presented in Table 13-4.

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<sup>291</sup> Highways England (2017) Highways England's Drainage Data Management System [online] available at <http://haddms.com/> (last accessed January 2019)

<sup>292</sup> Environment Agency, Water Quality Archive, available at <https://environment.data.gov.uk/water-quality/view/explore>, last accessed July 2019

**Table 13-4 Summary of Environment Agency Monitoring Locations**

Number	Location	Sample point name	Type	Sample Point Id	Samples Taken
1	Easting northing: 390540 215620 lat lon: 51.839097, -2.138701	Pasaderas Stp Fe	Sewage Discharges – Final/Treated Effluent – Not Water Company	MD-04122510	One sample taken in 2006
2	Easting northing: 390690 217030 lat lon: 51.851777, -2.136562	Brookwell Stp Fe		MD-04197490	13 samples taken between 20 and 2012
3	Easting northing: 391780 217402 lat lon: 51.855139, -2.120746	Wayside Stp Fe		MD-04280340	2 samples taken between 2006 a 2012
4	Easting northing: 389960 215300 lat lon: 51.83621, - 2.14711	The Orchard Stp, Droys Court, Fe		MD-04113470	3 samples taken between 2003 and 2.
5	Easting northing: 391070 214660 lat lon: 51.830475, -2.130983	Church Hill Cottage Wukcombe stp Fe		MD-04065830	2 samples taken between 2002 and 2003
6	Easting northing: 393330 216030 lat lon: 51.842825, -2.098215	Air Balloon Public House Stp	Sewage & Trade Combined – Unspecified	MD-04198900	15 samples taken between 2001 and 2006
7	Easting northing: 393094 213805 lat lon: 51.822817, -2.101595	Birdlip Waste Water Treatment Plant	Sewage Discharges – Final/Treated Effluent – Not Water Company	MD-01355950	74 samples taken between 2013 and 2019 Determinants: OD, Ammoniacal Nitrogen and Solids.
8	Easting northing: 394200 216640 lat lon: 51.848319, -2.085597	National Start Centre Stw: Coberley		TH-PUTE0282	19 samples taken between 2000 and 2018
9	Easting northing: 394605 216630 lat lon: 51.848233, -2.079717	Cotswold Hill Golf Club M1, Ullenwood		TH-PUTE0362	One sample taken in 2019
10	Easting northing: 394622 216587 lat lon: 51.847847, -2.07947	Cotswold Hill Golf Club M2, Ullenwood		TH-PUTE0363	One sample taken in 2019

### Flood Risk

13.6.32 The proposed scheme alignment is located entirely in the Flood Zone 1<sup>12</sup>, which is defined as having a risk of flooding from fluvial and tidal sources of less than 1 in 1000 (0.1%) in any year, and as a result is defined as being of 'Low' risk.

13.6.33 Sections of the proposed scheme alignment are indicated on the EA mapping to be at risk of flooding from surface water sources<sup>12</sup>. This mapping does not distinguish between areas at risk of flooding purely from surface water runoff (specifically during heavy rainfall events) and areas at risk from small watercourses that are too small to be included on fluvial flood risk mapping.

## **Groundwater**

### Aquifers

13.6.34 Full details on geological conditions are presented in chapter 9 Geology and Soils. A summary of the geology is provided below, with a focus on the hydrogeological interaction.

13.6.35 Within the study area the landscape can be broken down into three main geological components: superficial deposits, Middle Jurassic strata of the Cotswolds escarpment and Lower Jurassic strata of the Severn Valley. The interaction between these geological components, groundwater, surface water and recharge elements create the unique hydrogeological environment within the study area. A summary of the aquifers in the study area are presented in Table 13-5.

**Table 13-5 Summary of Aquifers in the Study Area**

Age	Group	Formation	Designation	Description	Thickness <sup>293</sup>	Hydrogeological properties
Quaternary	-	Superficial deposits including alluvium and colluvium	Alluvium – Secondary A aquifer Colluvium – no aquifer designation	Largely cohesive material with non-cohesive lenses	0m to >20m	Variable hydraulic conductivity
Middle Jurassic	Great Oolite (168-165Ma)	White Limestone	Principal aquifer	Limestone aquifer with clay beds	15m to 39m	Highly fissured with cambering, gull and enhanced dissolution features, particularly closer to escarpment/valleys and the ground surface. Degree of fracturing decrease with depth
		Hampen		Sandy and ooidal limestone aquifer with clay and marl beds	4m to 11m	
		Fuller's Earth	Unproductive aquifer	Mudstone aquitard with limestone beds	0m to 41m	
	Inferior Oolite (175-168Ma)	Salperton Limestone	Principal aquifer	Shelly, ooidal limestone aquifer	7m to 21m	Fissured with cambering, gull and enhanced dissolution features, particularly closer to escarpment/valleys and the ground surface. Degree of fracturing decrease with depth
		Aston Limestone		Shelly, sandy limestone aquifer	0m to 21m	
		Birdlip Limestone		Ooidal, sometimes sandy limestone aquifer with sandy clay layers	0m to 90m	
Lower Jurassic	Lias Group (200-175Ma)	Bridport Sand	Secondary (Undifferentiated) aquifer	Sandy mudstone and fine grained sandstone – minor aquifer	0m to 10m	Discontinuous presence within the study area. In hydraulic connection with base of Inferior Oolite, where present.
		Whitby Mudstone		Mudstone aquitard with limestone beds at base	12m to 98m	Relatively impermeable

<sup>293</sup> Sumbler, M.G., Barron, A.J.M. & Morigi, A.N. 2000. Geology of the Cirencester district. Memoir for 1:50,000 Geological Sheet 235 (England and Wales). British Geological Survey, London.



- 13.6.36 The extent of mapped superficial deposits is limited within the study area, as shown on figure 9.2 of chapter 9 Geology and Soils. Cheltenham Sand and Gravel superficial deposits are present at the western end of the proposed scheme, while alluvium, comprising clay, silt sand and gravel, is mapped on the northern side of the Bushley Muzzard SSSI. Both superficial deposits are designated by the EA as Secondary A aquifers indicating they are '*permeable layers capable of supporting water supplies at a local rather than a strategic scale, and in some cases forming an important source of base flow to rivers*'<sup>294</sup>.
- 13.6.37 Mass movement deposits, also known as colluvium, are mapped across the Cotswold escarpment, the Churn Valley (near Shab Hill Farm) and the Frome Valley (near Stockwell-Nettleton). These deposits typically comprise a random assortment of the underlying parent geology within a matrix of largely cohesive material, but the nature of these deposits can vary. The colluvium is not a designated aquifer, however many of the springs in the study area coincide with the colluvial areas that overlie limestone bedrock aquifers. It is understood that the variability of the colluvium has allowed springs to develop along preferential flow paths within the deposit.
- 13.6.38 Jurassic aged bedrock formations comprising Great Oolite Group, the Inferior Oolite Group and the Lias Group underlie the study area. These groups comprise limestone, mudstone, sandstone and undifferentiated argillaceous rocks. The western part of the study area is underlain by the Lias Group, but the bedrock is largely buried under a cover of colluvium. The Inferior Oolite Group overlies the Lias Group in the Crickley Hill area and forms the crest of the escarpment. The Great Oolite Group, which in turn overlies the Inferior Oolite Group, outcrops near Shab Hill Farm. Figure 13.5 shows the location and extent of the abovementioned formations in relation to the proposed scheme.
- 13.6.39 Structurally these bedrock units generally dip between 2° and 5° towards the east and south-east and are intersected by inferred faults in the region. Two north-west to south-east trending normal faults have been inferred in the vicinity, namely the Shab Hill Barn and Shab Hill faults, with throws between 10m and 24m. However, there is some debate over the exact location of the Shab Hill Barn fault and it may be closer to the Shab Hill fault. It is considered that faulting throughout the region is providing some conduit to flow, particularly between the Great and Inferior Oolite. Cambering and gulls are prevalent within the limestones of the Great Oolite Group and Inferior Oolite Group that are underlain by mudstones of the Fuller's Earth Formation and Lias Group respectively. The location of the faults is shown on figure 13.5.
- 13.6.40 The Great Oolite Group includes White Limestone Formation, the Hampen Formation and Fuller's Earth Formation. The Fuller's Earth formation is a grey mudstone with limestone beds which acts as an aquitard at the base of the Great Oolite Group over the Inferior Oolite Group. It is anticipated that there is leakage through the fractures and faults within the Fuller's Earth Formation that provides some connection between the Great Oolite Group to the Inferior Oolite Group. Borehole drilling within the Great Oolite Group encountered open and stained orange fractures, indicative of groundwater flow through the rock mass where no faults are present<sup>295</sup>.

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<sup>294</sup> Environment Agency, "Aquifers," 2017. [Online]. Available: <http://apps.environment-agency.gov.uk/wiyby/117020.aspx> [Accessed 2019]

<sup>295</sup> Mott MacDonald Sweco Joint Venture, 2019, Preliminary Groundwater Report, Doc No. HE551505-MMSJV-HGT-000-RP-CE-00004

- 13.6.41 The Inferior Oolite Group includes the Salperton Limestone Formation, the Aston Limestone Formation and the Birdlip Limestone Formation, which is underlain by the Lias Group mudstones. Assessment of the fractures encountered during borehole drilling show orange-brown staining indicative of weathering and groundwater flow within the Salperton Limestone Formation and the Aston Limestone Formation<sup>296</sup>. The degree of staining decreased with depth in the Aston Limestone Formation, suggesting more limited groundwater movement through the rock mass<sup>297</sup>.
- 13.6.42 The Great Oolite (excluding the Fuller's Earth Formation) and Inferior Oolite are classified as a Principal Aquifers, described as "*permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers*"<sup>298</sup>. Refer to figure 13.6.
- 13.6.43 The Fuller's Earth Formation is classified by the EA as an Unproductive aquifer associated with "*low permeability [and] negligible significance for water supply or river base flow*"<sup>299</sup>. Refer to figure 13.6.
- 13.6.44 The Lias Group in the Cotswold area comprises the Worcester Basin formations. The Worcester Basin includes the Bridport Sand Formation, the Whitby Mudstone Formation, the Marlstone Rock Formation, the Dyrham Formation and the Charmouth Mudstone Formation. It is considered that the Bridport Sand Formation at the top of the Lias Group is in hydraulically connected to the base of the Inferior Oolite Group, however is not laterally persistent within the study area.
- 13.6.45 The Lias Group is classified by the EA as a Secondary (undifferentiated) aquifer, described as "*both minor and non-aquifer in different locations due to the variable characteristics of the rock types*"<sup>300</sup>. Refer to figure 13.6.
- 13.6.46 A conceptual model of the hydrogeological interaction between the bedrock aquifers in the Cotswolds area is presented in Plate 13-1. It should be noted that the Lias Group and some zones of the Great Oolite Group and Inferior Oolite Group in the study area are covered by colluvial deposits.

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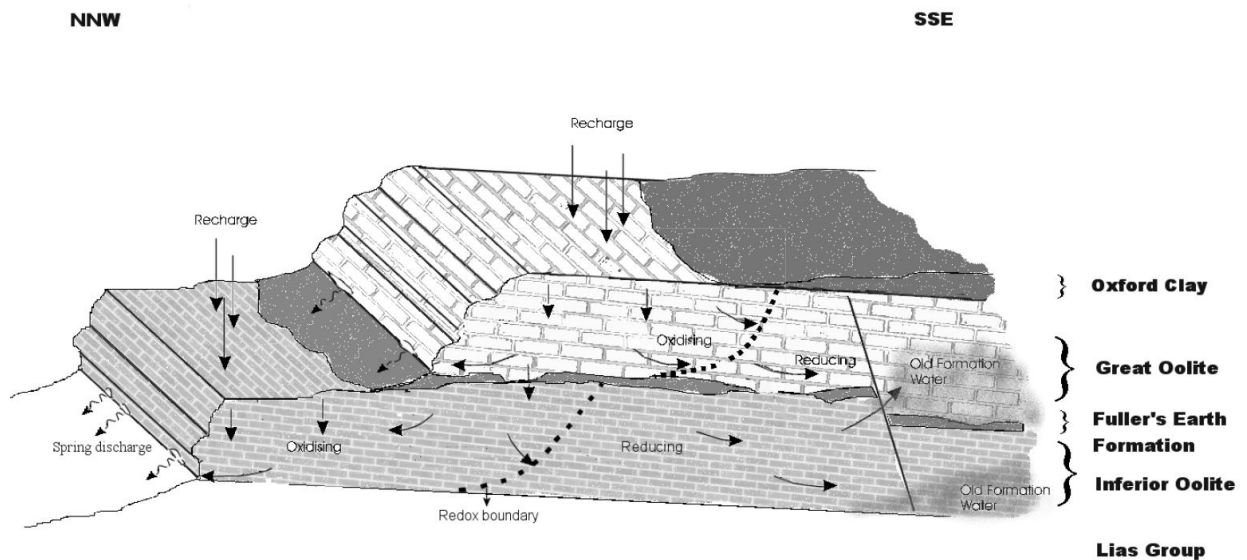
<sup>296</sup> Mott MacDonald Sweco Joint Venture, 2019, Preliminary Groundwater Report, Doc No. HE551505-MMSJV-HGT-000-RP-CE-00004

<sup>297</sup> Mott MacDonald Sweco Joint Venture, 2019, Preliminary Groundwater Report, Doc No. HE551505-MMSJV-HGT-000-RP-CE-00004

<sup>298</sup> Environment Agency, 2019, "Aquifer Designation Map (Bedrock Geology)". [Online] Available <https://magic.defra.gov.uk/magicmap.aspx> [Accessed 2019]

<sup>299</sup> Environment Agency, 2019, "Aquifer Designation Map (Bedrock Geology)". [Online] Available <https://magic.defra.gov.uk/magicmap.aspx> [Accessed 2019]

<sup>300</sup> Environment Agency, 2019, "Aquifer Designation Map (Bedrock Geology)". [Online] Available <https://magic.defra.gov.uk/magicmap.aspx> [Accessed 2019]



**Plate 13-1 Conceptual Model of the Groundwater Regime in the Cotswolds<sup>301</sup>**

### Groundwater WFD catchments

- 13.6.47 The study area is located over two groundwater catchments: the Severn to the west and the Thames to the east. The topographical catchment boundary generally correlates to the groundwater divide between these catchments<sup>302</sup>. In conjunction with the effects of cambers dipping towards the escarpment and anticipated increase in fracturing along the escarpment due to stress relief within the rock mass, the divide location is set back from the escarpment crest as illustrated in Plate 13-1. Consequently, it is expected that some recharged waters will drain towards the escarpment, following the dip of cambers and stress relief fracture, while some recharge waters will flow to the south-east, following the formation dip.
- 13.6.48 Within the Severn Vale catchment the Great Oolite Group, Inferior Oolite Group and the Lias Group drain towards the River Frome and its tributaries. The Severn Vale catchment is divided into the Severn Vale - Jurassic Limestone Cotswold Edge South (ID GB40901G305700) and the Severn Vale - Secondary Combined (ID GB40902G204900) groundwater bodies and operational catchments of the same name. The groundwater WFD catchment areas are shown in figure 13.4.
- 13.6.49 The Severn Vale - Jurassic Limestone Cotswold Edge South groundwater body generally correlates to areas of the Great Oolite Group, Inferior Oolite Group and Upper Lias Group, west of the groundwater divide in the study area.
- 13.6.50 The Severn Vale - Secondary Combined groundwater body includes areas underlain by the Charmouth Mudstone Formation at the base of the Lias Group at the western end of the proposed scheme.
- 13.6.51 Within the Thames catchment, the Great Oolite Group and the Inferior Oolite Group drain towards the south-east where the Inferior Oolite is confined by the Fuller's Earth Formation. Further down dip the Great Oolite Group becomes confined by the Oxford Clay Formation. The aquifers feed into the River Churn

<sup>301</sup> Neumann, I, Brown, S., Smedley, P. & Besien, T, 2003. Baseline Report Series: 7. The Great and Inferior Oolite of the Cotswolds District, British Geological Survey Commissioned Report No. CR/03/202c

<sup>302</sup> Maurice L., Barron A. J. M., Lewis M. A. & Robins N. S. (2008). The geology and hydrogeology of the Jurassic limestones in the Stroud-Cirencester area with particular reference to the position of the groundwater divide, British Geological Survey Commissioned Report, CR/08/146.

and its tributaries in the south-east. This is included within the Burford Jurassic WFD groundwater body (ID GB40601G600400) of the Burford Jurassic Operational Catchment of the Thames River Basin.

**Table 13-6 Summary of WFD Groundwater Bodies**

Groundwater body name	Burford Jurassic	Severn Vale – Jurassic Limestone Cotswolds Edge South	Severn Vale – Secondary Combined
Groundwater body ID	GB40601G600400	GB40901G305700	GB40902G204900
Operational catchment	Burford Jurassic	Severn Vale – Jurassic Limestone Cotswolds Edge South	Severn Vale – Secondary Combined
Management catchment	Thames GW	Severn England GW	Severn England GW
River basin district	Thames	Severn	Severn
Current overall status	Poor (2016)	Good (2016)	Good (2016)
Current quantitative status	Good (2016)	Good (2016)	Good (2016)
Current chemical status	Poor (2016) – poor nutrient management (diffuse sources) and private sewage treatments (point sources)	Good (2016)	Good (2016)
Quantitative objective	Good by 2015	Good by 2015	Good by 2015
Chemical objective	Good by 2027	Good by 2015	Good by 2015
Protected area	Drinking water protected area and nitrates directive.	Drinking water protected area and nitrates directive.	Drinking water protected area and nitrates directive.

13.6.52 The proposed scheme alignment is underlain by Principal aquifers with a current WFD status of ‘Good’ and ‘Poor’ and a Secondary (undifferentiated) aquifer with a status of ‘Good’, shown in Table 13-6. The majority of the extent of the proposed scheme alignment is not located within a SPZ, however east of Stockwell the proposed scheme runs adjacent to an SPZ3 for the Baunton abstraction. A summary of the geological aquifers and how they align with the WFD groundwater bodies is presented in Table 13-9.

**Table 13-7 Underlying Aquifer Characteristics**

Name	WFD groundwater body	Key characteristics
Superficial deposits - Secondary A aquifer	Not assessed as a WFD groundwater body by the EA	Aquifer may be a source of baseflow to tributaries feeding into tributaries of the River Frome or the Bushley Muzzard SSSI.
Lias Group - Secondary (undifferentiated) aquifer	Severn Vale – Secondary Combined	Springs issuing from the contact of the Lias Group and Inferior Oolite supply the River Frome.

