23. Climate Change Mitigation & Adaptation

Purpose of the Assessment

23.1 This Chapter has been prepared by Turley Sustainability and its purpose is to assess the likely significant climate change effects on and as a result of the Proposed Development, as is described in Chapter 5 of this Preliminary Environmental Information Report (PEIR) during the construction, operation and decommissioning phases. The requirement to address climate change has been introduced by the EIA (2017) Regulations with a specific requirement to consider the following:

- The impact of the project on climate (for example the nature and magnitude of greenhouse gas emissions) and the vulnerability of the project to climate change (Ref 23.1)

23.2 The Chapter sets out, the baseline conditions of The Site and Surroundings; the assessment methodology; likely environmental effects; adaptive mitigation measures required to prevent, reduce or offset any adverse effects; and the likely residual effects after these measures have been implemented.

23.3 The assessment has been undertaken broadly in accordance with guidance documents developed by the Institute of Environmental Management Assessment (IEMA) and through the application of professional judgement.

23.4 This Chapter is split into three key sections: the first introduces the topic and sets out the legislative framework and the outcome of scoping and consultation applicable to both climate change mitigation and adaptation; the second presents an estimation of the quantum, scale and significance of greenhouse gas (GHG) emissions resulting from the Proposed Development and the need for any mitigation measures; the third assesses the likely significant effects of climate change on the Proposed Development and the need for any adaptation measures and the resulting resilience to climate change.

23.5 This Chapter is supported by three technical appendices which are located in Volume 3 of this PEIR:

- Appendix 23.1: Rail Central GHG Assessment
- Appendix 23.2: Rail Central Road and Rail Freight Emission Factors
- Appendix 23.3: Rail Central Climate Change Risk Assessment

Legislative & Policy Framework

23.6 This section details the relevant legislation and specific planning policy that is relevant to the Project and this impact assessment, all key provisions of relevant legislation, policy and guidance are addressed throughout this Chapter.

Table 23.1: Relevant legislation and policy and guidance

Legislation / policy / guidance	Key provisions	Relevant section of Chapter where key provisions are addressed
Legislation: *Climate Change Act 2008* (Ref 23.2)	The *Climate Change Act 2008* sets a legally binding target for reducing UK CO_2 emissions by least 80% on 1990 levels by 2050. At the end of June 2016, Government published the Fifth Carbon Budget, setting out a target for emission cuts of 57% from 1990 levels by 2030.	An assessment of the Proposed Developments GHG emissions against relevant carbon budgets has been undertaken in Paragraphs 21.103,21.107,23.112 and 23.114 of this PEIR Chapter.
Legislation: *The Carbon Plan – delivering our Low Carbon Future ('Carbon Plan')* (Ref 23.3)	In 2011, the Government published an updated Carbon Plan setting out how the UK will achieve decarbonisation and make the transition to a low carbon economy. It sets this objective within a framework of mitigating and adapting to climate change and maintaining energy security in a way that minimises costs and maximises benefits to the economy. With regards to development, the Carbon Plan presents the UK Government's approach to promoting the delivery of low carbon, resilient and adaptive buildings and enabling sustainable transportation as positively contributing to these national carbon reduction targets. The Carbon Plan recognises that during the 2020s there will be a substantial shift toward the use of low-emission vehicles to reduce carbon emissions and improve air quality. Paragraph 34 recognises that one of the mechanisms to reduce carbon emissions from the transport sector is to encourage modal shift	This PEIR Chapter has assessed the impacts of the proposed decarbonisation of the economy and transportation network in the context of assessing the impact of the Proposed Development upon climate change via GHG emissions. As part of this assessment, the decarbonisation of the transport sector and specifically the freight network has also been considered. The results of this assessment are presented in Appendix 23.1, Appendix 23.3 and in Tables 23.11 and 23.12 within this Chapter. The Adaptation Section of this ES Chapter has assessed the resilience of the Proposed Development to the impacts of climate change.

	from road to rail.	
Legislative Guidance: *Meeting Carbon Budgets: Closing the Policy Gap* (Ref 23.4)	The 2017 Committee on Climate Change (CCC) report to Parliament sets out the latest update on the UK's progress to meeting its GHG targets. The documents states that the UK urgently needs new policies to cut GHG emissions. Although UK emissions fell by 6% in 2016 and are down by 19% since 2012, however progress has been dominated by the power sector, CO_2 emissions form transport and buildings rose in 2015 and 2016, while progress in driving emissions reductions in industry and for non-CO_2 GHG has been minimal.	An assessment of the Proposed Developments GHG emissions in the context of national carbon budgets has been undertaken in Paragraphs 21.103,21.107,23.112 and 23.114 of this PEIR Chapter.
National Policy: *National Policy Statement for National Networks (NN NPS)* (Ref 23.6)	The NN NPS sets out the UK strategy for new national infrastructure including the need for new SRFIs. Paragraph 2.35 states: *'Rail transport has a crucial role to play in delivering significant reductions in pollution and congestion. Tonne for tonne, rail freight produces 70% less carbon emissions than road freight, up to 15 times lower NOx emissions and nearly 90% lower PM10 emissions. It also has de-congestion benefits depending on its location, each freight train can remove between 43 and 77 HGVs from the road'.* The Statement sets out the government's aim to facilitate modal shift from road to rail and that a network of SRFIs is a key element in aiding the transfer of freight from road to rail, supporting sustainable distribution. Paragraph 4.40 of the NPSNN states that the accompanying environmental statement should set out how the proposal will take account of the projected impacts of climate change. It also states that the applicant should take into account the potential	This Chapter presents a GHG assessment of the Proposed Development which includes emissions from transport movements and those estimated to be saved as a result of moving freight from road to rail (i.e. modal shift). This Chapter also presents the embedded and adaptive mitigation to reduce GHG emissions and increase climate change resilience.

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 proposed infrastructure.

In terms of EIA the NPSNN sets out guidance for the assessment of new development with regards to climate change, and paragraph 4.41 states, "Where transport infrastructure has safety-critical elements and the design life of over 60 years or greater, the application should apply the *UK Climate Projections 2009 (UKCP09)* high emissions scenario (high impact, low likelihood) against the 2080 projections at the 50% probability level.

Paragraph 4.42 clearly sets out that applicants must consider the impacts of climate change when planning the location, design, build and operation of new national networks infrastructure, identifying appropriate mitigation and adaptation measures, covering the estimated lifetime of the new infrastructure.

Paragraphs 5.16-5.19 of the NPS present the policy situation with regard to carbon emissions from a DCO application. It states that the applicant must present an estimation of the carbon emissions from the application and an assessment of these emissions against the Carbon Budget. It is important to note that the NPS recognises that an increase in carbon emission is not necessarily a reason for refusal *unless the increase on the proposed scheme would have a material impact on the Government to meet its carbon targets.*

The NPS also notes the need for suitable mitigation measures which

	will be a material factor in the decision-making process.	
National Policy: *National Planning Policy Framework (NPPF)* (Ref 23.5)	Following its publication in March 2012, national planning policy is now provided by the NPPF sets out the Government's planning policies for England and how these are expected to be applied. It also sets out the requirements for the planning system only to the extent that it is relevant, proportionate and necessary to do so. The Government has made clear its expectation that the planning system should positively embrace well-conceived development to deliver the economic growth necessary to create inclusive and mixed communities. The NPPF states that: *'The purpose of the planning system is to contribute to the achievement of sustainable development'. It states clearly that in order to deliver sustainable development, the planning system must perform three distinct roles, aligned to the three pillars of sustainability, economic, social and environmental sustainability, which must not be taken in isolation and should be pursued jointly.'* Paragraph 31 states*, 'Local authorities should develop strategies for the provision of viable infrastructure necessary to support sustainable development including large scale facilities such as rail freight interchanges'.* Paragraph 95 states that *local planning authorities should plan for new development in locations and ways that reduce greenhouse gas emissions.*	This Chapter assesses the GHG emissions from the Proposed Development and assesses the impact upon climate change.
Local Policy: *The West Northamptonshire Joint Core Strategy* (Ref 23.8)	The overall objective of the West Northamptonshire Joint Core Strategy Local Plan (JCS) is to deliver sustainable development. It proposes to ensure this occurs through the implementation of 16 identified	Within the Mitigation section of this Chapter, an assessment of the GHG emissions has been undertaken taking into account embedded and

	spatial objectives with which development must align. It also requires that all development proposals to fully consider climate change adaption to meet the vision of sustainable development. Design must also incorporate sustainable building techniques to help combat climate change. Objective 1 of the JCS, Climate Change, highlights the need to 'minimise demand for resources and mitigate and adapt to climate change by': • Promoting sustainable design and construction in all new development; • Ensuring strategic development allocations are located and designed so as to be resilient to future climate change and risk of flooding; • Encouraging renewable energy production in appropriate locations; and • Ensuring new development promotes the use of sustainable travel modes. The JCS includes the following key sustainability policies. Policy S10 - Sustainable Development Principles: States development will: • Achieve high standards of sustainable design; • Be designed to improve environmental performance, energy efficiency and adapt to changes of use and a changing climate; • Make use of sustainably sourced materials; • Minimise resource demand and generation of waste and maximise opportunities for reuse and recycling; • Maximise the generation of	adaptive mitigation measures. A list of the embedded mitigation measures to reduce GHG emissions and those adaptive measures to be considered during the detailed design stage of the Proposed Development are provided. Both embedded and adaptive mitigation measures include those listed within Objective 1 of and Policy S10 and S11 of the JCS.

energy from decentralised and renewable energy or low carbon sources;

- Maximise water efficiency and promote sustainable drainage;
- Promote the creation of green infrastructure networks, enhance biodiversity; and
- Minimise pollution from noise, air and runoff.

Policy S11 - Low Carbon and Renewable Energy: States major development should contribute to reductions in carbon emissions and adapt to the effects of climate change through the sustainable development principles set out in Policy S10, to contribute to minimise energy use through sustainable design and construction, as well as maximise energy efficiency through the provision of low carbon and renewable energy, including where feasible and viable, the use of decentralised energy.

Proposals should be sensitively located and designed to minimise potential adverse impacts on people, the natural environment, biodiversity and should include measures to mitigate pollution.

All new non-residential development over 500m^2 gross internal floorspace is required to achieve a minimum BREEAM Very Good standard.

Policy C2 - New Developments: In relation to employment transport new development is expected to achieve a modal shift away from car travel, maximising travel choice.

Policy BN2 – Biodiversity: States development which has the potential to harm sites of ecological importance should demonstrate the methods used to conserve biodiversity in its design, construction and preparation, how habitat conservation,

	enhancement and creation can be achieved, and how designated sites will be protected. Policy BN7A - Water Supply, Quality and Wastewater Infrastructure: States new development proposals should ensure there is an adequate and appropriate water supply and should use sustainable drainage systems where practicable to improve water quality, reduce flood risk and provide environmental adaptation benefits.	
Local Policy: *Energy Efficiency SPD* (Ref 23.9)	Adopted in 2013 the *Energy Efficiency SPD* provides guidance for developers on the implementation of Core Strategy Policies S10 and S11 and aims to contribute towards the reduction in greenhouse gas emissions. Policies S10 and S11 require development to be built to the highest standards of sustainable design and the Council requires new developments to be accompanied by an Energy Statement setting out the predicted energy demand and how development meets current energy efficiency policies. The SPD sets out guidance on the measures that can be implemented for increasing Energy Efficiency in new development, as well as standards for the assessment of new buildings including BREEAM.	The adaptive mitigation measures proposed include consideration of energy efficiency measures during detailed design. Furthermore, the GHG assessment has considered the impact of grid decarbonisation on the GHG emissions of the Proposed Development during the operational phases.
Local Policy*: Low Carbon and Renewable Energy SPD* (Ref 23.10)	Adopted in 2013 in conjunction with the *Energy Efficiency SPD the Low Carbon and Renewable Energy SPD* aims to provide developers with guidance on how to meet the requirements of Core Strategy Policies S10 and S11. The SPD sets out guidance on potential low carbon renewable energy suitable for installation on industrial and commercial buildings, providing information on the constraints and opportunities for each	The adaptive mitigation measures proposed within this PEIR Chapter include the consideration of energy efficiency measures and renewable energy generation during detailed design.

	technology	
Local Policy: *Energy Demand* (Ref 23.11)	Adopted in 2007 the Council's *Energy and Demand SPD* sets out guidance on energy efficiency and renewable energy in relation to the superseded Government Planning Policy Strategy documents. The document includes practical options for reducing operational energy use as well as potential sources of renewable energy. The SPD also states an energy statement should accompany all planning applications and should set out details of energy efficiency and renewable energy measures proposed.	The adaptive mitigation measures proposed within this PEIR Chapter include the consideration of energy efficiency measures and renewable energy generation during detailed design.
National Guidance: Planning Practice Guidance (PPG) (Ref 23.12)	In March 2014 the Government released the updated Planning Practice Guidance ('the Guidance'). The Guidance provides information to local authorities on how to implement the policies of the NPPF and approach specific policy aims. The Guidance sets out how local authorities should include polices that protect the local environment and strategies to mitigate and adapt to climate change. It reiterates that local authorities should set sustainability policies for new development that are line with the Government's policy and nationally described standards. It supports developments of good design that are functional and adaptable for the future.	The Mitigation section of this PEIR Chapter presents the embedded and adaptive mitigation measures to reduce GHG emissions, with further reductions to be sought during detailed design. All measures are considered in line with Government Guidance. The Adaptation section of this Chapter presents the measures proposed to ensure the Proposed Development is resilient to a changing climate.
Best Practice Guidance: *IEMA Environmental Impact Assessment Guide to: Climate Change Resilience and Adaptation* (Ref 23.13)	Published in 2015, the guidance provides provide thoughts, guidance and areas of consideration for practitioners assessing climate change resilience and adaptation.	The Adaptation section of this Chapter presents in greater detail those areas where the guidance is implemented within this assessment. The guidance has been followed comprehensively and where necessary has been supplemented using

		professional judgement.
Best Practice Guidance: IEMA *Environmental Impact Assessment Guide to: Assessing Greenhouse Gas Emissions and Evaluating their Significance* (Ref 23.14),	Published in 2017, the guidance provides thoughts, guidance and areas of consideration for practitioners assessing GHG emissions and evaluating their significance. The guidance document provides a suggested methodology for the assessment of GHG emissions within EIA. It provides a number of key recommended steps along with guidance for practitioners to address each of the key stages.	Paragraph 23.28 of this Chapter presents in greater detail those areas where the guidance is implemented within this assessment. The guidance has been followed comprehensively and where necessary has been supplemented using professional judgement.

23.7 The best practice guidance produced by IEMA in 2015 and 2017 is intended to provide guidance to EIA practitioners with regard to the EIA Regulations (2017) and the requirement to address climate change mitigation and adaptation. Both documents provide a framework for the effective consideration of climate change but also acknowledge a number of principles when addressing this issue. These are that:

- the documents are not prescriptive 'how to' guides but provide thoughts, guidance and areas of consideration for practitioners;
- as with all EIA topics, professional judgement and proportionality are key to determining the correct scope and methodology of assessment; and
- with regard to assessment of significance, there is no single preferred methodology with on-going research to determine thresholds for GHG emissions along with science-based targets; and
- the assessment of climate change with EIA is still an emerging science and as such further guidance is likely as technical experts implement the new requirements.

23.8 These documents are, however, key to providing guidance for the assessment of climate change related to the Proposed Development and have been referenced within the methodology section of the mitigation and adaptation sections of this Chapter. Notwithstanding the principles listed above, the guidance has been implemented to ensure a robust assessment.

Scoping and Consultation

EIA Scoping

23.9 An Environmental Statement Scoping Report was issued to the Secretary of State in December 2015.

Scoping Opinion Response

23.10 The following table (Table 23.2) sets out the Planning Inspectorates ES Scoping Opinion response, setting out the responses gathered with regard to the development proposals.

23.11 No specific issues were raised with the proposed approach to assessment set out in the scoping by the PINS Scoping Opinion, although the inclusion of climate change considerations was welcomed by the Secretary of State.

23.12 Climate related issues were referenced by a single respondent to the consultation (Blisworth Parish Council) who requested that:

"A carbon impact assessment for the development taking into account all embodied carbon (including construction transport, raw materials production etc.) and all operational carbon over a range of time periods be undertaken.

23.13 In response to the comments by Blisworth Parish Council, the Secretary of State and in accordance with the NPS NN, EIA Regulations (2017) and the associated IEMA guidance a robust GHG assessment has been undertaken and is appended (Volume 3, Appendix 23.1); this includes a full assessment of relevant GHG emissions and the basis for any exclusions.

Table 23.2: Summary of Scoping Opinion

Scoping Opinion section/paragraph	Summary of issues raised	Where in the PEIR is this addressed?
Paragraph 3.13 and Annex A, Section 7	*'The Secretary of State welcomes the consideration of climate change within the ES". The Scoping Opinion also states that the ES should reflect the principles of the England Biodiversity Strategy published by Department for Environment Food & Rural Affairs (DEFRA). The ES should reflect these principles and identify how the development's effects on the natural environment will be influenced by climate change and*	Addressed within the adaption section of this PEIR Chapter.

	how ecological networks will be maintained.'	
Appendix 3 – Response from Blisworth Parish Council	The Scoping Opinion also includes a request from Blisworth Parish Council that the development carry out a *'carbon impact assessment for the development taking into account all embodied carbon (including construction transport, raw materials production etc.) and all operational carbon over a range of time periods*'….and *'an assessment of the time it will take to offset this carbon through the anticipated reduction in road transport using low, medium and high range forecasts of the potential switch from road to rail freight'.*	Addressed in the Climate Change Mitigation assessment and within Appendix 23.1.
Appendix 3 – Response from The Environment Agency	The response from the Environmental Agency notes that their interests aim to promote sustainable development. As such, the ES should demonstrate the environmental sustainability of the project, potential implications for the water and natural environment, ensuring best practice is followed in relation to waste generation and fluvial flood risk issues.	Assessed in the Climate Change Adaptation assessment

Consultation

23.14 The following table sets out the relevant consultation undertaken with the Local Authority with regards to the identification and application of local sustainability policy.

