7. Climate Change

7.1 Introduction

7.1.1 This chapter of the Environmental Statement (ES) reports the findings of an assessment of the likely significant effects on climate change as a result of the proposed Access to Witney development (hereafter referred to as the 'proposed development') in Oxfordshire.

7.1.2 Using the methodology outlined in section 7.4 of this chapter, likely significant effects (adverse and beneficial) have been identified and are described in section 7.7. A summary of residual significant effects is provided in section 7.9 but must be read in conjunction with the whole chapter.

7.1.3 To align with the requirements of the Environmental Impact Assessment (EIA) Regulations (Ref 7-1) and *Design Manual for Roads and Bridges (DMRB) LA 114 Climate* (Ref 7-2), the following two separate aspects have been considered for the potential for likely significant effects and reported herein:

- Lifecycle greenhouse gas (GHG) impact assessment – the effects on the climate of GHG emissions arising from the construction and operation of the proposed development; and
- An assessment of vulnerability of the proposed development to climate change – the resilience of the proposed development to climate change, including how the proposed development design has been adapted to take account for the projected impacts of climate change.

7.2 Legislation and planning policy context

7.2.1 This assessment has been undertaken taking into account relevant legislation and guidance set out in national, regional and local planning policy (summarised in the sections below). The legislation and policy requirements have informed the preparation of this ES chapter.

International legislation

Paris Agreement

7.2.2 The Paris Agreement (Ref 7-3) is a legally binding agreement within the United Nations Framework Convention on Climate Change (UNFCCC) dealing with GHG emissions mitigation, adaptation and finance starting in the year 2020. It requires all signatories to set a target, known as a nationally determined contribution (NDC) and to strengthen their climate change mitigation efforts to keep global warming to well below 2°C this century and to pursue efforts to limit global warming to 1.5°C. The agreement contains a 'ratchet' mechanism by which NDCs must be strengthened every five years. The UK updated its NDC in the first half of 2021. Under Article 7, the agreement requires all signatories to engage in adaptation planning and implementation.

EIA Directive 2011/52/EU (as amended)

7.2.3 The EIA Directive 2011/52/EU (Ref 7-4) sets out the requirement to undertake an Environmental Impact Assessment (EIA). Directive 2011/52/EU was amended by Directive 2014/92/EU (Ref 7-5). The amendments included the introduction of an express requirement to describe the likely significant effects resulting from the impact of a development on climate change. The amendment also requires the vulnerability of the proposed development to climate change to be considered. The EIA Directive still applies to UK law through the Environmental Assessments and Miscellaneous Planning (Amendment) (EU Exit) Regulations 2018 (SI 2018/1232).

National legislation

Town and Country Planning Environmental Impact Assessment (EIA) Regulations 2017 (as amended)

7.2.4 The EIA Regulations set out the requirement to undertake an EIA, implementing the EIA Directive as discussed above. Amendments included the introduction of a requirement to describe the likely significant effects resulting from the impact of a project on climate and the vulnerability of a project to climate change.

Climate Change Act 2008 (2050 Target Amendment) Order 2019

7.2.5 The Climate Change Act 2008 (Ref 7-6) (hereafter referred to as the 'Act') provides a framework to meet the UK's GHG emission reduction goals through legally binding national carbon emission budgets within five-year periods. The Act was amended in 2019 to revise the existing 80% reduction target and legislate for net zero emissions by 2050 (Ref 7-7).

7.2.6 A trajectory for the UK to achieve its carbon reduction targets is set out through a series of 5-year carbon budgets (Ref 7-8) which provide maximum emissions limits for GHG emissions. The sixth carbon budget is set to align with the 78% by 2035 reduction target, as announced in April 2021, and is the first carbon budget on a pathway to net zero emissions by 2050.

7.2.7 This Act defines 'net zero' carbon as "*the amount of net UK emissions of targeted greenhouse gases for a period adjusted by the amount of carbon united, credited or debited for the year 2050*". This means that by 2050, emissions will have to be avoided completely or offset by removal from the atmosphere and/ or traded in carbon units.

7.2.8 The impact of the proposed development on the existing UK carbon budgets is used to determine significance of GHG emissions.

Transport Decarbonisation Plan (DfT, July 2021)

7.2.9 Decarbonising Transport: A Better Greener Britain (Ref 7-9): This plan sets out the government's commitments and the actions needed to decarbonise the entire transport system in the UK. It includes:

a) a pathway to net zero transport in the UK,

b) the wider benefits net zero transport can deliver and

c) the principles that underpin the UK's approach to delivering net zero transport.

7.2.10 The plan also commits to driving "*decarbonisation and transport improvements at a local level by making quantifiable carbon reductions a fundamental part of local transport planning and funding*".

National planning policy and guidance

National Planning Policy Framework

7.2.11 At a national level, the UK Government published an update to the National Planning Policy Framework (NPPF) in July 2021 (Ref 7-10). The NPPF supersedes previous national planning policy guidance (PPGs) and planning policy statements (PPSs). The NPPF summarises in a single document the Government planning policies for England, and how these are expected to be applied. Policies of relevance to climate change and sustainability assessment as presented herein include those achieving sustainable development and meeting the challenge of climate change. The NPPF (para 152) states that:

"the planning system should support the transition to a low carbon future in a changing climate, taking full account of flood risk…. It should help to: shape places in ways that contribute to radical reductions in greenhouse gas emissions, minimise vulnerability and improve resilience; encourage the reuse of existing resources, including the conversion of existing buildings; and support renewable and low carbon energy and associated infrastructure."

National Planning Practice Guidance

7.2.12 The Planning Practice Guidance (PPG) (Ref 7-11) was published on the 6 March 2014 to provide more in-depth guidance to the NPPF. The PPG aims to make planning guidance more accessible, and to ensure that the guidance is kept up to date. As such, the PPG was amended in July 2017 to reflect the updated EIA Regulations, and further updated in 2019.

7.2.13 The NPPG advises how to identify suitable mitigation and adaptation measures in the planning process to address the impacts of climate change. It states that:

"effective spatial planning is an important part of a successful response to climate change as it can influence the emission of greenhouse gases… Planning can also help increase resilience to climate change impact through the location, mix and design of development (paragraph 001 Reference ID: 6-001-20140306)."

Local planning policy and guidance

West Oxfordshire Local Plan 2011-2031, adopted 2018

7.2.14 The Local Plan outlines West Oxfordshire District Council's (WODC) policies and proposals for land use and development in West Oxfordshire (Ref 7-12). The plan was formally adopted on 27 September 2018 and sets out the overall planning framework for the district from 2011 to 2031. Matters of relevance to the climate assessment include the following core environmental objectives:

- CO11: Maximise the opportunity for walking, cycling and use of public transport;
- CO15: Contribute to reducing the causes and diverse impacts of climate change, especially flood risk; and
- CO17: Minimise the use of non-renewable natural resources and promote more widespread use of renewable energy solutions.

7.2.15 The above environmental objectives are integrated into the following policies relating to climate change:

- Policy OS3: Prudent use of natural resources;
- Policy EH4: Public realm and green infrastructure;
- Policy EH6: Decentralised and renewable or low carbon energy development (excepting wind turbines;
- Policy T1: Sustainable transport; and
- Policy T3: Public transport, walking and cycling

West Oxfordshire Design Guide, 2016

7.2.16 Alongside the Local Plan, the West Oxfordshire Design Guide 2016 (Ref 7-13) contains a detailed analysis of both natural and man-made aspects of the District and detailed design advice. It was adopted by the Council in April 2016, and is a Supplementary Planning Document (SPD), so is a material consideration in planning decisions.