Name	WFD groundwater body	Key characteristics
Inferior Oolite - Principal aquifer	Severn Vale – Jurassic Limestone Cotswolds Edge South	Aquifer supports the Crickley Hill and Barrow Wake SSSI, springs, river headwaters including Norman’s Brook and private water abstractions.
Great Oolite - Principal aquifer	Burford Jurassic	Aquifer providing private water supply and local public water supply where the study area is within the SPZ3. Supports Bushley Muzzard SSSI, springs and headwaters of rivers, including the River Churn, within the catchment.

### Hydraulic Conductivity

- 13.6.53 The intergranular hydraulic conductivity of the Great Oolite Group and the Inferior Oolite Group is low, so groundwater flow through the formation is predominantly through secondary porosity features like fissures, faults and fractured zones. As a result, the Great Oolite Group and Inferior Oolite Groups have a high transmissivity but low storage capacity. Interpretation of borehole data obtained from the limited Phase 1 ground investigation scope suggests sub-vertical fracturing in the Great Oolite Group is restricted to thin limestone beds<sup>303</sup>. Interpretation of fractures within the Inferior Oolite are typically sub-horizontal with some open, sub-vertical fractures and a decrease of likely groundwater stained fractures with depth in the Aston Limestone Formation<sup>304</sup>.
- 13.6.54 Fissures within limestones present in the region are likely to have developed due to destressing of the rock mass in conjunction with movement within the underlying mudstones that facilitated the formation of camber and gull features. The fracture frequency is expected to be higher in rock mass closer to the ground surface and the escarpment. Fissures may be enhanced by dissolution, particularly close to the ground surface, where rainfall recharge percolates into the aquifer and the aquifer is exposed to repeated wetting and drying cycles.
- 13.6.55 During the construction of the Birdlip Bypass a number of larger fissures (0.3m wide and up to 17m depth) within the Inferior Oolite limestones were treated with lean mix concrete or a mixture of rock fill and concrete, in the case of smaller fissures at the formation level of the Barrow Wake Cutting<sup>305</sup>. Locally the hydraulic conductivity of the Inferior Oolite around the Birdlip Bypass is expected to be lower where these fissures have been treated.
- 13.6.56 The Fuller’s Earth Formation and Lias Group mudstones are low permeability formations where leakage through the formation is via faulting within the region. Generally, they are considered to have a very low rate of hydraulic conductivity.

### Groundwater Levels

- 13.6.57 The groundwater piezometric surface generally dips towards the south-east, following the dip of the main geological formations<sup>306</sup>. Locally the piezometric

<sup>303</sup> Mott MacDonald Sweco Joint Venture, 2019, Preliminary Groundwater Report, Doc No. HE551505-MMSJV-HGT-000-RP-CE-00004

<sup>304</sup> Mott MacDonald Sweco Joint Venture, 2019, Preliminary Groundwater Report, Doc No. HE551505-MMSJV-HGT-000-RP-CE-00004

<sup>305</sup> Hutchinson, J.N. (1991). A417 Crickley Hill Improvement Geotechnical Investigations and Schemes for Road Widening on the Northern Valley Side, Department of Civil Engineering, Imperial College.

<sup>306</sup> Neumann, I, Brown, S., Smedley, P. & Besien, T, 2003. Baseline Report Series: 7. The Great and Inferior Oolite of the Cotswolds District, British Geological Survey Commissioned Report No. CR/03/202c

surfaces can vary with the topographical features including valleys, outcrops and surface water features.

- 13.6.58 The groundwater level within the Great Oolite aquifer and the Inferior Oolite aquifer is expected to be very responsive to rainfall recharge making the aquifer quite 'flashy'. Consequently, the groundwater levels are expected to vary by several of metres due to these recharge events. In dry periods, it is expected that groundwater levels could decline rapidly so the aquifer is largely unsaturated. Great Oolite monitoring boreholes in the region display flat-bottom hydrographs due to maximum groundwater levels being controlled by spring elevations<sup>307</sup>.
- 13.6.59 During the limited Phase 1 groundwater monitoring completed to date, the saturated thickness of the Inferior Oolite Group around the Air Balloon area varied between 3.0m and 3.5m<sup>308</sup>. This corresponds to a groundwater depth of 31.5mbgl to 32.0mbgl. The Inferior Oolite Group features deeply incised valleys which have a strong effect on the piezometric surface within the group<sup>309</sup>.
- 13.6.60 The saturated aquifer thickness of the Bridport Sand Formation during the monitoring period was between 2.8m and 5.2m in the vicinity of Barrow Wake and up to 1.9m at Star College<sup>310</sup>. Groundwater levels at Barrow Wake were recorded at 39.3mbgl and 36.8mbgl, while levels at Star College were up to 22.1mbgl. The Bridport formation was not present in the monitoring boreholes drilled at Air Balloon.
- 13.6.61 Great Oolite limestones were not encountered the Phase 1 ground investigations therefore no site-specific groundwater monitoring data is available. It is anticipated that groundwater levels within the Great Oolite limestones behave similarly to the Inferior Oolite, where there is a relatively deep unsaturated zone over a thin saturated zone.
- 13.6.62 Larger seasonal variations are typically observed in the Great Oolite aquifer relative to the Inferior Oolite aquifer<sup>311</sup>. However, the piezometric surface of the Great Oolite aquifer is tens of meters higher and more uniform over the region, as it is less dissected by valley features compared to the Inferior Oolite aquifer<sup>312,313</sup>. Some Great Oolite aquifer monitoring boreholes in the region display flat-bottom hydrographs due to maximum groundwater levels being controlled by spring elevations<sup>314</sup>.
- 13.6.63 Perched groundwater is expected within the superficial deposits that will infiltrate to the bedrock aquifers and/or drain towards local surface water features. Areas of artesian and sub-artesian groundwater have been mapped along the southern side of Crickley Hill<sup>315</sup>.

<sup>307</sup> Sumbler, M.G., Barron, A.J.M. & Morigi, A.N. 2000. Geology of the Cirencester district. Memoir for 1:50,000 Geological Sheet 235 (England and Wales). British Geological Survey, London.

<sup>308</sup> Mott MacDonald Sweco Joint Venture, 2019, Preliminary Groundwater Report, Doc No. HE551505-MMSJV-HGT-000-RP-CE-00004

<sup>309</sup> Neumann, I, Brown, S., Smedley, P. & Besien, T, 2003. Baseline Report Series: 7. The Great and Inferior Oolite of the Cotswolds District, British Geological Survey Commissioned Report No. CR/03/202c

<sup>310</sup> Mott MacDonald Sweco Joint Venture, 2019, Preliminary Groundwater Report, Doc No. HE551505-MMSJV-HGT-000-RP-CE-00004

<sup>311</sup> Neumann, I, Brown, S., Smedley, P. & Besien, T, 2003. Baseline Report Series: 7. The Great and Inferior Oolite of the Cotswolds District, British Geological Survey Commissioned Report No. CR/03/202c

<sup>312</sup> Neumann, I, Brown, S., Smedley, P. & Besien, T, 2003. Baseline Report Series: 7. The Great and Inferior Oolite of the Cotswolds District, British Geological Survey Commissioned Report No. CR/03/202c

<sup>313</sup> Boak, R.A. & Grapes, T.R., 1996. Cotswolds Groundwater Unit. Internal Review, Environment Agency, Midlands Region

<sup>314</sup> Sumbler, M.G., Barron, A.J.M. & Morigi, A.N. 2000. Geology of the Cirencester district. Memoir for 1:50,000 Geological Sheet 235 (England and Wales). British Geological Survey, London.

<sup>315</sup> Hutchinson, J.N. (1991). A417 Crickley Hill Improvement Geotechnical Investigations and Schemes for Road Widening on the Northern Valley Side, Department of Civil Engineering, Imperial College.

13.6.64 A summary of the proposed scheme elements and anticipated groundwater levels at each scheme element are presented in Table 13-8.

**Table 13-8 Scheme Elements and Anticipated Groundwater Levels**

Scheme elements	Chainage (m)	Max change in formation level <sup>(1)</sup>	Nearest borehole with groundwater monitoring	Chainage of borehole (m)	Highest recorded		Potential groundwater level (m below foundation)
					Depth (mbgl)	Level (mOD)	
Crickley Hill embankment widening, diversion of Norman's Brook	0+000 to 1+700	8.0m	No borehole data available – assume groundwater levels are approximately at the level of Norman's Brook as groundwater springs contribute to the headwaters.				At existing ground level
Stabilisation of landslide deposits at Crickley Hill	0+500 to 1+700	N/A	No borehole data available – assume groundwater levels are approximately at the level of Norman's Brook as groundwater springs contribute to the headwaters.				At existing ground level
Air Balloon cutting	1+700 to 3+000	-27.0m	DSRC406 (Inferior Oolite)	1+800	31.5	207.15	4.5
Shab Hill Junction	3+000 to 3+400	20.1m	No borehole data available – assume shallow groundwater levels relative to the existing ground level due to the Great Oolite limestones over the Fuller's Earth Formation.				At existing ground level
Shallow cuttings and embankments	3+400 to 5+700	3m and -3m	No borehole data available – assume relatively shallow groundwater levels close to the interface of the Great Oolite limestones over the Fuller's Earth Formation.				At existing ground level

Note: (1) Negative numbers indicate a cutting and positive numbers indicate fill relative to existing ground level

### Springs

- 13.6.65 Groundwater springs and seepages in the region typically correlate to the geological boundary between the Great Oolite Group and the Fuller's Earth Formation and the boundary between the Inferior Oolite Group and the Upper Lias, where more permeable oolitic limestones are underlain by less permeable mudstone units.
- 13.6.66 Springs also emanate from the colluvial deposits along the Cotswold escarpment where preferential flow paths have developed through more permeable zones of the mixed material. At this stage it is difficult to determine exactly which aquifer each spring is associated with as the unstructured nature of the colluvial material is likely to mask where these springs are discharging from in the underlying bedrock.
- 13.6.67 Many springs in the study area are considered to be ephemeral features that dry out in response to lower groundwater levels within the respective source aquifers, or area linked to major fissures or gulls and respond only to rainfall.
- 13.6.68 Many watercourses in the study area are spring fed systems with losing and gaining reaches.
- 13.6.69 Tufa formations were identified along Norman's Brook during the Water Feature Survey undertaken. Tufa typically forms due to the precipitation of calcium carbonate, when carbon dioxide degasses from carbonate saturated waters. Tufa

formation is often influenced by microbial activity. Tufa formations are considered to be ephemeral features that have developed in response to long term readjustment of the groundwater regime following glaciation. Ephemeral features include surface water and groundwater elements with periods of no flow, that commonly occur over seasonal timescales and can be influenced by larger climatic trends, such as the North Atlantic Oscillation.

### Abstractions

- 13.6.70 The majority of the study area is not located within a designated groundwater SPZ. However, the SPZ for the Baunton public water supply abstraction (approximately 12km south-east of the proposed scheme) extends into the study area within the Thames groundwater catchment. Land east of Stockwell, and extending south along the proposed scheme, is located within a SPZ3. The southern end of the proposed scheme is approximately 2.8km from SPZ2 and 3.4km from SPZ1 in the south-east.
- 13.6.71 There are no further recorded licensed abstractions that are known of within the study area.
- 13.6.72 The Water Feature Survey identified 16 potentially unlicensed abstractions, boreholes and wells within the study area<sup>316</sup>. Many of these features were either not in use or details on their usage and groundwater source were not able to be obtained. Borehole dimensions are currently only available for two locations and it is envisaged that some locations may need to be revisited in the future to obtain further details.
- 13.6.73 Two unlicensed abstractions identified during the water feature survey are used for drinking water supply. The first unlicensed abstraction is a piped spring for shared between a private dwelling and Crickley Hill Tractors both at Grove Farm, which is likely to be sourced from the Inferior Oolite Group. The second unlicensed abstraction is a spring at Bushley Muzzard SSSI to supply Watercombe Farm, which is likely to be sourced from the Great Oolite Group.

### Consented Discharge

- 13.6.74 Two treated effluent discharges to underground strata are identified in the study area from the EA's consented discharges database<sup>317</sup>.

### Groundwater Dependent Habitats

- 13.6.75 Two SSSIs are located in the study area: the Crickley Hill and Barrows Wake SSSI in the northern section of the study area, around Air Balloon; and Bushley Muzzard SSSI in the southern half of the study area, near Nettleton.
- 13.6.76 Bushley Muzzard SSSI, previously known as Watercombe Marsh, is a potentially groundwater dependent habitat. The SSSI is within a valley feature adjacent to the contact between the Great Oolite Group over the Fuller's Earth Formation. Consequently, there are a number of springs in this area that contribute to the marshland conditions of the SSSI.

<sup>316</sup> Mott Macdonald Sweco JV, 2019, Water features survey, Report reference not available.

<sup>317</sup> Environment Agency, 2015. Consented Discharges to Controlled Waters with Conditions. [Online] <https://data.gov.uk/dataset/b3df52da-3e27-4343-9ec3-e630a9cbb52c/consented-discharges-to-controlled-waters-with-conditions> [accessed 2019]



### Recharge

13.6.77 Recharge to the aquifers is primarily from rainfall infiltrating directly to the unconfined Oolite aquifers and leakage between the Oolite aquifers via faults and fractures within the Fuller's Earth Formation.

### Groundwater Quality

13.6.78 Bicarbonate rich waters are expected to be the dominant water type in the region given the presence of limestone. The geochemistry of waters in carbonate aquifers is particularly affected by residence times and mixing with recharge, older formation water and/or anthropogenic influences. Water types can typically be categorised by source, age and geological conditions including aquifer confinement.

13.6.79 Groundwater close to recharge areas are typically oxidising and strongly pH buffered with calcium and bicarbonate ( $\text{HCO}_3^-$ ) as dominant dissolved ions<sup>318</sup>. Recharge areas are particularly susceptible to high nitrate concentrations from agricultural pollution. This is anticipated to be most reflective of unconfined waters the proposed scheme may encounter.

13.6.80 As groundwater becomes more confined, down gradient of recharge areas, ion-exchange processes occur, with sodium and bicarbonate being the dominant ions in the groundwater<sup>319</sup>. The process of ion exchange causes dissolved calcium ions in the groundwater to attach or 'absorb' onto the rock surface and, in exchange, sodium ions come off the rock surface and into the groundwater.

13.6.81 In more confined groundwaters, dissolved oxygen is reduced or absent, with conditions becoming more reducing, which is evidenced by redox-sensitive elements<sup>320</sup>. Lower nitrate levels can suggest that denitrification may be occurring<sup>321</sup>, however this could also be affected by mixing with old formation waters deep within the aquifer that have low nitrate levels when entering the aquifer.

13.6.82 Mixing with older formation water deeper within the confined aquifer results in a sodium-chloride type groundwater. Isotope analysis suggests a residence time in the order of thousands of years for these waters<sup>322</sup>.

13.6.83 Groundwater quality testing was completed during the Phase 1 groundwater monitoring programme, with three samples analysed<sup>323</sup>. The samples were from each of the Inferior Oolite Group, the Bridport Sand Formation and the Fuller's Earth Formation and were all calcium carbonate type waters<sup>324</sup>.

13.6.84 Samples from the Inferior Oolite Group and Bridport Sand Formation was below the detection limit results for ammoniacal nitrogen, ammonium and

<sup>318</sup> Neumann, I, Brown, S., Smedley, P. & Besien, T, 2003. Baseline Report Series: 7. The Great and Inferior Oolite of the Cotswolds District, British Geological Survey Commissioned Report No. CR/03/202c

<sup>319</sup> Neumann, I, Brown, S., Smedley, P. & Besien, T, 2003. Baseline Report Series: 7. The Great and Inferior Oolite of the Cotswolds District, British Geological Survey Commissioned Report No. CR/03/202c

<sup>320</sup> Neumann, I, Brown, S., Smedley, P. & Besien, T, 2003. Baseline Report Series: 7. The Great and Inferior Oolite of the Cotswolds District, British Geological Survey Commissioned Report No. CR/03/202c

<sup>321</sup> The Environment Agency, "Catchment Data Explorer," Environment Agency, 01 11 2017. [Online]. Available: <http://environment.data.gov.uk/catchment-planning/>. [Accessed 10 2017].

<sup>322</sup> Neumann, I, Brown, S., Smedley, P. & Besien, T, 2003. Baseline Report Series: 7. The Great and Inferior Oolite of the Cotswolds District, British Geological Survey Commissioned Report No. CR/03/202c

<sup>323</sup> Mott MacDonald Sweco Joint Venture, 2019, Preliminary Groundwater Report, Doc No. HE551505-MMSJV-HGT-000-RP-CE-00004

<sup>324</sup> Mott MacDonald Sweco Joint Venture, 2019, Preliminary Groundwater Report, Doc No. HE551505-MMSJV-HGT-000-RP-CE-00004

bicarbonate<sup>325</sup>. In the Bridport Sand Formation total oxidised nitrogen was also below the detection limit<sup>326</sup>.

13.6.85 Elevated levels of determinants within the Inferior Oolite Group and Bridport Sand Formation<sup>327</sup>, relative to the BGS Baseline Report<sup>328</sup> include:

- Arsenic - slightly exceeds 1 µg/L in both samples;
- Manganese - 210 mg/L (Inferior Oolite Group) and 83 mg/L (Bridport Sand Formation), exceeding the 18 µg/L reported by BGS;
- Bicarbonates - below the 10 mg/L detection limit. BGS reported a minimum value 128 mg/L; and
- Sulphate - 112 mg/L in the Inferior Oolite Sample, greater than the 79.4 mg/L maximum value reported by BGS.

### Accidental Spillage

13.6.86 Accidents occurring on roads can cause fuel spills and spills of other potentially polluting substances. These spills can enter into the road drainage system, and consequently enter surface waters that receive highway drainage. There is also a risk of spills entering groundwater from natural infiltration.

13.6.87 Personal Injury Collision data on the A417 has been collected for five years until the end of April 2018<sup>329</sup>. The data indicates that the number of incidents is equal the national average although there is a greater casualty rate per collision. As a result, there is potential for fuel spills and other spills of potentially polluting substances.

### Future Baseline

13.6.88 The future baseline conditions from the UK Climate Projections 2018 (UKCP18) indicates that the study area may undergo climatic changes including higher temperatures, increase in heat waves, reduced precipitation in summer and increased precipitation in winter.

13.6.89 The future baseline conditions are likely to reduce the amount of recharge to the groundwater which may have impacts upon features in the study area and cause some perennial features to become ephemeral. Abstractions, springs, groundwater fed watercourses, areas of flooded ground and Bushley Muzzard SSSI are likely to be particularly sensitive to these impacts. Groundwater quality is also likely to be affected by a reduction in the flushing of aquifers, which may increase the residence time of groundwater within them.

13.6.90 Surface water flows are likely to become more variable, with more frequent extremes including wetter winters and drier summers.