Table 23.3: PEIR Consultation Summary

Consultation and date	Summary of consultation	Where in the PEIR is this addressed?
South Northamptonshire Council (SNC) - January 2017.	The policy team from SNC have also been consulted with regards to any policies pertaining to sustainable design and construction and therefore the reduction of carbon emissions from new	Addressed within the Mitigation Section of this Chapter in the form of embedded and adaptive mitigation.

	development. The Council referred the applicant to the adopted Joint Core Strategy and its policies therein.

Climate Change Mitigation

23.15 This section considers the anticipated impact of Greenhouse Gas (GHG) emissions of the proposed development as a contributor to future climate change and the measures taken to mitigate these impacts during and post construction.

23.16 Determining the significance of impact is a complex issue as climate change is a consequence of numerous activities and developments across the globe, the vast majority of which are out with the control of the applicant. In this context, the approach taken has been to reasonably assess the potential impact on climate change of the project as a result of GHG emissions and minimise the impact of the development in accordance with the EIA hierarchy.

23.17 As summarised in Table 23.1 above, Paragraphs 5.17-5.19 of the NPSNN state the following with regard to GHG emissions:

- Paragraph 5.17 – The applicant is required to submit a carbon (GHG) assessment of the proposals and whilst it is unlikely that the impacts of a single project will affect the Government's ability to meet its carbon plan, the applicant should present an assessment of GHG emissions against the Governments carbon budgets.

- Paragraph 5.18 – States that any increase in carbon (GHG) emissions is not a reason to warrant a refusal unless the scale of GHG emissions would have a material impact on the ability to meet the carbon reduction budgets.

- Paragraph 5.19 – States the importance of including proportionate mitigation measures within the application to reduce GHG emissions where reasonable.

Rail Central in the context of GHG emissions

23.18 At the existing site, GHG emissions occur as a result of the current use of the site and include: direct emissions as a result of the combustion of fuel; indirect emissions through the use of purchased electricity in farm- and industrial-related activity; and indirect upstream and downstream emissions as a result of agriculture use (e.g. the manufacture and use of agrochemicals). Due to its strategic location and scale, the SFRI will also have a displacement impact during operation, encouraging modal shift from

the road network, and resulting in a change in the emissions profile of the freight being transported across the freight network. Existing upstream and downstream emissions therefore also include an assessment of freight movements across the network assuming all freight that will be dealt with by the SRFI is transported by road.

23.19 During construction, GHG emissions will be directly released due to the combustion of fuels in construction plant and vehicles, and indirectly through the consumption of electricity. Upstream emissions will result from the combustion of fuels and consumption of electricity, heat or steam in the processing of materials and manufacture of products, and the subsequent combustion of fuels in the transportation of materials and resources to the Proposed Development. Downstream emissions will occur as a result of the transportation of waste and treatment of water consumed in site activities.

23.20 During operation, GHG emissions will be directly released due to the combustion of fuels and from fugitive releases of refrigerant gases where refrigeration and air-conditioning equipment are present. Indirect releases will occur as a result of the consumption of electricity in buildings. Upstream emissions will be released from the combustion of fuel in vehicles used to transport employees to the Proposed Development, and to transport goods to the SRFI. Downstream emissions will occur as a result of fuel combustion in the onward movement of goods from the SFRI.

The Study Area

23.21 For the purposes of assessing the impacts of the Proposed Development on climate change, the immediate boundary is considered to be the red line boundary of the Proposed Development site. However, in some instances, due to the upstream and downstream nature of emissions and emission impacts, the boundary extends beyond this area. This includes emissions associated with electricity consumption, which are not generated on site but at power stations; and emissions associated with transport to and from the site, where gases are combusted in transit.

Emission Scopes & Boundaries

23.22 It should be noted that the assessment of GHG emissions is still an emerging science, despite the recent publication of specific guidance from IEMA (Ref 23.14) to which the authors of this PEIR Chapter contributed. The guidance also confirms that it will be updated once the process of incorporating GHG assessment in EIA matures. Nonetheless the IEMA guidance has been followed where possible in order to ensure a robust assessment.

23.23 IEMA's Climate Change Mitigation and EIA Principles published in 2010 (Ref 23.15) and reinforced within the 2017 guidance suggests that all new GHG emissions might contribute to a significant negative environmental effect and that the significance of

emissions associated with development should be based on the net GHG impact, which may be positive or negative. The guidance also strongly enforces the message that, similar to all EIA topics, a focus on proportionate assessment is also important in avoiding undue burden to developers and regulators.

23.24 The net GHG emission impacts for the proposed development are determined by considering the predicted deviation from the existing baseline site condition, comparison with the business-as-usual reference scenario and existing local and regional GHG estimates, both before and after additional mitigation.

23.25 The assessment of GHG emissions at Rail Central has been undertaken broadly in accordance with guidance set out in the GHG Protocol (Ref 23.16) which in itself is recognised as an approved GHG accounting methodology within the IEMA Environmental Impact Assessment Guide to Assessing Greenhouse Gas Emissions and Evaluating their Significance (Ref 23.14).

23.26 A project boundary has been identified that applies the principles of the operational control approach set out within the GHG Protocol to the Proposed Development site. Scope 1 and Scope 2 emissions therefore relate to the activities taking place within the site boundary; and Scope 3 emissions relate to activities that occur upstream and downstream of the site.

23.27 The GHG assessment (Volume 3, Appendix 23.1) assesses the GHG emissions for the existing site (Ex), construction of the SRFI and associated infrastructure, Junction 15a Works and other Minor Highways Works (C) and operation of the SRFI and all associated infrastructure (O). Table 23.4 sets out the relevant emission sources within each scope and the stages at which they are relevant. Some emission sources may be relevant, but the assessment of those emissions may be disproportionate to this assessment; in those instances, emission sources have been scoped out (SO). Where emissions have been scoped out, a full justification is provided within Volume 3 Appendix 23.1.

Table 23.4: GHG Emission Scopes and Sources

GHG Emission Scope	Emission Sources within Scope	Relevance
Scope 1	**Stationary combustion**	
	Production of electricity, heat or steam.	Ex, C, O
	Mobile combustion	
	Use of fuels in mobile plant and equipment	Ex, C, O (SO)
	Fugitive emissions	
	Agricultural emissions	Ex (SO)
	HFC emissions arising from the use of refrigeration and air-conditioning equipment.	O (SO)
Scope 2	**Stationary combustion**	
	Use of purchased electricity, heat or steam.	Ex, C, O
Scope 3	**Mobile combustion**	
	Transportation of freight	Ex, C, O
	Transportation of waste	Ex (SO), C, O
	Transportation of materials	Ex (SO), C, O (SO)
	Employee business travel	SO
	Employee commuting	Ex (SO), C, O
	Process Emissions	
	Agrochemical production and use	Ex
	Fuel and energy related emissions	Ex (SO), C, O
	Production of purchased materials	Ex (SO), C, O (SO)

23.28 The method of assessment adopted in this Chapter comprises the following components with those measures specifically listed which are in accordance with the IEMA GHG guidance:

- A review of legislation, regulation and planning policy, focussing on climate change issues
- An establishment of the Scope and Boundaries of the GHG assessment as per Section 4 and 5 of the IEMA Guidance.
- An assessment of the GHG emissions arising from existing use of the site to establish the baseline as per Section 4 of the IEMA Guidance
- An assessment of the GHG emissions arising during the construction, operation and decommissioning phases of the Proposed Development

- An assessment of additionality and resulting net emissions taking into account comparator scenarios such as existing freight movements, commuter journeys and warehouse space that will be displaced from elsewhere as a result of the SRFI.

- An assessment of the GHG emissions of the Proposed Development in the context of the Governments carbon budgets to establish context and magnitude of GHG emission impact.

- A wider assessment of the impacts of GHG emissions on the baseline environment before and after mitigation in accordance with the EIA hierarchy for managing project related GHG emissions.

23.29 Relevant climate change and emissions data has been collated from a number of sources to estimate the existing and potential future GHG emissions of the Proposed Development. The full assessment, including a full list of these sources is included in Volume 3, Appendix 23.1 with a further assessment specific to freight in Volume 3, Appendix 23.2.

23.30 With regard to the assessment methodology it is important to note that, throughout the PEIR and within the climate change adaptation section of this Chapter, the assessment has considered the impacts associated with each of the different project components.

GHG Emission Factors

23.31 Average GHG emission factors are produced annually for the UK by The Department of Business Energy and Industrial Strategy (BEIS) (Ref 23.17), including an extensive range of emission types covering all Scope 1, 2 and 3 emissions activities. For the purposes of corporate reporting, these emission factors are applied retrospectively to collected activity data to provide an estimate of GHG emissions post-emission; in this context they are applied to estimates of emissions, and where necessary, adjusted to reflect expected changes in emissions profiles over time.

23.32 In line with UK energy policy, energy infrastructure in the UK is changing, and an increasing proportion of renewable and low-carbon energy as a component of grid and non-grid supplies, in combination with closures of coal-fired power stations, is supporting national decarbonisation targets.

23.33 Whilst carbon budgets are in place, there is significant uncertainty in the medium- to long-term as to how they will be achieved in practice. That said, sufficient policies, incentives, and historical precedent are in place for us to assume that decarbonisation of supplies will continue, and that current emission factors are inappropriate for use in the assessment of future emissions. Further, the application of current emission factors

to future activities could result in inappropriate mitigation measures and higher GHG emissions in the long-term.

23.34 The assessment of GHG emissions therefore includes assumptions regarding future emission profiles, which are set out in Volume 3, Appendix 23.1 and Volume 3, Appendix 23.2.

Baseline Surveys & Data

23.35 Activity data is obtained from various sources as set out in Volume 3 Appendix 23.1, within the relevant emission scope and category depending on the emission type being assessed.

23.36 No field surveys have been undertaken in relation to this assessment and it has not been necessary to consult with any statutory or non-statutory bodies in gathering baseline information.

23.37 There is inherent uncertainty in the assessment of GHG emissions, as they can only be truly measured at source as they occur. In reality, this is impractical and disproportionate to the scale of any emissions expected as a result of the Proposed Development.

23.38 Instead, activity data (e.g. the consumption of fuel) is multiplied by an appropriate emission factor (e.g. quantity of GHG emissions produced per unit of fuel) to estimate GHG emissions as a result of an activity.

23.39 The availability of activity is dependent on the information available at the time of the assessment. At this stage, design details are only available in outline, so assumptions regarding aspects such as the design of buildings, quantities of materials and the precise quantities of freight that will be handled over time must be made. Assumptions related to each category of emissions are detailed in Volume 3, Appendix 23.1 and Volume 3, Appendix 23.2.

Baseline conditions

23.40 Baseline emissions occur as a result of activities already taking place on the existing site, and upstream/downstream of the site. As such, they can only be allocated to the site as a whole and not to individual components of the Proposed Development. The baseline conditions described below therefore relate to all proposed development work.

Current Baseline (2018)

23.41 The current site baseline includes the on-site and upstream/ downstream emissions associated with the current use of the Proposed Development site.

23.42 Emissions associated with the current use of the site and freight movements provide a benchmark for determining GHG emissions without development, and net emissions post-development.

23.43 The existing site consists mainly of farmland and some limited industrial activity. An assessment of fuel and electricity use is made based on farm energy use statistics (Ref 23.18). 2017 (current) emission factors, published by BEIS (Ref 23.17) are applied to the assumed fuel and electricity consumption to obtain CO_2e emissions associated with this consumption.

23.44 An assessment of the GHG emissions associated with the production and use of agrochemicals is made based on research carried out for the Crop Protection Association by Cranfield University into GHG emissions for different types of agricultural activity (Ref 23.19).

Predicted Future Baseline Scenario (2019)

23.45 The future site baseline assesses the emissions associated with the use of the site immediately prior to construction; this factors in any changes in emission factors for various fuels over the period between the current site baseline and the commencement of construction.

23.46 A detailed assessment of current and future baseline GHG emissions is provided in Volume 3, Appendix 23.1 and Volume 3, Appendix 23.2.Table 23.5 below sets out the total estimated emissions for each emission source.

Table 23.5: Summary of Current and Future Baseline GHG Emissions

Existing site	Baseline GHG Emissions [tCO_2e]	
	Current (2018)	Future (2019)
Stationary combustion: Production of heat and electricity	1	1
Mobile combustion: Fuel use in mobile plant & equipment	1,257	1,257
Fugitive emissions: Agricultural emissions	Scoped out	Scoped out
Stationary combustion: Use of purchased electricity	63	60
Total Site Emissions	**1,321**	**1,318**
Mobile combustion: Transportation of goods & waste	Scoped out	Scoped out
Process emissions: Agrochemical production and use	1,602	1,602
Process Emissions: Fuel & energy related emissions	29	29
Total Upstream & Downstream Emissions	**1,631**	**1,631**
TOTAL EXISTING BASELINE EMISSIONS	**2,952**	**2,948**

Cumulative Baselines

23.47 To compare the predicted construction phase (2019 – 2028) and short-term operational phase (2029 – 2039) with baseline emissions, the baseline must also be extended to cover the same periods of time, and the same assumptions applied regarding emission factors over those periods. Table 23.6 sets out the cumulative emissions for the two assessment periods.

Table 23.6: Summary of Cumulative Baseline GHG Emissions

Existing site	Baseline GHG Emissions [tCO_2e]	
	2019 - 2028	2019 - 2038
Stationary combustion: Production of heat and electricity	10	19
Mobile combustion: Fuel use in mobile plant & equipment	12,569	25,137
Stationary combustion: Use of purchased electricity	452	678
Total Site (Scope 1 & 2) Emissions	**13,030**	**25,834**
Process emissions: Agrochemical production and use	16,018	32,036
Process emissions: Fuel and energy related	289	579
Total Upstream & Downstream (Scope 3) Emissions	**16,307**	**32,614**
Total Existing Site Baseline Emissions	**29,338**	**58,448**

Baseline Emissions in Context

23.48 The current baselines therefore confirm that, in the absence of any development, GHG emissions occurring as a result of current activity on site are circa. 1,321 tCO_2 per annum. Activity upstream and downstream of the site are circa 1,631 tCO_2e per annum. These emissions will reduce over time as a result of external actions to reduce the emissions associated with the fuels consumed and electricity purchased.

23.49 In context, BEIS estimate that UK GHG emissions were 496.0 million tonnes CO_2e in 2016 (Ref 23.21), 4% lower than the previous 2015 estimate. Carbon dioxide accounts for 81% of GHG emissions and is estimated at 386.5 million tonnes CO_2 for 2016.

23.50 The Climate Change Act 2008 set a target to ensure that the net carbon account for the year 2050 is at least 80% lower than the 1990 baseline. The 1990 baseline is the

aggregate of net UK emissions of carbon dioxide and other targeted greenhouse gases for that year.

23.51 It is the duty of the Secretary of State to set for each succeeding period of five years (beginning with the period 2008 to 2012) an amount for the net UK carbon account (the 'carbon budget' and to ensure that the net quantity of emissions do not exceed the carbon budget.

23.52 Carbon budgets have been set up to 2032, and Government has noted that from this point forward (2018), an annual reduction in emissions of circa 3% is required to meet the 2050 target. On this basis, we have estimated the level of carbon budgets likely to be required post-2032 to meet the 2050 target. Table 23.7 sets out the carbon budgets.

Table 23.7: Summary of Cumulative Baseline GHG Emissions

Period	GHG Emissions [million tonnes CO_2e]
1st carbon budget (2008 – 2012)	3,018
2nd carbon budget (2013 – 2017)	2,782
3rd carbon budget (2018 – 2022)	2,544
4th carbon budget (2023 – 2027)	1,950
5th carbon budget (2028 – 2032)	1,725
6th carbon budget (2033 – 2037)	1,491
7th carbon budget (2038 – 2042)	1.255
8th carbon budget (2043 – 2047)	1,019
9th carbon budget (2048 – 2050)	468

23.53 2018 is currently within the 3rd carbon budget period, with an annual budget of 509 million tonnes CO_2e. Baseline emissions currently account for 0.00058% to this total. By 2028 (end of the construction period), with no emission reductions other than those as a result of external factors, annual baseline emissions would contribute 0.00085%; by 2038, this increases to 0.00116% and by 2050 0.00186%.

23.54 In accordance with Paragraph 5.17-5.18 of the NPSNN, this assessment will compare the GHG emissions of the Proposed Development against the carbon budgets presented within Table 23.7.

Method of Assessment

Overview

23.55 There is currently no single approved methodology to assess and evaluate the significance of GHG emissions; nor are there established criteria or a defined significance threshold for GHG assessments (Ref 23.14).

23.56 The Greenhouse Gas Protocol (Ref 23.23) suite of standards provides the basis for the majority of emissions assessments, and although the Corporate Standard (23.16) and Scope 3 Standards (Ref 23.24) are designed for organisations reporting on emissions that have occurred in the past, the general approach can be applied to anticipated future emissions. The GHG Protocol is one of the standards identified in the EIA Guidance (Ref 23.14) and has been applied to the assessment of emissions in this assessment.

23.57 Activity data is multiplied by an appropriate emission factor to result in an emission total over a given period. All emissions are assessed in units of carbon dioxide equivalent (CO_2e), which takes into account the 100-year impact of other prominent greenhouse gases (e.g. methane, nitrous oxides) which have a different Global Warming Potential (GWPs) to carbon dioxide.

23.58 The GHG assessment boundary includes all relevant on-site, upstream and downstream emissions, including those identified during the consultation.