7.2.17 Matters of relevance to the climate change assessment include:

- Design Guide 2 Planning Policy states that "*New development should…. …demonstrate resilience to future climate change, particularly increasing temperatures and flood risk, and the use of water conservation and management measures."*

West Oxfordshire District Council Climate Action in West Oxfordshire (2020)

7.2.18 WODC has made a commitment to becoming carbon-neutral by 2030, which is implemented through a framework for Climate Action in West Oxfordshire. This includes a proposed framework and timescale for developing a Climate Change Strategy (Ref 7-14) and a Carbon Action Plan (Ref 7-15), focusing on influencing change and driving forward Climate Action across the District, by working with partners and

stakeholders including residents and community groups, planners and developers, landowners and businesses.

7.2.19 A Climate Action Working Group drives Climate Action in West Oxfordshire. Decisions have been taken that inform and evolve local priorities for how the Council will respond to the climate and ecological emergency including:

- Development of objectives to influence the drafting of policy and supplementary planning documents to raise standards for sustainable design and construction to an exemplary level.

7.2.20 The Council is taking the first steps to develop a Carbon Action Plan by understanding baseline carbon emissions and the quantity of carbon emissions that will need to be removed to become a carbon-neutral Council.

7.2.21 The Climate Strategy works as an umbrella document and will be formulated through public and stakeholder engagement, climate action networks and issue specific action plans. The strategy will consider:

- Energy and carbon reduction;
- Flood risk and water conservation;
- Waste: Refuse, Reduce, Reuse and Recycle;
- Biodiversity and landscape;
- Air quality; and
- Sustainable transport.

South Leigh Parish Neighbourhood Development Plan, 2017-2031

7.2.22 South Leigh is situated to the south of the A40 with Ducklington to the west and Eynsham to the East. The South Leigh Neighbourhood Plan (Ref 7-16) relates to the whole of the geographic Parish of South Leigh, which covers Cogges to the north of the A40.

The Plan is written in conjunction with, and to conform to, the WODC Local Plan which contains a range of policies relevant to the Plan. The Plan also includes sections on the environment and climate change, which have been identified as key issues. Section 3.1 states *"How to mitigate, wherever possible, against the adverse effects of climate change caused by the way in which we live and in particular to mitigate against the impact on the climate of any development."*

7.2.23 Section 4.1 states: "*The Community supports the national move to a low carbon future. The Plan plays a role in helping secure reductions in greenhouse gas emissions, minimising vulnerability and providing resilience to the impacts of climate change, and supporting the delivery of renewable and low carbon energy*."

7.2.24 Section 4.5 addresses Traffic and Transport: *"The Plan seeks to minimise the impact of additional traffic generated by any new development, and especially the proposed Shores Green slip road off the A40 by SLPC engaging in active consultation with the OCC and WODC."*

Other relevant policy, standards and guidance

7.2.25 This climate assessment has been undertaken in accordance with the following guidance:

- BSI, PAS 2080 Carbon Management in Infrastructure (Ref 7-17).
- National Highways DMRB Guidance LA 114 for assessing climate in sustainability and environmental appraisal.
- European Commission Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment (Ref 7-18).
- European Commission Environmental Impact Assessment of Projects: Guidance on the preparation of the Environmental Impact Assessment Report (Ref 7-19).

- European Commission Guidance for the Calculation of Land Carbon Stocks provides a methodology for calculating carbon stocks from land use (Ref 7-20).
- Institute for Environmental Management and Assessment (IEMA) (2022) Environmental Impact Assessment Guide to: Assessing Greenhouse Gas Emissions and Evaluating their Significance (Ref 7-21).
- IEMA, (2020); Environmental Impact Assessment Guide to: Climate Change Resilience and Adaptation (Ref 7-22).
- The Department for Business, Energy and Industrial Strategy (BEIS) provides GHG emission factors for UK-based organisations (Ref 7-23).
- The British Standards Institution (BSI) BS EN ISO 14064-1:2019 (Ref 7-24) and 14064-2:2019 (Ref 7-25) specifications for organisational-level and project-level guidance for the quantification and reporting of GHG emissions and removals.
- The World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD) GHG Protocol (Ref 7-26) provides overarching guidance on developing GHG inventories and reporting standards.
- The Inventory of Carbon & Energy (ICE) database version 3 (Ref 7-27) has been used to source appropriate carbon factors to estimate the embodied carbon of materials used for construction of the proposed development. The ICE database uses some material property data from the Chartered Institution of Building Services Engineers (CIBSE).

7.3 Consultation

7.3.1 An EIA Scoping Report (*ES Volume II, Appendix 2-A*) was submitted to the Authority to accompany a request for a formal EIA Scoping Opinion in June 2021. The Authority issued an EIA Scoping Opinion on 1st July 2021 and a copy of this response is included in *ES Volume II, Appendix 2-B*.

7.3.2 A summary of the key responses received is provided in Table 7-1. The full list of responses to the comments raised in the Scoping Opinion is provided in *ES Volume II, Appendix 2-C: EIA Scoping Opinion Response*.

Table 7-1 Comments raised in Scoping Opinion

Consultee	*Comments Raised*	*Response Provided in the ES / Planning Application*
OCC Planning	*The Climate chapter should demonstrate how the proposals would contribute to the enhancement of the natural environment 'by establishing coherent ecological networks that are more resilient to current and future pressures,' as required by NPPF Para 174.* (Page 6, Para 3)	The landscape design strategy has been developed to ensure ecological connectivity is maintained wherever possible. Where there is habitat loss as a result of the proposed development, habitat creation and enhancement has been incorporated into the landscape design. Full details are available in *ES Volume I, Chapter 10: Landscape and Visual Impacts*. A Biodiversity Net Gain assessment has been undertaken which provides details on the opportunities for ecological enhancement identified both on and off-site. Full details of the ecological mitigation associated with the proposed development is set out within *ES Volume I, Chapter 6: Biodiversity*.

7.4 Assessment methodology

7.4.1 This section of this ES chapter presents the following:

- Information sources that have been consulted throughout the preparation of this chapter;

- The methodology behind the assessment of climate effects, including the criteria for the determination of sensitivity of receptor and magnitude of change from the existing of 'baseline' condition;
- An explanation as to how the identification and assessment of potential climate effects has been reached; and
- The significance criteria and terminology for the assessment of climate residual effects.

7.4.2 The detailed plans and elevations that define the proposed development have been reviewed and form the basis of the assessment of likely significant effects on climate.