<sup>325</sup> Mott MacDonald Sweco Joint Venture, 2019, Preliminary Groundwater Report, Doc No. HE551505-MMSJV-HGT-000-RP-CE-00004

<sup>326</sup> Mott MacDonald Sweco Joint Venture, 2019, Preliminary Groundwater Report, Doc No. HE551505-MMSJV-HGT-000-RP-CE-00004

<sup>327</sup> Mott MacDonald Sweco Joint Venture, 2019, Preliminary Groundwater Report, Doc No. HE551505-MMSJV-HGT-000-RP-CE-00004

<sup>328</sup> Neumann, I, Brown, S., Smedley, P. & Besien, T, 2003. Baseline Report Series: 7. The Great and Inferior Oolite of the Cotswolds District, British Geological Survey Commissioned Report No. CR/03/202c

<sup>329</sup> Highways England (2016), A417 Missing Link Combined Modelling and Appraisal Report

## 13.7 Consultation

- 13.7.1 A number of stakeholders have been consulted to both gather baseline data and inform the assessment. Each of these and the reasons for consultation with them (specific to this chapter) are described below.
- 13.7.2 A scoping opinion was provided by the Planning Inspectorate which included responses relating to road drainage and water resources from the EA, Cotswolds Conservation Board, Cowley and Birdlip Parish Council and GCC. These responses have been considered and included, where appropriate, in this chapter.
- 13.7.3 Consultation is ongoing with the EA. Currently this is focused around the scope of monitoring to be undertaking, as well as working to anticipate key effects of the proposed scheme and define mitigation. The EA will be consulted on future risk assessments for activities that may impede groundwater flow by impermeable barriers, such as piling, ground improvement works and foundations, as per their request.
- 13.7.4 GCC, Stroud District Council and Cotswold District Council will be consulted to obtain baseline data including local and unlicensed abstractions and GCC in particular in their capacity as LLFA with regards to the assessment of flood risk and crossing of ordinary watercourses. The Lower Severn Drainage Board will also be consulted.
- 13.7.5 Thames Water, Severn Trent Water and landowners are to be consulted during the development of the ES.

## 13.8 Assessment Assumptions and Limitations

- 13.8.1 For the assessment of construction impacts, where construction methods and sequencing are not available, standard construction practices are assumed.
- 13.8.2 Assessment of the road drainage and the water environment aspects of the proposed scheme will be carried out in accordance with LA 113, and supplementary methods as explained in previous sections for potential impacts not covered in LA 113.
- 13.8.3 Assessment of the groundwater aspects of the proposed scheme will be carried out in accordance with LA 113 and EA guidance for dewatering abstractions (SC040020/SR1) and groundwater abstractions (SC040020/SR2).
- 13.8.4 Limitations and assumptions associated with the recommended methods are discussed below.

### Surface Water

- 13.8.5 The baseline conditions have been derived from both desk-based and field studies. Additional baseline data collections and monitoring are ongoing.

### Groundwater

- 13.8.6 The understanding of the hydrogeological regime of the proposed scheme and its study area is currently limited to published reports, groundwater monitoring (for January to May 2019) from the Phase 1 ground investigation and water feature survey (completed between April 2018 to March 2019). The water features survey and groundwater monitoring are still on-going, and the methodology is currently

being refined based on the initial survey results. Furthermore, the Phase 2 ground investigation is progressing and results of this will be available at a later date. As additional information is received the conceptual models and assessment will be refined and tailored based on ground conditions encountered and existing information.

- 13.8.7 Given the lack of site specific information and the complexity of the study area and its interaction with the proposed scheme, numerical modelling of the groundwater regime will not be undertaken. It is unlikely a three-dimensional numerical model will be sufficiently detailed or robust enough to accurately represent the processes occurring within the study area and how they may be affected by the proposed scheme. Analytical and two-dimensional conceptual models will be developed for key assessment area which will be tailored for structural and geotechnical design assessments.
- 13.8.8 The Method C assessment results in a significance of effect that is relevant to the specific locale of the point of discharge, which is not relevant to the wider groundwater body due to dilution effects. Supplementary risk assessment is proposed to assess this situation if it arises which may include an RDP 20 Methodology for the derivation of remedial targets for soil and groundwater to protect water resources.

### **Gaps and Uncertainties**

- 13.8.9 Ground investigations and water monitoring are currently ongoing to determine the site-specific ground conditions and water receptors. Conceptual models will be continually refined as new information is received, at an outline stage and will be finalised later in the design process.
- 13.8.10 The drainage design is currently at an outline stage and will be finalised later in the design process.
- 13.8.11 It is acknowledged that considerable uncertainty, in particular with respect to the assessment of groundwater risks, remains and it is intended that this will be addressed in the ES.
- 13.8.12 Baseline data collection is ongoing and will be reported within the ES which will accompany the DCO application.
- 13.8.13 River and Tufa Habitat Surveys are also being undertaken at the time of writing and full results will be included in the ES.

## **13.9 Design, Mitigation and Enhancement Measures**

### **Construction Mitigation**

- 13.9.1 The Outline CEMP, to be provided as part of the ES, will include measures that are considered as standard good practice that would be implemented by the construction contractor to reduce the likelihood of effects or their magnitude if they were to occur. The Outline CEMP will also describe the procedures to be followed after an accidental spillage or other release of pollutants and a groundwater monitoring and sampling plan.
- 13.9.2 Works would also be carried out in accordance with any additional permitting requirements, for example Ordinary Watercourse Consent. Measures that are

non-standard or site specific are described below and these should be incorporated into the contractor's construction method statement.

- 13.9.3 The standard measures to be included in the Outline CEMP are to be based on the EA's Pollution Prevention Guidelines (PPGs) (withdrawn in 2015), subsequent guidance on GOV.UK, and the relevant CIRIA publications.
- 13.9.4 Examples of the standard practice mitigations that will be included in the Outline CEMP include the provision of spill kits, restricting site traffic to dedicated haul roads and ensuring hard-standing areas are regularly swept and maintained.
- 13.9.5 Effective delivery of the measures set out in the Outline CEMP would be monitored during the construction phase.
- 13.9.6 Additional site-specific measures could include:
- A surface water management system using measures such as temporary silt fencing, cut off ditches, settlement ponds and bunds set up early in the construction period to capture all runoff and prevent ingress of sediments and contaminants into existing drainage ditches where necessary. This would be managed by the CEMP in accordance with CIRIA Guidelines and the Environment Agency's approach to groundwater protection<sup>330</sup> and groundwater protection guidelines<sup>331</sup>.
  - Water with a higher risk of contamination which requires discharge, including groundwater pumped out of pilings during concrete pouring, would be contained and treated using appropriate measures such as coagulation of sediments, dewatering and pH neutralisation prior to discharge. There are various proprietary package treatment plants available that can provide these measures.
  - Contaminated water that cannot be treated on site would, if necessary, be pumped to a suitably licenced tanker before being exported off site for treatment at an appropriately permitted facility.
  - Areas of exposed sediment deemed at risk of erosion during heavy rainfall or flood inundation should be protected using either temporary measures (e.g. sheeting) or semi-permanent measures (for example coir matting) until vegetation is able to establish on these surfaces.
  - Works would be suspended during out-of-bank river flows or during intense rainstorms.
  - A water quality monitoring programme prior to and during construction works would be agreed with EA.
  - Tracer testing to identify and confirm groundwater flow paths and surface water interactions. It is anticipated additional tracer tests and hydraulic testing may be required to confirm hydraulic connectivity and properties of surface waters and groundwater bodies, define sub-catchments and fill gaps in knowledge following the previous rounds of survey and monitoring.
  - Tufa formation habitat surveys and consideration of relocating or recreating tufa formations lost at Norman's Brook, by way of academic research and engagement.

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<sup>330</sup> Environment Agency, 2017. Protect groundwater and prevent groundwater pollution. [online] Available at: <https://www.gov.uk/government/publications/protect-groundwater-and-prevent-groundwater-pollution> [accessed 2019]

<sup>331</sup> Environment Agency, 2017. Groundwater protection technical guidance. [online] Available at: <https://www.gov.uk/government/publications/groundwater-protection-technical-guidance> [accessed 2019]

- Appropriate sequencing and domaining of works, such as the Norman's Brook realignment, to minimise impacts to surface and groundwater flows to be temporarily diverted downstream of the works area.
- Consideration of local groundwater catchment and flow regimes that may be affected by dewatering design and discharging the abstracted water to the same groundwater catchment and down gradient of the dewatered element.
- Discharge from dewatering activities such as earthworks, works within a floodplain or within eight metres of a watercourse will have a tailored risk assessment, consent and licences from the EA. Dewatering abstractions may also require transfer licenses from the EA.
- Appropriate grouting methodology to be developed, where required
- Review and update of groundwater conceptual model as new, site specific information is received.
- Review and update of the hydrogeological assessment as new, site specific information is received.
- A foundation works risk assessment (FWRA) for the construction of underground structures and ground improvement works.

### **Operational Mitigation**

- 13.9.7 The following flow volume and quality control measures are incorporated into the proposed scheme design to provide a sustainable drainage system (SuDS) and are not considered to comprise additional mitigation.
- 13.9.8 The carriageway drainage may consist of a multi-stage treatment train which could potentially include grassed swales (dry), catch-pits and detention basins to remove and retain soluble and suspended pollutants to ensure discharges to groundwater or local watercourses are at acceptable levels.
- 13.9.9 Attenuation/infiltration basins would be designed to ensure that groundwater levels would not impede their performance. In addition, where embankments are to be constructed above key groundwater/surface water interactions (springs), culverts or drainage blankets will be incorporated into the design to maintain the existing flow regime and to ensure the sub-surface flows do not compromise the integrity of the earthworks.
- 13.9.10 Design of retaining walls or other structures within cuttings will incorporate drainage blankets allowing seepages of groundwater from the exposed rock faces to be collected separately from the highway drainage and to allow recharge to the underlying aquifers maintaining the existing recharge mechanisms.
- 13.9.11 These mitigations will be updated as the drainage design and assessment of effects are finalised.
- 13.9.12 The design of underground structures, such as piled foundations will consider design schemes that will minimise impacts on groundwater flow. For example, deeper and wider spaced piling to reduce flow barrier effects and allow a similar groundwater flow path and incorporating appropriate drainage solutions. A Foundation Works Risk Assessment (FWRA) will be undertaken to identify appropriate piling methodology. The FWRA will be made available for review by the EA as per their request, outlined in section 13.7.
- 13.9.13 Following the completion of post-construction groundwater monitoring, observation boreholes may be decommissioned. The decommissioning of the

boreholes should be done so that material placed in the observation well mimics the annulus construction.

### **Enhancement**

- 13.9.14 Realistic opportunities for enhancing the different aspects of the water environment shall be sought as part of proposed scheme.

## **13.10 Assessment of Effects**

- 13.10.1 The assessment of effects of the proposed scheme on surface water and groundwater receptors is presented in Table 13-9 and Table 13-10 for construction and operational effects respectively. The assessment is currently provisional and is based upon current available information and professional judgement. At this point a precautionary view has been taken. However, these effects could change as the EIA progresses.

**Table 13-9 Preliminary Assessment of Effects – Construction**

Receptor	Attribute	Quality	Importance	Potential Impacts and Effects	Design and Mitigation	Likely Significant Effects?
Surface waters	Water quality	'Good' chemical WFD classification	High	Dewatering during earthworks.	The contractor will adhere to best practice pollution prevention procedures outlined in the CEMP and in accordance with CIRA Guidelines. Appropriate risk assessments will be undertaken. All relevant consents will be obtained from the EA and a Land Drainage Consent will be obtained from the LLFA for working within 8m of a watercourse.	No
	Water quantity	Likelihood of species protected under UK legislation	High			
Surface waters	Water quality	'Good' chemical WFD classification	High	Water quality – work near to watercourses has the potential to discharge site runoff into watercourses. In addition, there is risk of accidental spillage of pollutants (e.g. fuel leakage from the storage of plant).	Comprehensive temporary works SuDS scheme to remove pollutants before reaching the environment.	No
	Water quantity	Likelihood of species protected under UK legislation	High			
Surface waters	Water quality	'Good' chemical WFD classification	High	Potential introduction of sediments, with particular reference to fine particles which could smother fish spawning sites.	Comprehensive runoff control installed at the start of construction to trap sediments.	No
	Water quantity	Likelihood of species protected under UK legislation	High			



Receptor	Attribute	Quality	Importance	Potential Impacts and Effects	Design and Mitigation	Likely Significant Effects?
Surface water - Norman's Brook only	Water quality	'Good' chemical WFD classification	High	Relocation/realignment of Norman's Brook.	Re-creation of watercourse following design. Appropriate sequencing of works and temporary works design. Consideration of translocation (subject to on-going surveys). Temporary (piped) diversion of water will have no impact on quality.	No
Groundwater and groundwater dependant features	Groundwater flow and quality	Principal aquifer  Unproductive aquifer  'Poor' to 'Good' overall WFD status	Low to high	Introduction of new flow paths between aquifers due to excavation, piling and/or ground investigation works allowing groundwater pollutants migration.	Temporary drainage design. CEMP (groundwater monitoring). FWRA. Appropriate construction method/ sequencing. Clean drilling technique. Appropriate decommissioning of installations.	No
Groundwater and groundwater dependant features	Groundwater quality	Principal aquifer  'Poor' to 'Good' overall WFD status	High	Degradation of groundwater quality (including spillage, stockpiles of construction material, earthworks, polluted run-off, temporary drainage, change in ground cover.	Baseline data collection and update of groundwater conceptual model. Temporary drainage design CEMP (surface water management, pollution control, groundwater monitoring).	No

Receptor	Attribute	Quality	Importance	Potential Impacts and Effects	Design and Mitigation	Likely Significant Effects?
Groundwater and groundwater dependant features	Groundwater quality	Principal aquifer  'Poor' to 'Good' overall WFD status	High	Pollution of groundwater due to loss of grout/cement from piling operations or ground improvement.	Baseline data collection and update of groundwater conceptual model including tracer tests. Development of appropriate grouting technology. FWRA. CEMP (pollution control, groundwater monitoring).	No
Groundwater and groundwater dependant features	Groundwater resource and flow	Principal aquifer  'Poor' to 'Good' overall WFD status	High	Construction activities of cuttings, trenches, voids (including dewatering), embankments, underground structures may affect groundwater flow - redistribution of flow paths and rate; new flow paths; affecting groundwater dependant features, aquifer and surface water recharge.	Baseline data collection an update of groundwater conceptual model. Temporary drainage design. FWRA. CEMP (pollution control, groundwater monitoring).	Potentially adverse
Groundwater and groundwater dependant features	Groundwater flow	Potential of species protected under UK legislation	Low to very high	Intensive rainfall may reactivate spring flow to cuttings or in dry valleys leading to flooding.	Temporary drainage design.	No
Groundwater	Groundwater resource	Principal aquifer  'Poor' to 'Good' overall WFD status	High	Change in run-off and aquifer recharge rates due to temporary drainage networks.	Baseline data collection and update of groundwater conceptual model.	No

**Table 13-10 Preliminary Assessment of Effects – Operation**

Receptor	Attribute	Quality	Importance	Potential Impacts and Effects	Design and Mitigation	Likely Significant Effects?
Surface waters	Water quality	'Good' chemical WFD classification	High	Changes to flow regime as a result of changes to groundwater-surface water interactions. Particularly excavation of the deep cutting through Shab Hill and the top of Crickley Hill may act as a pathway that diverts surface water between catchments (between sub catchments of the Severn catchment, and between Severn and Thames catchments).	Drainage design to maintain existing catchments. This assumes that water quality in each catchment is sufficiently similar that minor transfers between catchments will not lead to significant quality effects. This is subject to ongoing monitoring.	No
	Water quantity	Inherent value of flow regime	Assumed low		Mitigation for possible impacts yet to be designed. Assume that flow regime is not atypical and therefore rare or valuable.	No
	Flood risk	Floodplain with limited constraints and a low probability of flooding of residential and industrial properties	Low		Water flow will be subject to ongoing monitoring and should additional mitigation be required this will be incorporated into the design as appropriate.	No
Surface waters	Water quality	'Good' chemical WFD classification	High	Road drainage could introduce contaminants or increase concentrations of contaminants to watercourses.	Control surface water runoff at its source through the use of sustainable highways drainage techniques to manage road runoff.	No
	Water quantity	Likelihood of species protected under UK legislation	High			
Surface water	Water quality	'Good' chemical WFD classification	High	Creation of diverse habitat niches and	Delivered through design.	No

Receptor	Attribute	Quality	Importance	Potential Impacts and Effects	Design and Mitigation	Likely Significant Effects?
	Water quantity	Likelihood of species protected under UK legislation	High	sediment and flow regimes within diverted channel section(s).		
Surface water	Flood risk	Floodplain with limited constraints and a low probability of flooding of residential and industrial properties	Low	Introduction of artificial structures into the water environment (especially culverts).	Effective mitigation to be introduced at detailed design.	No
	Geomorphology	WFD morphology status of 'supports Good'	High		Culvert and structure design to incorporate best practice to minimise impact to geomorphology, flow and habitat	No
Surface water	Water quality	'Good' chemical WFD classification	High	Potential introduction of sediments, with particular reference to fine particles which could smother fish spawning sites.	Comprehensive SuDS scheme to trap sediment and provide habitat and amenity benefits.	No
	Water quantity	Likelihood of species protected under UK legislation	High			
Groundwater	Groundwater resource	Principal aquifer, Unproductive aquifer  'Poor' to 'Good' overall WFD status	High	Change in groundwater resource due to highway drainage.	Baseline data collection and update of groundwater conceptual model.  Drainage design to maintain existing groundwater regime. Drainage design is currently on-going.	No

Receptor	Attribute	Quality	Importance	Potential Impacts and Effects	Design and Mitigation	Likely Significant Effects?
Groundwater and groundwater dependant features	Groundwater resource and flow	Principal aquifer  'Poor' to 'Good' overall WFD status	High	Embankments and/or underground structures may affect groundwater flows and recharge rate; new flow paths; affecting aquifer and surface water catchment and recharge.	Baseline data collection and update of groundwater conceptual model. Design to include drainage solution to allow groundwater infiltration/flow. <i>Drainage design is currently on-going.</i>	No
Groundwater and groundwater dependant features	Groundwater resource and flow	Principal aquifer  'Poor' to 'Good' overall WFD status  SSSI designation  SPZ3	Very high	Drainage in cuttings may result in permanent lowering of groundwater levels and impacting groundwater resources/ dependent features including springs, abstraction points, SPZ3, Bushley Muzzard SSSI.	Baseline data collection and update of groundwater conceptual model. Drainage design to maintain existing groundwater regime. <i>Drainage design is currently on-going.</i>	No
Groundwater and groundwater dependant features	Groundwater flow	Potential of species/habitats protected under UK legislation	Low to very high	Drainage aspects of ground improvement works for colluvium stabilisation, and/ or road drainage resulting in partial or total loss of springs.	Baseline data collection and update of groundwater conceptual model. FWRA. Drainage design.	Potentially adverse
Groundwater and groundwater dependant features	Groundwater flow	Principal aquifer  'Poor' to 'Good' overall WFD status	High	Introduction of new pathways between aquifers due to underground structures e.g. piles or deep cuttings.	Drainage design. FWRA. Contiguous piling.	No

Receptor	Attribute	Quality	Importance	Potential Impacts and Effects	Design and Mitigation	Likely Significant Effects?
Surface water	Groundwater flow	'Poor' to 'Good' overall WFD status	Low to very high	Intensive rainfall may reactivate springs to cuttings and drainage system being overwhelmed leading to flooding.	Drainage design to consider groundwater flows.	No
Groundwater and groundwater dependant features	Groundwater flow	Potential of species protected under UK legislation	Low to very high	Intensive rainfall may reactivate springs flows in dry valleys buried by embankments drainage system being overwhelmed leading to flooding and potential instability issues.	Embankments design to allow for groundwater infiltration.	No
Groundwater and groundwater dependant features	Groundwater quality	'Good' chemical WFD status	High	Precipitation of calcium carbonate from groundwater may result in fouling of the drainage layer, resulting in potential impacts on stability also localised flooding.	Collection of baseline data to increase understanding of tufa formation process. Drainage design and maintenance options (also to incorporate long term maintenance considerations).	No

## 13.11 Monitoring

- 13.11.1 The development of a monitoring strategy for the proposed scheme is currently under discussion with the Environment Agency, including monitoring to establish a robust baseline. A comprehensive monitoring strategy is being developed to provide a holistic understanding of all aspects of the water environment in this locality, and the inter-relationships between groundwater, and surface water and particular elements of these including flow regime, water quality, ecology and geomorphology. The duration of this monitoring is intended to be sufficient to provide a baseline understanding of current conditions, as well as identify effects during construction and operation of the project.
- 13.11.2 The rationale of the proposed monitoring scheme is to identify groups of representative features to monitor, particularly watercourse, groundwater springs and existing groundwater boreholes.
- 13.11.3 Monitoring should continue during construction and operation to fully understand the hydrological and hydrogeological conditions, and their linkages with ecological receptors, and the impacts of the proposed scheme on these.

