A428 Black Cat to Caxton Gibbet improvements

TR010044

Volume 6

6.1 Environmental Statement

Chapter 14: Climate

Planning Act 2008

Regulation 5(2)(a)

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

26 February 2021

Infrastructure Planning

Planning Act 2008

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

A428 Black Cat to Caxton Gibbet improvements

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Chapter 14: Climate

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14 Climate

14.1 Competent expert evidence

14.1.1 This chapter presents the results of an assessment of likely significant effects of the Scheme on climate. This chapter outlines the methodology applied within the assessment and reports the effects on climate associated with greenhouse gas (GHG) emissions and the vulnerability of the Scheme to climate change.

14.1.2 The competent expert responsible for the assessment is an Associate Director who holds the qualification of BSc Environmental Studies and is a Chartered Environmentalist.

14.1.3 They have over 15 years of experience in the management and delivery of energy efficiency, carbon management and climate change assessment.

14.2 Legislative and policy framework

14.2.1 The following legislation and planning policy is of direct relevance to the assessment of climate. Compliance (or otherwise) with statute and policy relating to the UK's climate objectives and policies are addressed within the Case for the Scheme **[TR010044/APP/7.1]**.

14.2.2 Legislation and policy concerning the relationships between climate change, flood risk and water management are presented within **Chapter 13, Road drainage and the water environment** of the Environmental Statement **[TR010044/APP/6.1]**.

Climate Change Act 2008

14.2.3 The *Climate Change Act 2008* (Ref 14-1) originally set out a legally binding target for the UK Government to reduce national GHG emissions from 1990 levels by at least 80% by 2050. This target was supported by a series of five-year Carbon Budgets (Ref 14-2).

14.2.4 An update to the *Climate Change Act 2008* (Ref 14-1), the *Climate Change Act 2008 (2050 Target Amendment) Order 2019* (Ref 14-3) was published in 2019. This is an amendment revising the previous 2050 GHG target of an 80% reduction of GHG emissions compared to 1990 levels to a net zero carbon target. Achieving this will require future GHG emissions to be aligned (avoided or offset) with any future new or revised carbon budgets that may be set out by Government to achieve the target of net zero carbon by 2050.

14.2.5 The Climate Change Committee has released the recommendations for the sixth carbon budget (Ref 14-4), however at the time of writing it has not been adopted by Government.

14.2.6 The recommended sixth carbon budget is ambitious, reflective of the recent net zero carbon target, and the Climate Change Committee has indicated that the steep trajectory will continue through later carbon budgets (Ref 14-2).Therefore, the sixth recommended carbon budget has been displayed alongside the current carbon budgets for context when determining the significance of GHG emissions from the Scheme.

National Policy Statement for National Networks

14.2.7 The *National Policy Statement for National Networks* (NPSNN) (Ref 14-5) sets out how climate change should be taken into account when developing infrastructure.

14.2.8 Paragraph 5.17 of the *NPSNN* (Ref 14-5) states that projects are required to provide "*evidence of the carbon impact of the project and an assessment against the Government's carbon budgets"*. Evidence of mitigation is also required, for design and construction, to demonstrate that the carbon footprint is not 'unnecessarily high'.

14.2.9 Paragraphs 4.40 to 4.44 of the *NPSNN* (Ref 14-5) also outline that mitigation is essential to minimise the most dangerous impacts of climate change, noting that new development should be planned to avoid increasing vulnerability to the range of impacts arisings from this.

14.2.10 The potential impacts of climate change have been considered in the assessment, and through the design-development process in relation to the planning, location, design, build and operation of the Scheme, as described in **Chapter 3, Assessment of alternatives** of the Environmental Statement **[TR010044/APP/6.1]**. The assessment has also applied the latest available climate change projections across the 60 year lifetime (design life) of the Scheme, as described in Section 14.7.

Overarching National Policy Statement for Energy (EN-1)

14.2.11 The *Overarching National Policy Statement for Energy (EN-1)* (Ref 14-6) sets out the Government's policy on energy and infrastructure development.

14.2.12 In relation to climate, EN-1 (Ref 14-6) details how applicants should take the effects of climate change into account when developing infrastructure and identifies the need for developments to adapt to climate change – for example the incorporation of flood risk protection measures. It further identifies a need to apply the latest UK climate projections over the lifetime of the new infrastructure

14.2.13 The requirements of EN-1 (Ref 14-6) associated with the gas pipeline diversion within the Scheme have been accounted for in the assessment, in the manner described in paragraph 14.2.10.

National Policy Statement for Gas Supply Infrastructure and Gas and Oil Pipelines (EN-4)

14.2.14 The *National Policy Statement for Gas Supply Infrastructure and Gas and Oil Pipelines (EN-4)* (Ref 14-7) relates to gas supply and gas and oil pipelines and sits under EN-1 (Ref 14-6).

14.2.15 Although no specific requirements are contained within EN-4 (Ref 14-7) in relation to climate, it does identify that pipeline developments need to be resilient to the effects of climate change – for example the increased risk of flooding and the potential for earth movement or subsidence from flooding or droughts.

14.2.16 The need to consider climate change resilience within EN-4 (Ref 14-7) associated with the gas pipeline diversion within the Scheme have been accounted for in the assessment, in the manner described in paragraph 14.2.10.

National Planning Policy Framework

14.2.17 The *National Planning Policy Framework* (NPPF) (Ref 14-8) sets out the Government's planning policies for England and provides a framework within which Local Planning Authorities can formulate development plans.

14.2.18 The *NPPF* (Ref 14-8) states that the purpose of planning is to contribute to the achievement of sustainable development, and that positive improvements should be sought in the quality of the built, natural and historic environment, as well as in people's quality of life.

14.2.19 It further notes that new development should be planned for in ways that avoid increasing vulnerability to the range of impacts arising from climate change, and ways that can help to reduce GHG emissions.

14.2.20 These policy objectives have been accounted for in the design of the Scheme through the incorporation of drainage measures that have been designed and sized to accommodate future changes in road runoff resulting from climate change, as described in **Chapter 2, The Scheme** of the Environmental Statement **[TR010044/APP/6.1]**, and through the assessment of GHG emissions and climate change resilience reported within this chapter.

Planning Practice Guidance

14.2.21 Planning Practice Guidance for *Climate change* (Ref 14-9) provides context to the *NPPF* (Ref 14-8) and advises on how to identify suitable mitigation and adaptation measures to address the impacts of climate change.

14.2.22 This guidance has been considered in the assessment by predicting the GHG emissions that the Scheme would generate, their likely contribution to climate change, and by identifying measures to mitigate effects on (and arising from) climate change.

14.2.23 The following strategies, policies and plans 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:

a. *Cambridgeshire County Council Draft Climate Change and Environment Strategy 2020 – 2025* (Ref 14-10).

b. Cambridgeshire County Council's *Net Zero Cambridgeshire – 'What actions must Cambridgeshire County Council take to reach net zero carbon emissions by 2050?'* (Ref 14-11).

c. *South Cambridgeshire Local Plan 2018* (Ref 14-12).

d. South Cambridgeshire District Council's *Zero Carbon Strategy 2020* (Ref 14-13).

e. *Huntingdonshire's Local Plan to 2036* (Ref 14-14).

f. *Huntingdonshire's Local Plan to 2036: Final Sustainability Appraisal Report* (Ref 14-15).

g. Central Bedfordshire Council's *Core Strategy and Development Management Policies* (Ref 14-16).

h. *Central Bedfordshire Council Pre-submission Local Plan 2015 – 2035* (Ref 14-17).

i. Central Bedfordshire Council's *Environmental Framework* (Ref 14-18).

j. *Bedford Borough Local Plan 2030* (Ref 14-19).

k. Bedford Borough Council's *Carbon Reduction Delivery Strategy 2020 – 2030* (Ref 14-20)

l. Bedfordshire Borough Council's *Environmental Policy* (Ref 14-21).