Information sources

7.4.3 The following sources of information have been used:

- European Commission (2010). Commission Decision of 10 October 2010 on Guidelines for the Calculation of Land Carbon Stocks for the Purpose of Annex V to Directive 2009/28/EC;
- IEMA (2022). Environmental Impact Assessment Guide to: Assessing Greenhouse Gas Emissions and Evaluating their Significance;
- BEIS (2021). Greenhouse Gas Reporting: Conversion Factors 2020;
- BSI (2019). BS EN ISO 14064-1:2019. Greenhouse gases. Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals;
- BSI (2019). BS EN ISO 14064-2:2019. Greenhouse gases. Specification with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements;
- WRI & WBCSD (2015) The GHG Protocol. A Corporate Accounting and Reporting Standard. Revised Edition;
- BSI (2012). BS EN 15804:2012+A2:2019. Sustainability of construction work;
- PAS 2080 Carbon Management In Infrastructure;
- BEIS, (2021); UK Government GHG Conversion Factors for Company Reporting (Ref 7-28);
- IPCC (2021); Climate Change 2021: The Physical Science Basis (Ref 7-29);
- The University of Bath, (2019) The Inventory of Carbon and Energy version 3;
- EcoInvent Database 2020 (Ref 7-30);
- Met Office (2021). UKCP18 Factsheet: Wind (Ref 7-31); and
- The Met Office (2019). UK Climate Projections (UKCP18) (Ref 7-32).

GHG impact assessment methodology

Scope of assessment

7.4.4 The GHG emissions calculation methodology is based upon a lifecycle assessment. It is very unlikely that the proposed development will be demolished after its design life, as the road will have become an integral part of the strategic network infrastructure. The end-of-life assessment of the demolition and decommissioning phase has, therefore, been scoped out of the assessment. Lifecycle stages and the activities applicable to the proposed development are presented in Table 7-2, which is taken from the final approved Scoping Report. This approach is consistent with the principles set out in the DMRB Guidance, BS EN 15804 (BSI, 2012), PAS 2080, and IEMA guidance.

Table 7-2 Potential GHG emission sources for the lifecycle GHG impact assessment of the proposed development

PAS 2080 Lifecycle Stage	Activity	Description of emissions source
Pre-construction stage	Enabling works	GHG emissions from fuel consumed by construction vehicles and plant use.
	Land clearance	Losses of carbon sink, i.e., removal of a natural environment that has the ability to absorb GHG emissions.
Product stage	Use of products and/or materials required to build the proposed development	Embodied GHG emissions within the construction materials.
Construction process stage	Energy and water consumption used for the construction of the proposed development.	GHG emissions from grid electricity use during construction. GHG emissions from fuel consumed by construction vehicles and plant use. GHG emissions from the provision and treatment of water.
	Transportation of employees/contractors to the construction site.	GHG emissions arising from the fuel use for vehicles transporting workers to the construction site.
	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.
Operation Stage	Emissions from the operation and maintenance of the proposed development	Emissions arising from fuel consumed by maintenance vehicles and plant. Embodied GHG emissions within the materials used for maintenance. Grid electricity use during operation of the development (lighting/signs)
Use stage	Vehicle journeys	Variation in emissions from vehicles using the affected road network.

Methodology for determining baseline conditions and sensitive receptors

7.4.5 For the purposes of the GHG emissions impact assessment, the baseline conditions are defined as 'Do Minimum' scenario where the proposed development does not go ahead. The baseline comprises of existing carbon stocks and sources of GHGs within the boundary of the existing site. It also includes a forecast for road user GHG emissions based on the current road proposed development. The methodology for calculating GHG emissions and removals has been used consistently across the baseline, construction, and operational phases of the proposed development, and is as described below.

7.4.6 In line with BSI ISO14064, principles of the GHG Protocol and BEIS reporting guidance, the GHG emissions have been calculated by multiplying activity data by its relevant emission factor:

Activity data x GHG emissions factor = GHG emissions value

7.4.7 Activity data is a quantifiable measure of activity, such as operating hours or volumes of fuels used. Emission factors convert the activity data into GHG volumes. Activity data has been sourced from client data. Where specific data is not available, a mix of assumptions and industry benchmarks have been used to fill data gaps. Where this is not possible, then a qualitative approach to assessing the GHG impacts has been followed, in line with the IEMA guidance.

7.4.8 Emission factors have been sourced from publicly available sources, such as BEIS, IPCC, the Bath University ICE, and EcoInvent database.

7.4.9 The construction phase will occur in the near future (2022-2023) so the GHG calculations are based on current factors. Road user emissions are calculated using Defra's Emission Factor Toolkit v10.1 which takes into account fleet composition data, scaling factors (reflects improvements in fuel quality) and technology conversions (Ref 7-33). This accounts for some increase in the update of electric vehicles. This is discussed in paragraphs **Error! Reference source not found.** to 7.7.15.

7.4.10 The variation in GHG emissions sequestered due to land use change has been calculated using the European Commission's Guidelines for Land Carbon Stocks.

7.4.11 In line with the BSI ISO14064 and the principles of the GHG Protocol when calculating GHG emissions, the seven Kyoto Protocol GHGs have been considered, specifically:

- Carbon dioxide (CO_2);
- Methane (CH_4);
- Nitrous oxide (N_2O);
- Sulphur hexafluoride (SF_6);
- Hydrofluorocarbons (HFCs);
- Perfluorocarbons (PFCs); and
- Nitrogen trifluoride (NF_3).

7.4.12 These gases are broadly referred to in this chapter under an encompassing definition of 'GHGs', with the unit of tCO_2e (tonnes CO_2 equivalent) or Mt CO_2e (mega tonnes of CO_2 equivalent).

7.4.13 The identified receptor for GHG emissions is the global climate. As the effects of GHGs are not geographically constrained, the IEMA guide details that "*any GHG emissions might be considered significant*" due to their combined environmental effect in the atmosphere. To assess the impact of GHG emissions from the proposed development, UK Carbon Budgets and the total sectoral allocation for surface transport have been used as a proxy for the climate.

Methodology for determining proposed development effects

7.4.14 The alternative is a 'Do Something' scenario associated with the delivery of the proposed development, which includes the construction and operation paired with activities that will reduce or no longer occur because of the proposed development. The impact of the Scheme is the variation between the Do Minimum and Do Something scenarios.

7.4.15 The same methodology has been applied for determining baseline, construction, and operational GHG emissions resulting from the proposed development.

7.4.16 A lifecycle approach has been used to calculate the GHGs associated with the proposed development. This approach considers specific timescales and direct and indirect emissions from different lifecycle stages of the development, as detailed in Table 7-2.

Significance criteria

7.4.17 In GHG accounting, it is considered good practice to contextualise GHG emissions against pre-determined carbon budgets. In the absence of sector-based or local emissions budgets, the UK Carbon Budgets can be used to contextualise the level of effect significance, and this approach has been adopted in herein as a cogent and reasonable basis.

7.4.18 Both the Department of Energy and Climate Change (2013) and the PAS 2050 specification (Ref 7-34) allow emissions sources of <1% contribution to be excluded from emission inventories, and these inventories to still be considered complete for verification purposes. This exclusion of emission sources that are <1% of a given emissions inventory is based on a 'de minimis' (relatively minimal) contribution.

7.4.19 There is currently no published standard definition for receptor sensitivity of GHG emissions. All GHG emissions are classed as being capable of being significant on the basis that all emissions contribute to climate change. The global climate has been identified as the receptor for the purposes of the GHG assessment. The sensitivity of the climate to GHG emissions is considered 'high'. The rationale supporting this includes:

- GHG emission impacts could compromise the UK's ability to reduce its GHG emissions and therefore the ability to meet its future carbon budgets;
- The need to reduce GHG emissions to reduce the risks and impacts of climate change, as broadly identified by the climate science community and agreed under the Paris Agreement

which aims to keep global temperature rise this century below two degrees above pre-industrial levels. Additionally, a recent report by the IPCC highlighted the importance of limiting global warming below 1.5°C and

- A disruption to global climate is already having diverse and wide-ranging impacts to the environment, society, economic and natural resources. Known effects of climate change include increased frequency and duration of extreme weather events, temperature changes, rainfall and flooding, and sea level rise and ocean acidification. These effects are largely accepted to be negative, profound, global, likely, long-term to permanent, and are transboundary and cumulative from many global actions.

