Cardiff East Park and Ride, Llanrumney
Environmental Statement
Chapter 10: Climate Change

Iceni Projects on behalf of

Curtis Hall Ltd

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10. CLIMATE CHANGE

Introduction

10.1 This chapter of the ES has been prepared by Iceni Projects and presents an assessment of the likely significant effects of the Proposed Development with respect to Climate Change. Mitigation measures are identified, where appropriate, to avoid, reduce or offset any significant adverse effects identified and/or enhance likely beneficial effects. Taking into account the mitigation measures, the nature and significance of the likely residual effects are reported

10.2 The scope of this chapter includes the following:

- The **Greenhouse Gas (GHG) Emissions assessment** focuses on the direct and indirect release of GHGs during construction works. The GHG assessment also estimates the GHG emissions associated with the operation of the Proposed Development once it is completed, taking a lifecycle approach. The numerous mitigation and specific design measures to be embedded within the Proposed Development to minimise its GHG footprint are also presented. This section of the chapter has been prepared in line with the Institute of Sustainability and Environmental Professionals (ISEP, formerly IEMA) Guidance 'Environmental Impact Assessment Guide to Assessing Greenhouse Gas Emissions and Evaluating their Significance (2022)[i].

- The **Climate Change Resilience assessment** considers the ability of the Proposed Development to operate as intended when accounting for the anticipated effects of projected climate change, including associated weather effects. This section of the chapter has been prepared in line with the ISEP Guidance 'Environmental Impact Assessment Guide to Climate Change Resilience and Adaptation' (2020)[ii].

Competence

10.3 For a summary of the competence of the author of this chapter, please refer to **Appendix 1.4**.

Legislation and Policy Context

Legislation Context

10.4 The following legislation is relevant to the Proposed Development:

- Climate Change Act (2008)[iii];
- The Paris Agreement (2015)[iv]; and

- Environment (Wales) Act 2016 (2016)[v].

National Planning Policy

10.5 The following national planning policy is relevant to the Proposed Development:

- Planning Policies Wales (PPW) (2024)[vi].

Local Planning Policy

10.6 The following local planning policies are relevant to the Proposed Development:

- Cardiff Local Development Plan 2006 – 2016 (2016)[vii];
  - Policy KP5: Good Quality and Sustainable Design;
  - Policy KP8: Sustainable Transport;
  - Policy KP15: Climate Change; and
  - Policy KP18: Natural Resources.

Guidance

10.7 The following guidance is relevant to the Proposed Development:

- Royal Institute of Chartered Surveyors (RICS) Professional Standards and Guidance: Whole Life Carbon Assessment for the Built Environment (2017, updated 2023)[viii];
- The Sixth Carbon Budget (2020)[ix];
- The Seventh Carbon Budget: Advice for the UK Government (2025)[x];
- UK Greenhouse Gas Statistics (2025)[xi,xii];
- ISEP Environmental Impact Assessment Guide to Assessing Greenhouse Gas Emissions and Evaluating their Significance (2022); and
- ISEP Environmental Impact Assessment Guide to Climate Change Resilience and Adaption (2020).

Assessment Methodology and Significance Criteria

10.8 This section presents the methodology used to assess the potential effects of the Proposed Development in relation to Climate Change. The assessment adopts an ISEP-aligned lifecycle approach to greenhouse-gas emissions and climate resilience, applying standard government conversion factors and a stated significance framework.

Consultation

10.9 Specific consultation with respect to Climate Change has not been undertaken as the methodology follows technical guidance, and is informed by the other technical chapters of the ES, for which some consultation has been undertaken.

Study Area and Scope: GHG Emissions

Study Area

10.10 The Study Area includes the redline boundary of the Proposed Development, shown at Figure 1.1 of **Chapter 1: Introduction and EIA Methodology**.

10.11 However, some of the GHG emissions associated with the Proposed Development occur beyond the redline boundary of the Site. These emissions include, for example, the embodied GHG emissions associated with the extraction, processing and transportation of materials associated with the construction of the Proposed Development. In this way, the effects of GHGs associated with the Proposed Development is a local, national, and global issue.

10.12 The likely significant effect of the Proposed Development has been considered through comparison against the UK's 4th, 5th, 6th and proposed 7th carbon budgets. The assessment of significance of effects is drawn from the UK budget due to the global nature of the sensitive receptor (i.e. global climate). This is in line with the guidance provided within the ISEP 'Guide to Assessing Greenhouse Gas Emissions and Evaluating their Significance', which sets out significance criteria based on the GHG emissions contributions of a Proposed Development in the context of the UK's trajectory towards net zero.

Temporal Scope

10.13 At this stage, an indicative two-year build period has been assumed, with construction work anticipated to commence in 2026. As such, it has been assumed that the Proposed Development will be completed in 2028.

10.14 The reference study period for the assessment of operational effects is 60 years, as is most commonly referenced within industry guidance, including the RICS 'Professional Standards and Guidance: Whole Life Carbon Assessment for the Built Environment' and British Standard (BS) EN 15978:2011: 'Sustainability of construction works. Assessment of environmental performance of buildings. Calculation method'[xiii]. The first year of operation has been assumed as 2028, in line with the above.

Scope

10.15 The GHG Emissions assessment focuses on the GHGs emitted during the construction works. The assessment also estimates the GHG emissions associated with the operation of the Proposed

Development once it is completed, taking a lifecycle approach. The scope of the GHG Emissions assessment includes:

- Identification of the existing sources of GHG emissions at the Site, and consideration of how these may change under a 'do-nothing' scenario;
- Identification of the likely sources of GHG emissions arising from:
  - Construction activities associated with the delivery of the Proposed Development; and
  - The operation of the Proposed Development.
- Consideration of measures which may aid in reducing the GHG emissions associated with the Proposed Development.

10.16 It is highlighted that the recent ruling by the Supreme Court *'R (on the application of Finch on behalf of the Weald Action Group) v Surrey County Council and others [2024] UKSC 20'*[xiv] concluded that it is necessary to consider the downstream, Scope 3 GHG emissions associated with a project within an EIA where there is a direct link between the project and the creation of GHG emissions, such as the combustion of fossil fuels to be extracted as part of the project, as was the case in the ruling.

10.17 Although not raised during consultation, this chapter assesses the direct and indirect effects of the Proposed Development to climate change. Scope 3 emissions relating to the disposal of waste and excavated materials linked with the construction and operation of the Proposed Development (such as their disposal at specialist facilities) is not undertaken in this ES, as it is expected that disposal will be managed by the organisations who run these facilities in accordance with environmental best practice and the requirements of the Environmental Permits that are in place. As such, negligible effects are anticipated.

Assessment Methodology: GHG Emissions

Impact Areas

10.18 The assessment has adopted a project lifecycle approach to identifying the GHG emissions associated with each life cycle stage, or 'module', of the Proposed Development. This has enabled the identification of priority areas that require mitigation. This approach is in line with that set out within the ISEP 'Guide to Assessing Greenhouse Gas Emissions and Evaluating their Significance'.

10.19 In line with the guidance set out within the RICS 'Professional Standards and Guidance: Whole Life Carbon Assessment for the Built Environment', the following life cycle stages of the Proposed Development have been considered as part of the GHG Emissions assessment:

10.20 Construction phase (Modules A1 – A5):

- Extraction and processing of construction materials;

- Transport of construction materials;
- Number of construction workers predicted and an assumed daily travel commute distance; and
- Waste produced from enabling works and construction activities.

10.21 Operational phase (Modules B1 – B7):

- Regulated (i.e. those associated with lighting, hot water, pumps and fans, space heating, and space cooling) and unregulated (e.g. those associated with information technology (IT) equipment loads) operational emissions;
- Operational traffic arising as a result of the Proposed Development; and
- Use, maintenance, repair, replacement and refurbishment of materials associated with the Proposed Development.

10.22 The reference study period for the assessment is 60 years[1], as is most commonly referenced within industry guidance, including the RICS 'Professional Standards and Guidance: Whole Life Carbon Assessment for the Built Environment' and BS EN 15978:2011: 'Sustainability of construction works. Assessment of environmental performance of buildings. Calculation method'.

10.23 Emissions from construction Site activities, specifically the operation of machinery and plant on-Site, would form a very minor component of the GHG footprint during the construction works. These activities have therefore been scoped out of the assessment, however, consideration of how GHG emissions associated with these activities may be mitigated is provided in the Mitigation Measures section below.

Construction Assessment Methodology

10.24 GHG emissions associated with the construction of the Proposed Development relate to those embedded in the materials from which the Proposed Development is constructed, and with traffic movements generated during the enabling, earthworks and construction phases.

10.25 Embedded GHG emissions for the construction assessment have been calculated based on the GHG factors per square metre (m^2) of Gross Internal Area (GIA) of the Proposed Development set out in the RICS 'Methodology to calculate embodied carbon of materials'. RICS information paper, IP 32/2012' (2012)[xv], presented in **Figure 10.1**. The factors, which are provided as kilograms (kg) of

[1] It is noted that there is no intention to decommission the Proposed Development after 60 years, however this reference period has been applied for the purposes of this assessment to ensure adequate consideration of the potential impacts of the Proposed Development during its operation.

carbon dioxide equivalent (CO_2e) per m^2 GIA, are determined for the appropriate development type and are then multiplied by the indicative GIA for the Proposed Development.

Figure 10.1 GHG Emission Factors for Materials used in Construction

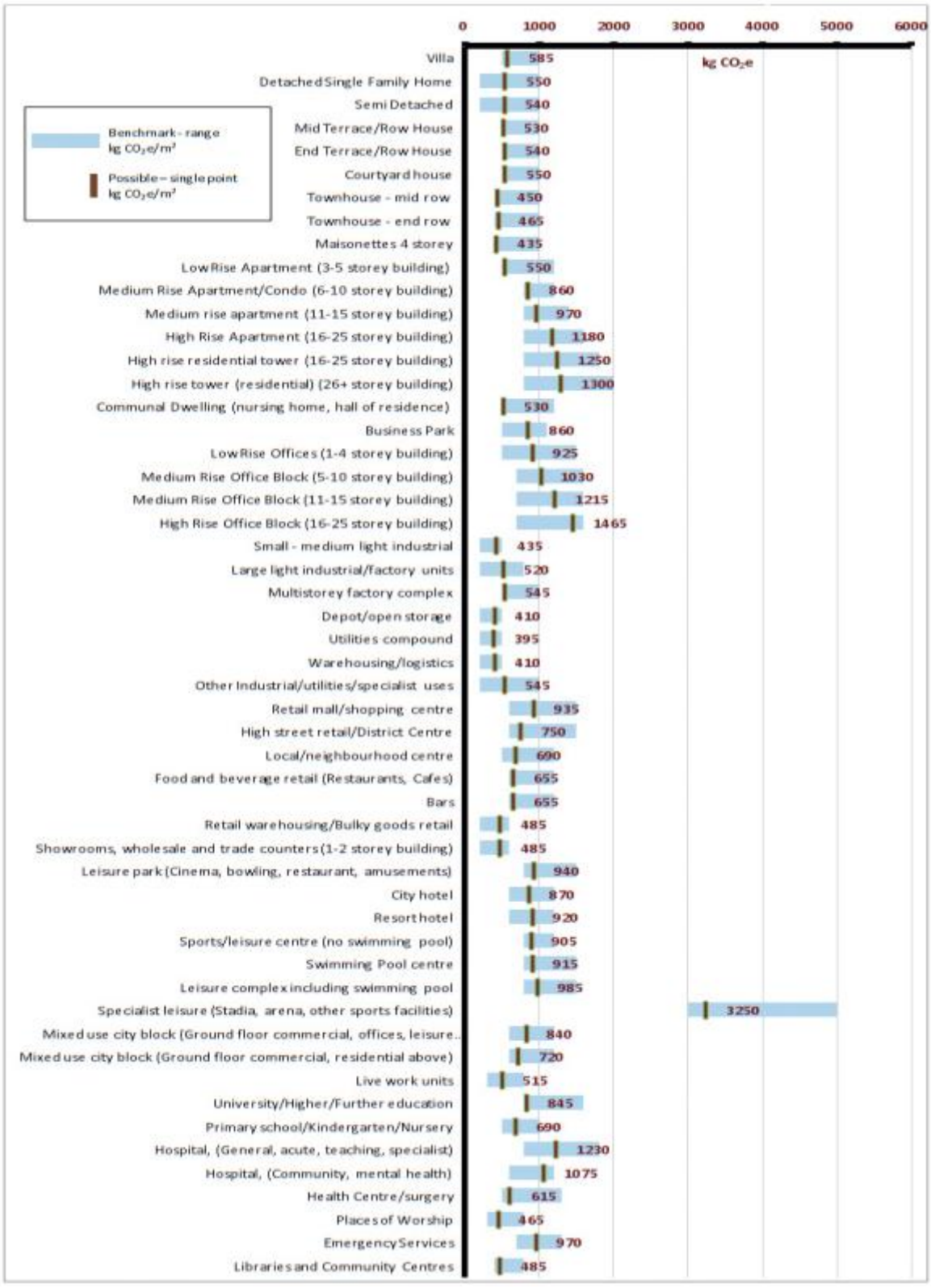

Figure reproduced from RICS, 'Methodology to calculate embodied carbon of materials. RICS information paper, IP 32/2012'.

