15. Climate Change

15.1. Introduction

15.1.1. Over recent decades, climate change has become a more important environmental, social and economic policy concern. Consequently, climate change is also seen to be an important consideration in relation to project level assessment and decision-making.

15.1.2. This chapter assesses the effects that may arise as a result of climate change on the Proposed Development (hereafter referred to as the 'Climate Change Resilience [CCR] Assessment') and the effects of greenhouse gas (GHG) emissions associated with the Proposed Development (hereafter referred to as the 'GHG Emissions Assessment') in accordance with the Town and Country Planning (Environmental Impact Assessment) Regulations 2017[1] (as amended) (hereafter referred to as the 'EIA Regulations').

15.1.3. The chapter describes the methods used to assess the likely significant effects, the baseline conditions currently existing at the site and surroundings, the potential direct and indirect effects of climate change on the Proposed Development and the potential direct and indirect effects of the Proposed Development on climate change, the mitigation measures required to prevent, reduce, or offset the identified significant effects and the residual effects.

15.1.4. This Chapter is supported by the following figures and appendices:

- **Figure 15.1:** IEMA's Best Practice Procedures for GHG Assessment;
- **Figure 15.2:** Local Average, Minimum and Maximum Temperatures for 2023;
- **Figure 15.3:** Wind Rose;
- **Appendix 15.1:** Steps Involved in Assessing CCR and Adaptation in EIA and Determining the Significance of Impacts;
- **Appendix 15.2:** Climate Variables Considered for Each Sensitive Receptor;
- **Appendix 15.3:** Legislation, Policies and Agendas Context;
- **Appendix 15.4:** Summary of Local, Regional and National GHG emissions (2020) for Relevant Sectors; and
- **Appendix 15.5:** Assessment of the Resilience of the Proposed Development to Climate Change.

[1] UK Government (updated 2020) Town and Country Planning (Environmental Impact Assessment) Regulations 2017 (the 'EIA Regulations'),: https://www.legislation.gov.uk/uksi/2017/571/2020-12-24

15.2. Assessment Approach

15.2.1. The likely significant environmental effects to be considered within this Climate Change chapter are as follows:

- The resilience of the Proposed Development to climate change;
- The influence of the Proposed Development on climate change (i.e. emissions of GHGs); and
- The cumulative effects of the Proposed Development.

15.2.2. The scope and methodologies for the resilience of the Proposed Development to climate change and the influence of the Proposed Development on climate change will be addressed in separate subsections in the remainder of this section.

Methodology and Scoping Criteria

Resilience of the Proposed Development to Climate Change

15.2.3. IEMA's guidance[2] for making a development resilient against, and adaptable to, climate change stresses that climate change should be an integrated consideration within the EIA. This includes, for example, in the review of alternatives and the project design, how baseline environmental conditions may change with a changing climate and the resilience of mitigation measures to climate change. It should be informed by an understanding of future climate change scenarios and of the potential range of effects associated with these projections.

15.2.4. By its very nature, climate change spans a range of topics and therefore elements of climate change are considered throughout this ES and other planning documents. This assessment applies the guiding methodology, the steps of which are set out in **Table 1** of **Appendix 15.1.**

Study Area

15.2.5. The study area consists of the infrastructure within the Site, as shown in the Site Layout Plan (n2277_001E Site Location Plan). Information on climate trends and projections at the regional and local scale (where available) have been utilised.

15.2.6. The location of the Site is shown in **Figure 1.1.**

Temporal Scope

15.2.7. The construction of the Proposed Development will last approximately 7 years. As the construction phase is expected to take less than 10 years (see **Chapter 4: Proposed Development and Alternatives** of this ES), the variability of the climate in the last 10 years has been taken into account when judging its resilience to climate change during this phase. The identification of recent extreme short-term weather events has also been completed, as recommended by IEMA[2]. Given the length of the construction phase, it will not be considered

[2] IEMA (2020) Environmental Impact Assessment Guide to Climate Change Resilience and Adaptation, https://www.iema.net/media/mabhqino/iema-eia-climate-change-resilience-june-2020.pdf

within the CCR Assessment. However, climate change-related mitigation measures for the construction phase will be recommended to bolster resilience.

15.2.8. In relation to the operational phase, the long-term impacts of climate change, as predicted in the UKCP18, will be used to judge its resilience. This accords with IEMA guidance[2]. Climate change-related mitigation measures for the operational phase will be based on these long-term projections, looking at changes over the planned lifetime of the Proposed Development, which is assumed to be at least 60 years from commissioning.

Baseline Data Collection

15.2.9. The baseline data collected and presented in this Chapter were sourced through desktop research, as well as information from other chapters within this ES.

15.2.10. Historical regional weather data published by the Met Office and data from relevant websites will be utilised to establish the current climate within the region and the Site in which the Proposed Development would be located.

15.2.11. Climate trends and projections are published by the Met Office through the UKCP website and provide the most up to date assessment of how the climate of the UK may change over this century. The projections that are used to define the future baseline against which resilience of the Proposed Development is assessed are 'UKCP18' projections for the 2080s under a high ('worst-case') emissions scenario ('Representative Concentration Pathway[3] 8.5') for the 12 km^2 UKCP18 grid square in which the Proposed Development would be located.

15.2.12. Data used within the CCR Assessment has been collected from the following sources:

- Relevant websites which provide information on recent weather patterns at the regional and local scales[4,5,6];
- UK Climate Projections (2018) (UKCP18[7]) – UK climate change projections used to define the future baseline against which the resilience of the Proposed Development to climate change is assessed;
- Centre for Environmental Data Analysis (CEDA[8]) – for observed climate data;
- Met Office regional climate profile for the Midlands[9] – for observed climate data; and

[3] A Representative Concentration Pathway is a greenhouse gas concentration trajectory adopted by the International Panel on Climate Change (IPCC).
[4] Met Office (no date) UK climate averages – Watnall Climate Station, https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-averages/gcrje93b8
[5] Meteostat (no date) Nottingham Weather Centre, https://meteostat.net/en/station/03354?t=2023-01-01/2023-12-31
[6] Weather Spark (no date) 2023 Weather History at East Midlands Airport, https://weatherspark.com/h/y/147821/2023/Historical-Weather-during-2023-at-East-Midlands-Airport-United-Kingdom
[7] Met Office (2018) UK Climate Projections (UKCP), https://www.metoffice.gov.uk/research/approach/collaboration/ukcp
[8] CEDA Catalogue UK Climate Projections 2018 (UKCP18), https://catalogue.ceda.ac.uk/uuid/c700e47ca45d4c43b213fe879863d589?jump=related-docs-anchor
[9] Met Office (2016) Midlands: climate, https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/weather/regional-climates/midlands_-climate-met-office.pdf

- Where relevant, information within assessments offered in respect of other Chapters within this ES.

15.2.13. Taken together, it is considered that the data sources in combination with other topical assessments that form the Application provide a robust indication of the prevailing baseline situation relevant to the assessment reported within this Chapter.

Identifying Sensitive Receptors

15.2.14. Sensitive receptors were identified through examination of:

- The Parameters Plan (**Figure 4.1**) for the Proposed Development;
- Other Chapters within this ES;
- Other documents which will be submitted as part of the Application, such as the Design and Access Statement; and
- Professional judgement.

15.2.15. Following a review of the above information, the following receptors have been identified as being sensitive:

- Substructure / Earthworks;
- Infrastructure / Building Structures / Ancillary Equipment;
- Roads / Footpaths;
- Landscaping / Habitats; and
- Humans.

15.2.16. **Appendix 15.2** lists the climate variables, including extreme weather events, which have been considered in the CCR Assessment (indicated with a tick in the table). Blank cells indicate variables that have not been considered further in this assessment due to geography and/or the context of the Proposed Development. A risk-based approach to assessing change adaptation for settlements and infrastructure has been applied and adapted using best practice guidance and professional judgement[2,10].

15.2.17. Given the location of the Site in relation to the coast, potential sea-related effects have not been considered relevant to the CCR Assessment and have therefore been excluded. The potential effects of wind have been scoped out of the CCR Assessment given the International Panel on Climate Change's (IPCC) prediction that the increase in wind speeds for the second half of the 21st century is not expected to deviate significantly compared to the current variability of wind speeds[11]. The potential effects of humidity and the salinity / pH have also been excluded based

[10] Standards Australia (2013) Climate change adaptation for settlements and infrastructure - A risk based approach, https://infostore.saiglobal.com/en-gb/standards/as-5334-2013-119943_saig_as_as_251367/

[11] Met Office (no date) UK and Global extreme events – Wind storms, https://www.metoffice.gov.uk/research/climate/understanding-climate/uk-and-global-extreme-events-wind-storms

on the professional judgement that any potential future effects of these variables would not lead to significant effects.

Determining the Significance of Impacts

Vulnerability and Sensitivity of Receptors

15.2.18. The CCR Assessment has not only identified the Proposed Development's potentially sensitive receptors to climate change, but also determined each receptor's sensitivity to these changes should they occur. In simplistic terms, the vulnerability of the proposals are determined as follows:

sensitivity of the receptor x susceptibility of the proposals to climatic change = the degree of vulnerability

15.2.19. To aid the user, definitions for each have been set out in **Table 15.1**.

Table 15.1: Definitions for Sensitivity of Receptors

Term	Definition
Receptor's Sensitivity	The degree of response of a receiver to a change and a function of its capacity to accommodate and recover from a change if it is affected.
Receptor's Susceptibility	Its ability to be affected by a change.
Receptor's Vulnerability	A measure of its potential exposure to the changing climate.

15.2.20. Identifying the sensitivity of receptors has been achieved by determining each receptor's susceptibility and vulnerability to climate change.

15.2.21. Criteria for determining a receptor's susceptibility in this assessment are included within **Table 2** of **Appendix 15.1**.

15.2.22. Criteria for determining a receptor's vulnerability are included within **Table 3** of **Appendix 15.1**.

15.2.23. Assessing the significance of potential effects on the Proposed Development has applied a risk-based methodology for identifying potential climate impacts and assessing their severity (IEMA[2]) and can be summarised into the following steps:

- Identifying potential climate change risks to a scheme or project;
- Assessing these risks (potentially prioritising to identify the most severe); and
- Formulating mitigation actions to reduce the impact of the identified risks.

15.2.24. The assessment of risk to the Proposed Development includes assessing the likelihood (or probability) and consequence of the impacts identified. The likelihood and consequence of each effect have been qualitatively assessed using the descriptions in **Table 4** and **Table 5** of **Appendix 15.1.** The determination of the likelihood and consequence have been based on professional judgement and IEMA guidance[2].

15.2.25. The assessment of the magnitude of impacts to receptors has considered factors including:

- The acceptability of any disruption in use if the Proposed Development fails;
- Its capital value if it had to be replaced;
- Its impact on neighbours;
- The vulnerability of the Proposed Development element or receptor; and
- Whether there are dependencies between the receptor and any interconnected network of nationally important assets on the Proposed Development.

Significance of Effects

15.2.26. The significance of the potential effects of climate change on receptors is determined by combining the likelihood and consequence ratings in **Table 4** and **Table 5** of **Appendix 15.1** respectively, as shown in **Table 15.2.**

Table 15.2: Matrix for Significance for CCR Assessment

Measure of Consequence	Measure of Likelihood				
	Very Low	**Low**	**Medium**	**High**	**Very High**
Negligible	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
Minor	Not Significant	Not Significant	Not Significant	Significant	Significant
Moderate	Not Significant	Not Significant	Significant	Significant	Significant
Large	Not Significant	Significant	Significant	Significant	Significant
Very Large	Not Significant	Significant	Significant	Significant	Significant

15.2.27. There are some instances where the effects of climate change may be beneficial for receptors. This is clearly stated where relevant within the CCR Assessment.

15.2.28. In accordance with best practice, short-term effects are considered to be those associated with the construction work and long-term effects are those associated with the completed and operational Proposed Development.

Applying Mitigation

15.2.29. Suitable mitigation measures to address adverse effects on the ability of resources and receptors to adapt to climate change will be developed by other topical specialists and chapter authors contributing to the ES. For example, climate change projections based on current Environment Agency guidance have been used in the Flood Risk Assessment as part of the assessment of drainage and flood-risk issues, and appropriate mitigation and design responses proposed.

