

A38 Derby Junctions
TR010022
Volume 6
6.1 Environmental Statement
Chapter 14 – Climate

Regulation 5(2)(a)

Planning Act 2008

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

April 2019

Infrastructure Planning

Planning Act 2008

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

A38 Derby Junctions
Development Consent Order 202[]

**6.1 Environmental Statement
Chapter 14 Climate**

Regulation Number	Regulation 5(2)(a)
Planning Inspectorate Scheme Reference	TR010022
Application Document Reference	6.1
Author	A38 Derby Junctions Project Team, Highways England

Version	Date	Status of Version
1	April 2019	DCO Application

Table of Contents

Chapter	Page
14. Climate	1
14.1 Introduction and competent expert evidence	1
14.2 Legislative and policy framework	2
14.3 Assessment methodology	4
14.4 Consultation	12
14.5 Assessment assumptions and limitations.....	13
14.6 Study area.....	14
14.7 Baseline conditions	15
14.8 Potential impacts.....	17
14.9 Design, mitigation and enhancement measures	20
14.10 Assessment of likely significant effects	23
14.11 Monitoring	27
14.12 Summary of assessment.....	27
14.13 References.....	28

List of Tables

Table 14.1: Relevant NPSNN Policies for the Climate Assessment	2
Table 14.2: GHG assessment scenarios	7
Table 14.3: Measure of climate event likelihood	9
Table 14.4: Measure of climate event consequence.....	9
Table 14.5: Effect significance	9
Table 14.6: Likelihood criteria for in-combination effects	10
Table 14.7: Consequence criteria for in-combination effects	11
Table 14.8: Significance criteria for in-combination effects.....	11
Table 14.9: Scoping opinion and response.....	12
Table 14.10: GHG emission sources - construction phase.....	18
Table 14.11: GHG emission sources - operation phase	19
Table 14.12: GHG mitigation measures.....	20
Table 14.13: Climate change resilience mitigation measures	22
Table 14.14: GHG emissions breakdown by construction activity	24
Table 14.15: Comparison of road user emissions - 'do-minimum' vs 'do-something' scenarios	24
Table 14.16: Construction and operation emissions in comparison to national carbon budgets.....	25

List of Appendices [TR010022/APP/6.3]

Appendix 14.1: Climate Resilience Baseline

Appendix 14.2: Climate Impact Effects

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. The assessment follows the methodology set out in the Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3, Part 1 (Air Quality) (Highways Agency, 2007) and Highways Agency's Interim Advice Note (IAN) 114/08 – Highways Agency Carbon Calculation and Reporting Requirements (Highways Agency, 2008).
- 14.1.2 The chapter summarises the regulatory and policy framework related to climate, details the methodology for the assessment and describes the existing environment in the area surrounding the Scheme. Following this, the design and mitigation measures proposed to manage and minimise potential climate impacts are specified, after which residual climate effects of the Scheme are presented. We also provide details of any assumptions and limitations made during the assessment.
- 14.1.3 To align with the requirements of the National Policy Statement for National Networks (NPSNN) (Department for Transport, 2014) and the EIA Directive, this chapter addresses three separate climate 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 the government to meet its carbon reduction plan targets.
 - b) **Climate change 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.
 - c) **In-combination climate change impact (ICCI) assessment:** the in-combination effects of a changing climate and the Scheme on the surrounding environment.
- 14.1.4 This chapter of the Environmental Statement (ES) has been prepared by competent experts with relevant and appropriate experience. The technical lead for the climate assessment has over 15 years' experience in the management and delivery of energy efficiency, carbon management and climate change assessment. The professional qualifications and experience of the technical lead for this climate chapter are summarised in Appendix 1.1 [TR010022/APP/6.3].

14.2 Legislative and policy framework

14.2.1 As discussed in Chapter 1: Introduction, 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 this ES chapter information is provided to address these policy requirements.

Table 14.1: Relevant NPSNN Policies for the Climate Assessment

Relevant NPSNN para. Ref.	Requirement of the NPSNN	Location where information addresses policy requirements
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 would take account of the projected impacts of climate change.	Sections 14.9 (Design, mitigation and enhancement measures) and Section 14.10 (Assessment of likely significant 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 14.7 (Baseline conditions) demonstrates application of the UK Climate Projections. UK climate projections (UKCP18) (UK Met Office, 2018) published in 2018 have been used for the climate assessment. These supersede UKCP09 projections. In accordance with UKCP18 guidance, Representative Concentration Pathway 8.5 (RCP8.5) has been analysed as the closest equivalent to the high emissions scenario within the UKCP09 data. The 2020s, 2050s and 2080s periods have been assessed at the 10%, 50% and 90% probability levels (see Appendix 14.1 [TR010022/APP/6.3]).

Relevant NPSNN para. Ref.	Requirement of the NPSNN	Location where information addresses policy requirements
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 environmental statement that is prepared identifies appropriate mitigation or adaptation measures. This should cover the estimated lifetime of the new infrastructure.	Section 14.7 (Baseline conditions) demonstrates application of the latest UK Climate Projections (UKCP18) (UK Met Office, 2018) to identify potential climate change impacts. Section 14.9 (Design, mitigation and enhancement measures) considers appropriate adaption measures to mitigate identified impacts.
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 14.7 (Baseline conditions) considers any potentially critical features of the Scheme design which may be seriously affected by climate change beyond that projected in the latest UK climate projections.
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 14.9 (Design, mitigation and enhancement measures) considers identification and implementation of any adaption measures.
5.17	Carbon impacts would 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 would 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 Section 14.10 (Assessment of likely significant effects) consider the carbon impacts of the Scheme and compares them against the Government's carbon budgets.