10.26 Owing to the outline nature of the planning application, the maximum quantum of floorspace for each land use proposed within the Proposed Development along with the RICS categories are presented in **Table 10.1**. In order to account for the flexibility and to provide a reasonable worst-case assessment, the embedded GHG calculations are based on the maximum permissible areas for each proposed use, as set out below in **Table 10.1**. The relevant GHG factor set out in **Figure 10.1** above has then been applied for each proposed use.

Table 10.1 Selected Embedded GHG Factors

Use	RICS GHG Factor ($kg/CO_2e/m^2$)	RICS Category	Proposed Development - Maximum Floorspace GIA (m^2)
Data Centre	545	Other industrial / utilities / specialist uses	23,226.5
Admin / Storage	925	Low rise offices	4,862
Substation	395	Utilities compound	2,304

10.27 The estimated number of construction trips to and from the Site during the construction works have been provided by the Transport Consultants, SLR. These have been provided for Heavy Goods Vehicles (HGVs) and Light Duty Vehicles (LDVs). The precise origin / destination of these trips is not known and so the average travel distance for all articulated HGVs has been assumed to be 14km. This distance is based on the distance by road from the Site to Newport Docks, from which imported construction materials may be sourced[2]. The assumed travel distance for rigid HGVs, such as tippers to deliver aggregates, concrete mixers and waste removal vehicles was also assumed to be 14km, which is sufficient to encompass key distribution locations for the construction materials and waste disposal used for the Proposed Development, such as concrete batching sites and construction waste transfer stations. The average travel distance for LDV (cars and vans) has been assumed to be 19.0km, which was based on data collected as part of the National Transport Survey: 2024 (2025)[xvi] and is based on the average distance by mode. Although these distances are estimates, and vehicle trips to and from the Site during construction works will vary greatly in origin and destination, the distances are intended to be overestimates that, when applied to all construction vehicles, will result in a robust estimate of overall construction traffic emissions.

10.28 GHG emission factors for construction transport in 2024 have been obtained from the Department for Energy Security and Net Zero, Department for Science, Innovation and Technology, and Department for Business and Trade (DESNZ; formerly Department of Business, Energy and Industrial Strategy (BEIS)) publication on GHG Conversion Factors for Company Reporting (2025)[xvii]. This sets out GHG emissions factors for a range of modes of transport valid for 2024 and includes

[2] Newport Docks are the nearest ports to the Site and have therefore been employed for the assumptions made as part of this assessment. The detailed construction logistics will be determined post-planning.

the most up-to-date factors available at the time of writing. The GHG emissions factors were applied to the calculated total construction travel distances to estimate the GHG emissions from construction transport. It is considered that the use of 2024 factors for construction transport is a conservative approach, as emissions from road transport are likely to decarbonise in future years as vehicles become more fuel efficient and there is a continued shift towards the use of electric vehicles.

10.29 A summary of the GHG emission factors for selected modes of transport are provided in **Table 10.2**.

Table 10.2 Transport GHG Factors by Mode

Mode	Type	Unit	GHG Factor ($kgCO_2e$)
LDV (car and van)	Average car	km	0.256
HGV	Average rigid HGV	km	0.891

Completed Development Assessment Methodology

10.30 GHG emissions associated with the operation of the Proposed Development relate to emissions from transport and energy use.

10.31 GHG emission factors for transport in 2025, which represents the latest data available at the time of writing, have been obtained from the DESNZ publication on GHG Conversion Factors for Company Reporting, and are shown in **Table 10.3** below. Factors for 2028, which is the first likely year of occupation of the Proposed Development, were determined by applying engine and fuel efficiency factors, sourced from the WebTAG data book[xviii], to the 2025 DESNZ factors, for different types of fuel/energy source, and vehicle size/type. Transport emissions (taking into account the transportation of materials to and from the Site) have then been calculated by applying GHG emission factors for the anticipated first year of operation (2028) of the Proposed Development to the total kilometres travelled by each transport mode, in line with the information provided by the Transport Consultants, SLR Consulting Ltd.

Table 10.3 2028 Transport GHG Factors by Mode

Mode	Type	Unit	GHG Factor ($kgCO_2e$)
Car	Average car	km	0.163
Passenger in Car	Average car	km	0.163
Motorcycle	Average motorcycle	km	0.114
Taxi	Average taxi	km	0.208
Bus/coach	Local bus	passenger.km	0.104
Rail	National Rail	passenger.km	0.035
Cycle	Pedal-powered bicycle	km	-
Walk	-	km	-

10.32 Operational GHG emissions associated with the regulated energy use, i.e. lighting, hot water, pumps and fans, space heating, and space cooling, of the Proposed Development have been calculated

using the operational energy benchmarks set out within the UK Green Building Council's (UKGBC) 'Energy performance targets for net zero carbon offices: Technical report and summary of consultation responses' (2020)[xix]. These benchmarks, which are provided as kilowatt-hours (kWh) per m^2 GIA per year, were determined for the appropriate development type, and were then multiplied by an assumed GIA for the Proposed Development. GHG emission factors for operational energy have been obtained from DESNZ publication on GHG Conversion Factors for Company Reporting. The factors, which are provided as $kgCO_2e$ per kWh, were determined for the appropriate fuel type, and were then multiplied by the calculated energy demand (kWh/year) for the Proposed Development. The carbon factors associated with the relevant fuel types are set out in **Table 10.5**, below.

Table 10.4 Carbon Factors of Selected Fuel Types

Fuel Type	Carbon Factor ($kgCO_2e$ per kWh)
National Grid Electricity	0.17700
High Pressure Gas (Natural Gas)	0.20448

10.33 A description of the Proposed Development is set out in **Chapter 3: Proposed Development, Demolition, Construction and Description of Alternatives** of the ES. The indicative quantum of floorspace for each land use within the Proposed Development along with the use categories set out within UKGBC's 'Energy performance targets for net zero carbon offices: Technical report and summary of consultation responses' are presented in **Table 10.5**. In order to account for the flexibility and to provide a reasonable worst-case assessment, the embedded GHG calculations are based on the indicative areas for each proposed use calculated in line with the assumptions set out under **Table 10.1** above. The relevant operational energy benchmark, as set out in **Table 10.5**, has then been applied for each proposed use.

Table 10.5 Selected Operational GHG Factors

Use	RIBA Operational Energy Benchmark ($kWh/m^2/year$)	RIBA Category	Proposed Development - GIA (m^2)
Data Centre	N/A	N/A	23,226.5
Admin / Storage	90	New Build Offices	4,862
Substation	N/A	N/A	2,304

10.34 Operational GHG emissions associated with the unregulated energy use, i.e. the energy load associated with the running of servers and the cooling of equipment within the Data Centre uses, of

the Proposed Development have been calculated using an assumed Power Usage Effectiveness (PUE)[3] value of 1.4.

10.35 There will also be GHG emissions associated with the repair, maintenance and refurbishment[4] of the buildings during the lifetime of the Proposed Development. These emissions are effectively "unregulated" as there is no policy or standard for establishing compliance, nor is there published data on good practice against which developments can be benchmarked. Nonetheless, to consider a reasonable worst-case scenario, emissions from repair, maintenance and refurbishment have been accounted for within the GHG assessment. Based on similar project experience, it is estimated that for data centre-specific uses, the embedded GHG emissions during use (i.e. repair, maintenance and refurbishment) are around 200% of the total lifetime embedded GHG. This accounts for the average service life of most mechanical, electrical and plumbing (MEP) equipment being approximately 15 to 20 years, as per the RICS 'Professional Standards and Guidance: Whole Life Carbon Assessment for the Built Environment', and the resultant need to replace this equipment twice over the assumed 60 year lifetime of the Proposed Development. For all other commercial areas, it has been assumed for the purposes of this assessment, that the embedded GHG emissions during use are around 100% of the total lifetime embedded GHG. The embedded GHG emissions to practical completion, as described in **Table 10.1** above, have therefore been uplifted by 200% for data centre-specific floorspace and 100% for all other floorspace to account for repair, maintenance and refurbishment.

Significance Criteria

10.36 The scale attributed to each effect has been determined based on the sensitivity of the receptor and magnitude of impact arising as a result of the Proposed Development. Professional judgement and experience have been drawn upon to assess the scale and significance.

10.37 As stated in the ISEP 'Guide to Assessing Greenhouse Gas Emissions and Evaluating their Significance':

"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."

[3] PUE is calculated as the total energy consumption of the Data Centre divided by the IT equipment energy consumption.

[4] Refurbishment refers to ongoing refurbishment of elements of the building as required during its estimated 60-year lifetime and does not include a complete whole-building refurbishment, as this would occur at the end of the building's practical life and would be subject to a future lifecycle GHG assessment.

10.38 It is noted within the ISEP Guidance that there is no single preferred methodology for the evaluation of significance, but that the greater the proportion of a relevant carbon budget (see below) the GHG emissions of a development represent, the greater the significance. With respect to GHG emissions, the global climate is considered as the sole receptor, meaning the magnitude of emissions generated drives the significance of the effect. As stated above, it is therefore practical for the assessment to be based on professional judgement, and in both a qualitative and comparative manner.

Receptors and Receptor Sensitivity

10.39 In line with the relevant ISEP Guidance, the sole receptor considered as part of the GHG emissions assessment is the global climate. This is considered to be highly sensitive to changes in GHG emissions.

Magnitude of Impact

10.40 The following magnitudes of impact to the sole receptor (i.e. the global climate) has been determined by considering the proportion of the relevant carbon budgets (the UK 5th, 6th and proposed 7th carbon budgets) represented by the estimated whole life carbon emissions of the Proposed Development. The scale used for determining the magnitude of an impact has been based on **Table 10.6**.

Table 10.6 Magnitude of Impact Description

Impact Magnitude	Description
High	GHG emissions associated with the Proposed Development represent >10.00% of relevant carbon budget.
Medium	GHG emissions associated with the Proposed Development represent between 1.00% and 9.99% of relevant carbon budget.
Low	GHG emissions associated with the Proposed Development represent between 0.10% and 0.99% of relevant carbon budget.
Very Low	GHG emissions associated with the Proposed Development represent <0.09% of relevant carbon budget.

The Carbon Budgets

10.41 As detailed above, the UK's 5th, 6th and proposed 7th carbon budgets have been employed to assess the likely effects of the Proposed Development against.

10.42 Based on the anticipated construction programme set out in **Chapter 3: Proposed Development, Demolition, Construction and Alternatives** of the ES, the 4th (2023 – 2027) carbon budget represents the appropriate carbon budgets for the construction works of the Proposed Development. With completion of the Proposed Development anticipated to occur in 2028, the appropriate carbon budgets for the fully operational phase of the Proposed Development are the 5th (2028 – 2032), 6th (2033 – 2037) and proposed 7th (2038 – 2042) carbon budgets.

10.43 The relevant UK carbon budgets for the assessment are set out in **Table 10.7** below, which demonstrates the decrease in the amount of GHG emissions that the UK may legally emit up to the

year 2037, and provisionally up to 2042, which at this time, the Proposed Development is expected to be completed and fully operational. This will result in the relative significance of GHG emissions associated with the Proposed Development increasing over time.

Table 10.7 Relevant UK Carbon Budgets

Carbon budget	Total budget ($MtCO_2e$)
4th (2023 – 2027)	1,950
5th (2028 – 2032)	1,725
6th (2033 – 2037)	965
Proposed 7th (2038 – 2042)	535

Assessing Significance

10.44 **Table 10.8** provides a matrix for determining the significance of an effect based on the sensitivity of the receptor and the magnitude of impact.