23.59 The method to calculate the GHG emissions for the Proposed Development is consistent with Paragraphs 5.17-5.19 of the NPSNN given that it will allow a comparison of the calculated GHG emissions from different phases of the Proposed Development against the Government's carbon budgets.

Assessing Significance of Effect

23.60 There are currently no established significance criteria for GHG emissions or a defined threshold. Therefore, the magnitude and significance criteria adopted for this assessment have been based on the IEMA guidance and developed through professional judgement.

23.61 IEMA's Climate Change Mitigation and EIA Principles published in 2010 (Ref 23.15) and reinforced within the 2017 Guidance (Ref 23.14) suggests that: '*GHG emissions have a combined environmental effect that is approaching a scientifically defined environmental limit, as such any GHG emissions or reductions from a project might be considered to be significant; and the EIA process should, at an early stage influence the location and design of projects to optimise GHG performance and limit likely contribution to GHG emissions*.'

23.62 This Chapter has qualitatively assessed the scale and significance of effect by calculating the net GHG emissions for the proposed development and considering the predicted deviation from the existing baseline site condition and existing local, regional and national GHG estimates, both before and after adaptive mitigation.

Magnitude of Effect

23.63 The contribution of the emissions of a single project to global climate change is small, however the combined GHG emissions as a result of global activities have been found to be significant. Determining an appropriate scale for the magnitude of effect is therefore a complex issue as the vast majority of emissions are out with the control of the applicant.

23.64 Current emission levels are already having an impact on the climatic system and to avoid catastrophic climate change, the level of global warming must remain within a two-degree limit, which will be exceeded if global emission reductions are not achieved; however, even by limiting warming to two degrees, there will still be some irreversible climatic impacts.

23.65 This means that maintaining current emission levels, with no change in emissions as a result of the Proposed Development, will still have a climatic impact.

23.66 Based on the assumption that national carbon budgets reflect the requirement to remain within global emission limits and that this will be reflected in baseline emissions over time (e.g. through decarbonisation of grid supplies), emission reductions related to the emission intensity applied to activity data are taken into account within the cumulative baseline.

23.67 However, activity reductions are also required to remain within emission limits, so for example, a low increase or decrease in emissions relative to the current baseline would still have a low adverse or beneficial effect on the receptor.

23.68 In the absence of any defined criteria for assessing magnitude of effect, a qualitative assessment utilising professional judgement and the criteria set out in Table 23.8, has been undertaken.

23.69 Paragraphs 5.17-5.18 of The NPSNN states that the scale of GHG emissions from the Proposed Development should be compared to the Governments carbon budgets to assist in quantifying impact of GHG emissions. Therefore, to assist with determining the Magnitude and Significance of impact and to provide context, a comparison of the GHG emissions against the carbon budgets will be undertaken for both the Proposed Development and the relevant baseline. This approach is in accordance with Section 6.2 of the IEMA Guidance.

Table 23.8: Defining Magnitude of Effect

Magnitude of Effect	Description
Very High	Very high decrease (beneficial)/ increase (adverse) in GHG emissions relative to the baseline and the Governments carbon budgets
High	High decrease (beneficial)/ increase (adverse) in GHG emissions relative to the baseline and the Governments carbon budgets
Moderate	Moderate decrease (beneficial)/ increase (adverse) in in GHG emissions relative to the baseline and the Governments carbon budgets
Low	Low decrease (beneficial)/ increase (adverse) in in GHG emissions relative to the existing baseline and the Governments carbon budget
Negligible	Negligible decrease (beneficial)/ increase (adverse) in GHG emissions relative to the existing baseline and the Governments carbon budget

Sensitivity of Receptor

23.70 In the case of GHG emissions, the receptor is the climatic system and as per IEMA principles, this receptor is considered to be sensitive to any increase in GHG emissions.

Significance of Effect

23.71 Given that it is established that the climatic system is sensitive to any increase in GHG emissions, the level of sensitivity of the receptor does not vary and the significance of effect is applied by qualitatively assessing the impact of the magnitude of effect. The scale applied in this assessment is set out in Table 23.9.

23.72 The effect can either be adverse (i.e. increase in GHG emissions) or beneficial (decrease in GHG emissions). A negligible effect is also possible if the magnitude of GHG emission change is marginal.

Table 23.9: Defining Significance of Effect

Magnitude of Effect	Significance of Effect
Very High	Major
High	Moderate
Moderate	Moderate

Low	Minor
Negligible	Negligible

23.73 At this stage it is considered that any moderate increase or decrease in GHG emissions is considered significant in EIA terms.

Duration of Effect

23.74 The duration of effect of GHG gases depends on their radiative efficiency and lifetime. The lifetime of GHGs vary from 0.7 years for methyl bromide (CH3Br) to 50,000 years for PFC-14 (CF4); to take into account differences in potency and lifetime, GHGs are assessed based on their impact over a set period of time relative to carbon dioxide. The most common assessment period is 100 years, and the quantity of carbon dioxide equivalent (CO_2e) calculated in this assessment relates to the 100-year impact of all GHGs relative to CO_2.

23.75 The Intergovernmental Panel Climate Change (IPCC) publish 20-year and 100- year figures for Global Warming Potentials of different gases; the Framework Convention on Climate Change requires the use of 100-year figures in Government emissions reporting and the UK Greenhouse Gas Inventory and associated emission factors are based on this data.

23.76 Emissions associated with the construction and operation of the development can therefore be assumed to have a long-term effect.

Embedded Mitigation

23.77 For the purpose of this assessment, embedded mitigation relating to climate change mitigation includes the principles set out in the Construction Environmental Management Plan (CEMP). Relevant to this assessment, this includes:

- compliance with principles of waste management and Site Waste Management Plan;
- all construction contractors will follow an Environmental Management System (EMS);
- appropriate management of excavated soils; and
- appropriate training of staff and contractors.

23.78 Also assumed as embedded mitigation are expected emission factor reductions associated with fuels and electricity consumed in the construction and operation of the Proposed Development.

Assessment of Construction Phase Effects

23.79 Construction effects are the GHG emissions that will occur as a result of the construction process. They include the on-site emissions associated with mobile construction plant and equipment and the purchase of electricity in the construction process; and more significantly, the upstream and downstream emissions associated with the transport of materials, waste and employees, and the production of energy and materials used on site.

23.80 An estimate of Scope 1 and Scope 2 on-site emissions is made based on proxy data per £m construction spend, and as such is assessed for the scheme as a whole rather than the component parts.

23.81 A profile of construction spend over time has been developed based on an outline construction programme and the likely number of people on site at any given time. It should be noted that the time taken and the number of personnel required to complete a section of works is not necessarily an accurate indicator of the profile of spend; however, in lieu of any further detail, it is considered proportional and appropriate for the assessment.

23.82 Given that the total spend is not allocated to specific components of the development, figures provided for on-site emissions relate to all proposed development works.

23.83 The transportation of materials is based on materials consumed in the construction of buildings and in the construction of all other roads and infrastructure and cannot be broken down into any further categories at this stage.

23.84 The transportation of waste is based on assumptions set out in the Chapter 22 Waste relating to quantities of waste generated during the construction of the scheme. This assumes benchmark figures relating to the quantum of building area under development, so although will include some aspects of external works, is predominantly related to the construction of buildings within the main development site.

23.85 Emissions related to employee commuting are based on the Framework Construction Traffic Management Plan produced by TPA (Ref 23.25), which estimates the number of vehicles that will travel to the site on a daily basis, based on outline construction phasing and delivery timescales. This can be roughly split between the construction of buildings and the construction of all other elements within the main development site.

23.86 Estimates of construction material quantities have been provided by RPS (Ref 23.26) based on the illustrative masterplan and assumptions regarding the build-up of buildings and roads. This assessment is broken down into materials for:

- Estate Roads & Temporary Construction Access

- Bridges on A43 Road & to Northampton Road
- Buildings
- Landscaping
- Intermodal
- Express Freight Platform

This therefore only assesses the impact of the main development site.

23.87 Fuel and energy related emissions relate to the upstream well-to-tank and transport and distribution impacts associated with fuels and electricity consumed and therefore relate to all proposed development works.

23.88 Table 23.10 sets out the construction-related emissions that occur during the construction phase (2019 – 2020).

Table 23.10: Construction Phase Construction Emissions (2019 – 2028)

Construction Emission Sources	GHG emissions [tCO_2e]	Direct/ indirect
Mobile combustion: Fuel use in mobile plant & equipment	97	Direct
Stationary combustion: Use of purchased electricity in buildings & infrastructure	718	Indirect
Total Site (Scope 1 & Scope 2) Emissions	**815**	-
Mobile combustion: Transportation of materials	3,259	Indirect
Mobile combustion: Transportation of waste	73	Indirect
Mobile combustion: Employee commuting	77,889	Indirect
Process emissions: Production of construction materials	220,504	Indirect
Process Emissions: Fuel and energy related emissions	463	Indirect
Total Upstream & Downstream (Scope 3) Emissions	**302,188**	-
Total Construction Phase Construction Emissions	**303,003**	-

23.89 All GHG emissions are considered **temporary** as they occur at a single point in time and last for a known period of time, depending on their radiative efficiency; however, for the purposes of GHG emission assessments they may result in potentially irreversible and permanent climate change impacts.

23.90 As the assessment considers the quantity of CO_2e over a 100-year lifespan, all construction emissions are therefore considered to have **long-term** effects despite the fact that they are emitted from temporary activities.

23.91 The Construction Phase Construction emissions represent 0.007% of the cumulative carbon budget over the corresponding period, compared with the 0.00068% contribution made by the cumulative baseline.

23.92 As there is a net increase in emissions, over the current site baseline, by construction emissions there is deemed to be an adverse effect. Given the quantum of increase relative to the carbon budget and cumulative baseline it is considered that there is a **minor adverse** effect on climate change.

Assessment of Operational Phase Effects

23.93 Operational effects are the GHG emissions that will occur as a result of the operation of the Proposed Development. They include the on-site emissions associated with energy use in buildings and site infrastructure; and the upstream and downstream emissions associated with the transport of freight, waste and employees, and the production of energy used on site.

23.94 An estimate of Scope 1 and Scope 2 on-site emissions is made based on the anticipated energy consumption of buildings and on-site infrastructure and long-term emission factor profiles. This includes an estimate for the consumption of external lighting and other site-wide infrastructure, but is predominantly related to the operation of buildings within the main development site.

23.95 The transportation of waste is based on assumptions set out in the Chapter 22 of this ES Waste relating to quantities of waste generated during the operation of the scheme. This assumes benchmark figures relating to the quantum of building area developed, and so is related to the operation of buildings within the main development site only.

23.96 Emissions related to employee commuting are based on the Transport Assessment produced by TPA (Ref 23.25), which estimates the number of vehicles that will travel to the site on a daily basis, based on benchmark data per sqm of industrial employment space and similar schemes elsewhere. This relates to the operation of the Main SRFI site only, as the highway elements are not considered a destination.

23.97 Fuel and energy related emissions relate to the upstream well-to-tank and transport and distribution impacts associated with fuels and electricity consumed and therefore relate to all on-site operational emissions.

23.98 Emissions are assessed for the following periods:

- During construction (2019 - 2028)

- Short-term operation (2029 - 2038)
- Long-term operation (2039 - 2089)

Construction Phase (2019 – 2028)

23.99 During construction, there is an annual increase in emissions as elements of the main SRFI complete and road freight begins to switch to rail. Table 23.11 sets out the total cumulative emissions over this period, taking into account embedded mitigation measures.

Table 23.11: Construction Phase Operational Emissions (2019 – 2028)

Operational Emission Sources (2019 – 2028)	GHG emissions [tCO_2e]	Direct/ indirect
Stationary combustion: Production of heat & electricity	3,151	Direct
Mobile combustion: Fuel use in mobile plant & equipment	Scoped out	Scoped out
Stationary combustion: Use of purchased electricity in buildings & infrastructure	30,166	Indirect
Total Site (Scope 1 & Scope 2) Emissions	**33,317**	-
Mobile combustion: Transportation of freight	-57,139	Indirect
Mobile combustion: Transportation of waste	544	Indirect
Mobile combustion: Employee commuting	28,559	Indirect
Process Emissions: Fuel and energy related emissions	—27,500	Indirect
Total Upstream & Downstream (Scope 3) Emissions	**-32,289**	-
Total Construction Phase Operational Emissions	**-1,028**	-

23.100 Despite not being fully operational during the period 2018-2028, total emissions are higher than for the short-term operation period between 2029 and 2038 due to the higher use of road freight and the annual increase in the decarbonisation of gas and electricity supplies over the medium-term.

23.101 All GHG emissions are considered **temporary** as they occur at a single point in time and last for a known period of time, depending on their radiative efficiency; however, the GHG emissions may result in potentially irreversible and permanent climate change impacts.

23.102 As the assessment considers the quantity of CO_2e over a 100-year lifespan, all operational emissions are considered to have **long-term** effects.

23.103 The total construction phase operational emissions are equivalent to 0.00002% of the cumulative carbon budget for the comparable period, compared with 0.00067% from the cumulative baseline.

23.104 As there is a net reduction in emissions over the site baseline, construction phase operational emissions are deemed to have a **minor beneficial** effect on climate change in the short-term operational phase

Short-term Operational Phase (2029 – 2038)

23.105 During short-term operation, all elements of the Proposed Development are assumed to be complete and fully operational. Table 23.12 sets out the total cumulative emissions over the short-term operational period, taking into account embedded mitigation measures.

Table 23.12: Short-term Operational Emissions (2029 – 2038)

Operational Emission Sources (2029 – 2038)	GHG emissions [tCO_2e]	Direct/ indirect
Stationary combustion: Production of heat & electricity	6,656	Direct
Mobile combustion: Fuel use in mobile plant & equipment	Scoped Out	Scoped Out
Stationary combustion: Use of purchased electricity in buildings & infrastructure	40,978	Indirect
Total Site (Scope 1 & Scope 2) Emissions	**47,633**	-
Mobile combustion: Transportation of freight	-203,052	Indirect
Mobile combustion: Transportation of waste	1,350	Indirect
Mobile combustion: Employee commuting	47,132	Indirect
Process Emissions: Fuel and energy related emissions	-15,139	Indirect
Total Upstream & Downstream (Scope 3) Emissions	**-169,708**	-
Total Short-term Operational Phase Emissions	**-122,075**	-

23.106 Were the existing site to continue in its current use, and the SRFI not go ahead, with no road freight displacement to rail, the total operational emissions over the period 2019 - 2028 are estimated to be circa 29,338 tonnes CO_2e; this compares with 123,857 tonnes CO_2e that would be saved as a result of the operation of the SRFI over the same period.

23.107 During the short-term operational phase of development, the SRFI will result in a reduction in GHG emissions equivalent to a 0.00391% of the cumulative carbon budget for the period. This compares with an increase in GHG emissions equivalent to 0.00093% of the cumulative carbon budget for the period that the cumulative baseline would have otherwise contributed.

23.108 As there is a net reduction in emissions over the current site baseline, short-term operational emissions are deemed to have a **minor beneficial** effect on climate change in the short-term operational phase.

Long-term Operational Phase (2039 – 2088)

23.109 A quantitative assessment of emissions beyond 2038 has not been made as there is considerable uncertainty and an absence of reliable date around future operational trends, technologies and innovations, energy supplies and emission factors.

23.110 Qualitatively, it is our professional judgement that emissions post-2038 will reduce significantly; indeed, this will be necessary to meet the UK's legally binding targets set for GHG emission reductions by 2050. This qualitative assessment is based upon the following assumptions derived from a number of Government reports, research papers and industry publications:

- By 2035 it is expected that emissions related to the use of electricity will reduce by almost 75% compared with current grid emissions (Ref 23.27).
- There is significant research currently being undertaken into the development of alternative fuels for HGVs and rail uses, which could have a significant impact on both road and rail freight emissions.
- Innovations and cost reductions in battery storage are likely to make the use of renewable energy and electric vehicles more viable in the medium- to long-term, resulting in a market-driven shift (as opposed to policy driven) in the commercial and transportation sectors to renewable fuels and low/ zero emission vehicles
- Many European cities and member states have made commitments relating to the types of vehicles that can be sold in the future, and this is supported by a growing number of manufacturer commitments to produce more vehicles to support cleaner fuels.
- Behaviour changes and the 'sharing economy', supported by disruptive IT infrastructure could reduce the number of private vehicles with the greatest potential for reductions relating to commuting. Greater collaboration and consolidation of freight could reduce the requirement

for shorter-distance freight movements, typically carried out by road; rail legs of such journeys would likely remain.

- Demand-side response and energy efficiency measures, particularly at replacement intervals, are likely to reduce the energy demand form buildings further.

23.111 Although a full quantitative assessment of emissions during the long-term operational phase has not been carried out, if we assume there are no further emission reductions post-2038 (which can be considered a worst case assessment), the cumulative emissions presented in Table 23.13 are observed.

Table 23.13: Long-term Operational Emissions

	GHG emissions [tCO_2e]	
Operational Emission Sources (2039 – 2088)	2039 -2050	2051 -2088
Stationary combustion: Production of heat & electricity	6,878	21,781
Stationary combustion: Use of purchased electricity in buildings & infrastructure	9,816	31,084
Total Site (Scope 1 & Scope 2) Emissions	**16,694**	**69,559**
Mobile combustion: Transportation of freight	-256,261	-811,492
Mobile combustion: Transportation of waste	1,474	4,688
Mobile combustion: Employee commuting	47,691	151,022
Process Emissions: Fuel and energy related emissions	-14,730	-46,644
Total Upstream & Downstream (Scope 3) Emissions	**-221,825**	**-702,446**
Total Long-term Operational Phase Emissions	**-205,131**	**-649,581**

23.112 Between 2038 and 2050, this represents a GHG emissions reduction equivalent to 0.00824% of the cumulative carbon budget for the period, compared with 0.0014% that the cumulative baseline would have otherwise have contributed.

