

A303 Amesbury to Berwick Down

TR010025

6.1 Environmental Statement

Chapter 14: Climate

Volume 6

APFP Regulation 5(2)(a)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed
Forms and Procedure) Regulations 2009

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14 Climate

14.1 Introduction and competent expert evidence

- 14.1.1 This chapter assesses the potential climate impacts of the construction and operation of the Scheme, following the methodology set out in the Design Manual for Roads and Bridges ("DMRB") Volume 11, Section 3, Part 1 (Air Quality) (Ref 14.1) and Highways England's Interim Advice Note (IAN) 114/08 – Highways Agency Carbon Calculation and Reporting Requirements (Ref 14.2). 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 Scheme. Following this, the design, mitigation and residual effects of the 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) (Ref 14.3) and the EIA Directive (Ref.14.4) this chapter addresses three separate aspects:
- a) Greenhouse gas (GHG) impact assessment – the effects on the climate of GHG emissions arising from the Scheme, including how the Scheme would affect the ability of government to meet its carbon reduction plan targets;
 - b) Climate resilience assessment – the resilience of the Scheme to climate change, including how the Scheme design would be adapted to take account for the projected impacts of climate change; and
 - c) In-combination climate assessment – the in-combination effects of a changing climate and the Scheme on the surrounding environment.
- 14.1.3 This chapter of the ES has been undertaken by competent experts with relevant and appropriate experience. The technical lead for the climate assessment is Ian Davies and his professional qualifications and experience are summarised in Appendix 1.1.

14.2 Legislative and policy framework

- 14.2.1 As discussed in Chapter 1, the primary basis for deciding whether or not to grant a Development Consent Order (DCO) is the NPSNN which, at sections 4 and 5, sets out policies to guide how DCO applications would be decided and how the impacts of national networks infrastructure should be considered. Table 14.1 identifies the NPSNN policies relevant to the climate assessment and where in the ES chapter information is provided to address the policy.

Table 14.1: Relevant NPSNN policies for climate assessment

Relevant NPSNN paragraph reference	Requirement of the National Policy Statement for National Networks (NPSNN)	Where in the ES Chapter is information provided to address this policy.
4.40	Applicants must consider the impacts of climate change when planning location, design, build and operation. Any accompanying environment statement should set out how the proposal will take account of the projected impacts of climate change.	Sections 14.8 Design Mitigation and Enhancement Measures and 14.9 Assessment of Effects consider how the Scheme would account for the projected impacts of climate change.
4.41	Where transport infrastructure has safety-critical elements and the design life of the asset is 60 years or greater, the applicant should apply the UK Climate Projections 2009 (UKCP09) high emissions scenario (high impact, low likelihood) against the 2080 projections at the 50% probability level.	Section 14.6 Baseline Conditions demonstrates application of the UK climate Projections (UKCP09) high emissions scenario (high impact, low likelihood) against the 2080 projections at the 50% probability level.
4.42	The applicant should take into account the potential impacts of climate change using the latest UK Climate Projections available at the time and ensure any environment statement that is prepared identifies appropriate mitigation or adaptation measures. This should cover the estimated lifetime of the new infrastructure.	Section 14.6 Baseline Conditions demonstrates application of the latest UK climate Projections. Section 14.8 Design Mitigation and Enhancement Measures considers appropriate mitigation and adaptation measures.

Relevant NPSNN paragraph reference	Requirement of the National Policy Statement for National Networks (NPSNN)	Where in the ES Chapter is information provided to address this policy.
4.43	The applicant should demonstrate that there are no critical features of the design of new national networks infrastructure which may be seriously affected by more radical changes to the climate beyond that projected in the latest set of UK climate projections. Any potential critical features should be assessed taking account of the latest credible scientific evidence on, for example, sea level rise and on the basis that necessary action can be taken to ensure the operation of the infrastructure over its estimated lifetime through potential further mitigation or adaptation.	Section 14.6 Baseline Conditions considers any potentially critical features of the design which may be seriously affected by climate change beyond that project in the latest UK climate projects.
4.44	Any adaptation measures should be based on the latest set of UK Climate Projections, the Government's national Climate Change Risk Assessment and consultation with statutory consultation bodies. Any adaptation measures must themselves also be assessed as part of any environmental impact assessment and included in the environment statement, which should set out how and where such measures are proposed to be secured.	Section 14.8 Design Mitigation and Enhancement Measures considers identification and implementation of any adaption measures.
5.17	Carbon impacts will be considered as part of the appraisal of scheme options (in the business case), prior to the submission of an application for DCO. Where the development is subject to EIA, any Environmental Statement will need to describe an assessment of any likely significant climate factors in accordance with the requirements in the EIA Directive., for road projects applicants should provide evidence of the carbon impact of the project and an assessment against the Government's carbon budgets.	Sections 14.3 Assessment Methodology and 14.9 Assessment of Effects considers the carbon impacts of the Scheme and compares them against the Government's carbon budgets.

- 14.2.2 In accordance with the NPPF, the NPSNN policies relating to the applicant's assessment are the primary source of policy guidance regarding this assessment. The NPPF was revised in 2018, but the requirements which relate to this assessment have not substantively changed, and the NPSNN remains the primary source of policy guidance.
- 14.2.3 Other relevant policies have been considered as part of the climate assessment where these have informed the identification of receptors and resources and their sensitivity; the assessment methodology; the potential for significant environmental effects; and required mitigation. The only other policy considered relevant is the Wiltshire Council Core Strategy Development Plan Document – core policy 68 (water resources) (Ref. 14.5).

- 14.2.4 This policy states that new development must incorporate water efficiency measures to limit the environmental stresses on rivers, especially as these stresses are likely to be exacerbated in the future due to climate change. Developers are expected to submit details of the water efficiency measures adopted throughout the design process. Further policies related to flood risk and water management from the development including climate change are set out in Chapter 11 Road Drainage and the Water Environment.
- 14.2.5 For developments within a Source Protection Zone, Safeguard Zone or Water Protection Zone, risk to groundwater resources and their quality must be assessed. Protection measures must be implemented throughout the construction and operation phases of the development.