Table 10.8 Significance of Effect Matrix

Receptor Sensitivity	Magnitude of Impact			
	High	Medium	Low	Very Low
High	Major Beneficial / Adverse	Moderate Beneficial / Adverse	Minor Beneficial / Adverse	Minor Beneficial / Adverse
Medium	Moderate Beneficial / Adverse	Minor Beneficial / Adverse	Minor Beneficial / Adverse	Negligible
Low	Minor Beneficial / Adverse	Minor Beneficial / Adverse	Negligible	Negligible
Very Low	Minor Beneficial / Adverse	Negligible	Negligible	Negligible

10.45 Effects classified as major or moderate are considered 'significant'. Effects classified as minor or negligible in scale are considered 'not significant' in EIA terms.

Limitations and Assumptions

10.46 The GHG emissions assessment has been based on the Proposed Development, as described in **Chapter 3: Proposed Development, Demolition, Construction and Alternatives**. The assessment has been based upon the validity of the collated information.

10.47 The GHG emissions, both embodied and operational, have been calculated based on assumed GIAs, calculated using the detailed and parameter plans (**Appendix 3.1**) and maximum quantum of uses. Owing to the outline nature of the Proposed Development, no detailed internal layouts, elevations or sectional plans of the proposed built form have been prepared for submission as part

of the planning application, which means indicative operational energy or embodied carbon modelling cannot be undertaken.

10.48 For the purposes of this assessment, it has been assumed that a temporary energy centre of up to 49.9 MW capacity will be in place to supply energy to the Proposed Development between 2028 and 2031, inclusive. The temporary energy centre will employ gas turbines, and will be connected to the high pressure gas network. Once a connection to the National Grid has been secured, it is assumed the Proposed Development will be gas-free.

10.49 The GHG emissions associated with traffic generated by the Proposed Development have been calculated using information provided by the Transport Consultants, SLR. GHG emissions arising during construction and operation have been quantified using the DESNZ publication on GHG Conversion Factors for Company Reporting, and the WebTAG data book.

10.50 CO_2e is a term describing GHG emissions in a common unit. For any quantity and type of GHG, 'CO_2e' signifies the amount of carbon dioxide (CO_2) which would have the equivalent global warming impact.

10.51 The current baseline for GHG emissions has been taken to be zero, representing a conservative worst-case scenario.

10.52 GHG emissions from the end-of-life stage of the Proposed Development have been scoped out of the assessment due to the anticipated operational length of the Proposed Development.

10.53 The GHG Emissions assessment was undertaken on the basis of the information available at the time of the assessment, based on professional judgement and evidence gathered by the Proposed Development design team.

Study Area and Scope: Climate Change Resilience

Study Area

10.54 The Study Area includes the redline boundary of the Proposed Development, shown at **Figure 1.1** of **Chapter 1: Introduction and EIA Methodology**, and includes all the physical infrastructure of the assets associated with the Proposed Development.

10.55 The Climate Change Resilience assessment considers the entire lifetime of the Proposed Development, which therefore covers the construction works, as well as the Proposed Development once completed and operational, with an operational lifespan of 60 years assumed.

Scope

10.56 The following aspects have been considered, as potential effects on these receptors are considered likely to be significant:

- Surface water flooding;
- Overheating and associated health implications;
- Soft landscaping failure due to increased frequency of extreme weather events and summer temperatures; and
- Water shortages for internal use and for landscaping due to summer droughts.

Assessment Methodology: Climate Change Resilience

10.57 The methodology set out within the ISEP 'Guide to Climate Change Resilience and Adaptation' has been followed. Within the guidance, the following main steps have been considered:

- Pre-EIA Stage: How has climate resilience and adaptation been embedded in the design;
- Scoping climate change adaptation into the EIA;
- Defining the future baseline;
- Identifying climate change vulnerability;
- Identifying and determining magnitude of effects;
- Significance assessment;
- Develop mitigation measures; and
- Post-EIA Stage: monitoring and adaptive management.

10.58 In line with the steps above, and using data provided as part of the United Kingdom's Climate Impact Programme (UKCIP)[xx], a qualitative assessment for both construction works, and for the Proposed Development once completed and operational, has been undertaken using professional judgement and the guidance set out by ISEP.

Impact Areas

10.59 The UK Climate Change Projections (UKCP18)[xxi] set out that, as a result of increasing global GHG emissions, climate change is projected to lead to increased annual temperatures, decreased summer rainfall and increased winter rainfall across the UK, including the Site.

10.60 The Climate Change Resilience assessment considers the ability of the Proposed Development to operate as intended when accounting for the anticipated effects of projected climate change, including associated weather effects. This assessment has been prepared in line with the ISEP 'Guide to Climate Change Resilience and Adaptation', as well as UKCP guidance.

10.61 The UK Climate Change Risk Assessment (UKCCRA3; 2022)[xxii] states that, whilst the international community agreed to make efforts to limit global warming to 1.5°C above pre-industrial levels within the United Nations Paris Agreement (2015), preparation should be made to warming of up to 4°C. Within UKCCRA3, the following potential risks and impacts of climate change relevant to the Proposed Development are identified:

- N1 – Risks to species and habitats from climate change;
- I1 – Risks to infrastructure networks from cascading failures;
- I2 – Risks to infrastructure from flooding;
- I7 – Risks to subterranean and surface infrastructure from subsidence;
- H1 – Risks to health and wellbeing from high temperatures;
- H3 – Risks to people, communities and buildings from river and surface water flooding;
- H5 – Risks to building fabric;
- B1 – Risks to business sites from flooding;
- B3 – Risks to businesses from water scarcity; and
- B5 – Risks to businesses from reduced employee productivity due to infrastructure disruption and higher temperatures in working environments.

10.62 The qualitative assessment takes account of the design of the Proposed Development, as defined in **Chapter 3: Proposed Development, Demolition, Construction and Alternatives** and the detailed and parameter plans (**Appendix 3.1**), and how the Proposed Development may be appropriately adaptable to the potential effects of climate change. It allows for the inherent uncertainty of climate change projections and seeks to reflect the realities of these changes.

10.63 An In-Combination Climate Change assessment has also been undertaken. This assessment considers the receptors associated with the topics scoped into the ES (**Chapters 4** to **9**). Using professional judgement, risks to these receptors are identified and the likelihood of their occurrence considered. The future climate change scenario (Representative Concentration Pathway (RCP) 8.5) has been considered in relation to each of the technical topics covered within this ES. The level of assessment and methodology is proportional to the available evidence base. The aim of this assessment is to consider whether the likely residual effects on receptors, both under current and future conditions without climate change, are likely to be different under an alternative future climate regime. In particular, the assessment aims to identify whether the potential impacts and likely residual effects of the Proposed Development would be worse, or if they would improve, under the future baseline, and therefore if these changes may alter the significance of the effects identified for the Proposed Development under the climate conditions in the present day, without climate change.

Significance Criteria

10.64 The ISEP 'Guide to Climate Change Resilience and Adaption Guidance' sets out a specific significance aspect that was considered for climate change resilience. Determination of the level of risk associated with a climate hazard, and therefore the significance of an associated effect, is based on a combination of the likelihood of and the resultant consequence(s) of that hazard occurring. The assessment is qualitative and uses professional judgement, informed by a review of relevant literature.

Likelihood of Occurrence

10.65 The categories of likelihood of a climate hazard occurring are set out in **Table 10.9** below.

Table 10.9 Likelihood Categories

Likelihood Category	Description (probability and frequency of occurrence)
Very High	It is highly probable that the impact would occur during the construction or lifetime (assumed as 60 years) of the Proposed Development.
High	The impact is expected to occur during the construction or lifetime (assumed as 60 years) of the Proposed Development.
Medium	The impact may occur during the construction or lifetime (assumed as 60 years) of the Proposed Development.
Low	The impact is not expected to occur during the construction or lifetime (assumed as 60 years) of the Proposed Development.
Very Low	It is highly improbable that the impact would occur during the construction or lifetime (assumed as 60 years) of the Proposed Development.

Measure of Consequence

10.66 The categorisation of the measures of potential consequences associated with climate hazards are set out in **Table 10.10** below.

Table 10.10 Measure of Consequence

Magnitude of Consequence	Description
Very Large Adverse	Regional level (or greater) disruption lasting longer than one week. Disruption to the Proposed Development lasting longer than one week. Very significant damage or harm to human and/or ecological systems.
Large Adverse	Regional level (or greater) disruption lasting longer than one day but less than one week. Disruption to the Proposed Development lasting longer than one day but less than week. Significant damage or harm to human and/or ecological systems.

Moderate Adverse	Local level (or greater) disruption lasting longer than one day but less than one week. Disruption to a section of the Proposed Development lasting longer than one day but less than one week. Moderate damage or harm to human and/or ecological systems.
Minor Adverse	Local level (or greater) disruption lasting less than one day. Disruption to a section of the Proposed Development lasting less than one day. Minor damage or harm to human and/or ecological systems.
Negligible	Disruption to an isolated section of the Proposed Development lasting less than one day. Negligible damage or harm to human and/or ecological systems.

Assessing Significance

10.67 **Table 10.11** provides a matrix for determining the risk, and resultant significance, of an effect based on the likelihood of a climate hazard occurring and the resulting consequence(s).

Table 10.11 Significance of Effect Matrix

Likelihood of Climate Change Impact	Magnitude of Consequence				
	Very Large Adverse	Large Adverse	Moderate Adverse	Minor Adverse	Negligible
Very High	Major Beneficial / Adverse	Major Beneficial / Adverse	Moderate Beneficial / Adverse	Moderate Beneficial / Adverse	Negligible
High	Major Beneficial / Adverse	Moderate Beneficial / Adverse	Moderate Beneficial / Adverse	Moderate Beneficial / Adverse	Negligible
Medium	Moderate Beneficial / Adverse	Moderate Beneficial / Adverse	Moderate Beneficial / Adverse	Negligible	Negligible
Low	Moderate Beneficial / Adverse	Moderate Beneficial / Adverse	Negligible	Negligible	Negligible
Very Low	Negligible	Negligible	Negligible	Negligible	Negligible

10.68 Effects classified as major or moderate are considered 'significant' in EIA terms. Effects classified as minor or negligible are considered 'not significant' in EIA terms.

Limitations and Assumptions

10.69 There are a number of assumptions and limitations inherent to the assessment of adaptation to projected climate change, as well as the risks that may be associated with more extreme weather and climate conditions. The assessment has employed climate projections provided as part of the UKCP18 study, with an appropriate RCP and timescale applied. It is noted, however, that there will

be fluctuations within and deviations from the projections included within this dataset due to the inherent uncertainties within the modelling undertaken as part of UKCP18.

10.70 Given the long-term nature of the assessment, which assumes a 60-year lifespan for the Proposed Development, and which employs climate projection data for up to the year 2100, a broad consideration of receptor types has been used when determining the likely significant effects of projected climate change, rather than specific receptors, as identified within other chapters of this ES.

Baseline Conditions

Establishing Baseline Conditions: GHG Emissions

Existing Baseline

10.71 A baseline period of 2005 to 2023 has been used due to the fact that data published by DESNZ[xxiii] in 2025 was the latest data available at the time of writing.

10.72 For the GHG Emissions assessment, the baseline is a reference point against which the GHG impact of the Proposed Development may be compared against. The Site currently comprises undeveloped agricultural land and is therefore considered to have no material operations. For the purposes of this assessment, and to assess the worst-case scenario, a zero-emission baseline has therefore been adopted and is considered a reasonable worst-case assumption as the assessment is based on net GHG emissions, i.e. the relative increase or decrease between the baseline and the Proposed Development, and therefore assuming there are no baseline GHGs emitted from the Site will result in a worst-case quantification of the net change in GHG emissions.

Future Baseline

10.73 If the Proposed Development was not to come forward, it is expected that, when also accounting for projected climate change, the Site would remain in its current state, as described in **Chapter 2: Site Description** of this ES. For the purposes of this assessment, the future baseline is therefore also assumed to be zero emissions. The natural evolution of the Site and surrounding area has been qualitatively considered.

10.74 Under the UK Climate Change Act, the UK Government has committed to the achievement of net zero GHG emissions by 2050. The trend across all sectors for reducing GHG emissions will therefore continue into the future to ensure this target is met.

10.75 Whilst new development within the area surrounding the Site will result in an incremental increase in baseline GHG emissions in the short term, when accounting for the projected decarbonisation of the National Grid, the increased take up of and improvements to low and zero carbon transport

technology, and improvements to building design and systems, it is likely that the UK will achieve the net zero GHG emissions target by 2050 required by the UK Climate Change Act.