- 14.2.2 In accordance with the National Planning Policy Framework (NPPF), the NPSNN policies relating to the applicant's assessment are the primary source of policy guidance regarding this climate assessment. The NPPF was revised in 2019 (Ministry of Housing, Communities & Local Government, 2019), 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. These policies are detailed below:
- Derby City Local Plan – Part 1 Core Strategy (Derby City Council (DCiC), 2017).
 - Derby Local Transport Plan LTP3 (2011 - 2026) (DCiC, 2011).
 - Derby's Climate Change Strategy (DCiC, 2015).
 - Erewash Core Strategy (Erewash Borough Council (EBC), 2014).
- 14.2.4 These policies 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 road surface deformation and increased flood risk.
- 14.2.5 Development priorities for mitigation and adaptation to climate change highlighted within these policies include:
- Reducing carbon emissions and energy use, including utilisation of low carbon technologies and renewable energy generation.
 - Protecting and utilising green and blue infrastructure as effective carbon sinks, for flood prevention and to improve air quality.
 - Minimising consumption of natural and non-renewable resources and generation of waste.
 - Demonstrating consideration and implementation of such mitigation and adaptation measures throughout the planning process.

14.3 Assessment methodology

GHG impact assessment

- 14.3.1 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. The end of life assessment of the demolition and decommissioning phase has, therefore, been scoped out of the assessment. This approach was confirmed in the Scoping Opinion (Planning Inspectorate, 2018) as provided in Appendix 4.1 [TR010022/APP/6.3]).

- 14.3.2 GHG emissions from construction have been calculated in line with guidance set out in Highways Agency's IAN 114/08 – Highways Agency Carbon Calculation and Reporting Requirements (Highways Agency, 2008). This methodology provides guidance on estimating the GHG contribution from construction activities, also referred to as 'construction carbon' and maintenance plus refurbishment activities. The IAN has been supplemented by use of Highways England's Carbon Reporting Tool¹.
- 14.3.3 The approach outlined in IAN 114/08 and the Highways England Carbon Reporting Tool is in line with the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) Greenhouse Gas Protocol guidelines (WRI & WBCSD, 2015). Data collection for input to the Carbon Reporting Tool is based on the following set of standard data quality principles as detailed in the Protocol which has been applied so that the results from the GHG assessment are as representative as possible:
- **Age:** the GHG assessment is based on activity data and GHG emissions factors applicable to the study period.
 - **Geography:** activity data reflects the design of the Scheme as detailed in Chapter 2: The Scheme. GHG emissions factors in the Carbon Reporting Tool are representative of the UK construction industry and UK transport sector.
 - **Technology:** the default solution was to apply data which is representative of the UK construction industry and transport sector.
 - **Methodology:** activity data was gathered directly from the Scheme's engineering and design teams to enable consistency and completeness of data collection.
 - **Competency:** activity data was generated by the Scheme's engineering and design teams in-line with applicable industry standards.
- 14.3.4 GHG emissions outputs from the Carbon Reporting Tool are reported as tonnes of carbon dioxide equivalent (tCO₂e) and consider the seven Kyoto Protocol gases:
- Carbon dioxide (CO₂).
 - Methane (CH₄).
 - Nitrous oxide (N₂O).
 - Sulphur hexafluoride (SF₆).
 - Hydrofluorocarbons (HFCs).
 - Perfluorocarbons (PFCs).
 - Nitrogen trifluoride (NF₃).

¹ <https://www.gov.uk/government/publications/carbon-tool>

14.3.5 GHG emissions for Scheme construction and maintenance have been assessed within the Carbon Reporting Tool using a calculation-based methodology as per the below equation:

$$\text{Activity data} \times \text{GHG emissions factor} = \text{GHG emissions value}$$

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 (Highways Agency, 2007). 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 fully accounted for under the HA 207/07 approach, however, commentary on the potential impact on GHG emissions from the use of the Scheme due to these technological advances is provided herein.

14.3.8 The UK Government Strategy ‘Road to Zero’ (HM Government, 2018) 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 that 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.

14.3.9 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 2017 (BEIS, 2017), up to 300 Terawatt 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 is also provided herein regarding the impact of grid decarbonisation.

14.3.10 All GHG emissions contribute to global climate change and can, therefore, be considered to have some level of significance. However, there is currently no specific guidance regarding significance levels for GHG emission impacts, although the guidance does indicate consideration of the UK National inventory. The UK has legally binding GHG reduction targets and, therefore, the level of significance considers how the Scheme would contribute to the UK National GHG inventory and the UK achieving its reduction targets. The Scheme’s calculated emissions have, therefore, been assessed against the UK’s carbon budgets.

14.3.11 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.

14.3.12 The first part of the GHG assessment considers the construction of the Scheme itself. The majority of these GHG emissions would be additional to the existing UK National GHG inventory and have been 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 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 (e.g. road users), they are not considered additional to the UK National 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 potential additional GHG emissions associated with Scheme operation.
- 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 embedded mitigation measures (refer to Section 14.9) are taken into account.
- 14.3.15 In line with the NPSNN, the significance of effects 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 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 embedded mitigation measures.