14.2.24 These documents identify the need for the consideration of the impacts of climate change throughout the development process. Impacts identified include a greater incidence of extreme weather conditions, such as hotter summers and milder and wetter winters, leading to increased flood risk, along with an increase in air, water and land pollution having adverse effects on human health.

14.2.25 Development priorities for mitigation and adaptation to climate change highlighted within these documents include:

a. Quantifying and reducing carbon footprints of new developments and proposals.

b. Supporting and increasing resilience against climate change and future weather trends.

c. Improving energy efficiency and reducing carbon emissions whilst ensuring new residential and commercial buildings are designed to maximise energy efficiency.

d. Enhancing and conserving natural capital resources such as wildlife, plants, air quality, water and soils.

e. Providing complementary green infrastructure enhancement and provision to balance recreational and biodiversity needs and to support climate change risk management.

f. Managing and minimising all forms of flood risk.

g. Ensuring all major development demonstrates a net gain in green infrastructure; linking, enhancing and extending existing green infrastructure assets creation of ecological networks.

14.2.26 These documents identify the need for the consideration of the impacts of climate change throughout the development process. Impacts identified include a greater incidence of extreme weather conditions, such as hotter summers and milder and wetter winters, leading to increased flood risk, along with an increase in air, water and land pollution having adverse effects on human health.

14.2.27 Development priorities for mitigation and adaptation to climate change highlighted within these documents include:

a. Quantifying and reducing carbon footprints of new developments and proposals.

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e. Providing complementary green infrastructure enhancement and provision to balance recreational and biodiversity needs and to support climate change risk management.

f. Managing and minimising all forms of flood risk.

g. Ensuring all major development demonstrates a net gain in green infrastructure; linking, enhancing and extending existing green infrastructure assets creation of ecological networks.

14.2.28 Relevant strategies, plans and policy objectives contained within these documents have been considered as part of the design-development of the Scheme and through the assessment of GHG emissions and Climate Change Resilience (CCR) reported within this chapter.

14.3 Assessment methodology

Scope of the assessment

14.3.2 A scoping exercise was undertaken in mid-2019 to identify the matters to be covered by the climate and GHG assessment and agree the approach with relevant statutory bodies.

14.3.3 The assessment scope was established at that time by comparing available design and landtake details for the Scheme with data and information relating to climate and GHG emissions.

14.3.4 The scoping exercise was informed by the technical and reporting guidance contained in the *Design Manual for Roads and Bridges Volume 11: Environmental Assessment* (Ref 14-22) (DMRB) and *Interim Advice Note 125/25: Environmental Assessment Update* (Ref 14-23).

14.3.5 The outcomes of scoping were recorded in a scoping report (Ref 14-24), which was consulted upon as part of a formal request to the Inspectorate for a scoping opinion and included a summary of all assessment work undertaken as part of the design-development of the Scheme.

14.3.6 The Inspectorate's scoping opinion **[TR010044/APP/6.5]** identified a number of additional overarching Environmental Impact Assessment (EIA) and topic-specific matters that were subsequently brought into the overall scope of the assessment. These further considerations are detailed in **Table 1** of **Appendix 4.3** of the Environmental Statement **[TR010044/APP/6.3]** and include a summary of how Highways England has responded to the points raised, and where this information is reported.

14.3.7 Subsequent to the publication of the scoping opinion **[TR010044/APP/6.5]**, Highways England published a series of new DMRB standards relating to sustainability and the environment (Ref 14-25), resulting in the phased withdrawal of the guidance used to inform the scoping exercise (Ref 14-22) from July 2019.

14.3.8 A decision was made by Highways England to adopt the new DMRB standards (Ref 14-25) part way into the assessment process, the details of which are summarised in **Chapter 4, Environmental assessment methodology** of the Environmental Statement **[TR01004/APP/6.1]**.

14.3.9 **Table 2** of **Appendix 4.3** of the Environmental Statement **[TR010044/APP/6.3]** sets out the changes to the scope and methodology of the climate assessment resulting from adoption of the new DMRB standards.

14.3.10 In addition to the matters raised in the scoping opinion [**TR010044/APP/6.5**] and through adoption of the new DMRB standards (Ref 14-25), the final assessment scope has also been shaped by the following:

a. The outcome of consultation and engagement with statutory bodies, non-statutory organisations and other stakeholders with an interest in climate change and GHG emissions.

b. Design changes made to the form and extent of the Scheme and the area of land required for its construction, operation and maintenance (the Order Limits).

c. The type and availability of information relating to construction materials requirements for the Scheme (see **Chapter 10, Materials assets and waste** of the Environmental Statement **[TR010044/APP/6.1]**), and its future predicted operational GHG emissions (see **Chapter 5, Air quality** of the Environmental Statement **[TR010044/APP/6.1]**).

d. The outcomes of further desk-based surveys undertaken to establish the baseline conditions associated with climate, and to inform the identification of the likely significant effects of the Scheme.

14.3.11 Consideration has been given within the scope of the assessment to climate effects arising from the future maintenance and management of the Scheme, as this forms an important stage of the life cycle assessment of GHG emissions.

14.3.12 As reported within the scoping opinion **[TR010044/APP/6.5]**, the consideration of GHG emissions associated with the end of life stage of the Scheme have been scoped out of the assessment, on the basis that it is unlikely that the Scheme would be decommissioned in the future.

14.3.13 This Chapter includes an In-combination Climate Change Impacts (ICCI) assessment. Although this is no longer a requirement in the new DMRB standard (Ref 14-26), it has been produced here to meet the assessment method presented in the scoping opinion. The ICCI assessment specifically considers the combined impact of the Scheme and future climate change on receptors identified within other environmental topic assessments. Accordingly, the ICCI assessment does not consider the cumulative impacts of the Scheme and other developments; these interactions are described within **Chapter 15, effects**

Assessment of cumulative effects of the Environmental Statement **[TR010044/APP/6.1]**.

Assessment standards and guidance

14.3.14 The following standards and guidance have been used to inform the scope and content of the assessment, and to assist the identification and mitigation of the likely significant effects. This builds upon the overarching EIA methodology and the following requirements and guidance presented in **Chapter 4, Environmental assessment methodology** of the Environmental Statement **[TR010044/APP/6.1]**.

Design Manual for Roads and Bridges

14.3.15 Requirements and advice within *LA 114 Climate* (Ref 14-26) has been supplemented by the use of Highway England's *Carbon reporting tool* (Ref 14-27), which has been developed to enable the better management of carbon emissions associated with the strategic road network.

14.3.16 Road user emissions have been calculated following *LA 105 Air quality* (Ref 14-28) using its regional assessment methodology.