## 13.12 Summary

- 13.12.1 This chapter of the PEI Report describes the existing conditions of study area's water environment prior to the ES, within which an assessment of the potential effects on the quality and quantity of surface and groundwaters, flood risk and WFD compliance as a result of the proposed scheme will be undertaken. A stand-alone Flood Risk Assessment and Water Framework Directive compliance assessment will be appended to the ES. It is considered that there is potential for the proposed scheme to have significant effects on the water environment, as a result of the highly sensitive nature of the receiving environment.
- 13.12.2 A summary of the preliminary likely significant effects of the proposed scheme is presented. This is based upon currently available information and professional judgement. However, these effects could change as the EIA progresses.

### Preliminary Construction Assessment

- **Adverse** effect on groundwater flows – construction activities of cuttings, trenches, voids incl. dewatering, embankments, underground structures may affect groundwater flow - redistribution of flow paths and rate; new flow paths; affecting aquifer and surface water recharge.

### Preliminary Operational Assessment

- No likely significant effects anticipated.

### Further Work

- 13.12.3 The WFD compliance assessment, hydrogeological assessment and flood risk assessment will be reported in the ES which will accompany the DCO application.
- 13.12.4 Collection of baseline conditions data is currently on-going and available information will be incorporated into the assessments.
- 13.12.5 Aquatic invertebrates and tufa springs surveys will be undertaken summer/autumn 2019 and will inform the assessment on terrestrial ecosystems.

## 14 Climate change

### 14.1 Introduction

- 14.1.1 This chapter assesses the potential climate impacts of the construction and operation of the proposed scheme, following the methodology set out in the Highways England's Interim Advice Note (IAN) 114/08<sup>332</sup> Carbon Calculation and Reporting Requirements and DMRB volume 11, section 3, part 1 HA207/07 Air Quality<sup>333</sup>. This chapter details the methodology followed for the assessment, summarises the regulatory and policy framework related to climate and describes the existing environment in the area surrounding the proposed scheme. Following this, the design, mitigation and residual effects of the proposed scheme are discussed, along with the limitations of the assessment.
- 14.1.2 To align with the requirements of the National Policy Statement for National Networks (NPSNN) and the EIA Directive this chapter addresses two separate aspects:
- the effects on the climate of greenhouse gas (GHG) emissions arising from the proposed scheme, including how the proposed scheme would affect the ability of government to meet its carbon reduction plan targets; and
  - the vulnerability of the proposed scheme to climate change and impacts relevant to climate change adaptation, assessed through a climate change resilience (CCR) assessment.
- 14.1.3 The in-combination effects of the proposed scheme and potential changes in climate variables on the receiving environment during construction and operation are considered for each topic in the relevant chapter of the PEI Report.
- 14.1.4 A quantified assessment of the greenhouse gas emissions due to the project has not been undertaken for the PEI Report. The ES will demonstrate Highways England's contribution to the UK Government's commitment to the reduction of greenhouse gases.

### 14.2 Legislative and Policy Framework

#### International

- 14.2.1 The Paris Agreement<sup>334</sup> is an international climate agreement aiming to limit global temperature increase this century to less than 2 degrees Celsius above pre-industrial levels. It additionally establishes a goal on adaptation of enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change. It was adopted in 2015 at the 21st Conference of the Parties to the United Nations Framework Convention on Climate Change (COP21), in Paris, France, and entered into force in November 2016. The guidelines for implementing the Paris Agreement that were adopted at the 24th Conference of the Parties (COP24), in Katowice, Poland.

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<sup>332</sup> Highways England, Interim Advice Note 114/08 <http://www.standardsforhighways.co.uk/ha/standards/ians/pdfs/ian114.pdf> [Accessed November 2017]

<sup>333</sup> Highways England, Design Manual For Roads and Bridges Volume 11, Section 3, Part 1 Air Quality, 2007 Available at: <http://www.standardsforhighways.co.uk/ha/standards/dmr/vol11/section3/ha20707.pdf>

<sup>334</sup> <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement>



- 14.2.2 Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report<sup>335</sup>, published in 2014, provides evidence that human influence on climate change is clear and growing. Climate change is the largest inter-related cumulative environmental effect which has the potential to lead to significant environmental effects on a wide range of sectors. This report outlines potential impacts of climate change in various geographical areas.
- 14.2.3 In 2018, the IPCC published a special report on limiting global temperature increases to 1.5°C above pre-industrial levels<sup>336</sup>. It identifies the need for systems transitions in all sectors including transport infrastructure in order to limit global warming to 1.5°C and avoid the climate-related risks associated with warming of 2°C or more.
- 14.2.4 At the European level, the EIA Directive 2011/92/EU<sup>337</sup> places a requirement upon projects which have the potential for significant effects on the surrounding environment and communities to make a formal assessment of these effects. The amended Directive 2014/52/EU identifies the important role that the EIA process can play in assessing climate change impacts. It states that EIAs shall identify, describe and assess the direct and indirect significant effects of climate change relevant to the proposed scheme. The regulations implementing this directive were transposed into UK legislation in May 2017.

### National legislation

- 14.2.5 The Climate Change Act 2008 committed the UK to its first statutory carbon reduction target to reduce carbon emissions by at least 80% from 1990 levels by 2050. The Climate Change Act 2008 (2050 Target Amendment) Order 2019<sup>338</sup> will amend the Climate Change Act 2008 by introducing a target for at least a 100% reduction of greenhouse gas emissions (compared to 1990 levels) in the UK by 2050, following advice from the Committee on Climate Change<sup>339</sup>. The Climate Change Act requires that that five-yearly carbon budgets are set and not exceeded to ensure that regular progress is made towards the target. The first three carbon budgets were set in 2009, with the fourth and fifth following in 2011 and 2016 respectively, as outlined in Table 14-1<sup>340</sup>.

**Table 14-1 UK Carbon Budgets (as legislated by the Climate Change Act 2008)**

Carbon budget	Carbon budget level	Reduction below 1990 levels
3rd carbon budget (2018- 2022)	2,544 MtCO <sub>2</sub> e	37% by 2020
4th carbon budget (2023- 2027)	1,950 MtCO <sub>2</sub> e	51% by 2020
5th carbon budget (2028- 2032)	1,725 MtCO <sub>2</sub> e	57% by 2020

- 14.2.6 In 2017, the UK Government published the Clean Growth Strategy, which is a plan for meeting the legislated carbon budgets<sup>341</sup>.

<sup>335</sup> <https://www.ipcc.ch/report/ar5/syr/>

<sup>336</sup> <https://www.ipcc.ch/sr15/chapter/summary-for-policy-makers/>

<sup>337</sup> 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. Available online at: <http://eur-lex.europa.eu/legalcontent/EN/TXT/?uri=celex%3A32014L0052>

<sup>338</sup> <http://www.legislation.gov.uk/uk/si/2019/1056/introduction/made>

<sup>339</sup> <https://www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming/>

<sup>340</sup> <https://researchbriefings.parliament.uk/ResearchBriefing/Summary/CBP-7555>

<sup>341</sup> HM Government, The Clean Growth Strategy – Leading the way to a low carbon future, 2017.

<https://www.gov.uk/government/publications/clean-growth-strategy>; accessed 14th November 2017.

- 14.2.7 In July 2018, the UK Government launched the Road to Zero<sup>342</sup>, a forward-looking route map to articulate the steps required to decarbonise and electrify road transport in line with their industrial strategy. The document outlines 46 policy interventions to aid in the drive to decarbonise road transport.
- 14.2.8 The Climate Change Act also established a requirement to undertake a climate change risk assessment every five-year period and develop a programme for adaptation action in response to the risks identified. The second Climate Change Risk Assessment was published in 2017<sup>343</sup>. It establishes the six priority risk areas for action over the following five years. It is based on the independent evidence report published by the committee on climate change<sup>344</sup>.
- 14.2.9 The second National Adaptation Plan<sup>345</sup> (NAP) was produced by DEFRA and launched in 2018. The plan sets out the government's response to the second Climate Change Risk assessment. It forms part of the five-yearly cycle of requirements laid down by the Climate Change Act, with the aim of driving a dynamic and adaptive approach to building the nation's resilience to climate change.

### National policy

- 14.2.10 The National Planning Policy Framework (NPPF) describes the role of planning policy in meeting the challenges posed by climate change and helping to shape places to secure radical reductions in greenhouse gas emissions as well as minimising vulnerability and providing resilience to the impacts of climate change. Chapter 14 states that developments should avoid increased vulnerability to the range of impacts arising from climate change and should be planned for in ways that can help to reduce greenhouse gas emissions (in line with the objectives and provisions of the Climate Change Act 2008).
- 14.2.11 The National Policy Statement for National Networks (NPSNN) (paragraph 5.18) states that carbon emissions anticipated over the next 10-15 years from the strategic road building programme are considered to be small (less than 0.1% of annual carbon budget). It also states that an increase in greenhouse gas emissions is not a reason to refuse development consent, unless the increase was large enough to have a material impact on the ability of the government to meet its carbon reduction targets. Paragraph 4.40 of the NPSNN states that applicants must consider the impacts of climate change when planning location, design, build and operation.

### Local Policy

- 14.2.12 Gloucester City Council launched their Climate Change Strategy<sup>346</sup> in 2010 committing themselves to maximising the reduction in greenhouse gas emissions and where possible working to exceed government and regional targets.
- 14.2.13 The South Gloucestershire Climate Change Strategy 2018-2023<sup>347</sup> affirms this scale of ambition through the targeting of an "at least" 80% reduction in carbon emissions by 2050. The Adaptation Plan for the region is included within the

<sup>342</sup> [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/739460/road-to-zero.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/739460/road-to-zero.pdf)

<sup>343</sup> <https://www.gov.uk/government/publications/uk-climate-change-risk-assessment-2017>

<sup>344</sup> <https://www.theccc.org.uk/tackling-climate-change/preparing-for-climate-change/uk-climate-change-risk-assessment-2017/>

<sup>345</sup> [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/727252/national-adaptation-programme-2018.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/727252/national-adaptation-programme-2018.pdf)

<sup>346</sup> <https://www.gloucester.gov.uk/media/1212/climatechangestrategy2009.pdf>

<sup>347</sup> <https://www.southglos.gov.uk/documents/Climate-Change-Strategy-2018-2023.pdf>

strategy to underline the equal importance of mitigation and adaptation in the region.

14.2.14 The Cotswolds AONB Management Plan 2018-2023<sup>348</sup> is a non-statutory plan, which sets out the vision, outcomes and policies for the management of the AONB. It contains seven cross-cutting outcomes and associated policies. Of direct relevance to this chapter is outcome 3 on climate change and Policy CC7 and Policy CC8 on climate change mitigation and climate change adaptation respectively.

## Guidance

### Effects on climate

14.2.15 The Government's Construction Industry Strategy<sup>349</sup> presents the UK's low carbon construction aspirations. It includes the aspiration to decrease construction carbon emissions by 50% by 2025 based on 1990 levels, as reported in the Green Construction Board's Low Carbon Route map for the Built Environment<sup>350</sup>.

14.2.16 Although there is no specific standard for reporting infrastructure carbon emissions in EIA, the following standards have been used to guide this assessment:

- The Publicly Available Specification (PAS) 2080<sup>351</sup> on carbon management in infrastructure;
- BS EN 15804<sup>352</sup> which outlines the requirement for quantifying and reporting emissions at a product level;
- IEMA's guide to assessing carbon emissions and evaluating their significance in EIA<sup>353</sup>;
- DMRB HA 207/07, which provides a calculation method for regional emissions<sup>354</sup>;
- Highways England's Interim Advice Note 114/08<sup>355</sup> Highways Agency Carbon Calculation and Reporting Requirements;
- Highways England Interim Advice Note 185/15<sup>356</sup>, which advises on emissions factors to be used to model carbon emissions from traffic; and
- Highways England's Carbon emissions calculation tool, which provided emissions factors for the assessment<sup>357</sup>.

<sup>348</sup> <https://www.stratford.gov.uk/doc/207836/name/Management%20Plan%202018%2023%20ADOPTED.pdf/>

<sup>349</sup> HM Government (2013) *Industrial Strategy: government and industry in partnership*. HM Government, London.

<sup>350</sup> The Green Construction Board, *Low Carbon Routemap for the UK Built Environment*, (2013:); <http://www.greenconstructionboard.org/otherdocs/Routemap%20final%20report%2005032013.pdf>; Accessed: 4 August 2016.

<sup>351</sup> British Standard Institute, (2016), PAS 2080:2016, *Carbon management in infrastructure*, PAS 2080:2016.

<sup>352</sup> British Standard Institute, (2013), BS EN 15804+A1:2013. *Sustainability of construction works. Environmental product declarations. Core rules for the product category of construction products*, BS EN 15804+A1:2013.

<sup>353</sup> IEMA (2017), *Environmental Impact Assessment Guide to: Assessing Greenhouse Gas Emissions and Evaluating their Significance*.

<sup>354</sup> Highways England (2007) DMRB HA 207/07 Air Quality.

<sup>355</sup> Highways England (2008) Interim Advice Note 114/08: Highways Agency Carbon Calculation and Reporting Requirements.

<sup>356</sup> Highways England (2015), Interim Advice Note 185/15: Updated traffic, air quality and noise advice on the assessment of link speeds and generation of vehicle data into 'speed-bands' for users of DMRB Volume 11, Section 3, Part 1 'Air Quality and Volume 11, Section 3, Part 7 Noise.

<sup>357</sup> Highways England, Carbon emission calculation tool, September 2016. <https://www.gov.uk/government/publications/carbon-tool/>; Accessed 2 October 2017.

### Vulnerability of the scheme to climate change

- 14.2.17 The European Commission (EC) has released sector specific guidance<sup>358</sup> on the interface between climate change and infrastructure, including projected impacts and resilience levels. The EC guidance on Integrating Climate Change and Biodiversity into EIAs<sup>359</sup> carried out under the amended EIA Directive 2014, includes climate change and biodiversity related guidance for screening and scoping, analysing evolving baseline trends, identifying alternative and baseline measures, monitoring and adaptive management.
- 14.2.18 IEMA has published guidance<sup>360</sup> on climate change resilience and adaptation in response to the requirements specified in the amended EIA Directive 2014. This guidance provides an approach to undertaking assessments of climate change resilience within the EIA process in the UK.
- 14.2.19 The Environment Agency<sup>361</sup> provides guidance on climate change allowances to be used in flood risk assessments as set out in the NPPF. This advice includes climate change allowances for peak river flow and peak rainfall intensity for flood risk assessments for different UK river basin districts, flood zones and land use sensitivities. The assessments made of the implications of climate change for future flood risks associated with the proposed scheme would take account of the content of this guidance.

## 14.3 Study Area

### Study Area and Assessment Scenarios

#### Effects on climate

- 14.3.1 The assessment of GHG emissions considers the following stages:
- emissions during the construction phase, i.e. material supply, transport, manufacturing and construction process associated with the proposed scheme; and
  - emissions during the operation phase, associated with the maintenance and refurbishment of the proposed scheme and road user carbon emissions arising from the use of the asset or vehicle emissions.
- 14.3.2 There are also GHG emissions and sequestration associated with land use throughout all phases of the proposed scheme. Opportunities to mitigate the effects on climate through minimising activities that generate GHGs, reusing and adopting low carbon materials, and maximising carbon sequestration through land use are also considered.
- 14.3.3 The GHG assessment in the ES would quantify and report the emissions associated with the construction and use of the proposed scheme. A proportionate approach would be applied to capture the principal contributing

<sup>358</sup> European Commission (2013), Adapting Infrastructure to Climate Change- Communication from the commission to the European Parliament, the council, the European economic and social committee and the committee of the regions: An EU Strategy on Adaptation to Climate Change. Available online at: [https://ec.europa.eu/clima/sites/clima/files/adaptation/what/docs/swd\\_2013\\_137\\_en.pdf](https://ec.europa.eu/clima/sites/clima/files/adaptation/what/docs/swd_2013_137_en.pdf)

<sup>359</sup> European Commission, (2013), Integrating Climate Change and Biodiversity into Environmental Impact Assessment; <http://ec.europa.eu/environment/eia/pdf/EIA%20Guidance.pdf> ; Accessed: 22 November 2017.

<sup>360</sup> Institute of Environmental Management and Assessment (IEMA) (2015), IEMA Environmental Impact Assessment Guide To Climate Change Resilience And Adaptation. Available at: [http://www.iema.net/system/files/iema\\_guidance\\_documents\\_eia\\_climate\\_change\\_resilience\\_and\\_adaptation.pdf](http://www.iema.net/system/files/iema_guidance_documents_eia_climate_change_resilience_and_adaptation.pdf)

<sup>361</sup> Environment Agency (2017), Flood risk assessments: climate change allowances. Available online at: <https://www.gov.uk/guidance/flood-riskassessments-climate-change-allowances>

factors associated with GHG emissions. The GHG emissions are not quantified in this PEI Report chapter due to the lack of information available. This chapter refers to 'carbon' to include all main greenhouse gases<sup>362</sup>. PAS 2080 uses the terms capital, operational and user carbon to refer to the GHG emissions from capital works, asset operation and infrastructure users respectively.