14.3 Assessment methodology

GHG impact assessment

- 14.3.1 The GHG emissions arising from the construction and operation of the Scheme are within the scope of this assessment. It is very unlikely that the Scheme would be demolished after its design life as the road would have become an integral part of nationally important infrastructure. End of life assessment of the demolition phase is therefore scoped out of the assessment.
- 14.3.2 Emissions from construction have been calculated in line with guidance set out in Highways England's IAN 114/08 – Highways Agency Carbon Calculation and Reporting Requirements (Ref 14.2). This methodology provides guidance on estimating the contribution from construction activities, also referred to as 'construction carbon' and the maintenance/refurbishment activities. The IAN has been supplemented by use of Highways England's Carbon Reporting Tool (Ref 14.6).
- 14.3.3 The approach outlined in IAN 114/08 and the Highways England Carbon Reporting Tool is in line with the World Business Council for Sustainable Development (WBCSD)/World Resources Institute (WRI) Greenhouse Gas Protocol guidelines (Ref 14.7). Data collection for input to the Carbon Reporting Tool is based on the following set of standard data quality principles detailed in the Protocol which have been applied so that the results from the GHG assessment are as accurate and representative as possible:
- a) Age – the GHG assessment is based on activity data and GHG emissions factors applicable to the study period;
 - b) Geography – activity data reflects the design of the Scheme. GHG emissions factors in the Carbon Tool are representative of the UK construction industry and UK transport sector;
 - c) Technology – the default solution was to apply data which is representative of the UK construction industry and transport sector.

- d) Methodology – activity data was gathered directly from the Scheme’s engineering and design teams to enable consistency and completeness of data collection; and
 - e) Competency – activity data was generated by the engineering and design teams in-line with applicable industry standards.
- 14.3.4 GHG emissions outputs from the Carbon Tool are reported as tonnes of carbon dioxide equivalent (tCO₂e) and consider the six Kyoto Protocol gases:
- a) Carbon dioxide (CO₂);
 - b) Methane (CH₄);
 - c) Nitrous oxide (N₂O);
 - d) Sulphur hexafluoride (SF₆);
 - e) Hydrofluorocarbons (HFCs); and
 - f) Perfluorocarbons (PFCs).
- 14.3.5 GHG emissions for construction and maintenance have been assessed within the Carbon Tool using a calculation-based methodology as per the below equation:
- a) Activity data x GHG emissions factor = GHG emissions value
- 14.3.6 Road user emissions have been calculated following the guidance provided in DMRB volume 11, section 3, part 1, HA 207/07 – regional assessment methodology (Ref 14.1). This methodology estimates the contribution from traffic on the road, also referred to as ‘road user carbon’.
- 14.3.7 The uptake of lower carbon fuels, electric vehicles (EVs) and increased vehicle technology is not accounted for under the HA 207/07 approach, however commentary has been provided on the potential impact on GHG emissions from the use of the Scheme due to these technological advances. The UK Government Strategy ‘Road to Zero’ (Ref 14.8) sets out a route map for the UK to move towards cleaner road transportation. The long term aspirations set out in this strategy are that by 2030 between 50% and 70% of new car sales and 40% of van sales will be ultra-low emission vehicles and by 2040 all new petrol and diesel cars and vans will be zero carbon. This is supported by a range of initiatives to increase the supply of low carbon fuels and to grow the EV charging network.
- 14.3.8 In addition, future decarbonisation of the grid will have an impact upon the GHG emissions associated with the operation of the Scheme. According to the Department for Business, Energy and Industrial Strategy (BEIS) Updated Energy and Emissions Projections 2017 (Ref 14.9), up to 300 Tera Watt hours (TWh) could be generated by low carbon energy sources (renewables and

nuclear) by 2035, with as little as 100 TWh generated using natural gas and from imports. Commentary has also been provided on the impact of grid decarbonisation.

- 14.3.9 All GHG emissions would contribute to global climate change and can therefore be considered to have some level of significance. The UK has legally binding GHG reduction targets and therefore the level of significance considers how the Scheme would contribute to the National GHG inventory and the UK achieving its reduction targets. In addition, the Scheme's calculated emissions have been assessed against GHG emissions allocated for the UK transport sector within the UK's carbon budgets.
- 14.3.10 There is currently no guidance regarding significance levels for GHG emission impacts, although the guidance does indicate consideration of the UK National inventory and the effect that the development may have on the UK meeting its reduction targets.
- 14.3.11 Whilst the scope of the assessment covers the lifecycle stages of the project, the GHG assessment comprises two parts reflecting both the level of certainty of future activity and GHG emissions, and the extent that the predicted GHG emissions would be additional to the existing GHG inventory.
- 14.3.12 The first part of the GHG assessment considers the construction of the Scheme itself. The majority of these emissions would be additional to the existing National GHG inventory and would be compared to the relevant UK carbon budgets.
- 14.3.13 The second part of the GHG assessment comprises the operation and 'use' of the Scheme i.e. those emissions resulting from mechanical and electrical energy use such as tunnel lighting and ventilation and the impact from a variation in vehicle journeys travelling on the road and surrounding area of assessment. As at least part of the GHG emissions associated with the operation of the Scheme would have been displaced from other parts of the road network (e.g. road users), they are not considered additional to the UK GHG inventory. Identifying and quantifying the balance of what is additional versus displaced with any level of certainty is challenging. The GHG assessment for Scheme operation was therefore done on a scenario basis, with quantification of different scenarios to provide a range for the additional GHG emissions associated with the Scheme.
- 14.3.14 The first scenario considered is a 'do-minimum' scenario whereby the Scheme is not implemented. The second scenario considered is a 'do-something' scenario, whereby the Scheme goes ahead and the GHG emission reductions from the embedded mitigation measures are taken into account.
- 14.3.15 In line with the NPSNN (Ref 14.3), significance of impacts has been assessed by comparing estimated GHG emissions arising from the Scheme with the relevant UK carbon budgets, and the associated reduction targets.