Other guidance

14.3.17 The assessment has also referenced guidance and advice contained within the following documents:

a. The World Business Council for Sustainable Development and World Resources Institute *Greenhouse Gas Protocol* (Ref 14-29).

b. The Institute of Environmental Management and Assessment's *Environmental Impact Assessment Guide to: Assessing Greenhouse Gas Emissions and Evaluating their Significance* (Ref 14-30).

c. The Institute of Environmental Management and Assessment's *Environmental Impact Assessment Guide to: Climate Change Resilience and Adaptation* (Ref 14-31).

d. The European Commission's *Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment* (Ref 14-32).

e. The British Standards Institution's *PAS 2080:2016 Carbon Management in Infrastructure* (Ref 14-33).

f. Highways England's Design Manual for Roads and Bridges: GG 103 - Introduction and general requirements for sustainable development and design (Revision 0) (Ref 14-25).

g. Defra and Highways England's Climate adaptation reporting second round: Highways England (Ref 14-35).

Establishment of the baseline

14.3.18 The baseline conditions for the GHG impact assessment were determined using modelled volumes of traffic currently on the existing affected road network, and its predicted future use (accounting for increases in traffic and associated congestion) through to year 2086 (assuming a Scheme lifetime of 60 years).

Desk study

14.3.19 Data was gathered from the following sources to determine the baseline conditions for the CCR and ICCI assessments:

a. *The* UK Climate Impacts Programme *UK Climate Projections 2018* (UKCP18) (Ref 14-36) – to identify the relevant climate projections for the appropriate geographic area of the Scheme. UKCP18 are currently the leading climate change projections for the UK.

b. Department for Environment, Food and Rural Affairs (Defra*) UK Climate Change Risk Assessment 2017 Evidence Report* (Ref 14-37) – to identify the climate change risks relevant to the Scheme and geographic area of the Scheme.

c. Met Office historic climate data (Ref 14-38) – to identify the historic trends of relevant climate parameters for the appropriate geographic areas of the Scheme.

14.3.20 In addition to the Scheme design and construction details presented within **Chapter 2, The Scheme** of the Environmental Statement **[TR010044/APP/6.1]**, reference was also made to the findings of the following assessments which have a direct relationship to the assessment of climate:

a. Air quality – in relation to GHG emissions associated with vehicles, as reported in **Chapter 5, Air quality** of the Environmental Statement **[TR010044/APP/6.1]**.

b. Biodiversity – in relation to GHG emissions associated with land use change, as reported in **Chapter 8, Biodiversity** of the Environmental Statement **[TR01044/APP/6.1]**

c. Material assets and waste – in relation to GHG emissions associated with construction of the Scheme, as reported in **Chapter 10, Material asset and waste** of the Environmental Statement **[TR010044/APP/6.1]**.

d. Road drainage and the water environment – in relation to flood risk and climate change, as reported in **Chapter 13, Road drainage and the water environment** of the Environmental Statement **[TR010044/APP/6.1]**.

Consultation

14.3.21 Details regarding the statutory consultation undertaken as part of the Scheme, and its outcomes in relation to climate, are presented in the Consultation Report **[TR010044/APP/5.1]**.

14.3.22 In addition to statutory consultation, non-statutory consultation has been undertaken with the Greater Cambridgeshire Shared Planning team in relation to sharing the climate methodology.

Identification and assessment of impacts

14.3.23 The identification of the impacts associated with climate comprises three distinct components:

a. GHG impact assessment: the effect 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. CCR assessment: the resilience of the Scheme to climate change, including how the Scheme design would be adapted to take account of the projected impacts of climate change.

c. ICCI assessment: the combined effects of the impacts of the Scheme and potential climate change impacts on the receiving environment.

Greenhouse gas impact assessment

14.3.24 All GHG emissions contribute to global climate change. The UK has legally binding GHG reduction targets and therefore the level of significance has considered how the Scheme would contribute to the UK's ability to achieve its carbon reduction targets and meet the carbon budgets.

14.3.25 Whilst the scope of the assessment covers the lifecycle stages of the Scheme, 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:

a. The first considers the construction of the Scheme itself; the majority of GHG emissions from which would be additional to the existing national GHG emissions inventory and are compared to the relevant UK carbon budgets.

b. The second considers the operation (including maintenance) and 'use' of the Scheme; comprising GHG emissions resulting from energy use, such as road lighting and the impact from a variation in vehicle journeys travelling on the Scheme and the surrounding area. 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 (for example road users), they are not considered additional to the GHG inventory.

14.3.26 GHG emissions from construction have been calculated using Highways England's *Carbon reporting tool* (Ref 14-27). Data used for the calculation was based on the following set of standard data quality principles detailed in World Business Council for Sustainable Development/World Resources Institute *Greenhouse Gas Protocol Corporate Accounting and Reporting Standard* (Ref 14-29); which has been applied so that the results from the GHG assessment are as 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 reporting tool* (Ref 14-27) 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.

e. Competency – activity data was generated by the engineering and design teams in-line with applicable industry standards.

14.3.27 GHG emissions outputs from the *Carbon reporting tool* (Ref 14-27) have been reported as tonnes of carbon dioxide equivalent (tCO_2e) and have considered the following gases:

a. Carbon dioxide (CO_2).

b. Methane (CH_4).

c. Nitrous oxide (N_2O).

d. Sulphur hexafluoride (SF_6).

e. Hydrofluorocarbons (HFCs).

f. Perfluorocarbons (PFCs)[1].

14.3.28 GHG calculations performed without the use of the *Carbon reporting tool* (Ref 14-27) also consider nitrogen trifluoride, which was added to the list of six Kyoto Protocol GHGs in 2018.

14.3.29 GHG emissions arising from construction and maintenance have been assessed using a calculation-based methodology as per the below equation (aligned with the GHG Protocol guidelines):

Activity data x GHG emissions factor = GHG emissions value

14.3.30 The emissions factors used have been selected from the Department of Business, Energy and Industrial Strategy's *Government conversion factors for company reporting of greenhouse gas emissions* (Ref 14-39) and the *Inventory for Carbon and Energy Databas*e (Ref 14-41).

14.3.31 Land use change has been calculated according to the methodology and factors set out in the EU Commission's *guidelines for the calculation of land carbon stocks* (Ref 14-40).

14.3.32 Road user emissions have been calculated following the requirements and advice provided in *DMRB LA 114* (Ref 14-26). This methodology estimates the contribution from traffic on the road, also referred to as 'road user carbon'.

14.3.33 The uptake of lower carbon fuels, electric vehicles and increased vehicle technology are partially accounted for within the assessment of operational GHG emissions using Defra's *Emissions Factors Toolkit* (Ref 14-42); however, it is accepted that such technological advances and changes are likely to beneficially contribute to reducing GHG emissions in the future.

[1] Calculations for embodied carbon performed using the *Highways England Carbon Emissions Tool* (Ref 14-26) only account for the six Kyoto Protocol GHGs defined prior to the addition of nitrogen trifluoride (NF_3) in 2018.

14.3.34 The GHG emissions operational assessment adopts a scenario-based assessment, with the quantification of different scenarios to provide a range for the potential additional GHG emissions associated with Scheme operation. These scenarios include:

a. A 'do-minimum' (DM) scenario whereby the Scheme is not implemented.

b. A 'do-something' (DS) scenario whereby the Scheme goes ahead and the GHG emissions reductions from embedded mitigation measures are taken into account.

14.3.35 A comparison of the GHG emissions for the DM and DS scenarios have been undertaken between the year of Scheme opening (2026) and for the lifetime year (2086), 60 years on from the opening year.

Climate change resilience assessment

14.3.36 The identification and assessment of CCR within EIA is an area of emerging practice. There is no single prescribed format for undertaking such assessments; therefore, the approach adopted to undertaking and reporting the assessment has drawn on good practice from other similar developments and studies.