- 14.3.17 A comparison of the GHG emissions for the ‘do-minimum’ and ‘do-something’ scenarios was undertaken for the Scheme opening year (2024) and the future design year (2039) in line with HA 207/07 (Highways Agency, 2007).

Climate change resilience assessment

- 14.3.18 The climate change resilience assessment has considered the strategic aims and objectives encompassed within planning strategies and planning policies from the government, Highways England and the local planning authorities. The overarching aim of these strategies and policies is to minimise adverse impacts of climate change, by requiring new developments to consider climate change within their designs. Options to increase the resilience of the Scheme to climate change have been assessed and mitigation measures identified (refer to Section 14.9).

- 14.3.19 Consideration of climate change adaptation within EIAs is an area of emerging practice. There is no prescribed format for undertaking such assessments, therefore, the approach has followed new and emerging guidelines and good practice from other similar transportation infrastructure development assessments.
- 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 includes 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 UK Climate Projections 2018 (UKCP18) (UK Met Office, 2018).
- 14.3.22 The assessment of the Scheme's vulnerability to climate change takes into account mitigation measures that have been integrated into the Scheme design. The link between the climate change resilience assessment, and the assessments reported within other chapters of the ES, are cross-referenced as appropriate.
- 14.3.23 Following assessment of the future climate projections, the Scheme receptors which are vulnerable to climate change impacts are identified as:
- Construction phase receptors including the workforce, plant, and machinery.
 - Scheme assets and their operation, maintenance and refurbishment (e.g. pavements, structures, earthworks and drainage, technology assets etc.).
 - Scheme end-users (e.g. 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) has been assessed, for the selected future time frame for Scheme operation (through to the 2080s). Likelihood, consequence and significance definitions are outlined in Tables 14.3, 14.4 and 14.5. Scheme lifetime is considered to include construction and operational stages and is taken to be 60 years. For the construction phase, as this is planned to occur over a much shorter period compared to the operation of the road (completed in 2024), future climate change is less relevant and the assessment of potential impacts follows a more descriptive approach.

Table 14.3: Measure of climate event likelihood

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 four 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

Table 14.4: Measure of climate event consequence

Consequence of impact	Description
Very large adverse	National level (or greater) disruption to strategic route(s) lasting more than one week.
Large adverse	National level disruption to strategic route(s) lasting more than one day but less than one week OR Regional level disruption to strategic route(s) lasting more than one week.
Moderate adverse	Regional level disruption to strategic route(s) lasting more than one day but less than one week.
Minor adverse	Regional level disruption to strategic route(s) lasting less than one day.
Negligible	Operational Phase: Disruption to an isolated section of a strategic route lasting less than one day.

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

Table 14.5: Effect significance

		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

14.3.26 A series of flood risk assessments (FRAs) have been undertaken in order to determine the potential flooding impacts faced by the Scheme (refer to Appendices 13.2A, 13.2B and 13.2C [TR010022/APP/6.3], and Chapter 13: Road Drainage and the Water Environment). These assessments consider the worst-case scenario according to the latest Environment Agency guidelines utilising the upper end allowance category for the 2080s time period (2070 - 2115), as defined within the Environment Agency’s FRA climate change allowances guidance (Environment Agency, 2016). The FRA undertaken for Little Eaton junction is based on a 50% increase in flows for a 1% annual exceedance probability (AEP) event (as related to the River Derwent and Dam Brook). As Kingsway junction is predominantly an urban catchment, the modelling is based on a 40% increase in rainfall intensity for a 1% AEP event. Flood risk modelling was not required at Markeaton junction due to the low flooding risks at the junction. More information can be found within Appendices 13.2A, 13.2B and 13.2C [TR010022/APP/6.3] and Chapter 13: Road Drainage and the Water Environment.

ICCI assessment

14.3.27 An ICCI assessment has been undertaken to evaluate the combined impacts of future climate change and the Scheme on identified receptors in the surrounding environment.

14.3.28 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.

14.3.29 UKCP18 projections for temperature and precipitation variables were analysed to identify potential climate hazards that may impact receptors in the vicinity of the Scheme. Potential hazards identified include increased winter precipitation levels leading to a potential increase in flood risk, and higher summer temperatures combined with decreased summer precipitation levels potentially leading to greater heat stress and increased incidence of droughts.

14.3.30 The likelihood of climate hazards leading to an in-combination impact considers both the likelihood of an impact occurring (e.g. contaminant soil exposure due to ground movements) and the confidence levels associated with the change in climate hazard within the timescale (e.g. intense rainfall would increase contaminant soil migration). The likelihood is defined using the likelihood criteria outlined in Table 14.6, based on an assessment of the UKCP18 (UK Met Office, 2018), 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

14.3.31 The consequence of in-combination impacts is 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 assessments reported within this ES. The consequence criteria for in-combination effects are 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 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 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 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.

14.3.32 The significance of effects is a combination of 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

14.3.33 Effects that are moderate and major are deemed to be significant, whilst effects that are negligible or minor are not significant.

Scoping

14.3.34 The proposed scope of the climate assessment was detailed in the EIA Scoping Report (Highways England, 2018) submitted to The Inspectorate on 15 March 2018 (refer to Chapter 1: Introduction, para. 1.3.5).