15.2.30. Measures will be embedded into the design of the Proposed Development which would increase its resilience to climate change. Following the identification of any residual impacts, additional

mitigation measures might also be recommended to further increase the Proposed Development's resilience to climate change.

Assumptions and Limitations

15.2.31. The assumptions and limitations which apply to the CCR Assessment are outlined in **Table 15.3**. For each assumption or limitation, an explanation of the possible effect of the assumption has been provided, as well as a description of any corrective actions that have been taken to adjust for any limitations. These assumptions are considered reasonable and are not likely to impact on the outcome of the assessment.

Table 15.3: CCR Assessment Assumptions and Limitations

Assumption/Limitation	Consequence	Resolution
The assessment undertaken provides a broad indication of the potential impacts of climate change on the Proposed Development.	The assessment is based on a qualitative assessment and professional judgement.	An approach has been developed and applied in this assessment based on existing best practice IEMA guidance.
The UKCP18 projections have been used to infer future changes in a range of climate variables that may affect the resilience of the Proposed Development to climate change. At the time of writing, these represent the most up-to-date representation of future climate in the UK.	There are inherent uncertainties associated with climate projections and they are not predictions of the future. It is possible that future climate will differ from the baseline climate against which the resilience of the Proposed Development has been assessed depending on global emissions over the next century.	A 'high' emissions scenario (Representative Concentration Pathways (RCP) 8.5) using the 2080s time-slice (2070- 2099 – the longest temporal scale available through UKCP18) has been used to develop the baseline against which resilience has been assessed. This is consistent with the precautionary principle (i.e. 'worst case' scenario).
Analysis of climate projections is based on selected observational data available at the time of assessment.	Future climate projections, which may be more accurate, could not be accounted for within this assessment.	Any future decision-making based on this analysis should consider the range of literature, evidence and research available at that time and any changes to this.
The determination of resilience has been undertaken under the assumption that industry design standards will be adhered to where detailed information is unavailable.	Industry design standards may not have been updated to account for climate resilience.	Industry design standards are to be applied, as applicable, as the design, construction and operation of the Proposed Development develops.
Limitations associated with the approach taken	Climate change, by its very nature, is associated with a range	Assessments made in relation to 'consequence' and

Assumption/Limitation	Consequence	Resolution
for the in-combination climate change impacts (ICCI) Assessment relate to uncertainties inherent within UKCP18 Projections.	of assumptions and limitations. For example, there is uncertainty regarding how global climatic trends will be reflected at the regional scale. To overcome these issues, probabilistic forecast climate change data has been used from UKCP18. This has been coupled with the replication of proven effective approaches undertaken for similar project types.	'likelihood' rely on professional judgement and evidence gathered through other environmental disciplines. All assumptions and limitations, including any exclusions, together with assumptions for choices and criteria leading to exclusion of input and output data have been documented as part of the assessment.

Influence of the Proposed Development on Climate Change

15.2.32. The GHG Assessment relates to the effects of GHG emissions relating to the Proposed Development which would contribute to climate change. The Proposed Development will be assessed within the context of the UK's evolving carbon agenda. The GHG Assessment follows IEMA's best practice procedures, the steps of which are illustrated in **Figure 15.1**.

15.2.33. In selecting or developing an approach for a GHG Assessment suitable for the purposes of EIA, the aim should be to deliver a robust, proportionate, appropriate and consistent assessment.

Study Area

15.2.34. GHG emissions are not geographically limited. They have a global effect rather than directly affecting any specific local receptor to which a level of sensitivity can be assigned. The GHG Assessment is not restricted by geographical area and a spatially limited study boundary cannot be clearly drawn as the scale of the impact considered in the context of atmospheric GHG concentrations is global. Therefore, in accordance with IEMA guidance[12], the receptor for GHG emissions is the global atmosphere. Reference has been made to the global context as appropriate. However, for the purposes of this assessment, the study area relates to the Proposed Development's Site boundary, as shown in the **Figure 1.1** and the immediate roads that vehicles either enter or exit the Site from. Traffic flows associated with other roads included within the affected transport network, as set out in the Transport Assessment (**Appendix 9.1**) for the Proposed Development, have not been included to avoid the double counting of traffic. Assumptions for the journey length of each vehicle is set out in the 'Baseline Data Collection' sub-section below.

Identifying Sensitive Receptors

15.2.35. In accordance with IEMA guidance[12], the global environment within which GHG emissions are emitted is considered to be the sensitive receptor within the GHG Assessment; the sensitivity of the global atmosphere is high.

Sources of GHG Emissions

15.2.36. Sources of carbon emissions have been grouped to differentiate between primary, secondary and tertiary sources as follows:

- **Scope 1** refers to emissions from sources that an organization owns or controls directly – for example from burning fuel in our fleet of vehicles (if they're not electrically-powered).

- **Scope 2** are emissions that a company causes indirectly and come from where the energy it purchases and uses is produced. For example, the emissions caused when generating the electricity that we use in our buildings would fall into this category.

- **Scope 3** encompasses emissions that are not produced by the company itself and are not the result of activities from assets owned or controlled by them, but by those that it's indirectly responsible for up and down its value chain. An example of this is when we buy, use and dispose of products from suppliers. Scope 3 emissions include all sources not within the scope 1 and 2 boundaries.

15.2.37. **Table 15.4** sets out the GHG emissions considered, whether it was proposed to scope them in or out of the GHG Assessment, and whether it was proposed to assess them quantitatively or qualitatively if scoped in. It was proposed to scope natural capital out of the assessment given the low levels of green and blue infrastructure on the existing Site. The scoping process was used to determine a proportionate assessment for the Proposed Development. It should be recognized that qualitative assessments are acceptable in accordance with IEMA guidance[12] where, for example, data is unavailable.

[12] IEMA (2022) Assessing Greenhouse Gas Emissions and Evaluating their Significance, https://www.iema.net/media/soanjg22/eia-guide_ghg-assessment-and-significance_iema_16may17.pdf

Table 15.4: GHG Emissions Scoping

GHG Emissions Sources	Description	Scope Type	Scoped In/ Out	Quantitative/Qualitative
Construction				
Direct GHG (Energy)	Construction energy – On-site fuel combustion (e.g. construction plant)	Scope 1	Scoped In	Quantitative (within Embodied Carbon)
Direct GHG (Vehicles)	Vehicular Emissions	Scope 1	Scoped In	Qualitative for construction employee commuting movement. Quantitative for transport of construction materials to Site (within Embodied Carbon)
Indirect GHG (Construction)	Embodied carbon associated with construction (A1 – A5 lifecycle stages only)	Scope 1	Scoped In	Quantitative
Solid Waste	Waste arising during construction	Scope 3	Scoped In	Qualitative
Water	Water demand associated with construction works	Scope 3	Scoped In	Qualitative
Operation				
Direct GHG (Vehicles)	Vehicular emissions	Scope 1	Scoped In	Quantitative
Direct GHG (Energy)	Operational energy – On-site fuel combustion (e.g. gas, biomass, solar provisions, vehicular emission)	Scope 1	Scoped In	Quantitative
Indirect GHG (Energy)	Operation energy - Off-site generation (e.g. Grid electricity, heat and steam)	Scope 2	Scoped In	Quantitative
Water	Water demand associated with the non-domestic buildings	Scope 3	Scoped In	Qualitative
Solid Waste	Waste arising from building occupants and visitors (non-domestic buildings and different housing typologies)	Scope 3	Scoped In	Qualitative
Natural Capital	Green and blue infrastructure (e.g. soft landscaping, water bodies, sustainable drainage features)	Scope 3	Scoped Out	N/A

15.2.38. GHGs related to vehicular emissions during operation have been considered by utilising current and future baseline data provided by the Applicant's Transport Consultant for the Proposed Development, and the Department of the Environment, Food and Rural Affairs (Defra) Emission Factors Toolkit (EFT) v12.1, which is the most current iteration of the tool at the time of writing and is deemed suitable for large scale and high-level applications.. At the time of writing, data for construction worker commuter movements was not available for the construction phase, so this will be assessed qualitatively.

15.2.39. GHG emissions associated with solid waste and water consumption have been assessed qualitatively rather than quantitatively as it is the professional opinion of the author that GHG emissions associated with these sources would make up a very small minority of the total GHG emissions and would not have a material effect on whether total GHG emissions would constitute a significant adverse impact.

15.2.40. An assessment of Natural Capital has been scoped out for the following reasons:

- Soil depths can vary greatly, even within one field, so there is no affordable method of estimating soil volume;
- There is no affordable method of estimating the bulk density of soil; and
- There is no reliable method of measuring soil carbon per cubic metre as carbon levels can fluctuate greatly within a single field.

Maintenance

15.2.41. Maintenance associated with the Proposed Development is not considered to be a significant source of GHG emissions. Therefore, this has been scoped out.

Decommissioning

15.2.42. The effects of the decommissioning phase of the Proposed Development have been scoped out due to a design life of over 25 years and uncertainties around the carbon intensity of fuels which would be used within the deconstruction techniques. It is therefore not possible to proportionally assess effects and impacts during decommissioning. Given that decommissioning is anticipated to occur post 2050, and consistent with policy, the UK construction sector (for decommissioning works) is expected to be net zero.

Baseline Data Collection

15.2.43. Baseline data for the GHG Assessment has been collected from the following sources:

- UK Local and regional CO_2 emissions – data tables[13] ; and
- The traffic data provided by the Transport Consultant with respect to development-related vehicle movements during the construction and operational phases.

[13] Gov.uk (2023) 'UK local authority and regional greenhouse gas emissions national statistics'. Available from: https://www.gov.uk/government/collections/uk-local-authority-and-regional-greenhouse-gas-emissions-national-statistics

15.2.44. 24-hour annual average daily traffic (AADT) flows for light duty vehicles (LDVs) and heavy goods vehicles (HGVs) were provided by the Transport Consultant (ADC Infrastructure) for the operational phase. All trip rates are two-way.

15.2.45. In the absence of pre-defined distances for commuter vehicles (LDVs), the most recent UK average journey distance as defined by the Department for Transports (DfT) statistics for 'data on distance travelled by trip purpose'[14] (8 miles / 12.9 km) was applied. This was also used for HGVs to account for waste vehicles, and supermarket deliveries, for example. The roads were classified as "Urban (not London)" as applicable. An assumed load of 100% has been applied for all vehicle movements, thus presenting a worst- case. An average vehicle speed of 30 mph (48 kph) has been assumed based on the speed limit of the roads surrounding the Site. A summary of the assumptions of the annual inputs used in the carbon modelling are provided in **Table 15.5**.

[14] Department for Transport (2023): NTS0403: Average number of trips, miles and time spent travelling by trip purpose: England, 1995 onwards

Table 15.5: Traffic Modelling Assumptions

Proposed Development Site Traffic Modelling Assumption	
Average Link Length (LDV)	12.9 km
Average Link Length (HGV)	12.9 km
Road Type	Urban (not London)
Assumed Load	100%
Average Vehicle Speed	48 kph / 30 mph

15.2.46. The following scenarios were provided for the operational phase:

- Baseline year without the Proposed Development (2022);
- Future Year 'without development' scenario (2041); and
- Future Year 'with development' scenario (2041).

15.2.47. Traffic data flow assumptions for the three scenarios above are shown in **Table 15.6**. In accordance with the Transport Assessment, it is assumed that construction of the Proposed Development will commence in 2034 and is expected to last approximately seven years and will be built out in its entirety by 2041.

Table 15.6: Future Year Traffic Data

	Baseline Year (2022)		Future Year 'without development' (2041)		Future Year 'with development' (2041)	
	LDV	**HGV**	**LDV**	**HGV**	**LDV**	**HGV**
Total Network	19,739	403	21,972	821	23,894	831*
Daily Occupier Increase Compared to Baseline	N/A	N/A	+2,233	+418	+1,922	+10

* Traffic from the Proposed Development is assumed to be made up of 0.5% HGVs to account for waste vehicles and supermarket deliveries, for example.