23.113 As a result, the cumulative significance of effect into the long-term operational phase will continue to reduce and has the potential to deliver a **minor beneficial** effect over time.

23.114 The combination of construction and operational phase emissions over the construction operational, short-term operational and long-term operational phases, net of baseline emissions, and compared with carbon budget (CB) emissions over the same periods are shown in Table 23.14 below.

Table 23.13: Cumulative Emissions compared with Carbon Budgets

Cumulative Emissions	2019 - 2028	2019 -2038	2019 - 2050	2019 - 2088
Carbon budget [million tCO_2e]	4,378	7,500	9,991	N/A
Baseline Emissions [tCO_2e]	29,338	58,448	53,109	116,175
Proposed Development Emissions [tCO_2e]	304,031	181,956	-23,175	-544,437
Net Proposed Development Emissions [tCO_2e]	**247,693**	**123,508**	**-116,488**	**-660,613**
Baseline emissions as % of CB	0.00067%	0.00078%	0.00093%	N/A
Proposed Development emissions as % of CB	0.00694%	0.00243%	-0.00023%	N/A
Net emissions as % of CB	0.00063%	0.00016%	-0.00012%	N/A

23.115 By the end of the construction phase (2028), cumulative emissions from the Proposed Development equate to 0.00694% of the carbon budget, reducing to 0.00063% when baseline emissions are displaced.

23.116 By the end of the short-term operational phase (2038), cumulative emissions from the Proposed Development equate to 0.00243% of the carbon budget, reducing to 0.00016% when baseline emissions are displaced. This is still a net increase in emissions, but by an increasingly reduced quantity as the impact of GHG emissions from the construction phase become proportionally less It is significant that at 2050, and the point at which the UK is legally required to have reached an 80% reduction in emissions compared with the 1990 baseline, cumulative emissions from the Proposed Development are estimated to generate a saving over the baseline of 23,175 tonnes CO_2e, thereby contributing to a reduction in the Governments carbon budget.

23.117 By the end of the long-term operational phase (2088), cumulative emissions from the Proposed Development could potentially result in a reduction of circa 544,437 tonnes CO_2e compared with the baseline, resulting in a net saving of 660,613 tonnes CO_2e.

Assessment of Decommissioning Phase Effects

23.118 Decommissioning phase effects are the effects resulting from the activities associated with the removal of the Proposed Development once it is no longer required.

23.119 It is not known when there will no longer be a need for the Proposed Development and many elements of the development are unlikely to be decommissioned at all. The design life of the warehousing buildings will be in the order of 60+ years, and the rail infrastructure and civil engineering works will be significantly longer than this. Once the warehouses reach their design life, it is entirely feasible that they will be re-

provided in a modern form. Should that occur, that process would be subject to its own assessment of effects at the relevant time.

23.120 Predicting the baseline so far into the future to enable a meaningful assessment of the sensitivity of the environment, and the significance of effects from the decommissioning of the Proposed Development upon GHG emissions is considered disproportionate to the nature of project given the highly variable nature of the assumptions that would be necessary to support such an assessment.

23.121 When and if the development is decommissioned, the appropriate environmental assessments will be undertaken.

23.122 However, applying current assumptions regarding the demolition, transport, waste processing and disposal of key materials, and the reuse/ recovery/ recycling potential based on current market trends, an assessment of decommissioning phase effects is summarised below.

23.123 Life-cycle assessment (LCA) data has been obtained for the majority of construction materials that are likely to be used in the buildings and infrastructure at Rail Central, and the emissions set out in Tables 23.15 and 23.16 cover approximately 93% of the expected materials quantities in buildings and 97% of the materials quantities in infrastructure respectively.

Table 23.14: Building Decommissioning and End-of-Life Emissions

Material	Quantity [tonnes]	Stages C1 – C4 [$kgCO_2e/kg$]	Stage D	Total CD [tCO_2e]
Steelwork	36,268	6.00E-02	-9.59E-02	-1,302
Cladding	8,044	0.00E+00	-9.68E-01	-7,785
Concrete	553,897	2.74E-03	0.00E+00	1,518
Aggregates	524,183	1.50E-02	-3.99E-03	5,760
Plasterboard	520	1.40E-02	-4.97E-02	-19
Tarmac	31,685	1.30E-02	-1.46E-02	-50
Total	**1,156,309**	**-**	**-**	**-1,874**

Table 23.15: Infrastructure Decommissioning and End-of-Life Emissions

Material	Quantity [tonnes]	Stages C1 – C4 [$kgCO_2e/kg$]	Stage D	Total CD [tCO_2e]
Steelwork	1,744	6.00E-02	-9.59E-02	-1,062
Cladding	378	0.00E+00	-9.68E-01	-367
Concrete	98,597	2.74E-03	0.00E+00	270

Aggregates	112,287	1.50E-02	-3.99E-03	1,234
Tarmac	63,185	1.30E-02	-1.46E-02	-100
Total	**1,156,309**	**-**	**-**	**-21**

23.124 Exclusions include items such as M&E fittings, pipes, manholes and fencing, where at this stage specifications and materials are unknown.

23.125 The impact at the end-of-life, taking into account both the emissions generated during the decommissioning process and current reuse/ recovery/ recycling trends, indicate that there will be small a net reduction in emissions of 1,895 tonnes CO_2e.

23.126 As the assessment considers the quantity of CO_2e over a 100-year lifespan, all emissions are considered to have **long-term** effects.

23.127 As there is a further reduction in emissions during the decommissioning phase end-of-life emissions are deemed to have a **minor beneficial** effect on climate change.

Cumulative Effects

Cumulative Assessment: Intra-Project Effects

23.128 All relevant GHG emissions associated with other PEIR topics have been considered within this Chapter and no additional intra-project effects are considered likely. The impact of global emissions is considered in the adaptation section of this Chapter.

23.129 For the reasons as set out above there is therefore no need to assess any intra-project cumulative effects.

Cumulative Effects: Inter-Project Effects

23.130 The GHG emissions presented in this Chapter are based on circumstances specific to the Proposed Development; whilst external factors could have an impact on the quantity of estimated emissions, reasonable endeavours have been taken to ensure that likely scenarios are accounted for, for example in projections of future emission factors. Beyond this, there are no specific projects identified that are likely to have an inter-project effect on the quantity of GHG emissions.

23.131 It should be noted that IEMA's overarching principles on climate change and EIA state that the GHG emissions from all projects will contribute to climate change, the largest inter-related cumulative environmental effect. Central estimates of the effects of climate change are presented as part of the adaptation section of this Chapter, and no further assessment of cumulative effects is considered necessary.

Mitigation

23.132 IEMA guidance recommends the use of the IEMA GHG Mitigation Hierarchy which presents a structure for mitigating GHG emissions and which has been adopted at Rail Central.

23.133 Despite the assessment of the operational impacts of the Proposed Development upon climate change revealing a minor beneficial effect, further mitigation measures have been considered on the basis that any further reductions in GHG emissions can only be beneficial. Paragraph 5.19 of the NPSNN also requires appropriate mitigation to ensure the carbon footprint is not 'unnecessarily high'

23.134 It is acknowledged however that many of the adaptive mitigation measures proposed are only applicable during the detailed design phase of the Proposed Development and that legislation (such as Building Regulations) and technology may change which can result in further reductions in GHG emissions. It is therefore considered more appropriate to ensure the mechanisms and procedures are in place to seek GHG emission reductions as opposed to defining specific targets or technologies at this stage.

Table 23.16: EIA Hierarchy for Managing Project Related GHG Emissions

Avoid	Investigate and deploy options to eliminate GHG emissions
Reduce	Ensure that construction and operational activities will deliver efficient use of energy and resources.
Substitute	Commit to deploying renewables and low carbon materials, methods and technologies in place of more carbon intensive sources.
Compensate	Develop a strategy to compensate for residual or unavoidable emissions.

23.135 Identified adaptive mitigation measures are outlined in Table 23.18 below:

Table 23.17: Proposed Adaptive Mitigation Measures

Potential effect	Proposed mitigation	Means of implementation	Mechanism for securing mitigation
Construction			

GHG emissions arising from the operation of the construction site beyond best practice levels assumed.	Emissions reductions to be sought in CEMP to manage and reduce GHG emissions where possible.	Implementation of CEMP	Requirement in the DCO
GHG emissions arising from the production of materials used in construction.	Development of a life-cycle assessment for all materials quantified in this assessment to target a reduction in assessed emissions.	Embodied Carbon Assessment	Requirement in the DCO
GHG emissions arising from the transportation of construction waste.	A resource efficiency target in line with three credits under BREEAM New Construction 2014 of less than 3.2 tonnes of waste per 100m^2 gross internal floor area.	Developer/ contractor commitment via implementation of Site Waste Management Plan	Site Waste Management Plan secured via a Requirement in the DCO

Potential effect	Proposed mitigation	Means of implementation	Mechanism for securing mitigaton
Operation			
GHG emissions arising from buildings	Target reduction in the CO_2 emissions from buildings above Building Regulations through sustainable design measures	Energy Strategy with individual applications	Requirement within the DCO

23.136 Table 23.19 sets out estimated construction emissions assuming the adaptive mitigation measures set out in Table 23.18 are applied.

Table 23.18: Construction Phase Construction Emissions after Adaptive Mitigation

Construction Emission Sources	GHG Emissions [tCO_2e]
Mobile combustion: Fuel use in mobile plant & equipment	97

Stationary combustion: Use of purchased electricity in buildings & infrastructure	718
Total Site (Scope 1 & Scope 2) Emissions	**815**
Mobile combustion: Transportation of materials	3,259
Mobile combustion: Transportation of waste	19
Mobile combustion: Employee commuting	77,889
Process emissions: Production of construction materials	176,403
Process Emissions: Fuel and energy related emissions	463
Total Upstream & Downstream (Scope 3) Emissions	**258,033**
Total Construction Phase Emissions	**258,847**

23.137 It is estimated that a 15% reduction in construction emissions could be achieved following the adaptive mitigation measures identified in Table 23.18. Total construction emissions following mitigation are estimated to be 258,847 tonnes CO_2e.

23.138 Table 23.20 sets out estimated operational emissions between 2019 and 2038, assuming the adaptive mitigation measures set out in Table 23.15 are implemented and reductions are secured.

Table 23.19: Operational Emissions (2019 – 2028)

Operational Emission Sources	2019 - 2028 GHG emissions [tCO_2e]	2029 -2038 GHG emissions [tCO_2e]
Stationary combustion: Production of heat & electricity	2,962	6,273
Stationary combustion: Use of purchased electricity in buildings & infrastructure	28,427	41,777
Total Site (Scope 1 & Scope 2) Emissions	**31,389**	**48,050**
Mobile combustion: Transportation of freight	-57,139	-203,052
Mobile combustion: Transportation of waste	544	1,350
Mobile combustion: Employee commuting	28,559	47,132
Process Emissions: Fuel and energy related emissions	-5,503	-17,338
Total Upstream & Downstream (Scope 3) Emissions	**-33,539**	**-171,907**

Total Operational Phase Emissions	**-2,150**	**-123,857**

23.139 With the adaptive mitigation measures proposed, total operational emissions following could be reduced to 948,863 tonnes CO_2e, resulting in a further 2% reduction in operational emissions over the period 2019 - 2038.

Residual Effects

23.140 Given the absence of any significant criteria or thresholds, professional judgement is used to determine the scale and significance of any mitigation measures in the context of residual impact.

Table 23.20: Summary of Residual Effects

Description of impact	Significance of effect	Possible mitigation measures	Residual effect
Construction			
Quantity of GHG emissions	Minor adverse	Identified in Table 23.18	Minor adverse
Operation			
Quantity of GHG emissions	Minor beneficial	Identified in Table 23.18	Minor beneficial
Combined Construction & Operation			
Quantity of GHG emissions	Minor adverse	Identified in Table 23.18	Minor beneficial

Monitoring

23.141 During the detailed design phase of the Proposed Development we would recommend that a GHG assessment be undertaken for each phase of development in order to facilitate GHG reductions.

Limitations and Assumptions

23.142 As this is a predictive assessment, there is inherent uncertainty in the results. As far as practicable, data specific to the Proposed Development has been used to develop the activity and emissions profiles, but in some cases this is not possible and other external sources of data are used. In accordance with the principles of the GHG Protocol, all assumptions and data uncertainties are disclosed.

Activity Data

23.143 Information pertaining to the detailed design of the scheme is not yet available, so where necessary, proxy data has been used to provide an estimate of activity for both baseline and estimated actual emissions. Assumptions made have been fully disclosed in the Data Sources sub-section for each category of emissions; any uncertainty around those assumptions has been assessed in the relevant Data Quality and Uncertainty sub-section.

Emission Factors

23.144 The primary source for current emission factors used in this report is the *UK Government GHG Conversion Factors for Company Reporting* (Ref 23.17*),* termed "*BEIS Emission Factors*" hereafter. The BEIS Emission Factors are produced annually and are provided for use by UK based organisations reporting on UK operations that occurred during the period 1st April 2016 to 31st March 2023. However, it should be noted that this data is two years out of date and relates to the period 1st April 2014 to 31st March 2015.

23.145 BEIS Emission Factors are based on various sources that are reviewed at different frequencies, some of which may not be annual. Where annual averages are provided, they may not be reflective of the actual supply that will be procured.

23.146 Assessments have been made of likely future emission factors based on data published by various sources relating to the decarbonisation of energy supplies.

23.147 For electricity, this includes *Updated energy and emissions projections: 2017* (Ref 23.27), including *Figure 5.2: emissions intensity in gCO_2e per kWh electricity from 2017 to 2035*. Beyond 2035, it is assumed that no further emissions reductions are made.

23.148 For gas, this includes:

- *Next steps for UK heat policy* (Ref 23.28), and the assumption that in order to meet the fifth carbon budget (central scenario), a reduction in heating emissions of 22% to 2030 relative to 2015 is required.

- *Decarbonising the Gas Network* (Ref 23.29), *w*hich references the above and sets out that the most likely transition to a lower carbon network up to 2030 would include a bio methane injection of up to 4%. Post 2030, a range of measures, including hydrogen, could achieve larger savings. Urgent research is required to understand the costs of and technical issues posed by a hydrogen gas gird, but Government and industry stakeholders advocate one of two broad strategies: hydrogen blending where up to 20% hydrogen could enter the grid, increasing as technologies mature and the supply chain develops; or 100% hydrogen switch which would rapidly

achieve major carbon savings, but would require the conversion of all appliances (e.g. boilers) from natural gas to pure hydrogen.

23.149 It is therefore assumed that a linear reduction in emissions is achieved to 2030 by annual increases in the supply of bio methane to the gas grid. Beyond 2030, it is assumed that 20% hydrogen enters the grid, and that it is produced by electrolysis.

23.150 This reduces emissions in use but increases upstream well-to-tank (WTT) and transport and distribution (T&D) emissions.

23.151 Assumptions relating to other fuels are made and explained in full in Volume 3, Appendix 23.1 along with a full table of emission factors applied in this assessment.

Climate Change Adaptation

23.152 This section of the climate change Chapter addresses the issue of climate change adaptation i.e. how the proposed development may be affected by the future climate and what measures, if any, are needed to adapt to the future climate and improve resilience. This Chapter has been guided by the IEMA adaptation guidance in combination with professional judgement of the Chapter authors.

23.153 It should be noted that the assessment of climate change in new development is still an emerging science despite the recent publication of specific guidance from IEMA (Ref 23.13). The guidance acknowledges that the documents are not a 'prescriptive how to guide' but provides areas for consideration by EIA practitioners which should be applied in accordance with professional judgement.

Study Area

23.154 The study area for the climate change adaptation assessment comprises the Proposed Development which includes:

- The Main SRFI site;
- Works related to improve Junction 15a of the M1
- A number of Other Minor Highway Works.

23.155 All elements of the Proposed Development are assessed within this section.

23.156 Due to the nature of climate change, the impacts and implications of the effects may be outside of the study area and may be affected by the development or have an impact on the development, for example:

- The risk of surface water flooding, likely to increase due to climate change, can both impact on the development with surface water from the

surrounding area impacting on the site or surface water from the site travelling across the site boundary to the wider area.

Baseline Surveys and Data

23.157 The current and future baseline climate data for the Proposed Development are based on available data from the UK Met Office and the UK Climate Change Projections published in 2009.

Current Climatic Baseline

23.158 The current climatic baseline is based on the long-term average data from the UK Met Office (Ref 23.30). The Met Office continually records climate data from over 300 locations around the UK and long-term average data from 1981-2010 is available.

23.159 The nearest climate station to the Proposed Development Area is Northampton Moulton Park approximately 12km to the North East and is considered appropriate to use in setting out the baseline conditions for the site. This has been used qualitatively to provide context for the assessment of future climate change.

Climate Change Predictions

23.160 The Future Baseline and climate change adaptation assessment has been based upon data sourced from the UKCP09 website which is the source of the climate projections data for the United Kingdom (UK). The UKCP09 website (Ref 23.31) is managed by the Environment Agency working with the Met Office.

23.161 The UKCP09 website allows users to access information on plausible changes in 21st century climate for the United Kingdom. UKCP09 provides future climate projections for land and marine regions as well as observed (past) climate data for the UK.

23.162 UKCP09 was produced in 2009, funded by a number of agencies led by Defra. It is based on sophisticated scientific methods provided by the Met Office, with input from over 30 contributing organisations. UKCP09 can be used to help organisations assess potential impacts of the projected future climate and to explore adaptation options to address those impacts.