14.3.35 An overview of the Inspectorate's Scoping Opinion (refer to Appendix 4.1 [TR010022/APP/6.3]) in relation to climate is presented in Table 14.9. Where the assessment has been undertaken in accordance with the Scoping Opinion point, a response and the relevant ES section is provided. Where an alternative approach has been agreed with the relevant stakeholders, an explanation is provided.

Table 14.9: Scoping opinion and response

Scoping Opinion	Where addressed within the ES
Planning Inspectorate	
The Inspectorate considers that end of life assessment of the demolition phase may be scoped out based on the nature of the Proposed Development and its proposed operational lifespan.	Para. 14.3.1 and para. 14.5.2
Table 15.1 of the Scoping Report details the 'key anticipated GHG emission sources', which include preconstruction, product stage, construction, operation, maintenance and use of the Proposed Development. The introductory text states that the scope is 'GHG emissions arising from the construction, operation, maintenance and use of the Scheme'. It is therefore unclear whether pre-construction and product stage are intended to be scoped out. The likely significant effects relating to GHG emissions from the proposed development (including preconstruction and product stage) should be assessed, where relevant.	Para. 14.6.1 and para. 14.6.2
As set out in the NPSNN the Applicant should ensure that the ES takes into account the potential impacts of climate change using the latest UK Climate Projections, this should include the anticipated UKCP18 projections where appropriate.	Para. 14.5.5
Environment Agency	
<p>In its response to the consultation, the Environment Agency made the following comments:</p> <p>Flood risk: The scoping report covers what we would expect to see in the Flood Risk Assessment. Any loss in floodplain capacity will need to be considered and level for level compensation provided where possible. We would expect the relevant climate change allowances to be used and any recommendations from our modelling review to be completed.</p>	<p>Refer to Chapter 13: Road Drainage and the Water Environment and Appendices 13.2A, 13.2B and 13.2C [TR010022/APP/6.3].</p>
Derbyshire County Council (DCC)	
<p>In its response to the consultation, the DCC made the following comments:</p> <p>Climate Change: it is considered that the study's scope on the impact of the Scheme on Climate Change is limited and parameters of what is considered very narrow. Given what we know about greenhouse gas emissions and the likely future climate of Derbyshire, it is disappointing that extensive dedicated cycle routes have not been included in the design. Whilst it is accepted that such a scheme is necessary given the predicted population growth of the city, it is disappointing that the presented scheme is likely to encourage people to drive vehicles more and does little to alleviate the problem of greenhouse gases or active health. If realistic walking and cycling alternatives were created as part of the Scheme this would help mitigate and adapt to climate change.</p>	<p>Issues associated with pedestrian and cycling provisions as included in the Scheme design are detailed in Chapter 12: People and Communities. This chapter indicates that the Scheme would generate a number of long-term beneficial effects for pedestrians and cyclists.</p>

14.4 Consultation

- 14.4.1 The Preliminary Environmental Information Report (PEIR) was published in September 2018 (Highways England, 2018) and presented the environmental information collected together with the preliminary findings of the assessment of likely significant environmental effects of the Scheme at the time.

- 14.4.2 Comments in response to the PEIR provided by DCiC and Derbyshire County Council (DCC) regarding Scheme drainage, flood risk, material use and waste that indirectly relate to GHG emissions and climate resilience impacts can be found in Chapter 13: Road Drainage and the Water Environment and Chapter 11: Material Assets and Waste, respectively. Comments in relation to material assets and waste that indirectly relate to GHG emissions and climate resilience impacts include the requirement to:
- Where possible, source and reuse materials locally to reduce travel distances.
 - Provide full details of the types and quantities of the fill materials used within the ES.
- 14.4.3 In relation to road drainage and the water environment, DCiC highlights the requirement outlined in paragraph 160 of the NPPF (Ministry of Housing, Communities & Local Government, 2019) whereby the Scheme should not increase flood risk elsewhere and, where possible, should reduce flood risk overall.
- 14.4.4 The consultation comments outlined above are addressed within the relevant chapters within this ES.

14.5 Assessment assumptions and limitations

- 14.5.1 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 Scheme 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 assessments presented within this ES.
- 14.5.2 GHG emissions from the end of life stage (decommissioning) of the Scheme have been scoped out of the assessment due to the anticipated operational timescale of the Scheme. The replacement of particular elements of the Scheme is included as part of the maintenance lifecycle stage of the GHG assessment.
- 14.5.3 The assessment uses the lifespan of the Scheme (estimated at 60 years) and the lifecycle stages 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).
- 14.5.4 Limitations associated with the approach taken for this climate change risk assessment relate to uncertainties inherent within UKCP18 (UK Met Office, 2018).

- 14.5.5 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 would be reflected at the regional scale. To overcome these issues, the assessment has used forecast climate change data from UKCP18 (UK Met Office, 2018). These projections provide an update to the UKCP09 projections, and provide climate projections out to 2100, facilitating the assessment of risk exposure to future climate conditions.
- 14.5.6 Assessments made in relation to 'consequence' and 'likelihood' have relied on professional judgement and evidence gathered through other environmental topic assessments.
- 14.5.7 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.

14.6 Study area

GHG impact assessment

- 14.6.1 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 construction materials, arising as a result of the energy used for their production, as well as emissions arising from the transportation of materials, waste and construction workers to and from the Scheme site.
- 14.6.2 The assessment of GHG impacts occurring during the Scheme construction stage focusses on construction activities. The spatial coverage of the assessment is, therefore, the area of construction works falling within the Scheme boundary.
- 14.6.3 The study area for the assessment of GHG emissions arising during Scheme operation 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 (refer to Chapter 4 Environmental Impact Assessment Methodology, para. 4.2.14).