Establishing Baseline Conditions: Climate Change Resilience

Existing Baseline

10.76 A baseline year of 2020 has been used because the most up-to-date Met Office data[xxiv] available at the time of writing comprises an averaged 30-year (1991 – 2020) dataset.

10.77 For the Climate Change Resilience assessment, the baseline represents the average climatic conditions at the Site in the existing case. This has been established through the use of Met Office data, which has enabled the compilation of a current climate baseline for the wider region within which the Site is located.

Future Baseline

10.78 The future baseline employed within the Climate Change Resilience assessment has been established in line with the ISEP 'Guide to Climate Change Resilience and Adaption', as set out below.

10.79 The UKCP18 project has been reviewed to establish an appropriate future baseline. The assessment has established the climatic data surrounding current seasonal temperatures and precipitation from the Met Office. This data has been used to analyse the current climate and compare these findings, in relation to the Proposed Development, to the RCPs used in the UKCP18. The RCPs reflect the concentration of GHGs that have been modelled to occur within the global atmosphere in the year 2100.

10.80 Due to inherent uncertainties associated with the projection of future climate and that the modelling undertaken to support the UKCP18 project is underpinned by vast datasets, the 'UKCP18 Factsheet: Derived Projections'xxv has been used to establish the future baseline used in this assessment. This Factsheet provides a clear summary of the data employed within the UKCP18 project, as well as the assumptions made and associated limitations.

10.81 A future assessment timeframe of 2081 to 2100 has been used, as this represents a period within which the Proposed Development, with an assumed lifespan of 60 years, is expected to still be in operation.

Baseline Conditions: GHG Emissions

10.82 The Site the existing Cardiff Park and Ride East, areas of woodland (including Ancient Woodland and TPO trees) and amenity/scrub land with Public Rights of Way (PRoW) and informal footpaths. For the purposes of this assessment, however, a zero-emission baseline has been adopted to ensure a worst-case scenario is considered.

10.83 To understand the trends in GHG emissions within Cardiff, a review of emissions associated with transport, domestic and industrial/commercial uses has been undertaken for the period 2005 to 2023 and is displayed in **Table 10.12**, below. This review has employed the UK Local Authority and regional GHG emissions national statistics, published by DESNZ in 2025.

Table 10.12 Historic GHG Emissions within Cardiff

Year	Industry and Commercial Total ($ktCO_2$)	Domestic Total ($ktCO_2$)	Transport Total ($ktCO_2$)	Grand Total ($ktCO_2$)	Population ('000s; mid-year estimate)	Per Capita Emissions (tonnes CO_2)
2005	1,082.5	628.3	727.6	2,480.4	345.4	7.2
2006	901.3	678.7	730.3	2,665.5	348.1	7.7
2007	888.1	660.0	721.0	2,557.1	350.0	7.3
2008	898.4	554.6	737.4	2,261.2	350.9	6.4
2009	840.2	529.3	739.1	2,129.1	351.6	6.1
2010	855.6	502.3	760.9	2,053.3	353.0	5.8
2011	697.4	472.7	746.8	1,985.5	354.3	5.6
2012	839.3	467.8	745.9	1,900.9	355.1	5.4
2013	776.0	449.4	724.0	1,818.7	357.1	5.1
2014	683.5	440.4	598.1	1,618.9	360.3	4.5
2015	627.5	445.3	672.9	1,803.2	359.8	5.0
2016	580.5	385.8	679.5	1,667.2	371.1	4.5
2017	486.9	361.6	681.6	1,551.1	383.5	4.0
2018	492.1	628.3	727.6	2,480.4	345.4	7.2
2019	448.3	678.7	730.3	2,665.5	348.1	7.7
2020	390.5	660.0	721.0	2,557.1	350.0	7.3
2021	436.7	554.6	737.4	2,261.2	350.9	6.4
2022	391.8	529.3	739.1	2,129.1	351.6	6.1
2023	349.6	502.3	760.9	2,053.3	353.0	5.8

10.84 When considering GHG emissions in the context of population growth, the above demonstrates that there has been a reduction in per capita emissions over the past 19 years. It is therefore expected that this trend will continue.

Baseline Conditions: Climate Change Resilience

10.85 Met Office data for the region within which the Site is located has been compiled to establish the baseline conditions at the Site. Regional data for Wales over a 30-year averaging period (1991 – 2020) compiled by the Met Office in 2016[xxvi] is presented within **Table 10.13** below. The mountainous nature of the landscape in Wales means that large areas are only sparsely populated, with most of the settlements on or near the coast and in the southernmost counties, where almost half the

population lives. Wales has an essentially maritime climate, characterised by weather that is often cloudy, wet and windy but mild. However, the shape of the coastline and the central spine of high ground from Snowdonia southwards to the Brecon Beacons introduce localised differences. This information has been used, in part, to establish the baseline against which the potential vulnerability of the Proposed Development to projected climate change may be assessed.

Table 10.13 Climate Baseline for Wales (1981 – 2010)

Climate Variable	Description
Temperature	Mean daily minimum temperatures can range from 0°C to 4°C in winter, whilst summer mean daily maximum temperatures are in the region of 17°C to 21°C.
Rainfall	Rainfall in Wales varies widely, with the highest average annual totals being recorded in the central upland spine from Snowdonia to the Brecon Beacons. Snowdonia is the wettest area with average annual totals exceeding 3,000mm. In contrast, places along the coast and, particularly, close to the border with England, are drier, receiving less than 1,000mm of rainfall a year. Over much of Wales, the number of days with a rainfall total of 1mm or more ('wet days') tends to follow a pattern similar to the monthly rainfall totals. In the higher parts, over 50 days is the norm in winter (December to February) and over 35 days in summer (June to August). In the driest areas of the east and south, about 40 days in winter and about 25 days in summer are typical.
Wind	Wales is one of the windier parts of the UK, with the windiest areas being over the highest ground and along the coasts, particularly those facing directions between north-west and south.
Sunshine	The hilly nature of the terrain in Wales and its proximity to the Atlantic tends to encourage cloud cover. Even so, the south-western coastal strip of Pembrokeshire receives an average annual sunshine total of over 1,700 hours. Conversely, the dullest parts of Wales are the mountainous areas, with average totals of less than 1,200 hours of sunshine.
Snow Fall	Snow is comparatively rare near sea level in Wales, but much more frequent over the hills. The average number of days each year when sleet or snow falls varies from 10 or less in south-western coastal areas to over 30 in Snowdonia.

10.86 In addition to the above, meteorological data from the Cardiff, Bute Park climate station, which is the nearest Met Office[xxvii] climate station to the Site, has been obtained over a 30-year averaging period (1991 – 2020). This data has been used to further inform the climate baseline for the Site, as set out in **Table 10.14** below.

Table 10.14 Climate Baseline for Cardiff, Bute Park (1991 – 2020)

Climate Variable	Description

Temperature	Mean daily minimum temperatures can range from 2.5°C to 2.8°C in winter, whilst summer mean daily maximum temperatures are in the region of 20.1°C to 21.8°C.
Rainfall	The region received an average of 1,203mm of rainfall annually across the study period.
Wind	Whilst no data is provided for Cardiff, Bute Park specifically, the annual mean wind speed recorded within South Wales and South-west England across the study period was 9.31 knots, with the lowest mean wind speeds recorded in August (7.91 knots), and the highest in January (10.80 knots)
Sunshine	Across the study period, an average of 1,573 annual sunshine hours were received.
Air Frost	On average, air frost was recorded on 32.9 days of the year across the study period.

Receptors

10.87 A list of existing and future receptors is included in **Table 10.15**.

Table 10.15 Existing and Future Sensitive Receptors

Receptor	Sensitivity
GHG Emissions: Existing and Future Receptors	
Global Climate	High
Climate Change Resilience: Existing Receptors	
All receptors identified within **Chapters 4 to 9:**	Negligible to High
Chapter 4: Air Quality	
R1 – Glan-Yr-Afon Primary School	High
R2 – 247 Bryn Celyn Road	High
R3 – St Cadoc's RC Primary School	High
R4 – 263 Ball Road	High
R5 – 6 Ball Lane	High
R6 – Bryn Hafod Primary School	High
R7 – St Teilo's Church in Wales High School	High
R8 – 20 King Wood Close	High
R9 – 2 Seaview Cottages Newport Road	High
R10 – Quarry Hill Care Home	High
R11 – 850 Newport Road	High
R12 – Medical Care	High
R13 – 611 Newport Road	High

R14 – 11 Pant Glass	High
Chapter 5: Ecology	
Special Area of Conservation (SAC), Special Protection Area (SPA) and Ramsar	High
Rhymney River Site of Importance for Conservation (SINC)	High
Ancient Semi-Natural Woodland (ASNW)	High
Natural habitats on site – semi-natural broadleaved woodland, dense scrub, scattered scrub, broadleaved parkland / scattered trees and poor semi-improved grassland	Medium
Bats	High
Birds	Medium
Otter	Medium
Reptiles	Medium
Badger	Medium
Dormouse	High
Hedgehog	Medium
Great Crested Newt (GCN)	Negligible
Amphibians (excluding GCN)	Low
Invertebrates	Low
Invasive Non-Native Species (INNS)	N/A
Chapter 6: Landscape and Visual Impact	
Site: Natural / Physical Landscape	Low to Medium
Site: Cultural / Social Landscape	Low to Medium
Site: Perceptual Landscape	Low
CRDFFVS051 Rhymney Valley floor and sides: Natural / Physical Landscape	Medium
CRDFFVS051 Rhymney Valley floor and sides: Cultural / Social Landscape	Low to Medium
CRDFFVS051 Rhymney Valley floor and sides: Perceptual Landscape	Low
CRDFFLH010 River Rhymney and surrounds: Natural / Physical Landscape	Medium
CRDFFCL015 Rhymney Valley Corridor: Cultural / Social Landscape	Medium
Viewpoints 1 to 13	Low to Medium
Chapter 7: Socio-Economics	
Local Economy	Low
Employment	Medium
Socio-Economic Profile	High
Chapter 8: Transport	
Eastern Avenue Slip Roads (N)	Low

Pentwyn Road	Low
Bryn Celyn Road	Low
Eastern Avenue Slip Roads	Low
Park & Ride Access (existing)	Low
Ball Road (N)	Low
Ball Road (S)	Low
Chapter 9: Water Resources and Flood Risk	
Existing Residential Properties	High
Third Party Landowners	High
Park and Ride Visitors / Employees	Low
Ball Lane Footbridge	Low
Playing Fields and Public Open Space	Low
River Rhymney	Medium
River Rhymney Section SSSI	High
Severn Estuary Ramsar, SAC & SPA	High
Nant Glandulas	Low
Nant Pontprennau	Low
Climate Change Resilience: Future Receptors	
Proposed Development	High
Construction employees and future Site users	High
Construction operations	Medium
Site infrastructure	Medium
Site habitats and species	High
All receptors identified within **Chapters 4 to 9:**	Negligible to High
Chapter 4: Air Quality	
R1 – Glan-Yr-Afon Primary School	High
R2 – 247 Bryn Celyn Road	High
R3 – St Cadoc's RC Primary School	High
R4 – 263 Ball Road	High
R5 – 6 Ball Lane	High
R6 – Bryn Hafod Primary School	High
R7 – St Teilo's Church in Wales High School	High
R8 – 20 King Wood Close	High
R9 – 2 Seaview Cottages Newport Road	High
R10 – Quarry Hill Care Home	High
R11 – 850 Newport Road	High

R12 – Medical Care	High
R13 – 611 Newport Road	High
R14 – 11 Pant Glass	High
Chapter 5: Ecology	
SAC, SPA and Ramsar	High
Rhymney River SINC	High
ASNW	High
Natural habitats on site – semi-natural broadleaved woodland, dense scrub, scattered scrub, broadleaved parkland / scattered trees and poor semi-improved grassland	Medium
Bats	High
Birds	Medium
Otter	Medium
Reptiles	Medium
Badger	Medium
Dormouse	High
Hedgehog	Medium
GCN	Negligible
Amphibians (excluding GCN)	Low
Invertebrates	Low
INNS	N/A
Chapter 6: Landscape and Visual Impact	
Site: Natural / Physical Landscape	Low to Medium
Site: Cultural / Social Landscape	Low to Medium
Site: Perceptual Landscape	Low
CRDFFVS051 Rhymney Valley floor and sides: Natural / Physical Landscape	Medium
CRDFFVS051 Rhymney Valley floor and sides: Cultural / Social Landscape	Low to Medium
CRDFFVS051 Rhymney Valley floor and sides: Perceptual Landscape	Low
CRDFFLH010 River Rhymney and surrounds: Natural / Physical Landscape	Medium
CRDFFCL015 Rhymney Valley Corridor: Cultural / Social Landscape	Medium
Viewpoints 1 to 13	Low to Medium
Chapter 7: Socio-Economics	
Local Economy	Low
Employment	Medium
Socio-Economic Profile	High

Chapter 8: Transport	
Eastern Avenue Slip Roads (N)	Low
Pentwyn Road	Low
Bryn Celyn Road	Low
Eastern Avenue Slip Roads (S)	Low
New Link Road	Low
Ball Road (N)	Low
Ball Road (S)	Low
Chapter 9: Water Resources and Flood Risk	
Proposed Development Visitors / Employees	High
Proposed Viaduct	Low

Future Baseline: GHG Emissions

10.88 When considering the trends in GHG emissions presented in **Table 10.12** above, as well as the legal, and proposed, GHG emissions limits set for the UK outlined in **Table 10.7**, the requirements of the UK Climate Change Act to achieve net zero by 2050 and the policy support for reducing GHG emissions, it is considered that future GHG emissions reductions would occur. It is anticipated that these reductions would occur as a result of, for example, the replacement of petrol and diesel as the primary fuel for vehicles with electricity, the uptake of smart technology to reduce energy demand, and the projected decarbonisation of the National Grid.