23.163 UKCP09 provides climate projections for the UK for three different future greenhouse gas emissions scenarios: a low emissions scenario, a medium emissions scenario and a high emissions scenario, all three of which are based upon the scenarios presented by the Intergovernmental Panel on Climate Change (IPCC) report (Ref 23.32). The climate projections under each scenario differ with greater variability in climate impacts projected using the high emissions scenario with corresponding lower variability from the low emissions scenario.

23.164 The Government's NN NPS (Ref 23.6) includes guidance on the assessment of climate change and states: *'Where transport infrastructure has safety-critical elements and the design life of the asset is 60 years or greater, the applicant should apply the UKCP09 high emissions scenario against the 2080 projections at the 50% probability level. '*

23.165 In this context and given the nature of the Proposed Development on the national rail network and its anticipated life of 60 years it is considered appropriate to follow the Government's guidance and use the high emissions scenario, 2080 projections.

23.166 The consideration of potential climate change impacts has been undertaken in accordance with defined and agreed timeframes for construction and operation. Table 23.22 below details the anticipated construction and operational timescales.

23.167 It should also be noted that the Government have recently provided funding to update the UKCP09 datasets in line with recent trends in global GHG emissions and internationally significant GHG reduction agreements such as the Paris Accord.

Table 23.20: Proposed Development and UKCPO9 timeframes

Timeframe	Construction	First Operation	Short term Operation	Long Term Operation
Proposed Development Timeframe	2019-2029	2021	2029-2039	2039-2089
Corresponding UKCPO9 Timeframe	2020	2020	2050	2080

Field Surveys

23.168 No field surveys were considered necessary for the production climate change adaptation assessment as the effects of climate change are related to the construction and operation of the Proposed Development and not the existing site.

Baseline Conditions

23.169 This section sets out the existing and future baseline conditions, setting out how the UK and East Midlands climate is anticipated to change over time relevant to the Proposed Development.

23.170 The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 requires that the ES present an outline of the likely evolution of baseline conditions without implementation of the Proposed Development (i.e. the 'do nothing scenario') as far as natural changes from the baseline scenario can be assessed with reasonable effort on the basis of the availability of environmental information and scientific knowledge.

23.171 With regards to adaptation, as noted in the previous section the future baseline scenario at 2080 is presented as this is considered to be the worst case future climate scenario for the purposes of the assessment based on the anticipated long-term operation of the site.

Existing and Future Baseline

23.172 The existing and future climatic scenario, based on the UKCP09 projections are set out below to aid the qualitative assessment of the predicted effects of climate change on the Proposed Development.

Existing Climatic Conditions (the 2016-23 baseline)

23.173 The existing climate for the Proposed Development Area, covering all of the Proposed Development works is demonstrated in Table 23.23 which shows the average climate data for Northampton Moulton Park climate station (Ref 23.33), approximately 12km to the North East of the Proposed Development Area), setting out average climate data from 1981 to 2010.

Table 23.21: Baseline Climate Data

Month	Max. temp (°C) (°C)	Min. temp(°C) (°C)	Days of air frost (days)	Sunshine (hours)	Rainfall (mm)	Days of rainfall >= 1 mm (days)
Jan	6.8	1.1	10.9	55.7	54	11.4
Feb	7.1	0.9	11.1	77.9	41.1	9.4
Mar	10	2.7	6.3	108.2	44.1	9.8
Apr	12.8	4	3	151.4	49.4	10
May	16.2	6.8	0.2	189.9	54.4	9.6
Jun	19.2	9.7	0	233.8	54.9	9.4
Jul	21.7	11.9	0	199.3	49.2	8.1
Aug	21.5	11.8	0	185.2	54.5	8.5
Sep	18.4	9.8	0	134	57.6	8.9
Oct	14.1	7	0.8	109.6	63.9	10.2
Nov	9.7	3.7	4.5	64.4	60	10.8
Dec	7	1.5	10.6	49.5	55.3	10.8
Annual	13.7	5.9	47.3	1498.9	638.1	116.9

Future Climatic Baseline

23.174 Table 23.24 below summarises the UKCP09 dataset for East Midlands for the 2020s, 2050s (Ref 23.34, Ref 23.35) and 2080s (Ref 23.36) for the high emissions scenario in line with the construction, long-term operational and decommissioning phases of the Proposed Development covering all of the proposed works.

23.175 The future baseline climatic conditions cover the whole of the Proposed Development Area and are relevant to all of the Proposed Development components assessed by this ES which are:

- The Main SRFI Site;
- The Junction 15a Works; and
- Other Minor Highway Works.

Table 23.22: UKCP09 East Midlands Climate Change projections as obtained from the UKCP09 website

Timeframe	2020s	2050s	2080s
Temperature	Under high emission, the central estimate of increase in winter mean temperature is 1.3C	Under high emission, the central estimate of increase in winter mean temperature is 2.5C	Under high emissions, the central estimate of increase in winter mean temperature is 3.6C
	Under high emissions, the central estimate in summer mean temperature is 1.4C	Under high emissions, the central estimate in summer mean temperature is 2.8C	Under high emissions the central estimate of increase in summer mean temperature is 4.4C
	Under high emissions, the central estimate of increase in summer mean maximum temperature is 1.8C	Under high emissions, the central estimate of increase in summer mean maximum temperature is 3.8C	Under high emissions, the central estimate of increase in summer mean daily maximum temperature is 6C
	Under high emissions, the central estimate of increase in summer mean daily minimum temperature is 1.5C	Under high emissions, the central estimate of increase in summer mean daily minimum temperature is 3.1C	Under high emissions, the central estimate of increase in summer mean daily minimum temperature is 4.9C
Rainfall	Under the high	Under the high	Under the high

	emissions, the central estimate of change in annual mean precipitation is 0%	emissions, the central estimate of change in annual mean precipitation is 0%	emissions, the central estimate of change in annual mean precipitation is 1%
	Under high emissions, the central estimate of change in winder mean precipitation is 6%	Under high emissions, the central estimate of change in winder mean precipitation is 16%	Under high emissions, the central estimate of change in winder mean precipitation is 25%
	Under high emissions, the central estimate of change in summer mean precipitation is --4%	Under high emissions, the central estimate of change in summer mean precipitation is -23%	Under high emissions, the central estimate of change in summer mean precipitation is -25%

23.176 In addition to the summary of findings set out in Table 23.24, Table 23.25 presents the UKCP09 climate change predictions of potential changes relating to wind, storms, lightning, snow and fog where possible for the period up to 2080.

23.177 For each of the climate variables below, where available the change described is specific to the period up to 2080 and takes into account the 50% probability estimated and is used on the basis that it is considered a worst-case scenario for assessment.

Table 23.23: Changes in Wind, Storms, Lightning, Snow and Fog in the East Midlands

Climate Variable	Estimated potential changes at 2050 and where stated 2080
Wind – (Ref23.37)	Minor decrease in wind speed of between -0.1m/s in winter and -0.2 in summer under the high emissions scenario.
Storms – (Ref 23.38)	There is no consistent signal of change in either storms or blocking near the UK. Such changes as are seen are relatively modest, and the potential for substantial change appears to be small. Data is not time specific
Lightning – (Ref 23.39)	Increase in lighting projected for all four seasons across the UK up to the period of 2080
Snow – (Ref 23.40)	Reduced snowfall - Snow days projected to reduce by 80-90% in winter and 60-80% in Spring due to a shift from snow to rain up to the period of 2080
Fog – (Ref 23.41)	Reduced fog predicted across the UK between 10-40% through to the year 2080.

Summary of Climate Change Impacts

23.178 Qualitatively the future climate of the project location at 2050 and with increasing variability up to 2080 will likely include:

- An increase in annual average temperature by 3.6 degrees in winter and 4.4 degrees in summer;
- More very hot days particularly in long term operation with an increase in daily maximum temperature of 6 degrees; More intense downpours of rain;
- Increase in winter rainfall with reduced snowfall and winter rainfall increasing by 25%;
- An increase in dry spells particularly in summer months with summer rainfall dropping by 25%;
- Minimal change in wind speed;
- No consistent change in storm frequency;
- Increase in lightning events; and
- Reduced fog and snowfall.

Baseline conditions in the 'do nothing' scenario

23.179 The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 requires that the ES present an outline of the likely evolution of baseline conditions without implementation of the Proposed Development.

23.180 With regards to the future impact on the climatic baseline, it is highly likely that the future climate change scenario will occur in the absence of the Proposed Development under the 'do nothing' scenario.

Matters which have been scoped out of the assessment

23.181 Utilising professional judgement, it is considered that the following future climatic factors can be scoped out of this assessment:

- **Wind and Storms -** Potential impacts associated with wind and storms: Given the marginal projected difference in the 2080 (worst case) scenario from the current baseline no significant effects from climate change influenced wind or storms are anticipated.
- **Lightning -** Although there is an anticipated increase in lightning events from the current baseline these are relatively rare with the vast majority

confined to the atmosphere with little or no impact upon the built environment, new buildings and structures include lightning protection as standard. It is therefore not considered appropriate to assess the potential effects and impacts of lightning further.

- **Fog -** The occurrence of fog is also thought to reduce as a result of climate change and as this is a phenomenon that currently does not appear to have any negative impact upon the built environment it is not considered appropriate to assess this further.

- **Snowfall -** A significantly reduced occurrence of snowfall is likely to have a projected benefit upon the Proposed Development in terms of reduced disruption due to a decrease in snow days however it is noted that the reduced snowfall will transfer to an increase in rainfall.

Summary of Climate Change Impacts

23.182 In this context for the assessment of effects the following impacts have been used:

- Increase in winter mean temperature.
- Increase in summer mean and daily maximum temperature.
- Decrease in summer rainfall.
- Increase in winter rainfall.

Method of Assessment

Overview

23.183 Climate change is anticipated to have a significant impact on the UK climate leading to more frequent periods of weather extremes including higher peak and average temperatures and increased rainfall events.

23.184 There is now a requirement within the EIA Regulations (Ref 23.1) for the built environment to understand the potential future effects of climate change and identify the need for any resilience measures.

23.185 It is also appropriate to note that the potential effects of climate change may also be addressed by other Chapters within this PEIR in accordance with policy and legislation specific to that environmental topic. This Chapter will not duplicate such work but will reference such assessments where necessary in order to provide a holistic overview of how the impacts of climate change has been assessed for the Proposed Development.

23.186 Key disciplines which are affected by Climate Change in the context of the Proposed Development include Hydrology, Ecology, and Transport, in addition there are key construction stage measures included within the CEMP confirmed with the appropriate consultants. A full list of Chapters and details of adaptive climate change mitigation measures considered in this assessment is included as part of the intra-project cumulative effects section further on in this Chapter.

23.187 The method of assessment adopted in this Chapter to assess climate change adaptation comprises the following principal components:

- A review of legislation, regulation and planning policy, focussing on climate change issues (as set out above).
- Identification of the existing baseline climatic conditions utilising data from the met office and identification of the relevant UKCP09 future climate change scenario and baseline (see above).
- Preparation of a Climate Change Risk Assessment which identifies the risks to the Proposed Development from the change in climate factors (see Volume 3, Appendix 23.3)
- A qualitative assessment of the potential effects and impacts of the future climate change scenario during the construction and operational phases of the development.
- Identification of any mitigation measures as necessary and a review of the residual impacts.

Climate Change Risk Assessment

23.188 Utilising the existing and future baseline conditions for the Proposed Development a Climate Change Risk Assessment has been prepared to demonstrate the scale of climate variation anticipated over the construction and operational phase of the Proposed Development. This is included in Volume 3, Appendix 23.3 of this PEIR.

23.189 This section provides a summary of the risk assessment carried out to determine the potential risk climate change poses to the Proposed Development and the likelihood of occurrence. The table below provides a summary of the Climate Change Risk Assessment accompanying this Chapter. This reviews the severity and nature of each risk to determine the overall risk and potential likelihood for an impact. Those with a moderate or higher risk are considered significant and will be considered in the assessment of climate change effects in the climate change section of this Chapter.

Table 23.24: Proposed Development Risk Assessment Summary

Climate Change Impact	Risk	Severity of Impact	Nature of Impact	Risk Assessment
Increase in Winter Mean Temperature	Risk to landscape and mitigation for species and habitats from changing climate space	Moderate – Potential for the loss of species through climate space changes	Continual – Linked to a rise in summer temperature this risk is considered to be continual	High
Increased summer mean and daily maximum temperature	Risk to landscape and mitigation for species and habitats from changing climate space	Moderate – Potential for the loss of species through climate space changes	Continual – Linked to a rise in summer temperature this risk is considered to be continual	High
	Increase in energy demand from additional cooling required in buildings	Low – Likely to have minor change to operational energy	Frequent/Seasonal – Linked to periods of extreme temperature, likely to be short lived	Moderate
	Damage to electrical infrastructure, i.e. substation overheating	High – Potential damage to electrical equipment likely to be a severe impact	Frequent/Seasonal – Linked to periods of extreme temperature, likely to be short lived	High
	Risk of overheating impacting health and wellbeing	Low – Likely to have minor impact on wellbeing	Frequent/Seasonal – Linked to periods of extreme temperature, likely to be short lived	Moderate
	Risk of damage to rail infrastructure including rail and electrical equipment	High – Potential damage to electrical equipment likely to be a	Frequent/Seasonal – Linked to periods of extreme temperature, likely to be short	High

		severe impact	lived	
Decrease in summer rainfall	Risk to landscape and mitigation for species and habitats from water availability	Moderate – Potential for the loss of biodiversity /severe impact on habitats and species	Seasonal – Linked to increased summer rainfall and a decrease in rainfall over the same period	High
	Risk to fresh water supplies	Low – Likely to have minor impact on operation	Seasonal – Linked to increased summer rainfall and a decrease in rainfall over the same period	Moderate
	Risk to building and infrastructure foundations from ground movement	High – Potential damage to infrastructure and have a severe impact	Seasonal – Linked to periods of extreme temperature and reduction in summer rainfall	High
Increase in winter rainfall	Risk of increase in flooding (fluvial and surface water) due to increased rainfall	High – Potential damage to infrastructure and have a severe impact	Seasonal – Increase in winter rainfall also linked to an increase in winter temperature	High
	Risk to building and infrastructure foundations from ground movement	High – Potential damage to infrastructure and have a severe impact	Seasonal – Linked to an increase in winter temperature and saturated ground	High

23.190 In addition to the Proposed Development risks identified above and number of opportunities were identified during this assessment that have the potential to provide benefits to the Proposed Development and should also be considered in the assessment of effects within the Environmental Statement.

Table 23.25: Climate Change Opportunities

Climate Change Impact	Opportunity
Increase in winter mean temperature	Opportunity for new species colonisation and increase in climate space

	Opportunity for improvement in health and wellbeing
	Opportunity for reduced energy use and therefore reduced GHG emissions
Increased summer mean and daily maximum temperature	Opportunity for new species colonisation and increase in climate space

Assessing Significance of Effect

23.191 Determining the magnitude and significance of climate change on the Proposed Development is a complex issue given the uncertainty in the magnitude of the future changes to the climate and the frequency of 'climate change' related events.

23.192 The magnitude, sensitivity and significance criteria adopted for this assessment have been developed based on available IEMA guidance and through the application of professional judgement. The tables in this section provide a summary of how significance of impact has been determined for the climate change adaptation assessment.

Magnitude of Effects

23.193 Table 23.28 sets out the definition for the magnitude of the effects associated with climate change, which have the potential to impact on the construction and operational phases of the different Proposed Development components.

23.194 The effects of climate change can be either positive or negative, for example the increase in winter temperature can improve working conditions, or, an increase in summer mean and daily maximum temperature can lead to overheating or buildings thereby creating a negative impact.

23.195 Potential negative impacts can be seasonal or ongoing or have structural impacts on elements such as the rail lines, buildings and roads or have an operational effect, i.e. overheating of buildings leading to reduced working hours.

Table 23.26: Climate Change Adaptation – Defining Magnitude of Effect

Magnitude of Effect	Description
High	Ongoing annual impact with the potential for extreme events to cause operational or structural damage. For example higher temperatures causing a major failure in structures or buildings with the potential for injury.
Moderate	Seasonal impact with the potential for climatic events to cause operational or structural damage. For example increased summer maximum temperatures can effect structures through

	the movement of materials, foundations etc.
Low	Seasonal impact with the potential for minor operational loss. For example higher summer temperatures can cause overheating which can lead to a loss in operational hours.
Very low	Increased maintenance required to mitigate annual operational impacts. For example increased winter rainfall can cause damage to drainage systems requiring maintenance.
Negligible	Effect minimal, neither positive or negative and likely to be mitigated through resilience measures included through regulatory or best practice.

Sensitivity of Receptors

23.196 The sensitivity of the identified receptors is key to determining the need for mitigation. In the case of the Proposed Development the most sensitive receptors are considered to be those whereby any impact may lead to a risk or injury to humans or that may constitute safety critical infrastructure.

23.197 Table 23.29 therefore sets out criteria for determining the sensitivity of a receptor which will be identified using professional judgement.

Table 23.27: Climate Change Adaptation – Defining Sensitivity of Receptors

Sensitivity of identified receptor	Description
High	Receptor particularly sensitive to the climate effect and potential impacts, and/or, receptor includes safety critical infrastructure which if damaged could result in significant risks to people and/or property. Mitigation required to reduce the impact as a priority.
Moderate	Receptor sensitive to the climate effect and potential impacts and mitigation will need to be provided
Low	Receptor has low sensitivity to potential climate effects, additional mitigation may be considered to further reduce sensitivity to the climate effect
Very Low	Receptor has very low sensitivity to potential climate effects and mitigation unlikely to be required, although could be used to improve resilience.
Negligible	Receptor not sensitive to the effects of climate change effects and mitigation not required.

Duration of Effect

23.198 The impact of climate change is ongoing and in this context the effects of climate change are relative to the phase of the Proposed Development being assessed. Table 23.24 sets out the climate change projections to be used for the assessment of each phase of the Proposed Development.