- 14.3.16 The scenarios used for the GHG assessment of the operation of the Scheme are summarised in the Table 14.2:

Table 14.2: GHG assessment scenarios

Scenario		Description
'Do-minimum'	Without scheme	'Business as usual' - baseline conditions.
'Do-something'	With scheme and mitigation	Scheme implemented with maximum GHG mitigation measures.

- 14.3.17 A comparison of the GHG emissions for the 'do-minimum' and 'do-something' scenarios has been made at the year of scheme opening and for the future design year (2041) in line with HA207/07.

Climate resilience assessment

- 14.3.18 The climate change resilience assessment has considered the strategic aims and objectives encompassed within the Government's, Highways England's and local planning strategy and policy, which has the overarching aim of minimising the adverse impacts of climate change, whilst requiring new development to take climate change considerations into account within design. Ways in which resilience of the Scheme to climate change can be enhanced have been assessed and mitigation measures have been identified.
- 14.3.19 Consideration of climate change adaptation within EIAs is an area of emerging practice. There is not a prescribed format for undertaking such assessments, therefore the approach taken has followed new and emerging guidelines (Ref 14.10) and good practice from other similar studies.
- 14.3.20 An assessment of climate change resilience has been conducted for the Scheme which identifies potential climate change impacts and considers their potential consequence and likelihood of occurrence.
- 14.3.21 The assessment has included all infrastructure and assets associated with the Scheme. It has assessed resilience against both gradual climate change and the risks associated with an increased frequency of severe weather events as per the UKCP09 climate change projections (Ref 14.11).
- 14.3.22 The assessment of potential impacts and the Scheme's vulnerability takes into account the mitigation measures that have been designed into the Scheme. As there is a link between the climate change resilience assessment and the assessments reported within other chapters, cross-references are included where appropriate.
- 14.3.23 Following identification of the future climate projections, the project receptors which are vulnerable to climate change are identified as:

- a) Construction phase receptors including the workforce, plant, and machinery.
- b) The assets and their operation, maintenance and refurbishment (i.e. pavements, structures, earthworks and drainage, technology assets, etc.); and
- c) End-users (members of public, commercial operators etc.).

14.3.24 For the operational phase of the Scheme, once potential impacts have been identified, the likelihood and consequence of each impact occurring to each receptor (where relevant) is assessed, for the selected future time frame for operation (2080s). Likelihood, consequence and significance definitions are outlined in the tables below. Project lifetime is considered to include construction and operational stages and is taken to be 60 years. With respect to the construction phase, as this is planned to occur over a much shorter period compared to the operation of the road and within the next 10 years¹, future climate change is less relevant and the assessment of potential impacts follows a more descriptive approach.

Table 14.3: Measure of likelihood

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).

* The event is defined as the climate event (such as heatwave) and the hazard (such as overheated electrical equipment) occurring in combination

Table 14.4: Measure of consequence

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.

¹ The Scheme is assumed to commence construction in 2021, with the year of opening anticipated to be 2026.

Consequence of Impact	Description
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	Operational Phase: Disruption to an isolated section of a strategic route lasting less than 1 day.

14.3.25 Significance is derived through multiplying outcomes from the consequence and likelihood assessments, as shown in Table 14.5.

Table 14.5: Significance measure

		Measure of Likelihood				
		Very Low	Low	Medium	High	Very High
Measure of Consequence	Negligible	NS	NS	NS	NS	NS
	Minor adverse	NS	NS	NS	S	S
	Moderate adverse	NS	NS	S	S	S
	Large adverse	NS	S	S	S	S
	Very Large adverse	NS	S	S	S	S

S= Significant

NS= Not significant

In-combination climate change impact (ICCI) assessment

- 14.3.26 An in-combination climate impact assessment has been undertaken to evaluate the combined impacts of future climate change and the proposed development on identified receptors in the surrounding environment.
- 14.3.27 Projected changes to average climatic conditions, as a result of climate change, and an increased frequency and severity of extreme weather events have the potential to impact the ability of the surrounding natural environment to adapt to climate change.
- 14.3.28 UKCP09 projections for temperature and precipitation variables have been obtained and analysed to identify potential climate hazards that may impact receptors. Potential hazards identified include increased average temperatures, more frequent and heavier precipitation events and an increase in the frequency of severe storms.
- 14.3.29 The likelihood of climate hazards leading to an in-combination impact considers both the likelihood of an impact occurring (i.e. contaminant soil exposure due to ground movements) and the confidence levels associated with the change in climate hazard within the timescale (i.e. intense rainfall would increase

contaminant soil migration). The likelihood is defined using the likelihood criteria outlined in Table 14.6, based on our assessment of the UKCP09 Climate Projections, confidence in the projections, and professional judgement.

Table 14.6: Likelihood criteria for in-combination effects

Likelihood of Impact Occurring	Confidence of Climate Hazard Occurring	
	Low	High
Low	Low	Medium
High	Medium	High

- 14.3.30 The consequence of in-combination impacts has been based on the change to the significance of the effect of the Scheme on the resource or receptor for each relevant environmental discipline, given existing mitigation measures as outlined in the relevant discipline assessment as shown in Table 14.7.

Table 14.7: Consequence criteria for in-combination effects

Consequence	Consequence Criteria
High	The climate change parameter in-combination with the effect of the Scheme causes the significance of the effect of the Scheme on the resource/ receptor, as defined by the topic, to increase from moderate to major.
Medium	The climate change parameter in-combination with the effect of the Scheme causes the significance of the effect of the Scheme on the resource/ receptor, as defined by the topic, to increase from low to moderate.
Low	The climate change parameter in-combination with the effect of the Scheme causes the significance of the effect of the Scheme on the resource/ receptor, as defined by the topic, to increase from negligible to low.
Very Low	The climate change parameter in combination with the effect of the Scheme does not impact the significance of the effect of the Scheme on the resource/ receptor, as defined by the topic.

- 14.3.31 The significance of effects has been determined through combining likelihood and consequence as shown in Table 14.8.