Quantifying Effects

15.2.48. GHG quantification follows the principles outlined in key documents such as the GHG Protocol

Corporate Standard[15], BS EN ISO 14064-2:2019[16] or PAS 2080.

15.2.49. Calculations have been taken at different scales reflecting specific activities, components or elements of construction. Therefore, individual calculations have been summed to form a GHG emissions inventory for the quantification as a whole.

15.2.50. GHGs include the following seven gases: CO_2, Methane (CH_4), Nitrous oxide (N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Sulphur hexafluoride (SF_6) and Nitrogen trifluoride (NF_3). CO_2 equivalent, abbreviated as 'CO_2e', is a metric used to compare the emissions from various GHGs on the basis of their global-warming potential (GWP) for a 100-year period, by converting amounts of other gases to the equivalent amount of CO_2 with the same GWP. This includes scaling factors reflecting improvements in the quality of fuel, the increase in EVs, and fleet composition based on European emission standards from pre-Euro I to Euro 6/VI (including Euro 6 subcategories).

15.2.51. When undertaking a quantification calculation, the formula for determining a GHG emission (or removal value), associated with the construction works, energy consumption and vehicular trips has applied the following structure:

GHG emission factor × Activity data = GHG emission or removal

15.2.52. The CO_2e for a gas is derived by multiplying the tonnes of the gas by the associated GWP. Reporting of GHG emissions in this Chapter is done in kilo tonnes of CO_2e ($ktCO_2e$), which is the cumulative emissions of GHGs for a particular process (i.e. fossil fuel-powered vehicles emissions result in more types of GHGs than just CO_2).

Assessing Effects

Embodied Carbon

15.2.53. Upfront embodied carbon stages A1 - A5 calculations were completed using a carbon modelling tool based on regulated emissions from Part L[17] of the Building Regulations. This tool takes into account The Future Homes Standard[18], compliance which is set to become compulsory in 2025. The model is a high-level tool, using a number of assumptions, and is not intended to be a substitute for detailed calculations. The GHG emissions considered include: the extraction, transporting and manufacturing processes associated with the construction products; transport of these elements to the Site; and the construction of the buildings. Stage A5 includes Site electricity, water consumption and construction waste generated on-site.

[15] World Resources Institute (2004): The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard, https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf

[16] British Standards Institute (2019): Greenhouse gases - Specification with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements, https://www.iso.org/standard/66454.html

[17] HM Government (2021) Conservation of fuel and power: Approved Document L, https://assets.publishing.service.gov.uk/media/662a2e3e55e1582b6ca7e592/Approved_Document_L__Conservation_of_fuel_and_power__Volume_1_Dwellings__2021_edition_incorporating_2023_amendments.pdf

[18] HM Government (2021) The Future Homes Standard: changes to Part L and Part F of the Building Regulations for new dwellings, https://assets.publishing.service.gov.uk/media/60114c6c8fa8f565494239a7/Government_response_to_Future_Homes_Standard_consultation.pdf

15.2.54. Quantification of upfront embodied carbon using this tool is based on the following assumptions:

- 51% detached and 49% attached housing mix with no flats or apartments;
- A fabric standard of 35 kWh/m2.year;
- No gas requirement;
- To meet Part L carbon standard; and
- A target embodied carbon standard of 'C' in line with the LETI Design 2020 Target.

Vehicular Emissions

15.2.55. An indicative assessment for vehicular emissions during both the construction phase and operational phase was determined for relevant scenarios using applicable traffic data and Department of the Environment, Food and Rural Affairs (Defra) Emission Factors Toolkit (EFT) v12.1, which is the most current iteration of the tool at the time of writing and is deemed suitable for large scale and high-level applications. The EFT allows users to calculate road vehicle pollutant emission rates for NO_x, PM_{10}, $PM_{2.5}$ and CO_2, the GHGs which comprise the vast majority of exhaust fumes from vehicles, for a specified year, road type, vehicle speed and vehicle fleet composition. The main product of fuel combustion in vehicles is CO_2. Though long-lived gases, like CH_4, N_2O, CO, and H_2, are GHGs and have global effects on atmospheric chemistry and climate, they have not been assessed independently as they are more difficult to estimate and depend strongly on technology, vehicle type and driving conditions; this is information which is not available at the time of writing. Furthermore, the contribution of these gases is considered small in comparison to CO_2.

15.2.56. The EFT is updated periodically due to updates to underlying data including vehicle fleet composition and emissions factors. The default fleet projections in EFT v12.1 are based on fleet growth assumptions which were current before the Covid-19 outbreak in the UK. In consequence, default fleet outputs from the tool do not reflect short or longer term impacts on emissions in 2020 and beyond resulting from behavioral change during the national or local lockdowns. The projection method considers the local baseline Euro fleet and the national fleet projections. It is assumed that the local fleet will follow the same profile as the national fleet, and that the difference between the two fleets is due to the local fleet being either 'ahead' or 'behind' the national fleet in terms of Euro class uptake.

15.2.57. A summary of the results of GHG emission modelling for the operational phase are included in **Table 15.23** in the 'Assessment of Likely Significant Effects' section of this Chapter.

Energy Emissions

15.2.58. A provisional Standard Assessment Procedure (SAP) Assessment has been undertaken as part of an Energy Statement for the Proposed Development (Briary Energy, dated December 2024), which has been submitted with the application. GHG emissions from the Proposed Development have been calculated using the baseline total energy demand from total floor areas in conjunction with

the building specification. Associated carbon emissions have been calculated using methodology set out in Part L1 2021[19], calculated using approved (SAP) software.

Determining Significance

15.2.59. The key information from IEMA guidance[12] in relation to determining the significance of effects is as follows:

- *"The GHG emissions from all projects will contribute to climate change, the largest interrelated cumulative environmental effect. 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";*
- *"The crux of significance is not whether a project emits GHG emissions, nor even the magnitude of GHG emissions alone, but whether it contributes to reducing GHG emissions relative to a comparable baseline consistent with a trajectory towards net zero by 2050";*
- *"The UK has set a legally binding GHG reduction target for 2050 with interim five-yearly carbon budgets which define a trajectory towards net zero. The 2050 target (and interim budgets set to date) are, according to the CCC, compatible with the required magnitude and rate of GHG emissions reductions required in the UK to meet the goals of the Paris Agreement, thereby limiting severe adverse effects";*
- *"To meet the 2050 target and interim budgets, action is required to reduce GHG emissions from all sectors, including projects in the built and natural environment. An EIA for any development must therefore give proportionate consideration to whether and how that development will contribute to or jeopardise the achievement of these targets";*
- *"For the avoidance of doubt, a 'minor adverse' or 'negligible' non-significant effect conclusion does not necessarily refer to the magnitude of GHG emissions being carbon neutral (i.e. zero on balance) but refers to the likelihood of avoiding severe climate change, aligning project emissions with a science-based 1.5°C compatible trajectory, and achieving net zero by 2050"; and*
- *"When evaluating significance, all new GHG emissions contribute to a significant negative environmental effect; however, some projects will replace existing development that have higher GHG profiles. The significance of a project's emissions should therefore be based on its net impact, which may be positive, negative or negligible"*.

15.2.60. Although it is accepted that all GHG emissions contribute to climate change, IEMA has set out how to determine whether GHG emissions associated with individual developments are significant in EIA terms.

15.2.61. IEMA guidance[12] states that the significance of effects can be defined and compared against various carbon budgets, such as local authority budgets and sectoral budgets. Where this cannot be achieved, or where it is more suitable, the determination of significance can also be defined and

[19] HM Government (2021) Conservation of fuel and power: Approved Document L, https://assets.publishing.service.gov.uk/media/662a2e3e55e1582b6ca7e592/Approved_Document_L__Conservation_of_fuel_and_power__Volume_1_Dwellings__2021_edition_incorporating_2023_amendments.pdf

compared against UK Carbon Budget Targets, which are set out in **Table 15.7**. Such is the case here as Broxtowe Borough Council (BBC) Climate Change and Green Futures Strategy 2023-2027 is centered around emissions controlled by the council and, therefore, are not deemed applicable to private development.

Table 15.7: UK Carbon Budgets

Carbon Budget Years	Total Carbon Budget ($ktCO_2e$)
Five-year UK Total GHG Budget Targets	
2023 - 2027 (4th Carbon Budget)	1,950,000
2028 – 2032 (5th Carbon Budget)	1,765,000
2033-2037 (6th Carbon Budget)	965,000
2038-2042 (7th Carbon Budget)	525,000
Relevant Yearly Total UK GHG Budget Targets	
2034*	215,452
2041**	87,526
Relevant Sectoral Yearly UK Carbon Budget Target for Manufacturing and Construction	
2034	23,095
Relevant Sectoral Yearly UK Carbon Budget Target for Residential Buildings	
2041	17,567
Relevant Sectoral Yearly UK Carbon Budget Target for Surface Transport Sector	
2034	37,678
2041	9,776
Relevant Sectoral Yearly UK Carbon Budget Target for Electricity Supply	
2041	3,752

* 2034: Peak year of construction

*** 2041: Opening year of Development / Operational Circumstances*

15.2.62. IEMA guidance[12] notes that in relation to the largest-scale developments, "*an indicative threshold of 5% of the UK or devolved administration carbon budget in the applicable time period is proposed, at which the magnitude of GHG emissions irrespective of any reductions is likely to be significant. A project that meets this threshold can in itself materially affect achievement of the carbon budget*". As the Proposed Development is not considered to qualify as a development of the largest scale, a more stringent threshold of 1% of the relevant sectoral and UK Carbon Budgets has been set.

15.2.63. **Table 15.8** sets out the significance criteria for the GHG Assessment.

Table 15.8: Significance Criteria for GHG Emissions

Effect Significance	Description of Criteria
Negligible	The project's GHG impacts would be reduced through measures that go well beyond existing and emerging policy and design standards for projects of this type, such that radical decarbonisation or net zero is achieved well before 2050. A project with negligible effects provides GHG performance that is well 'ahead of the curve' for the trajectory towards net zero and has minimal residual emissions; or emissions are equal to the emissions predicted in the 2034 (construction) / 2041 (operational) 'Do Nothing' baseline scenarios.
Minor Adverse	The project's GHG impacts would be fully consistent with applicable existing and emerging policy requirements and good practice design standards for projects of this type. A project with minor adverse effects is fully in line with measures necessary to achieve the UK's trajectory towards net zero, and/or: An increase in combined (i.e. total) emissions predicted in the 2034 (construction) / 2041 (operational) 'Do Nothing' baseline scenarios, but less than 1% of total emissions from the relevant sectoral and UK Carbon Budgets and with a commitment to reasonable and deliverable measures to seek to reduce these emissions in accordance with relevant policy and guidance.
Moderate Adverse	The project's GHG impacts are partially mitigated and may partially meet the applicable existing and emerging policy requirements but would not fully contribute to decarbonisation in line with local and national policy goals for projects of this type. A project with moderate adverse effects falls short of fully contributing to the UK's trajectory towards net zero, and/or: An increase in combined (i.e. total) emissions predicted in the 2034 (construction) / 2041 (operational) 'Do Nothing' baseline scenarios, but less than 1% of total emissions from the relevant sectoral and UK Carbon Budgets and without a commitment to reasonable and deliverable measures to seek to reduce these emissions, in accordance with relevant policy and guidance.
Major Adverse	The project's GHG impacts are not mitigated or are only compliant with do-minimum standards set through regulation, and do not provide further reductions required by existing local and national policy for projects of this type. A project with major adverse effects is locking in emissions and does not make a meaningful contribution to the UK's trajectory towards net zero, and/or: An increase in combined (i.e total) emissions predicted in the 2034 (construction) / 2041 (operational) 'Do Nothing' baseline scenarios, that results in GHG emissions representing greater than 1% of total emissions from the relevant sectoral and UK Carbon Budgets.

15.2.64. For the purposes of the GHG Assessment, negligible and minor adverse effects are not considered to be significant in EIA terms and in line with measures necessary to achieve the UK's trajectory towards net zero. Moderate and major adverse effects are considered to be significant in EIA terms.