23.199 Given the nature of the Proposed Development it is anticipated that the effects of climate change on the construction phase will mostly be short term, apart from those components where the design impacts performance over the long term, and the effects on operation will be of a longer-term nature as the UK climate changes over time.

Nature of impact

23.200 Any resulting impacts could be both positive and negative and will be identified utilising professional judgement, but which could be categorised as follows:

- An adverse (negative) impact will result in the potential for harm to the environment, buildings, infrastructure or humans as a result of a climatic variable
- A beneficial (positive) impact will result in an improvement to the environment, buildings, infrastructure of humans as a result of a climatic variable.

Significance of Effect

23.201 The significance of the effects has been assessed using Table 23.30, which has been developed based on IEMA guidance (Ref 23.13) and professional judgement, which defines the significance from negligible, i.e. a very low magnitude of impact likely to only effect annual maintenance with a very low sensitivity of the receptor and unlikely to need specific mitigation, to, a major adverse effect where there is the potential for impacts to particularly sensitive receptors where additional mitigation will be required.

23.202 Depending on the effect the significance of effect may be either positive or negative.

Table 23.28: Climate Change Adaptation - Significance of Effect

Climate Change Adaptation – Significance of Effect					
Magnitude of Effect	Sensitivity of Receptor				
	High	Moderate	Low	Very Low	Negligible
High	Major	Major	Moderate	Moderate	Minor

Moderate	Major	Moderate	Minor	Minor	Negligible
Low	Moderate	Moderate/Minor	Minor	Negligible	Negligible
Very Low	Moderate	Minor	Minor	Negligible	Negligible
Negligible	Minor	Minor	Negligible	Negligible	Negligible

23.203 At this stage it is considered that any effects with moderate negative or moderate beneficial significance and above are considered significant in EIA terms and would require additional mitigation to ensure the resilience of the Proposed Development to climate change effects.

Identifying Climate Resilience and Mitigation

23.204 Once the significance of the impact has been identified the resilience of the Proposed Development to the impact of the climatic variables will be assessed.

23.205 The level of Climate Change Resilience will be assessed using Table 23.31 below which has been developed using professional judgement.

Table 23.29: Climate Change Resilience

Climate resilience level	Definition
High	A low level of climate vulnerability to specific climate risk. Further action or adaptation not considered necessary.
Medium	A moderate level of vulnerability remains. Further action or adaptation could improve resilience, however appropriate resilience is considered to have been provided.
Low	A significant level of vulnerability to specific climate risk remains. Mitigating action or adaptation is required.
Very Low	A very significant level of vulnerability to specific climate risk remains. Mitigating action or adaptation is required.

Embedded Mitigation

23.206 Prior to the assessment of climate change effects on the Proposed Development consultation with the design team and EIA practitioners has identified a number of embedded mitigation measures contained within the following supporting documents:

- The Main SRFI site Parameters Plan;
- The Green Infrastructure Plan – Main SRFI
- The Green Infrastructure Plan – Junction 15a; and

- The draft Construction Environmental Management Plan (CEMP).

23.207 In the context of an EIA assessment the impacts of climate change are unique as they constitute an impact on the development rather than due to the development (with the exception of the GHG emissions). In this context the effects of climate change are relevant to all aspects of the Proposed Development.

23.208 In terms of the embedded mitigation a range of measures have been noted in the developments supporting documents covering the design and construction of the Proposed Development. The embedded mitigation is summarised below for each of the Proposed Development components.

23.209 Some elements of the embedded mitigation below are the same for different components of the Proposed Development and to avoid repetition this is stated where relevant.

Main SRFI site

Main SRFI site Parameters Plan

23.210 The Main Parameters Plans shows the key development parameters including the proposed transport connections, areas for development and key features such as the proposed rail infrastructure attenuation basins and bunds. Key elements of embedded climate change mitigation include:

- Surface Water Drainage – The Main Parameters Plan includes the areas of surface water attenuation incorporated into the main SRFI site. These have been sized to take into account the anticipated surface water run-off for a 1 in 200 year storm with a 40% allowance for climate change as set out in the ES Hydrology Chapter. (Ref 23.29).

Green Infrastructure Plan – Main SRFI

23.211 The Green Infrastructure Plan shows an outline of the proposed green spaces within the development. At this stage it does not show any detail in relation to the landscaping, habitats or species proposed, and therefore does not detail the impact on the site biodiversity. This detail is included as part of the Ecology Chapter and therefore forms part of the adaptive mitigation. In this context it is therefore considered not to include any specific climate change adaptation mitigation.

Green Infrastructure Plan – Junction 15a

23.212 Not applicable.

CEMP

23.213 The CEMP is a live document which will be updated during the application and detailed design process. It includes a number of sections which relate to construction best practice and climate change, including:

23.214 Construction Compound – The Construction compound will be designed in line with best practice and with provision for surface water drainage which includes silt traps and oil separators to prevent pollution run-off. This will include an allowance for increased winter rainfall due to climate change.

23.215 Construction Site Drainage – During construction run-off from the site will be treated appropriately to reduce silt loads and any potential pollution. The drainage system put in place will include an allowance for increased rainfall due to climate change.

23.216 Health and Wellbeing – During construction provision will be made to include suitable facilities to protect the health and wellbeing for employees including water supplies and shaded areas to reduce the risk of overheating.

23.217 Air Quality and Dust – The CEMP states a Dust Management Plan (DMP) will be prepared to include measures to control emissions. This includes reference to the need to into account a potential increase in dust due to warmer, dryer summer climate during construction.

23.218 Protection of Controlled Waters – The protection of controlled waters and specifically the design of storage, and pollution control systems will include allowance for future climate change due to increased winter rainfall.

23.219 Water Efficiency – To minimise water use during construction measures will be put in place, for examples measures to be considered include the monitoring and recording of water use and capture and re-use rainwater.

J15A Works

Main SRFI site Parameters Plan – Not applicable.

Green Infrastructure Plan – Main SRFI – Not applicable.

23.220 ***Green Infrastructure Plan – Junction 15a –*** The Green Infrastructure Plan shows an outline of the Junction 15a works and associated green spaces. At this stage it is not considered to include any climate change adaptation mitigation.

CEMP – As per Main SRFI site.

Other Minor Highway Works

Main SRFI site Parameters Plan – Not applicable.

Green Infrastructure Plan – SFRI Site– Not applicable.

Green Infrastructure Plan – Junction 15a – Not applicable.

CEMP – As per Main SRFI site.

Assessment of **Construction** Stage Effects

23.221 The following sections set out the assessment of climate change effects on the different stages of construction and operation and decommissioning, and those relevant to the different Proposed Development components.

23.222 The Climate Change Risk Assessment section of this Chapter sets out the potential climate change impacts and associated areas of risk considered in the Assessment of Effects.

23.223 The following sections and tables set out the initial assessment of effects with the Embedded Mitigation proposed and the level of climate change resilience incorporated into the Proposed Development at this stage.

23.224 The following tables set out an assessment of the construction phase effects of the anticipated climate change impacts for each individual component.

23.225 Due to the nature of the impacts of climate change the effects are likely to be applicable to all of the components of the Proposed Development; however given the nature of each individual component the sensitivity of the receptor is anticipated to be slightly different in each case. In this context individual assessment tables have been prepared for each component.

23.226 Given the construction timeframe proposed the impacts have been considered under the climate change projections for 2020 which have a lower impact than those stretching out to 2080.

23.227 As the construction phase is relatively short the effects of climate change over this period are predominantly considered to be temporary.

Main SRFI Site

23.228 Table 23.32 sets out the assessment of construction stage effects related to the Main SRFI Site. At this stage it is anticipated that given the short-term nature of the construction stage, and limited climate change impacts during the 2020s the significant environmental effects which would require additional mitigation beyond that embedded into the proposals are limited.

The exception to this is the construction of foundations related to the proposed building, road and rail infrastructure, increased temperature extremes and changes to

rainfall over the longer term require consideration at the construction stage to ensure this effect is minimised. At this stage there is no embedded mitigation proposed apart from that inherent in the requirements the Building Regulations and associated construction legislation. In this context additional adaptive mitigation is considered necessary to minimise the risk associated with the climate change impacts.

Table 23.30: Assessment of Construction Stage Effects - Main SRFI Site

Assessment of Construction Stage Effects - Main SRFI Site						
Climatic Variable	Potential climatic effect	Embedded Mitigation	Magnitude and nature of impact	Sensitivity of receptor(s)	Significance of effect	Climate change resilience
Increase in winter mean temperature	Higher average winter temperatures are likely to result in lower instances of disruption from ice and snow and provide for a warmer working environment.	No embedded mitigation proposed	Low beneficial – This is a temporary impact associated with construction.	Low – Sensitivity of construction equipment and employees and equipment considered low.	Minor Beneficial	High
Increase in summer daily maximum temperature	Higher average mean summer temperatures and daily maximum temperatures may increase the potential for impacts upon the foundations of infrastructure and buildings as a result of shrinkage.	No embedded mitigation proposed beyond that inherent in legislation	Moderate negative – Ground movement has the potential to have structural impacts to development elements.	Moderate – Buildings, roads, rail infrastructure sensitive to ground movement and foundation damage	Moderate negative	Medium
	Higher average mean summer temperatures and daily maximum	The CEMP sets out a requirement for	Low negative – temporary	Low – Sensitivity of	Minor negative	High

Assessment of Construction Stage Effects - Main SRFI Site						
Climatic Variable	Potential climatic effect	Embedded Mitigation	Magnitude and nature of impact	Sensitivity of receptor(s)	Significance of effect	Climate change resilience
	temperatures may lead to a health and safety risk.	construction to be carried out in accordance with the UK legislation on Health and Safety. Welfare facilities are also to be provided to workers during construction.	impact associated with construction	employees and equipment considered low with mitigation provided		
Increase in winter rainfall	An increase in winter rainfall may increase the potential for construction site flooding, damage to materials and disruption to construction.	The CEMP sets out construction compound details, and site drainage strategy confirming how during construction the site compound and wider site will manage surface water.	Low negative - This is a temporary impact associated with construction	Very Low - Sensitivity of construction equipment and construction considered	Negligible	High
Increase in winter rainfall	An increase in winter rainfall may increase the potential for contamination to nearby water courses and/or ground water through increased run off washing contaminants from the site.	The CEMP sets out measures to ensure the cleaning of site roads and storage of materials, a drainage plan and groundwater management plan which includes measures to	Very Low negative - This is a temporary impact associated with construction but mitigation	Low – With the potential for pollution to nearby watercourses these receptors are considered to	Minor adverse	High

Assessment of Construction Stage Effects - Main SRFI Site						
Climatic Variable	Potential climatic effect	Embedded Mitigation	Magnitude and nature of impact	Sensitivity of receptor(s)	Significance of effect	Climate change resilience
		reduce the risk of pollution from surface water runoff.	will reduce potential magnitude	have a low sensitivity		
Increased winter rainfall	Increased winter rainfall may increase the potential for impacts upon the foundations of infrastructure and buildings as a result of ground movement and subsistence.	No embedded mitigation proposed beyond that inherent in legislation	Moderate negative – Ground movement has the potential to have structural impacts to development elements.	Moderate – Buildings, roads, rail infrastructure sensitive to ground movement and foundation damage	Moderate negative	Medium
Decrease in summer rainfall	A decrease in summer rainfall may restrict water supply disrupting construction.	The CEMP contains procedures to improve water efficiency during construction.	Very Low – Lack of water availability has the potential for minor seasonal operational loss	Very Low – Absence of water is unlikely however mitigation will improve water availability	Negligible	High

Assessment of Construction Stage Effects - Main SRFI Site						
Climatic Variable	Potential climatic effect	Embedded Mitigation	Magnitude and nature of impact	Sensitivity of receptor(s)	Significance of effect	Climate change resilience
Decrease in summer rainfall	A decrease in summer rainfall may lead to an increase in dust generation from construction due to dry land conditions impacting on existing habitats.	The CEMP sets out measures to mitigate the risk of air quality and dust pollution.	Very Low negative - This is a temporary impact associated with construction	Very Low – Low sensitivity of receptors to dust considered appropriate	Negligible	High

Junction 15a Works

23.229 Table 23.33 sets out the assessment of construction stage effects related to the Junction 15a Works. At this stage it is anticipated that given the short-term nature of the construction stage, and limited climate change impacts during the 2020s the significant environmental effects which would require additional mitigation beyond that embedded into the proposals are limited.

23.230 The exception to this is the construction of foundations related to the Junction 15a works, increased temperature extremes and changes to rainfall over the longer term require consideration at the construction stage to ensure this effect is minimised. At this stage there is no embedded mitigation proposed apart from that inherent in the requirements of the Building Regulations and associated construction legislation. In this context additional adaptive mitigation is considered necessary to minimise the risk associated with the climate change impacts.

Table 23.31: Assessment of Construction Stage Effects - Junction 15a works

Assessment of Construction Stage Effects - Junction 15a Works						
Climatic Variable	Potential climatic effect	Embedded Mitigation	Magnitude and nature of impact	Sensitivity of receptor(s)	Significance	Climate change resilience
Increase in winter mean temperature	Higher average winter temperatures are likely to result in lower instances of disruption from ice and snow and provide for a warmer working environment.	No embedded mitigation proposed	Low beneficial – This is a temporary impact associated with construction.	Low – Sensitivity of construction equipment and employees and equipment considered low.	Minor Beneficial	High
Increase in summer daily maximum temperature	Higher average mean summer temperatures and daily maximum temperatures may increase the potential for impacts upon the foundations or infrastructure and buildings as a result of shrinkage.	No embedded mitigation proposed beyond that inherent in legislation	Moderate negative – Ground movement has the potential to have structural impacts to development elements.	Moderate – Road infrastructure sensitive to ground movement and foundation damage	Moderate negative	Medium
	Higher average mean summer temperatures and daily maximum	The CEMP sets out a requirement for	Low negative – This is a	Low – Sensitivity of	Minor negative	High

Assessment of Construction Stage Effects - Junction 15a Works						
Climatic Variable	Potential climatic effect	Embedded Mitigation	Magnitude and nature of impact	Sensitivity of receptor(s)	Significance	Climate change resilience
	temperatures may lead to a health and safety risk.	construction to be carried out in accordance with the UK legislation on Health and Safety. Welfare facilities are also to be provided to workers during construction.	temporary impact associated with construction	employees and equipment with mitigation		
Increase in winter rainfall	An increase in winter rainfall may increase the potential for construction site flooding, damage to materials and disruption to construction.	The CEMP sets out construction compound details, and site drainage strategy confirming how during construction the site compound and wider site will manage surface water.	Low negative - This is a temporary impact associated with construction	Very Low - Sensitivity of construction site with mitigation	Negligible	High
Increased winter rainfall	Increased winter rainfall may increase the potential for impacts upon the foundations of infrastructure and buildings as a result of ground movement and subsistence.	No embedded mitigation proposed beyond that inherent in legislation	Moderate negative – Ground movement has the potential to have structural impacts to	Moderate – Road infrastructure sensitive to ground movement and foundation damage	Moderate negative	Medium

Assessment of Construction Stage Effects - Junction 15a Works						
Climatic Variable	Potential climatic effect	Embedded Mitigation	Magnitude and nature of impact	Sensitivity of receptor(s)	Significance	Climate change resilience
			development elements.			
Increase in winter rainfall	An increase in winter rainfall may increase the potential for contamination to nearby water courses and/or ground water through increased run off washing contaminants from the site.	The CEMP sets out measures to ensure the cleaning of site roads and storage of materials, a drainage plan and groundwater management plan which includes measures to reduce the risk of pollution from surface water runoff.	Very Low negative - This is a temporary impact associated with construction but mitigation will reduce potential magnitude	Low – With the potential for pollution to nearby watercourses these receptors are considered to have a low sensitivity	Minor negative	High
Decrease in summer rainfall	A decrease in summer rainfall may restrict water supply disrupting construction.	The CEMP contains procedures to improve water efficiency during construction.	Very Low – Lack of water availability has the potential for minor seasonal operational loss	Very Low – Absence of water is unlikely however mitigation will improve water availability	Negligible	High

Assessment of Construction Stage Effects - Junction 15a Works						
Climatic Variable	Potential climatic effect	Embedded Mitigation	Magnitude and nature of impact	Sensitivity of receptor(s)	Significance	Climate change resilience
Decrease in summer rainfall	A decrease in summer rainfall may lead to an increase in dust generation from construction due to dry land conditions impacting on existing habitats.	The CEMP sets out measures to mitigate the risk of air quality and dust pollution.	Very Low negative - This is a temporary impact associated with construction	Very Low – Low sensitivity of receptors to dust considered appropriate	Negligible	High

Other Minor Highway Works

23.231 Table 23.34 sets out the assessment of construction stage effects related to the other minor Highway works. At this stage it is anticipated that given the short term nature of the construction stage, and limited climate change impacts during the 2020s the significant environmental effects which would require additional mitigation beyond that embedded into the proposals are limited.

23.232 The exception to this is the construction of road and other infrastructure foundations, increased temperature extremes and changes to rainfall over the longer term require consideration at the construction stage to ensure this effect is minimised. At this stage there is no embedded mitigation proposed apart from that inherent in the requirements of the Building Regulations and associated construction legislation. In this context additional adaptive mitigation is considered necessary to minimise the risk associated with the climate change impacts.