The UK Carbon Budgets

7.4.20 The UK carbon budgets are in place to restrict the amount of GHG emissions the UK can legally emit in a five-year period. The UK is currently in the 3rd carbon budget period, which runs from 2018 to 2022, as detailed in Table 7-3. The sixth carbon budgets reflect the commitment to a 78% reduction target by 2035 and is the first carbon budget on a pathway to the current target of net zero emissions by 2050.

7.4.21 The 6th carbon budget was enshrined in law in June 2021. In line with the recommendation from the Committee on Climate Change (CCC), this 6th Carbon Budget limits the volume of GHG gases emitted over a 5-year period from 2033 to 2037 to 965Mt CO_2e, taking the UK more than three-quarters of the way to reaching net zero by 2050. The Carbon Budget will ensure the UK remains on track to achieve its contribution to global mitigation efforts, consistent with the Paris Agreement temperature goal to limit global warming to well below 2°C and pursue efforts towards 1.5°C.

Table 7-3 UK Carbon Budgets

UK Carbon Budget	*Total Budget ($MtCO_2e$)*
3rd (2018-2022)	2,544
4th (2023-2027)	1,950
5th (2028-2032)	1,725
6th (2033-2037)	965[1]

7.4.22 Construction of the proposed development is likely to intersect the 3rd and 4th Carbon Budget. The proposed development operation will then continue through the 4th, 5th and 6th Carbon Budgets and intersect the net zero target in 2050.

Vulnerability to climate change assessment

Scope of assessment

7.4.23 This assessment has identified whether anticipated changing climate conditions and weather events are likely to have significant adverse effects on the project during construction and operation.

7.4.24 UK Climate projections (UKCP18) have been used to identify potential climate hazards which may impact the Scheme. Climatic parameters to be included in the assessment are presented in Table 7-4. This table is consistent with Table 3.35N in DMRB LA114

Table 7-4 Climatic parameters for the vulnerability assessment

Climate Parameter	Scoped In or Out	Rationale
Extreme weather events	In	The proposed development may be vulnerable to extreme weather events such as storm damage to structures and assets.
Temperature	In	Climate change may lead to increased temperatures in the area of the proposed development, which could impact on structural integrity of roads and materials.
Sea level rise	Out	The proposed development site is not located in an area that is susceptible to sea level rise.

[1] Enshrined in law June 2021.

Precipitation	In	The proposed development may be vulnerable to changes in precipitation, for example, damage to structures and drainage systems during periods of heavy precipitation.
Wind	Out	The impacts of wind on receptors in the surrounding environment are likely to be no worse relative to baseline conditions.

7.4.25 The degree to which the frequency of these potential hazards may change as a result of climate change is explained in the *UKCP18* climate change projections.

7.4.26 Wind is scoped out of the assessment. In the UKCP18 Wind Factsheet, the Met Office states: "*There are no compelling trends in storminess, as determined by maximum gust speeds, from the UK wind network over the last four decades*." and "*Wind speed is not available for the probabilistic projections as they did not pass our credibility checks*." While reference could be made to the winter wind speed anomaly data from the 12km land projections dataset, the climate models do not show any clear trends.

7.4.27 Additional potential climatic hazards for the vulnerability assessment, such as fog/lightning and cold temperature/ice have been considered under 'extreme weather events'.

Method for determining baseline conditions and sensitive receptors

7.4.28 The receptor for the climate change vulnerability assessment is the construction and operation of the proposed development itself, including associated proposed development users (construction workers and members of the public).

7.4.29 For the purposes of the climate change vulnerability assessment, the current baseline conditions are based upon historic climate change data obtained from the Met Office recorded by the closest meteorological station to the proposed development (Witney).

7.4.30 Future baseline emissions are based on UKCP18

Methodology for determining proposed development construction effects

7.4.31 The vulnerability assessment follows the method detailed in the *DMRB LA 114 Climate* (Highways England, 2021). This has been completed in liaison with the proposed development design team and the other EIA technical disciplines by considering the UKCP18 data for the geographical location and timeframe of the proposed development (from construction through to operation).

7.4.32 *DMRB LA 114 Climate* details how to assess the relevance of potential climate impacts during a project's construction, significance criteria, evaluation of significance and when further design and mitigation measures are required. *DMRB LA114 Climate* para 3.40 states "For the construction phase, a qualitative description of disruption risk shall be reported."

Methodology for determining proposed development operation effects

7.4.33 This assessment addresses the resilience of the proposed development to climate change impacts. It includes all infrastructure and assets associated with the proposed development and assessed resilience against both gradual climate change, and the risks associated with an increased frequency of extreme weather events.

7.4.34 The assessment assumes that the proposed development will be designed to be resilient to impacts arising from current weather events and climatic conditions, and designed in accordance with current planning, design and engineering practice and codes. The assessment took into account the existing resilience and adaptation measures for each risk either already in place or in development for infrastructure and assets.

7.4.35 The vulnerability assessment follows the method detailed in the *DMRB LA 114 Climate*. This was completed in liaison with the project design team and the other EIA technical disciplines by considering the *UKCP18* projections for the geographical location and timeframe of the proposed development (from construction through to operation).

7.4.36 UKCP18 climate change projections are used to identify potential climate impacts during the proposed development's operational phase. The likelihood and consequences of these impacts upon proposed development receptors have been assessed according to Table 7-5 and Table 7-6.

7.4.37 In line with the *DMRB LA114 Climate* (paragraph 3.31), for the purposes of the vulnerability assessment, a proposed development operational lifespan of 60 years has been used.

Table 7-5 Measure of likelihood for vulnerability assessment (LA 114 table 3.39a)

Likelihood	*Description (probability and frequency of occurrence)*
Very high	The event occurs multiple times during the lifetime of the project (60 years) e.g., approximately annually, typically 60 events
High	The event occurs several times during the lifetime of the project (60 years) e.g., approximately once every five years, typically 12 events.
Medium	The event occurs limited times during the lifetime of the project (60 years) e.g., approximately once every 15 years, typically 4 events.
Low	The event occurs during the lifetime of the project (60 years) e.g., once in 60 years.
Very low	The event can occur once during the lifetime of the project (60 years).

Table 7-6 Measure of consequence for vulnerability assessment (LA 114 Table 3.39b)

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.

Significance criteria

7.4.38 The significance of each climatic impact has been evaluated through the matrix as detailed in Table 7-7. The assessment takes into account design and mitigation measures, as described by LA 114 (refer to section 7.6.1). If significant effects remain, additional design and mitigation measures will be defined, and residual risks reassessed until a non-significant acceptable level is achieved.