- 14.3.4 For the assessment of capital carbon emissions (defined as emissions associated with the creation, refurbishment and end of life treatment of assets such as buildings and infrastructure), the study area principally takes account of emissions associated with project activities and their associated transport.
- 14.3.5 During the operation phase, the proposed scheme would have capital carbon emissions associated with maintenance and refurbishment. These would be assessed using the Highways England Carbon Reporting Tool. There would be no emissions associated with operating the road, as there is no energy consuming operational equipment such as street lighting or intelligent transport systems. Sequestration of GHGs in the landscape of the proposed scheme would occur over the operational life of the project.
- 14.3.6 The study area for road user carbon during the operation phase would be based on a traffic model of the Affected Road Network, as defined by HA 207/07. This includes emissions from vehicles using the proposed scheme and those in the wider road network which have been positively or negatively influenced by the proposed scheme. The assessment of user carbon includes the total emissions across the model, irrespective of presence and location of receptors.
- 14.3.7 For emissions during the operation phase (i.e. maintenance and user emissions), a 60-year appraisal period would be adopted.

#### Vulnerability of the scheme to climate change

- 14.3.8 The study area of the CCR assessment includes temporary and completed works within the project boundary and affected receptors identified within other environmental factors scoped in to the assessment.
- 14.3.9 The study area includes all potential climate hazards for infrastructure and assets associated with the proposed scheme. The assessment of climate effects on the proposed scheme are assessed over the 60-year operational life cycle of the project.
- 14.3.10 Assessment scenarios are based on current and future climate baselines, as described in section 15.6. The CCR assessment is based climate trends associated with the UK Climate Projections 2018 (UKCP18) high emissions scenario (50% probability) projection. The time periods for climate projections are selected based on the lifespan and stages of the project.

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<sup>362</sup> The seven main GHGs are: carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), sulphur hexafluoride (SF<sub>6</sub>) and nitrogen trifluoride (NF<sub>3</sub>). Source: National Atmospheric Emissions Inventory (2017), Overview of greenhouse gases. Available online at: <http://naei.defra.gov.uk/overview/ghg-overview>

## 14.4 Potential Impacts

### Effects on climate

- 14.4.1 The proposed scheme would result in GHG emissions during construction as well as operation. User carbon emissions are likely to increase as a result of the proposed scheme.

### Vulnerability of the scheme to climate change

- 14.4.2 The A417 provides an important transport link for Gloucester and is a part of the strategic road network in the region. The proposed scheme is expected to increase the resilience of transport systems in the region to a range of hazards, including climatic hazards and climate change, and hence provide benefit for the overall resilience of the region.
- 14.4.3 Assets and infrastructure designed and constructed as part of the proposed scheme are likely to be impacted by climate change in a number of ways. The potential risks are expected to be largely mitigated through the use of appropriate design standards, delivered through quality construction, as well as appropriate asset management procedures during operation.
- 14.4.4 As noted, details of the in-combination climate change impacts relevant to each environmental topic are presented within the chapters of each discipline.

## 14.5 Assessment Methodology

### **Magnitude of Impacts**

#### Effects on climate

- 14.5.1 The assessment of the magnitude of carbon emissions would be undertaken in accordance with the principal steps identified in PAS2080 and the IEMA guidance. Consideration has also been given to TAG Unit A3 Environmental Impact Appraisal, Chapter 4 Greenhouse Gases<sup>363</sup>.
- 14.5.2 A whole-life approach would be adopted, capturing both direct and indirect carbon emissions arising because of the proposed scheme, across supply chain, construction, operation and use. End of life would not be considered due to the long design life of the asset and given that emissions associated with end of life are commonly relatively small.
- 14.5.3 The scenarios to be used for the GHG assessment of the operation of the proposed scheme are summarised in Table 14-2.

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<sup>363</sup> Department for Transport (August 2019) TAG unit A3 environmental impact appraisal <https://www.gov.uk/government/publications/tag-unit-a3-environmental-impact-appraisal> [Accessed on 09/2019]

**Table 14-2 GHG Assessment Scenarios**

Scenario	Description
'Do-minimum'	'Business as usual' – baseline conditions without proposed scheme.
'Do-something'	Proposed scheme implemented with without GHG mitigation measures.
'Do-something' with mitigation	Proposed scheme implemented with maximum GHG mitigation measures.

14.5.4 GHG emissions in each scenario would be compared in order to assess the contribution of the proposed scheme to climate change. Values would be reported in metric tonnes of carbon dioxide equivalents (tCO<sub>2e</sub>).

#### Vulnerability of the scheme to climate change

14.5.5 The CCR assessment qualitatively assesses the impacts and risks of climate change on the proposed scheme and was undertaken using professional expertise and judgement.

14.5.6 In the case of flood risk, detailed planning requirements and design guidance relating to climate change exist. A Flood Risk Assessment would be undertaken as part of the EIA and reported in chapter 13 Road Drainage and Water Environment of the ES as part of the DCO application. This would take into account current Environment Agency (EA) climate change allowances for increases in peak river flow and rainfall intensity.

14.5.7 The climate change resilience assessment is composed of two main parts: the assessment of climate hazards, and the risk and resilience assessment.

14.5.8 The following climate change hazards would be considered in the CCR risk assessment:

- high temperatures;
- low temperature;
- high precipitation;
- low precipitation;
- humidity;
- insolation (solar irradiation);
- storms/lightning strikes; and
- wind.

14.5.9 As part of the climate change resilience assessment, the potential likelihood and consequence of climate change risks during the operation of the infrastructure and assets associated with the proposed scheme are scored using a qualitative five point scale, based on the latest approach by Highways England; these are set out in Table 14 3 and Table 14 4.

**Table 14-3 Qualitative five-point scale of likelihood of climate change risks**

Likelihood Category	Description (probability and frequency of occurrence)
Very High	The event occurs multiple times during the lifetime of the project (60 years) e.g. approximately annually, typically 60 events.
High	The event occurs several times during the lifetime of the project (60 years) e.g. approximately once every five years, typically 12 events.
Medium	The event occurs limited times during the lifetime of the project (60 years) e.g. approximately once every 15 years, typically 4 events.
Low	The event occurs during the lifetime of the project (60 years) e.g. once in 60 years.
Very Low	The event may occur once during the lifetime of the project (60 years).

**Table 14-4 Qualitative five-point scale of consequences of climate change risks**

Consequence of impact	Description
Very large adverse	National level (or greater) disruption to strategic route(s) lasting more than 1 week.
Large adverse	National level disruption to strategic route(s) lasting more than 1 day but less than 1 week. OR Regional level disruption to strategic route(s) lasting more than 1 week.
Moderate adverse	Regional level disruption to strategic route(s) lasting more than 1 day but less than 1 week.
Minor adverse	Regional level disruption to strategic route(s) lasting less than 1 day.
Negligible	Disruption to an isolated section of a strategic route lasting less than 1 day.

- 14.5.10 The CCR assessment for risks for the construction phase focuses on weather resilience of the construction process. Risks are qualitatively assessed with respect to the potential disruption to the construction programme, whereby the potential disruption is classified as 'small', 'medium' or 'large'. These qualitative descriptions are assigned based on expert judgement.
- 14.5.11 A qualitative assessment of uncertainty is undertaken for each climate change risk, based on the uncertainty of the relevant climate change projections and the uncertainty in the respective effect on asset performance. This process has been adapted from the process for assessing uncertainty in climate change effects on road infrastructure presented in the Highways England Climate Adaptation Risk Assessment - 2016.
- 14.5.12 As part of the risk assessment the need for any additional resilience measures to protect against the effects of climate change would be identified, based on those risks assessed as significant, as per the risk matrix in Table 14-6. High level resilience measures would be developed in collaboration with engineering and design team and reported in the ES.



## Assessment of significance

### Effects on climate

- 14.5.13 Given lack of data available at this stage, an assessment of significance has not been made in PEI Report and would be presented in the ES. This will be based on the Highways England Carbon Reporting Tool and assessment of road user emissions in line with HA 207/07.
- 14.5.14 In accordance with the National Policy Statement for National Networks (NPSNN), carbon emissions associated with the proposed scheme would be compared to the national UK carbon budgets. The UK Government has currently passed into law, carbon budgets up to 2030:
- 3<sup>rd</sup> carbon budget period (2018 to 2022) allows the UK to emit 2544 MtCO<sub>2e</sub>
  - 4<sup>th</sup> carbon budget (2023 to 2027) allows the UK to emit 1950 MtCO<sub>2e</sub>
  - 5<sup>th</sup> carbon budget (2028 to 2032) allows the UK to emit 1725 MtCO<sub>2e</sub>
- 14.5.15 A significant effect would occur where the increase in carbon emissions resulting from the proposed scheme would have a material impact on the ability of Government to meet its carbon reduction targets.

### Vulnerability of the scheme to climate change

- 14.5.16 The significance of the identified risks is assessed using the significance matrix shown in Chapter 4 Table 4-3.

## 14.6 Baseline Conditions

### Effects on climate

- 14.6.1 A 'do-minimum' scenario would be used to develop a baseline for the proposed scheme. In this scenario it is assumed that no construction activity takes place on any of the roads in the area, aside from maintenance, across the study period.
- 14.6.2 The baseline GHG emissions for the 'do minimum' scenario are summarised in Table 14-5. As noted, GHG emissions data from road users is not presently available and so has not been included at this stage.

**Table 14-5 Summary of Baseline Carbon for Study Area**

Carbon component	Definition	Estimated carbon over study period (tCO <sub>2</sub> )
Capital GHG emissions	GHG emissions associated with the maintenance of the existing road(s) and carbon sequestered in the vegetation and land within the proposed scheme boundary	To be calculated (anticipated to be <0.1% of total GHG emissions)
Operational GHG emissions	Reduction in atmospheric GHGs associated with sequestration of GHGs over time by landscape within the proposed scheme boundary	To be calculated
User GHG emissions	GHG emissions from the tailpipes of vehicles driving in the Affected Road Network	To be calculated

### Vulnerability of the scheme to climate change - current climate

- 14.6.3 The Met Office holds historical regional climate information, in which the study area is included within the Midlands region. High-level climate observations for the Midlands over a 30-year averaging period between 1981-2010 are presented in Table 14-6.

**Table 14-6 High Level Climate Observations for the Region (1981-2010)**

Climatic Conditions	Climate Observations
Temperature	Mean daily temperatures ranged from 0°C to 1.5°C in winter, whilst summer daily maximum temperatures were in the region of 22°C.
Rainfall	Atlantic depressions or convection are the source of the majority of rain in the midlands, particularly in autumn and winter where Atlantic Lows are more vigorous. Annual rainfall in the Cotswolds averages 800mm. Monthly rainfall is variable but is highest in winter months. The number of days with rainfall greater than 1mm are 30-35 days in winter months, dropping to an average of 20-25 days in summer.
Wind	The Midlands is one of the more sheltered regions of the UK. The strongest winds are associated with the passage of deep areas of low pressure close to or across the UK. The frequency and strength of these depressions is greatest in the winter period, when mean speeds and gusts are strongest at approximately 10 knots.
Sunshine	Average annual sunshine totals were between 1400 and 1600 hours. A mid-century decline in heavy industry across the region has led to an increase in sunshine duration due to reduced industrial pollution.
Air Frost	The average number of days with air frost varies from 40 to 60 days per year.

- 14.6.4 A Local Climate Impacts Profile (LCLIP) for Wiltshire Council<sup>364</sup> was developed as part of a larger South West LCLIP (2010). The Wiltshire LCLIP has been used as a proxy for the current local weather experienced in the neighbouring area of Gloucester where the proposed scheme is located, as the Gloucester LCLIP was not available in the preparation of the PEI Report. The profile aims to provide an understanding of the nature of past extreme weather events and the impacts they have had on the community, environment and economy. Table 14-7 summarises the primary weather events currently affecting the region and provides a high-level overview of the impacts experienced.

**Table 14-7 Local Climate Impacts Profile for Wiltshire Council**

Weather Event	Impacts
Heavy rain/Flash floods	<ul style="list-style-type: none"> <li>properties across several Wiltshire towns susceptible to flooding. Health and Safety worries along with significant damage and costs;</li> <li>infrastructure disruption across county (primarily road and rail); and</li> <li>services whose premises of normal operations are affected can only provide normal service with additional resources.</li> </ul>

364 <http://www.wiltshire.gov.uk/eco-local-climate-impact-profile.pdf>

Weather Event	Impacts
Snow/Frost/Ice	<ul style="list-style-type: none"> <li>• damage to infrastructure;</li> <li>• services which involve travel require employment of additional resources to maintain a normal service; and</li> <li>• increased maintenance costs for highways.</li> </ul>
Heatwave	<ul style="list-style-type: none"> <li>• strains on water and energy utilities;</li> <li>• disruption to road and rail infrastructure;</li> <li>• significant damage to infrastructure (primarily road and rail); and</li> <li>• excess deaths – danger to vulnerable groups is significant.</li> </ul>
Wind	<ul style="list-style-type: none"> <li>• property damage;</li> <li>• infrastructure disruption;</li> <li>• power cuts; and</li> <li>• blocked transport routes.</li> </ul>

### Vulnerability of the scheme to climate change - future climate

- 14.6.5 This section presents projected climate conditions and extreme weather events for the area encompassing the proposed scheme for the 2020s and 2080s. Full details of the assessment are in appendix 14.1.
- 14.6.6 Using the historical baseline data, two methods are implemented to establish the future climate baseline. The changes in average climate conditions are obtained from the UKCP18 probabilistic projections of climate change<sup>365</sup>. The changes in extreme weather events are obtained using the UKCP18 Weather Generator<sup>366</sup>.
- 14.6.7 Climate change projections for a range of meteorological parameters are presented for different probability levels and emission scenarios for the near-term and long-term future time periods. Table 14-8 presents changes in extreme weather events, such as number of heavy rain days and Table 14-9 presents expected changes in climate conditions, such as mean temperature and precipitation.
- 14.6.8 Temperatures in the area are projected to increase in both winter and summer. The largest increase in temperature is projected to be in the mean daily maximum temperature in summer, which is expected to increase by 5.7°C to 26.4°C in the 2080s, in the high emissions scenario.
- 14.6.9 Mean precipitation rates in the region are anticipated change significantly throughout the century, increasing by 5%-23% in the winter and decreasing by 6%-37% in summer in the second half of the century (2070-2099).
- 14.6.10 The number of hot days, when the maximum temperature is above 25°C, is anticipated to increase from 9.5 to 49 days per year in the 2080s for the high emission scenario. The average number of days in a given year, when the mean daily temperature is below 0°C, is anticipated to decrease from 39.9 to 11.8 until the end of the century under the high emissions scenario.
- 14.6.11 In the case of extreme precipitation, the number of days with heavy rain (precipitation greater than 25mm/day) in a given year is expected to decrease

365 UKCP18 climate change projections. Available at: <http://ukclimateprojections.metoffice.gov.uk/21684> ; Accessed on 18 June 2019.

366 UKCP18 Weather Generator. Available at: <http://ukclimateprojections.metoffice.gov.uk/22540> ; Accessed 18 June 2019.

from 1.7 in the baseline period to 0.8 by the 2080s. Similarly, the average annual number of dry spells (periods of at least 10 consecutive days with no precipitation) is projected to decrease from 1.5 for the baseline period to 0.8 for the 2080s under the high emissions scenario.

**Table 14-8 UKCP18 Climate Change Projections for Extreme Weather Events for the Local Area for the 2020s and 2060s**

Parameter		Projected baseline	2020s (2010-2039)			2060s (2070-2099)		
			Min	Mean	Max	Min	Mean	Max
Temperature	Number of frost days (daily minimum temperature equal or lower than 0°C)	39.9	14.8	26.6	40.4	6.3	11.8	19.5
	Heatwaves (2 days with maximum temperature higher than 29°C and minimum temperature higher than 15°C)	0.4	0.3	1.1	2.8	2.9	7.1	12.9
	Summer highest daily maximum temperature	35.7	32.3	37.6	39.7	40.3	42.4	47.8
	Number of hot days (daily maximum temperature higher than 25°C)	9.5	11.6	24.3	47.8	32.3	58.5	84.4
Precipitation	Dry spells (10 days or more with no precipitation)	1.5	0.7	1.7	3.0	1.7	2.8	3.8
	Annual number of days per year when precipitation is greater than 25mm per day (Met Office definition of 'heavy rain')	1.7	1.1	1.9	2.6	1.5	2.5	3.5
Wind	Wind above 10m/s	1.1	0.2	1.0	2.4	0.2	1.1	2.7

**Table 14-9 UKCP18 Climate Change Projections for Average Climate Variables for the Local Area for the 2020s and 2080s**

	Parameter and baseline (in brackets, 1981-2010)	2020s (2010-2039)		2080s (2070-2099)	
		Medium emissions scenario (50 <sup>th</sup> percentile)	Range (10 <sup>th</sup> to 90 <sup>th</sup> Percentile)	Medium emissions scenario (50 <sup>th</sup> percentile)	Range (10 <sup>th</sup> to 90 <sup>th</sup> Percentile)
Temperature	Mean winter daily temperature [°C] (4.4°C)	0.7	-0.1 to 1.4	3	1.1 to 5
	Mean summer daily temperature [°C] (15.9°C)	0.9	0.2 to 1.7	0.9	0.2 to 1.7
	Mean daily summer maximum temperature [°C] (20.7°C)	1.2	0.3 to 2.1	5.7	2.2 to 9.4
	Mean daily winter minimum temperature [°C] (1.5°C)	0.6	-0.1 to 1.4	3	1 to 5.4
Precipitation (%)	Winter mean precipitation rate (2.4%)	5%	-4% to 15%	23%	2% to 47%
	Summer mean precipitation rate (1.8%)	-6%	-22% to 9%	-37%	-65% to -9%
Specific humidity (%)	Winter (85.7%)	4%	-2% to 10%	22%	7% to 39%
	Summer (75.8%)	4%	-1% to 8%	16%	3% to 30%

## 14.7 Consultation

- 14.7.1 The Scoping Opinion published in response to the Environmental Scoping Report and included responses relating to climate change. These have been considered and included, where appropriate, in this chapter.
- 14.7.2 A summary of the responses relevant to the climate assessments and the respective changes made to the scope of this chapter would be reported within the ES, which would accompany the DCO application.