Table 23.32: Assessment of Construction Stage Effects - Other Minor Highway Works

Assessment of Construction Stage Effects – Other Minor Highway Works						
Climatic Variable	Potential climatic effect	Embedded Mitigation	Magnitude and nature of impact	Sensitivity of receptor(s)	Significance	Climate change resilience
Increase in winter mean temperature	Higher average winter temperatures are likely to result in lower instances of disruption from ice and snow and provide for a warmer working environment.	No embedded mitigation proposed	Low beneficial – This is a temporary impact associated with construction.	Low – Sensitivity of construction equipment and employees and equipment considered low.	Minor Beneficial	High
Increase in summer daily maximum temperature	Higher average mean summer temperatures and daily maximum temperatures may increase the potential for impacts upon the foundations of infrastructure and buildings as a result of shrinkage.	No embedded mitigation proposed beyond that inherent in legislation	Moderate negative – Ground movement has the potential to have structural impacts to development elements.	Moderate – Road and other infrastructure sensitive to ground movement and foundation damage	Moderate negative	Medium

Assessment of Construction Stage Effects – Other Minor Highway Works						
Climatic Variable	Potential climatic effect	Embedded Mitigation	Magnitude and nature of impact	Sensitivity of receptor(s)	Significance	Climate change resilience
	Higher average mean summer temperatures and daily maximum temperatures may lead to a health and safety risk.	The CEMP sets out a requirement for construction to be carried out in accordance with the UK legislation on Health and Safety. Welfare facilities are also to be provided to workers during construction.	Low negative – This is a temporary impact associated with construction	Low – Sensitivity of employees and equipment considered low.	Minor negative	High
Increase in winter rainfall	An increase in winter rainfall may increase the potential for construction site flooding, damage to materials and disruption to construction.	The CEMP sets out construction compound details, and site drainage strategy confirming how during construction the site compound and wider site will manage surface water.	Low negative - This is a temporary impact associated with construction	Very Low - Sensitivity of construction equipment and construction considered low with mitigation.	Negligible	High
Increased winter rainfall	Increased winter rainfall may increase the potential for impacts upon the foundations or	No embedded mitigation proposed beyond that inherent in legislation	Moderate negative – Ground	Moderate – Road and other	Moderate negative	Medium

Assessment of Construction Stage Effects – Other Minor Highway Works						
Climatic Variable	Potential climatic effect	Embedded Mitigation	Magnitude and nature of impact	Sensitivity of receptor(s)	Significance	Climate change resilience
	infrastructure and buildings as a result of ground movement and subsistence.		movement has the potential to have structural impacts to development elements.	infrastructure sensitive to ground movement and foundation damage		
Increase in winter rainfall	An increase in winter rainfall may increase the potential for contamination to nearby water courses and/or ground water through increased run off washing contaminants from the site.	The CEMP sets out measures to ensure the cleaning of site roads and storage of materials, a drainage plan and groundwater management plan which includes measures to reduce the risk of pollution from surface water runoff.	Very Low negative - This is a temporary impact associated with construction the magnitude of which is reduced through mitigation	Low – The receptors are considered to have a low sensitivity	Minor negative	High

Assessment of Construction Stage Effects – Other Minor Highway Works						
Climatic Variable	Potential climatic effect	Embedded Mitigation	Magnitude and nature of impact	Sensitivity of receptor(s)	Significance	Climate change resilience
Decrease in summer rainfall	A decrease in summer rainfall may restrict water supply disrupting construction.	The CEMP contains procedures to improve water efficiency during construction	Very Low – Lack of water availability has the potential for minor seasonal operational loss	Very Low – Absence of water is unlikely however mitigation will improve water availability	Negligible	High
Decrease in summer rainfall	A decrease in summer rainfall may lead to an increase in dust generation from construction due to dry land conditions impacting on existing habitats.	The CEMP sets out measures to mitigate the risk of air quality and dust pollution.	Very Low negative - This is a temporary impact associated with construction	Very Low – Low sensitivity of receptors to dust considered appropriate	Negligible	High

Assessment of Operational Phase Effects

23.233 The following tables set out the assessment of operational effects of future climate change on the individual development components.

23.234 The future impacts of climate change will affect the entire site and therefore any impacts are likely to be similar across all development components. Given the nature of each individual component however the specific effect and sensitivity of the receptor is anticipated to be slightly different in each case. In this context individual assessment tables have been prepared for each component.

23.235 Given the operational timeframe proposed the impacts have been considered under the climate change projections for 2080 to cover the long term operation and worst case scenario.

23.236 Where appropriate in each section the significant impacts are identified where additional residual mitigation is required, and also where additional voluntary mitigation could be provided to improve the climate change resilience of the development component and wider development.

Main SRFI Site

23.237 Table 23.35 sets out the assessment of operational stage effects related to the Main SRFI Site. At this stage the following effect(s) are deemed to have a moderate or higher significance and require further adaptive mitigation to reduce the effect and improve resilience to Climate Change:

- Increase in summer and winter temperatures and changes in rainfall – The increase in temperatures and changes in rainfall are anticipated to lead to greater swings in ground conditions through summer and winter which can lead to ground movement impacting on the Main SRFI site infrastructure foundations. Given the potential for structural damage this is therefore considered to have a moderate significant negative effect. In this context ensuring best practice design measures taking into account the impacts of climate change are incorporated prior to construction is key to mitigating this effect.

- Increase in summer mean and daily maximum temperature - The increase in summer mean and daily maximum temperature may result in an increased need for cooling which could increase energy use and therefore GHG emissions. The Building Regulations require development to consider the potential for overheating and it is considered this will provide sufficient resilience to the buildings at this stage. However the consideration of additional measures during the design stage to install

cooling systems in line with the cooling hierarchy would enhance the resilience of the new buildings.

- Increased winter rainfall – The impact of increased winter rainfall may lead to an increase in surface water flood risk to buildings and infrastructure as well as potentially impacting on road conditions. Adaptive mitigation is required to ensure that drainage systems, floor levels and critical infrastructure elements are raised sufficiently and protected against potential surface water flooding.

- Reduced summer rainfall – The impact of reduced summer rainfall may affect local and national water supplies. As the East Midlands is in an area of moderate water stress this could impact on the operation of the site and therefore water efficiency measures should be incorporated to reduce consumption and the risk of water supply shortages.

23.238 At this stage the embedded mitigation set out in the following table is considered to be suitable to provide the development with an adequate level of resilience from specific environmental effects, however further enhanced mitigation could improve the resilience of the development for the following:

- Reduced Summer Rainfall – A reduction in summer rainfall may have a minor negative effect on site biodiversity through a lack of rainfall or water irrigation supplies. Provision of ongoing habitat management and use of onsite irrigation utilising water from the surface water attenuation areas could help minimise this impact.

Table 23.33: Assessment of Operational Stage Effects - Main SRFI Site

Assessment of Operational Stage Effects - Main SRFI Site						
Climatic Variable	Potential climatic effect	Embedded Mitigation	Magnitude and nature of impact	Sensitivity of receptor(s)	Significance	Climate change resilience
Increase in winter mean temperature	Higher winter mean temperatures are anticipated to have different effects on the species present at the completed development providing a number of benefits and disadvantages for site biodiversity proposed as part of the Green Infrastructure Plan.	No embedded mitigation is proposed	Negligible – Discussions with the project consultant ecologist confirms the likely species selection will be able to adapt to climate change.	Very Low – While susceptible to climate change both positive and negative effects overall limit the sensitivity of species.	Negligible	High
Increase in winter mean temperature	Higher winter mean temperatures will reduce heating requirement and therefore energy use and GHG emissions.	No embedded mitigation is considered necessary	Low beneficial – A reduction in energy use in buildings has the potential to be a long term benefit in reduced GHG emissions.	Low – Heating requirements for buildings makes up a relatively small portion of the energy use from the entire development	Minor	High
Increase in summer mean and daily maximum temperature	Higher average mean summer temperatures and daily maximum temperatures may increase the potential for impacts upon the foundations of infrastructure and buildings as a result of	No embedded mitigation proposed beyond that inherent in legislation	Moderate negative – Ground movement has the potential	Moderate – Buildings, roads, rail infrastructure sensitive to	Moderate negative	Medium

Assessment of Operational Stage Effects - Main SRFI Site						
Climatic Variable	Potential climatic effect	Embedded Mitigation	Magnitude and nature of impact	Sensitivity of receptor(s)	Significance	Climate change resilience
	shrinkage.		to have structural impacts to development elements.	ground movement and foundation damage		
Increase in summer mean and daily maximum temperature	Higher average mean summer temperatures and daily maximum temperatures could impact on the sites electrical equipment and infrastructure.	No embedded mitigation proposed	Moderate negative – Damage to electrical equipment could cause major operational disruption	Low – Systems such as this are regularly checked and would be subject to maintenance anticipated to forestall any issues.	Minor	High
Increase in summer mean and daily maximum temperature	Higher average mean summer temperatures and daily maximum temperatures may lead to building overheating	Buildings to be designed in accordance with the Building Regulations which includes an assessment for overheating based on climatic conditions. Measures to reduce overheating will be implemented as required.	Low – An increase in maximum temperatures would like be mitigated through systems put in place as a result of required energy modelling.	Very Low The Building Regulations require new buildings to take into account potential overheating	Negligible	High

Assessment of Operational Stage Effects - Main SRFI Site						
Climatic Variable	Potential climatic effect	Embedded Mitigation	Magnitude and nature of impact	Sensitivity of receptor(s)	Significance	Climate change resilience
Increase in summer mean and daily maximum temperature	Higher summer temperatures and an increase in daily maximum temperatures may lead to an increase in cooling requirements, increasing energy use and GHG emissions.		Low negative – An increase in GHG emissions is considered a negative impact, however this is anticipated to be an infrequent occurrence	Moderate – Buildings will be sensitive to warmer climates	Moderate/ Minor	Moderate
Increase in summer mean and daily maximum temperature	Higher summer mean and daily maximum temperatures are anticipated to have a mixed impact providing benefits and disadvantages for the on-site biodiversity.	No embedded mitigation is proposed	Negligible – Discussions with the project consultant ecologist confirms the likely species selection will be able to adapt to climate change.	Very Low – While susceptible to climate change both positive and negative effects overall limit the sensitivity of species.	Negligible	High
Increase in winter rainfall	An increase in winter rainfall is likely to lead to an increase in surface water run-off	The Main Parameters Plan includes provision for Sustainable Drainage Systems (SuDS) to manage surface water run-off. The Hydrology Chapter includes details of the drainage system to be included	Low – Seasonal impact with potential for some operational loss	Low – Inclusion of SuDS reduces the sensitivity of the receptor	Minor	High

Assessment of Operational Stage Effects - Main SRFI Site						
Climatic Variable	Potential climatic effect	Embedded Mitigation	Magnitude and nature of impact	Sensitivity of receptor(s)	Significance	Climate change resilience
		which will include a 40% allowance for the effects of climate change.				
Increase in winter rainfall	An increase in winter rainfall could lead to an increased risk of surface water flooding which could impact site infrastructure and operation.	No embedded mitigation noted at this stage	Moderate – Seasonal impact where flooding could impact on the operation of the site.	Moderate – Buildings, infrastructure and key elements such as electrical substations sensitive to flooding.	Moderate	Low
Increase in winter rainfall	An increase in winter rainfall may increase the potential for impacts upon the foundations of infrastructure and buildings as a result of ground movement and subsistence.	No embedded mitigation proposed beyond that inherent in legislation	Moderate negative – Ground movement has the potential to have structural impacts to development elements.	Moderate – Buildings, roads, rail infrastructure sensitive to ground movement and foundation damage	Moderate negative	Medium

Assessment of Operational Stage Effects - Main SRFI Site						
Climatic Variable	Potential climatic effect	Embedded Mitigation	Magnitude and nature of impact	Sensitivity of receptor(s)	Significance	Climate change resilience
Decrease in summer rainfall	A decrease in summer rainfall may have an adverse impact on site biodiversity	No embedded mitigation proposed	Very Low– There could be an impact from water stress	Moderate Biodiversity is sensitive to reductions in water	Minor	Moderate
Decrease in summer rainfall	A decrease in summer rainfall may lead to reduced water availability for the development affecting operation.	No embedded mitigation	Low – Seasonal impact with low potential for impacting operation	Moderate – The area is considered under 'water stress'	Moderate	Low

Junction 15a Works

23.239 Table 23.38 sets out the assessment of operational stage effects related to the Junction 15a Works. At this stage the following effect(s) are deemed to have a moderate or higher significance and require further mitigation:

- Increase in summer and winter temperatures and changes in rainfall – The increase in temperatures and changes in rainfall are anticipated to lead to greater swings in ground conditions through summer and winter which can lead to ground movement impacting on the Junction 15a road and infrastructure foundations. Given the potential for structural damage this is therefore considered to have a moderate significant negative effect. In this context ensuring best practice design measures taking into account the impacts of climate change are incorporated prior to construction is key to mitigating this effect.

- Increased winter rainfall – The impact of increased winter rainfall may lead to an increase in surface water run-off and surface water flood risk which could impact on road conditions. Additional mitigation is required to ensure that drainage systems are designed to minimise the potential for surface water flooding.

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Table 23.34: Assessment of Operational Stage Effects - Junction 15a Works

Assessment of Operational Stage Effects - Junction 15a Works						
Climatic Variable	Potential climatic effect	Embedded Mitigation	Magnitude and nature of impact	Sensitivity of receptor(s)	Significance	Climate change resilience
Increase in winter mean temperature	Higher winter mean temperatures are anticipated to have different effects on the completed development species providing a number of benefits and disadvantages for site biodiversity proposed as part of the Green Infrastructure Plan.	No embedded mitigation is proposed	Negligible – Discussions with the project consultant ecologist confirms the likely species selection will be able to adapt to climate change.	Very Low – While susceptible to climate change both positive and negative effects overall limit the sensitivity of species.	Negligible	High
Increase in summer mean and daily maximum temperature	Higher average mean summer temperatures and daily maximum temperatures may increase the potential for impacts upon the foundations of infrastructure and buildings as a result of shrinkage.	No embedded mitigation proposed beyond that inherent in legislation	Moderate negative – Ground movement has the potential to have structural impacts to development elements.	Moderate – Road infrastructure sensitive to ground movement and foundation damage	Moderate negative	Medium
	Higher summer mean and daily maximum temperatures are anticipated to have a mixed impact providing a number of benefits and disadvantages for biodiversity	No embedded mitigation is proposed	Negligible – Discussions with the project consultant	Very Low – While susceptible to climate change both positive and	Negligible	High

Assessment of Operational Stage Effects - Junction 15a Works						
Climatic Variable	Potential climatic effect	Embedded Mitigation	Magnitude and nature of impact	Sensitivity of receptor(s)	Significance	Climate change resilience
			ecologist confirms the likely species selection will be able to adapt to climate change.	negative effects overall limit the sensitivity of species.		
Increase in winter rainfall	An increase in winter rainfall has the potential to lead to an increase in surface water run-off.	No embedded mitigation	Moderate– Seasonal impact with the potential for some disruption	Moderate– Areas of road susceptible to surface water flooding if drainage systems are inundated.	Moderate	Low
Increased winter rainfall	Increased winter rainfall may increase the potential for impacts upon the foundations of infrastructure and buildings as a result of ground movement and subsidence.	No embedded mitigation proposed beyond that inherent in legislation	Moderate negative – Ground movement has the potential to have structural impacts to development elements.	Moderate – Road infrastructure sensitive to ground movement and foundation damage	Moderate negative	Medium
Decrease in summer rainfall	A decrease in summer rainfall may have an adverse impact on site habitats and species.	No embedded mitigation	Very Low negative – There could be an impact from	Low – Habitats are sensitive to a lack of water	Minor	High

Assessment of Operational Stage Effects - Junction 15a Works						
Climatic Variable	Potential climatic effect	Embedded Mitigation	Magnitude and nature of impact	Sensitivity of receptor(s)	Significance	Climate change resilience
			water stress however the magnitude is reduced given the scale of GI proposed			

Other Minor Highway Works

23.240 Table 23.37 sets out the assessment of operational stage effects related to the Other Minor Highway Works. At this stage the following effect(s) are deemed to have a moderate or higher significance and require further mitigation:

- Increase in summer and winter temperatures and changes in rainfall – The increase in temperatures and changes in rainfall are anticipated to lead to greater swings in ground conditions through summer and winter which can lead to ground movement impacting on the road and other highways infrastructure foundations. Given the potential for structural damage this is therefore considered to have a moderate significant negative effect. In this context ensuring best practice design measures taking into account the impacts of climate change are incorporated prior to construction is key to mitigating this effect.

- Increased winter rainfall – The impact of increased winter rainfall may lead to an increase in surface water run-off and surface water flood risk which could impact on road conditions. Additional mitigation is required to ensure that drainage systems are designed to minimise the potential for surface water flooding.