Applying Mitigation

15.2.65. It is important that project designers incorporate measures to reduce GHG emissions at an early stage. GHG mitigation is best achieved by taking a planned and focused approach following the IEMA GHG management hierarchy principles. The IEMA GHG Management Hierarchy, as shown in **Table 15.9**, comprises the following stages: eliminate; reduce; substitute and compensate.

Table 15.9: GHG Mitigation Hierarchy

Step	Strategy
Eliminate	Within all major development decisions, 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 renewables and low carbon materials, methods and technologies in place of more carbon intensive sources.
Compensate	Develop a strategy to compensate residual or 'unavoidable' emissions.

Assumptions and Limitations

15.2.66. Uncertainty can arise from quality of data, study boundaries and period of assessment, and can never be eliminated from a study.

15.2.67. The assumptions and limitations which apply to the GHG Assessment are outlined in **Table 15.10**. For each assumption or limitation, an explanation of the possible effect of the assumption has been provided as well as a description of any corrective actions that have been taken to adjust for any limitations. These assumptions are considered reasonable and are not likely to impact on the outcome of the GHG Assessment.

15.2.68. It should be noted that a calculated approach for quantifying GHG emissions is of course completed in advance of supply chain mobilisation and associated construction works.

Table 15.10: GHG Assessment Assumptions and Limitations

Assumption/Limitation	Consequence	Resolution
Data on the anticipated transportation distances for LDVs and HGVs along links modelled for the Transport Assessment have not been provided and have been based on average journey distances as defined by the National Travel Survey.	Any changes to the distances could be considered to materially affect the chapter outcomes.	The transportation distances assumed have been used in GHG emission modelling using the Defra EFT v12.1 and are considered reasonable based on professional judgement.
The future traffic levels for the GHG Assessment of the Proposed Development are based upon the year it will be operational in full, predicted to be in 2041. An operational period of 60 years has been assumed for the assessment of GHG emissions.	If the Proposed Development was to become fully operational in a year other than 2041, vehicular GHG emissions would be less accurate.	As the assessment provides an indicative amount of GHG emissions, it is considered that calculations are representative of approximate emissions if the fully operational year deviates a little from 2041.
The embodied carbon of the Proposed Development calculations were completed using a high level carbon modelling tool, not intended to be a substitute for detailed calculations.	These calculations will not be as accurate as a full Embodied Carbon Assessment.	These calculations are considered to reasonable to assess significance of effect based on professional judgement.
The housing mix for the upfront embodied carbon assessment is based on an indicative housing mix for a neighbouring project (known as Land at Toton East)	The actual upfront embodied carbon of the Proposed Development may be greater than assessed in this Chapter.	The assessment is based on the most up to date information available at the time of writing. A 'do minimum' approach based on LETI Design 2020 Target is also assumed to account for a current worst-case scenario which conforms with Part L Regulations.

Assessing In-Combination and Cumulative Effects

15.2.69. This chapter should be read in conjunction with the description of the Proposed Development provided in **Chapter 4: Proposed Development and Alternatives**. The GHG Assessment should be read in conjunction with relevant parts of the Transport Assessment (**Appendix 9.1**).

15.2.70. The CCR Assessment should be read in conjunction with relevant parts of other environmental topic chapters/reports where common receptors have been considered and where there is an overlap or relationship between the assessment of effects. The relevant chapters/reports are:

- Air Quality ES Chapter;
- Biodiversity ES Chapter;
- Flood Risk and Drainage Chapter (including Flood Risk Assessment and Drainage Strategy); and
- Contaminated Land and Ground Conditions ES Chapter.

Resilience of the Proposed Development to Climate Change

15.2.71. In relation to the resilience of the Proposed Development to climate change, the in-combination climate change impacts (ICCI) Assessment relates to the combined effect of the potential impacts of the Proposed Development and potential climate change impacts on the receiving environment. The approach to the ICCI Assessment followed the guidance set out by IEMA[2] in **Appendix 15.1**. The ICCI Assessment involved a review of other chapters within this ES which have the potential to affect the significance of impacts identified in relation to climate change.

15.2.72. The ICCI Assessment scenario considers construction and operation of the Proposed Development. The baseline for the ICCI Assessment is the same as that identified for the CCR Assessment. The likelihood of an ICCI occurring is determined based on the likelihood of a climate hazard occurring, combined with the sensitivity of the receptor to the combined impact of the climate hazard and the Proposed Development. The determination of significance is the same as that for CCR Assessment.

Influence of the Proposed Development on Climate Change

15.2.73. In relation to GHG emissions, as GHG emission impacts and resulting effects are global rather than affecting one localised area, the approach to cumulative effects assessment for GHGs differs from that for many EIA topics where only projects within a geographically bounded study area of, for example, 10 km would be included. Therefore, all global cumulative GHG sources are relevant to the effect on climate change, and this has been considered in defining the receptor (the atmospheric concentration of GHGs) as being of 'high' sensitivity to further emissions. Effects of GHG emissions from specific cumulative projects therefore in general should not be individually assessed, as there is no basis for selecting any particular (or more than one) cumulative project that has GHG emissions for assessment over any other (IEMA, 2022[12]). Furthermore, information on the amount of GHG emitted from projects is often unavailable within documentation submitted for planning applications.

15.2.74. However, given that the Applicant for two neighbouring projects (known as Land at Toton North and Land at Toton East respectively) is the same as for the Proposed Development, a cumulative assessment of the three projects has been undertaken.

Legislative and Policy Framework

15.2.75. The full planning policy context for climate change is presented in **Appendix 15.3**, with key planning policies outlined below.

National Planning Policy

15.2.76. National Planning Policy Guidance on Climate Change, published by the Department for Levelling Up, Housing and Communities and the Ministry of Housing, Communities and Local Government[20], describes how to identify suitable mitigation and climate adaptation measures to incorporate into the planning process. It states that "*effective spatial planning is an important part of a successful response to climate change as it can influence the emission of greenhouse gases*" and that "*Planning can also help increase resilience to climate change impact through the location, mix and design of development*".

15.2.77. The guidance promotes adaptation of developments to climate change through:

- *"Identifying no or low cost responses to climate risks that also deliver other benefits, such as green infrastructure that improves adaptation, biodiversity and amenity;*
- *building in flexibility to allow future adaptation if it is needed, such as setting back new development from rivers so that it does not make it harder to improve flood defences in future; and*
- *the potential vulnerability of a development to climate change risk over its whole lifetime".*
- *In relation to mitigating impacts of new development on climate change, the guidance advises that "the distribution and design of new development and the potential for servicing sites through sustainable transport solutions, are particularly important considerations that affect transport emissions".*

The Local Plan

15.2.78. BBC declared a climate emergency in July 2019 and made a commitment to become carbon neutral by 2027.

15.2.79. In September 2014, along with Nottingham City and Gedling Borough Councils, BBC adopted Part 1 of the Local Plan , which contains the following relevant policies:

- Policy 1: Climate Change, which is focuses on Sustainable Design and Adaptation; reducing CO_2 emissions; and Flood Risk and Drainage;
    - "*All development proposals will be expected to mitigate against and adapt to climate change, to comply with national and contribute to local targets on reducing carbon emissions and energy use unless it can be demonstrated that compliance with the policy is not viable or feasible.*"

[20] HM Government (updated 2019) Guidance Climate change, https://www.gov.uk/guidance/climate-change

- Policy 10: Design and Enhancing Local Identity, which specifies that all new development should be designed to be adaptable to meet the changing needs of occupiers and the effects of climate change; and

- Policy 16: Green Infrastructure, Parks and Open Space, which sets out that new green infrastructure assets should make provision for tackling and adapting to climate change.

15.2.80. In October 2019, BBC adopted Part 2 of the Local Plan, which contains the following relevant policy:

- Policy 1: Flood Risk, which sets out that by use of Sustainable Drainage Systems, development on greenfield sites should maintain greenfield (pre-development) surface water run off rates; and

- Policy 20: Air Quality, which sets out the need for development proposals to provide effective alternatives for users of the development to utilise modes of transport other than the private car and to avoid significant deterioration in air quality.

15.2.81. Under Part 2, the Site is allocated for Mixed Use.

Consultation

15.2.82. As set out in Chapter 2 of this ES, EIA Scoping is not a statutory requirement, when committing a scheme to EIA. The Applicants have not requested a formal Scoping Opinion in relation to Toton West in isolation, however have instead followed the scope of that agreed in relation to the larger, separate 'Toton North' scheme, which lies northeast to the Toton West Site. Given the primary reason for undertaking an EIA is in relation to the potential significant cumulative effects that could occur with Toton North (and other potential schemes), this is considered appropriate and robust.

15.2.83. The scope of the assessment therefore is to take two main approaches to determine the project's climate change impacts, aligning with IEMA guidance[2,12]:

- The direct and indirect influence of the Proposed Development on climate change (GHG emissions) (mitigation); and

- The vulnerability of the Proposed Development to climate change (adaptation / resilience).

15.2.84. Aside from the current guidance set out above, there is no defined methodology for the assessment of climate change within an ES and therefore a proportionate assessment using the guidance and professional judgement of the technical expert will apply the methodology outlined within this Chapter.

15.3. Baseline Conditions

Site Description and Context

15.3.1. For the context of baseline collection, the study area for the CCR Assessment is the local area and the Midlands region. For the GHG Assessment, the study area is the relates to the Proposed Development's access roads, as shown in the Illustrative Masterplan (**Figure 4.2**). and the immediate roads that vehicles either enter or exit the Site from.

15.3.2. There are no statutory or non-statutory designations on the Site relevant to this assessment.

Baseline Survey Information

Resilience of the Proposed Development to Climate Change

Regional Climatic Conditions

15.3.3. Information relating to climatic conditions in the Midlands, the geographic region in which the Site is located, was obtained from the Met Office[Error! Bookmark not defined.] and is summarised below to provide a general indication of climatic conditions in the region. Climate conditions which are more relevant to the Site is discussed in the 'Local Climatic Conditions' sub-section below.

Temperature

15.3.4. The mean annual temperature across the region varies from around 8°C to just over 10°C. Temperature shows both a seasonal and diurnal variation. Minimum temperatures usually occur around sunrise and maximum temperatures are normally around 2-3pm. The annual temperature range is more pronounced than in most parts of the UK due to the Midland's distance from the sea, which has moderating effects on temperature. Temperature extremes of both winter and summer (sharp winter frosts and occasional very hot summer days) are a key characteristic of the Midlands climate.

15.3.5. January is the coldest month, with mean daily temperatures ranging from just below 0°C to about 1.5°C. Cold air drainage into the river valleys results in large-scale frost hollows, with the Severn, Wye and Avon valleys enhancing the general frostiness of the western half of the Midlands. The lowest ever temperature in England was recorded in the Midlands: -26.1 °C at Newport, Shropshire on 10 January 1982.

15.3.6. July is the warmest month with mean daily maximum temperatures exceeding 22°C in the South and East Midlands. Extreme maximum temperatures can occur in July or August; On 3 August 1990, temperatures exceeded 34 °C widely over the Midlands, with a new national record until August 2003 of 37.1 °C at Cheltenham.

15.3.7. Mean temperatures across the region are similar, with only a gradual south to north gradient. Extreme temperature minima are dictated more by local topography.

15.3.8. Frost is a widespread characteristic of the Midlands. An 'air frost' refers to when the temperature at 1.25 metres above the ground falls below 0 °C, whereas 'ground frost' means a temperature below 0 °C measured on a grass surface. The average number of days with air frost in the Midlands ranges from around 40 to 60 per annum. Ground frost occurs on average on about 100 to 125 days per year, with a similar distribution.

Precipitation

15.3.9. Rainfall is greatly impacted by altitude, meaning average rainfall often follows topography. However, because most rainfall arrives from the west with Atlantic depressions, much of the West Midlands lies in the 'rain shadow' of the Welsh mountains. This means that the region is relatively dry, with the effect enhanced locally by the Severn and Wye valleys.

15.3.10. The wettest areas in the Midlands, with an average of over 800 mm per annum, are along the Welsh border, in the Cotswolds and, especially, in the Peak District. The more sheltered areas of the South and East Midlands experience the least rainfall with less than 600 mm per annum in parts of Northamptonshire, the lower Trent valley and the Avon valley.