Table 7-7 Significance matrix ('S' significant, 'NS' not significant) (DMRB Table 3.41)

		Measure of Likelihood				
		Very Low	*Low*	*Medium*	*High*	*Very High*
Measure of consequence	*Very large*	NS	S	S	S	S
	Large	NS	NS	S	S	S
	Moderate	NS	NS	S	S	S

Minor	NS	NS	NS	NS	NS
Negligible	NS	NS	NS	NS	NS

Limitations and assumptions

Assumptions

7.4.39 The GHG emissions calculations, undertaken as part of the GHG impact assessment (see section 0) are based on assumptions derived from a combination of existing project data and information, industry benchmarks and professional judgement. The following assumptions, inclusions and exclusions, made on a precautionary basis, have been used, using information as supplied by:

- proposed development construction activities will take approximately 41 weeks to complete, starting in August 2022, completing in May 2023. This duration is based on construction activities being undertaken from Monday to Friday during the construction period.
- Fuel usage on-site is not currently available at the current design stage
- Details regarding materials and products and their quantities are based on information supplied by AECOM cost estimate team e.g., tonnes of asphalt, cubic metres of structural or ancillary concrete as follows:
  - Aggregate 8,015 m^3;
  - Asphalt 3,173 m^3;
  - Steel 55 tonnes;
  - Concrete – in-situ 635 m^3, precast 83m^3;
  - Timber 2m^3;
  - Generic fill 5,750m^3.
- Water requirements for the construction purposes (e.g., wheel washing and dust suppression) are not currently available and are therefore not included. The impact of water requirements is likely to be negligible and well within the 1% ‘de minimis’ allowable under PAS 2050 guidance.
- Details regarding wastes are based on data supplied by the AECOM cost estimate team in the form of cubic metres of material.
- It is assumed that there will be a net loss of vegetated areas due to land take for road construction, based upon information supplied by the AECOM cost estimate team.
- There is currently no information available on HGV movements during construction. Consequently, transport GHG emissions have been estimated using the material quantities in the Bill of Quantities and emissions factors in $kgCO_{2e}$/tonne.km as provided by BEIS.
- At the current design stage, information on the number of workers on site and energy use in commuting is not available.
- Information on additional maintenance activities during the operational phase is not currently available. However, this is expected to be negligible and well within the 1% ‘de minimis’ allowable under PAS 2050 guidance.
- Energy usage on site has been estimated based on an emission rate of 14,000 kg CO2 per £1 million (Ref 7-35)
- It is assumed that there will be 25 workers per day on a 6-day working week. A distance of 15 km from the site has been assumed and a return trip has been included. It is assumed all commuting is undertaken in a petrol car, with an occupancy rate of 1 per vehicle.

Limitations

7.4.40 Given that the detailed design of the proposed development has not been undertaken, some data is not available to enable a fully quantified assessment of the GHG emissions from the construction and

operation of the proposed development. Accordingly, appropriate estimates provided by the AECOM cost estimate team (as detailed above) have been used.

7.4.41 Limitations associated with the approach to be taken for the climate resilience assessment relate to uncertainties inherent within UK Climate Projections (UKCP18 data). By its very nature, climate change is associated with a range of assumptions and limitations. UKCP18 are currently the leading climate change projections for the UK.

7.4.42 While the weather projections used in the vulnerability assessment represent anticipated average weather conditions, they do not capture the full range of possible future severe weather events (i.e. droughts, heatwaves and prolonged, heavy rainfall). A 'high' emissions scenario (RCP8.5) has been used to develop the baseline against which resilience has been assessed. This is consistent with the precautionary principle.

7.5 Baseline conditions

GHG impact assessment

7.5.1 The baseline environment assesses the 'Do Minimum' scenario where the proposed development does not go ahead. The current and future baseline for the lifecycle GHG impact assessment is a 'business as usual' scenario where the proposed development is not constructed, and the existing road network remains. For the purposes of determining net changes in GHG emissions through the proposed development, the difference in activities between the 'Do Minimum' baseline and the 'Do Something' scenario have been examined.

Vulnerability to climate change assessment

7.5.2 The current baseline for the vulnerability assessment is based on historic climate data obtained from the Met Office recorded by the closest meteorological station to the proposed development (Oxford, approximately 10km east from Witney) for the period 1981-2010. These data are listed in Table 7-8.

Table 7-8 Historic Climate Data 1981-2010

Climatic variable	*Month*	*Value*
Average annual maximum daily temperature (°C)	-	14.5
Warmest month on average (°C)	July	22.7
Coldest month on average (°C)	January	7.6
Mean annual rainfall levels (mm)	-	55.6
Wettest month on average (mm)	October	70.9
Driest month on average (mm)	February	41.8

7.5.3 Evidence shows that the climate is changing beyond that of expected natural fluctuations. Met Office records show that Central England temperatures have increased by 1°C since the 1970s, total summer rainfall has decreased in most parts of the UK, and the UK has experienced nine of the ten warmest years on record since 1990 of which 6 were since 2014 (i.e., in 2015, 2016, 2017, 2018, 2019 and 2020).

7.5.4 The Met Office historic 10-year averages for the England Southeast and Central South region identify gradual warming (although not uniformly so) between 1969 and 2018, with increased rainfall also. Information on mean maximum annual temperatures (°C) and mean annual rainfall (mm) is summarised in Table 7-9.

Table 7-9 Historic 10-year averages for temperature and rainfall for the England southeast and central south region

Climate Period	*Climate Variable*	
	Mean maximum annual temperatures (°C)	*Mean annual rainfall (mm)*
1969-1978	13.731	731.91
1979-1988	13.481	777.26
1989-1998	14.434	745.95
1999-2008	14.84	830.05
2009-2018	14.794	799.27

7.5.5 The future baseline for the vulnerability assessment is based on future UKCP18 from the Met Office for the Witney area. This projection data provides probabilistic indications of how global climate change is likely to affect areas of the UK using pre-defined climate variables and time periods.

7.5.6 For the assessment, UKCP18 probabilistic projections for pre-defined 20-year periods for the following average climate variables have been obtained and further analysed:

- Mean annual temperature;
- Mean summer temperature;
- Mean winter temperature;
- Maximum summer temperature;
- Minimum winter temperature;
- Mean annual precipitation;
- Mean summer precipitation; and
- Mean winter precipitation.

7.5.7 Projected temperature and precipitation variables are presented in Table 7-10 and Table 7-11, respectively. UKCP18 probabilistic projections have been analysed for the 25km grid square in which the proposed development is located (Grid cell: 437500.00, 212500.00). These figures are expressed as temperature/ precipitation anomalies in relation to the 1981-2000 baseline.

7.5.8 The 25km projections have been used because these are UKCP18's Probabilistic Projections, meaning the range of emission scenarios allows for consideration of the potential climate extremes and the uncertainty in climate models. The regional (12km) or local (2.2km) projections would give enhanced spatial detail (or hourly data from the 2.2km data), however they only downscale versions of the Hadley Centre climate model (i.e., not other model ensembles such as CMIP5) model and the RCP8.5 scenario, and so sample a narrower uncertainty range.

7.5.9 UKCP18 uses a range of possible scenarios, classified as Representative Concentration Pathways (RCPs), to inform differing future emission trends (Ref 7-36). These RCPs *"… specify the concentrations of greenhouse gases that will result in total radiative forcing increasing by a target amount by 2100, relative to preindustrial levels."* RCP8.5 has been used for the purposes of this assessment as a worst-case scenario. RCP 8.5 highlights the UKs worst-case scenario, representing a 4.3 °C temperature increase by 2081 – 2100, where greenhouse gas emissions continue to grow unmitigated.