14.3.37 The assessment has considered the strategic aims and objectives encompassed within the national and local policies and strategies summarised in Section 14.2, which collectively seek to minimise the adverse impacts of climate change whilst requiring new development to take climate change considerations into account.

14.3.38 An assessment of CCR has been undertaken for the Scheme to identify potential climate change impacts, and to consider their potential consequence and likelihood of occurrence, taking account of the measures incorporated into the design of the Scheme.

14.3.39 The assessment has included all infrastructure and assets associated with the Scheme and has assessed resilience against both gradual climate change and the risks associated with an increased frequency of extreme weather events, referencing *UKCP18* data, Representative Concentration Pathways (RCP) 8.5, 50th Percentile for the 2020s and 2080s (Ref 14-36) as presented in **Appendix 14.1** of the Environmental Statement **[TR010044/APP/6.3]**.

14.3.40 The types of receptors considered vulnerable to climate change are:

a. Construction phase receptors (i.e. workforce, plant and machinery).

b. The highway assets and their operation, maintenance and refurbishment (i.e. pavements, structures, earthworks and drainage, technology assets, etc).

c. End-users (i.e. members of public, commercial operators, etc).

14.3.41 The 60-year Scheme lifetime includes the operational phase. As the construction phase would be much shorter in duration than the operational phase, and would be undertaken within the next ten years, future climate impacts for the construction phase, while considered using the same methodology as the longer term assessment, are considered to be less severe than longer term climate impacts. For this lifecycle stage the climate projections for the 2020s has been selected.

14.3.42 For the operational assessment, the likelihood and consequence of impacts and effects on receptors has been assessed based on a future time frame of operation (2080s).

14.3.43 Criteria used to determine the likelihood of an event occurring, based on its probability and frequency of occurrence, are detailed in **Table 14-1**.

Table 14-1: Measure of likelihood for CCR assessment

Likelihood Category	Description (probability and frequency of occurrence)
Very high	The event* occurs multiple times during the lifetime of the Scheme (60 years) e.g. approximately annually, typically 60 events.
High	The event occurs several times during the lifetime of the Scheme (60 years) e.g. approximately once every five years, typically 12 events;
Medium	The event occurs limited times during the lifetime of the Scheme (60 years) e.g. approximately once every 15 years, typically 4 events.
Low	The event occurs during the lifetime of the Scheme (60 years) e.g. once in 60 years.
Very low	The event may occur once during the lifetime of the Scheme (60 years).
* The event is defined as the climate event (such as heatwave) and the hazard (such as overheated electrical equipment) occurring in combination	

14.3.44 The consequence of an impact has been measured using the criteria detailed in **Table 14-2**.

Table 14-2: Measure of consequence for CCR assessment

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.

14.3.45 The identification of likely significant effects on receptors has been undertaken using professional judgement and the views of relevant technical specialists, based on knowledge and experience of similar schemes, by combining the measure of likelihood with the predicted consequence of impact, as shown in **Table 14-3**.

Table 14-3: Significance criteria for CCR assessment

Measure of consequence	Measure of Likelihood				
	Very low	Low	Medium	High	Very High
Negligible	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
Minor	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
Moderate	Not Significant	Not Significant	Significant	Significant	Significant
Large	Not Significant	Not Significant	Significant	Significant	Significant
Very Large	Not Significant	Significant	Significant	Significant	Significant

In-combination climate change impact assessment

14.3.46 An In-combination Climate Change Impact (ICCI) assessment has been undertaken to evaluate the combined impacts of future climate change and those associated with the Scheme.

14.3.47 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.

14.3.48 Temperature and precipitation variables have been obtained from *UKCP18* (Ref 14-36) and analysed to identify potential climate hazards that may impact receptors.

14.3.49 The likelihood has been defined using the criteria outlined in **Table 14-4**, using *UKCP18* (Ref 14-36) data and professional judgement.

Table 14-4: Likelihood criteria for ICCI assessment

Likelihood of impact occurring	Confidence of climate hazard occurring	
	Low	High
Low	Low	Medium
High	Medium	High

14.3.50 The consequence of in-combination climate change impacts has been based on the change to the significance of the effect of the Scheme on the resource or receptor within each relevant environmental discipline, taking into account existing mitigation measures reported within each relevant assessment, as shown in **Table 14-5**.

Table 14-5: Consequence criteria for ICCI assessment

Consequence	Consequence criteria
High	The climate change parameter in-combination with the effect of the Scheme causes the significance of the impact 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 impact 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 impact 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 impact of the Scheme on the resource/receptor, as defined by the topic.

14.3.51 The significance of effects has been determined through combining likelihood and consequence, as presented in **Table 14-6**.

Table 14-6: Significance criteria for ICCI assessment

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

14.3.52 Significant effects comprise those effects that are within the moderate, large or very large categories, in accordance with *LA 104 Environmental assessment and monitoring* (Ref 14-43).

14.4 Assessment assumptions and limitations

Scheme design and limits of deviation

14.4.2 The assessment has been based on the Scheme description presented in **Chapter 2, The Scheme** of the Environmental Statement **[TR010044/APP/6.1]** and has taken into account the lateral limits of deviation illustrated on the Works Plans **[TR010044/APP/2.3]**, and the vertical limits of deviation, in order to establish a realistic worst case assessment scenario.

14.4.3 This scenario identifies and reports the effect that any lateral (horizontal) and/or vertical deviation would realistically give rise to.

14.4.4 Notwithstanding any potential deviation, all embedded and essential mitigation measures would remain deliverable within the extents of the limits of deviation.

Baseline data

14.4.5 The assessment has been undertaken with reference to the baseline conditions recorded at the time of undertaking the assessment.

14.4.6 Climate change, by its very nature, is associated with a range of assumptions and limitations. To overcome these issues, current climate change data and science has been incorporated into the assessment, and proven effective approaches undertaken for similar project types are being replicated.

14.4.7 The embodied carbon within materials and transportation of materials has the potential to contribute to GHG emissions. GHG emissions for construction of the Scheme have been calculated based on estimated material quantities. As the location where these materials will be sourced is not known at this stage of the design, emissions from the transportation of materials has been based on a conservative estimate of the distance the materials will be transported.

14.4.8 Information relating to waste material quantities was obtained from **Chapter 10, Material assets and waste** of the Environmental Statement

[TR010044/APP/6.1] to maintain consistency in relation to demolition volumes and waste management routes.

14.4.9 Based on the availability of traffic data an assessment year of 2025 has been selected. As set out in **Chapter 2, The Scheme** of the Environmental Statement **[TR010044/APP/6.1]**, the Scheme is scheduled to open for traffic in 2026, however 2025 represents a conservative assumption due to predicted improvements in background concentrations and fleet emissions in later years.

Impact assessment and mitigation

14.4.10 The assessment has been based on information obtained from the appointed buildability advisor for the Scheme in respect of energy use and waste relating to the preliminary design of the Scheme, as described in **Chapter 2, The Scheme** of the Environmental Statement **[TR010044/APP/6.1]**.

14.4.11 The replacement of components and elements of the Scheme has been included as part of the maintenance lifecycle stage of the GHG assessment.

14.4.12 The assessment has used the design life of the Scheme (60 years) and its lifecycle stages to determine the relevant periods over which the climate projections are selected, to ensure climate projections are considered for the whole of the Scheme lifetime.

14.4.13 Limitations associated with the approach taken for the climate resilience assessment relate to uncertainties inherent within UK climate projections contained in the *UKCP18* (Ref 14-36) data.