15.3.11. Rainfall is generally well-distributed through the year, however the wettest month varies across the region. Where the Site is situated in the East Midlands tends to have an even distribution of rainfall through the year, with summer amounts there associated with showery, convective rainfall.

15.3.12. Over much of the Midlands, the number of days with rainfall totals of 1 mm or greater ('wet days') follows a pattern similar to the monthly rainfall totals. In the higher parts of the west and north in winter (December -February), 40 to 45 wet days normal with around 30 in summer (June - August). In the drier east and south, there are around 30 to 35 wet days in winter and 20 to 25 wet days in summer.

15.3.13. Periods of prolonged rainfall can lead to widespread flooding, especially in winter and early spring when soils are usually near saturation. The Severn valley is particularly prone, since it drains extensive upland areas in mid-Wales. There have been several periods of heavy rain and flooding in the region Late October and early November 2000 where there was severe flooding, particularly in areas bordering the Rivers Severn and Trent. Several counties in the Midlands recorded their wettest September on record in 2024 with over three times the 1991-2020 September average rainfall[21].

15.3.14. Thunderstorms are most likely to occur from May to September, and reach their peak in July and August, with eastern areas of the UK being among the most prone. A notable example that affected Birmingham was the storm of 14 July 1982, with about 35 mm falling in 20 minutes and peak intensities of over 250 mm/hour at Edgbaston, causing extensive flooding.

Sunshine

15.3.15. The number of hours of bright sunshine is controlled by the length of day and by cloudiness, so in general December is the dullest month and June or July are the sunniest. On average, sunshine duration decreases with increasing altitude, increasing latitude and distance from the coast. Industrial pollution and smoke haze can also reduce sunshine amounts but, since the Clean Air Act of 1956 and a decline in heavy industry, sunshine duration over the industrial Midlands has increased.

15.3.16. Over the Midlands, average annual sunshine durations range from below 1,400 hours in the higher northern and western fringes to around 1,600 hours near the southern boundary. The tendency for convective cloud to develop over inland areas in summer leads to sunshine averages that are lower than coastal sites.

15.3.17. The highest known monthly sunshine totals in the region are 314.7 hours at Brize Norton in July 2006 compared to the highest in the UK of 383.9 hours at Eastbourne (East Sussex) in July 1911. In the dullest winter months, less than 20 hours have been recorded, with only 4.1 hours at Buxton in January 1996.

Wind

15.3.18. The Midlands area is one of the more sheltered parts of the UK, with the windiest areas being in western and northern Britain, closer to the Atlantic. Mean speeds and gusts (short duration peak

[21] Met Office (2024)'Exceptionally wet month for parts of the Midlands, September 2024, https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/uk-past-events/interesting/2024/2024_07_september_rain.pdf

values) are strongest from December to February when the frequency and strength of depressions of low pressure is greatest.

15.3.19. Another measure of wind exposure is the number of days when gale force is reached (if the wind reaches a mean speed of 34 knots or more over any ten consecutive minutes). Over the Midlands, the average is around 2 days per year but exposed areas, especially in the west and north, see about 5 gales per annum.

15.3.20. Springtime tends to have a maximum frequency of winds from the north east. In the Midlands, periods of very light or calm winds with no preferred direction usually occur for around 5% of the year.

15.3.21. The annual wind rose for open, level locations across the region typically shows a prevailing south-westerly wind direction through the year.

15.3.22. A tornado is a violently-rotating column of air, caused by the rapid displacement of warm moist air by cold dense air often associated with the occurrence of active cold fronts. On average, 33 tornados are reported each year in the UK although the number can vary significantly from year to year. One of the strongest tornadoes to affect the UK in 30 years struck in the Midlands region in Birmingham on 28 July 2005 with estimated 110 knot winds.

Snowfall

15.3.23. Over the majority of the Midlands, snowfall is normally confined to the months from November to April, but upland areas may experience brief falls in October and May. On average, the number of days with snow falling is about 20 per winter in the lower lying areas, particularly

15.3.24. the lower Severn valley. In upland areas in the north and near the Welsh border, this rises to 35. An average increase of about 5 days of snow falling per year per 100 metres increase in altitude is typical. The number of days with snow lying is also mainly dependent upon altitude but partly upon proximity to cold (easterly) and warm (south-westerly) air masses, meaning this varies from about 6 days per year in the lower Severn valley to over 20 in upland areas such as the Peak District.

15.3.25. In most places, January is the month with most days of both snow lying (ground is more than 50 % covered at 09:00) and snow falling. Snowfall does, however, vary from year to year, such as in Birmingham where there were 75 days with snow lying in the unusually cold winter of 1962/63 but only 2 days in winter 1960/61.

15.3.26. The depth of undried snow does not often exceed 15cm at low altitudes but on occasions depths of 30 to 60 cm may occur over a wide area. When depths exceed 15 cm in association with strong winds, serious drifting may occur, especially in hilly areas, such as on 7/8 December 1990 when much of the Midlands had snow 20 cm deep, with over 40 cm in the Birmingham area. Here, NE winds whipped the snow into drifts 2 metres deep, resulting in considerable transport disruption.

Local Climatic Conditions

Historical Weather Data

15.3.27. Average monthly climatic conditions between 1991 - 2020 at Watnall Climate Station (located 9.7 km north of the Site and the nearest weather station for which this information was available) was obtained from the Met Office[4], are shown in **Table 15.11**. This table shows that average maximum and minimum temperatures have been lowest between December and February, whilst average

maximum and minimum temperatures have been highest between May and September. Most rainfall has occurred between October and December, whilst the least has occurred between March and May. The monthly mean wind speed has been highest between January and April, whilst it has been weakest between June and September.

Table 15.11: Average Monthly Climatic Conditions Between 1991 – 2020 at Watnall Climate Station

Month	Maximum Temperature (°C)	Minimum Temperature (°C)	Days of air frost (days)	Sunshine (hours)	Rainfall (mm)	Days of rainfall ≥1 mm (days)	Monthly mean wind speed at 10 m (knots)
January	6.91	1.65	9.17	56.00	59.06	11.63	7.99
February	7.66	1.67	8.68	77.71	49.82	10.93	8.08
March	10.06	2.96	4.77	116.24	45.51	10.10	7.89
April	13.19	4.75	1.60	152.29	47.63	9.40	7.23
May	16.38	7.45	0.00	191.49	49.84	9.03	6.89
June	19.18	10.38	0.00	170.51	66.86	9.80	6.29
July	21.49	12.39	0.00	191.45	65.20	9.44	6.03
August	21.09	12.30	0.00	177.56	63.65	9.53	5.99
September	18.12	10.22	0.00	137.51	57.35	9.80	6.21
October	13.90	7.43	0.53	96.87	71.73	11.23	6.90
November	9.78	4.24	3.37	64.05	69.49	12.70	7.15
December	7.17	1.99	8.81	55.32	69.61	12.33	7.53
Annual Average / Total	**13.78 (Avg.)**	**6.48 (Avg.)**	**36.93 (Total)**	**1487.00 (Total)**	**715.57 (Total)**	**125.92 (Total)**	**7.01 (Avg.)**

Recent Weather Data

15.3.28. Weather data for 2023 was collected to build a profile of recent weather conditions in proximity to the Site. Data presented was obtained from the Meteostat and Weather Spark websites, and interpolated from recorded weather conditions at the following weather stations:

- Nottingham Weather Centre[5] (Watnall Climate Station) (9.7km north of the Site)
- East Midlands Airport[6] (10.75km south-west of the Site)

Temperature

15.3.29. In 2023, the warmest part of the year was between early June and mid-September, whilst the coldest part of the year was between mid-October and March.

15.3.30. Maximum temperatures peaked at 30.4°C on 9th September, whilst the lowest temperature was -5.6°C recorded on 2nd December. Average, minimum and maximum temperatures for 2023 are shown in **Figure 15.2.**

Precipitation

15.3.31. The total amount of precipitation at Nottingham Weather Centre in 2023 was 1029.1 mm. The most precipitation in one day was 53.9 mm on 20th October. Generally, the amount of precipitation was higher in winter months than in summer months.

Wind

15.3.32. Wind speeds were generally consistent throughout 2023, increasing slightly in December. December witnessed the highest number of days (8) that had gusts of wind stronger than 60 kph, with the strongest (94 km/h) occurring on 28th December. The majority of wind direction was from the south-west. The distribution of wind direction at the Site is represented by the wind rose which is included in **Figure 15.3.**

Influence of the Proposed Development on Climate Change

Existing GHG Baseline

National Emissions

15.3.33. According to the Department for Energy Security & Net Zero[22], in 2022, net territorial emissions in the UK of the basket of seven GHGs covered by the Kyoto Protocol were estimated to be 406,200 ktCO_2e, a decrease of 9.3% compared to the 2019 figure (the most recent pre-Covid pandemic year) and 50.0% lower than they were in 1990. CO_2 made up around 80% of the 2022 total.

15.3.34. The transport sector consists of emissions from road vehicles, domestic aviation and shipping (including military), fishing vessels, and railways. It is estimated to have been responsible for around 28% of CO_2 emissions in the UK in 2022. The main source of emissions from this sector is the use of petrol and diesel in road transport. CO_2 emissions from transport fell by 10% in 2022 compared to 2019. Between 1990 and 2019, there was relatively little overall change (3% decrease) in the level of GHG emissions from the transport sector.

Local, Regional and National Emissions Comparison

15.3.35. A summary of local, regional and national GHG emissions (2022) for relevant sectors are presented in **Appendix 15.4**.

[22] Department for Energy Security & Net Zero (2024) 2022 UK Greenhouse Gas Emissions, Final Figures, https://assets.publishing.service.gov.uk/media/65c0d15863a23d0013c821e9/2022-final-greenhouse-gas-emissions-statistical-release.pdf

Existing Site Land Use

15.3.36. The Site comprises undeveloped agricultural land and the Proposed Development is likely to result in a net increase of GHG emissions.

Vehicular Emissions from Road

15.3.37. Department for Energy Security & Net Zero[23] data demonstrates an overall trend in the reduction in vehicular carbon emissions from local, regional and national sources from the year 2005, with forecasts showing a continuation in reductions over the next years in keeping policy, targets and a betterment in technology. The data shows that vehicular road emissions contributed approximately 41.7% of the total GHG emissions within Broxtowe in 2022.

15.3.38. The total GHG emissions from road transport for 2022 (267.3 $ktCO_2e$) constitute a reduction of 12.8% compared to the equivalent figure for 2005 (306.4 $ktCO_2e$).

15.3.39. Using baseline (2022) data provided by the Transport Consultant, total GHG emissions from vehicles on the roads surrounding the Site have been estimated to result in 16.93 ktCO2e as presented in **Table 15.12**.

Table 15.12: Baseline Vehicular Road Emissions (2022)

Total Number of Vehicles (per annum)	Total LDV ($ktCO_2e$/yr)	Total HGV ($ktCO_2e$/yr)	Total $ktCO_2e$/yr
20,142	15.29	1.64	16.93

Future Baseline / 'Do Nothing' Scenario

Resilience of the Proposed Development to Climate Change

15.3.40. With a changing climate, the UK is generally likely to have hotter, drier summers and warmer, wetter winters. Temperatures in the UK exceeded 40°C for the first time on record in the summer of 2022, and extreme weather events are likely to become even more frequent.