10.89 When accounting for the projected decarbonisation of the National Grid, it can be expected that future GHG emissions would reduce such that the future baseline would align with the carbon budgets set out within **Table 10.7** above.

Future Baseline: Climate Change Resilience

10.90 The UKCP18 project includes four RCPs: RCP2.6, RCP4.5, RCP6.0 and RCP8.5. For the purposes of this assessment, RCP8.5 has been used as this represents the most conservative and highest-impact scenario. As detailed within the ISEP 'Guide to Climate Change Resilience and Adaption Guidance', the choice of RCP and the time period for which climate projections selected are an important step in establishing the future baseline considered as part of the assessment.

10.91 The future baseline established for this assessment, and as set out within the 'UKCP18 Factsheet: Derived Projections', is as follows, assuming a 2°C increase in global mean temperature:

- For temperature:
  - the largest warming in the UK will be in the South East where summer temperatures may increase another 3 to 4°C relative to the present day (1981 – 2000);

- median warming will be at least 1 to 2°C throughout the year across the whole of the UK;
- winter cool days will warm by 1 to 1.5°C across the country, whilst temperatures on warmer winter days will increase by less than 1°C; and
- in summer, both hot and cool days will warm by 1 to 1.5°C across Scotland, and 1.5 to 2°C across England.

- For precipitation:
  - changes are uncertain, but suggest slightly wetter winters and drier summers, with summer drying more in the South; and
  - dry days in summer will have 30% less precipitation in parts of the South West.

10.92 Future baseline climate conditions for the Site have been established using the Met Office's most up to date climate projections UKCP18 for the 25km OS grid square within which the Site is located (312500, 187500). These projections detail forecast changes relative to the 1981 – 2010 baseline conditions for annual and seasonal temperatures and rainfall, whilst also considering sea level rise and changes to wind speeds. In line with the ISEP 'Guide to Climate Change Resilience and Adaption Guidance', projections are taken from the 'high' emissions scenario (RCP8.5), 50th percentile (median) scenario for the 2050s and 2080s. The projected changes are set out in **Table 10.16** below:

Table 10.16 Future Climate Baseline

Description	Baseline	2050s		2080s	
		Change to Baseline	Future Baseline	Change to Baseline	Future Baseline
Maximum summer temperature (°C)	21.10	+2.91	24.01	+5.37	26.47
Minimum winter temperature (°C)	2.60	+1.43	4.03	+2.74	5.34
Summer rainfall (mm per month)	87.31	-21.39%	68.63	-46.62%	46.61
Winter rainfall (mm per month)	119.84	+8.36%	129.86	+22.31%	146.58

10.93 Over this period, and as demonstrated in **Table 10.17** below, the general projected trends are to be a move towards warmer, wetter winters, and hotter, drier summers. However, natural variations in climate will continue to result in some cold winters, some dry winters, some cool summers and some wet summers. The table below displays trends relative to the present day, which for the purposes of this assessment falls within the reference period of 1991 – 2020. Whilst the table below presents the general trends across the UK as a whole, with the Site located within Cardiff, Wales has been selected as the most appropriate geographical location for consideration within the future assessment.

Table 10.17 Projected Trends in Climatic Variables

Variable	Projected change in trend at		
	10th percentile	50th percentile	90th percentile
Temperature			
Mean minimum winter temperature (°C) Mean winter temperature (°C) Mean summer temperature (°C) Mean maximum summer temperature (°C)	↑	↑	↑
Warmest day of summer (°C)	↓		
Precipitation			
Annual mean precipitation (%)	↓	↕	
Mean winter precipitation (%)	↕	↑	
Mean summer precipitation (%)	↓	↓	↑
Wettest day in winter (%)	↕	↑	
Wettest day in summer (%)	↓	↕	
Snow			
Snow fall – winter		↓	
Snow fall – spring		↕	
Sea Level			
Sea level rise (cm)		↑	

Key: ↑ - projected increase in variable; ↓ - projected decrease in variable; ↕ - projected increases and decreases in variable.
Note: The above demonstrates only the projected direction of change in a variable, and does not consider the potential magnitude of change.

Assessment of Effects (Construction and Operational): GHG Emissions

10.94 During the construction works, there is potential for GHG emissions to arise from the sourcing, transportation, fabrication and construction of all materials and products to the Site. The construction works also have the potential to generate GHG emissions through the transportation of waste and materials from the Site, and through embodied carbon within the fabric of building materials. In

addition to the GHG emissions embedded in materials used for construction, GHG emissions will be emitted when transporting materials to the Site.

10.95 During the operation of the Proposed Development, there is potential for GHG emissions to arise from traffic and transport movements within, to and from the Site. GHG emissions will also arise as a result of operational energy use within the Proposed Development, as well as during the maintenance and repair of the buildings.

Environmental Design and Management

Construction Phase

10.96 As detailed within **Chapter 3: Proposed Development, Demolition, Construction and Alternatives**, circular economy principles have been embedded within the design of the Proposed Development and materials will be procured in consideration of sustainability credentials and embodied carbon emissions. This, in addition to the implementation of lean design principles and the preferential use of recycled and reused materials, where appropriate, will aid in ensuring materials with low embodied carbon emissions are employed within the construction of the Proposed Development.

10.97 The land use change[5] resulting from the Proposed Development would not cause an increase in land use related GHG emissions owing to the Proposed Development including extensive landscaping and habitats, such as thicket mix, native hedgerow and species-rich grassland planting.

10.98 The management of construction traffic emissions will aid in reducing associated GHG emissions, as would the sourcing of products within the local area to reduce transportation distances. As detailed within **Chapter 3**, locally sourced materials will be employed where appropriate, which will further aid in mitigating the generation of GHG emissions associated with the transportation of materials to the Site.

Operational Phase

10.99 During the operation of the Proposed Development, transport emissions will be minimised through the delivery of active travel links, including pedestrian and cycle routes throughout the Site, as set out within the Transport Assessment (**Appendix 8.1**), together with the provision of dedicated cycling facilities. This will aid in promoting the preferential use of sustainable and active modes of transport to move away from the use of private, combustion-engine vehicles. Further to this, as within the Transport Assessment (**Appendix 8.1**), electric vehicle charging facilities will be delivered throughout

[5] Land use change can result in GHG emissions through, for example, the removal of habitats such as trees that act as carbon sinks.

the Proposed Development, encouraging the uptake of electric vehicles which, when accounting for the anticipated decarbonisation of the National Grid, will result in zero associated GHG emissions by 2050.

10.100 As set out within **Chapter 3**, the Proposed Development will target the operational energy benchmarks set out within the UKGBC's 'Energy performance targets for net zero carbon offices: Technical report and summary of consultation responses', which will reduce the energy demand and associated GHG emissions of the Proposed Development during its operation. This will be achieved through the employment of a 'fabric first' approach, with energy demand minimised through the specification of low u-values, high levels of air tightness, the minimisation of thermal bridging, and the employment of highly efficient systems and equipment. Further to this, with the exception of the period 2028 to 2031 during which gas turbines will be employed, the Proposed Development will be gas-free. All-electric systems will be employed to deliver space and water heating and, where required, space cooling, throughout. The incorporation of the measures set out within **Chapter 3** will result in significant GHG emissions reductions over the Building Regulations[xxviii] baseline for the Proposed Development, where relevant.

10.101 Further to this, due to the intended employment of electric-only systems, the Proposed Development will benefit from the anticipated decarbonisation of the National Grid, with the intention that, subject to this continued decarbonisation of the National Grid, net-zero CO_2 emissions in operation be achieved by 2050.

10.102 In addition to this, and as set out within **Chapter 3**, the Data Centre uses to be delivered as part of the Proposed Development will be constructed in line with the 2024 Best Practice Guidelines for the EU Code of Conduct on Data Centre Energy Efficiency[xxix]. Measures to be implemented to reduce the energy consumption of the proposed Data Centre uses include:

- The employment of Direct Evaporating Cooling, which predominantly uses outdoor air to cool the servers, and therefore enhances energy efficiency by reducing reliance on energy intensive compressors;
- Elevation of Data Hall temperatures to take advantage of free cooling and maximise efficiency of cooling systems;
- Integration of highly efficient aisle containment systems to maximise cooling efficiency;
- Use of energy-saving Electronically Commutated (EC) fans;
- Provision of low loss transformers (ECO tier 2) to minimise energy losses;
- Incorporation of market-leading, efficient Uninterruptible Power Supply (UPS) systems;
- Employment of direct evaporative Air Handling Units (AHUs) with variable air volume conditioning; and

- Achievement of a PUE no greater than 1.4, through the incorporation of highly efficient computing equipment.

Effects During Construction

10.103 The calculation of the embedded GHG emissions associated with the Proposed Development is shown in **Table 10.18**.

Table 10.18 Calculation of Embedded GHG Emissions from Construction

Use	Proposed Development - Maximum Floorspace GIA (m^2)	RICS GHG Factor ($kg/CO_2e/m^2$)	Embedded GHG Emissions from Construction (tonnes CO_2e)
Data Centre	23,226.5	545	12,658
Admin / Storage	4,862	925	4,497
Substation	2,304	395	910
Total			18,066

10.104 The total embedded GHG emissions from the Proposed Development from construction to practical completion are 18,066 tonnes. Based on the indicative construction programme in **Chapter 3** this equates to 9,033 tonnes CO_2e per year.

10.105 The calculation of construction transport-related GHG emissions is presented in **Table 10.19**.

Table 10.19 Calculation of GHG Emissions from Construction Transport

Mode	2026 Emission Factor per km or passenger.km ($kgCO_2e$)	Distance Travelled across Construction Period (km)*,**	GHG Emissions from Construction Transport (tonnes CO_2e)
LDV	0.256	311,493,600	79.742
HGV	0.891	114,801,260	102.288
Total			182,030

* Assumes an average of 34,003 vehicle movements per year, of which 22,770 are LDVs and 11,233 are HGVs over the construction period (2 years).

** Assumes 365 working days per year as a worst-case scenario.

10.106 The total construction transport GHG emissions from the Proposed Development are 182,030 tonnes CO_2e. Based on the indicative build period to practical completion, this equates to 91,015 tonnes CO_2e per year.

10.107 The total GHG emissions during the construction of the Proposed Development, including the embodied GHG emissions of the materials used and the emissions associated with construction traffic, as described above, and a comparison with the 4th UK carbon budget are presented in **Table 10.20** below.

Table 10.20 GHG Emissions during Construction and Comparisons to the National Carbon Budget

Construction Impact	GHG Emissions (tonnes CO_2e) for Construction Period	Percentage of 4th UK carbon budget (%)
Embodied Carbon of Materials and Plant (Modules A1 – A5)	18,066	0.00093%
Construction Traffic	182,030	0.00933%
Total	200,096	0.01026%

10.108 The total anticipated GHG emissions associated with the construction of the Proposed Development are 200,096 tonnes CO_2e. This is considered to be **negligible** (**not significant**) at a higher spatial (UK) level, equating to 0.01026% of the 4th carbon budget.

Effects Once the Proposed Development is Operational

10.109 The assessment of transport-related GHG emissions for the Proposed Development within the opening year (2028) is presented in **Table 10.21** below.