7.5.10 The proposed development has varying design life elements, with the pavement surface at 15 years, the pavement at 40 years and the structures at 120 years. The projected climate variables are presented in Table 7-10 and Table 7-11 – the 2020-2039 period intersects the proposed development construction

stage, the start of proposed development operation and the end of the design life for pavement surfacing. DMRB LA 114 recommends that a 60-year design life is used within the vulnerability assessment.

7.5.11 The vulnerability assessment considers an RCP scenario that reflects a high level of greenhouse gas emissions at the 10%, 50% and 90% probability levels to assess the impact of climate change over the lifecycle of the proposed development. A 10% probability result indicates that 10% of model results were below this figure. A 50% probability results indicates that 50% of model results were above and below this figure. A 90% result indicated that 90% of model results were below this figure.

Table 7-10 Projected Changes in Temperature Variables (°C), 50% Probability (10% and 90% probability in parenthesis) (RCP8.5)

Climate Variable	*Time Period*		
	2010-2039	***2040-2069***	***2070-2099***
Mean annual air temperature anomaly at 1.5 m (°C)	+0.8 (+0.3 to +1.3)	+1.9 (+0.9 to +3.0)	+3.8 (+2.0 to +5.7)
Mean summer air temperature anomaly at 1.5 m (°C)	+1.0 (+0.3 to +1.8)	+2.5 (+1.0 to +4.2)	+5.0 (+2.3 to +8.0)
Mean winter air temperature anomaly at 1.5 m (°C)	+0.7 (0 to +1.4)	+1.7 (+0.5 to +2.9)	+3.1 (+1.1 to +5.0)
Maximum summer air temperature anomaly at 1.5 m (°C)	+1.2 (+0.3 to +2.1)	+2.9 (+1.0 to +5.0)	+5.7 (+2.3 to +9.4)
Minimum winter air temperature anomaly at 1.5 m (°C)	+0.6 (-0.1 to +1.4)	+1.7 (+0.4 to +3.1)	+3.0 (+1.0 to +5.4)

Table 7-11 Projected Changes in Precipitation Variables (%), 50% Probability (10% and 90% probability in parenthesis) (RCP 8.5)

Climate Variable	*Time Period*		
	2010-2039	*2040-2069*	*2070-2099*
Annual precipitation rate anomaly (%)	+0.7 (-3.1 to +4.7)	-1.1 (-6.7 to +4.6)	+3.0 (+0.1 to +5.4)
Summer precipitation rate anomaly (%)	-6.2 (-21.6 to +9.0)	-22.2 (-47.5 to +3.0)	-39.4 (-71.0 to -2.7)
Winter precipitation rate anomaly (%)	+5.7 (-3.5 to + 15.7)	+11.0 (-4.1 to +27.3)	+21.3 (+0.4 to +45.4)

7.6 Environmental design and management

GHG emissions

7.6.1 The GHG impact of the proposed development should be put into the wider context of the UK Strategic Road Network (SRN). The length of the proposed development represents less than 0.1% of the 4,500-mile UK SRN. Therefore, although it is important that the relative GHG impact of the proposed development is considered so that mitigation measures can be integrated into the proposed development, the overall impact is expected to be minimal when considered in the national context (**Error! Reference source not found.**).

7.6.2 Mitigation measures would be implemented to reduce lifecycle emissions across the proposed development as shown in Table 7-12 .

Table 7-12 Embedded GHG emission mitigation measures

Lifecycle stage	*Mitigation measures*	*Delivery mechanism*
Construction	The Principal 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. Energy consumption and materials use would be recorded and reported on an ongoing basis during the construction phase.	Construction Environmental Management Plan (CEMP) by the Principal Contractor.
	Where practicable, measures would be implemented to manage material resource use during construction including: • using materials with lower embodied GHG emissions and water consumption; • using sustainably sourced materials; and • using recycled or secondary materials.	
	Where possible, the use of local construction staff to minimize commuting distances.	
	Use of well-maintained plant, and no idling of plant or vehicles when stationary.	CEMP
	Use contractors/suppliers with low emission fleet vehicles.	CEMP
	Waste management measures to reduce wastes include: • Agreements with material suppliers to reduce the amount of packaging or to participate in a packaging take-back proposed development; • Implementation of a 'just-in-time' material delivery system to avoid materials being stockpiled, which increases their risk of damage and disposal as waste; • Attention to material quantity requirements to avoid over-ordering and generation of waste materials; • Re-use of materials wherever feasible, e.g., re-use of excavated soil for landscaping. Concrete would be taken off-site for crushing and re-use; • Segregation of waste at source where practical; and • Re-use and recycling of materials off-site where re-use on-site is not practical (e.g., through use of an off-site waste segregation facility and re-sale for direct re-use or re-processing).	Site Waste Management Plan
	During the design phase, opportunities to reduce wastes included: • waste arisings would be prevented and designed out where possible; • opportunities to re-use material resources would be sought where practicable, such as the re-use of existing on-site lighting if in adequate condition; and • where re-use and prevention are not possible, waste arisings would be managed in line with the waste hierarchy.	Waste Minimisation Statement
Operation	Lighting of new and improved sections of road within the proposed development has been confined to locations where road safety is a priority.	Maintenance Plan Landscape Plan
	Energy efficient road lighting would be implemented to minimise operational energy consumption.	
	Net gain of biodiversity through retained, enhanced, or created habitats through landscaping.	
	Encouragement of low or carbon neutral forms of transport through the construction of additional shared cycle/footway.	
	Provision of solar studding over artificial lighting of the shared cycle/footway.	

Climate change vulnerability

7.6.3 Mitigation measures would be implemented to reduce climate change vulnerability across the lifecycle of the proposed development. Measures to mitigate the potential impact of climate change impacts are summarised in Table 7-13 .

Table 7-13 Embedded climate change vulnerability mitigation measures

Lifecycle stage	*Receptors*	*Mitigation measures*	*Delivery mechanism*
Construction	Construction staff and assets (i.e., plant, vehicles, materials etc)	The Principal Contractor would develop and implement a plan to prevent or reduce the likelihood of climatic hazards affecting construction staff and assets.	Mitigation measures would be set out in a CEMP to be developed by the Principal Contractor. Site Waste Management Plan. Site Safety Plan.
Operation	End-users (members of public, commercial operators etc.) The assets and their operation, maintenance, and refurbishment (i.e., pavements, structures, earthworks & drainage, technology assets, etc.).	A climate change allowance of 40% has been added to the 1% annual exceedance probability (AEP) storm used to assess fluvial flood risks and the design of the proposed development drainage systems. With reference to fog/lightning and cold temperature hazards, it is standard practice that all materials used would be HAPAS (Highways Authority Product Approval Scheme) approved so those things would be taken into account through certification.	Applicable climate allowances have been made during the design of the drainage strategy. See *ES Volume II, Appendix 14-A Surface Water Drainage Strategy.*

7.7 Assessment of effects and significance

GHG Emissions Impact Assessment

Effects during construction

7.7.1 As described in *ES Volume I, Chapter 4: The Proposed Development*, the construction stage is anticipated to take approximately 41 weeks and entails the introduction of new west-facing slip roads at the A40 and B4022 junction to offer alternative routes for traffic in the Witney area.

7.7.2 Potential impacts for the lifecycle GHG impact assessment applicable to the construction phase are presented in Table 7-2. This approach is consistent with the principles set out in the DMRB guidance, BS EN 15804, PAS 2080, and IEMA guidance.