14.4.14 Assessments made in relation to climate change risk and impact likelihood and severity have relied upon a number of factors including modelling accuracy, data input and ultimately the professional judgement and evidence gathered as part of other environmental topic assessments undertaken within the EIA.

14.5 Study area

Greenhouse gas impact assessment

14.5.2 The study area adopted for the GHG impact assessment covers the direct GHG emissions (those arising from construction and operational activities undertaken within the Order Limits) and indirect GHG emissions (those associated with construction materials and the transportation of materials and waste).

14.5.3 The assessment of construction GHG emissions focusses on construction activities. The spatial extent of this assessment therefore comprises the area of construction works falling within the Order Limits.

14.5.4 The study area for the assessment of operational GHG emissions includes both direct emissions arising from energy use within the Order Limitsas well as emissions from road users on the road network within and beyond the Order Limits, based on the extents of the Scheme's traffic model contained in the Transport Assessment **[TR010044/APP/7.2]**.

Climate change resilience assessment

14.5.5 The study area for the CCR assessment comprises the Order Limitswhich captures the assets and infrastructure associated with the Scheme, including the temporary works.

In-combination climate change impact assessment

14.5.6 The study area for the ICCI assessment comprises the Order Limits and the surrounding environment that is predicted to be impacted by the Scheme, as defined within the environmental topic chapters.

14.6 Baseline conditions

Greenhouse gas impact assessment

Current baseline

14.6.2 The baseline conditions for the GHG impact assessment comprise those with the DM scenario whereby the Scheme does not go ahead, but accounts for the future use and maintenance of the existing road network.

14.6.3 The baseline conditions for the DM scenario were identified based on the modelling volumes of traffic currently on the existing road network, and its predicted use (accounting for increases in traffic and associated congestion) through to year 2041 (the design year for the Scheme). This established the baseline against which the Scheme was subsequently compared, in order to identify any variation in GHG emissions over time.

Future baseline

14.6.4 The opening year baseline (2026) would consist of GHG emissions from road users along with emissions arising from operational energy use (for example lighting, signs and other mechanical and electrical sources).

14.6.5 The data related to the current and future baselines noted above are presented in Section 14.9.

14.6.6 As noted in Section 14.3, technological advances and decarbonisation of the grid are expected to beneficially reduce GHG emissions from operational energy use in the next 20 to 30 years; however, these reductions have not been taken into account within the assessment.

Climate change resilience and in-combination climate change impact assessments

14.6.7 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** of the Environmental Statement **[TR010044/APP/6.3]**.

14.6.8 The Scheme sits within the Met Office East Anglia region. Climate observations for this region, presented as 10-year averages between 1969 and 2018, identify gradual warming, with an increase of 1.163 °C in mean maximum annual

temperatures between the periods 1969-1978 and 2009-2018. Mean annual rainfall has increased by 43.5% between the same periods.

14.6.9 The latest *UKCP18* data (Ref 14-36) for the 25 km^2 grid square within which the Scheme is located suggests an increase in mean summer and winter air temperatures, with a summer temperature anomaly of +4.9^oC and a mean winter temperature anomaly of +3.1^oC at the 50% percentile under the high (RCP8.5) scenario. Precipitation rates are expected to become more seasonal, with an increased precipitation anomaly of +21% expected in winter and a decreased precipitation anomaly of -34% in summer at the 50% percentile under the high (RCP8.5) scenario.

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 has been applied using available design, construction and transportation data.

14.7.2 The likely key GHG emission sources considered in the assessment are described in the following section for both the construction and operation phases of the Scheme.

Construction

Greenhouse gas impact

14.7.3 Potential likely impacts during the construction of the Scheme are presented in **Table 14-7** and have been categorised in line with the *Carbon reporting tool* (Ref 14-27) and guidance set out in *PAS 2080: 2016* (Ref 14-33).

Table 14-7: GHG emission sources – construction phase

Main stage of project lifecycle	PAS 2080 lifecycle stage	Carbon tool reporting category	Activity	Description of emission sources
Construction Stage	Pre-construction 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 use change	Site clearance, for example, the removal of vegetation for replacement with another land use.	Losses of carbon sink i.e. removal of a natural environment that has the ability to absorb GHG emissions.
	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.

Main stage of project lifecycle	PAS 2080 lifecycle stage	Carbon tool reporting category	Activity	Description of emission sources
	Construction process stage	Fuel, electricity and water	Energy and water consumption used for the construction of the Scheme.	GHG emissions from grid electricity to power auxiliary facilities. GHG emissions from fuel consumed by construction vehicles and plant. GHG emissions from the provision of water and treatment of wastewater.
		Business and employee travel	Transportation of construction workers to the site.	GHG emissions arising from the fuel consumed for worker commuting to and from the construction site.
		Materials transport	Transportation of construction materials to site.	GHG emissions arising from the fuel consumed for transportation of construction materials to site.
		Waste and waste transport	Waste generated and transported during the construction phase.	GHG emissions arising from the treatment of waste. GHG emissions arising from the transportation of the waste to treatment/ disposal facility.
		Land use change	Landscaping, i.e., planting of vegetation as part of the Scheme	Gains of carbon sink i.e. addition of a natural environment that has the ability to absorb GHG emissions.

Climate change resilience

14.7.4 During construction, receptors are likely to be vulnerable to a range of climate risks. Potential impacts during the construction phase could include:

a. Inaccessible construction site(s) due to severe weather events associated with flooding, snow and ice, and storms restricting working hours and delaying operations.

b. Health and safety risks to the workforce during severe weather events.

c. Increased frequency and severity of unsuitable conditions, for example due to very hot weather or very wet weather during construction activities

involving laying pavement materials and the delivery of construction plant, thereby increasing the need to repeat certain works.

d. Increased frequency and severity of damage to construction materials, plant and equipment, including damage to temporary buildings/facilities such as offices, compounds, material storage areas and worksites, temporary access, temporary bridges and haul routes.

Operation

Greenhouse gas impact

14.7.5 Potential likely impacts during the operation of the Scheme, use of the Scheme by motorised vehicles and maintenance of the Scheme are presented in **Table 14-8**.

Table 14-8: GHG emission sources: operation, maintenance and use of the Scheme

Main stage of project lifecycle	PAS 2080 lifecycle stage	Activity	Description of emission sources
Operation (Use Stage)	Operational stage (Operation of Infrastructure)	Operation of the associated road and sign lighting, overhead gantries, pedestrian crossings etc. Planting of new vegetation.	GHG emissions from energy consumer (grid electricity and other fuel use). Sequestration of GHG emissions by the newly planted vegetation.
	Operational stage (Operational use)	Additional vehicle journeys on the public road network.	GHG emissions from vehicle use.
	Operational stage (Maintenance)	Maintenance including re-surfacing	Embodied GHG emissions within materials.

Climate change resilience

14.7.6 Once operational, the Scheme has the potential to be impacted by a changing climate and in particular more frequent severe weather events in the medium to long term.

14.7.7 Potential impacts on the Scheme likely to occur during the operational phase include:

a. Material and asset deterioration due to high temperatures.

b. Overheating of electrical equipment, for example information and communication systems.

c. Health and safety risks to road users.

d. Changes in travel patterns of network users.

e. Longer vegetation growing seasons resulting in increased periods of leaf 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 due to prolonged or heavy precipitation leading to subsidence.

i. Storm damage to structures.

j. Inaccessibility of the network during severe weather events.