Table 10.21 Calculation of GHG Emissions from Transport in 2028

Mode	2028 Emission Factor per km or passenger.km Factor ($kgCO_2e$)	Distance Travelled (km)	GHG Emissions from Operational Transport (tonnes CO_2e)
Car	0.163	3,561,579	581
Passenger in Car	0.163	387,270	63
Motorcycle	0.114	23,148	3
Taxi	0.208	20,776	4
Bus/coach	0.104	334,752	35
Rail	0.035	87,556	3
Cycle	-	44,520	-
Walk	-	146,155	-

Total	689

10.110 The total operational transport GHG emissions from the Proposed Development during the opening year are 689 tonnes CO_2e. Based on an assumed 60-year operational lifespan, this equates to 41,310 tonnes CO_2e across the lifetime of the Proposed Development.

10.111 The assessment of regulated operational energy consumption-related GHG emissions for the Proposed Development is presented in **Table 10.22** below.

Table 10.22 Calculation of Annual GHG Emissions from Regulated Operational Energy Consumption

Use	Proposed Development - GIA (m^2)	RIBA Operational Energy Benchmark ($kWh/m^2/year$)	Relevant Carbon Factor ($kgCO_2e/kWh$)	GHG Emissions from Regulated Operational Energy Consumption (tonnes CO_2e)
Data Centre	23,226.5	N/A	N/A	-
Admin / Storage	4,862	90	0.20448 / 0.177000	4,695
Substation	2,304	N/A	N/A	-
Total				4,695

10.112 The total regulated operational energy consumption-related GHG emissions from the Proposed Development are 90 tonnes CO_2e per year for the first four years of operation, and 77 tonnes of CO_2e per year for the remaining assumed period of operation. Based on an assumed 60-year operational lifespan, this equates to 4,695 tonnes CO_2e across the assumed 60-year lifetime of the Proposed Development.

10.113 The assessment of unregulated operational energy consumption-related GHG emissions for the Proposed Development is presented in **Table 10.23** below.

Table 10.23 Calculation of Annual GHG Emissions from Unregulated Operational Energy Consumption

Use	Capacity (MW)	Unregulated Energy Demand (MW)	Unregulated Energy Consumption (MWhr/year)	Relevant Carbon Factor ($kgCO_2e/kWh$)	GHG Emissions from Unregulated Operational Energy Consumption (tonnes CO_2e)
Data Centre	150	210	1,839,600	0.20448 / 0.177000	19,738,761
Admin / Storage	N/A	N/A	N/A	N/A	-
Substation	N/A	N/A	N/A	N/A	-
Total					19,738,761

10.114 The total unregulated operational energy consumption-related GHG emissions from the Proposed Development are 376,161 tonnes CO_2e per year for the first four years of operation, and 325,609 tonnes of CO_2e per year for the remaining assumed period of operation. Based on an assumed 60-year operational lifespan, this equates to 19,738,761 tonnes CO_2e across the assumed 60-year lifetime of the Proposed Development.

10.115 Further to this, GHG emissions will be generated during the maintenance and repair of the buildings. The assessment of maintenance and repair-related GHG emissions for the Proposed Development is presented in **Table 10.24** below.

Table 10.24 Calculation of Embedded GHG Emissions from Maintenance and Repair

Use	Proposed Development - GIA (m^2)	Embedded GHG Emissions from Construction (tonnes CO_2e)	RICS Uplift Factor (%)	GHG Emissions from Maintenance and Repair (tonnes CO_2e)
Data Centre	23,226.5	12,658	200	25,317
Admin / Storage	4,862	4,497	100	4,497
Substation	2,304	910	100	910
Total				29,814

10.116 The total GHG emissions associated with the maintenance and repair of the Proposed Development during its lifetime are 29,814 tonnes. Based on an assumed 60-year operational lifespan, this equates to 497 tonnes CO_2e per year.

10.117 The total GHG emissions during the operation of the Proposed Development, including those arising from operational energy use, transport and maintenance and repair, as described above, and a comparison with the 5th, 6th and proposed 7th UK carbon budgets are presented in **Table 10.25** below.

Table 10.25 GHG Emissions during Operation and Comparisons to the National Carbon Budget

Operational Impact	GHG Emissions (tonnes CO_2e) from Operation	Percentage of 5th UK carbon budget (%)	Percentage of 6th UK carbon budget (%)	Percentage of proposed 7th UK carbon budget (%)
Regulated Operational Energy	4,695	0.00003%	0.00004%	0.00072%
Unregulated Operational Energy	19,738,761	0.18966%	0.30431%	3.04308%
Operational Traffic	41,310	0.00016%	0.00036%	0.00656%
Maintenance and Repair	29,814	0.00012%	0.00026%	0.00474%
Total	19,814,580	0.10640%	0.16936%	3.05510%

10.118 The total anticipated GHG emissions during the operation of the Proposed Development are 19,814,580 tonnes CO_2e.This is considered to be **Moderate Adverse** (**significant**) at a higher spatial (UK) level, equating to 0.10640% of the 5th carbon budget, 0.16936% of the 6th carbon budget and 3.05510% of the proposed 7th carbon budget.

Future Decarbonisation of the National Grid

10.119 Each year, the National Energy System Operator (NESO) publishes Future Energy Scenarios (FES). This is an independent view of a range of future pathways for the whole energy system. Within the 2025 Future Energy Scenarios: Pathways to Net Zero[xxx], a number of pathways are set out for the achievement of a net zero carbon National Grid by 2025, as follows:

- Holistic Transition: this assumes that net zero is met through a mix of electrification and hydrogen, with hydrogen employed around industrial clusters. This represents a high-renewable capacity pathway, with unabated gas dropping sharply.

- Electric Engagement: this assumes that net zero is met largely through electrified demand, with consumers employing smart technologies that reduce energy demand. This pathway requires high nuclear and renewable capacities.
- Hydrogen Evolution: this assumes that net zero is met through fast progress for hydrogen in industry and heat, with widespread access to a national hydrogen network assumed. This pathway sees high levels of hydrogen dispatchable power plants, leading to reduced need for renewable and nuclear capacities.
- Falling short: this assumes that some decarbonisation progress is made, but that this is not at a pace that is sufficient to achieve net zero. This pathway accounts for the current level of low carbon projects in the pipeline and increased policy ambition.

10.120 When applying the 'Hydrogen Evolution' pathway, which is considered to represent the most flexible of the future pathways presented by NESO, this results in the following regulated and unregulated operational energy-related GHG emissions for the Proposed Development:

Table 10.26 Calculation of Annual GHG Emissions from Regulated Operational Energy Consumption – Hydrogen Evolution Pathway

Use	Proposed Development - GIA (m^2)	RIBA Operational Energy Benchmark (kWh/m^2/year)	Relevant Carbon Factor (kgCO_2e/kWh)	GHG Emissions from Regulated Operational Energy Consumption (tonnes CO_2e)
Data Centre	23,226.5	N/A	N/A	-
Admin / Storage	4,862	90	0.20448 / 0.177000	797
Substation	2,304	N/A	N/A	-
Total				797

Table 10.27 Calculation of Annual GHG Emissions from Unregulated Operational Energy Consumption – Hydrogen Evolution Pathway

Use	Capacity (MW)	Unregulated Energy Demand (MW)	Unregulated Energy Consumption (MWhr/year)	Relevant Carbon Factor (kgCO_2e/kWh)	GHG Emissions from Unregulated Operational Energy Consumption (tonnes CO_2e)
Data Centre	150	210	1,839,600	0.20448 / 0.177000	1,848,088

Use	Capacity (MW)	Unregulated Energy Demand (MW)	Unregulated Energy Consumption (MWhr/year)	Relevant Carbon Factor ($kgCO_2e/kWh$)	GHG Emissions from Unregulated Operational Energy Consumption (tonnes CO_2e)
Admin / Storage	N/A	N/A	N/A	N/A	-
Substation	N/A	N/A	N/A	N/A	-
Total					1,848,088

10.121 Accounting for the potential decarbonisation of the National Grid via the 'Hydrogen Evolution Pathway', the total GHG emissions during the operation of the Proposed Development, including those arising from operational energy use, transport and maintenance and repair, as described above, and a comparison with the 5th, 6th and proposed 7th UK carbon budgets are presented in **Table 10.28** below.

Table 10.28 GHG Emissions during Operation and Comparisons to the National Carbon Budget – Hydrogen Evolution Pathway

Operational Impact	GHG Emissions (tonnes CO_2e) from Operation	Percentage of 5th UK carbon budget (%)	Percentage of 6th UK carbon budget (%)	Percentage of proposed 7th UK carbon budget (%)
Regulated Operational Energy	797	0.00002%	0.00002%	0.00003%
Unregulated Operational Energy	1,848,088	0.01285%	0.09001%	0.14163%
Operational Traffic	41,310	0.00016%	0.00036%	0.00656%
Maintenance and Repair	29,814	0.00012%	0.00026%	0.00474%
Total	1,920,010	0.01315%	0.09065%	0.15297%

10.122 When accounting for the potential decarbonisation of the National Grid via the 'Hydrogen Evolution Pathway', the total anticipated GHG emissions during the operation of the Proposed Development are 1,920,010 tonnes CO_2e.This is considered to be **Minor Adverse** (**not significant**) at a higher spatial (UK) level, equating to 0.01315% of the 5th carbon budget, 0.09065% of the 6th carbon budget and 0.15297% of the proposed 7th carbon budget.

10.123 Changes to climatic conditions, combined with the occurrence of more extreme weather events, can lead to a number of effects. These can be considered in terms of the risk that they pose to the Proposed Development and its occupiers directly, or in terms of the potential for in-combination effects with other anticipated impacts, as identified within the other chapters of this ES.

10.124 Based on the above UKCP data, the key climate change hazards for Wales are as follows:

- Construction phase:
  - Increase in the number of extremely hot days; and
  - Climate changes in 2020 – 2044 time period and increased probability of extreme weather events.
- Operational phase:
  - Increased number of extremely hot days;
  - Extremely cold weather;
  - Increased frequency of flooding from river, surface and ground sources;
  - Increased risk of drought;
  - Extreme wind speeds; and
  - Increased risk of lightning strikes.

Environmental Design and Management

Construction Phase

10.125 The following measures have been embedded within the design and construction of the Proposed Development to ensure the risk to sensitive receptors present at the Site during the construction phase is reduced as far as possible:

- Robust materials will be employed in the construction of roads and pavements;
- Foundations will be constructed in line with the requirements of the Building Regulations; and
- Where required, earthworks will be undertaken in line with the guidance and requirements set out in the relevant British Standard(s).

Operational Phase

10.126 The following measures have been embedded within the design of the Proposed Development to ensure the risk to sensitive receptors present at the Site during the operation of the Proposed Development is reduced as far as possible:

- Robust materials will be employed in the construction of roads and pavements;
- A site-wide surface water management system will be integrated within the Proposed Development to manage surface water runoff. The Surface Water Drainage Strategy (SWDS), set out within the Flood Consequences Assessment (**Appendix 9.1**) and the Drainage Strategy (**Appendix 9.2**), has been designed to account for flood risk and climate change;
- Projected heat and rainfall stresses across the next 60 years will be incorporated within the detailed structural design of all buildings, in line with the requirements of the Building Regulations;
- The Proposed Development will include a diversity of habitats and species. Plants will be drought-resistant, where feasible;
- Facilities for rainwater harvesting will be provided, to reduce demand on potable water supplies by enabling the collection of rainwater for non-potable purposes;
- The Proposed Development would include the provision of green and blue infrastructure and incorporate trees to provide shade; and
- Whilst a detailed design matter, buildings would include passive cooling measures, supported by mechanical ventilation or cooling where required.

Effects During Construction

10.127 The Climate Change Resilience assessment undertaken for the construction of the Proposed Development is set out in **Table 10.29** below.