Table 14.8: Significance criteria for in-combination effects

Consequence	Likelihood		
	Low	Medium	High
Very Low	Negligible	Negligible	Minor
Low	Negligible	Minor	Moderate
Medium	Minor	Moderate	Major
High	Moderate	Major	Major

Scoping

- 14.3.32 Table 14.9 summarises the consultee responses to the climate section of the Scoping Report and where the comments are addressed within this chapter. Where assessment has been undertaken in accordance with the Scoping Opinion point, a response and the relevant ES section is provided; where an alternative approach was agreed with the relevant stakeholder, an explanation is provided. The Scoping Opinion as received is provided in Appendix 4.1.

Table 14.9: Scoping Opinion and response

Scoping Opinion	Where addressed within the ES
Planning Inspectorate	
Notwithstanding the comments made in respect of decommissioning at section 2.3 of this Opinion, the Inspectorate agrees that an assessment of GHG impacts in terms of decommissioning can be scoped out of the EIA	GHG impacts associated with the decommissioning of the scheme have been scoped out of Section 14.3.1
The study area is broadly set out in terms of referencing the components of the scheme in its entirety (which does not specifically assist the understanding of the approach to establishing the study area). The ES needs to clearly establish the study area through a clear description and/or figures that enable the limits of the study area to be understood.	A clear description of the study area has been provided in Section 14.5.
Reference is made to the “entire project construction site and the surrounding natural environment”. This is considered to be slightly ambiguous and the ES should clearly explain and depict these defined areas for both the GHG impact assessment and climate change resilience assessments.	Defined areas for the GHG impact assessment and climate change resilience assessments are provided in Section 14.5.
Reference is made to “available and relevant information sources” these are not listed or discussed and as such, the Inspectorate cannot comment. The ES should clearly set out the nature and relevance of specifically cited information sources.	Details on the relevance and applicability of the information sources used for this assessment are detailed in Section 14.6.

Scoping Opinion	Where addressed within the ES
<p>Where information on energy use, types and quantities of materials used and waste generated require assumptions based on industry approximations, professional judgement or best practice will be made, these should be consistent with other aspects within the ES, for example the materials assessment.</p>	<p>Information used in in the Chapter 14 for the climate assessment has been cross checked with information used in Chapter 12 Materials to provide consistency. Information on assumptions and limitations of data is covered in 14.4</p>
<p>The dates for the baseline and the future baseline should be clearly identified in the ES and these terms should be applied consistently across other relevant aspects within the ES The Applicant should discuss and agree with relevant statutory consultees the most appropriate data sets for the assessment.</p>	<p>Consideration of dates for the baseline and future baseline has been provided in Chapter 4. Information on the selection of data sets and stakeholder agreement is included in Section 14.3.33 and 14.3.34.</p>
<p>The Scoping Report does not make reference to the potential need for monitoring of GHG emissions during construction and / or operation that may be necessary, depending on the outcomes of the assessment. The need for and scope of any such monitoring should be considered as part of the ES.</p>	<p>The approach to monitoring GHG emissions has been detailed in Section 14.10.2.</p>
<p>The Inspectorate recommends that the Applicant consults with Wiltshire Council and relevant statutory bodies to identify specific concerns relating to climate change and how it could affect (or be affected by) the Proposed Development.</p>	<p>Section 14.3 considers responses provided by stakeholders on climate impacts.</p>
<p>The Applicant seeks to scope out any assessment of “demolition after design life” of the Proposed Development as part of the EIA given that “It is considered highly unlikely that the Scheme would be demolished after its design life” (Paragraph 5.4.3 of the Scoping Report). The Inspectorate interprets this reference to be akin to “decommissioning” of the Proposed Development. The Inspectorate considers that this is a reasonable approach taking into account the specific characteristics of the Proposed Development. However, the Inspectorate considers that any decommissioning associated with dismantling and replacing particular elements of the Proposed Development (e.g. lighting columns) once they reach the end of their design life should be assessed if significant effects are likely to occur (and the design life should be specifically defined).</p>	<p>Section 14.7. considers potential carbon impacts of the scheme.</p>

Scoping Opinion	Where addressed within the ES
The ES should include a description of the potential vulnerability of the Proposed Development to risks of major accidents and/or disasters, including the vulnerability to climate change, which are relevant to the Proposed Development.	A description of the proposed vulnerability of the scheme to risks of major accidents and the vulnerability of the scheme to climate change are included in Section 14.6 and Chapter 4.

Consultation

- 14.3.33 No comments have been provided by stakeholders that directly relate to the climate assessment. Comments provided on flood risk and water management that indirectly relate to climate resilience impacts can be found in Chapter 11 Road Drainage and the Water Environment.
- 14.3.34 The approach taken by Highways England to assess the resilience of the Scheme to climate change and to calculate the construction and operational greenhouse house gas (GHG) emissions for the Scheme has been discussed with the Environment Agency (EA) and Wiltshire Council. It is consistent with that used by Wiltshire Council in their own Climate Change Adaption Plan and Council Carbon Management Plan. The calculation of GHG emissions is also consistent with the approach taken by the EA for the development of their ERIC Carbon Calculator tool. The EA currently host and have approved the Scheme's use of the UK climate projections (UKCP09) data, which is also used by Wiltshire Council as the basis for their climate adaptation reports. UKC09 is the only climate projection data set currently publicly available and is widely used across numerous government bodies. The EA are helping government to develop the next set of updated projections due at the end of 2018.

14.4 Assessment assumptions and limitations

- 14.4.1 The assessment is based on information in respect of energy use, types and quantities of materials used and waste generated that was available during the design process. Where information was not available, assumptions based on professional judgement have been made. These assumptions are consistent with those made by other topics for their assessment presented in this Environmental Statement.
- 14.4.2 GHG emissions from the end of life stage of the Scheme have been scoped out of the assessment due to the anticipated operational length of the Scheme. The replacement of particular elements of the Scheme is included as part of the maintenance life cycle stage of the GHG assessment.
- 14.4.3 The assessment uses the lifespan of the project (60 years) and the lifecycle stages being assessed to determine the relevant period (short, medium and

long-term) over which the climate projections are selected e.g. 2020s (2010-2039), 2050s (2040-2069), and 2080s (2070-2099).