## 14.8 Assessment Assumptions and Limitations

### Effects on climate

- 14.8.1 Data on the climate baseline and future projections are based on freely available information from third-parties, including the historical meteorological variables recorded by the Met Office and the UK Climate Projections (UKCP09) developed by the Met Office. In addition, the assessment has been informed by a selected range of existing climate change research and literature, available at the time of writing this assessment.
- 14.8.2 Climate projections are not predictions or forecasts but simulations of potential scenarios of future climate, under a range of hypothetical emissions scenarios and assumptions. Therefore, the results from running the climate models cannot be treated as exact or factual, but projection options. They represent internally

consistent representations of how the climate may evolve in response to a range of potential forcing scenarios, and their reliability varies between climate variables. Scenarios exclude outlying "surprise" or "disaster" scenarios in the literature, and any scenario includes, out of necessity, subjective elements and is open to various interpretations. In general, global projections are more certain than regional projections, and temperature projections are more certain than those for precipitation. Furthermore, the degree of uncertainty associated with all climate change projections increases for projections further into the future.

14.8.3 An updated quantitative assessment of GHG emissions has not been undertaken for the PEI Report as there is insufficient information available. As the scheme design progresses, a greater level of detail will allow an informed estimate to be calculated.

14.8.4 In the ES, GHG emissions would be quantified as per the approach outlined in this chapter.

#### Vulnerability of the scheme to climate change

14.8.5 The CCR assessment has been informed by the following principle assumptions:

- the assessment has assumed that mitigation measures relevant to different assets would be implemented effectively; and
- the assessment is affected by assumptions associated with climate modelling and climate change projections, incorporated in UKCP18.

14.8.6 The CCR assessment has the following limitations:

- the assessment is largely qualitative, with the exception of assessments relevant to drainage assets and flood risk, which have been informed by the Environment Agency climate change allowances for increases in peak river flow and rainfall intensity;
- there is limited methodological guidance on climate change resilience assessment in EIA from Government, and other institutions;
- there is inherent uncertainty in climate change projections. This study has been quantified using UKCP18, the latest set of probabilistic climate projections for the UK;
- there is often uncertainty in the relationship between changes in climate hazards and the respective response in terms of asset performance. This uncertainty has been assessed qualitatively; and
- the evidence relating to climate change impacts for some categories of assets and infrastructure is limited. In these cases, the assessment has been informed by professional judgement.

14.8.7 Mitigation measures relevant to the CCR assessment listed in this PEI Report are only indicative or missing altogether. This is a result of the maturity of design and environmental topic assessments at the time of drafting of this chapter. Details about the relevant mitigation and resilience measures would be confirmed and updated as part of the ES.

## 14.9 Design, Mitigation and Enhancement Measures

### Construction Mitigation

#### Effects on climate

14.9.1 Mitigation measures would be developed and reported in the ES.

14.9.2 In line with Highways England's licence requirement for minimising GHG emissions and the UK Government's carbon reduction plan, the proposed scheme would seek to reduce GHG emissions as far as practicable in all cases to contribute to the UK's net reduction in carbon emissions and maximise its potential for reducing GHG emissions. The following high level options would be applied and developed when seeking to reduce GHG emissions on projects:

- maximise potential for re-using and/or refurbishing existing assets to reduce the extent of new construction required, and / or explore alternative lower carbon options to deliver the project objectives (i.e. shorter route options with smaller construction footprints);
- apply low carbon solutions (including technologies, materials and products) to minimise resource consumption during the construction, operation, user's use of the project, and at end-of-life; and construct efficiently: use techniques (e.g. during construction and operation) that reduce resource consumption over the life cycle of the project.

#### Vulnerability of the scheme to climate change

14.9.3 All weather, and climate-related risks to construction activities are expected to be mitigated through the relevant measures, set out in the Outline CEMP, providing a level of resilience to the proposed scheme throughout construction.

### Operation Mitigation

#### Effects on climate

14.9.4 Mitigation measures would be developed and reported in the ES.

#### Vulnerability of the scheme to climate change

14.9.5 Most weather and climate-related resilience effects during operation are expected to be mitigated through measures already embedded in the design of the proposed scheme, providing a level of resilience throughout its operation.

14.9.6 The CCR assessment results are summarised in section 14.10, with detailed results presented in appendix 14.1. The assessment has identified two potential additional mitigation measures, which may be considered in the design to increase the resilience of the proposed scheme during its operation:

- the need to review design temperature ranges for structure expansion joints, in line with projected increases in summer temperatures; and
- the potential to use a different road surface material in order to increase performance in hotter weather conditions.

## 14.10 Assessment of Effects

14.10.1 This section provides a summary of the climate change effects associated with the proposed scheme.

14.10.2 A detailed assessment of capital, operational and user carbon emissions has not been undertaken at this stage. These would be quantified as part of the ES once the scheme design has progressed and traffic modelling has been completed. This will enable an informed estimate to be calculated.

14.10.3 The key GHG emission sources that are being considered in the GHG assessment are set out in Table 14.10.

**Table 14-10 Key anticipated GHG emission sources**

Lifecycle stage	Activity	Primary emission sources
Capital GHG emissions (Construction stage)	Enabling works to prepare the site for construction.	Vehicles and fuel use for generators on site. Workers travelling to and from the site of the proposed scheme.
	Land clearance for example removal of any vegetation or habitats for replacement with other land use.	Losses of carbon sink i.e. removal of a natural environmental that could absorb GHG emissions.
	Use of products and/or materials required to build the proposed scheme.	Embodied GHG emissions within the construction materials i.e. emissions resulting from the extraction of raw materials, the manufacturing/processing of materials into secondary/final products for use and the transportation of those materials.
	On-site construction activity including: <ul style="list-style-type: none"> <li>• Use of construction vehicles and plant including tunnel boring machinery;</li> <li>• Transport of materials to the construction site (where these are not included in embodied GHG emissions);</li> <li>• Transportation of construction workers to site;</li> <li>• Disposal of any waste or other materials generated by the construction processes.</li> </ul>	GHG emissions from vehicle and plant use. GHG emissions from disposal of waste.
Operational GHG emissions	Operation of the associated road and tunnel lighting, overhead gantries etc. Maintenance including resurfacing. Proposed planting of new vegetation.	GHG emissions from energy and fuel use. Embodied emissions associated with re-surfacing materials. Sequestration of GHG emissions by new vegetation acting as a carbon sink.
User GHG emissions	Vehicle journeys both on the road and within the vicinity of the road.	GHG emissions per vehicle km. Energy consumption

14.10.4 The detailed preliminary results from the CCR assessments are presented in appendix 14.1.

## Construction Effects

### Effects on climate

14.10.5 If the DCO is granted, construction is planned to start in late 2021 and the proposed scheme is due to open to traffic in 2024. Therefore the construction



period for the proposed scheme falls within the 3rd and 4th carbon budgets. Operation of the proposed scheme is assessed over a 60 year period commencing within the 4th carbon budget period. Operational emissions will be compared against the 5th carbon budget up to 2032. No carbon budget has yet been set after this date.

- 14.10.6 The ES will report CO<sub>2</sub> emissions at both construction and operation against their relevant UK government carbon budgets, expressed as a net figure compared to emissions from the 'do-minimum' scenario.
- 14.10.7 The method to calculate the UK carbon budgets is different to that used for the calculation of lifecycle emissions from a road scheme and therefore some caution must be taken when making a direct comparison. However, for the purposes of identifying to what extent the proposed scheme may impact the ability of the UK meeting its carbon budgets it is necessary to make this comparison to put the proposed scheme into context.
- 14.10.8 The NPSNN states that it is very unlikely that the impacts of a road project would, in isolation, affect the ability of Government to meet its carbon reduction plans. In the ES, project emissions would be reported against the relevant carbon budget periods of the UK Government. This would demonstrate that the proposed scheme would not have a material impact on the ability of Government to meet its carbon reduction targets. Hence there is no likely significant effect on climate.

#### Vulnerability of the scheme to climate change

- 14.10.9 No significant climate change resilience effects have been identified for the construction stage and no further climate change resilience measures are proposed. Details of the significance assessment are contained in appendix 14.1.
- 14.10.10 Most climate change risks to assets and infrastructure during the period during which construction works are to be undertaken have been assessed as 'low' or 'very low' risk due to implementation of the measures contained within the Outline EMP and adherence to relevant health and safety standards.
- 14.10.11 Several risks during construction have been assessed as 'medium', due to the very high potential consequences relating to health and safety if the respective event does occur, for example because of a potential earthworks failure. However, the likelihood of such risks occurring is 'very low', due to the implementation of robust mitigation measures; a summary of the mitigations for each climate change risk is included as part of the assessment results presented in appendix 14.1.

#### In-combination Climate Change Impacts (ICCI) assessment

- 14.10.12 As noted previously, details of the in-combination climate change impacts relevant to each environmental topic are presented within the chapters of each discipline.

### **Operation Effects**

#### Effects on climate

- 14.10.13 As noted in the study area section, there are no operational emissions associated with physical assets on the proposed scheme. However, as noted in the baseline conditions, reduction in atmospheric GHGs associated with sequestration of

GHGs over time by landscape within the project boundary would be considered as part of the ES.

- 14.10.14 User GHG emissions would be included within the ES when relevant data would be available to undertake the assessment. User GHG emissions will constitute the vast majority of the whole life GHG emissions of the proposed scheme.

#### Vulnerability of the scheme to climate change

- 14.10.15 Climate change risks to infrastructure assets designed and constructed as part of the proposed scheme have been assessed in their lifecycle of operation. Most climate change risks to assets during the operation of the proposed scheme are found to be 'low' or 'very low', as a result of mitigation measures already embedded within design. Like risk during construction, several risks have been assessed as 'medium', due to the large consequences associated with them. However, the likelihood of such risks occurring is considered to be 'very low', due to the implementation of robust mitigation measures, as described in the detailed results presented in appendix 14.1. Additionally, several risks have been assessed as 'medium', where the consequence may be low, but the likelihood of occurrence is deemed to be high, for example increased risk of potholing due to increases in summer temperature as well as diurnal temperature ranges. Such risks would be mitigated as detailed in the assessment results presented in appendix 14.1.
- 14.10.16 In terms of operational resilience in cold weather during winter, it is recommended that current levels of preparedness are maintained, because although average temperatures are projected to rise, cold spells may be more intensive and sporadic and have the potential to have a large impact on performance.

### **14.11 Monitoring**

- 14.11.1 As no significant effects have been identified for the climate assessment, no monitoring of significant effects is proposed. Monitoring requirements, should they be required, would be specified within the ES accompanying the DCO application.
- 14.11.2 Highways England is committed to reducing carbon emissions and working closely with suppliers to reduce emissions from network related activity. As a requirement of the outline CEMP, energy consumption and materials use will be recorded and reported on an ongoing basis during the construction phase of the scheme using Highways England Carbon Reporting Tool. It is not considered practical to monitor GHG emissions from road users during the operational phase of the proposed scheme.

### **14.12 Summary**

- 14.12.1 The climate change chapter in this PEI Report describes two separate assessments: the GHG assessment and the climate change resilience (CCR) assessment.
- 14.12.2 The proposed scheme would result in GHG emissions due to construction materials and activities during the construction phase and vehicles using the road during the operation phase. GHG emissions will be quantified in the ES.
- 14.12.3 Assets and infrastructure designed as part of the proposed scheme are likely to be affected by climate change. A number of potential risks have been identified

and assessed; these would be mitigated by applying robust design standards or relevant mitigation measures would be incorporated in the relevant asset management processes.

14.12.4 The proposed scheme impacts are likely to be not significant based on the fact the proposed scheme would not have a material impact on the ability of Government to meet its carbon reduction targets. Therefore, the following conclusions can be made.

#### Preliminary construction assessment

- Effects on climate: no likely significant effect.
- Vulnerability of the scheme to climate change: no likely significant effect.

#### Preliminary operation assessment

- Effects on climate: no significant effect.
- Vulnerability of the scheme to climate change: no likely significant effect.

### **Further Work**

14.12.5 A detailed assessment of effects on the climate of the GHG emissions during the construction and operational phases of the proposed scheme will be undertaken based on the Highways England Carbon Reporting Tool and assessment of road user emissions in line with HA 207/07.

14.12.6 The following will be carried out for the EIA:

- Revision of the traffic model to ensure traffic data used in the GHG assessment is consistent with the design of the proposed scheme.
- Consultation with local authorities and other relevant stakeholders will be carried out to agree the methodology of the GHG assessment.
- Quantitative assessment of GHG emissions associated with the construction, operation and use of the road, based on the proposed scheme design.
- The potential for mitigation of climate change risks related to high temperatures, including reviewing design temperature ranges for structure expansion joints and road surface material, will be undertaken.
- Project-specific mitigation measures and monitoring requirements during construction and operation will be considered and addressed in the ES.

## 15 Assessment of Cumulative Effects

### 15.1 Introduction

- 15.1.1 Cumulative effects are those that arise as a result of impacts from more than one project (under construction or reasonably foreseeable projects), combining together to have an effect on a receptor (or group of receptors) that may be larger than if the effect were considered separately. Broadly, reasonably foreseeable projects are those that are known to the planning system or are already consented (but not yet built).
- 15.1.2 This PEI Report discusses the approach to cumulative assessment that will be used to undertake an assessment of cumulative effects arising from the proposed scheme in combination with other reasonably foreseeable projects in the local area. A list of other developments that will be considered by each environmental topic in the assessment and an assessment of these developments will be provided in the ES accompanying the DCO application.

### 15.2 Legislative Context

- 15.2.1 The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 sets out in schedule 4 part 5 that the ES should include:

*“the cumulation of effects with other existing and/or approved projects, taking into account any existing environmental problems relating to areas of particular environmental importance likely to be affected or the use of natural resources.”*

- 15.2.2 The requirement for cumulative effects is also outlined in planning policy. The National Policy Statement for National Networks, paragraph 4.3 states that:

*“In considering any proposed development, and in particular, when weighing its adverse impacts against its benefits, the Examining Authority and the Secretary of State should take into account:*

- *its potential benefits, including the facilitation of economic development, including job creation, housing and environmental improvement, and any long-term or wider benefits;*
- *its potential adverse impacts, including any longer-term and cumulative adverse impacts, as well as any measures to avoid, reduce or compensate for any adverse impacts.”*

- 15.2.3 DMRB volume 11 section 2 LA 104 states environmental assessments shall assess cumulative effects which include those from:

- a single project (e.g. numerous different effects impacting a single receptor); and
- different projects (together with the project being assessed).

### 15.3 Cumulative Assessment Methodology

- 15.3.1 There is currently no standard methodology for cumulative effects assessment (CEA) and combined effects although there is a range of guidance available. The following guidance has been taken into consideration during the preparation of this PEI Report and will also be employed in production of the ES:

- Advice Note 17: Cumulative effects assessment relevant to nationally significant infrastructure projects<sup>367</sup>.
- Advice Note 9: Rochdale Envelope<sup>368</sup>.

15.3.2 Planning Inspectorate Advice Note 17 provides a systematic approach to cumulative effects assessment which can be split into four distinct phases explained in Table 15-1. The guidance notes that the recommended process focusses on cumulative effects with ‘other developments’. It should not be confused with the assessment of interrelationships between topics, which are assessed within the individual specialist topic chapters. This aligns with DMRB LA 104.

**Table 15-1 Stages of Cumulative Effects Assessment**

CEA stage	Activity
<p><u>Stage 1:</u> Establish the Zone of Influence (ZOI) of the proposed scheme and identify long list of ‘other developments’.</p>	<ul style="list-style-type: none"> <li>• identify the ZOI for each of the environmental topics covered by the ES;</li> <li>• identify a long list of other developments in the vicinity of the proposed scheme which may have cumulative effects; and</li> <li>• undertake desktop review of available environmental information for identified cumulative developments.</li> </ul>
<p><u>Stage 2:</u> Identify short list of ‘other developments’.</p>	<ul style="list-style-type: none"> <li>• identify which of the identified other developments from Stage 1 has the potential to give rise to significant cumulative effects by virtue of overlaps in temporal scope, due to the scale and nature of the ‘other development’/receiving environment; or any other relevant factors.</li> </ul>
<p><u>Stage 3:</u> Information gathering</p>	<ul style="list-style-type: none"> <li>• information related to the shortlisted cumulative developments is gathered and reviewed.</li> </ul>
<p><u>Stage 4:</u> Assessment</p>	<ul style="list-style-type: none"> <li>• CEA of shortlisted cumulative development is undertaken. Each individual ‘other development’ is reviewed in turn to identify whether there is potential for significant cumulative effects; and</li> <li>• mitigation measures are identified.</li> </ul>

**Stage 1 Establish the NSIP’s ZOI and Long List of ‘Other Development’**

15.3.3 The zone of influence (ZOI) refers to the spatial area over which an effect from a project is likely to be experienced. The ZOI for the proposed scheme varies for each environmental topic and has been set out in the study area for each environmental topic assessment, presented in the topic chapters of the PEI Report.


**Establishing the long list of ‘other developments’**

15.3.4 The Planning Inspectorate guidance recommends that a wide range of future projects is included within the CEA which can be tiered (from Tier 1 – 3) according to how far advanced the development is within the planning system and to the level of detail that is likely to be available for each tier. The tiers are set out in Table 15-2.

<sup>367</sup> The Planning Inspectorate (August 2019) Cumulative Effects Assessment, Advice note seventeen: Cumulative effects assessment relevant to nationally significant infrastructure projects: <https://infrastructure.planninginspectorate.gov.uk/wp-content/uploads/2015/12/Advice-note-17V4.pdf>

<sup>368</sup> Planning Inspectorate (July 2018) Using the Rochdale Envelope, Advice note nine: <https://infrastructure.planninginspectorate.gov.uk/wp-content/uploads/2013/05/Advice-note-9.-Rochdale-envelope-web.pdf>

**Table 15-2 Project Tiering for the Purpose of CEA**

Tier 1	<ul style="list-style-type: none"> <li>Projects under construction;</li> <li>Permitted application(s) but not yet implemented;</li> <li>Submitted application(s) but not yet determined;</li> </ul>	<p><b>Decreasing level of detail likely to be available.</b></p> 
Tier 2	<ul style="list-style-type: none"> <li>Projects on the Planning Inspectorate’s Programme of Projects where a scoping report has been submitted.</li> </ul>	
Tier 3	<ul style="list-style-type: none"> <li>Projects on the Planning Inspectorate’s Programme of Projects where a scoping report has not been submitted.</li> <li>Identified in the relevant Development Plan (and emerging Development Plans - with appropriate weight being given as they move closer to adoption) recognising that much information on any relevant proposals will be limited; and</li> <li>Identified in other plans and programmes (as appropriate) which set the framework for future development consents/approvals, where such development is reasonably likely to come forward.</li> </ul>	

15.3.5 The less information that is available for the future projects (i.e. environmental impacts predicted, project definition), the less likely that the CEA will be able to make any robust assessment in relation to these projects. Reasonable steps will be taken to review publicly available information when conducting the CEA.