Table 10.29 Climate Change Resilience Assessment for the Construction of the Proposed Development

Receptor	Aspect	Potential Effect to Proposed Development (Impact)	Embedded Design Measures	Likelihood Category	Consequence of Impact	Significance
Pavements and Road Infrastructure	Laying of surface dressing, micro-surfacing and other temperature susceptible materials	During extended periods of hot, sunny conditions, asphalt can remain workable for a considerable time, making it difficult to maintain profile during compaction.	Employment of robust materials for the construction of roads and pavements.	Very High	Negligible	Not Significant
Geotechnical Conditions	Workforce	An increase in mean temperature and a decrease in summer precipitation has the potential to lead to health risks associated with overheating and dehydration.	Climatic conditions will be assessed on a day-to-day basis, while identification of physical risks constantly observed and mitigated. Provision of potable water supplies, shaded refuge and sufficient ventilation for temporary Site accommodation will be delivered in compliance with the Construction (Design and Management) Regulations 2015 (CDM Regulations)[31].	Very High	Negligible	Not Significant
Buildings	Wind actions	An increase in wind speed has the potential to increase the risk of disruption to construction works, with the potential that the Site would be unable to operate during times of high winds.	Whilst there is no specific projection of the effects of climate change with respect to high wind speeds or the intensity of storms at the Site, working conditions will be assessed each day, in compliance with the CDM Regulations.	Medium	Negligible	Not Significant
	Increased thermal range giving rise to increased earth pressures for buildings	Increases in mean temperatures, as well as extreme temperatures, have the potential to result in stronger fill materials being required within the foundations of buildings, which could increase the quantities of excavated materials becoming waste.	Foundations will be constructed in line with the requirements of the Building Regulations, accounting for the British Standard BS 8004:2015+A1:2020: Code of practice for foundations[32].	Very High	Negligible	Not Significant

Receptor	Aspect	Potential Effect to Proposed Development (Impact)	Embedded Design Measures	Likelihood Category	Consequence of Impact	Significance
	Stability of earthworks	Increased volumes of precipitation could increase the risk of earthworks instability, due to the potential susceptibility of fill materials to moisture.	Earthworks will be undertaken in line with the guidance and recommendations set out within British Standard BS EN 16907-1:2018 Earthworks - Principles and general rules[33].	Very High	Negligible	Not Significant
	Earthworks compaction	Increases in extreme temperatures and decreases in summer precipitation may lead to reduced levels of soil moisture, which in turn may lead to a requirement for increased levels of ground compaction.	Climatic conditions will be assessed on day-to-day basis, with soils to be observed prior to the commencement of construction works that may be affected, in compliance with the CDM Regulations.	Very High	Negligible	Not Significant

10.128 On the basis of the inclusion of the embedded measures set out above in accordance with the relevant regulations, the effects of climate change on sensitive receptors during the construction of the Proposed Development are anticipated to be **negligible** (**not significant**).

Completed Development: Climate Change Resilience

10.129 The Climate Change Resilience assessment undertaken for the operational Proposed Development is set out in **Table 10.30** below.

Table 10.30 Climate Change Resilience Assessment for the Proposed Development once Completed

Receptor	Aspect	Potential Effect to Proposed Development (Impact)	Embedded Design Measures	Likelihood Category	Consequence of Impact	Significance
Pavements and Road Infrastructure	Design of foundations	An increase in winter precipitation, or a decrease in summer precipitation, may result in a change in groundwater levels and soil moisture, which has the potential to generate increased ground movements, and soil settlement.	Employment of robust materials for the construction of roads and pavements.	Very High	Negligible	Not Significant
	Materials specifications and construction details	An increase in extreme temperatures, both during the summer and winter, has the potential to put the Proposed Development at risk of an increased degree of surface failure or deterioration. This may include, for example, the creation of uneven internal stresses within concrete paving blocks that can give rise to curling or warping, and which may be compounded by passing traffic. Large changes in temperature also have the potential to generate thermal contraction and expansion within paving slabs that may generate large longitudinal internal stresses and excessive movement at joints, leading to surface degradation.		Very High	Negligible	Not Significant

	Roads	An increase in the frequency and/ or intensity of storm events may discourage the use of non-motorised forms of transport, such as walking or cycling, to complete journey, which may result in increased numbers of road users.	Sustainable urban drainage systems (SuDS) have been integrated into the Proposed Development to manage surface water drainage. The drainage system would be designed to capture rain falling as close to source as possible, up to and including a 1-in-100 year return period event including an allowance for climate change.	Very High	Negligible	Not Significant
	Pavements	An increase in heavy rain could potentially lead to flooding and closures and diversions of footpaths.		Very High	Negligible	Not Significant
		Large changes in temperatures may result in thermal contraction and expansion of paving slabs, leading to cracking of pavement surfaces, as well as large longitudinal internal stress, and excessive movements at joints.	Employment of robust materials for the construction of roads and pavements.	Very High	Negligible	Not Significant
		Newly laid pavement surfaces may maintain temperatures that are high enough to result in excessive rutting, as well as the embedding of chipping, which may cause a reduction of texture depth.		Very High	Negligible	Not Significant

Geotechnical Conditions	Surface water drainage systems, road-edge drainage, attenuation, outfalls, and drainage ditches	An increase in winter precipitation and a decrease in summer precipitation has the potential to change groundwater levels at the Site, which may increase the risk of flooding from this source, in addition to associated increases in the risk of surface water and fluvial flooding. This could result in a need for additional drainage and the use of stronger materials.	SuDS have been integrated into the Proposed Development to manage surface water drainage and takes into account the groundwater conditions identified on the Site. The drainage system would be designed to capture rain falling as close to source as possible, up to and including a 1 in 100 year return period event including an allowance for climate change.	Very High	Negligible	Not Significant
Buildings	Non-domestic buildings	An increase in extreme temperatures may require the use of more robust, and potentially, therefore, more expensive materials, such as joints, bearings and paint systems. There is also potential for increased movement of building elements as a result of increased temperatures, which would require greater consideration when setting gaps. Some buildings have the potential to fail to operate within original design parameters. This could induce failures meaning additional works would then be required to strengthen them.	Projected heat and rainfall stresses across the next 60 years would be incorporated within the detailed structural design of all buildings, in line with the requirements of the Building Regulations.	Very High	Negligible	Not Significant
		Increases in precipitation rates, as well as the frequency and intensity of storm events, could lead to premature deterioration rates for joints, bearings, surfaces and external fabric of buildings, which may lead to an increased risk of building collapse.		Very High	Negligible	Not Significant

		An increase in mean temperatures and increased humidity levels has the potential to lead to an increased need for maintenances for the building fabric and discomfort for the resident (overheating and reduced ventilation).		Very High	Negligible	Not Significant
		Increased precipitation has the potential to lead to isolated flooding (flood damage, damp, mould).		Very High	Negligible	Not Significant
		Increased drought could lead to the subsidence in the buildings.		Very High	Negligible	Not Significant

	Earth pressures and foundation design affected by changes in groundwater levels	An increase in winter precipitation and a decrease in summer precipitation has the potential to change groundwater levels at the Site, which may result in impacts on the foundations of the non-domestic buildings to be delivered as part of the Proposed Development.	The Site is not at risk of groundwater flooding, and the SuDS have been designed to account for climate change. Numerical flood modelling has been undertaken for the Proposed Development to inform suitable design to manage flood risk to the Proposed Development. Ground raising will be undertaken at the Site to ensure that all proposed buildings and the majority of the development area is not predicted to flood during a 1 in 100 year + climate change allowance magnitude flood event. The footprint of the Proposed Development will also be raised to ensure it meets the acceptability criteria for a 1 in 1,000 year + climate change allowance magnitude flood event.	Very High	Negligible	Not Significant
Landscape	Landscape design	A decrease in mean rainfall may lead to drought tolerant trees becoming more prevalent. This may cause a change in the landscape character of the area.	The Proposed Development would include a diversity of habitats and species. Plants would be drought-resistant, where feasible.	Very High	Negligible	Not Significant

		An increase in mean temperature and changes in precipitation patterns may alter the growing characteristics such as soil properties and length of growing season. This may impact the species identified as part of the landscape strategy and thus alter the character of the landscape.		Very High	Negligible	Not Significant
		An increase in precipitation and, as a consequence, a potentially increased risk of flooding, has the potential to adversely impact plants in higher flood risk areas.		Very High	Negligible	Not Significant
		An increase in frequency and intensity of heavy rainfall and flooding events could cause temporary flooding of public open spaces and public realm areas.	The SuDS have been designed to account for flood risk and climate change.	Very High	Negligible	Not Significant
Water	Continuity of water supplies to non-domestic buildings	Increased risk of household and business water supply interruptions during droughts and from burst pipes in cold weather.	Water efficient appliances and systems would be installed throughout the Proposed Development. Facilities for rainwater harvesting would also be provided, to reduce demand on potable water supplies by enabling the collection of rainwater for non-potable purposes. It is intended that direct evaporative AHUs be employed within the Data Centre uses, which will also aid to reduce the consumption of water associated with cooling.	Very High	Negligible	Not Significant

Ecology	Habitats, flora and fauna	An increase in mean temperatures may exceed thresholds for certain habitats and species identified for enhancement as part of the Proposed Development.	The Proposed Development would include a diversity of habitats and species. Plants would be drought-resistant, where feasible.	Very High	Negligible	Not Significant
Human Health	Increased temperatures	An increase in summer average temperatures and the number of days above 30°C could cause overheating in living spaces and could discourage the use of active transport modes.	The Proposed Development would include the provision of green and blue infrastructure and the incorporate trees to provide shade. Whilst a detailed design matter, buildings would include passive cooling measures, supported by mechanical ventilation or cooling where required.	Very High	Negligible	Not Significant

	Changes to precipitation	Wales is expected to experience changes in overall precipitation and the intensity of rainy days. This is expected to impact on the likelihood of surface flooding events.	The SuDS have been designed to account for flood risk and climate change. Numerical flood modelling has been undertaken for the Proposed Development to inform suitable design to manage flood risk to the Proposed Development. Ground raising will be undertaken at the Site to ensure that all proposed buildings and the majority of the development area is not predicted to flood during a 1 in 100 year + climate change allowance magnitude flood event. The footprint of the Proposed Development will also be raised to ensure it meets the acceptability criteria for a 1 in 1,000 year + climate change allowance magnitude flood event.	Very High	Negligible	Not Significant

10.130 It is considered that the consequences of each of the above effects is **negligible**. This is derived from the ISEP definition of negligible included in the ISEP 'Guide to Climate Change Resilience and Adaption Guidance', as follows:

"It is expected that there will be only localised disruption or loss of service. No permanent damage, minor restoration work required: disruption lasting less than one day. Small financial losses and/or slight adverse health or environmental effects".

10.131 On the basis of the above, the likely effects of climate change on the Proposed Development itself during its operation are anticipated to be **negligible** (**not significant**).

In-Combination Climate Change Assessment

10.132 In considering the in-combination climate change effects, the assessment has taken account of both the construction works and the operation of the Proposed Development. It is considered that the Proposed Development would not result in significant in-combination climate change related effects on the receptors in **Table 10.15** above covered within **Chapter 4: Air Quality**.

10.133 Likely significant in-combination climate change related effects have been considered further below for **Chapters 5 to 9** of the ES.

Ecology

10.134 The Proposed Development would include a diversity of plant species which would be drought-resistant, where feasible, as stated in **Chapter 3**.

10.135 Further to this, the Surface Water Drainage Strategy (SWDS), which has been designed in consideration of climate change and is set out within the Flood Consequences Assessment (**Appendix 9.1**) and the Drainage Strategy (**Appendix 9.2**), will include pollution control measures, such as swales, to separate and filter pollutants before surface water is discharged off the Site.

10.136 It is considered that, when accounting for the projected effects of climate change, the conclusions drawn within **Chapter 5: Ecology** will remain unchanged.

Landscape and Visual Impact Assessment

10.137 As detailed within **Chapter 6: Landscape and Visual Impact**, new green infrastructure will be incorporated within the Proposed Development, as per the Landscape Strategy Plan (**Appendix 3.1**), and will serve to provide sustainable drainage systems, as well as providing areas for wildlife. As detailed in **Chapter 3**, species will be selected in consideration of long-term resilience to climate change. This will include a diversity of plant species and landscape areas.

10.138 It is considered that the conclusions drawn within **Chapter 6: Landscape and Visual Impact** will remain unchanged when accounting for the projected effects of climate change.

Socio Economics and Health

10.139 There are several weather and climate aspects that have the potential to vary in the future as a result of climate change:

- The mean average air temperature is expected to increase; and
- The annual volume of precipitation is expected to increase.

10.140 The local economy and levels of employment may be impacted as a result of any economic downturn associated with extreme weather-related worker illness and disruption to travel. However, through the incorporation of the measures detailed in **Tables Table 10.29** and **Table 10.30** above, this risk is not anticipated to change the sensitivity of relevant receptors, nor magnitude of impacts expected to be experienced, when considering the economic and employment opportunities to be delivered as part of the Proposed Development in the context of climate change. It is therefore not anticipated that the beneficial effects of the Proposed Development on the local labour market and the local economy, during both construction and operation, will be altered as a result of climate change. Similarly, the expected beneficial effects of the Proposed Development on deprivation experienced by existing residents are considered to be unchanged in the context of climate change when accounting for the measures detailed within **Tables Table 10.29** and **Table 10.30** above.