Climate change resilience assessment

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

ICCI assessment

- 14.6.5 The study area for the ICCI assessment is as defined by the other disciplines contributing to this ES, covering the three junctions that comprise the Scheme, including the Scheme footprint and an area up to 1km from the Scheme boundary.

14.7 Baseline conditions

GHG impact assessment

Current baseline

- 14.7.1 The baseline for the GHG impact assessment is a 'do-minimum' scenario (refer to Table 14.2), whereby the Scheme does not go ahead. Under this scenario GHG emissions associated with the future use and maintenance of the existing A38 are included. The detailed baseline was developed using traffic models based on the current A38 layout and its predicted future use, accounting for any increase in traffic and associated congestion, through to 2039 (the design year for the Scheme). This model established a baseline against which the Scheme can be compared, to identify any variation in GHG emissions over time.

Construction year baseline (2020)

- 14.7.2 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 (2024)

- 14.7.3 The Scheme opening year baseline consists of GHG emissions from road users along with emissions arising from operational energy use (e.g. for road lighting, road signals and any other mechanical and electrical sources such as the highway runoff pumping station at Markeaton junction (refer to Chapter 13: Road Drainage and the Water Environment)).

Future year baseline (2039)

- 14.7.4 The future year baseline consists of GHG emissions from road users along with emissions arising from operational energy use (e.g. for road lighting, road signals and any other mechanical and electrical sources such as the highway runoff pumping station at Markeaton junction).

Climate change resilience assessment

Current baseline

- 14.7.5 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 provided in Appendix 14.1 [TR010022/APP/6.3].
- 14.7.6 A review of the recent and current climate of the region in which the Scheme is sited indicates that there is already evidence of gradual warming and increases in average annual precipitation amounts between 1961 and 2006.

- 14.7.7 The Local Climate Impacts Profile (LCLIP) for Derby (DCiC, 2011) analyses the impact that climate change and severe weather has had on DCiC and its related services and activities. As recorded in the LCLIP, between 2000 and 2010, a total of 60 severe weather events negatively impacted Derby, with each of these having varying degrees of consequence. The most commonly recorded events were associated with flooding and heavy rains, followed by high winds, storms, freezing temperatures and heavy snow. Evidence suggests that the number of severe weather events is increasing, with intense rainfall events occurring more frequently over the LCLIP analysis period. Heavy snow and strong winds are also noted as severe weather events known to cause disruption.
- 14.7.8 Specifically relating to highways, flooding, snow and ice have been the biggest weather-related issues recorded over the ten year LCLIP analysis period. Flooding on major roads into the city on numerous occasions has resulted in accessibility problems and has created extra workload for Derbyshire Fire and Rescue by, for example, resulting in stranded motorists requiring rescue. Storms have resulted in a large numbers of fallen trees, whilst freezing temperatures and heavy snow have caused disruption and road accidents.
- 14.7.9 The UK Climate Change Risk Assessment (CCRA) (Committee on Climate Change, 2017) 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.
- 14.7.10 The Scheme sits within the Met Office East Midlands region (UK Met Office, 2006). Climate observations for this region identify gradual warming, with an increase of 1.64°C in annual average daily temperatures between 1961 and 2006. Annual average daily maximum temperatures increased by 1.79°C over the same period, and the annual average number of days with air frost has decreased by 25.3 days.
- 14.7.11 For the Met Office East Midlands region, climate observations indicate an 8.1% increase in average annual precipitation amounts between 1961 and 2006. This can be broken down to a 4.6% average decrease in precipitation levels in spring, a 2.6% average increase in summer, a 28.7% average increase in autumn, and an 11% average increase in winter (UK Met Office, 2006).
- Construction year baseline (2020)*
- 14.7.12 UKCP18 (UK Met Office, 2018) indicates that for the area surrounding the Watnall Weather Station (the closest weather station to the Scheme), there is projected to be an increase in annual temperatures and increased seasonality in rainfall, with wetter winters and drier summers being expected.

- 14.7.13 Climate change projections for the area surrounding the Watnall Weather Station have been assessed under the UKCP18 Representative Concentration Pathway 8.5 (RCP8.5), 50% probability level. By the 2020s (2010 - 2039), average annual air temperatures at 1.5m are projected to be 0.8°C higher than the 1981 - 2010 baseline average. For the same future time period, mean annual precipitation rates are projected to increase by 1%, with a 4% increase projected for winter, and a 6% decrease projected for summer (when compared to the 1981 - 2010 baseline average).
- 14.7.14 More detailed information on the climate change projections for the construction year baseline can be found in Appendix 14.1 [TR010022/APP/6.3].
Opening year baseline (2024) and 15 years after opening baseline (2039)
- 14.7.15 The Scheme opening year baseline would be much the same as the construction year baseline, as 2024 still falls within the 2020s climate projection period. It is, however, likely to be slightly warmer than in 2020 as the average temperature moves towards those projected within the 2050s period. This is also the case with regard to 2039 which is 15 years after Scheme opening.
- 14.7.16 More detailed information on the climate change projections for the Scheme opening year baseline, and up to the 2080s (2070 - 2099), can be found in Appendix 14.1 [TR010022/APP/6.3].