Table 23.35: Assessment of Operational Stage Effects - Other Minor Highway Works

Assessment of Operational Stage Effects – Other Minor Highway Works						
Climatic Variable	Potential climatic effect	Embedded Mitigation	Magnitude and nature of impact	Sensitivity of receptor(s)	Significance	Climate change resilience
Increase in winter mean temperature	Higher winter mean temperatures are anticipated to have different effects on the species present at the completed development providing a number of benefits and disadvantages for site biodiversity proposed as part of the Green Infrastructure Plan.	No embedded mitigation is proposed	Negligible – Discussions with the project consultant ecologist confirms the likely species selection will be able to adapt to climate change.	Very Low – While susceptible to climate change both positive and negative effects overall limit the sensitivity of species.	Negligible	High
Increase in summer mean and daily maximum temperature	Higher average mean summer temperatures and daily maximum temperatures may increase the potential for impacts upon the foundations of infrastructure and buildings as a result of shrinkage.	No embedded mitigation proposed beyond that inherent in legislation	Moderate negative – Ground movement has the potential to have structural impacts to development elements.	Moderate – Road and other infrastructure sensitive to ground movement and foundation damage	Moderate negative	Medium
	Higher summer mean and daily maximum temperatures are anticipated to have a mixed impact providing a number of benefits and disadvantages for biodiversity	No embedded mitigation is proposed	Negligible – Discussions with the project consultant	Very Low – While susceptible to climate change both positive and	Negligible	High

Assessment of Operational Stage Effects – Other Minor Highway Works						
Climatic Variable	Potential climatic effect	Embedded Mitigation	Magnitude and nature of impact	Sensitivity of receptor(s)	Significance	Climate change resilience
			ecologist confirms the likely species selection will be able to adapt to climate change.	negative effects overall limit the sensitivity of species.		
Increase in winter rainfall	An increase in winter rainfall has the potential to lead to an increase in surface water run-off.	No embedded mitigation	Moderate– Seasonal impact with the potential for some disruption	Moderate– Areas of road susceptible to surface water flooding if drainage systems are inundated.	Moderate	Low
Increased winter rainfall	Increased winter rainfall may increase the potential for impacts upon the foundations of the proposed road as a result of ground movement and subsistence.	No embedded mitigation proposed beyond that inherent in legislation	Moderate negative – Ground movement has the potential to have structural impacts to development elements.	Moderate – Road and other infrastructure sensitive to ground movement and foundation damage	Moderate negative	Medium
Decrease in summer rainfall	A decrease in summer rainfall may have an adverse impact on site habitats and species.	No embedded mitigation	Very Low negative – There could be an impact from	Low – Habitats are sensitive to a lack of water	Minor	High

Assessment of Operational Stage Effects – Other Minor Highway Works						
Climatic Variable	Potential climatic effect	Embedded Mitigation	Magnitude and nature of impact	Sensitivity of receptor(s)	Significance	Climate change resilience
			water stress however the magnitude is reduced given the scale of GI proposed			

Assessment of Decommissioning Phase Effects

23.241 Decommissioning includes all works and processes required to undertake the closure, dismantling and removal of the Proposed Development.

23.242 At this stage the long term operational lifespan is unknown. The design life of the proposed buildings will be in the order of 60 or more years and the rail infrastructure significantly longer. At present the impacts of climate change upon the operational phase have been assessed against a 2080 baseline which is the only point at which UKCP09 data is available. Given that no climate change data is available beyond this time there is no baseline with which to assess the impacts of climate change upon the decommissioning of the Proposed Development and so this has been scoped out of the assessment.

Cumulative Effects

23.243 This section sets out the inter-project, and intra-project cumulative effects of the Proposed Development.

Intra-project Cumulative Effects

23.244 As stated throughout this Chapter there are a number of noticeable interactions between the future effects of Climate Change and other ES topics. Where necessary relevant members of the technical team have been contacted to discuss these intra-project cumulative effects and appropriate assessment and mitigation undertaken accordingly.

23.245 Below is a summary of the interaction with the other PEIR Chapters, highlighting where climate change is anticipated to have an effect and those areas where there is no impact.

23.246 **Air Quality-** It is anticipated that the effects of climate change, in particular increased summer temperatures could increase dust emissions during construction. In this context the CEMP has been updated to ensure mitigation measures will be put in place to minimise this risk. With regard to the wider development and operation the Air Quality Chapter confirms that there will be no measurable effects on air quality due to climate change.

23.247 **Agricultural Land –** Given the nature of the Proposed Development it is not anticipated climate change will have an impact in relation to agriculture.

23.248 **Archaeology –** While ground conditions may be affected through increased summer mean and maximum temperatures and increased winter rainfall it is not anticipated this will impact on any archaeological remains on the site.

23.249 **Cultural Heritage –** Given the nature of the Proposed Development it is considered climate change will have no impact in relation to cultural heritage.

23.250 **Ground Conditions –** The impacts of climate change including the increased summer and winter temperatures, reduced summer rainfall and increased winter rainfall have the potential to affect ground conditions potentially affecting the foundations of infrastructure and buildings. (Ref 23.43)

23.251 Consultation with the Ground Conditions consultant has confirmed that through the use of best practice design the impacts of climate change and ground movement will be mitigated.

23.252 **Hydrology, Drainage and Flood Risk –** The impacts of climate change including increased winter rainfall have the potential to increase the risk of surface water run-off and flooding. In liaison with the Hydrology consultants the details of appropriate mitigation have been confirmed to minimise the risk of surface water flooding for all components of the development including and allowance for future climate change.

23.253 **Utilities –** The assessment of operational effects notes the potential for increased temperatures to impact on the performance and/or damage onsite electrical equipment. Through liaison with the Utilities consultant and design team it has been confirmed the onsite infrastructure will be designed in accordance with best practice and regularly maintained. Where appropriate measures will be put in place to protect the system from changes in future climate change.

23.254 **Biodiversity –** Climate change may involve increases in average temperatures, winter rainfall, summer drought, and extreme weather events, amounting to an increase in the Continental character of the climate. Because the biota of the site already lives under the relatively Continental climate of eastern England, there is less risk of adverse impact upon species than there might be elsewhere in Britain. The ecology consultant confirms that both positive and negative effects can be envisaged, and the net effect is unlikely to be significant. The green infrastructure plan will enhance the resilience of the development to climate change by avoiding species that are invasive in a warmer climate, and by enhancing biodiversity to the extent that net gains should remain even after the impact of any species losses due to climate change.

23.255 **Landscape and Visual –** Given the nature of the Proposed Development it is considered climate change will have no impact in relation to landscape and visual impact.

23.256 **Noise and Vibration –** Given the nature of the Proposed Development it is considered climate change will have no impact in relation to noise and vibration.

23.257 **Highway and Transportation –** It is anticipated that climate change may impact on infrastructure through changes to ground conditions and flooding. Consultation with

the Ground Conditions and Hydrology consultants has confirmed suitable mitigation to reduce the impacts of climate change.

23.258 **Socio Economics –** Given the nature of the Proposed Development it is considered climate change will have no impact in relation to Socio Economics.

23.259 **Lighting –** Given the nature of the Proposed Development it is considered climate change will have no impact in relation to Lighting, albeit the use of LED lighting is noted as a potential measures for reducing energy use and GHG emissions.

23.260 **Waste –** Given the nature of the Proposed Development it is considered climate change will have no impact in relation to Waste.

23.261 **Health -** Given the nature of the Proposed Development it is considered climate change will have no impact in relation to Health

23.262 **Major Accidents and Disaster -** Given the nature of the Proposed Development it is considered climate change will have no impact in relation to Major Accidents and Disasters,

23.263 **Built Heritage -** Given the nature of the Proposed Development it is considered climate change will have no impact in relation to Built Heritage.

Inter-project cumulative effects

23.264 The effects of Climate Change predominantly impact on the development rather than the development impacting on Climate Change with the exception of GHG emissions assessed in the first part of this Chapter. However, indirectly there is a risk associated with surface water runoff, as noted above and in the following mitigation section the proposed development aims to reduce surface water runoff as there is an increased risk of flooding due to an increase in winter rainfall associated with climate change.

23.265 In combination with related cumulative development, i.e. the Northampton Gateway there is the potential for a greater increased risk of surface water flooding with both sites, however, as noted in this Chapter and the Hydrology Chapter the measures put in place to limit this risk are regulatory and therefore the Northampton Gateway development will include similar measures.

23.266 In this context with regard to climate change adaptation, no inter-project cumulative effects are anticipated on the basis that the adaptation effects and impacts are specific to this particular development and will not result in any additional impacts to neighbouring development.

Mitigation

23.267 This section sets out the adaptive mitigation included within the design of the Proposed Development within each development component to reduce identified significant effects, or provide additional climate change resilience.

Main SRFI Site

23.268 The initial assessment of effects for the SRFI site noted a number of significant effects during construction and operation. The following tables set out the adaptive mitigation proposed to mitigate the significant effects identified and further additional mitigation proposed to enhance the climate change resilience of the site.

Adaptive Mitigation – Mitigating Significant Effects

23.269 The following table sets out the adaptive mitigation to reduce the identified significant effects.

Table 23.36: Main SRFI Site - Adaptive Mitigation – Mitigating Significant Effects

Potential effect	Proposed Mitigation	Means of implementation	Mechanism for securing mitigation and DCO reference (where applicable)
Construction			
During construction increase in annual temperatures and changes in rainfall may impact on ground conditions and infrastructure foundations	Use of best practice design and construction practices in line with relevant guidance including consideration of climate change	Inclusion of climate change impacts and guidance in design specifications for infrastructure foundations.	Requirement in respect to future detailed design specifications for infrastructure elements to consider climate change impacts and potential ground movement.
Operation			
The increase in summer mean and maximum temperature may lead to an increase in the need for building cooling	Provision of measures to enable building cooling as required utilising the cooling hierarchy prioritising passive design features over mechanical cooling	Implementation of recommendations set out in building energy modelling	Requirement in respect of future detailed design of new buildings to include consideration of the cooling hierarchy.
The increase in	The Hydrology	Implementation of	Requirement in

winter rainfall may lead to increased surface water flooding.	Chapter accompanying the assessment sets out measures to include SuDS to reduce the risk of surface water flooding.	measures set out in the Hydrology Chapter.	relation to the Hydrology Chapter.
The impact of reduced rainfall in the summer may lead to restrictions on water use impacting on site operation.	Provision of measures to reduce water use in the operation of the proposed buildings, meeting the water efficiency targets of BREEAM Excellent.	Assessment of buildings against BREEAM, in particular ensuring buildings achieve the required water reduction in line with BREEAM Excellent.	Through the provision of a Requirement relating to the water efficiency of new buildings.
Decommissioning			
N/A			
Cumulative			
N/A			

Adaptive Mitigation – Enhancing Climate Change Resilience

23.270 The following table sets out the adaptive mitigation to enhance the climate change resilience of the development.

Table 23.37: Main SRFI Site - Adaptive Mitigation – Enhancing Climate Change Resilience

Potential effect	Proposed Mitigation	Means of implementation
Construction		
N/A		
Operation		
The reduction in summer rainfall may have a negative impact on site biodiversity	Provision of a habitat management plan to facilitate the use of rainwater for irrigation.	Preparation of a habitat management plan which includes consideration of Climate Change and reduced summer waiter availability.

Junction15a Works

23.271 The initial assessment of effects for the J15a Works noted a number of significant effects during construction and operation. The following tables set out the adaptive mitigation proposed to mitigate the significant effects identified and further additional mitigation proposed to enhance the climate change resilience of the site.

Adaptive Mitigation – Mitigating Significant Effects

23.272 The following table sets out the adaptive mitigation to reduce the identified significant effects.

Table 23.38: Junction 15a Works - Adaptive Mitigation – Mitigating Significant Effects

Potential effect	Proposed Mitigation	Means of implementation	Mechanism for securing mitigation and DCO reference (where applicable)
Construction			
During construction increase in annual temperatures and changes in rainfall may impact on ground conditions and infrastructure foundations	Use of best practice design and construction practices in line with relevant guidance including consideration of climate change	Inclusion of climate change impacts and guidance in design specifications for infrastructure foundations.	Requirement in respect to future detailed design specifications for infrastructure elements to consider climate change impacts and potential ground movement.
Operation			
The increase in winter rainfall has the potential to increase surface water run-off and increase the risk of flooding for the new road elements	The Hydrology Chapter sets out the measures incorporated into the design of road elements and SuDS systems to mitigate the impact of surface water flood risk and drainage taking into account of climate change.	Design in accordance with the details of the Hydrology Chapter and Flood Risk Assessment and Drainage strategy which accompany the application.	Requirement the associated Flood Risk and Drainage strategy.
Decommissioning			
N/A			

Cumulative
N/A

Other Minor Highway Works

23.273 The initial assessment of effects for the Other Minor Highway Works noted a number of significant effects during construction and operation. The following tables set out the adaptive mitigation proposed to mitigate the significant effects identified and further additional mitigation proposed to enhance the climate change resilience of the site.

Adaptive Mitigation – Mitigating Significant Effects

23.274 The following table sets out the adaptive mitigation to reduce the identified significant effects.

Table 23.39: Other Minor Highway Works - Mitigating Significant Effects

Potential effect	Proposed Mitigation	Means of implementation	Mechanism for securing mitigation and DCO reference (where applicable)
Construction			
During construction increase in annual temperatures and changes in rainfall may impact on ground conditions and infrastructure foundations	Use of best practice design and construction practices in line with relevant guidance including consideration of climate change	Inclusion of climate change impacts and guidance in design specifications for infrastructure foundations.	Requirement in respect to future detailed design specifications for infrastructure elements to consider climate change impacts and potential ground movement.
Operation			
The increase in winter rainfall has the potential to increase surface water run-off and increase the risk of flooding for the new road elements	The Hydrology Chapter sets out the measures incorporated into the design of road elements and SuDS systems to mitigate the impact of surface water flood risk and drainage taking into account	Design in accordance with the details of the Hydrology Chapter and Flood Risk Assessment and Drainage strategy which accompany the application.	Requirement in the associated Flood Risk and Drainage strategy.

	of climate change.
Decommissioning	
N/A	
Cumulative	
N/A	

Residual Effects

23.275 The following tables set out the assessment of residual climate change effects taking into account the adaptive and enhanced mitigation measures proposed in the previous section. This includes an assessment of the climate change resilience of the development in this context. The tables set out the residual assessment for the individual development components.

Main SRFI Site

23.276 The following table sets out an assessment of the residual effects taking into account the proposed residual and enhanced mitigation for the Main SRFI Site.

Table 23.40: Main SRFI Site - Assessment of Residual Effects

Description of Impact	Significance of Effect	Possible Mitigation Measures	Residual Effect	Climate Change Resilience
Construction				
During construction increase in annual temperatures and changes in rainfall may impact on ground conditions and infrastructure foundations	Moderate negative	Use of best practice design and construction measures taking into account relevant design guidance including consideration of the effects climate change and ground movement.	Minor negative	High
Operation				
The increase in summer mean and daily maximum temperature may increase cooling requirements increasing energy	Moderate negative	Design of cooling systems in accordance with the cooling hierarchy	Minor Negative	High

use and GHG emissions				
Increase in winter rainfall may increase surface water flood risk.	Moderate negative	Provision of measures as set out in the Hydrology Chapter which include an allowance for future climate change	Minor negative	High
The impact of reduced rainfall in the summer may lead to issues with water availability	Moderate negative	Assessment of buildings against BREEAM, in particular ensuring buildings achieve the required water reduction in line with BREEAM Excellent.	Minor negative	High

Junction 15a Works

23.277 The following table sets out an assessment of the residual effects taking into account the proposed adaptive and enhanced mitigation for the Junction 15a Works.

Table 23.41: Junction 15a Works - Assessment of Residual Effects

Description of Impact	Significance of Effect	Possible Mitigation Measures	Residual Effect	Climate Change Resilience
Construction				
During construction increase in annual temperatures and changes in rainfall may impact on ground conditions and infrastructure foundations	Moderate negative	Use of best practice design and construction measures taking into account relevant design guidance including consideration of the effects climate change and ground movement.	Minor negative	High
Operation				
Increase in winter rainfall may increase surface	Moderate negative	Provision of measures as set out in the Flood Risk and	Minor negative	High

water run-off and flood risk.		Drainage assessment which includes an allowance for future climate change		

Other Minor Highway Works

23.278 The following table sets out an assessment of the residual effects taking into account the proposed adaptive and enhanced mitigation for the Other Minor Highway Works.

Table 23.42: Other Minor Highway Works - Assessment of Residual Effects

Description of Impact	Significance of Effect	Possible Mitigation Measures	Residual Effect	Climate Change Resilience
Construction				
During construction increase in annual temperatures and changes in rainfall may impact on ground conditions and infrastructure foundations	Moderate negative	Use of best practice design and construction measures taking into account relevant design guidance including consideration of the effects climate change and ground movement.	Minor negative	High
Operation				
Increase in winter rainfall may increase surface water run-off and flood risk.	Moderate negative	Provision of measures as set out in the Flood Risk and Drainage assessment which includes an allowance for future climate change	Minor negative	High

Monitoring

23.279 The mitigation measures proposed to be carried out to remove the identified significant impacts together within the construction and operational phases are intended to be subject to a Requirement imposed on the Development Consent Order for the Proposed Development.

23.280 As the proposed mitigation measures would reduce any significant environmental effects which would be enforced through planning condition, no post mitigation monitoring is required.

Limitations and Assumptions

23.281 There are a number of limitations and assumptions relevant to the climate change adaptation assessment carried out in this Chapter. These are summarised below.

Climate Change Projections

23.282 The future impacts of climate change are based on data from the IPCC, reviewed and updated for the UK climate. The IPCC data is based upon a range of assumptions with regards to global GHG emissions and climate modelling which themselves are variable.

23.283 The UK projections as set out on the UKCP09 website provides climate projections for the UK for three different future greenhouse gas emissions scenarios, low, medium and high. The climate projections under each scenario differ with greater variability in climate impacts projected using the high emissions scenario with corresponding lower variability from the low emissions scenario.

23.284 At this time, the UKCP09 data is being updated in light of recent GHG emission data and internationally significant GHG emission reduction agreements such as the Paris Accord. These variances in data and predicted future climate must therefore be considered in the context of this assessment

23.285 In this context the data and projections themselves may change in the future, however while the expected temperature or rainfall changes may alter it is anticipated the overall trends generated are proven and provide a sound basis for the assessment of effects set out in this Chapter.

Climate Change Adaptation Assessment

23.286 Climate change adaptation is a unique assessment as it reviews the impacts of the changing climate and how this may affect the Proposed Development. As acknowledged within the IEMA Guidance, there is no regulated or agreed method of presenting climate information and approaches vary depending on the scale of the Proposed Development and the application of professional judgement.

Where possible as part of this assessment key evidence to determine the risks posed by climate change to the Proposed Development have been reviewed to provide context for the qualitative assessment carried out. This approach is considered suitable given the nature of the Proposed Development.

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