- 14.4.4 Limitations associated with the approach taken for this climate change risk assessment relate to uncertainties inherent within UK Climate Projections (UKCP09 data) (Ref 14.11).
- 14.4.5 Climate change, by its very nature, is associated with a range of assumptions and limitations. For example, there is uncertainty regarding how global climatic trends will be reflected at the regional scale. To overcome these issues, forecast climate change data has been used from the UK Climate Projections (UKCP09). These are a result of over seven years of work at the Met Office's Hadley Centre and over thirty years of work from other contributing organisations. This has been coupled with the replication of proven effective approaches undertaken for similar project types.
- 14.4.6 Assessments made in relation to 'consequence' and 'likelihood' have relied on professional judgement and evidence gathered through other environmental topic assessments.
- 14.4.7 All assumptions and limitations, including any exclusions, together with assumptions for choices and criteria leading to exclusion of input and output data are documented as part of the assessment.

14.5 Study area

GHG impact assessment

- 14.5.1 The study area covers all direct GHG emissions arising from activities undertaken within the Scheme boundary during the construction and operation of the Scheme. It also includes indirect emissions embedded within the construction materials arising as a result of the energy used for their production as well as emissions arising from the transportation of materials and waste to and from the site.
- 14.5.2 The assessment of GHG impacts occurring during the construction stage of the Scheme focusses on construction activities. The spatial coverage of the assessment is therefore the area of construction works falling within the Scheme boundary, outlined in Figures 2.1A and 2.1B.
- 14.5.3 The study area for the assessment of GHG emissions arising during the operation of the Scheme includes both direct emissions arising from energy use within the Scheme boundary but also emissions from road users which are presented for the whole traffic model study area for consistency with WebTAG (Ref 14.12).

Climate resilience assessment

- 14.5.4 The study area for the resilience assessment is the Scheme boundary i.e. it covers all assets and infrastructure which constitute the Scheme.

14.6 Baseline conditions

GHG impact assessment

Current baseline

- 14.6.1 The baseline for the GHG impact assessment is a 'do-minimum' scenario whereby the Scheme does not go ahead. Under this scenario GHG emissions associated with the future use and maintenance of the existing road are included. The detailed baseline was developed using traffic models based on the current road scheme layout and its predicted use, accounting for any increase in traffic and associated congestion, through to 2041 (the design year for the Scheme). This model has established a baseline against which the Scheme can be compared to identify any variation in GHG emissions over time.

Construction year baseline

- 14.6.2 The construction year baseline for the GHG assessment incorporates GHG emissions from fuel use for construction activities along with embodied carbon within materials used for construction.

Opening Year baseline (2026)

- 14.6.3 The opening year baseline consists of GHG emissions from road users along with emissions arising from operational energy use of the tunnel e.g. for lighting, signs and other mechanical and electrical sources.

Future Year baseline (2041)

- 14.6.4 The future year baseline consists of GHG emissions from road users along with emissions arising from operational energy use of the tunnel e.g. for lighting, signs and other mechanical and electrical sources.

Current baseline - climate resilience assessment

- 14.6.5 A review of relevant information sources has been undertaken to establish existing and future baseline data and current understanding with regards to climate and extreme weather impacts. A summary is provided in the following paragraphs, with more detailed information in Appendix 14.1.
- 14.6.6 A review of the recent and current climate of the region in which the Scheme is sited has indicated that there is already evidence of gradual warming and increases in average annual precipitation amounts between 1961 and 2006.
- 14.6.7 The Local Climate Impacts Profile for Wiltshire (LCLIP) (Ref 14.13) has assessed the vulnerability of the county to weather events and provides evidence to suggest that infrastructure disruption has been the most common form of severe weather-related impact during the 2003 to 2010 LCLIP study period. The UK Climate Change Risk Assessment (CCRA 2017) (Ref 14.14) also presents the argument that the UK's transport infrastructure is already being affected by severe weather events, specifically through flooding and changes to extreme weather event frequency and severity.

- 14.6.8 The Scheme and the nearest Met Office Weather Station (Boscombe Down) sit within the UK Climate Projections' South West region. Climate observations for this region (Ref 14.15) identify gradual warming, with an increase of 1.37°C in annual average temperatures between 1961 and 2006. Annual average daily maximum temperatures have increased by 1.54°C over the same period, and the annual average number of days with air frost has reduced by 20.9.
- 14.6.9 For the UK Climate Projections' South West region, climate observations indicate a 9.7% increase in average annual precipitation amounts between 1961 and 2006. This can be broken down to an average of a 4.0% average increase in precipitation levels in spring, an 8.8% average decrease in summer, a 28.6% average increase in autumn, and a 15.9% average increase in winter (Ref 14.11).

Future baseline – climate resilience assessment

Construction year baseline (2021)

- 14.6.10 The UK Climate Projections 2009 (UKCP09) (Ref 14.11) indicate that, for the South West of England, there is projected to be an increase in annual temperatures and increased seasonality in rainfall, with wetter winters and drier summers expected.
- 14.6.11 Climate change projections for the South West of England have been assessed under the UKCP09 High Emissions Scenario, 50% probability level. By the 2020s (2010-2039), annual average daily temperatures are projected to be 1.45°C higher than the 1961-90 baseline average. For the same future time period, annual mean daily precipitation levels are projected to be 0.4% higher, with a 6.5% increase projected for winter, and a 4.8% decrease projected for summer (when compared to the 1961-90 baseline average).
- 14.6.12 UKCP09 projections for changes to the frequency of severe weather events (under the High Emissions Scenario, 50% probability level), have been assessed for the Scheme's location. These projections indicate that there is likely to be an increase in the average annual frequency of heatwaves, days when the temperature exceeds 28°C, prolonged periods with no rainfall (10+ days) and days when precipitation is greater than 25mm per day. These projections are against a baseline average for 1961-90 for precipitation, and 1961-1995 for the other variables.
- 14.6.13 More detailed information on the climate change projections for the construction year baseline can be found in Appendix 14.1.