7.7.3 In order to assess the magnitude of the impact of the proposed development on the climate, GHG emissions associated with the enabling works, construction and operation of the proposed development have been calculated based on the methodologies discussed in section 7.4.

7.7.4 As detailed in Table 7-14 the total GHGs estimated to be emitted from the construction phase associated with the proposed development have been calculated to be 2,208 tCO2e over the course of the 41-week construction period. The majority of emissions are associated with embodied carbon in construction

materials, accounting for approximately 43% of all construction emissions, with land use change accounting for a further 25% of construction emissions.

7.7.5 All these emissions are considered 'additional' and are included in the impact assessment of the proposed development. They are defined as additional as they are considered new and would not occur if the proposed development did not go ahead.

Table 7-14 Estimated Enabling Works and Construction GHG Emissions

Emission Source	*Emissions (tCO_2e)[2]*	*Percentage of Stage Emissions[3]*
Land use change	560	25%
Embodied carbon in raw materials	947	43%
Energy use on site	195	9%
Worker commuting	40	2%
Transport of material	240	11%
Disposal of construction waste	227	10%
Total emissions	2,208	

Effects once the proposed development is complete and operational

7.7.6 7.7.10 Potential impacts for the lifecycle GHG impact assessment applicable to the operation phase of the proposed development are presented in Table 7 2. This approach is consistent with the principles set out in the DMRB, BS EN 15804, PAS 2080 and IEMA guidance.

Table 7-15 Road user emissions

Scenario	*Emissions- Year of Opening (tCO2e)*	*Emissions- Design Year (tCO2e)*
Baseline Scenario 'Do-minimum'	503,344	488,339
Project Scenario 'Do-something'	502,605	487,815
Net Difference from Baseline to Project Scenarios	-739	-524

7.7.7 Table 7 17 indicates that in the year of opening (2024), with the proposed development in operation, GHG emissions are estimated to be approximately 739 tCO2e lower than without the proposed development (the DM scenario).

7.7.8 For the design year (2039), GHG emissions with the proposed development are estimated to be approximately 524 tCO2e lower than without the proposed development. The calculated reduction in GHG emissions with the proposed development in operation is due to a reduction in congestion and journey times resulting from the improvements at the junction.

Significance

7.7.9 As stated in section 7.4, all emissions are considered to be capable of being significant due to their combined environmental effect in the atmosphere. To contextualise the level of significance, these emissions have been compared to the UK Carbon budgets. As highlighted in **Error! Reference source not found.**8, detailing the emissions against that of the relevant UK Carbon Budgets the proposed

[2] Values rounded to the nearest 1 tCO_{2e}
[3] Expressed as integer values – may not sum to 100 due to rounding

development contributes - 0.00005% to the 3rd Carbon Budget, -0.00009% to the 4th Carbon Budget, -0.00016% to the 5th Carbon Budget and -0.00027% to the 6th carbon budget.

7.7.10 The magnitude of impact is therefore considered to be low. This is considered to be a minor adverse (not significant) effect.

Table 7-16 Scheme emissions in comparison to national carbon budgets

Project stage	Net GHG emissions over relevant carbon budget period (DS-DM)	3rd Carbon budget period (tCO2e)	4th Carbon budget period (tCO2e)	5th Carbon budget period (tCO2e)	6th Carbon budget period (tCO2e)
Construction	2,208	1,173	1,034	0	0
Operation	-8,200	0	-2,773	-2,806	-2,621
Total	-5,993	1,173	-1739	-2,806	-2,621
Percentage of carbon budget	-	0.00005%	-0.00009%	-0.00016%	-0.00027%

7.7.11 Of note is that 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 is not currently fully captured in the modelling scenarios of future road traffic emissions.

7.7.12 At the time of the assessment, road user emissions have been calculated by using Defra's Emission Factor Toolkit v10.1 and applying the National Highways speed banded emission factors spreadsheet in line with DMRB LA105. The emission factors and fleet projections do not go beyond 2030 therefore 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 to have been overestimated as EV uptake is expected to increase beyond this time.

7.7.13 In addition, future decarbonisation of the national electricity grid would have an impact upon the GHG emissions associated with the operation of the proposed development. According to the Department for Business Energy and Industrial Strategy (BEIS) Updated Energy and Emissions Projections 2019 (Ref 7-38), 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.

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

7.7.15 The magnitude of impact during operation is therefore considered to be low. This is considered to be a minor beneficial (not significant) effect.

Vulnerability to climate change

Effects during construction

7.7.16 During enabling and construction works, receptors such as the construction work force, construction assets such as plant, vehicles, materials and workplan may be vulnerable to a range of climate risks. These risks include:

- Inaccessible construction site due to severe weather event (flooding, snow and ice, 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; and
- Damage to construction materials, plant, and equipment, including damage to temporary buildings/facilities within the site boundary, such as offices, compounds, material storage areas and worksites, for example as a result of stormy weather.

7.7.17 In consideration of the embedded and design mitigation and management measures described in section 7.6, the resulting significance matrix for climate vulnerability has been undertaken in Table 7-17. No significant vulnerability impacts have been identified for the construction phase of work, due to the duration and nature of the construction activities associated with the Scheme. 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. In addition, the Principal Contractor will develop a plan to prevent or reduce the risk of extreme weather events such as the implementation of emergency systems and response plans.

Table 7-17 Construction Stage Climate Vulnerability Significance Assessment

Climate Variable	Receptors	Potential Impacts from Climate Variables	Likelihood (Probability and Frequency of Occurrence) 2020-2039	Measure of Consequence	Significance Level
Increased frequency and severity of extreme weather events (such as heavy and/or prolonged precipitation, storm events and heatwaves)	Construction workers and assets (i.e., plant, vehicles, materials etc)	Flooding and storm damage to site and site assets, danger to construction workers, inaccessible work site, possible power disruption, overheating of electrical equipment	Low	Minor adverse	Not significant
Increased winter precipitation	Construction workers and assets (i.e., plant, vehicles, materials etc)	Flooding of construction site, damage to site assets, danger to construction workers, inaccessible work site	Medium	Minor adverse	Not significant
Decreased summer precipitation	Construction assets (i.e., plant, vehicles, materials etc)	Drought	Low	Negligible	Not significant
Increased summer and winter temperatures	Construction workers and assets (i.e., plant, vehicles, materials etc)	Heat stress to construction workers, deterioration of materials and assets, overheating of electrical equipment	Medium	Minor adverse	Not significant

Effects once the proposed development is complete and operational

7.7.18 During operations, receptors such as the road users, physical assets, maintenance workers, maintenance plant and maintenance vehicles may be vulnerable to a range of climate risks. These could include:

- Inaccessible maintenance site due to severe weather event (flooding, snow and ice, storms) restricting working hours and delaying construction;
- Health and safety risks to the workforce and road users during severe weather events;
- Unsuitable conditions (due to very hot weather or very wet weather, for example) for certain construction activities; and
- Damage to assets, landscaping, materials, plant, and equipment as a result of stormy weather, flooding and excessive heat.

7.7.19 In consideration of the embedded and design mitigation and management measures described in section 7.6, the resulting significance matrix for climate vulnerability has been undertaken in Table 7-18. No significant vulnerability impacts have been identified for the operational phase of work.