14.8 Potential impacts

- 14.8.1 To assess the potential GHG emissions arising from the construction and operation of the Scheme, a lifecycle assessment approach has been undertaken using design, construction and transportation data. This approach is consistent with the principles set out in BS EN 15804 (British Standards Institution (BSI), 2012), the Publicly Available Specification (PAS) 2080 (BSI, 2016), Institute of Environmental Management & Assessment (IEMA) guidance (IEMA, 2017) and Chapter 4 of TAG Unit A3 Environmental Impact Appraisal (Department for Transport, 2015). The key GHG emission sources considered in the GHG assessment are set out in Table 14.10 and Table 14.11 for the Scheme construction and operation stages, respectively.
- 14.8.2 Mitigation measures incorporated into the Scheme design, and measures to be taken to manage environmental effects during Scheme construction, are set out in Section 14.9. Prior to implementation of such mitigation measures, the Scheme has the potential to affect climate (positively or negatively), both during Scheme construction and operation. These potential impacts are outlined in the following sections.

Construction

GHG impact assessment

- 14.8.3 Potential impacts during Scheme construction are presented in Table 14.10 and are categorised in line with Highways England Carbon Reporting Tool and guidance set out in PAS 2080 (BSI, 2016).

Table 14.10: GHG emission sources - construction phase

PAS 2080 lifecycle stage	Carbon Tool reporting category	Activity	Primary emission sources
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.
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 and processing of materials into secondary and 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 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 and contractors to and from the construction site.	GHG emissions arising from the fuel use for vehicles transporting workers to and from 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 change resilience assessment

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

- Inaccessible construction site due to severe weather events (flooding, snow and ice, and storms) restricting working hours and delaying construction.

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

Operation

GHG impact assessment

14.8.5 Potential impacts during Scheme operation are set out in Table 14.11.

Table 14.11: GHG emission sources - operation phase

PAS 2080 lifecycle stage	Activity	Primary emission sources
Operational stage	Operation of the associated road lighting, pedestrian crossings and pumping station. Maintenance including re-surfacing.	GHG emissions from grid electricity and other fuel use. Embodied emissions associated with re-surfacing materials.
Use stage	Vehicle journeys within the affected road network.	GHG emissions per vehicle km. Energy consumption.

Climate change resilience assessment

14.8.6 The Scheme 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:

- Material and asset deterioration due to high temperatures.
- Overheating of electrical equipment, such as information and communication systems.
- Health and safety risks to road users.
- Increased frequency of fog episodes, which may reduce visibility and access.
- Changes in travel patterns of network users.
- Longer vegetation growing seasons resulting in increased periods of tree fall and increased maintenance and management requirements.
- Damage to roads from periods of heavy rainfall.

- 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.
- Increased slope instability as a result of prolonged or heavy precipitation leading to subsidence.
- Storm damage to structures.
- Inaccessible network during severe weather events.

14.9 Design, mitigation and enhancement measures

GHG impact assessment

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

14.9.2 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:

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

Table 14.12: GHG mitigation measures

Lifecycle stage	Mitigation measures	Delivery mechanism	Embedded / additional	Method of reduction
Construction (including preliminary works)	The construction contractor would 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 would be recorded and reported on an ongoing basis during the construction phase of the Scheme using the Highways England Carbon Reporting Tool.	Outline Environmental Management Plan (OEMP, (refer to Appendix 2.1 [TR010022/APP /6.3]) (which would be developed into a Construction Environmental Management Plan (CEMP) by the construction contractor)	Embedded	Avoid/prevent

Lifecycle stage	Mitigation measures	Delivery mechanism	Embedded / additional	Method of reduction
	<p>Where practicable, measures would be implemented to manage the use of material resources during Scheme construction including:</p> <ul style="list-style-type: none"> Using materials with lower embedded greenhouse gas emissions and water consumption. Using sustainably sourced materials. Using recycled or secondary materials. 	<p>OEMP (refer to Appendix 2.1 [TR010022/APP /6.3]) (developed into a CEMP by the construction contractor)</p>	Embedded	Avoid/prevent
	<p>Trees, shrubs and hedgerows planted as part of the landscape design would offset some of the carbon emissions associated with land use change and subsequent loss of carbon sink (refer to Chapter 7: Landscape and Visual Impact Assessment, for details of Scheme landscape planting design).</p>	<p>Refer to the landscape design drawings - Figures 7.8a - 7.8c [TR010022/APP /6.2]</p>	Embedded	Remediate
Operation	<p>Lighting of new and improved sections of road within the Scheme has been confined to locations where road safety is a priority. It was the original intention to provide lighting columns throughout Little Eaton junction – however, as indicated in Chapter 3: Scheme History and Assessment of Alternatives, Table 3.5, given the comments received at statutory consultation, an assessment was carried out to determine whether an alternative lighting solution at Little Eaton junction could be used or whether the lighting could be removed altogether. A safety assessment determined that this section of road could operate with an acceptable level of safety if the lighting along the new A38 mainline was removed. To ensure drivers would be aware of the bend in the road at this location, appropriate signing would be installed along with the provision of solar powered studs integrated within the road pavement. This approach has been integrated within the Scheme design and would avoid the need to install approximately 56 lighting columns, thus reducing operational energy use.</p>	<p>Environmental Mitigation Schedule (refer to Appendix 2.2 [TR010022/APP /6.3])</p>	Embedded	Reduce

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

Climate change resilience assessment

- 14.9.4 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 other discipline chapters within this ES and through the development of 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.
- 14.9.5 A series of mitigation measures integrated into the Scheme design are summarised in Table 14.13.