10.141 Further to this, the Proposed Development will be designed to comply with the Building Regulations, including the regulations pertinent to internal overheating, and the SWDS, set out within the Flood Consequences Assessment (**Appendix 9.1**) and the Drainage Strategy (**Appendix 9.2**), has been designed to account for climate change. Measures to mitigate the risk of overheating and flooding within the Proposed Development have therefore been embedded within its design. This will ensure that the potential impacts of increased temperatures and volumes of precipitation on the health and wellbeing of existing and future employees and Site users will be mitigated.

10.142 It is considered that, when accounting for the projected effects of climate change, the conclusions drawn within **Chapter 7: Socio-Economics and Health** will remain unchanged.

Transport

10.143 The construction of the Proposed Development, as well as its operation, will result in an increased level of traffic. This, in combination with an increased risk of rainfall and extended periods of increased temperatures associated with future climate change, may cause increased stress on the road network within and surrounding the Site. However, it is expected that through the incorporation of the measures detailed in **Tables Table 10.29** and **Table 10.30** above, this risk is not anticipated to change the sensitivity of relevant receptors, nor magnitude of impacts expected to be experienced,

when considering the effects of the Proposed Development on existing residents, road users, cyclists and pedestrians in the context of climate change:

10.144 It is considered that, when accounting for the projected effects of climate change, the conclusions drawn within **Chapter 8: Transport** will remain unchanged.

Water Resources and Flood Risk

10.145 The Proposed Development would include the changing of ground levels in parts of the Site so that all proposed buildings and the majority of the development area is not predicted to flood during a 1 in 100 year + climate change allowance magnitude flood event. The footprint of the Proposed Development will also be raised to ensure it meets the acceptability criteria for a 1 in 1,000 year + climate change allowance magnitude flood event.

10.146 The SWDS and associated SuDS within the Proposed Development have been designed to account for a 40% increase in rainfall intensity as a result of climate change.

10.147 It is considered that, when accounting for the projected effects of climate change, the conclusions drawn within **Chapter 9: Water Resources and Flood Risk** will remain unchanged.

Mitigation Measures

Mitigation During Construction: GHG Emissions

10.148 In advance of the commencement of enabling and construction works for each phase, a Construction Environmental Management Plan (CEMP) would be submitted to, and approved by, Cardiff City Council for implementation through a suitably worded planning condition.

10.149 Prior to the commencement of the construction of the Proposed Development and at the detailed design stage, consideration should be given to materials with lower associated embodied carbon emissions, for example the sourcing of materials with a high recycled content, or the use of cement with a higher content of fly-ash.

10.150 Consideration should be given to overall quantities of materials used, for example through the inclusion of thinner floor slabs or piles with reduced widths or depths. Care must be taken, however, to consider the need to adapt to climate change and balance this with the opportunities to reduce GHG emissions that are associated with the operation of the Proposed Development, as well as the opportunities to further embed circular economy principles with respect to the safeguarding of opportunities to reuse or better recycle building materials or components. Whilst it is not possible to quantify the effectiveness of applying this mitigation measure at this stage, it is noted that there will be opportunities to reduce the embodied GHG emissions associated with the Proposed Development throughout the continued detailed design process, and that potential measures may be considered as part of future reserved matters applications.

10.151 GHG emissions may be further reduced during the construction of the Proposed Development through the preferential use of construction plant with low operational emissions that has been purchased since the Non-Road Mobile Machinery (NRMM) Directive (97/68/EC)[xxxiv], including subsequent amendments. Additional measures to mitigate the effects associated with construction plant may be implemented through a CEMP.

10.152 Additional measures may also be set out within a CEMP to mitigate GHG emissions associated with construction transport, such as details on the levels of on-Site parking that would be present for construction staff, and measures to encourage the use of public transport for staff travelling to and from the Site. Additional measures to mitigate the effects associated with construction traffic will be implemented through the detailed Construction Traffic Management Plan (CTMP), submitted on appointment of a contractor.

10.153 Measures to mitigate GHG emissions arising as a result of the generation of waste during construction should be set out within the CEMP, in addition to a Site Waste Management Plan (SWMP) and a Materials Management Plan (MMP), both of which would similarly be secured via a suitably worded planning condition. These documents will set out measures related to environmental control and monitoring, as well as those related to the smart procurement of construction materials, such as the local sourcing of materials, the procurement of sustainable products, and the use of off-site manufacturing or pre-fabricated techniques. Targets may also be set to track and monitor against key performance indicators for energy usage and waste production throughout the construction of the Proposed Development. A SWMP may also specifically identify the types of waste generated during construction, and how this waste will be reduced, reused and recycled.

Mitigation Once the Proposed Development is Operational: GHG Emissions

10.154 As a primary objective, it is intended that waste be prevented at source. Waste management will be considered as part of reserved matters applications, ensuring that suitable spaces are provided within the Proposed Development to reduce the generation of waste, and to encourage higher rates of material recycling and reuse.

10.155 Energy monitoring should be undertaken to aid in understanding how the buildings perform in operation, which in turn will contribute to the minimisation of performance gaps, as well as the continued development of knowledge, skills and innovation within the design and construction industry.

Mitigation During Construction: Climate Change Resilience

10.156 No additional mitigation measures are proposed to mitigate the likely effects of climate change during the demolition works and the construction of the Proposed Development, beyond those that will be embedded within the design, and which are outlined in **Table 10.29** above.

Mitigation Once the Proposed Development is Operational: Climate Change Resilience

10.157 As outlined above, no significant in-combination climate change related effects have been identified and no mitigation is considered necessary. However, climate change adaptation and resilience should be considered in detail at the reserved matters application stages.

Residual Effects and Monitoring

10.158 The residual effects arising from the Proposed Development are summarised in **Table 10.31** below.

Table 10.31 Summary of Residual Effects

Effect	Receptor (Sensitivity)	Nature of Effect and Geographic Scale	Magnitude of Impact*	Classification of Effect (Statement of Significance BEFORE mitigation)	Mitigation and Monitoring	Residual Effect
Construction Effects						
GHG Emissions						
Production of GHG emissions	Global Climate (High)	Short and Long Term Local and Global	High	Negligible	Adherence to the CEMP, CTMP, SWMP and MMP	Negligible (not significant)
Climate Change Resilience						
Increased temperatures	Pavement and Road Infrastructure (High)	Short Term Local	Very High	Negligible	N/A	Negligible (not significant)
Increased temperatures and decreased precipitation	Geotechnical Conditions (High)	Short Term Local	Very High	Negligible	Adherence to the CEMP	Negligible (not significant)
Increased mean and extreme temperatures, increased wind speeds, and variation (both increased and decreased) in precipitation	Buildings (High)	Short Term Local	Very High	Negligible	Adherence to the CEMP and SWMP	Negligible (not significant)

Operational Effects						
GHG Emissions						
Production of GHG emissions	Global Climate (High)	Short and Long Term Local and Global	High	Negligible	Monitoring of operational energy usage	Without future National Grid decarbonisation: Moderate Adverse (significant) With future National Grid decarbonisation: Minor Adverse (not significant)
Climate Change Resilience						
Increased extreme temperatures, greater variation in temperatures, and changes to the frequency and magnitude of rainfall and storm events	Pavement and Road Infrastructure (High)	Short and Long Term Local	Very High	Negligible	N/A	Negligible (not significant)
Increased temperatures and changes to the frequency and magnitude of rainfall events	Geotechnical Conditions (High)	Short and Long Term Local	Very High	Negligible	N/A	Negligible (not significant)

Increased mean and extreme temperatures, increased humidity, increased precipitation and increased drought	Buildings (High)	Short and Long Term Local	Very High	Negligible	N/A	Negligible (not significant)
Increased temperatures, variations (both increased and decreased) in precipitation, and increased wind speeds	Landscape (High)	Short and Long Term Local	Very High	Negligible	N/A	Negligible (not significant)
Increased drought and decreased temperatures during the winter	Water (High)	Short and Long Term Local	Very High	Negligible	N/A	Negligible (not significant)
Increased mean temperatures	Ecology (High)	Short and Long Term Local	Very High	Negligible	N/A	Negligible (not significant)
Increased temperatures and variations (both increased and decreased) in precipitation	Human Health (High)	Short and Long Term Local	Very High	Negligible	N/A	Negligible (not significant)

Notes: * incorporating environmental design and management, ** incorporating mitigation and monitoring measures

Likely Significant Environmental Effects

10.159 Whilst the construction of the Proposed Development will result in the production of GHG emissions, it is considered that the GHG emissions associated with the construction works will have a **negligible effect**, and therefore **not significant** effect on the global climate.

10.160 During the operation of the Proposed Development, it is considered that the GHG emissions will have a **Moderate Adverse**, and therefore **significant** effect on the global climate. It is highlighted, however, that this is based on the assumption that there will be no further decarbonisation of the National Grid, with the GHG emissions generated per kWh of energy consumed assumed to remain as per the existing case in 2025. When accounting for the anticipated continued decarbonisation of the National Grid, therefore, it is considered that the Proposed Development will have a **Minor Adverse**, and therefore **not significant** effect on the global climate with respect to GHG emissions.

10.161 With respect to the adaptation of the Proposed Development to the effects of projected climate change, it is considered that there will be **no significant** effects on the sensitive receptors identified this chapter, nor those identified within **Chapters 4** to **9** of this ES.

Summary and Conclusions

10.162 This chapter has considered both how the Proposed Development will mitigate its potential impact on the global climate by reducing GHG emissions throughout its lifetime, as well as how it may be affected by, and in turn adapt to, a changing climate over time.

GHG Emissions

10.163 Due to the lack of data available with respect to the existing energy and transport use of the Site, a zero-emission baseline has been assumed to assess a worst-case scenario.

10.164 In line with relevant guidance, a life cycle assessment methodology has been applied in the undertaking of the GHG emissions assessment, which includes an assessment of the emissions arising from materials, transportation, operational energy, and repairs and refurbishments.

10.165 A range of embedded mitigation measures, which are appropriate to the scale and available opportunities present, are included within the design of the Proposed Development that will aid in minimising GHG emissions. These include, but are not limited to, the employment of highly efficient IT equipment to reduce the unregulated energy demand of the Proposed Development as far as possible, the employment of low carbon and renewable technologies to serve the heating and cooling demands of the Proposed Development, the provision of active and sustainable access, and the employment of robust materials that have low associated embodied carbon emissions within the construction of the buildings.

10.166 The residual effects, following the incorporation of mitigation measures, are considered to be **negligible** (**not significant**) in the context of the UK Carbon Budgets during the construction of the Proposed Development. When assuming that there will be no further decarbonisation of the National Grid, with the GHG emissions generated per kWh of energy consumed assumed to remain as per the existing case in 2025, the residual effects of the Proposed Development during its operation in the context of the UK Carbon Budgets are considered to be **Major Adverse** (**significant**). When accounting for the anticipated continued decarbonisation of the National Grid, however, this effect is considered to be reduced to **Minor Adverse** (**not significant**).

10.167 Additional mitigation measures may be implemented during the construction and the operational phases to further reduce GHG emissions. These measures may include, but are not limited to, the consideration of employing materials with lower associated embodied carbon emissions and the undertaking of energy monitoring during the operation of the Proposed Development.

Climate Change Assessment

10.168 The existing baseline for the Proposed Development has been set according to the weather patterns observed within Wales over the last 30 years. Using a future assessment timeframe covering the years 2081 to 2100, which represents a period over which the Proposed Development is expected to still be in operation, it is anticipated that the general trends of climate change will result in warmer, wetter winters, and hotter, drier summers. It is noted, however, that natural variations will mean that some cold and some dry winters, and some cool and some wet summers will continue to occur.

10.169 The risk associated with climate hazards, and therefore the significance of the associated effect, has been determined based on a combination of likelihood and consequence. The assessment is qualitative, and uses professional judgement based on knowledge of similar schemes, engagement with the wider technical team, and a review of relevant literature.

10.170 A number of embedded mitigation measures, outlined within the technical studies carried out in support of the planning application, have been included for within the design of the Proposed Development.

10.171 Based on the assessment, it is considered that the conclusions drawn within **Chapters 4** to **9** of the ES will be unchanged from the existing scenario when assessed against future projected climate change. It is also concluded that the impacts of climate change on the sensitive receptors identified within this chapter will be **negligible** (**not significant**).

10.172 It is considered that there will be no significant effects with respect to climate change resilience and adaptation.

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