Opening year baseline (2026)

- 14.6.14 The opening year baseline would be much the same as the construction year baseline as 2026 still falls within the 2020s climate projection period. It is, however, likely to be slightly warmer than in 2021 as the average temperature moves towards those projected within the 2050s period.

- 14.6.15 More detailed information on the climate change projections for the opening year baseline, and up to the 2080s (2070-2099), can be found in Appendix 14.1.

14.7 Potential impacts

- 14.7.1 To assess the GHG emissions arising from the construction and operation of the Scheme a lifecycle assessment approach was undertaken using design, construction and transportation data. This approach is consistent with the principles set out in BS EN 15804 (Ref 14.16), PAS 2080 (Ref 14.17), IEMA guidance (Ref 14.18) and Chapter 4 of TAG Unit A3 Environmental Impact Appraisal (Ref 14.19). The key GHG emission sources considered in the GHG assessment are set out in Table 14.10 and Table 14.11 for the construction and operation stages, respectively.
- 14.7.2 Mitigation measures incorporated in the design and construction of the Scheme are set out in this section. Prior to implementation of the mitigation measures, the Scheme has the potential to affect climate (positively or negatively), both during construction and during operation of the Scheme. These potential impacts are outlined in the following sections.

Construction

GHG impact assessment

- 14.7.3 Potential impacts during the construction phase of the proposed development are presented in Table 14.10 and are categorised in line with the Highways England Carbon Tool and guidance set out in PAS 2080.

Table 14.10: GHG emission sources - construction phase

PAS 2080 Lifecycle Stage	Carbon Tool Reporting Category	Activity	Description of emissions source
Preconstruction stage	Fuel, electricity and water	Energy and water consumption used for enabling works to prepare the site for construction.	GHG emissions from fuel consumed by construction vehicles and plant use.
		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 environment that has the ability to absorb GHG emissions.

PAS 2080 Lifecycle Stage	Carbon Tool Reporting Category	Activity	Description of emissions source
Product stage	Embodied Carbon in raw materials	Use of products and/or materials required to build the 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.
Construction process stage	Fuel, electricity and water	Energy and water consumption used for the construction of the Scheme.	GHG emissions from grid electricity use for powering the tunnel boring machine and other auxiliary facilities. GHG emissions from fuel consumed by construction vehicles and plant use. GHG emissions from the provision and treatment of water.
	Business and Employee travel	Transportation of employees/contractors to the construction site.	GHG emissions arising from the fuel use for vehicles transporting workers to the construction site.
	Waste and waste transport	Waste generated and transported during the construction phase.	Emissions arising from the treatment of waste. Emissions arising from the transportation of the waste to the place of treatment.

Climate resilience assessment

14.7.4 During the construction process, receptors may be vulnerable to a range of short term (2020s) climate risks. Potential impacts during the construction phase could include:

- a) Inaccessible construction site, especially the tunnel construction area via a temporary bridge or major site accesses serving the tunnel construction, due to severe weather event (flooding², snow and ice, storms) restricting working hours and delaying construction;

² The construction of the Tilshead Reservoir, a 95,000m³ storage area that attenuates flow from excess groundwater emerging from springs and overland runoff to the north of Tilshead would modify the current flood risk baseline. Designed as a flood alleviation scheme to reduce flood risk to properties in the villages of Tilshead and Orcheston and

- b) Health and safety risks to the workforce during severe weather events;
- c) Unsuitable conditions (due to very hot weather or very wet weather, for example) for certain construction activities, such as laying pavement materials, tunnelling or delivery of construction plant and the TBM and increasing the need to repeat certain works; and
- d) Damage to construction materials, plant and equipment, including damage to temporary buildings/facilities within the site boundary, such as offices, compounds, material storage areas and worksites, temporary access, temporary bridges, TBM and haul routes.

Operation

GHG impact assessment

- 14.7.5 Potential impacts during the construction phase of the proposed development are set out in Table 14.11.

Table 14.11: GHG emission impacts – operation phase

Lifecycle stage	Activity	Primary emission impacts
Operational stage	Operation of the associated road and tunnel lighting, overhead gantries etc. Maintenance including re-surfacing. Proposed planting of new vegetation.	GHG emissions from grid electricity and other fuel use. Embodied emissions associated with re-surfacing materials. Sequestration of GHG emissions by new vegetation acting as a carbon sink.
Use stage	Vehicle journeys within the Affected Road Network.	GHG emissions per vehicle km. Energy consumption

Climate resilience assessment

- 14.7.6 The Scheme also has the potential to be impacted upon by a changing climate and, in particular, more frequent severe weather events, in the medium to longer-term (2050s and 2080s). Potential impacts on the Scheme during the operational phase include:
- a) Material and asset deterioration due to high temperatures;
 - b) Overheating of electrical equipment, such as information and communication systems;
 - c) Health and safety risks to road users;
 - d) Changes in travel patterns of network users;

the A360 highway, this would reduce existing flood risk in these areas prior to the implementation of the Scheme. For further information see Chapter 11 Road Drainage and the water Environment.

- e) Longer vegetation growing seasons resulting in increased periods of tree fall and increased maintenance and management requirements;
- f) Damage to roads from periods of heavy rainfall;
- g) Flood risk (surface, groundwater, fluvial and snow/ice melt) on the network and damage to drainage systems with the potential for increased runoff from adjacent land contributing to surface water flooding;
- h) Increased slope instability as a result of prolonged/heavy precipitation leading to subsidence;
- i) Storm damage to structures; and
- j) Inaccessible network during severe weather events.

14.7.7 Non-significant but beneficial potential impacts are also expected such as: reduced pavement deterioration from less exposure to freezing, snow and ice; reduced need for snow clearing and reduced frequency of fog episodes, which reduce visibility and road access.

14.8 Design, mitigation and enhancement measures

GHG assessment

14.8.1 Mitigation measures would be implemented to reduce emissions across the lifecycle of the Scheme. Key emissions impacts during construction would be from construction activities and embedded carbon materials. Measures being considered to mitigate the impact of GHG impacts are summarised in Table 14.12.