Table 14.13: Climate change resilience mitigation measures

Lifecycle stage	Mitigation measures	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), and incorporation of current road design standards and future climate change allowances.	OEMP (refer to Appendix 2.1 [TR010022/APP/6.3]) (developed into a CEMP by the construction contractor)	Embedded
Operation	The Scheme drainage strategy takes into account the potential effects of climate change (refer to refer to Chapter 13: Road Drainage and the Water Environment and the Road Drainage Strategy in Appendix 13.4 [TR010022/APP/6.3]). A range of measures would be put in place to improve the resilience of the Scheme to climate change during the Scheme operation, including maintenance plans for drainage systems to allow them to operate effectively. Implementation of the Highways England Severe Weather Plan for the East Midlands (Highways England, 2018) would further increase the resilience of the Scheme to extreme weather conditions.	Handover Environmental Management Plan (HEMP) (upon completion of Scheme construction, the CEMP would be converted into the HEMP)	Embedded
Operation	Flood alleviation measures included in the Scheme design would improve the resilience of the Scheme to potential flooding events as a result of climate change. The Scheme drainage strategy takes into account the potential effects of climate change, whilst flood mitigation measures at Kingsway junction and Little Eaton junction also take account of climate change, including the use of flood storage areas and a floodplain compensation area (refer to Chapter 13: Drainage and the Water Environment and Appendices 13.2A, 13.2B and 13.2C [TR010022/APP/6.3]).	Environmental Mitigation Schedule (refer to Appendix 2.2 [TR010022/APP/6.3])	Embedded

Lifecycle stage	Mitigation measures	Delivery mechanism	Embedded / additional
Operation	The low point at the proposed dual carriageway at Markeaton junction is 54.60m above ordnance datum (AOD) which is lower than the existing drainage outfall level of 55.48m AOD and the Markeaton Lake level of 55.73m AOD. A pumping station would, therefore, be required to drain the Scheme. This would be designed to accommodate a 1 in 100 year storm event (with climate change considered) without flooding the carriageway. Refer to Chapter 13: Drainage and the Water Environment and Appendices 13.2A, 13.2B and 13.2C [TR010022/APP/6.3]	Environmental Mitigation Schedule (refer to Appendix 2.2 [TR010022/APP/6.3])	Embedded

14.10 Assessment of likely significant effects

GHG impact assessment

- 14.10.1 Of the lifecycle stages scoped into the assessment as shown in Table 14.14, the embodied carbon associated with the use of materials 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 has reviewed the materials proposed to be used (refer to Chapter 11: Material Assets and Waste) and calculated the associated carbon emissions from their production, as well as their transport to site.
- 14.10.2 Construction activities would also contribute to GHG emissions due to associated plant use, which requires fuel such as diesel. The treatment, disposal and associated transportation of waste material from the site also have the potential to contribute to the GHG construction footprint.
- 14.10.3 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. Therefore, professional judgement and conservative estimates have been used to calculate GHG emissions associated with material transportation to site.
- 14.10.4 Land use change would also contribute to the Scheme construction GHG footprint as although some mitigation such as planting would take place, the loss of carbon sink associated with land clearance would not be balanced out by the carbon sink gain from such landscape planting mitigation.
- 14.10.5 Table 14.14 contains the breakdown and comparison of emissions from each assessed activity during the Scheme construction stage.

Table 14.14: GHG emissions breakdown by construction activity

Reporting category	Emissions (tCO ₂ e) (approximate)	% construction emissions
Land clearance (loss of carbon sink)	4,027	3.08%
Embodied carbon in raw materials and transportation of materials to site ²	118,713	90.72%
Fuel used on site	4,749	3.63%
Worker travel	3,199	2.44%
Disposal of construction waste	168	0.13%
Total	130,858	100%

14.10.6 A comparison of operational road user GHG emissions between the 'do-minimum' and 'do-something' scenarios for the Scheme opening year (2024) and the design year (2039) are presented in Table 14.15.

Table 14.15: Comparison of road user emissions - 'do-minimum' vs 'do-something' scenarios

Reporting category	Year of Scheme opening (2024) (tCO ₂ e)	Design year (2039) (tCO ₂ e)
Do-minimum	7,933,641	8,879,454
Do-something	7,934,497	8,882,177
Variation	856	2,723

14.10.7 Table 14.15 indicates that in the year of Scheme opening, GHG emissions would be approximately 856 tCO₂e higher than the do-minimum scenario, whilst for the design year (2039), GHG emissions with the Scheme would be approximately 2,723 tCO₂e higher than the do-minimum scenario. The increase in emissions in the do-something scenario is due to the increase in vehicle kilometres travelled as a result of the Scheme.

14.10.8 The extent of the projected uptake of lower carbon fuels, EVs and improved vehicle technology since the UK Government published the 'Road to Zero' Strategy (HM Government, 2018) is not currently fully captured in the modelling scenarios of future road traffic emissions. The new strategy sets out aspirations that by 2030 between 50% and 70% of new car sales and 40% of van sales will be ultra-low emission vehicles and that by 2040 all new petrol and diesel cars and vans will be zero carbon.