15.3.41. The following future climatic conditions are predicted for the 12 km^2 area within which the Site is located based on extensive weather measurement records collected by the Met Office and reported in the UKCP18 [24]. These predictions are based on a 4°C rise in global average temperatures by 2100, which aligns with RCP 8.5, and are as follows:

- The hottest summer day is likely to be 40.9°C, which is an increase of 5.5°C compared to the hottest summer day between 1991 – 2019;

[23] Department for Energy Security & Net Zero (2024) UK local authority and regional greenhouse gas emissions statistics, 2005 to 2022, https://www.gov.uk/government/statistics/uk-local-authority-and-regional-greenhouse-gas-emissions-statistics-2005-to-2022

[24] British Broadcasting Corporation (2022) What will climate change look like near me?, https://www.bbc.co.uk/news/resources/idt-d6338d9f-8789-4bc2-b6d7-3691c0e7d138

- The warmest winter day is likely to be 20.4°C, which is an increase of 2.3°C compared to the hottest winter day between 1991 – 2019;
- It is expected that there may be fifteen "summer days" (days above 25°C per month on average) compared to three summer day between 1991 – 2019;
- A decrease in the average number of rainy days per month in summer to seven days, compared to nine days between 1991 – 2019. No change is expected in the average number of rainy days per month in winter compared to the average number (11) between 1991 – 2019;
- An increase in the wettest day of summer to 69 mm of rain, compared to 62 mm of rain for the wettest day of the summer year between 1991 – 2019; and
- An increase in the wettest day of winter to 42 mm of rain, compared to 31 mm of rain for the wettest day of winter between 1991 – 2019.

15.3.42. In relation to wind, according to UKCP18[25] projections there is projected to be "*an increase in near surface wind speeds over the UK for the second half of the 21st century for the winter season when more significant impacts of wind are experienced. However, the increase in wind speeds is modest compared to natural variability from month to month and season to season, so confidence is low"*.

Sensitivity of Receptors

15.3.43. The resilience of the Proposed Development to climate change depends on the level of exposure of the receptors to changes in different climate variables. In the short-term, natural vulnerability will dominate the weather-related risks that are experienced, including any extreme events (such as storms and heatwaves). Over the long term, the climate we experience will be influenced by levels of GHG emissions.

15.3.44. The sensitivity of each receptor was determined through professional judgement and the results are shown in **Table 15.13**.

[2525] Met Office (no date) UK and Global extreme events – Wind storms, https://www.metoffice.gov.uk/research/climate/understanding-climate/uk-and-global-extreme-events-wind-storms

Table 15.13: Sensitivity of Receptors

Receptor	Susceptibility	Vulnerability	Sensitivity
Substructure / Earthworks	Low	Low	Low
Infrastructure / Built Structures / Ancillary Equipment	Moderate	Moderate	Moderate
Roads / Footpaths	Moderate	Moderate	Moderate
Landscaping / Habitats	Low	Moderate	Moderate
Humans	Moderate	Moderate	Moderate

The Influence of the Proposed Development on Climate Change

Vehicular GHG Emissions

15.3.45. Under the 2041 'Do Nothing' scenario for the operational phase of the Proposed Development, GHG emissions are expected to decrease by 5.14 $ktCO_2e/yr$ compared to the 2022 baseline scenario as shown in **Table 15.14**. This is due to the improvement in fuel efficiency and increased sales of EVs.

Table 15.14: Baseline Scenario Comparison for Operation

Year	Total Vehicles	Total LDV	Total HGV	Total $ktCO_2e$
2022 Baseline Scenario	20,142	19,739	403	16.93
2041 'Do Nothing' Scenario	22,793	21,972	821	11.79
Predicted Change	+2,651	+2,233	+418	-5.14

Energy

15.3.46. According to the UK's 5th Carbon Budget, GHG emissions would need to be reduced to 87,528 $ktCO_2e$ by 2041, the completed year of the Proposed Development.

15.3.47. This Carbon Budget shows that residential buildings should contribute 17,576 $ktCO_2e$ to the abatement of CO_2 through energy efficiency measures by the same year, if the UK is to achieve its Net Zero targets.

15.4. Assessment of Likely Significant Effects

Resilience of the Proposed Development to Climate Change

15.4.1. The significance of potential impacts on receptors due to climate change depends on the likelihood of them occurring and the consequence if they do occur.

15.4.2. Future climatic conditions predicted for the area under RCP 8.5, as set out in the 'Future Baseline' subsection of this Chapter, were considered when assessing the significance of climate impacts on receptors.

Construction

15.4.3. As set out in the 'Assessment Methodology and Significance Criteria' section of this Chapter, potential effects of climate change during construction have not been considered due to the construction phase lasting less than 10 years (i.e. circa 7 years). However, mitigation measures to bolster resilience during the construction phase have been provided in the 'Additional Mitigation / Enhancement Measures' section.

Operation

15.4.4. As well as consideration of future climatic conditions, the CCR Assessment has also considered mitigation embedded into the design of the Proposed Development.

15.4.5. **Appendix 15.5** presents the outcome the CCR Assessment with respect to the significance criteria. It has also taken account of the embedded mitigation measures described in Section 5 of this Chapter. All impacts related to the operational phase are considered to be long-term and local.

15.4.6. As can be seen in **Appendix 15.5**, no significant effects are expected to occur on any on the identified sensitive receptors.

Influence of the Proposed Development on Climate Change

Construction

Embodied Carbon

15.4.7. Given the current methods of producing construction materials, it is inevitable that a large amount of carbon will be embedded within the materials used for the construction of the Proposed Development. Embodied carbon generally constitutes the largest proportion of GHG emissions during the construction phase.

15.4.8. The results of the upfront embodied carbon quantification are presented in **Table 15.15**.

Table 15.15: Embodied Carbon Assessment Results

Life Cycle Stage	Embodied Carbon ($ktCO_2e$)
Stages A1-A5	21.23

15.4.9. As the construction phase would occur across the time period for the 6th and 7th UK Carbon Budgets, the most stringent data available (the 7th Carbon Budget, 525,000 $ktCO_2e$) has been assessed against. **Table 15.16** summarises the percentage of these totals against relevant carbon budgets. It should be noted that this assumes the totals are unmitigated.

Table 15.16: Significance of Embodied Carbon Emissions

Carbon Budget	Carbon Budget Total ($ktCO_2e$)	Embodied Carbon Total ($ktCO_2e$)	Percentage of Total Carbon Budget	Effect
UK's 7th Carbon Budget (2038 – 2042)	525,000	21.23	0.004%	Permanent Moderate Adverse
UK's Residential Sectoral Budget (2041)	17,576	21.23	0.12%	Permanent Moderate Adverse

15.4.10. As can be seen in **Table 15.16**, if unmitigated, each of the totals would result in a **permanent, moderate, adverse** effect. In accordance with the methodology for determining significance, this is significant.

Vehicular Emissions

15.4.11. Given the location of the Site, commuting distances for construction workers are expected to be relatively short. Furthermore, a Construction Traffic Management Plan (CTMP) will be developed for the construction phase of the Proposed Development, which will help to minimise GHG emissions associated with HGVs. The GHG emissions associated with construction phase vehicular emissions for materials are included within the Embodied Carbon calculations.

Solid Waste and Water

15.4.12. GHG emission sources from solid waste and water are expected to be relatively minor compared to other sources, however, could constitute **permanent, moderate, adverse** effects before mitigation, which in accordance with the methodology for determining significance, would be significant. It is expected that these emissions could be largely avoided or minimised through appropriate mitigation measures recommended in the Construction Environmental Management Plan (CEMP) and Site Waste Management Plan (SWMP) for the Proposed Development. Standard measures within these documents which help to reduce GHG emissions include:

- Providing adequate capacity for the storage and disposal of recyclable materials;
- Ordering materials at appropriate times and appropriate storage of materials to avoid waste;
- Repairing any damaged items which experience water flow; and
- Providing water efficient hygiene facilities.

Operation

Vehicular Emissions

15.4.13. Total vehicular GHG emissions during the operational phase are presented in **Table 15.17** for the 'Do Nothing' scenario year 2041 and the 'Do Something' scenario year 2041. As 2041 is expected to be the year when the Proposed Development will be built in full and operational, the 'Do Something' scenario represents the 'worst case' scenario for these vehicular GHG emissions as emissions would be expected to reduce year on year as there is increased uptake in Electric Vehicles (EVs) and increases in fuel efficiency. A comparison of the differences between the total traffic flow and associated $ktCO_2e$ is also provided.

Table 15.17: Vehicular Emissions for Operation

Year	Total Vehicles	Total LDV	Total HGV	Total $ktCO_2e$
2041 'Do Nothing' Scenario	22,793	21,972	821	11.79
2041 'Do Something' Scenario	24,725	23,894	831	13.00
Predicted Change	+1,932	+1,922	+10	+1.21

15.4.14. As can be seen in **Table 15.17**, it is anticipated that GHG emissions due to vehicle movements would lead to a total of 13.00 $ktCO_2e$ in 2041 under the 'Do Something' Scenario, which constitutes a 1.21 $ktCO_2e$ increase compared to the 'Do Nothing' Scenario.

15.4.15. This 1.21 $ktCO_2e$ represents 0.001% of the UK's Carbon Budget for 2041 (87,526 $ktCO_2e$) and 0.01% of the UK's Surface Transport Carbon Budget for 2041 (9,776 $ktCO_2e$) which would result in a **permanent, moderate, adverse effect**. In accordance with the methodology for determining significance, this is considered to be a **significant** impact in EIA terms.

Energy

15.4.16. According to the Energy Statement for the Proposed Development, which has been submitted with the application, the total energy consumption per year is expected to be 467,563 kWh equating to emissions of 81,372 kgCO2e per year.

15.4.17. This 0.0814$ktCO_2e$ represents 0.00009% of the UK's Carbon Budget for 2041 (87,526 $ktCO_2e$) and 0.002% of the UK's Electricity Supply Carbon Budget for 2041 (3,752 $ktCO_2e$) which would result in a **permanent, moderate, adverse** effect. In accordance with the methodology for determining significance, this is considered to be a **significant** impact in EIA terms.

Solid Waste and Water

15.4.18. GHG emission sources from solid waste and water are expected to be relatively minor compared to other sources, however, could constitute **permanent, moderate, adverse** effects before mitigation, which in accordance with the methodology for determining significance, is **significant**.

15.5. Mitigation, Enhancement and Residual Effects

Mitigation by Design

15.5.1. This section describes the measures which have been 'embedded' into the Proposed Development. Adaptation and mitigation are complementary strategies for reducing and managing the risks of climate change. Many adaptation and mitigation options can help address climate change, but no single option is sufficient by itself[26].

15.5.2. The Proposed Development has been designed, as far as possible, to avoid and minimise impacts and effects relating to GHG and climate change through the process of design-development and by embedding mitigation measures as recommended within other Chapters within this ES. Details of embedded mitigation measures that have been integrated into the design of the Proposed Development in order to improve its resilience to various extreme weather events and to minimise GHG emissions have been set out below. Design also includes best practice design measures and mitigation associated with the conservation of ecological assets and flood risk protection.

Resilience of the Proposed Development to Climate Change

15.5.3. The Parameter Plan (**Figure 4.1**) shows that a large number of trees and hedgerows within the Site will be retained, which will assist with flood alleviation.

15.5.4. Surface water would be attenuated using sustainable drainage system (SuDS) features, including a drainage basin, which would be suitably designed to accommodate the volume of surface water runoff generated from the critical duration 1% annual probability storm event, including the appropriate allowance for climate change (35%).

Influence of the Proposed Development on Climate Change

15.5.5. The Proposed Development will be designed to minimise this requirement for energy through the following measures:

- A 'fabric first' approach concentrating on reducing energy demand;
- Incorporation of passive design solutions using consideration of dwelling orientation and layout;
- Incorporation of energy efficiency measures through the design of services and improved fabric performance;
- Calculation of the predicted design energy consumption rates and associated annual CO_2 emissions in comparison with a 'baseline' building (using Part L Regulations compliance standards) including regulated and un-regulated energy use; and
- Assessment of the viability of incorporating low and zero carbon energy sources, leading to the recommendation of Solar Photovoltaic Collectors and Air Source Heat Pumps (ASHPs).

[26] IPCC (2014): Climate Change 2014 Synthesis Report, https://www.ipcc.ch/report/ar5/syr/

Additional Mitigation.

Resilience of the Proposed Development to Climate Change

Construction

15.5.6. The impacts of climate change on the Proposed Development during the construction stage would be managed through a CEMP, which would contain detailed procedures to minimise any potential impacts associated with extreme weather events. This will compliment best practice mitigation measures employed in the construction industry.

15.5.7. Construction contractors will use a short to medium-range weather forecasting service from the Met Office, or other approved meteorological data and weather forecast provider, to inform short to medium-term programme management, environmental control and impact mitigation measures.