14.8.2 As the government body tasked with operating, maintaining and modernising England's motorways and major A-roads, Highways England has an important role to play in helping the government meet their commitments for minimising GHG emissions. Mitigation measures identified in Table 14.12 are divided into the following hierarchy options:

- a) Avoid/prevent: measures that maximise potential for reusing and /or refurbishing existing assets;
- b) Reduce: measures that apply low carbon solutions including technologies, materials and products to minimise resource consumption;
- c) Remediate: after addressing 1 and 2 measures to further reduce carbon through on or off-site offsetting or sequestrations.

Table 14.12: GHG mitigation measures

Lifecycle stage	Mitigation measure	Delivery mechanism	Embedded / Additional	Method of reduction
Construction	The construction contractor will develop and implement a plan to reduce energy consumption and associated carbon emissions. This could include the consideration of renewable and/or low or zero carbon energy sources and record percentage of savings implemented Highways England is committed to reducing carbon emissions and works closely with suppliers to reduce emissions from network related activity. 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.	OEMP	Embedded	Avoid/ prevent
	Where practicable, measures will be implemented to manage material resource use during construction including: <ul style="list-style-type: none"> • using materials with lower embedded greenhouse gas emissions and water consumption; • using sustainably sourced materials; and • using recycled or secondary materials. 	OEMP	Embedded	Avoid/ prevent

No operational mitigation measures have been proposed. It is not practical to monitor GHG emissions from road users during the operational phase of the scheme as Highways England does not have direct control over road user emissions.

Climate change resilience assessment

- 14.8.3 A number of general mitigation and adaptation measures to address the potential impacts associated with climate change events have been considered, many of which have been identified within the other topic chapters of the EIA and through the Scheme design. The assessment identifies and takes into account existing resilience measures for each climate variable and associated impacts either already in place or in development for infrastructure and assets.
- 14.8.4 A series of mitigation measures designed into the Scheme are summarised in Table 14.13.

Table 14.13: Climate change resilience mitigation measures

Lifecycle stage	Mitigation measure	Delivery mechanism	Embedded/ Additional
Construction	The Scheme would be designed to improve its resilience to climate change through a range of design and material specification measures including where practicable: the use of construction materials with superior properties (such as increased tolerance to fluctuating temperatures), incorporation of current road design standards and future climate change allowances, adequate space within tunnels and ventilation shafts for anticipated future cooling and ventilation requirements.	OEMP	Embedded
Operation	A range of measures would be in place to improve the resilience of the Scheme to climate change during operation including maintenance plans for drainage systems to allow them to operate effectively and systems in place to assist road users through the installation of appropriate emergency systems being in place, e.g. variable messaging systems (VMS) are specified as part of the design	OEMP	Embedded

14.9 Assessment of effects

GHG assessment

- 14.9.1 Of the lifecycle stages scoped into the assessment as shown in Table 14.14, the embodied carbon associated with materials use is the biggest contributor to the carbon footprint of the Scheme. Materials such as steel, concrete and bitumen can have high embodied carbon contents depending on the specifications used. The assessment looked at the materials used and calculated the associated carbon emissions from their production as well as transport to site.
- 14.9.2 Of the construction stage, activities associated with the excavation of the tunnel are likely to contribute significantly, such as the use of tunnel boring machines which require a mains electricity supply, and the disposal of excavated material. Construction of the Scheme is likely to result in approximately one million cubic metres of wet chalk. The treatment, disposal and associated transport of this material have the potential to contribute to a large part of the construction footprint. The chalk excavated material from the tunnel boring process, as detailed in Chapter 12.7.8 Materials Assets and Waste, would be processed on site and this processing, as well as onward treatment and transport of the excavated material, has been taken into account during this assessment

- 14.9.3 Transportation of materials to the site also has the potential to make a significant contribution to the construction footprint. At this stage data regarding the precise source location of materials, and therefore transportation distance to site, is unavailable. Professional judgement and conservative estimates have therefore been used to calculate GHG emissions associated with material transportation to site.
- 14.9.4 Table 14.14 contains the breakdown and comparison of emissions from each activity during the construction stage.

Table 14.14: Emissions breakdown by construction activity

Reporting category	Emissions (tCO ₂ e)	% construction emissions
Embodied carbon in raw materials and transportation of materials to site	267,100	57%
Fuel, electricity and water	198,935	43%
Business and employee travel	645	<1%
Waste and waste transport	235	<1%
Total	466,900	100%

- 14.9.5 A comparison of operational road user GHG emissions between the ‘do-minimum’ and ‘do-something’ scenarios for the year of opening and the design year (2041) are presented in Table 14.15.

Table 14.15: Comparison of road user emissions – ‘do-minimum v ‘do-something’ scenarios

Reporting category	Year of opening (tCO ₂ e)	Design year (tCO ₂ e)
Do-minimum	59,124,590	66,939,225
Do-something	59,148,580	66,973,140
Variation	23,990	33,915

- 14.9.6 In line with the requirement of the NPSNN, Table 14.16 provides an assessment of the Scheme’s GHG emissions impact against the UK Government’s five year carbon budgets.
- 14.9.7 The UK Government has currently passed into law the carbon budgets up to 2030:
- 3rd carbon budget (2018 to 2022) 2544 MtCO₂e;
 - 4th carbon budget (2023 to 2027) 1950 MtCO₂e;
 - 5th carbon budget (2028 to 2032) 1725 MtCO₂e.

- 14.9.8 The construction period for the Scheme runs from 2021 to 2026 and therefore falls within the 3rd and 4th carbon budgets. Operation of the Scheme is assessed over a 60 year period commencing within the 4th carbon budget period. Operational emissions have also been compared against the 5th carbon budget up to 2032. No carbon budget has yet been set after this date. Table 14.16 presents the net tCO₂e associated with operation during the 4th and 5th carbon budget period.