14.8 Design, mitigation and enhancement measures

14.8.1 Highways England is committed to reducing carbon emissions from activity on its network by implementing the following mitigation hierarchy:

a. Avoidance/prevention – to maximise the potential for reusing and/or refurbishing existing assets.

b. Reduction – through the application of low carbon solutions including technologies, materials and products to minimise resource consumption.

c. Remediation – applied to further reduce carbon through on or off site offsetting or sequestrations.

14.8.2 The Scheme has been designed, as far as practicable, to avoid and minimise impacts and effects relating to GHG and climate change through the process of design-development (see **Chapter 3, Assessment of alternatives** of the Environmental Statement **[TR010044/APP/6.1]**), and by embedding mitigation measures into the design of the Scheme.

14.8.3 A number of essential mitigation measures have also been identified, which would be implemented by the Principal Contractor to reduce the impacts and effects that construction of the Scheme would have on GHG emissions.

Embedded mitigation measures

14.8.4 Through the design-development and assessment processes, the Scheme has been designed, as far as possible, to reduce the effects on climate change through option identification, appraisal, selection and refinement, as described in **Chapter 3, Assessment of alternatives** of the Environmental Statement **[TR010044/APP/6.1]**.

14.8.5 Mitigation measures have been integrated (embedded) into the Scheme for the purpose of minimising the effects on carbon emissions and to provide climate change resilience. These measures are described in **Chapter 2, The Scheme** of the Environmental Statement **[TR010044/APP/6.1]** and in summary comprise the following:

GHG mitigation

a. The use of energy efficient road lighting to reduce energy consumption, and hence GHG emissions, during operation of the Scheme.

b. The planting of trees, shrubs and hedgerows planted as part of the landscape design which would offset some of the carbon emissions associated with land use change and subsequent operation of the Scheme.

c. Retention where possible of existing highway infrastructure within the Scheme design to reduce GHG emissions associated with demolition activities and the transportation of associated arisings off-site.

d. The inclusion of borrow pits within the Scheme to provide suitable construction material for the Scheme (particularly at the existing Black Cat roundabout) and to reduce the requirement to import material, resulting in decreased traffic movements and their associated GHG emissions.

e. The reuse, where possible, of material arisings generated from construction works, to minimise GHG emissions associated with their transportation both on and off site.

Climate change resilience

f. The incorporation of Sustainable Drainage Systems (SuDS) to handle road runoff and provide resilience against potential future flood events associated with climate change.

g. The specification and installation of highway equipment capable of withstanding high temperatures (including electrical equipment comprising information and communication systems, bridge joints and paved surfaces) arising from severe weather events to provide resilience to climate change.

h. Implementation of emergency systems and response plans, including the identification of suitable network redundancies and diversion routes, to respond to severe weather events, would further increase the resilience of the Scheme to extreme weather conditions.

Essential mitigation

14.8.6 Measures have been identified which would be implemented by the Principal Contractor to reduce the impacts and effects that construction of the Scheme is likely to have on climate change and GHG emissions.

14.8.7 The First Iteration EMP **[TR010044/APP/6.8]** details the best practice measures that would be undertaken during construction of the Scheme to mitigate temporary effects relating to GHG emissions and climate change. Essential measures relating to GHG emissions within this plan focus on:

a. Implementing measures to manage material resource use during construction, including using materials and plant with lower embedded GHG emissions and water consumption, using sustainably sourced materials, and using recycled or secondary materials.

b. The specification of energy efficient construction lighting and durable construction materials to reduce energy consumption.

c. The sustainable use of soil and aggregate materials won from excavation and demolition activities, where feasible, to minimise GHG emissions associated with the importation of materials to site and embodied carbon associated with additional materials.

14.8.8 Essential measures relating to climate resilience comprise the identification, selection and use of construction materials with superior properties that offer increased tolerance of fluctuating temperatures associated with climate change.

Enhancement measures

14.8.9 The implementation and delivery of enhancement measures relating to procurement and further energy reduction would be driven by the Principal Contractor through their Second Iteration EMP, which would involve the development and implementation of a management plan to reduce energy consumption and associated GHG (carbon) emissions, and would include measures relating to the use of renewable and/or low or zero carbon energy sources and the recording of savings achieved.

14.9 Assessment of significant effects

14.9.1 The prediction of impacts and the assessment of effects (and their significance) during construction and operation of the Scheme on climate change and GHG emissions has taken account of the embedded and essential mitigation measures presented in Section 14.8.

Construction

Greenhouse gas emissions

14.9.2 Of the lifecycle stages scoped into the assessment as shown in **Table 14-7**, the embodied carbon associated with the use of materials is the biggest contributor to the carbon footprint of the Scheme, where typical road construction materials such as steel, concrete and bitumen can have high embodied carbon contents depending on the specifications used.

14.9.3 In addition, construction activities would also contribute to GHG emissions due to the associated plant use, which requires fuels and oils such as diesel. The treatment, disposal and associated transportation of waste material from the site also has the potential to contribute to the GHG construction footprint.

14.9.4 Transportation of materials to the site would contribute to the construction GHG footprint. At this stage, data regarding the precise material source locations of materials are uncertain, and therefore transportation distances to site for material sources are also uncertain. Professional judgement and conservative estimates have been used to calculate GHG emissions associated with material transportation to site where estimates were not provided, in this case a distance of 50 kilometres (31 miles) from the site has been assumed.

14.9.5 Land use change provides a carbon sink gain due to proposed landscape planting, which provides a larger carbon sink when compared to the sink lost during construction.

14.9.6 **Table 14-9** contains the breakdown and comparison of emissions from each assessed activity during the Scheme construction stage[2].

[2] Each figure is rounded to the nearest 10 tCO_2e

Table 14-9: Emissions breakdown by construction activity

Reporting category	Emissions (tCO_2e) (approximate)	% construction emissions[3]
Land clearance (loss of carbon sink)	-5,850	-3%
Embodied carbon in raw materials and transportation of materials to site[4]	163,230	78%
Fuel used on site	45,210	22%
Worker travel	4,430	2%
Transport of construction waste	1,180	1%
Disposal of construction waste	180	0%
Total	**208,380**	**100%**

14.9.7 A construction emissions benchmark has been created based on various other Highways England schemes[5], normalised by road length, which gives a range of 19,090 tCO_2e to 35,900 tCO_2e per km of road.

14.9.8 The calculated construction emissions associated with the Scheme fall below the average benchmark at 11,600 tCO_2e per km of road.

Climate change resilience

14.9.9 The assessment has identified that climate resilience impacts and effects on the Scheme during the construction phase are not expected to be significant, due to the duration and nature of the construction activities associated with the Scheme.

14.9.10 The frequency and severity of impacts from climate change are predicted to increase over long-term timeframes (2080s), however, the construction period is in the near future and shorter in duration. Accordingly, these impacts have not been considered further in the assessment.

Operation

Greenhouse gas emissions

14.9.11 A comparison of operational road user GHG emissions between the DM and DS scenarios for the Scheme opening year (2026) and the design year (2041) are presented in **Table 14-10**[6].

[3] Sum of percentages reported may not equate to 100% due to rounding.
[4] Any calculations performed using the Highways England Carbon Emissions Tool only account for the six Kyoto Protocol GHGs defined prior to the addition of nitrogen trifluoride (NF_3) in 2018.
5 Other Highways England Schemes used for the construction emissions benchmark were: A38 Derby Junctions, A46 Coventry Junctions, M54-M6 Link Road, A303 Amesbury to Berwick Down, M42 J6.
[6] Each figure is rounded to the nearest 10 tCO_2e.