15.5.8. The lead contractor will ensure appropriate measures within the CEMP are implemented and, as appropriate, additional measures to ensure the resilience of the proposed mitigation of impacts during extreme weather events.

15.5.9. The lead contractor's Environmental Management System will consider all measures deemed necessary and appropriate to manage extreme weather events and should specifically cover training of personnel and prevention and monitoring arrangements. As appropriate, method statements should also consider extreme weather events where risks have been identified.

15.5.10. **Table 15.18** details examples of mitigation measures for each of the identified receptors during the construction phase.

Table 15.18: Mitigation to Increase Resilience During Construction

Receptor	Measure to avoid, reduce or manage any adverse effects and/or to deliver beneficial effects	How measure would be secured		
		By Design	By S.106	By Condition
Substructure / Infrastructure / Built Structures	• Stormwater management system, including water tanks to store water for drought events, to reduce risk of flooding and subsidence; • Vegetation planting to improve slope stability; • Appropriate storage of construction materials when not in use to prevent drying out; • Good design and earthwork failure monitoring; • Establish a fire safety manual; • Provision of lightning rods on built structures; and • Appropriate ventilation to reduce humidity.			X
Roads / Footpaths	• Ensure construction activities do not increase flood risk on travel infrastructure; and • Erect temporary fencing where appropriate to protect pedestrians and cyclists from heavy winds.			X
Landscaping / Habitats	• Provision of guidance on ecological best practice methods to be followed in order to mitigate potential ecological effects during construction; • Ensure potential on-site flood risk does not occur near sensitive ecological receptors; and • Ensure pollutants do not migrate to sensitive areas during heavy rainfall events.			X
Ancillary Equipment	• Stormwater management system to stop drain blockage and water accumulation during heavy rainfall; • Provide shading for equipment during heatwaves; • Provide buffers to block heavy winds at wind-sensitive receptors; and • Ensure power supply and other linked infrastructure is appropriately located to avoid damage/disruption.			X
Construction Employees	The Principal Contractor will ensure that: • Adequate breaks are taken during hot weather; • Drinking water is readily available; and • Provision for areas to shelter during extreme rainfall events.			X

Operation

15.5.11. As no significant effects have been identified for the CCR Assessment, no monitoring of any effects is proposed.

15.5.12. Adaptation and resilience to climate and weather-related risks should be considered periodically through maintenance regimes. A schedule of general inspections and principal inspections of each structure should be carried out to determine their condition and identify any potential maintenance requirements. In addition, a list of extreme weather-related incidents (for example, road surface deformations, snow and ice, etc.) should be maintained by the occupant of each building to assist in identifying thresholds which, when exceeded, would require maintenance. The following should be implemented appropriately:

- Have emergency response and contingency plans in place;
- Undertake effective, essential winter maintenance;
- Regularly review and updated winter maintenance plans;
- Inspect assets regularly to detect deterioration and damage;
- Produce standard operating procedures for use in the event of necessary road closure and/or traffic diversion;
- Use construction materials with superior properties which offer increased tolerance to fluctuating temperatures;
- Provide road/site user warning systems in areas exposed to high winds;
- Undertake regular sweeping and cleaning to remove debris;
- Undertake effective vegetation maintenance;
- Undertake regular surveys, management and monitoring of lighting to ensure asset stability; and
- Undertake regular maintenance and cleaning of drainage systems.

<u>The Influence of the Proposed Development on Climate Change</u>

15.5.13. The overarching principles for management of carbon emissions follows the process outlined in **Table 15.9.** Where GHG emissions cannot be avoided, the assessment should aim to reduce the residual significance of a project's emissions at all stages – design, construction and operation.

Construction

Embodied Carbon

15.5.14. A review of materials to be utilised in the construction of the Proposed Development should be undertaken at the detailed design stage to determine where savings could be made in relation to embodied carbon. This may be done as part of a Whole Life-Cycle Carbon Assessment.

15.5.15. As the Proposed Development will be built out in its entirety in 2041, it is recommended that the LETI Design 2030 Target (A) embodied carbon standard is used, which reduces the carbon intensity target from 500 $kgCO_2e/m^2$ to 300 $kgCO_2e/m^2$ compared to Target C.

15.5.16. The procurement of high quality, durable, ethical and sustainable materials (from local sources where appropriate) should be prioritised to reduce lifetime embodied carbon emissions of the building process. Examples include:

- Utilising a less carbon-intensive alternative to cement in concrete;
- Increasing the use of low carbon products, such as timber, in lieu of high carbon materials such as steelwork;
- Liaising with contractors and suppliers to engage in their research to reduce embodied carbon; and
- Sourcing building materials from sustainable and, where practicable, local sources.

15.5.17. The following standard measures should be included within the Construction Environmental Management Plan (CEMP) which would minimise the use of GHGs by construction plant Emissions associated with construction plant:

- Using fuel-efficient vehicles and machinery where reasonably practicable; and
- Switching off machinery and vehicles when not in use.

Vehicular Emissions

15.5.18. The employment of local construction workers and the provision of information which would maximise the use of sustainable modes of transport by these workers would contribute to the avoidance of GHG emissions.

15.5.19. Emissions associated with vehicular emissions will be mitigated by implementing the mitigation measures recommended within the Construction Traffic Management Plan (CTMP).

Solid Waste and Water

15.5.20. The re-use, recycling and reduction of any construction waste should be promoted to reduce the Proposed Development's overall carbon footprint by minimising the need to extract raw materials.

15.5.21. It is expected that emissions from solid waste could be largely avoided or minimised through appropriate mitigation measures recommended in a Site Waste Management Plan (SWMP). Standard measures within these documents which help to reduce GHG emissions include:

- Providing adequate capacity for the storage and disposal of recyclable materials;
- Ordering materials at appropriate times and appropriate storage of materials to avoid waste; and
- Excavated material should be re-used on-site wherever possible.

15.5.22. The following measures could be included in the CEMP to reduce emissions associated with water usage:

- Repairing any damaged items which experience water flow; and
- Providing water efficient hygiene facilities.

Operation

Vehicular Emissions

15.5.23. It is expected that GHG emissions from vehicles accessing and egressing the Site will decrease gradually over the operational phase of the Proposed Development to account for Government standards and polices and industry trends as the proportion of hybrid and EVs on the road will increase and petrol and diesel vehicles are phased out. Furthermore, new vehicles will have to meet progressively tighter European type approval emissions categories, referred to as 'Euro standards'. This in turn could limit the effects on the tropospheric ozone and lead to a cooling effect, while the effect of reduced NO_X may also limit overall effects on warming. The increase in EVs may also result in a decrease of direct emissions, though it will in turn increase the demand on the national grid where indirect emissions may result, depending on the energy source.

15.5.24. Key mitigation measures included in the Travel Plan (doc. ref. no: ADC3648-RP-B), which has been submitted with the application, to reduce GHG emissions associated with the Proposed Development include the following:

- The Site access route will include a 3m wide shared foot/cycle route to the north of the carriageway and a 3m segregated cycle route and 2m footway to the south of the carriageway. This cycle route will provide a continuous cycle route through the Proposed Development, connecting existing bridleway routes to the west of the Site with the Park and Ride site, development proposals at Toton East and Toton North, and bridleway routes to the east of the B6003 leading to Chilwell, Stapleford and Bramcote;
- The Site access junction will provide signal-controlled pedestrian and cycle crossings on all arms;
- Improvements to the surfacing, lighting and waymarking of the existing public footpath route along the northern and western boundaries will be provided. There is also potential for improvements to c.165m length of existing public footpath, immediately to the west of the B6003 that abuts the northern Site boundary falls outside of the Proposed Development area, and c.300m length of the public footpath route adjacent to the south western corners of the Site to provide an enhanced connection to Banks Road and local facilities/amenities (e.g. shops, school, bus stop) within the existing residential area to the south;
- The Site is well located for access to the existing Nottingham tram network, with the Toton Lane Park and Ride site being within a reasonable walk/cycle distance of the entire Site, with access enhanced by the above measures. In addition, a corridor will be retained through the Site to accommodate any future western extension of the NET tram line;
- The Site access route has been designed to enable access by bus services; and
- The internal highway layout and route will be designed to cater for buses should access for bus services be required as part of the wider Toton growth proposals and will also include for full highway connections to the adjacent site to the north, which forms part of the wider Toton strategic location for growth.

Energy

15.5.25. The Energy Statement proposes passive and active design measures to help reduce electricity demand during operation. This includes a range of low carbon technologies explored and assessed. The Statement concluded that Solar Photovoltaic Collectors and ASHPs have been proposed.

Solid Waste and Water

15.5.26. An Operational Waste Management Plan would be produced to ensure that waste is managed appropriately during the operational phase so as to avoid as much waste as possible being exported to landfill.

Indirect Emissions Reduction / Carbon Savings

15.5.27. Where not specifically recommended within other ES Chapters and planning reports / assessments, the following should be considered to help reduce GHG emissions during the operational phase of the Proposed Development:

- Avoiding mechanical cooling and investing into natural cooling and natural ventilation;
- Optimising the building envelope for thermal regulation;
- Designing automatic lighting controls and fit low energy and LED lighting throughout the Site;
- Implementing building management technology to control energy consumption;
- Minimise the use of finite sources and using renewable sustainable elements instead;
- Providing recycling facilities; and
- Using recycled components wherever possible.

Enhancements

15.5.28. The Energy Statement states that the 'fabric first' approach to the design of dwellings will provide a 81.60% carbon savings under the Building Regulations, which represents a 74.18% energy demand reduction.

Residual Effects

Resilience of the Proposed Development to Climate Change

Construction

15.5.29. Given that the construction phase is only expected to last seven years and that a CEMP would be produced for the Proposed Development which would include mitigation measures to increase resilience to climate change during construction, it is **not expected** that there will be significant effects due to climate change during the construction phase.

Operation

15.5.30. As shown in **Appendix 15.5**, the CCR Assessment determined that **no significant effects** are expected to occur on any on the identified sensitive receptors.

Influence of the Proposed Development on Climate Change

Construction

Embodied Carbon

15.5.31. It is assumed that the design team will review the respective Embodied Carbon and would choose materials with lower embodied carbon where feasible. It is also assumed that the LETI Design 2030 Target (A) embodied carbon standard will be met.

15.5.32. With due consideration for this mitigation, it is considered that GHG emissions associated with embodied carbon would result in a **permanent minor adverse** residual impact, which is **not significant** in EIA terms.

Vehicular Emissions

15.5.33. With due consideration for the fact that a CTMP will be produced for the Proposed Development, it is considered that GHG emissions associated with vehicular emissions during construction would result in a **permanent minor adverse** residual impact, which is **not significant** in EIA terms.

Solid Waste and Water

15.5.34. With due consideration for mitigation to be included within the CEMP, it is considered that GHG emissions associated with solid waste and water would result in a **permanent minor adverse** residual effect, which is **not significant** in EIA terms.

Operation

Vehicular Emissions

15.5.35. With due consideration for the proposed mitigation measures in relation to operational phase vehicular emissions, it is considered that GHG emissions associated with these emissions would result in a **permanent minor adverse** residual impact, which is **not significant** in EIA terms.

Energy

15.5.36. With due consideration for the proposed mitigation measures in relation to operational phase energy demand, it is considered that GHG emissions associated with these emissions would result in a **permanent minor adverse** residual impact, which is **not significant** in EIA terms.

Solid Waste and Water

15.5.37. With due consideration for mitigation to be included within the Operation Waste Management Plan, it is considered that GHG emissions associated with solid waste and water would result in a **permanent minor adverse** residual effect, which is **not significant** in EIA terms.

Total GHG Emissions

15.5.38. A summary of the total quantified GHG emissions associated with the Proposed Development is provided in **Table 15.19**.

Table 15.19: Total GHG Emissions

GHG Source	GHG Emissions ($ktCO_2e$)
Construction	
Embodied Carbon	21.23
Operation	
Vehicular Emissions	1.21
Energy	0.08

15.5.39. As can be seen in **Table 15.19**, of the GHG emission sources quantified, the total amount of GHG emissions anticipated to be emitted during the construction phase is anticipated to be 21.23 $ktCO_2e$, whilst the amount of yearly emissions during the operational phase is anticipated to be 1.29 $ktCO_2e$.