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

² Any calculations performed using the Highways England Carbon Reporting Tool only account for the six Kyoto Protocol GHGs defined prior to the addition of nitrogen trifluoride (NF₃) in 2018.

- 14.10.10 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 BEIS Updated Energy and Emissions Projections 2017 (BEIS, 2017), up to 300 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. Only vehicle exhaust 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.
- 14.10.11 The operational GHG emissions reported herein, therefore, represent a worst-case scenario and are likely to be mitigated by existing plans and initiatives to decarbonise the grid and electrify road transport.
- 14.10.12 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.
- 14.10.13 The UK Government has currently passed into law the carbon budgets up to 2030:
- 3rd carbon budget (2018 to 2022) 2,544 MtCO₂e.
 - 4th carbon budget (2023 to 2027) 1,950 MtCO₂e.
 - 5th carbon budget (2028 to 2032) 1,725 MtCO₂e.
- 14.10.14 The construction period for the Scheme runs from 2020 to 2024 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 Scheme operation during the 4th and 5th carbon budget period.

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

Scheme stage	Net tCO ₂ e	Relevant carbon budgets
Construction	56,086	3 rd carbon budget period (2018 to 2022)
	74,772	4 th carbon budget period (2023 to 2027)
Operation	12,342	4 th carbon budget period (2023 to 2027)
	20,569	5 th carbon budget period (2028 to 2032)

- 14.10.15 The method to calculate the UK carbon budgets varies from 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.

14.10.16 The NPSNN 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. Indeed emissions arising as a result of the Scheme represent less than 0.01% of total emissions in any five year carbon budget during which they arise.

14.10.17 In this context, it is concluded that the GHG impact of the Scheme would not have a material impact on carbon reduction targets as set by the UK government.

Climate change resilience assessment

14.10.18 The potential climate resilience impacts on the Scheme during the construction phase, as identified in Section 14.8, are not assessed to be significant due to the duration and nature of the construction activities.

14.10.19 The Scheme may, however, be vulnerable to a range of potentially significant resilience impacts during the operational phase. These have been assessed in accordance with the methodology as set out in Section 14.3.

14.10.20 The assessment found that, based on the mitigation measures embedded within the Scheme design, assumed management practices, UKCP18 climate change projections, and information from other environmental disciplines reported herein, that none of the potential impacts identified in Section 14.8 would be significant (and are therefore classed as non-significant).

14.10.21 These non-significant climate resilience impacts, identified using criteria set out in the assessment methodology, are presented in Appendix 14.2 [TR010022/APP/6.3] and include:

- Health and safety risks to road users, and disrupted and/or inaccessible network due to snow, ice, standing water and other weather events.
- Damage to roads, cuttings and drainage systems due to flooding.
- '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 dangerous (similar to ice on the road).
- 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.
- Increased slope instability leading to subsidence and landslides.
- Damage and disruption to power supply and other linked infrastructure.
- Increased pollution from road runoff.
- Increased sediment transport.
- 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.

- Reduced pavement friction coefficient.
- Reduced pavement deterioration from less exposure to freezing, snow and ice.

ICCI assessment

14.10.22 The ICCI assessment has not identified the potential for significant combined impacts of future climate change and the Scheme on identified receptors in the surrounding environment. Potential non-significant effects are reported in Appendix 14.2 [TR010022/APP/6.3] and include:

- Negligible and minor adverse impacts upon landscape.
- Negligible and minor adverse impacts upon human health.

14.11 Monitoring

14.11.1 As no significant effects have been identified for the climate assessment, no monitoring of significant effects is proposed.

14.11.2 The OEMP (refer to Appendix 2.1 [TR010022/APP/6.3]) sets out details of the monitoring to be undertaken during the Scheme construction stage to determine whether the mitigation measures embedded in the Scheme design are being 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 (refer to Appendix 2.1 [TR010022/APP/6.3]), energy consumption and materials use would be recorded and reported on an ongoing basis during the Scheme construction phase using the Highways England Carbon Reporting Tool.

14.11.3 It is not considered practical to monitor GHG emissions from road users during the Scheme operational phase.

14.12 Summary of assessment

GHG impact assessment

14.12.1 Approximately 130,858 tCO₂e is estimated to be emitted over the Scheme construction period, the majority of which (90.72%) is from embodied carbon within construction materials. In the context of the relevant UK carbon budgets, these emissions are not deemed to be significant.

14.12.2 Scheme operational emissions within the 'do-something' scenario are estimated as being approximately 856 tCO₂e higher than those within the 'do-minimum' scenario for the opening year (2024) and approximately 2,723 tCO₂e higher than those within the 'do-minimum' scenario in the design year (2039). This equates to an overall increase in emissions of 148,455 tCO₂e over the Scheme's 60-year operational lifetime compared to the baseline. These emissions are not deemed to be significant in the context of the relevant carbon budgets.

Climate change resilience assessment

- 14.12.3 Due to the near future timescale for Scheme construction, and the overall duration of the construction phase, no significant climate change impacts are anticipated. Although the Scheme may be vulnerable to climate change impacts during the operational phase, the assessment indicates that none of the potential impacts identified would be significant following the implementation of identified mitigation measures built into the Scheme design.

ICCI assessment

- 14.12.4 Although some potential ICCI impacts were identified in relation to landscape and human health, the assessment concluded that none were significant.

14.13 References

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