Table 14-10: Comparison of road user emissions – 'DM' vs 'DS' scenarios

Reporting category	Year of Scheme opening (tCO_2e)	Design year (tCO_2e)
Do-minimum (DM)	97,061,440	110,096,340
Do-something (DS)	97,096,720	110,146,690
Variation (DS-DM)	35,280	50,350

14.9.12 **Table 14-10** indicates that in the year of Scheme opening, GHG emissions would be approximately 35,280 tCO_2e higher than the DM scenario, whilst for the design year (2041), GHG emissions with the Scheme would be approximately 50,350 tCO_2e higher than the DM scenario. The increase in emissions here is due to the increase in vehicle kilometres travelled as a result of the Scheme.

14.9.13 The extent of the projected uptake of lower carbon fuels, electric vehicles (EVs) and improved vehicle technology since the UK Government announced the move to end the sale of new petrol and diesel cars by 2030 (Ref 14-43) is not currently fully captured in the modelling scenarios of future road traffic emissions.

14.9.14 Within the future road traffic modelling scenarios, increasing proportions of EVs are considered up until 2030, from which point the 2030 level of EV usage is assumed. Therefore, from 2030 onwards vehicle emissions are likely overestimated as EV uptake is expected to increase beyond this time.

14.9.15 In addition, future decarbonisation of the grid would 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 2019 (Ref 14-45), up to 260 Tera Watt hours (TWh) could be generated by low carbon energy sources (renewables and nuclear) by 2035, with less than 100 TWh generated using natural gas and from imports. Only tailpipe emissions are considered within the future road traffic modelling scenarios, so emissions data relating to electricity production and decarbonisation of the grid are not considered.

14.9.16 The operational GHG emissions reported herein are, therefore, a worst-case scenario and are likely to be mitigated by existing plans and initiatives to decarbonise the grid and electrify road transport.

Carbon budgets

14.9.17 In line with the requirement of the NPSNN (Ref 14-5), **Table 14-11** provides an assessment of the Scheme's GHG emissions impact against the UK Government's five-year carbon budgets.

14.9.18 The UK Government has currently passed into law the carbon budgets up to 2032:

a. 3rd carbon budget (2018 to 2022) 2,544 MtCO2e.

b. 4th carbon budget (2023 to 2027) 1,950 MtCO2e.

c. 5th carbon budget (2028 to 2032) 1,725 MtCO2e.

14.9.19 The 6th Carbon Budget is a recommendation only and is included here for context, it does not form part of the significance testing:

a. 6th carbon budget (2033 – 2037) 194 MtCO2e.

14.9.20 Tightening of the recommended 6th carbon budget has occurred to reflect the recent commitment to a net zero carbon economy by 2050, and the Climate change Committee has indicated that the steep trajectory will continue through later carbon budgets (Ref 14-2).

14.9.21 The Decarbonising Transport Plan (DTP), due to be published by Government in Spring 2021, will set out Government plans for decarbonising road transport in light of the net zero by 2050 target and Paris Agreement[7]. It is planned to align with the legislated carbon budgets and net zero by 2050 trajectory.

14.9.22 The carbon assessment has considered emissions from the Scheme in two separate phases, emissions during construction and emissions during operation. Construction of the Scheme is a short-term activity that runs from 2022 to 2026. Emissions from construction therefore fall within the nearer term third and fourth carbon budgets. Emissions from the operation of the Scheme will fall into the fourth fifth, sixth and subsequent future budgets once set through to 2050. **Table 14-11** presents the net tCO2e associated with Scheme operation during each of these legally binding carbon budget periods[8].

Table 14-11: Construction and operation emissions in comparison to national carbon budgets

Project stage	Estimated total GHG emissions over relevant carbon budgets (tCO2e) (DS Scenario)	Net GHG emissions over relevant carbon budgets (tCO2e) (DS - DM)	Net GHG Scheme GHG emissions per relevant carbon budget (tCO2e)		
			3rd (2018 to 2022)	4th (2023 to 2027)	5th (2028 to 2032)
Construction	0	0	52,090	156,280	0
Operation	97,096,720	537,000	0	73,570	201,520
Total	97,096,720	537,000	52,090	229,850	201,520

[7] The Paris Agreement was adopted at COP 21 in Paris, December 2015, when Parties to the UNFCCC reached a landmark agreement to combat climate change and to accelerate and intensify the actions and investments needed for a sustainable low carbon future. It is the s the first universal, legally binding global climate change agreement and has a central aim to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius. Additionally, the agreement aims to strengthen the ability of countries to deal with the impacts of climate change.
[8] Each figure is rounded to the nearest 10 tCO2e

14.9.23 Operational emissions calculated for the years within each carbon budget period include the vehicle use emissions for each specific year, plus the average annual GHG emissions associated with maintenance and operational energy use.

14.9.24 This assessment has established that during the period when carbon emissions from the Scheme would be at their highest level (short- and near-term construction activity and the first year of operation), the Scheme would only contribute to 0.012% of the UK's carbon budget for the relevant carbon budget period (the fourth carbon budget period). The Scheme's carbon emissions would equate to 0.011% of the UK's carbon budget for the fifth carbon budget period. These figures are based on a precautionary assessment which does not take into account or rely upon the further decarbonisation of the UK electricity system or the transition to lower carbon fuels for vehicles.

14.9.25 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.

14.9.26 The NPSNN (Ref 14-5) states that it is very unlikely that the impacts of a road project would, in isolation, affect the ability of the Government to meet its carbon reduction plans. For the purposes of identifying to what extent the Scheme may impact the Government's ability to meet its carbon budgets, a comparison has been made between the UK carbon budget assessment findings and those identified within the calculation of lifecycle emissions.

14.9.27 The assessment has identified that the emissions arising as a result of the Scheme represent less than 0.012% of the total emissions in any five year UK legally binding carbon budget during which they would arise. Accordingly, the assessment has concluded that the GHG emissions impact of the Scheme would not have a material impact on the UK Government meeting its legally binding carbon reduction targets.

14.9.28 Although the 6th carbon budget is not yet legally binding, and therefore no significance test is required under planning law, for context emissions from the scheme have been compared against the 6th carbon budget: the Scheme represents less than 0.117% of the total emissions in the budget period.

Climate change resilience

14.9.29 The assessment of operational impacts and effects has considered the likelihood of climate events and hazards occurring, and the consequence of the potential impacts on disruption on the road network, taking into account of the identified embedded and essential mitigation measures.

14.9.30 The findings of the assessment are presented within **Table 14-12**, and these have concluded that no significant effects would occur to the Scheme in respect of climate change.