15.3.6 Whilst projects that are Tier 2 and Tier 3, as defined by the Planning Inspectorate guidance are referenced within this assessment, it is considered that there is limited value in including schemes for which there is no environmental assessment information available as it will not be possible to assess environmental effects arising from those projects. Moreover, it will be challenging to determine the timeframe (temporal scope as noted in Table 15-4) within which effects arising from these schemes are likely to occur.

15.3.7 The identification of ‘other development’ will be identified through consultation with the local councils and their planning portals:

- Cotswold District Council;
- Gloucester City Council; and
- Tewkesbury Borough Council.

15.3.8 The National Infrastructure Planning website will also be consulted. The list of ‘other developments’ will be provided in the ES accompanying the DCO application.

**Stage 2 Identify Shortlist of ‘Other Development’ for CEA**

15.3.9 The long list of other developments identified under Stage 1 will be subject to further threshold and criteria to identify a proportionate list of developments to be assessed within the CEA. This will be reported in the ES.

15.3.10 The threshold and criteria considered in shortlisting a development is outlined in Table 15-3. Criteria has been adapted from the Planning Inspectorate guidance and the EIA Regulations 2017.

**Table 15-3 Criteria for Shortlist of 'Other Development'**

Threshold	Description
The temporal scope of 'other development' potential for interaction.	<ul style="list-style-type: none"> <li>• Consideration of relative construction, operation and decommissioning programmes of the 'other development' identified in the ZOI with the proposed scheme programme, to establish whether there is overlap, or similar temporal scope for construction and operation phases, and any potential for interaction.</li> </ul>
The scale and nature of 'other development'	<ul style="list-style-type: none"> <li>• Consideration of whether the scale and nature of the developments identified in the ZOI are likely to interact with the proposed scheme and to result in a cumulative effect;</li> <li>• Characteristics of other developments in relation to use of natural resources, pollution and nuisances, and risks to human health;</li> <li>• The scale of developments which are more than 1 hectare of urban development which is not a dwelling development;</li> <li>• The development includes more than 150 dwellings; or</li> <li>• The overall area of the development exceeds 5 hectares.</li> </ul>
Any other relevant factors	<ul style="list-style-type: none"> <li>• Nature and/or capacity of the receiving environment that would make a significant cumulative effect with 'other development'. The sensitivity of the receiving environment includes whether the sites are within: <ul style="list-style-type: none"> <li>a) wetlands, riparian areas, river mouths;</li> <li>b) coastal zones and the marine environment;</li> <li>c) mountain and forest areas;</li> <li>d) nature reserves and parks;</li> <li>e) European sites and other areas classified or protected under national legislation;</li> <li>f) areas in which there has already been a failure to meet the environmental quality standards, laid down in Union legislation and relevant to the project, or in which it is considered that there is such a failure;</li> <li>g) densely populated areas; and</li> <li>h) landscapes and sites of historical, cultural or archaeological significance.</li> </ul> </li> <li>• The relative abundance, availability, quality and regenerative capacity of natural resources in the area.</li> <li>• Potential for creation of source-pathway-receptor impacts.</li> <li>• The likely significance of effects where environmental assessments have been undertaken for the 'other developments' as having moderate to large significance.</li> </ul>

15.3.11 Professional judgement would be applied to 'other development' that exceeds the thresholds but do not give rise to discernible effects. The reasons for excluding any 'other development' from further consideration will be outlined within the ES.

### Stage 3 Information Gathering

15.3.12 Information on the 'other developments' will be compiled from publicly available documents on the Cotswold District Council, Gloucester City Council and Tewkesbury Borough Council's websites, the Planning Inspectorate's website and through direct liaison with the councils directly.

### Stage 4 Assessment

15.3.13 The assessment of significance of the combined and cumulative effects will be presented in the ES and will be determined in accordance with the significance

assessment as detailed under chapter 4 Approach to Environmental Impacts of this PEI Report.

15.3.14 For the purposes of the CEA, the value of a resource and magnitude of impact will be determined according to the criteria set within the preceding chapters of this PEI Report and to be set out in full within the ES accompanying the DCO application. The significance of effect is then carried forward from preceding chapters to enable an ‘on balance’ assessment of combined significance upon environmental receptors, as well as to identify the significance of cumulative effects with other developments.

15.3.15 The significance criteria for cumulative effect has been standardised into five categories. This is set out in Table 15-4 and will be used in the assessment to be reported in the ES.

**Table 15-4 Determining Significance of Cumulative Effects**

<b>Significance</b>	<b>Effect</b>
Severe	Effects that the decision-maker must take into account as the receptor/resource is irretrievably compromised.
Major	Effects that may become key decision-making issue.
Moderate	Effects that are unlikely to become issues on whether the project design should be selected, but where future work may be needed to improve on current performance.
Minor	Effects that are locally significant.
Not Significant	Effects that are beyond the current forecasting ability or are within the ability of the resource to absorb such change.

15.3.16 The assessment of cumulative effects will vary depending on each topic. The results of the CEA will be provided in the ES.

15.3.17 Where significant cumulative effects beyond those identified as residual effects from the proposed scheme in isolation are identified, an assessment of the need for additional mitigation will be undertaken.

### **Combined Effects**

15.3.18 Cumulative impacts from the combined action of a number of different impacts upon a single resource/receptor (including the interrelationship of visual, noise and air quality impacts on residential, commercial, ecological and heritage receptors) have also been considered for this PEI Report and will be presented within the ES. As mentioned in the stage 4 CEA methodology above, the assessment of combined effects is based on the significance assessment as detailed in chapter 4 Approach to Environmental Impacts.

15.3.19 The study area for the assessment of combined effects reflects the study areas, also termed the spatial ZOI i.e. corresponding to the spatial area over which an effect from a project is likely to be experienced.



## 15.4 Summary

- 15.4.1 In line with DMRB LA 104, cumulative effects should be assessed when the conclusions of individual environmental factor assessments have been reached and reported.
- 15.4.2 For this PEI Report, a full cumulative effects assessment and combined effects assessment has not been undertaken as the proposed scheme environmental assessments are still being undertaken at this stage. Therefore, this chapter presents the methodology to undertake a CEA through a four-stage process which will be completed and included in the ES.

## 16 Summary

### 16.1 Summary of effects

- 16.1.1 Based on this preliminary assessment, the scale and location of the proposed scheme means that several different aspects of the environment would potentially be affected. Some of these effects would occur during construction, such as the loss of land, vegetation and wildlife habitat, and the generation of dust and noise. Other impacts would occur during operation, such as noise from traffic, changes to travel conditions, development of new habitats from the landscape and ecological mitigation proposals.
- 16.1.2 The previous technical chapters 5 to 14 present the preliminary assessments for the individual EIA topics. Each assessment provides a preliminary assessment of the likely significant effects and Table 16-1 provides a high-level summary of these effects.
- 16.1.3 The ongoing EIA will consider these effects and assess their significance, taking into account proposed mitigation measures. This will be presented in the ES prepared to accompany the DCO application.

**Table 16-1 Summary of Preliminary Assessment of Likely Significant Environmental Effects**

Topic	Preliminary assessment of likely significant environmental effects*	
	Construction stage	Operation stage
Air Quality	<ul style="list-style-type: none"> <li>No likely significant effects anticipated</li> </ul>	<ul style="list-style-type: none"> <li>No likely significant effects anticipated</li> </ul>
Cultural Heritage	<ul style="list-style-type: none"> <li>Permanent <b>adverse</b> effects on the setting of 5 No. scheduled monuments, which include: barrows and Crickley Hill Camp.</li> <li>Permanent <b>adverse</b> effects on Shab Hill Barn Grade II Listed Building</li> <li><b>Adverse</b> effect anticipated if below ground archaeology is directly impacted.</li> </ul>	<ul style="list-style-type: none"> <li>None assessed at PEI Report stage – see chapter 6.</li> </ul>
Landscape and Visual	<ul style="list-style-type: none"> <li>Temporary <b>adverse</b> effects to the landscape character and on the Special Qualities of the Cotswolds AONB.</li> <li>Temporary <b>adverse</b> effects likely for landscape character areas that are directly affected by the proposed development including, LCT 2 Escarpment, LCT 7 High Wold, LCT 8 High Wold Valley and LCT 18 Settled Unwooded Vale.</li> <li>Temporary adverse effects experienced by residents of Little Witcombe and Great Witcombe, Shab Hill, Cowley, Stockwell, visitors to the Cotswolds AONB, and users of the public rights of way (PRoW) network.</li> </ul>	<ul style="list-style-type: none"> <li>Combination of <b>adverse</b> and <b>beneficial</b> permanent effects to the landscape character and on the Special Qualities of the Cotswolds AONB.</li> <li>A mix of <b>adverse</b> and <b>beneficial</b> permanent significant effects likely for landscape character areas that are directly affected by the proposed development including, LCT 2 Escarpment, LCT 7 High Wold, LCT 8 High Wold Valley and LCT 18 Settled Unwooded Vale.</li> <li>Combination of <b>adverse</b> and <b>beneficial</b> permanent effects experienced by residents of Little Witcombe and Great Witcombe, Shab Hill, Cowley, Stockwell, visitors to the Cotswolds AONB, and users of the public rights of way (PRoW) network.</li> </ul>
Biodiversity	<ul style="list-style-type: none"> <li><b>Adverse</b> effects likely on ancient woodland and veteran trees due to irreplaceable habitat.</li> <li><b>Adverse</b> effect possible on bats depending on outcome of ongoing surveys.</li> </ul>	<ul style="list-style-type: none"> <li><b>Beneficial</b> effect on ecological connectivity.</li> <li><b>Adverse</b> effect likely due to irreplaceable habitat.</li> <li><b>Adverse</b> effect possible on bats depending on outcome of ongoing surveys.</li> </ul>
Geology and Soils	<ul style="list-style-type: none"> <li>Permanent <b>adverse</b> or permanent <b>beneficial</b> effects on SSSI or geologically designated sites, including the distinctive geomorphology of the Cotswold escarpment, Crickley Hill and Barrow Wake SSSI, and the Churn Valley.</li> </ul>	<ul style="list-style-type: none"> <li>No likely significant effects anticipated.</li> </ul>

Topic	Preliminary assessment of likely significant environmental effects*	
	Construction stage	Operation stage
	<ul style="list-style-type: none"> <li>• <b>Adverse</b> effect on best and most versatile agricultural land (subject to an Agricultural Land Classification survey).</li> </ul>	
Material Assets and Waste	<ul style="list-style-type: none"> <li>• No likely significant effects anticipated.</li> </ul>	<ul style="list-style-type: none"> <li>• No likely significant effects anticipated.</li> </ul>
Noise and Vibration	<ul style="list-style-type: none"> <li>• Temporary <b>adverse</b> noise effects from construction activities for residential properties and particular footpath links in the AONB near new alignment.</li> <li>• Temporary <b>adverse</b> vibration effects at one location.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Beneficial</b> noise effects at residential locations near section of removed A417, particularly at Birdlip and particular footpath links in the AONB near Crikley Hill.</li> <li>• <b>Adverse</b> noise effects for residential properties near new alignment and particular footpath links nearby in the AONB.</li> <li>• No operational vibration effects.</li> </ul>
Population and Human Health	<ul style="list-style-type: none"> <li>• Potential for <b>significant adverse</b> effects on one business and one residential property.</li> </ul>	<ul style="list-style-type: none"> <li>• Likely <b>beneficial</b> effects on connectivity and amenity for users of the PRoW network.</li> <li>• Likely <b>beneficial</b> health effects in relation to air quality.</li> </ul>
Road Drainage and the Water Environment	<ul style="list-style-type: none"> <li>• <b>Adverse</b> effect on groundwater flows - construction activities of cuttings, trenches, voids incl. dewatering, embankments, underground structures may affect groundwater flow - redistribution of flow paths and rate; new flow paths; affecting aquifer and surface water recharge.</li> </ul>	<ul style="list-style-type: none"> <li>• No likely significant effects anticipated.</li> </ul>
Climate	<ul style="list-style-type: none"> <li>• No likely significant effects anticipated.</li> </ul>	<ul style="list-style-type: none"> <li>• No likely significant effects anticipated.</li> </ul>

\*Note - After inclusion of the proposed mitigation measures

## 17 Abbreviations

Table 17-1 Table of Abbreviations

Abbreviation	In Full
AADT	Annual Average Daily Traffic
ADS	Advanced Direction Signs
AGLV	Area of Great Landscape Value
AIA	Agricultural Impact Assessment
ALC	Agricultural Land Classification
AMS	Arboriculturally Method Statement
AMS	Archaeological Mitigation Strategy
AOD	Above Ordnance Datum
AONB	Area of Outstanding Natural Beauty
AQAPs	Air Quality Action Plans
AQMA	Air Quality Management Areas
AQO	Air Quality Objective
AQS	Air Quality Strategy
AR5	Fifth Assessment Report
ARN	Affected Road Network
ARP	Adaption Reporting Power
ARS	Active Roost Sites
BAP	Biodiversity Action Plan
BGS	British Geological Society
BMV	Best Most Versatile Agricultural Land
BOAT	Byway Open to All Traffic
BPM	Best Practicable Means
BRES	Business Register and Employment Survey
BTO	British Trust for Ornithology
CA	Character Areas
CA	Conservation Area
CBC	Common Bird Census
CCB	Cotswold Conservation Board
CCI	Community Conservation Index
CCR	Climate Change Resilience
CCRA	Climate Change Risk Assessment
CCTV	Closed Circuit Television
C&D	Construction and Demolition
CDC	Cotswold District Council
CDE	Construction, Demolitions and Excavation
CDW	Construction and Demolition Waste
CEA	Cumulative Effects Assessment
CEMP	Construction Environmental Management Plan
CERC	Cambridge Environmental Research Consultants

<b>Abbreviation</b>	<b>In Full</b>
Ch(#)	Chainage
CIEEM	Chartered Institute of Ecology and Environmental Management
CL:AIRE	Contaminated Land: Applications in Real Environments
CNA	Community Neighbourhood Area
CO	Carbon Monoxide
CO <sub>2</sub>	Carbon Dioxide
COP21	21st Conference of The Parties
COSHH	Control of Substances Hazardous to Health Regulations
CRoW	Countryside and Rights of Way
CRTN	Calculation of Road Traffic Noise
CS	Conservation Score
CSM	Common Standards Monitoring
CWS	County Wildlife Sites
D2AP	Two Lane All-Purpose Dual Carriageway
DAS	Discretionary Advice Survey
dB	Decibel
DCO	Development Consent Order
dDCO	draft Development Consent Order
DECC	Department of Energy and Climate Change
DEFRA	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
DM	Do-Minimum
DMRB	Design Manual for Roads and Bridges
DPD	Development Plan Document
DQRA	Detailed Quantitative Risk Assessment
DS	Do-Something
DTM	Digital Terrain Map
DWI	Drinking Water Inspectorate
EA	Environment Agency
EC	European Commission
ECoW	Ecological Clerk of Works
EE	Environmental Elements
EEA	European Economic Area
EF	Environmental Functions
EFA	Education Funding Agency
EIA	Environmental Impact Assessment
ELC	European Landscape Convention
EMF	Electric and Magnetic Fields
EMP	Environmental Management Plan
EMS	Environmental Management System
EPDs	Environmental Product Declarations
EPA	Environmental Protection Act

<b>Abbreviation</b>	<b>In Full</b>
EPS	European Protected Species
EQS	Environmental Quality Standards
ERT	Electrical Resistivity Tomography
ES	Environmental Statement
ESCR	Earth Science Conservation Review
EU	European Union
FEQS	Freshwater Environmental Quality Standards
FRA	Flood Risk Assessment
FRMP	Flood Risk Management Plan
FSC	Forest Stewardship Council
GAC	Generic Assessment Criteria
GCER	Gloucestershire Centre for Environmental Records
GCR	Geological Conservation Review
CDE	Construction, Demolition and Excavation (Waste)
GHER	Gloucestershire Historic Environment Record
GHG	Greenhouse Gases
GI	Ground Investigation
GIR	Ground Investigation Report
GIS	Geographical Information Systems
GLVIA	Guidelines for Landscape and Visual Impact Assessment
GPS	Global Positioning System
GQRA	Generic Quantitative Risk Assessment
GWDD	Groundwater Daughter Directive
GWDTE	Groundwater Dependent Terrestrial Ecosystem
GWT	Gloucestershire Wildlife Trust
HAGDMS	Highways Agency Geotechnical Data Management System
HEWRAT	Highways England Water Risk Assessment Tool
HE	Highways England
HEGS	Hedgerow Evaluation and Grading Systems
HEMP	Handover Environmental Management Plan
HER	Historic Environment Records
HDV	Heavy Duty Vehicle
HGV	Heavy Goods Vehicle
HPIs	Habitats of Principal Importance
HSA	High Specification Aggregates
HRA	Habitats Regulations Assessment
IAN	Interim Advice Note
IAQM	Institute of Air Quality Management
ICCI	In-Combination Climate Change Impact
IEEM	Institute of Ecology and Environmental Management
IEMA	Institute of Environmental Management and Assessment
IP	Inter-Peak

<b>Abbreviation</b>	<b>In Full</b>
ICCI	In-Combination Climate Change Impacts
ISIS	Invertebrate Species-Habitat Information System
IPCC	Intergovernmental Panel on Climate Change
JCS	Joint Core Strategy
JNCC	Joint Nature Conservation Committee
KPI	Key Performance Indicator
LAQM	Local Air Quality Management
LB	Listed Building
LCA	Landscape Character Area
LCLIP	Local Climate Impacts Profile
LDS	Local Direction Sign
LDV	Light Duty Vehicles
LE	Landscape Elements
LIGS	Locally Important Geological and Geomorphological Sites
LLFA	Local Lead Flood Authority
LMVR	Local Model Validation Report
LNR	Local Nature Reserves
LOAEL	Lowest Observed Adverse Effect Levels
LOD	Limit of Detection
LOD	Limit of Deviation
LSA	Likely Significant Effects
LSOA	Lower Super Output Areas
LV	Limit Values
L VIA	Landscape and Visual Assessment
MAGIC	Multi-Agency Geographic Information for the Countryside
MPI	Major Project Instruction
MMP	Materials Management Plan
mOD	Metres Above Ordinance Datum
MRV	Minimum Reporting Values
MSOA	Mid-Level Super Output Areas
NAP	National Adaption Programme
NAQS	National Air Quality Strategy
NCA	National Character Area
NCN	National Cycle Network
NE	Natural England
NERC	Natural Environment and Rural Communities
NH <sub>3</sub>	Ammonia
NHLE	National Heritage List for England
NIR	Noise Insulation Regulations
NMU	Non-Motorised User
NNR	National Nature Reserves
NO <sub>2</sub>	Nitrogen Dioxide