15.5.40. **Table 15.20** summarises the residual effects in relation to GHG emissions. As shown in this table, no significant effects are expected to occur with respect to GHG emissions.

Table 15.20: GHG Emissions Residual Effects Summary

Description of Effect	Embedded Mitigation	Potential Effect (inc. Significance)	Further Mitigation	Residual Effect (inc. Significance)
Construction				
Vehicular Emissions from commuters	N/A	Permanent moderate adverse (Significant)	Employment of local workers where possible and use of sustainable modes of transport	Permanent minor adverse (Not significant)
Embodied Carbon	N/A	Permanent moderate adverse (Significant)	Review of Embodied Carbon Reports at the detailed design stage to consider materials with less embodied carbon	Permanent minor adverse (Not significant)

Description of Effect	Embedded Mitigation	Potential Effect (inc. Significance)	Further Mitigation	Residual Effect (inc. Significance)
			and use of LETI Design 2030 Target embodied carbon standard	
Solid Waste and Water Consumption	N/A	Permanent moderate adverse (Significant)	SWMP and CEMP	Permanent minor adverse (Not significant)
Operation				
Energy	Passive and active design measures to increase efficiency and reduce demand	Permanent moderate adverse (Significant)	Low and zero carbon technologies	Permanent minor adverse (Not significant)
Vehicular Emissions	N/A	Permanent moderate adverse (Significant)	Provision of sustainable transport infrastructure and measures within the Travel Plan	Permanent minor adverse (Not significant)
Solid Waste and Water Consumption	N/A	Permanent moderate adverse (Significant)	Operational Waste Management Plan	Permanent minor adverse (Not significant)

15.6. Cumulative and In-Combination Effects

Resilience of the Proposed Development to Climate Change

15.6.1. Projected changes to average climatic conditions, as well as an increased frequency and severity of extreme weather events, have the potential to affect the ability of the natural environment surrounding the Site and surrounding schemes to adapt to climate change. Of the climate variables included in consideration for the CCR Assessment, only extreme precipitation events have been considered applicable due to the potential for excess surface water runoff from committed developments to enter Site or increase the demand on drainage infrastructure in proximity to the Site.

15.6.2. No significant residual cumulative effects are anticipated as it is expected that any committed developments which gain planning approval would need to demonstrate that national and local policies related to flood risk and drainage, including accounting for climate change, are met prior to the granting of planning permission by BBC.

<u>In-Combination Climate Change Effects</u>

15.6.3. Other ES Chapters below were examined to determine whether any potential identified effects would be likely to increase the significance of any effects assessed within this Chapter in relation to resilience to climate change. For completeness, the Air Quality and Contaminated Land and Ground Conditions ES chapters were also examined, however no effects relevant to climate change resilience were identified. No effects which would alter the results of the Resilience Assessment were identified within any chapters. **Table 15.21** summarises effects considered.

Table 15.21: In-combination Climate Change Impact Assessment

Environmental Topic	Receptor	Potential Effect	Proposed Mitigation	Significance of Effect
Construction				
Biodiversity	Habitats	Loss of grassland, bramble scrub, mixed scrub, 5 individual trees, tree line and hedge hence potential for reduced capacity for flood alleviation.	Creation of larger areas of grassland and scrub and areas of woodland planting, lengths of new hedge creation and individual tree planting, also in association with hedgerows within GI.	Not Significant
Flood Risk and Water Resources	Infrastructure, Roads, Habitats and Humans	Increased flood risk due to construction activities.	Implementation of measures within a CEMP.	Not Significant
Operation				
Biodiversity	Habitats	No effects identified	N/A	N/A
Flood Risk and Water Resources	Infrastructure, Roads, Habitats and Humans	Increased flood risk due to hardstanding.	Frequent maintenance of ditches, provision of drainage gullies, limiting discharge of surface water from the Site and grading of the Site to ensure all runoff is kept within the Site boundary.	Not Significant

The Influence of the Proposed Development on Climate Change

15.6.4. As stated in the 'Methodology' section of this Chapter, a cumulative assessment has been undertaken based on information available for the Land at Toton North and Land at Toton East projects. **Table 15.22** provides a summary of this assessment.

15.6.5. For the purposes of this assessment, the same embedded and additional mitigation measures are applicable across all three projects. Therefore, an assessment of known emissions against relevant carbon budgets only has been provided. Furthermore, the relevant construction and operational year for carbon budgets is aligned with Land at Toton North, which is expected to be the last of the three to be constructed. This provides a worst-case scenario assessment.

Table 15.22: Cumulative GHG Assessment

Description of Effect	Total GHG Emissions	Relevant Carbon Budgets ($ktCO_2e$)	Percentage of Budget	Residual Effect (inc. Significance)
Construction				
Embodied Carbon	73.53 $ktCO_2e$ *	UK GHG Budget Target for 2034 (215,452 $ktCO_2e$)	0.03%	Permanent minor adverse (Not Significant)
		UK Carbon Budget Target for Manufacturing and Construction for 2034 (23,095 $ktCO_2e$)	0.32%	Permanent minor adverse (Not Significant)
Operation				
Vehicular Emissions	3.50 $ktCO_2e$	UK GHG Budget Target for 2041 (87,526 $ktCO_2e$)	0.004%	Permanent minor adverse (Not significant)
		UK GHG Budget Target for Surface Transport for 2041 (9,776 $ktCO_2e$)	0.04%	Permanent minor adverse (Not significant)
Energy	0.304 $ktCO_2e$	UK GHG Budget Target for 2041 (87,526 $ktCO_2e$)	0.0003%	Permanent minor adverse
		UK Carbon Budget Target for Electricity Supply for 2041 (3,752 $ktCO_2e$)	0.008%	Permanent minor adverse (Not significant)

*This figure differs to that presented in the Land at Toton North application due to changes in the number of detached and attached dwellings in the Land at Toton East development since the time of writing.

15.7. Summary

Introduction

15.7.1. Over recent decades, climate change has become a more important environmental, social and economic policy concern.

15.7.2. This chapter assesses the effects that may arise as a result of climate change on the Proposed Development and the effects of GHG emissions associated with the Proposed Development in accordance with the EIA Regulations[1]. This chapter also considers the cumulative effects of the Proposed Development.

Baseline Conditions

15.7.3. For the CCR Assessment, a baseline survey has been undertaken to include the regional climatic conditions for the Midlands, covering temperature, precipitation, sunshine and snowfall. Local climatic conditions and historical weather data were also considered, along with recent weather data.

15.7.4. For the GHG Emissions Assessment, local, regional and national emissions have been compared for relevant sectors, including vehicular emissions from road.

15.7.5. A Future Baseline / 'Do Nothing' Scenario was considered whereby for the CCR Assessment, future climatic conditions for the Site location were found considering a worse case 4°C rise in global average temperatures. For the GHG emissions assessment, data from the Transport Consultant was used to predict the future baseline for vehicular GHG emissions.

Likely Significant Effects

Resilience of the Proposed Development to Climate Change

Construction

15.7.6. **No significant effects** due to climate change are expected during the construction phase. Furthermore, mitigation measures would be incorporated into a detailed CEMPs for each phase of the Proposed Development, which would greatly reduce potential impacts.

Operation

15.7.7. The Resilience Assessment (**Appendix 15.5**) determined that there would be **no significant effects** during the operational phase of the Proposed Development. Additional mitigation measures have been recommended to bolster resilience.

Influence of the Proposed Development on Climate Change

15.7.8. Although it is accepted that all GHG emissions contribute to climate change, IEMA has set out how to determine whether GHG emissions associated with individual developments are significant in EIA terms.

Construction

15.7.9. An indicative quantitative assessment of embodied carbon was undertaken for the construction phase. The total amount of GHG emissions anticipated to be emitted during the construction

phase is 21.23 $ktCO_2e$, which is considered to be a **permanent, moderate adverse** effect. However, the implementation of mitigation measures such as selective material selection and a more stringent embodied carbon target are expected to reduce this to a **permanent, minor adverse** effect, which is **not considered to be significant** in EIA terms. This would align with the LETI Design 2030 Target and would also not inhibit the UK Government's trajectory to reach net zero by 2050.

Operation

15.7.10. Quantitative assessment of vehicular emissions and energy production were undertaken for the operational phase. The total yearly amount of GHG emissions anticipated to be emitted during the operation phase is 1.29 $ktCO_2e$, which is considered to be a **permanent, moderate adverse** effect. However, the implementation of mitigation measures such as: the provision of sustainable transport measures within the Travel Plan; and Solar Photovoltaic Collectors and ASHPs is expected to reduce this to a **permanent, minor adverse** effect, which is **not considered to be significant** in EIA terms and would not cause the UK Government to fail in reaching their net zero trajectory by 2050.

Mitigation and Enhancement

15.7.11. Mitigation measures have been embedded into the Proposed Development, and additional measures have been proposed to increase resilience to climate change and reduce the influence on climate change. Within the design, a large number of trees and hedgerows will be retained, helping with flood alleviation and the drainage basin has been designed to account for climate change. Sustainable transport options such as walking and cycling have also been incorporated to reduce GHG emissions. The Proposed Development's energy demand has also been reduced by a 'fabric first' approach.

15.7.12. Additional mitigations including a CEMP, CTMP, selective procurement of materials to reduce embodied carbon and use of the LETI Design 2030 Target for embodied carbon have been proposed for construction, with a SWMP, Travel Plan, Operational Waste Management Plan and the implementation of low carbon technologies proposed for operation.

15.7.13. The 'fabric first' approach to the design of dwellings will provide a 81.60% carbon savings under the Building Regulations, which represents a 74.18% energy demand reduction.

Conclusion

15.7.14. In the CCR Assessment, potential effects of climate change during construction have not been considered due to the construction phase lasting just 7 years, however mitigation measures to bolster resilience during the construction phase have been provided. When considering the embedded mitigation measures described in this chapter and effects explored in other chapters, no significant effects are expected to occur on any on the identified sensitive receptors during the operational phase. **Table 15.23** provides a summary of effects, mitigation and residual effects with respect to the GHG Assessment.

Table 15.23: Summary of Effects, Mitigation and Residual Effects

Receptor / Receiving Environment	Description of Effect	Nature of Effect	Sensitivity Value	Magnitude of Effect	Geographical Importance	Significance of Effects	Mitigation / Enhancement Measures	Residual Effects
Construction								
Global Atmosphere	Vehicular Emissions from commuters	Permanent	High	N/A	International	Moderate Adverse	Employment of local workers where possible and use of sustainable modes of transport	Minor Adverse
Global Atmosphere	Embodied Carbon	Permanent	High	N/A	International	Moderate Adverse	Review of Embodied Carbon Reports at the detailed design stage to consider materials with less embodied carbon and use of LETI Design 2030 Target embodied carbon standard.	Minor Adverse
Global Atmosphere	Solid Waste and Water Consumption	Permanent	High		International	Moderate Adverse	SWMP and CEMP	Minor Adverse
Operation								
Global Atmosphere	Energy	Permanent	High	N/A	International	Moderate Adverse	Low and zero carbon technologies	Minor Adverse
Global Atmosphere	Vehicular Emissions	Permanent	High	N/A	International	Moderate Adverse	Provision of sustainable transport infrastructure and measures within the Travel Plan	Minor Adverse
Global Atmosphere	Solid Waste and Water Consumption	Permanent	H**igh**	N**/A**	International	Moderate Adverse	Operational Waste Management Plan	Minor Adverse
Cumulative and In-Combination								

Global Atmosphere	Embodied Carbon	Permanent	High	N/A	International	Moderate Adverse	Review of Embodied Carbon Reports at the detailed design stage to consider materials with less embodied carbon and use of LETI Design 2030 Target embodied carbon standard.	Minor Adverse
Global Atmosphere	Vehicular Emissions	Permanent	High	N/A	International	Moderate Adverse	Provision of sustainable transport infrastructure and measures within the Travel Plan	Minor Adverse
Global Atmosphere	Energy	Permanent	High	N/A	International	Moderate Adverse	Low and zero carbon technologies	Minor Adverse