7.7.20 No climate impacts to vulnerable safety critical features have been identified.

Table 7-18: Operational Stage Climate Vulnerability Significance Assessment

Climate Variable	Receptors	Potential Impacts from Climate Variables	Likelihood	Measure of Consequence	Significance Level
Increased frequency and severity of extreme weather events (such as heavy and/or prolonged precipitation, storm events and heatwaves)	End-users (members of public, commercial operators etc.) The assets and their operation, maintenance and refurbishment (i.e. pavements, structures, earthworks & drainage, technology assets, etc.).	Flooding and storm damage to site and site assets, danger to maintenance workers and road users, inaccessible work site, possible power disruption, overheating of electrical equipment, damage and deterioration of assets, 'summer ice' slippery roads after prolonged periods of no rain, land subsidence, traffic related rutting and migration of road material, damage to landscaping.	Medium	Minor adverse	Not significant
Increased winter precipitation	End-users (members of public, commercial operators etc.) The assets and their operation, maintenance and refurbishment (i.e. pavements, structures, earthworks & drainage, technology assets, etc.).	Flooding of construction site, damage to site assets, danger to maintenance workers and road users and drainage systems, inaccessible work site, damage to roads, land subsidence, damage to landscaping.	Medium	Minor adverse	Not significant
Decreased summer precipitation	The assets and their operation, maintenance and refurbishment (i.e., landscaping.).	Drought, damage to landscaping.	Medium	Negligible	Not significant
Increased summer and winter temperatures	End-users (members of public, commercial operators etc.) The assets and their operation, maintenance and refurbishment (i.e. pavements, structures, earthworks & drainage, technology assets, etc.).	Heat stress to maintenance workers, deterioration of materials and assets, overheating of electrical equipment, thermal expansion and movement of bridge joints and paved surfaces, damage to landscaping.	Medium	Minor adverse	Not significant

Summary of overall effects (pre-mitigation) of the proposed development

7.7.21 There will be unavoidable GHG emissions resulting from both the construction and operation of the proposed development as materials, energy and fuel use, and transport would be required. An assessment of the magnitude and significance of these emissions has deemed them to be not significant. The significance of operational emissions in the future may become more significant as the UK moves towards net zero in 2050.

7.7.22 A number of climate change hazards have been identified for the construction and operation of the proposed development, which may lead to range of potential impacts to the proposed development itself. In consideration of the embedded design measures, all residual significance levels have been determined as not significant.

7.8 Mitigation and monitoring

7.8.1 Due to the minor adverse significance of the GHG emissions and the climate change resilience design measures that are proposed as part of the proposed development, no additional mitigation measures are required.

7.8.2 Climate change vulnerability has been assessed as not significant during construction and operational stages; in consideration of the measures already proposed no additional mitigation measures are proposed.

7.8.3 The climate assessment has concluded that the proposed development will not result in significant climate effects being generated, and as such, no monitoring is required.

7.8.4 However, the Principal Contractor's CEMP will set out monitoring to be undertaken during the construction stage to ensure that the mitigation measures embedded in the design are appropriately implemented to reduce carbon emissions where possible.

7.9 Residual effects and conclusions

7.9.1 There will be unavoidable GHG emissions resulting from both the construction phase and the operational phase of the proposed development as materials, energy and fuel use, and transport will be required. The effects are minor adverse and minor beneficial, therefore 'not significant', and no mitigation measures further to the ones detailed in section 7.6 of this ES chapter have been identified.

7.9.2 The residual effects resulting from the proposed development are summarised in Table 7-19 .

Table 7-19 Climate Change Summary of Potential Effects

Description of Effect	*Sensitivity of Receptor*	*Nature of Effect / Geographic Scale*	*Magnitude of Impact*	*Initial Classification of Effect (with embedded mitigation)*	*Additional Mitigation*	*Residual Effect Significance*
Construction						
Effect of GHG emissions on global climate	High	Long term global	Low	Minor adverse	No further mitigation measures are proposed	Not significant
Complete and Operational						
Effect of GHG emissions on global climate	High	Long term global	Low	Minor beneficial	No further mitigation measures are proposed	Not significant

Overall Summary of the residual effects of the proposed development

7.9.3 The effect of GHG emissions on the global climate during both construction and operational phases are considered ‘minor adverse’ and ‘minor beneficial’ resulting in residual effects being assessed as ‘not significant’.

Likely significant environmental effects

7.9.4 There are no likely significant adverse effects on climate change resulting from the proposed development. However, GHG emissions from the operational proposed development will become more significant during the design life of the proposed development towards the 2050 net zero UK target.

7.10 Cumulative effects assessment

7.10.1 Climate change is the result of cumulative impacts as it is the result of innumerable minor activities, a single activity may itself result in a minor or insignificant impact, but when combined with many other activities, the cumulative impact could be significant.

7.10.2 The assessment of road user emissions is inherently cumulative as it is based on a traffic model which takes into account the impact of new development on traffic on the network.

7.10.3 The cumulative effects of GHG emissions on the global climate are acknowledged as being potentially significant but it is not possible to quantitatively assess these effects within this assessment. Whilst the emissions from this individual proposed development can be estimated and compared against regional and national carbon budgets, the combined effect together with all other GHG-emitting activities nationally cannot be assessed.

7.11 References

Ref 7-1 Her Majesty's Stationary Office, HMSO (2017); 'The Town and Country Planning (Environmental Impact Assessment)' (Amendment) (Wales) Regulations 2017.

Ref 7-2 Highways England (2021). DMRB LA 114 Climate. Sustainability and Environment Appraisal

Ref 7-3 UNFCCC (2016). Conference of the Parties, Report of the Conference of the Parties on its twenty-first session, held in Paris from 30 November to 13 December 2015. FCCC/CP/2015/10 (online). Available: https://unfccc.int/sites/default/files/resource/docs/2015/cop21/eng/10a01.pdf [Accessed 30 June 2021]

Ref 7-4 EIA Directive 2011/52/EU (as amended) https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32014L0052

Ref 7-5 EIA Directive 2014/92/EU (as amended) https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32014L0052

Ref 7-6 UK Government (2008). Climate Change Act 2008 (online). Available: http://www.legislation.gov.uk/ukpga/2008/27/contents [Accessed 30 June 2021]

Ref 7-7 UK Government, (2019). The Climate Change Act 2008 (2050 Target Amendment) Order 2019 (online). Available: https://www.legislation.gov.uk/uksi/2019/1056/contents [Accessed 30 June 2021]

Ref 7-8 Committee on Climate Change, (2020); UK Carbon Budgets. Available at https://www.theccc.org.uk/publication/sixth-carbon-budget/ [Accessed 30 June 2021]

Ref 7-9 Department for Transport (DfT) (2021) Transport Decarbonisation Plan. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1009448/decarbonising-transport-a-better-greener-britain.pdf [Accessed: 30th June 2021]

Ref 7-10 Ministry of Housing, Communities and Local Government (MCHLG) (2019) National Planning Policy Framework (NPPF). Conserving and enhancing the historic environment. Ministry of Housing, Communities & Local Government. Available online at: www.gov.uk/government/publications/national-planning-policy-framework--2

Ref 7-11 MCHLG (2014) Planning practice Guidance 2014. Available at: https://www.gov.uk/government/collections/planning-practice-guidance#history [Accessed 17 August 2021].

Ref 7-12 West Oxfordshire District Council (2018) West Oxfordshire Local Plan 2031. Available at: https://www.westoxon.gov.uk/media/feyjmpen/local-plan.pdf [Accessed 17 August 2021].

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