<b>Abbreviation</b>	<b>In Full</b>
NOx	Nitrogen Oxides
NPPF	National Planning Policy Framework (2018)
NPSE	Noise Policy Statement for England
NPSNN	National Policy Statement for National Networks
NSIP	Nationally Significant Infrastructure Project
NVC	National Vegetation Classification (Survey)
OBS	Observed Breeding Sites
ONS	Office for National Statistics
OP	Off-Peak
OUV	Outstanding Universal Value
PAH	Polycyclic Aromatic
PAS	Publicly Available Specification
PCF	Project Control Framework
PCM	Pollution Climate Mapping
PEFC	Programme for The Endorsement of Forest Certification
PEI Report	Preliminary Environmental Information Report
PHE	Public Health England
PICS	Personal Injury Collisions
PINS	Planning Inspectorate
PM <sub>10</sub>	Fine Particulates
PMA	Private Means of Access
PNS	Potential Nest Site
POPE	Post Opening Project Evaluation
PPE	Personal Protective Equipment
PPG	National Planning Practice Guidance
PPGs	Pollution Prevention Guidelines
PPS	Planning Policy Statement
PPV	Peak Particle Velocity
PRF	Potential Roosting Feature
PRoW	Public Rights of Way
RBD	River Basin Districts
RBMPs	River Basin Management Plans
RDB	Red Data Book
REAC	Register of Environmental Actions and Commitments
RIGS	Regionally Important Geological and Geomorphological Sites
RIS	Road Investment Strategy
RPG	Registered Parks and Gardens
RTC	Road Traffic Collision
SAC	Special Area of Conservation
SAT	Specific Assemblage Types
SEB	Statutory Environmental Bodies
SFRA	Strategic Flood Risk Assessment

<b>Abbreviation</b>	<b>In Full</b>
SIAA	Statement to Inform an Appropriate Assessment
SIC	Standard Industrial Classification of Economic Activities
SINC	Sites of Importance for Nature Conservation
SM	Scheduled Monument
SMC	Scheduled Monument Consent
SO <sub>2</sub>	Sulphur Dioxide
SOAEL	Significant Observed Adverse Effect Levels
SoCG	Statement of Common Ground
SoS	Secretary of State
SPA	Special Protection Area
SPIs	Species of Principal Importance
SPZ	Source Protection Zone
SRN	Strategic Road Network
SSSI	Site of Special Scientific Interest
SuDs	Sustainable Drainage Systems
SWMP	Site Waste Management Plan
SWRA	South Western Regional Assembly
TAG	Transport Analysis Guidance
tCO <sub>2</sub> e	Tonnes of Carbon Dioxide Equivalent
TDCR	Traffic Data Collection Report
TFR	Traffic Forecasting Report
TMP	Traffic Management Plan
TRA	Traffic Reliability Area
The act	The Planning Act 2008
TPH	Total Petroleum Hydrocarbons
TPO	Tree Preservation Order
TRS	Temporary Rest Site
TWG	Technical Working Group
UAEL	Unacceptable Adverse Effect Levels
UKCP09	United Kingdom Climate Projections 2009
UKDWS	UK Drinking Water Standards
UNECE	United Nations Economic Commission for Europe
UWWT	Urban Waste Water Treatment
UXO	Unexploded Ordnance
VDV	Vibration Dose Value
VMS	Vehicle Message Sign
VP	View Point
VRS	Vehicular Restraint System
WCA	Wildlife and Countryside Act
WCH	Walkers Cyclists and Horse Riders
WDI	Waste Data Interrogator
WFD	Water Framework Directive 2000/60/Ec

<b>Abbreviation</b>	<b>In Full</b>
WG	Weather Generator
WHO	World Health Organisation
WHS	World Heritage Site
WPD	Western Power Distribution
WRA	Water Resources Act 1991
WRAP	Waste and Resources Action Plan
ZOI	Zone of Influence
ZVI	Zone of Visual Influence
ZTV	Zone of Theoretical Visibility

## 18 Glossary

Table 18-1 Glossary Table

Glossary Term	Description
Affected Road Network (ARN)	Defined in Design Manual for Roads and Bridges volume 11, section 3, part 1 Air Quality (DMRB HA207/07) (Highways Agency et al., 2007) as those roads within the traffic reliability area which in the proposed scheme opening year meet specific criteria set out in the DMRB HA207/07.
Air Quality Plan	Documents setting out the UK's plan for reducing roadside nitrogen dioxide concentrations.
Controlled waters	<p>These are fully defined in section 104 of the Water Resources Act 1991. They include in summary:</p> <ol style="list-style-type: none"> <li>a) relevant territorial waters which extend seaward for three miles from the low-tide limit from which the territorial sea adjacent to England and Wales is measured;</li> <li>b) coastal waters from the low-tide limit to the high-tide limit or fresh-water limit of a river or watercourse;</li> <li>c) inland freshwaters: <ul style="list-style-type: none"> <li>• natural and artificial lakes, ponds, reservoirs, rivers or watercourses above the fresh-water limit;</li> <li>• natural and artificial underground rivers and watercourses;</li> <li>• surface water sewers, ditches and soakaways that discharge to surface or groundwater;</li> <li>• it also includes those that may be currently dry; and</li> </ul> </li> <li>d) groundwaters– any waters contained in underground strata.</li> </ol>
Definitive Map (PC)	A definitive map is a map prepared by a surveying authority which is a legal record of the public's rights of way in one of four categories (footpath, bridleway, restricted byway or byway open to all traffic). If a way is shown on the map, then that is legal, or conclusive, evidence that the public had those rights along the way at the relevant date of the map (and has them still, unless there has been a legally authorised change). But the reverse is not true. So the showing of a way as a footpath does not prove that there are not, for example, additional unrecorded rights for horse-riders to use the way. Nor is the fact that a way is omitted from the definitive map proof that the public has no rights over it. <sup>369</sup>
Department of Environment and Rural Affairs (DEFRA)	UK government department responsible for safeguarding the natural environment, supporting the food and farming industry, and sustaining a thriving rural economy.
Designated Environmentally Sensitive Sites	The Environmentally Sensitive Areas were introduced in 1987 to offer incentives to encourage farmers to adopt agricultural practices which would safeguard and enhance parts of the country of particularly high landscape, wildlife or historic value. The proposed scheme has now closed to new applicants. Defra

<sup>369</sup> [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/414670/definitive-map-guide.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/414670/definitive-map-guide.pdf)

Glossary Term	Description
	introduced a new Environmental Stewardship Scheme on 3 March 2005 which supersedes (with enhancements) the Environmentally Sensitive Areas and Countryside Stewardship Schemes. There are 22 ESAs in England, covering some 10% of agricultural land. <sup>370</sup>
Designer	The organisation commissioned to undertake the various stages of proposed scheme preparation and supervision of construction. This includes specialist subconsultants brought in to advise on specific areas of assessment and mitigation.
Design speed	The design speed is a tool used to determine geometric features of a new road design based on the anticipated vehicle speeds on the road.
Detailed assessment	Method applied to gain an in-depth appreciation of the beneficial and adverse consequences of the project and to inform project decisions. Detailed Assessments are likely to require detailed field surveys and/or quantified modelling techniques.
Development Consent Order (DCO)	A Development Consent Order is the means of obtaining permission for developments categorised as Nationally Significant Infrastructure Projects. This includes energy, transport, water and waste projects.
Do-Minimum	<p>The 'Do-Minimum' forecast scenario in the Opening/Design Year is the base road and traffic network against which alternative improvements can be assessed. In many cases, the definition of the 'Do-Minimum' is straight forward; it is simply the 'Do-Nothing' scenario. However, one or more of the following four cases may arise, in which the 'Do-Minimum' differs from the 'Do-Nothing':</p> <ul style="list-style-type: none"> <li>a) The case where works will be carried out regardless of whether or not the 'Do-Something' proposed scheme is built.;</li> <li>b) The case where the existing network may be improved to form a 'Do-Minimum' proposed scheme which can be tested as an alternative to carrying out major Do-Something improvements;</li> <li>c) The case where traffic conditions can be improved without significant capital expenditure; and</li> <li>d) The case where the area covered by the modelled network includes road proposals other than the one under immediate consideration.</li> </ul>
Do-Nothing	The Do-Nothing forecasting scenario is simply the existing network without modification in the Opening/Design Year.
Do-Something	The 'Do-Something' forecast scenario is the road proposal under consideration in the Opening/Design Year.
Environment Agency	The Environment Agency is responsible for environmental protection and regulation in England and plays a central role in implementing the government's environmental strategy. The Environment Agency is the main body responsible for managing the regulation of major industry and waste, treatment of

<sup>370</sup> <https://data.gov.uk/dataset/a5b0ccc4-a144-4027-91fa-49084ff07da2/environmentally-sensitive-areas-england>

Glossary Term	Description
	contaminated land, water quality and resources, fisheries, inland river, estuary and harbour navigations, and conservation and ecology. They are also responsible for managing the risk of flooding from main rivers, reservoirs, estuaries and the sea.
Environment Agency Recorded Pollution Incidents	A record of pollution incidents to water, land and air held by the Environment Agency
Environmental Management Plan	An Environmental Management Plan (EMP) provides the framework for recording environmental risks, commitments and other environmental constraints and clearly identifies the structures and processes that will be used to manage and control these aspects. The EMP also seeks to ensure compliance with relevant environmental legislation, government policy objectives and scheme specific environmental objectives. It also provides the mechanism for monitoring, reviewing and auditing environmental performance and compliance.
Flood Risk Assessment	An assessment of the likelihood of flooding in a particular area so that development needs and mitigation measures can be carefully considered.
HDVs	Heavy Duty Vehicles. As HGVs with the inclusion of buses and coaches.
HGVs	Heavy Goods Vehicles, over 3.5 tonnes and includes rigid and articulate lorries.
Historic England	The public body that looks after England's historic environment. Championing historic places and helping people understand their value and care for them.
Listed building	A building which is considered by the Secretary of State (for Culture, Media and Sport) to be of special architectural or historic interest in accordance with the regime set out in the Town and Country Planning (Listed Buildings and Conservation Areas) Act 1990.
Local authorities	An administrative body in local government
Local Authority Pollution Prevention Controls	<p>Local authorities who regulate businesses are usually district or borough councils. If an area has only one council (a unitary council) then that's the regulator. The Port Health Authority may be the regulator in port areas.</p> <p>This guidance helps local authorities:</p> <ul style="list-style-type: none"> <li>• follow statutory guidance under regulation 64 of the Environmental Permitting Regulations (EPR); and</li> <li>• understand the EPR's main functions, procedures and terminology<sup>371</sup>.</li> </ul>
Lowest Observed Adverse Effect Level (LOAEL)	This the level of noise above which adverse effects on health and quality of life can be detected.

<sup>371</sup> <https://www.gov.uk/government/publications/local-authority-pollution-control-general-guidance-manual>

Glossary Term	Description
National Air Quality Strategy (NAQS)	The Air Quality Strategy intends to provide a clear framework for improving air quality through
National Cycle Network (NCN)	The National Cycle Network is a series of safe, traffic-free paths and quiet on-road cycling and walking routes that connect to every major town and city.
National Parks (NP)	Protected areas because of their beautiful countryside, wildlife and cultural heritage.
National Planning Policy Framework (NPPF)	The National Planning Policy Framework sets out the Government's planning policies for England.
National Pond Survey	This is a national scheme to develop a classification of ponds in Britain based on the composition of their plant and macroinvertebrate communities.
Natural England	<p>Natural England are responsible for:</p> <ul style="list-style-type: none"> <li>• helping land managers and farmers protect wildlife and landscapes;</li> <li>• advising on the protection of the marine environment in inshore waters (0 to 12 nautical miles);</li> <li>• improving public access to the coastline;</li> <li>• managing 140 National Nature Reserves and supporting National Trails;</li> <li>• providing planning advice and wildlife licences through the planning system;</li> <li>• managing programmes that help restore or recreate wildlife habitats;</li> <li>• conserving and enhancing the landscape; and</li> <li>• providing evidence to help make decisions affecting the natural environment.</li> </ul>
Nature Conservancy	The Nature Conservancy is the leading conservation organization working around the world to protect ecologically important lands and waters for nature and people. <sup>372</sup>
Noise Important Areas	These areas provide a framework for the local management of the Important Areas.
Nationally Significant Infrastructure Projects (NSIP)	Any infrastructure project that is deemed, according to the criteria set in the Planning Act, 2008 (as amended) to be nationally significant. Such projects are authorised through a statutory process that requires an application for a DCO, rather than a conventional planning application or the traditional model through the publication of Statutory Orders and the holding of Public Inquiries.
NOx	Oxides of Nitrogen – which encompasses all nitrogen species although mainly NO and NO <sub>2</sub> .

<sup>372</sup> <https://www.nature.org/about-us/index.htm>

Glossary Term	Description
Outline Construction Environmental Management Plan	A CEMP at outline stage which will later be refined and expanded into a full CEMP as more information becomes available and there is more certainty in terms of the proposed layout, construction methods, programme and the likely environmental effects.
Materials Management Plan	A Materials Management Plan (MMP) is a mechanism by which those who are developing a site can comply with Environment Agency regulations for excavated ground materials <sup>373</sup> .
National Planning Policy Framework	A statement of central government guidance on planning policy, replacing the previous system of topic-specific Planning Policy Guidance Notes (PPGs) and Planning Policy Statements (PPSs).
Paris Agreement (Climate)	The Paris Agreement, Paris climate accord or Paris climate agreement, is an agreement within the United Nations Framework Convention on Climate Change dealing with greenhouse gas emissions mitigation, adaptation and finance starting in the year 2020.
Parish Councils	A parish council is a civil local authority found in England and is the lowest tier of local government. They are elected corporate bodies, have variable tax raising powers, and are responsible for areas known as civil parishes, serving in total 16 million people.
Planning Inspectorate (PINS)	On 1 April 2012, under the Localism Act 2011, the Planning Inspectorate became the agency responsible for operating the planning process for nationally significant infrastructure projects (NSIPs).
PM10	PM10 Particulate matter with a diameter of 10 microns or less.
Pollution Prevention Guidelines	Practical advice and guidance for the prevention of pollution during construction and demolition projects. The guidance explains what is required by law and describes good practice measures to reduce the risks of a pollution incident.
Public Rights of Ways	A way over which the public have a right to pass and repass. The route may be used on foot, on (or leading) a horse, on a pedal cycle or with a motor vehicle, depending on its status. Although the land may be owned by a private individual, the public may still gain access across that land along a specific route.
Road Investment Strategy (RIS)	The Road Investment Strategy outlines a long-term programme for England's motorways and major roads supported by stable funding needed to plan ahead.
Scheduled Monument	A scheduled monument is a historic building or site that is included in the Schedule of Monuments kept by the Secretary of State for Culture, Media and Sport under the regime set out in the Ancient Monuments and Archaeological Areas Act 1979.
Scheme Assessment Report	The main aims of the assessment reporting process are to permit consideration of the likely environmental, economic and traffic effects of alternative proposals, and to allow the public and

<sup>373</sup> [https://www.designingbuildings.co.uk/wiki/Materials\\_Management\\_Plan\\_\(MMP\)](https://www.designingbuildings.co.uk/wiki/Materials_Management_Plan_(MMP))



Glossary Term	Description
	statutory bodies to comment on proposals taking account of their environmental, economic and traffic implications. <sup>374</sup>
Scoping Opinion	A written opinion of the relevant consenting authority, following a request from the applicant, as to the information to be provided in the Environmental Statement.
Significant Observed Adverse Effect Level (SOAEL)	This is the level of noise above which significant adverse effects on health and quality of life occur.
Simple Assessment	Initial, brief assessment activity based on the assembly of data and information that is readily available, to fulfil one of the following functions: <ul style="list-style-type: none"> <li>a) to address unknown aspects in the Scoping assessment level;</li> <li>b) to reach an understanding of the likely environmental effects to inform;</li> <li>c) the final design and assessment; or,</li> <li>d) to reach an understanding of the likely environmental effects that identifies the need for a Detailed Assessment.</li> </ul>
Site of Special Scientific Interest (SSSI)	A SSSI is a conservation designation denoting a protected area in the United Kingdom, designated due to special interest in its flora, fauna, geological or physiographical features. They are protected by law to conserve their wildlife or geology.
Site Waste Management Plan (SWMP)	SWMPs encourage the effective management of materials and ensure waste is considered at all stages of a project - from design through to completion. Although no longer a regulatory requirement in England, SWMPs are still considered to be good practice.
Special Area of Conservation (SAC)	A Special Area of Conservation is a site designated under the Habitats Directive. These sites, together with Special Protection Areas (or SPAs), are called Natura sites and they are internationally important for threatened habitats and species.
Special Protection Area (SPA)	A special protection area is a designation under the European Union Directive on the Conservation of Wild Birds. Under the Directive, Member States of the European Union (EU) have a duty to safeguard the habitats of migratory birds and certain particularly threatened birds.
Statement of Common Ground (SoCG)	A written statement prepared jointly by the applicant and another party or parties, setting out any matters on which they agree. In some cases, statements of common ground will also identify areas where agreement has not been reached.
The Consultation Report	The Consultation Report is a report giving details of the consultation activity carried out by the A417 at the Pre-Application stage, in particular:

<sup>374</sup> <http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol5/section1/td3793.pdf>

Glossary Term	Description
	<ul style="list-style-type: none"> <li>• what has been done to comply with the Planning Act 2008, including, s42 (consultation with prescribed consultees), s47 (consultation with the community), and s48 (publicity);</li> <li>• details of any relevant responses; and</li> <li>• the account taken of any relevant responses during the preparation of the application.</li> </ul>
Unexploded ordnance	Unexploded ordnance, unexploded bombs, or explosive remnants of war are explosive weapons that did not explode when they were employed and still pose a risk of detonation, sometimes many decades after they were used or discarded.
United Nations Economic Commission for Europe (UNECE)	The United Nations Economic Commission for Europe (UNECE) was set up in 1947 it is one of five regional commissions of the United Nations.
Waste Hierarchy	The “waste hierarchy” ranks waste management options according to what is best for the environment. It gives top priority to preventing waste in the first place. When waste is created, it gives priority to preparing it for re-use, then recycling, then recovery, and last of all disposal (e.g. landfill).
Waste Local Plan	Provides further information in support of the implementation of waste planning policy.
World Health Organisation (WHO)	The World Health Organization is a specialized agency of the United Nations that is concerned with international public health.
Zone of Theoretical Visibility (ZTV)	This is the zone from which the proposed scheme is theoretically visible over ‘bare earth.’
Zone of Visual Influence (ZVI)	The area within which a project may be visible and may influence the quality of views. The ‘zone of visual influence’ approximately covers all land from which the proposed scheme is visible. It is limited by topographic features such as hill and valleys and by visual barriers such as woodland and buildings.