Table 14-12: Summary of operational effects

Receptor	Climate event	Impact (climate event and hazard occurring together)	Mitigation built into Scheme design/ assumed management practices	Measure of likelihood	Measure of consequence	Effect significance (likelihood x consequence)
End-users (members of public, commercial operators etc.)	Severe weather events	Health and safety risks to road users, and disrupted and/or inaccessible network.	Identification of suitable network redundancies and diversion routes. Emergency response and contingency plans in place. Standard operating procedures in place for use in the event of necessary road closure and/ or traffic diversion. Regular maintenance of drainage systems and incorporation of increased maintenance capacity to allow for potential extended maintenance intervals.	Low	Moderate adverse	Not significant
	Increased frequency of heavy precipitation events	Damage to roads, bridges, cuttings and drainage systems due to flooding.	Emergency response and contingency plans in place. Incorporation of SuDS where appropriate. Road drainage design includes future climate change allowances in line with DMRB standards to	Medium	Minor adverse	Not significant

Receptor	Climate event	Impact (climate event and hazard occurring together)	Mitigation built into Scheme design/ assumed management practices	Measure of likelihood	Measure of consequence	Effect significance (likelihood x consequence)
			improve its resilience. Use of attenuation features to detain runoff from all events expected to occur with 1% annual probability or more frequently. Scheme design includes flood storage areas at which take appropriate account of climate change. Regular sweeping and cleaning to remove debris. Regular maintenance of assets to detect deterioration, such as bridge scour, and damage in line with relevant DMRB standards at the time of construction.			
	Increased frequency of dry spells and heavy precipitation events	'Summer Ice', which 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 very slippery and	Regular sweeping and cleaning to remove debris. Regular maintenance of drainage systems to allow for effective drainage of the residues.	Medium	Minor adverse	Not significant

Receptor	Climate event	Impact (climate event and hazard occurring together)	Mitigation built into Scheme design/ assumed management practices	Measure of likelihood	Measure of consequence	Effect significance (likelihood x consequence)
The assets and their operation, maintenance and refurbishment (i.e. pavements, structures, earthworks & drainage, technology assets etc.).		dangerous (similar to ice on the road).				
	Increasing average temperatures and increasing frequency of hot days and heatwaves	Material and asset deterioration due to high temperatures.	Use of construction materials with superior properties (such as increased tolerance to fluctuating temperatures). Regular maintenance of assets to detect deterioration and damage. Deterioration models used identify appropriate maintenance regimes.	Medium	Minor adverse	Not significant
	Severe weather events	Increased slope instability leading to subsidence and landslides.	Emergency response and contingency plans in place. Flood storage area, alterations to the locations of embankments, or localised reprofiling of land.	Medium	Minor adverse	Not significant
	Severe weather events	Damage and disruption to gantries, power supply and other linked infrastructure.	Emergency response and contingency plans in place.	Medium	Minor adverse	Not significant

Receptor	Climate event	Impact (climate event and hazard occurring together)	Mitigation built into Scheme design/ assumed management practices	Measure of likelihood	Measure of consequence	Effect significance (likelihood x consequence)
			Identification of suitable network redundancies and diversion routes.			
	Increasing average temperatures and increasing frequency of hot days and heatwaves	Overheating of electrical equipment, such as information and communication systems.	Emergency response and contingency plans in place. Installation of equipment capable of withstanding high temperatures.	Medium	Minor adverse	Not significant
	Gradual climate change Severe weather events	Traffic related rutting and migration of materials.	Use of construction materials with superior properties (such as increased tolerance to fluctuating temperatures). Regular maintenance of assets to detect deterioration and damage. Deterioration models used identify appropriate maintenance regimes	Low	Moderate adverse	Not significant
	Increasing average temperatures and increasing frequency of hot	Thermal expansion and movement of bridge joints and paved surfaces.	Use of construction materials with superior properties (such as increased tolerance to high temperatures).	Low	Moderate adverse	Not significant

Receptor	Climate event	Impact (climate event and hazard occurring together)	Mitigation built into Scheme design/ assumed management practices	Measure of likelihood	Measure of consequence	Effect significance (likelihood x consequence)
	days and heatwaves		Regular maintenance of assets to detect deterioration and damage. Deterioration models used to identify appropriate maintenance regimes.			
	Increased frequency of dry spells and heavy precipitation events	Increased pollution from road runoff. Increased sediment transport.	Control surface water runoff at its source through the use of sustainable highways drainage techniques to manage road runoff.	Low	Moderate adverse	Not significant
	Gradual climate change Severe weather events	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.	Regular maintenance of assets to detect deterioration and damage. Regular sweeping and cleaning to remove debris. Regular maintenance of the soft estate. Emergency response and contingency plans in place.	Medium	Negligible	Not significant

Receptor	Climate event	Impact (climate event and hazard occurring together)	Mitigation built into Scheme design/ assumed management practices	Measure of likelihood	Measure of consequence	Effect significance (likelihood x consequence)
	Severe weather events	Reduced safety and visibility as a result of standing water.	Regular maintenance and cleaning of drainage systems. Emergency response and contingency plans in place.	Low	Minor adverse	Not significant
	Gradual climate change	Safety risks due to snow and ice.	Ensure effective, essential winter maintenance. Emergency response and contingency plans in place. Standard operating procedures in place for use in the event of necessary road closure and/ or traffic diversion.	Very low	Minor adverse	Not Significant
	Snow and ice Increased frequency of heavy precipitation events Increasing average temperatures and increasing frequency of hot	Reduced pavement friction coefficient.	Use of construction materials with superior properties (such as increased tolerance to fluctuating temperatures). Regular maintenance of assets to detect deterioration and damage. Deterioration models used to identify appropriate maintenance regimes.	Low	Minor adverse	Not significant

Receptor	Climate event	Impact (climate event and hazard occurring together)	Mitigation built into Scheme design/ assumed management practices	Measure of likelihood	Measure of consequence	Effect significance (likelihood x consequence)
	days and heatwaves		Use of appropriate materials on pavement sections to maintain adequate friction coefficient. Regular sweeping and cleaning to remove debris.			
	Gradual climate change	Reduced pavement deterioration from less exposure to freezing, snow and ice.	Regularly reviewed and updated winter maintenance plans. Regular monitoring and maintenance of pavement condition.	Low	Negligible	Not significant
	Gradual climate change	Reduced need for snow clearing.	Regularly reviewed winter maintenance plans.	Low	Negligible	Not significant

In-combination climate change impact assessment

14.9.31 The outcomes of the assessment of the likelihood and consequence of in-combination impacts, and the significance of in-combination effects during the construction and operational phases of the Scheme, are presented within **Table 14-13.**

Table 14-13: Summary of in-combination effects

Receptor	Potential in-combination impact	Likelihood	Consequence	Significance	Additional mitigation measures
Landscape	The impact of natural aesthetics to the Scheme could be exacerbated by increased frequency and severity of drought events, which may adversely affect flora, fauna, and water features affecting loss of environmental features, and disruption of field pattern.	Low	Low	Negligible	No mitigation measures required.
	The aesthetic changes to landscape character caused by the Scheme could be exacerbated by increased temperature and frequency and severity of heat waves, which may lead to increased frequency of forest/ grass fires. This may result in loss of trees and biodiversity.	Low	Medium	Minor adverse	No mitigation measures required.
Human health	Increased temperatures or precipitation may affect people's travel choices. Warmer temperatures may lead to more cycling/ walking and more rain may lead to the opposite for short local trips.	Low	Very low	Negligible	No mitigation measures required.
	Increased frequency and severity of drought events may adversely affect magnitude and duration of dust generation during construction.	Low	Medium	Minor adverse	No mitigation measures required.

14.10 Monitoring

14.10.1 The climate assessment has concluded that the Scheme would not result in significant climate effects being generated, as such, no monitoring is required.

14.10.2 However, the First Iteration EMP **[TR010044/APP/6.8]** sets out monitoring to be undertaken during the construction stage to ensure that the mitigation measures embedded in the Scheme design are appropriately implemented.

14.10.3 The Principal Contractor would be required to periodically report carbon performance during construction to Highways England using the *Carbon reporting tool* (Ref 14-27).

14.11 References

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