Table 14.16: Construction and operation emissions in comparison to national carbon budgets

Project Stage	Net tCO ₂ e	Relevant Carbon Budgets
Construction	66,577	3 rd carbon budget period (2018 to 2022)
	399,429	4 th carbon budget period (2023 to 2027)
Operation	49,802	4 th carbon budget period (2023 to 2027)
	136,080	5 th carbon budget period (2028 to 2032)

- 14.9.9 The method to calculate the UK carbon budgets varies 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 Scheme may impact the ability of the UK meeting its carbon budgets it is necessary to make this comparison to put the scheme into context.
- 14.9.10 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. Indeed emissions arising as a result of the Scheme represent less than 0.03% of total emissions in any five year carbon budget during which they arise.
- 14.9.11 In this context it is concluded that the GHG impact of the Scheme would not have a material impact on the Government meeting its carbon reduction targets.

Climate change resilience assessment

- 14.9.12 Climate resilience impacts on the Scheme during the construction phase, as outlined in Section 14.7, are not expected to be significant due to the duration and nature of the construction activities. Therefore, these impacts have not been assessed any further.
- 14.9.13 The Scheme may, however, be vulnerable to a range of potentially significant impacts during the operational phase. These have been assessed in accordance with the methodology set out in Section 14.3.
- 14.9.14 The assessment has found that, based on the mitigation built into the design and assumed management practices, as well as the UKCP09 climate change projections, information from other environmental disciplines, and details on scheme design, that none of the potential impacts identified would be significant (and are therefore classed as non-significant).

- 14.9.15 These non-significant climate resilience impacts, identified using criteria the set out in the assessment methodology, are presented in detailed in Appendix 14.2 and include
- a) Health and safety risks to road users, and disrupted and/ or inaccessible network due to snow, ice, standing water and other weather events.
 - b) Damage to roads, tunnels, cuttings and drainage systems due to flooding.
 - c) 'Summer Ice' – Occurs after a prolonged period of no rain when dirt and oil residue builds up on the road. When the first rain event occurs this material becomes incredibly slippery and dangerous (similar to ice on the road).
 - d) Material and asset deterioration due to high temperatures including Traffic related rutting and migration of materials and thermal expansion and movement of bridge joints and paved surfaces
 - e) Overheating of tunnel and electrical equipment, such as information and communication systems leading to a potential fire risk.
 - f) Increased slope instability leading to subsidence and landslides.
 - g) Damage and disruption to power supply and other linked infrastructure.
 - h) Increased pollution from road runoff (including the pollutants discard into the Chalk aquifer).
 - i) Increased sediment transport.
 - j) Longer vegetation growing seasons leading to reduced soil moisture and/or increased tree leaf coverage combined with an increased magnitude and frequency of storm events may result in tree fall and increased maintenance and management requirements.
 - k) Signs, tall structures and high-sided vehicles at risk from increasing wind speeds.
 - l) Reduced pavement friction coefficient.
 - m) Reduced pavement deterioration from less exposure to freezing, snow and ice.

In-combination climate change impact (ICCI) assessment

- 14.9.16 The in-combination climate impact assessment has not identified the potential for significant combined impacts of future climate change and the proposed development on identified receptors in the surrounding environment. Potential non-significant effects are reported in Appendix 14.2 and include:
- a) Minor impacts upon groundwater and surface water;

- b) Negligible impacts upon agricultural holdings; and
- c) Negligible impacts upon ecology and nature conservation specifically the River Till and River Avon.

14.10 Monitoring

- 14.10.1 As no significant effects have been identified for the Climate assessment, no monitoring of significant effects is proposed
- 14.10.2 The OEMP sets out monitoring to be undertaken during the construction stage to ensure that the mitigation measures embedded in the scheme design are appropriately implemented. 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 OEMP 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 Scheme.

References

- Ref 14.1: Highways England (2007) Design Manual for Roads and Bridges Volume 11, Section 3, Part 1 (Air Quality)
- Ref 14.2: Highways England's Interim Advice Note (IAN) 114/08 – Highways Agency Carbon Calculation and Reporting Requirements
- Ref 14.3: Department for Transport (2014) National Policy Statement for National Networks
- Ref 14.4: Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU
- Ref 14.5: Wiltshire Council (2015) Wiltshire Core Strategy
- Ref 14.6: Highways England, Carbon Reporting Tool, v1.03
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/553866/Task_446_Carbon_Tool_v1.03.xlsm
- Ref 14.7: The GHG Protocol website. Web link: www.ghgprotocol.org
- Ref 14.8: Road to Zero Strategy, HM Government, July 2018
- Ref 14.9: Department for Business, Energy and Industrial Strategy (BEIS) Updated Energy and Emissions Projections, 2017
- Ref 14.10: IEMA (November 2015) IEMA Environmental Impact Assessment Guide to: Climate Change Resilience and Adaptation
- Ref 14.11: UK Climate Projections (UKCP09). Accessed at: <http://ukclimateprojections.metoffice.gov.uk/>
- Ref 14.12: Department for Transport (DfT), 2015. Transport Analysis Guidance (TAG) Environmental Impact Appraisal (UNIT A3), Section 3 Air Quality Impacts. Dated December 2015.
- Ref 14.13: Wiltshire Council (2010) Local Climate Impacts Profile for Wiltshire (LCLIP)
- Ref 14.14: UK Climate Change Risk Assessment 2017 Evidence Report. Accessed at: <https://www.theccc.org.uk/tackling-climate-change/preparing-for-climate-change/uk-climate-change-risk-assessment-2017/>
- Ref 14.15: The Met Office historic climate data. Link: www.metoffice.gov.uk/public/weather/climate/gcqfp5e8q (Accessed 01/06/2018)
- Ref 14.16: British Standards Institution (2012) BS EN 15804:2012+A1:2013 – Sustainability of construction works. Environmental product declarations. Core rules for the product category of construction products
- Ref 14.17: British Standards Institution (2016) PAS 2080
- Ref 14.18: IEMA (2017) Environmental Impact Assessment Guide to: Assessing Greenhouse Gas Emissions and Evaluating their Significance
- Ref 14.19: Department for Transport (2015) TAG Unit A3 – Environmental Impact Appraisal

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